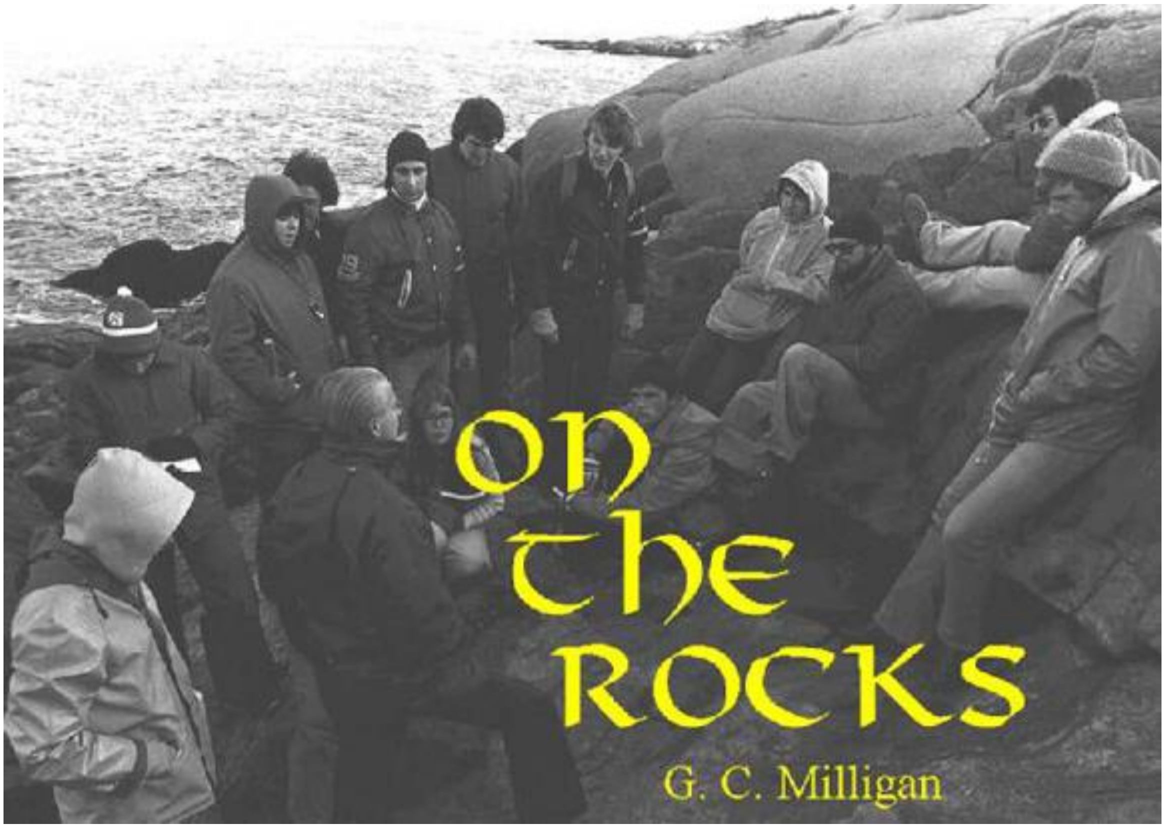


THE TRAINING OF GEOLOGISTS AT DALHOUSIE

DALHOUSIE UNIVERSITY
1995

Distribution License

DalSpace requires agreement to this non-exclusive distribution license before your item can appear on DalSpace.

NON-EXCLUSIVE DISTRIBUTION LICENSE

You (the author(s) or copyright owner) grant to Dalhousie University the non-exclusive right to reproduce and distribute your submission worldwide in any medium.

You agree that Dalhousie University may, without changing the content, reformat the submission for the purpose of preservation.

You also agree that Dalhousie University may keep more than one copy of this submission for purposes of security, back-up and preservation.

You agree that the submission is your original work, and that you have the right to grant the rights contained in this license. You also agree that your submission does not, to the best of your knowledge, infringe upon anyone's copyright.

If the submission contains material for which you do not hold copyright, you agree that you have obtained the unrestricted permission of the copyright owner to grant Dalhousie University the rights required by this license, and that such third-party owned material is clearly identified and acknowledged within the text or content of the submission.

If the submission is based upon work that has been sponsored or supported by an agency or organization other than Dalhousie University, you assert that you have fulfilled any right of review or other obligations required by such contract or agreement.

Dalhousie University will clearly identify your name(s) as the author(s) or owner(s) of the submission, and will not make any alteration to the content of the files that you have submitted.

If you have questions regarding this license please contact the repository manager at dalspace@dal.ca.

Grant the distribution license by signing and dating below.

Name of signatory   Date

CONTENTS

TABLES

FIGURES

APPENDICES

PREFACE

These notes on the history of the Geology department were begun at the request of Dr. Zentilli, who was the chairman of the department at that time.

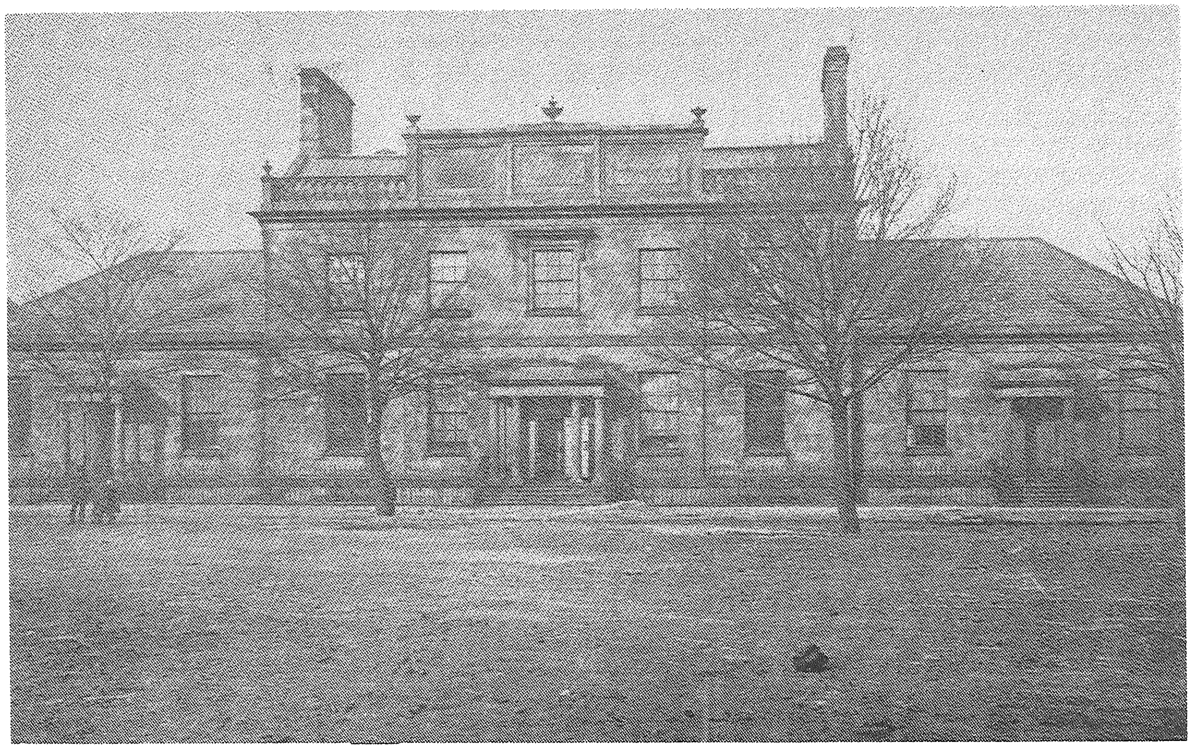
Information has, of course, been drawn from a number of sources. For the early years especially, the minutes of Senate from 1864 to 1955 have been the main source and the University calendars since 1864 have provided details of course programs and related material. Departmental annual reports and the minutes of departmental meetings since 1970 have been examined carefully, but essentially no use has been made of departmental files of correspondence. In fact, such files for all except the last few years appear to be missing. These sources have been supplemented by minutes of meetings of the Faculty of Arts and Science and of certain committees of the Faculty. Minutes of meetings of the Board of Governors have been consulted on a few matters. Statistical and financial data have been drawn from Business Office files now in the University Archives, or have been supplied by the Registrar's office and by the Administrator of the Faculty of Arts and Science. Class enrollments from 1932 to 1971 were obtained by using examination returns to track individuals through their programs.

While financial data are probably sufficiently accurate for present purposes, I am only too well aware that no person not an accountant should venture into old accounts without a "seeing-eye dog", and I have had some difficulty reconciling the data. When the "Financial Statement" shows for the Faculty a surplus of $590,500 for one year, and the same expenditures, re-worked a year later, convert the surplus to a loss of $5,170,000, there has obviously been a change of accounting procedure, but lesser discrepancies may be inexplicable to the uninitiated. When figures for what appear to be identical expenditures are obtained from different sources, they almost never agree; such have been reconciled as seemed best on the advice available.

For assistance willingly rendered, I extend sincere thanks to the staff of the Registrar's office, especially Mary McGillivray; to Don Miller, the Administrator of the Faculty of Arts and Science; to Dr. Charles Armour, the University Archivist; to Dianne Crouse, and to the staff of the Geology Department. Special thanks go to Norma Keeping, who has patiently typed the manuscript and dealt with the nearly endless amendments and corrections thereto.

G. C. M.

April, 1994



OLD DALHOUSIE COLLEGE

1

FIRST GEOLOGY PROGRAM AT DALHOUSIE

Dalhousie was established in 1818 and a building for it was begun in 1820, but the College had a number of problems and was closed in 1845. It was reopened in 1863, and has operated since that time. Although classes in mineralogy were taught from the beginning as part of the Chemistry program, Rev. Dr. David Honeyman, the first, but unpaid and part-time, "Professor of Geology, Paleontology and Mineralogy" was not appointed till 1879, when a Department of Science was set up in the College. Geology was then a one-man operation and such it continued to be for 75 years. Obviously there would be many changes during that time, but some traces of the former objectives, educational philosophy, and procedures could still be recognized by students in the department in 1954.

What sort of situation would a student find in the Geology class of 1879?

Character of the College

Location

When the College was resurrected in 1863, the single building that had been built for it was already 40 years old. The building was at the north end of the Grand Parade, where City Hall now stands. On the hill above it were the buildings of the garrison and below it were the business establishments, so the College was, almost literally, in the middle of the town. It remained there until it moved to the Forrest Building, in October 1887.

The building had been used for many things during the period prior to 1863 and continued to be so used, even after it was finally occupied by the College. A portion was occupied by the Mechanics Museum (the distant ancestor of the Nova Scotia Museum) from 1845 to 1849. It is not clear whether the Museum had been removed from the building for an interval, but it was certainly there in 1867, because the "removal of the Mechanics Museum" was a necessary preliminary to use of the "Museum Room" as a library.

In 1903, George Patterson described in the *Gazette* the College building as he had known it as a student between 1878 and 1882, the period when Honeyman was the Professor of Geology. Part of the lowest floor, two levels below the surface of the Parade, and facing Barrington Street, was rented and used as a shop. The northwest part of the same floor was the storage vault of Olands Brewery, with entrance on Duke Street and no direct connection to the College - no doubt to the chagrin of mischievous students. This section was reorganized as a gymnasium in 1880. On the second floor, and still below the level of the Parade and to the left of the main entrance, lived the janitor and his family. The janitor also "moonlighted" as a postman. To the right of the entrance were two students' rooms; one was a reading room, and the other Patterson described as a "loafing place" where the students hatched their mischief. On the main floor, at Parade level, at the east end was the library, where the classes in English and Modern Languages were held and where Honeyman held his Geology classes. At the west end was the Chemistry class-room. On the long hall between were two offices, for the Professor of Classics and for the Principal. On the fourth floor was an office, the Physics class-room and laboratory and, at the other end, the room where, according to Patterson, Charles Macdonald had for years made Math interesting. (This was the man who is commemorated by the Macdonald Library building). After the early 1870's the fifth floor held the Chemistry laboratory. It is perhaps worth nothing that Patterson explains in the *Gazette* how he almost was on that floor once, but that he never did actually see the Chemistry lab.

Regulations

Although they were training their students to be the leaders in the growing colony, the staff of the College had no illusions about the guidance required by these young gentlemen. So there were regulations: In the late twentieth century, white shoes and blue denim jeans are the student's uniform; in the nineteenth, every student attending more than one class was required to provide for himself a cap and gown, to wear them to classes, and also going to and from the College. "While in the College and going to and from it, students must conduct themselves in an orderly manner" and, judging by some of the cases that came before the Senate, the staff had very definite views about what constituted disorder. For example, in 1880 four students were fined 25 cents each for appearing at examinations without their gowns. In the summer session of the same year, damage to the students' room, and delay by the students in making the required repairs, resulted in the threat by Senate that the "Session be immediately closed and no terminal examinations held." Dropping snuff from a gallery onto Convocation was frowned upon and, on another occasion, a rough-house, where small bags of flour were thrown about, involved the President in a mini-mutiny. Attendance and punctuality were considered important, and persistent absence or tardiness could, and did, disqualify a student.

Nowadays the University does not consider itself *in loco parentis*, but at that time it took that responsibility seriously. Consequently, students who were not living with a parent or guardian were required to report their place of residence, and the Principal might "disallow such residence if he see good cause". Every student was expected to attend divine service on Sunday.

Then, as now, plagiarism was a serious crime. In 1909, a student submitted an exercise in the Physics laboratory in which he used the results his brother had obtained in a former year. Senate ruled "that the work done by him in all classes during the present session together with his attendance in them, be disallowed and that he be allowed to enter again only upon probation, and that his continued attendance thereafter at the University be conditional upon reports on his conduct and work".

Academic Years and Fees

In 1864, the "winter session" began on 19 October and ended late in April. It was followed by a "spring session", which ended on 28 June, 1865. The six-month winter session was extended to seven months in 1883 and, in 1887, Senate recommended an increase to eight months, but it is not clear when that action was taken.

The degree program required attendance at four winter sessions, or three winter sessions plus three summer sessions. The summer session was evidently regarded as optional, offered reduced numbers of classes and, in many years, was cancelled because of lack of students. In 1864, the student body totalled twenty-five, consisting of "undergraduate" and "occasional" students. The latter were not required to pass any entrance examination and could attend any classes they chose. They were not candidates for the B.A. degree - the only one then offered - at the end of the course. It appears that "occasional" students were later known as "general" students. By 1876 the enrollment was 94.

Fees are always a matter of concern. Fees were payable "and tickets issued" on the first day of lecture in the session.

"The fee to each Professor, whose class or classes a Student attends, is *six dollars* for the Winter Session; and *four dollars* for the Summer Session; or *eight dollars* for both". Apparently the fees were paid directly to the professor, and the "ticket" was an accounting mechanism for registration purposes. There was also a special provision that an undergraduate who had paid fees twice, either to the Professor of Classics or Mathematics, could attend the classes of those professors during the remainder of the undergraduate course without paying an additional fee. This all worked out so that, in the first year for example, the three classes required, (Classics, Mathematics, and Rhetoric) at six dollars each, plus two dollars matriculation fee, made the total of $20 for the year. For the second year the total fee was $24, for four classes. The special provision for Classics and Mathematics seems to have taken effect then; for third year the fee was $12 and for the fourth only $6. There were some scholarships that provided free tuition; they were awarded on the basis of examination. If we try converting these fees via the gold standard then in use, the first year fee is equivalent to about $500 today.

Examinations and Grades

All educational institutions regard examinations as a necessary evil. Students consider them an important, if unpleasant, hurdle and are concerned about grade requirements. In 1865, the passing grade was "a Third Part of the value of the Examination Exercise in that Subject". Apparently this came to be interpreted as 30 per cent for, in February, 1903, Senate "agreed that the percentage required for securing a 'Pass' in the subject required for the Engineering degree be 40 instead of the 30 required for the Arts and Science degrees, and that for Distinction of the Second Class 60 per cent be required; and for the First Class 75%, and for a High First 85% in those subjects in which no additional work is prescribed for Distinction".

The passing grade was later raised to 40 per cent and remained at that value till 1948, when it was raised to 50 per cent, where it remains today --except that it is now called "D".

A passing grade of 30 per cent may strike us now as very low and easy of attainment, but a very great deal depends upon the performance demanded. It is very improbable that the instructors of the day even considered fitting grades in such small classes to any kind of probability curve, as some now do. It is inconceivable that a student in those small classes could attend no lectures, do no exercises, write no examinations and get a "B" grade, as has happened in the not very distant past. Even when the minimum passing grade was 40, it was rare to have many marks greater than 65 per cent. A sampling of five large classes in 1935, for example, shows the following:

An extract from the minutes of Senate:

Some damage had been done to the Student's Room; representatives of the students had been brought before Senate and after due enquiry, they had been informed that repairs must be made, by the students, forthwith.

Dalhousie College
June 26th 1880

This day the Senate met; the Rev. Principal Ross in the chair. Present Professors Lyall, Johnson and Macdonald.

In reference to the minute of Senate of June 19th. it was found that no repairs had been executed in the Students Room but that certain cuttings of the wood work had been puttied up. Whereupon it was resolved that the students be informed that some one of their number must appear before the Senate on Monday June 28th at 10 o'clock A.M. to give guarantee that the repairs shall be satisfactorily executed; that for this purpose the Examinations in Latin be postponed till 2 o'clock P.M. on Monday and that failing such appearance and guarantee the Session be immediately closed and no terminal Examinations held; and that if the ~~...~~ repairs are not executed within this week (Commencing June 28th.) this Summer Session be cancelled. It was further agreed that the guarantee required should be Five dollars, to be deposited with the Principal on Monday June 28th at 10 o'clock A.M. and to be returned when the repairs are made. Professor Johnson undertook to communicate this resolution to the Students.

The Senate adjourned till June 28th, 10 o'clock A.M.

James Ross, Principal
C. Macdonald, Recording Secy, pro tem.

One should note that, in 1880, the entire tuition fees for a first year student were $20.00.

Class	Examiner	N	X	Highest Mark	>80	70-79	60-69	F
English 2	Bennet	106	52.7	85*	1	3	10	11
History 1	Wilson	53	55.0	85*	1	5	12	4
Math 1	Adshead Walmsley	94	41.7	96	3	1	10	33
Physics 1	Johnstone	55	48.8	87	3	3	8	13
Chem 1	Nickerson	90	46.3	78 (2)	-	4	15	21
		398	48.4					
Geology 1	Douglas	29	57.5	86	1	6	9	2

* Same individual

Douglas was evidently more generous than his colleagues.

Library Facilities

Every schoolboy knows that a college needs a library and the effort to provide one for Dalhousie started with enthusiasm. The minutes of Senate record that at Convocation, in April of 1867, "Rev. G. M. Grant then took occasion to mention the subject of a Library for the College, stating that he had already been promised 200 dollars towards this object. Whereupon John Tobin Esq^{r}. offered 200 dollars, the Lieutenant-Governor 400 dollars, and several other gentlemen present added their subscriptions."

By chance, no doubt, one of the first volumes in the new library must have been the Reports for 1863-66 of the Geological Survey of Canada. The volume was received on 13 May 1867. This began the accumulation of Survey reports. Later, our library also had the good luck to inherit, through Professor Douglas, the Survey reports from the library of F. D. Adams, of McGill, so we are blessed with complete files of Survey publications.

Assembly of a functioning library took some time, however. The Mechanics Museum could not be moved out for about a year, because the space to which it was to be moved could not be ready earlier. By February of 1868, Senate had made up lists of books required for the libary by each professor and a book-seller in Aberdeen, Scotland, had agreed to accept their order at list price less 16 per cent. In May 1868, Lawson was instructed to clear out the Museum for use as a library. Thereafter additions were made from time to time: In 1872, there was $600 for "apparatus" used for the library; $400 the following year and, in 1876, another $300. As the years went by of course, there were additional funds, bequests, etc., as the library gradually built up, but in the first thirty years library facilities were obviously very limited.

Women Students

Without comment on the background, or discussion thereof, the Senate recorded, on 24 October, 1881, a resolution of the Board of Governors proclaiming equality of the sexes and "no distinction in regard to College work or degrees between male and female students".

Certainly women were not a large part of the student body for a long time thereafter, but on 13 October, 1885, Senate considered a letter from Miss A. A. Stewart, of Pictou, applying for admission to 4th year "as a Candidate for B.Sc. degree with Honors in Mathematics and Physics". She had passed the "Intermediate Examination in Science of the University of London". She was admitted conditional upon passing "examinations in German, Astronomy and Practical Physics". In that same year, Belle C. Crowe was a member of the first year class in Chemistry and, as time passed, more women appeared in the student body, including the Medical School.

It is probably true that, at that time, the professional fields generally open to women were nursing and teaching, with an occasional woman working as an accountant. Yet the above suggests that the stereotype of the mores of the time requires some modification.

Teaching Conditions

It is difficult to get a clear picture of how classes were conducted in the late nineteenth century. It is obvious from the content of the offerings that the emphasis was on the classical arts program, with its stress on the Latin and Greek authors, History, Mathematics, and Philosophy. Examination questions were regularly published in the calendar and, from them, one gets the impression that instruction, in Mathematics for example, was at what would now be considered a rather elementary level, at least for the first couple of years. Such a program would require a library and class-room space, but not elaborate laboratory facilities. Classes were small, less than 20 in most cases, and one would suppose that an instructor would become well acquainted with his students and the abilities and weaknesses of each.

Laboratories and laboratory instruction is a different matter. In the description of the original College building, summarized on page 1, Patterson makes it clear that most students never saw the Chemistry laboratory. In his history of the Chemistry department, Dr. Chute points out that Lawson, the Professor of Chemistry, in 1876 had $100 to provide chemicals and equipment; in 1886, he had $60, so it is no wonder that students were expected to supply their own test tubes and some chemicals, such as acetone, ether and salts of silver, gold and platinum. Nor is it any great marvel that the students avoided laboratory work, regardless of any influence the classicists may have had upon their attitudes. For many years, prior to the arrival of Honeyman, Lawson regularly gave a class in mineralogy in the summer session, from late April to late June.

Any instructor who attempts to teach about rocks must have rocks available for illustration. Accordingly, one may wonder how Honeyman managed with his one or two students, whom he taught in the library room. Honeyman's public, and primary, duty was as Curator of the Provincial Museum. Some, at least, of his instruction was conducted there and with the Museum's material, for it is so described in the calendars of the time. The same source also implies that in the summer sessions Honeyman also taught in the field, the best possible geological laboratory, but he must have relied very heavily upon the Museum's collection of fossils and minerals during the winter session. It is worth remembering that many of the famous fossils of the Arisaig area, for example, were first collected by Honeyman, though their formal description was, in many cases, done by specialists in Britain, and he had been publishing about them since 1859. He also had prepared the collections of Nova Scotian minerals and products for international exhibitions in London, Paris, Dublin, and Philadelphia, and those collections would have been available to him. Assuming that he used them, Dalhousie did very well out of its unpaid professor.

Geology Program

In the program that Honeyman introduced in 1878, Geology initially came in the second and third years and apparently was not taught as discrete units, e.g. mineralogy or petrology, as is now common practice. Instead, as is still the case in some jurisdictions, a year's work was a survey of the whole subject, but the subject was examined in greater depth year by year.

In the second year, the program for the winter session (October to April) included discussion of:

"Physiographic Geology": especially of Nova Scotia and Cape Breton.
"Lithological Geology": Rock Material of the Globe, Constituent Minerals of Rocks, Mineral Classification, Structure in Rocks, Arrangement of Strata.
"Historical Geology": Rocks in order of formation and contemporaneous events in Geological History, Principal rock formations of British America and the United States, Characteristic Minerals.
"Floras, Faunas": Rhizopods or Foraminifers; their characters and distribution in time and space.
"Dynamical Geology": Effects of Life on the Earth's Crust, Cohesive Attraction, Crystallization, The Atmosphere, Water, Heat.
"Practical Geology": Methods of Investigation, Measurements, Use of Clinometer.

The recommended textbooks were:
Dana's Text Book or Manual of Geology, edition of 1878.
Chapman's *Outlines of the Geology of Canada.*
Dana's (abridged) *Manual of Mineralogy and Petrography,* edition of 1878
To these were added, in the third year:
Geological Survey of Canada reports
Dawson's Acadian Geology
Transactions of N. S. Institute of Science
The summer session involved "Demonstrations in the Provincial Museum and Field Work". Honeyman was the founder and director of the provincial museum. The class met three times each week.

It is a bit difficult to form a picture of just what this involved or how it was presented. Probably it was presented as a survey course including the aspects listed above. Certainly the classes were small. In November, 1880, Honeyman had two students in his class; the previous year he had one. Under such circumstances it is possible that the presentation would avoid formal lectures and become assigned reading, laboratory work, and discussion with Dr. Honeyman. For example, Dana's *Manual of Mineralogy*, as many generations of Dalhousie students know, concentrated upon recognition of minerals in hand specimen, and upon "blowpipe" methods of mineral identification - a technique now almost completely forgotten - and would lend itself to this method of instruction. One can also infer that regional geology was a major emphasis. But was it taught as a collection of observations, complete with memorization of stratigraphic sections? or were the data used to illustrate, and form the basis for discussion of, broader principles and problems? From his

1880 - 81

GEOLOGY, PALAEONTOLOGY AND MINERALOGY

Examiner . . . . REV. PROF. HONEYMAN D.C.L., F.S.A., &c.

PART I. - TIME: 2 1/2 HOURS.

1. The Archaean formation - what is it ?
2. Name typical localities and characteristic rocks.
3. What is the supposed life of the period - its zoological character and relations ?
4. What are essential minerals in these rocks, and what accidental ?

PART II. - TIME AS ABOVE.

1. The great Auriferous formation of Nova Scotia - what is its age ?
2. What are its rocks ?
3. What are its minerals ?
4. How does gold occur, and with what minerals is it sometimes associated.
5. How is the relative age of rocks ascertained ?
6. In the county of Halifax what formation is found associated with the auriferous formation, and what inference in reference to the age of the latter might be deduced from the association
7. What are breaks in succession ? Give examples in nature and fill up the break.
8. What are the strike and dip of rocks and how are they observed ?
9. How is the thickness of a series of strata ascertained ? Give the formula for finding the thickness of an inclined series.

PART III. - TIME AS ABOVE.

1. What Palaezoic formations occur between the Archaean and Upper Silurian ?
2. Give typical localities and the characteristic fauna of each.
3. State particulars regarding the Trilobites and Graptolites, especially the range in time and space of particular forms.
4. Give the morphology of a Triobite and of a Graptolite.
5. When did Cephalopoda appear, and what was the primitive genus ?

1881 - 82

GEOLOGY

Examiner . . . . PROFESSOR HONEYMAN, D.C.L.

FIRST EXAMINATION.

TIME : TWO AND A-HALF HOURS.

1. What are the divisions of the Quaternary - English, American, Acadian ?
2. What are the typical localities in Nova Scotia and New Brunswick, and the formations in each ?
3. Make remarks in reference to sequences in these localities, and also life.
4. What are the typical life of the 1st and 2nd divisions ?
5. Give the character of the 3rd division, and prominent phenomena, especially in Halifax and vicinity.

SECOND EXAMINATION.

TIME: TWO AND A-HALF HOURS.

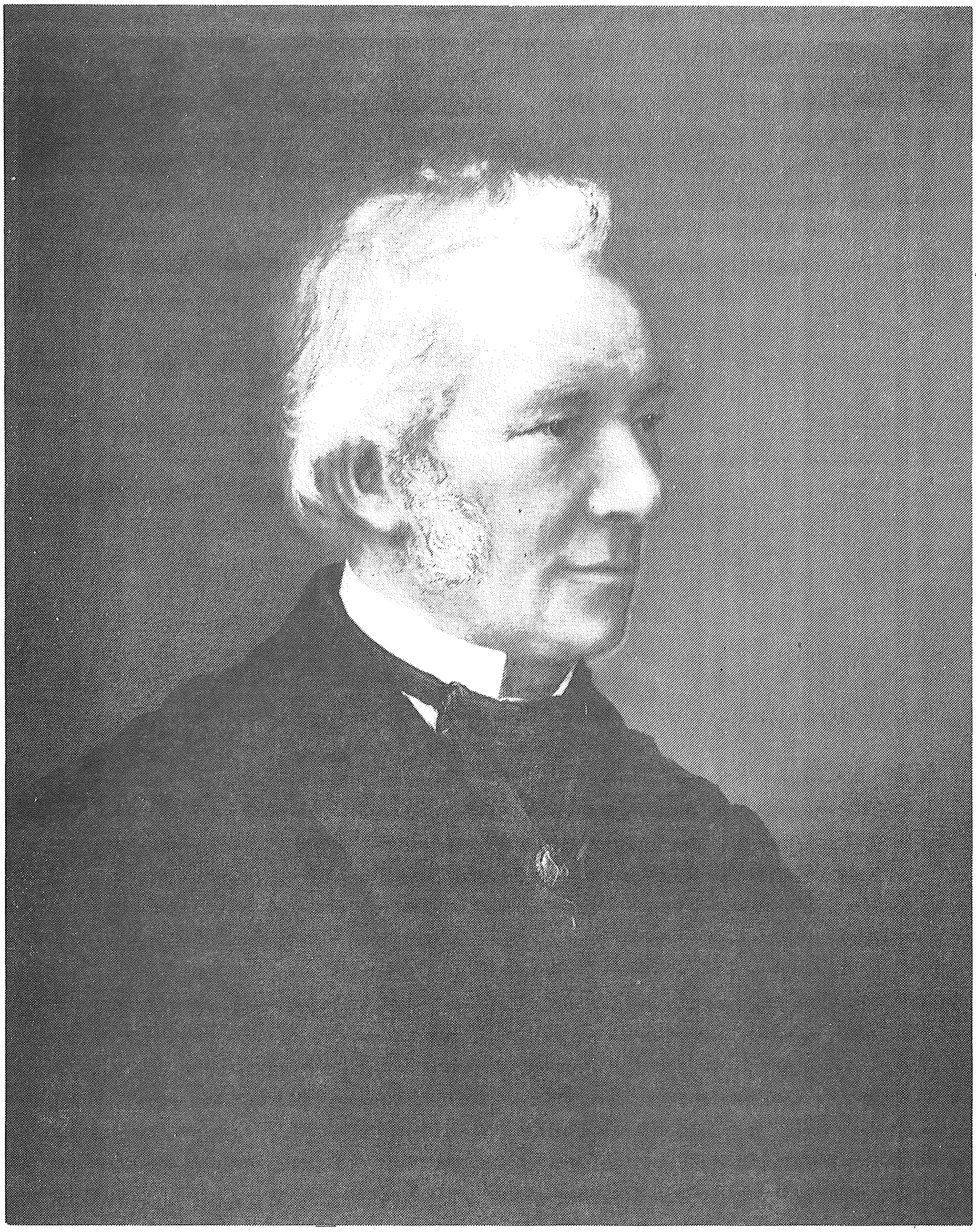
1. What are the Tertiaries of (a) the Paris Basin ; (b) the London Basin ?
2. Give a detailed account of the members of the series in (a) the Paris Basin ; (b) the London Basin ; (c) the Isle of Wight.
3. What is the character of the agencies employed in the formation the strata of (a) the Paris Basin ; (b) the London Basin ?
4. Name and classify characteristic fauna and flora of the Paris Basin.
5. What is to be inferred from the character of these in reference to land, water and climate ?
6. Give facts in reference to the distribution of the Tertiaries in Europe and asia, naming the principal mountain ranges in which they are found, the elevation, and the period when the elevation took place.
7. What are the Tertiaries of America - especially ot the Wyoming Basin ?
8. Of what mountain system are the latter constituents ?
9. What are characteristic fauna of the Wyoming Basin, and corresponding fauna of the Paris Basin ?
10. Name peculiar minerals.
11. Indicate rocks and minerals of economic importance.

THIRD EXAMINATION.

TIME : TWO AND A-HALF HOURS.

1. Make a section from Hertfordshire in England to Sens in France ; describe the formations traversed and their mode of occurence.
2. In a section from Walmer to Romney Marsh, parallel to the Straits of Dover, describe the formations occuring in decending order.
3. What is the Wealdon series ? Between what formations does it occur, and wherein does it differ from these in reference to conditions of formation ?
4. The artesian well of Grenelle, Paris, - what formations does it penetrate ? and where does the lowest come to the surface and receive the water supply ?
5. Where and in what formation is the entrance to the tunnel works of the Strait of Dover ?
6. What formations are required to fill up the break between the Quaternary and Triassic of Nova Scotia.
7. Name and arrange geologically and zoologically the thirty fossils given you by the Examiner.
8. Name and arrange, according to Dana's classification of 1878, the thirty specimens of minerals given you by the Examiner.

Obviously Honeyman did not repeat a set of standard questions !



Rev. David Honeyman
Professor of Geology 1878 - 1883

First student of the fossils of Arisaig, N.S., 1859, who also produced the first geological map of Antigonish County.

publications, it is clear that Honeyman was quite familiar with all the "natural philosophy" and geological questions of time, and one might guess that the regional geology was used in the discussion thereof.

Honeyman left his unpaid position in 1882. Because he was unpaid he was not a member of Senate and this caused irritation and some problems:

To the Honorable the Board of Governors of Dalhousie College and University.

I respectfully beg to submit the following:

My class in Geology Paleontology and Mineralogy in Dalhousie College is in full operation. It is an improvement on my former class. In it I had one student, in this I have two. I had expected in the Third year of our Science Course a much larger attendance. In the initial arrangement of the Science Course agreed upon by the Science Faculty, the Study of Geology commenced in the Second Winter Term. The Senate has so rearranged it as to commence the Study of Geology in Third Winter Term & to concentrate in the Fourth Winter Term. -- This makes a very material & unnecessary difference. Not being a member of the Senate, I had nothing to say in this arrangement & I did not discover the alteration until it was too late for remonstrance. As my fees up to the present have only amounted to $20, they have come far short in paying the working expenses of my classes. These are as much as though I had a hundred students.

I consider that it is incumbent on your board to take such steps as will improve the existing state of things.

I may state that every Professor benefits more or less by the Munro Benefactions but myself, as none of the Scholarships ever reach my Department all being conferred on Arts Students. I think that in this matter there should have been some encouragement to Science Study.

The only way to remedy matters seems to be to attach a Salary to the Chair of Geology, say for the present incumbent Four or Five Hundred Dollars per annum together with a place in the Senate which seems to follow a fixed salary.

respectfully submitted

by D. Honeyman, Prof. of Geology

Postscript

At the solicitation of the Rev. Principal McKnight, I formed inthe College a class for the Study of Hebrew Language, for Arts Students of the Third & Fourth Years. I charge no Fee in this Class. There are Three Students in attendance.

D. H.
Dalhousie College
Nov. 25, 1880

Halifax, Nov. 2/81

Wm. M. Doull, Esq.

My Dear Sir.

We are now in our Winter Session. I have not met with my collegaues in a body except in Convocation. I do not know what arrangements have been made about anything, about hours of meeting or anything else. I have made all my own arrangements as to time and places of meeting. So that I may find that my hours and place of meeting may interfere with the arrangements of the Senate. Last session I occasionally found the Library Room, where I held my classes, pre occupied and either had to go to another class room or to tell my class that there could be no meeting.

Now this is not as it should be. Even in the matter of meeting in convocation I received a note of request to attend as all outsiders. I presume none of the other Professors required to be similarly notified. It is true Prof. Leichti asked me to attend a meeting of Senate as he intended to do on Saturday last to see that proper arrangements were made. As I did not consider I had any right to intrude upon the Senate I did not do so.

As the hours of the meeting of the Senate are either hours when I am occupied with my public duties or class hours, It is not likely that I will be able to attend frequently, yet I consider that I am entitled to attend if I can.

My views on many points do not coincide with the views of the Senate as expressed in the Calendar, e.g. upon the times and the modes of conducting the General Examinations - Last Session I took my own mode and time and had the examinations at times suited to the requirements of my class. In an independent ticket which I have posted up at the College I have intimated that I intend to do the same this Session. The Calendar has appointed one time which I cannot but regard as ill timed - - I have appointed other times. As Prof. Liechti has given me your views on the question of our right to have a place in the Senate, I merely send you this as a private communication leaving it to your own discretion as to the manner in which this matter is to be brought before the Senate. If there is nothing done in the matter, I shall just have to follow my usual course, that is to do what I think to be right.

Yours very truly,

D. Honeyman

P.S. As I stated about this time last year, I would now say that if the non-reception of some sort of salary is the only disqualification for being a member of the Senate, I shall have no objection to have the disability removed.

I consider that am I entitled to something of the sort. I do the work of two Professors having First & Second Classes in Geology & a Miner [?] Course, as well *as a class in Hebrew. Hebrew this session has been made a subject in the Arts Course.*

I humbly think that when Speakers at Convocations are eloquently urging the getting up of Salaries for non-professors they should be informed that some better provision should be made for those who are professors and receive no salaries.

D. H.

I may state that my salary from the Govt. is $1200 so you may consider that $300 or $400 would not elevate me above my colleagues.

One may argue that Honeyman could easily have obtained the information he sought, and that he had been permitted to go his own way in the matter of class and examination hours and of many other matters. Senate may also have considered that the whole was a dodge by Honeyman to increase his income by 25 percent.

The Board of Governors asked Senate for advice. The minutes of Senate for November 15 record that:

"Professor Macdonald reported for the Committee appointed to consider Dr. Honeyman's letter. After much discussion it was resolved that":

"Regarding the letter of Dr. Honeyman of date 1st Nov. addressed to the Secy of the Board of Governors, the Senate, on request of Sir Wm. Young to express their opinion concerning it, concur in the following:-

"(1) That Dr. H. at the time he accepted office as Professor in the Faculty of Science was presumably aware of the conditions of his appointment and that he was a member of the Faculty of Science and not of the Senate; that a seat in the Senate, inasmuch as it implies a share in the management of the College ought to involve responsibility for the successful carrying on of the College, and that this responsibility does not attach to Professors or Lecturers whose services are gratuitous and possibly temporary or who are not receiving the salary which is by the act of 1863 a condition of Professorship. They consider that as Dr. H. has no statutory right to a seat in the Senate, for the above and other reasons it is inexpedient to grant his request.

"(2) That Dr. H's complaint of being slighted in the Senate's arrangements is without foundation. The instance he alleges of being invited to the Convocation by circular letter has happened to Professors in the Arts Faculty -- He also complained of being turned out of his class room (the Library) in the afternoon when he was teaching. But this was occasioned by the limited accomodation in the College involving the necessity of holding examinations in the Library-room; and Dr. H. was treated on this occasion not otherwise than on some other occasions Professors of the Arts Faculty and even the whole body of the Senate itself -

"(3) That the Senate originally fixed Dr. H's hours of teaching to meet his expressed convenience and that he has been left free to choose his own days of teaching -- Dr. H. ought to know that the Senate is always willing to consult his convenience in the arrangement of hours and classes. As for his preference of his own modes and times of holding examinations to those the Senate judge the best, Dr. H. has without objection hitherto emanating from the Senate, used a liberty that would not have been conceded to him were he a member of that body.

"(4) That the Senate while agreeing that the College is indebted to Dr. H. for his useful services, yet considering that he was associated as a volunteer in the tuition, with the distinct understanding that he should receive no remuneration beyond College fees, are not of the opinion that these services constitute a claim for salary - although he says he is doing the work of two Professorships, viz, Professor of Geology and Professor of Hebrew, the work done is a very small part of the work of the undergraduate course, whether measured by the time spent in teaching or by the number of students in attendance with him -- The Senate thinks that before the claims put forth by Dr. H. should be entertained, there are many more pressing wants in connection with the teaching Faculty of the College that ought to command such funds as the Governors can spare-"

The Secretary of the Board of Governors was therefore instructed to write "a courteous note to the reverend gentleman and tell him no money was available". Apparently the "courteous note" was never sent. If Honeyman got wind of his colleagues' opinion of his value, his last letter is hardly surprising:

Halifax, June 9/82

To the Board of Governors of Dalhousie College and University

At the beginning of the last Session of Dalhousie College I addressed a note to your Honorable Board. I have since been waiting patiently for the receipt of an answer.

I presume that silence, in this case, is the opposite of consent.

I am not disposed, in consequence, to continue my connection with Dalhousie College. You need not therefore count upon my services, for next session.

I have the honor to be
Your obedt serv't
D. Honeyman

W. M. Doull Esq.
Sec'y of Board
of Governors of Dalhousie College

Professor Lawson was again left to teach

Chemistry and Mineralogy. Apparently Lawson continued to do this until he resigned, because of ill health, on 22 October, 1895. He died on 11 November - three weeks later. In 1896 he was succeeded as "Professor of Chemistry and Mineralogy" by Dr. Ebenezer McKay, who continued in that position for many years.

Honeyman's Obituary

Honeyman died suddenly seven years later, on 17 October, 1889 and in November the *Gazette* carried a lengthy obituary, from which much of the following is extracted. Some other items come from his great-grand-daughter, Beatrice Robb, who was for many years the University's Cashier:

Honeyman was born at Corbie Hill, Fifeshire, in 1817. Following early education at Dundee High School, he entered St. Andrew's University at the age of 17. His program was the rather strange combination of natural science and oriental languages, including Hebrew, Chaldean, Syriac and Persian. "While yet a student he was selected to teach Hebrew to a class consisting largely of clergymen. In natural science he quickly became so well known as a collector that he was employed to assist in providing a museum for the Watt Institution of Dundee."

On graduation from St. Andrews he entered the United Session Theological Hall, and studied at Glasgow and Edinburgh. He was licensed to preach in 1841 and in 1846 came to Nova Scotia to teach Hebrew in the Free Church College in Halifax, but he resigned shortly after. Though he had planned to go to the United States, he accepted a call to be the minister of the Presbyterian congregation at Shubenacadie, whence he moved a few years later to Antigonish. Family tradition says that there he and the local Catholic priest were practicing ecumenism a hundred years before the Vatican II council. In his spare time he had acquired a thorough knowledge of the geology of the eastern part of the province, and after a few years he resigned his pastorate at Antigonish to devote himself wholly to scientific work. His first paper on the fossiliferous rocks of Arisaig was published in 1859.

His reputation as a naturalist led to his "appointment by the N. S. Government to make a collection of our minerals for the London International Exhibition of 1862, and to superintend the whole of the Nova Scotian section at that Exhibition". He was sent on the same service to Dublin in 1865, Paris in 1867, Philadelphia in 1876, and the London Fisheries Exhibition of 1883. In 1869, he worked, apparently briefly, for the Geological Survey of Canada, but did not publish anything in the Survey reports.

When he left the Survey he was appointed "Curator of the Provincial Museum, of which he had been to a large extent the creator ... As Curator he frequently gave courses of lectures on Geology and Mineralogy. He helped to establish the Science Faculty in this College ... and the Technologist School was organized by him, in conjunction with Professors Bayne [Chemistry] and MacKenzie [Natural Philosophy, i.e. Physics]. He was one of the originators of the Institute of Natural Science ...."

He published many papers on geological topics in the Proceedings of the N. S. Institute of Natural Science, of which he was editor for many years, but also in the journals of the Geological Societies of London and Paris, the Royal Society of Canada, the British Association for the Advancement of Science, and the American Journal of Science. He was awarded an honorary D. C. L. by King's. He was a Fellow of the Royal Society of Canada and of the Geological Society of London, and a member of the Geological Society of France. He was an honorary or corresponding member of several British societies involved in science and the arts, and was an original member of the Geological Society of America, which was established a year before he died.

He received numerous medals in connection with international exhibitions. The story has been handed down in the family that he, himself, considered his greatest honour a medal awarded by the Duke of Mantua "for scientific eminence", an honour he shared with Galileo, Michaelangelo, and Molière.

With Honeyman's departure in 1882, the arrangements reverted to those operating prior to his arrival, and that situation continued for another twenty years. What were those arrangements, and how had they arisen? Every Dalhousian knows that the university had a very difficult early existence; to understand why the early years were difficult, why the difficulties arose, and why the early course offerings took the form they did, it is necessary to look back to the circumstances existing when the university was founded.

2

EDUCATION IN NOVA SCOTIA - 1800-1900*

Lord Dalhousie founded the university in 1818, "in imitation of the University of Edinburgh" and as a non-sectarian institution, using as the initial endowment the customs duties that had been collected at Castine, Maine, when that port was occupied during the war of 1812-14. King's College was then at Windsor and was the only college in the colony. There was more to Lord Dalhousie's move, however, than a mere desire to increase the educational opportunities in a growing colony.

Governments of the day recognized that illiteracy spread rapidly in a pioneer community, and they generally took some steps to deal with the matter. In Nova Scotia, these took the form of land grants for schools; it was an attempt to provide at least a primary education for all. (In Newfoundland, no such provision was made and, by 1814, an appalling illiteracy forced the Methodist church to set up Sunday schools to provide at least enough instruction in reading and writing to enable their people to read the Bible and take part in hymn singing. This was the beginning of today's church schools in Newfoundland.)

King's College was established by Bishop Charles Inglis at Windsor in 1789, was endowed by British funds, and received regular provincial government grants. Even before all the Loyalists had left New York, some Anglican clergymen had proposed such a seminary to Sir Guy Carleton. The purpose was to provide, at home, a secondary education for the sons of the Loyalists, instead of sending them south to the States, where they would be subjected to the republican and egalitarian ideas from which the Loyalists had just removed themselves. This is a very understandable reaction, in the circumstances, and a similar proposal was also adopted by Simcoe, in Upper Canada.

The government of the day took further steps to prevent importation of the ideas the Loyalists had left behind. Although Bishop Inglis apparently held somewhat liberal views, for his time, government was concerned chiefly with developing a small elite minority trained for Law and Divinity, instead of providing widely available secondary education. Sir Alexander Croke, the Attorney-General, influenced the governors of King's to adopt, in 1803, a requirement that every student should subscribe to the Thirty-nine Articles of Religion as set forth in the Book of Common Prayer. This eliminated all but Anglicans from the only college in the colony. The exclusion of dissenters from King's forced other denominations to set up their own schools, if for no other reason than the training of their own clergy.

Thomas McCulloch established Pictou Academy in 1808, where he established a fine reputation for the quality of his "classical and philosophical course" and for innovative methods of teaching natural philosophy. This reputation was justified: seven of his students at Pictou eventually held the degree of Doctor of Divinity and six were knighted, including Sir William Dawson, (the young man who assisted Sir Charles Lyell during his investigations in Nova Scotia in 1842, the "young Mr. Dawson, a very excellent geologist" according to Logan in 1843), who became Principal of McGill in 1855, and for whom our Dawson Geology Club is named. (It was his son, George Dawson, who became Director of the Geological Survey of Canada.)

McCulloch had obtained some reluctant assistance from government for his school, apparently on the ground that it was non-sectarian, although it came to be widely seen as a Presbyterian school. Eventually McCulloch came under great pressure to change the character and purpose of his academy, became deeply embroiled in the religious and political turmoil of the day, and lost much of the support of even the Presbyterian clergy as a result. He grew weary of this and turned to the scheme that was then being promoted by Joseph Howe.

Howe was advocating "one good college, free from sectarian control, and open to all denominations, maintained by a common fund, and rallying around it the affections of the whole people".

Dalhousie was the obvious location for such a college. Although Lord Dalhousie had founded the school in 1818, and the building on the Grand Parade had been completed in 1823, everything had languished because many of the trustees were Anglican and discouraged competition with King's. By 1836, there was persistent demand that Dalhousie should be available to those excluded from King's, and it was generally agreed that McCulloch was the best qualified to be its principal. This appears to have been genuine

*Much of the material for this section is derived from: Walsh, H.H.: *The Christian Church in Canada,* Ryerson Press, Toronto, paperback, 1968, pp. 151-166.

recognition of his abilities, and not political manoeuvering. He was made principal of Dalhousie by act of the Assembly in 1838.

The appointment immediately embroiled him in political and sectarian warfare, and the consequences thereof are still causing trouble a hundred and fity years later. It was expected that different denominations would be represented on the teaching staff. Instead, the governors refused to appoint Crawley, an Anglican who had turned Baptist as the result of a schism in St. Paul's church. McCulloch, himself, refused to work with O'Brien, the Catholic nominee (... "When Mr. O'Brien comes in at one door, I go out at the other.") Crawley immediately proceeded to become the leader in building a Baptist College at Horton Academy, which had been opened in 1829 to raise the standards of the Baptist clergy. Today it is Acadia University. The Catholic bishop, Fraser, succeeded in obtaining an act of incorporation for St. Mary's College, in 1841. In 1831, the Catholic bishop in Prince Edward Island had opened St. Andrew's College in Charlottetown, again primarily to train priests for the diocese. In 1855, the name was changed to St. Dunstan's, and it is today the University of Prince Edward Island. The Methodists had remained largely outside the controversies, partly because their local group was subordinated to the English Wesleyan Conference. Partly also, they had been able to obtain government grants because their activities did not go beyond elementary education. In 1842, however, C. F. Allison, a wealthy merchant living in Sackville, N. B., provided buildings and staff for a Methodist college that is, today, Mount Allison.

In short, the religious intolerance of the mid-nineteenth century produced the initial impetus that has resulted in a multiplicity of universities in the Maritimes - nine degree-granting institutions in Nova Scotia alone. Now, a hundred and fifty years later, we are left to try to "rationalize" the situation and combine, by some mechanism, the operations of institutions widely dispersed and each tied into facilities and capital equipment that cost very many millions and are adaptable to very little else than their present uses.

Because their initial reason for existence was to train the clergy and other leaders for the growing colony, the early programs of studies had a strong emphasis on the classics, philosophy, and theology, although some "natural philosophy" was included. The exception was Mount Allison which, from its beginning, combined professional training with a general course.

McCulloch died in 1843 and Dalhousie closed in 1845. McCulloch's instructional program, which he carried to Dalhousie, was patterned after that of the Scottish universities, with a strong emphasis upon languages, the classics, and perhaps a generous dollop of natural philosophy. This was a very broad base, upon which the individual was expected to continue to build the broad education that was summed up in the phrase "a well-read person". At the same time, admission requirements were carefully tailored to make the College accessible to "any likely lad" (in the phrase of the day) whether coming from the schools or from private study. It has been argued that Dawson, at McGill, and Grant (another graduate of Pictou Academy) at Queen's, did much to spread this Scottish tradition in Canadian education.

After a period when its funds were used to support a high school, and a year when it was combined with the Arts Department of Gorham College, a Congregationalist school at Liverpool, Dalhousie re-opened in 1863, with James Ross, D.D. as its Principal. This resurrection no doubt had many causes; an important one was an act of the Legislature that empowered the Board of Governors to grant "to any body of christians, or any individual, or number of individuals, the privilege of nominating a representative to the Board, and a professor, for every chair ... supported by them to the extent of 1200 dollars per year". This caused the Presbyterian church to close its schools in Truro and Halifax and support two professors. It later withdrew this support after the two professors died. The Church of Scotland also endowed a chair in Mathematics - an endowment that may still be operating.

THE EARLY PROGRAM AT DALHOUSIE - 1863 TO 1900

As would be expected from the foregoing outline, the program of studies available to the students when Dalhousie re-opened was designed to train the graduate to take a responsible role in the growing province - and in the about-to-be-formed country. The staff consisted of:

Rev. James Ross, D.D., Principal, who taught Logic, Ethics, Political Economy
Rev. William Lyall, LLD, who taught Metaphysics, Esthetics, Belles Lettres
George Lawson, Ph.D., LLD, who taught Chemistry and Mineralogy
John Johnson, M.A., who taught Classics
Charles Macdonald, M.A., who taught Mathematics
Thomas McCulloch who taught Natural Philosophy

In October, 1865, James DeMill, M.A. was added to replace McCulloch who had died in March, 1865, and James Leichti was added as tutor in Modern Languages. DeMill taught Rhetoric and History. In 1866 Lyall's responsibilities were listed as Psychology and Metaphysics. One should note that this McCulloch was not the first Principal, but his son.

Admission Requirements

A student seeking admission presented "himself to the Principal or someone designated by him" and an assessor, appointed by the Governors, and was required to show an adequate knowledge of:

1. Latin or Greek grammar and "ability to translate and parse a passage from some easy Latin author" (Caesar, Virgil or Cicero) or "one easy Greek author" (Xenophon, Homer, The New Testament) "and to apply the rules of prosody in hexameter verse".
2. Mathematics: Arithmetic; the first book of Euclid.
3. English Grammar: English composition.
4. History of England.
5. Geography.

This implies individual examination, which was partly in writing - "to test the attainments of the applicant, in writing, spelling, and composition". The minutes of Senate, describing the Convocation of 19 Oct., 1864, say: "The Principal then having intimated that the Entrants to the College would be examined in the afternoon of this day, closed the meeting with a benediction". The following day the minutes report that nine students had passed. In 1866, "Thirteen students had presented themselves at the Matriculation Examination" and "ten had passed".

Of a student body of 25 in 1864, 2 survived to graduation.

Class Offerings, 1864

In the Winter Session, the following classes were offered:

First Year:	Classics, Mathematics, Logic
Second Year:	Classics, Mathematics, Metaphysics and Belles Lettres
Third Year:	Classics, Mathematics, Natural Philosophy and Modern Languages, Psychology and Elementary Chemistry
Fourth Year:	Chemistry, Modern Languages, Ethics and Political Economy, and either Classics or Mathematics

The passing grade in all classes was "a Third Part of the value of the Examination Exercise in that Subject".

In the Summer Session classes were available in Classics, Mathematics, Modern Languages and "lectures will be given in such branches of science as may from time to time be thought most expedient, such as Classical and English Literature, Rhetoric, History, Botany, Geology, Mineralogy, & c".

There were the usual examinations in each class at the end of each year and, for the B.A. degree, in addition, at the beginning of the second session, in Greek and Roman History, and at the beginning of the third session, in English History, Literature and Composition.

Lawson taught "Chemistry and Mineralogy", but he must have wandered further afield than those terms would now imply. The calendar for 1865-66 lists, as texts in Mineralogy: Nichols' or Dana's Mineralogy, as one would expect, but also "Page's Text Book" and Dawson's <u>Acadian Geology</u>.

CHANGES IN SUCCEEDING YEARS

The program was rearranged and revised in 1866, in the light of the experience gained in the three years since re-opening of the College, but the changes were largely a re-arrangement of sequence, with little change in content. The revision process is one that has continued with remarkable regularity ever since.

The sessions began about mid-October and finished about the end of April. Presumably this was accomodation to the annual cycle of labour and the seasons in an agricultural community. Although there was also a summer session, which lasted till the end of June, it was not uncommon, in the early years especially, for scheduled classes to be cancelled because only one or two students had appeared for each class offered. In 1875, for example, only one candidate appeared and the entire summer session was cancelled. In 1876 and 1877, no candidates appeared for the summer school, although the student body had grown to 94 students: 47 undergraduates and 47 general, - up from a total of 53 in 1868.

In these early years, classes that would now be included in the sciences were limited to Chemistry, Botany, and Physics (the latter included in Mathematics and Natural Philosophy). As indicated above, Chemistry included some Mineralogy, and the summer session of 1866 included an offering in "Geological Mineralogy", although that was omitted again in 1867.

Science Course, 1871-1874

A Science Course developed very soon, however. By November, 1871, Senate was considering "further Regulations respecting the Degree of B.Sc. and the Degree of B.A. with Honours". At that time it was decided that special examinations for honours, for students of the fourth year, would be held at the close of the session (i.e. April, 1872) in Classics, Mathematics and Natural Philosophy, Metaphysics, Logic and Philosophy, Ethics, Political Economy and History, Natural Science, and Modern Languages. (It is worth noting how these topics were combined: Political Economy and History, for example.) "A student who satisfied the Examination for Honours in any of these subjects and passes in the prescribed subjects of the

Ordinary Course, will obtain the B.A. degree with Honours."

In November, 1871, it was also decided that a B.A. could obtain the B.Sc. "by taking an additional year's attendance at College, in which he will be required to take the Classes prescribed for the B.Sc. course, viz:-German, Botany and Zoology, Chemistry, Mineralogy and Geology, Analytical Chemistry, and Anatomy or Physiology, and such other subjects as the Senate may from time to time prescribe for the B.Sc. Course; and passing the required Examinations in these subjects". There was a complication because "Botany and Zoology" was taught in alternate years with "Mineralogy and Geology", and both were imperatives. So a student was permitted to take, in his third and fourth year, the class that would not be available in the fifth - and there would be examinations in *both* at the end of the fifth year.

The above implies that the normal route to a B.Sc. degree was to complete first the B.A. program, and present-day students may recognize here the six classes still required as the minimum additional for a second degree. This B.Sc. program was discontinued in 1874.

Geology Program prior to 1879

When Dalhousie re-opened in 1863, the science of Geology was in its infancy. The last volume of Lyell's *Principles of Geology* was only 27 years old, although its impact had already been widely felt. On his way to set up the Geological Survey of Canada, Logan had measured the famous section of Joggins in 1845 and the first edition of Dawson's *Acadian Geology* had been published as recently as 1856.

The subject was included in "Natural Philosophy", which was taught by Thomas McCulloch, the son of Dalhousie's first Principal. The position of matters geological in the scheme of things can be inferred from the schedule of final examinations: in the afternoon of Tuesday, 26 April, 1864, there was a two-hour examination in "Logic, Metaphysics and Natural Philosophy".

One hundred and twenty five years later this may seem a little odd. We must remember the circumstances, however. To the philosophers of the late eighteenth century, the world was the work of a divine and infallible Creator. It therefore followed that it was without flaw and that all parts had been perfectly designed for the place to which each had been assigned in the Divine plan. (This was no doubt a comforting thought when considering social matters.) It followed, also, that all organisms fitted this perfect design and that species were therefore fixed and unchangeable. So we find Linnaeus developing his catalogue of organisms in an effort to see the full complexity of God's design, and Buffon going beyond Linnaeus in a search for general governing laws, comparable to those Newton had found in the mechanical universe.

The miners, however, and engineers such as William Smith, had recognized the principle of superposition and it was recognized that fossils in younger sedimentary rocks differed, in many cases, from those in older rocks and both also differed, in many cases, from modern forms. Then God must have changed His mind about retaining some of the organisms He had initially created? Or had there been more than one act of Creation? Or had He made the wrong organisms at the time of Creation? If so, where was Divine infallibility and perfection of the Universe? Could God have made mistakes? Could He do so again? These were profoundly disturbing questions well meriting the attention of natural (and other) philosophers. Small wonder that, in the nineteenth century, the geological problems were included where they were!

Thomas McCulloch died in March of 1865. For many years thereafter Professor Lawson taught "Chemistry and Mineralogy" or "Chemistry and Natural Philosophy" (1871). Continued classes in "Natural Philosophy" are indicated by the pass lists for 1873-74, but in the following year the corresponding class was listed as "Natural History".

Department of Science, 1879-1880

It is not clear why the B.Sc. program was discontinued in 1874, and the situation again changed fairly quickly. In May, 1878, Senate was considering "the Report of Professors Lawson and DeMill on the proposal of a Science Course". In November of that year, William M. Fraser included in an enquiry about his status a list of classes he had taken. This included Quantitative Analysis, Geology and Botany. He was instructed to take "this winter ... subjects of the Second Year's B.Sc. Course as laid down in the Calendar for the year". This implies that there was an established Science Course extending through the entire four-year program, although, no doubt, many parts of it coincided with the B.A. requirements - in Languages, for example. In June, 1879, Senate "agreed to classify, in the Calendar, under the Department of Science, those students who were studying Scientific subjects only". Incidentally, Mr. Fraser was awarded his B.Sc. in 1880, and apparently he was the first to receive that degree. He became the Public Analyst in Halifax.

Faculty of Science, 1880-1882

The Department of Science remained such for only a year. In March, 1880 it was converted to the Faculty of Science. Its staff consisted of "the Professors of the Faculty of Arts together with James Liechti, Professor of Modern Languages and Rev. David Honeyman, D.C.L., Professor of Geology, Paleontology and Mineralogy". Liechti had been on the staff since 1865. Honeyman had joined in 1879.

The new B.Sc. course occupied four years. The program indicates what the Senate of the day considered important, so it is worth a brief examination:

First Year:	(1) Mathematics (2) Inorganic Chemistry (3) Rhetoric (4) Latin or German
Second Year:	(1) Mathematics (2) Zoology (3) Organic Chemistry (4) Latin or German (5) French (6) Either (a) Extra Mathematics and Chemical Laboratory, or (b) Chemical Laboratory (Extended Course), or (c) Geology and Chemical Laboratory
Third Year:	(1) Logic (2) Latin (3) French (4) Geology (5) Mathematical Physics (6) Either (a) Mathematics or (b) Chemistry Laboratory
Fourth Year:	(1) Latin or German (2) French (3) Experimental Physics (4) Geology (5) Either (a) Mathematics and Optics and Astronomy or (b) Organic Chemistry and Chemistry Laboratory, or (c) Geology and Biological Laboratory

"Whichever Group A or B a student enter on, he must continue to the end of his course. If German be taken in the first year, it must be taken throughout the course; but Latin may be taken in the first two years and German the last two, according to the option of the student."

This program exposed the student to at least two languages, of which French was compulsory. One supposes the inclusion of German reflected the importance of German work in science, but the inclusion of Latin has less obvious reasons. Presumably this option was included for the same reasons that retained Latin as a matriculation requirement into the 1930's; the Latin requirement for the Medical School was finally abolished in February, 1947. The emphasis upon Mathematics is also notable, as is the appearance of "Mathematical Physics". There had previously been instruction in Mathematics and Physics under the name "Mechanics", but from the examination questions in "Mathematical Physics", as published in the calendars of that time, it appears that this was a class in Mathematics with some examples drawn from Physics.

When Honeyman resigned in 1882, Principal Ross took over his duties as Professor of Hebrew and Professor Lawson was instructed to make the best arrangements he could to provide a substitute for the Geology classes. Lawson offered to give a course of lectures in Mineralogy, and this was accepted as a substitute for the previous instruction in petrography, stratigraphy, dynamics, physiography, paleontology, and the "field and museum work" done in the summer session. Evidently this was making the best of a bad job and Honeyman's departure must have caused considerable difficulty, especially for the students of the third and fourth year in Science.

Although Honeyman's departure caused difficulty, no doubt it would be an exaggeration to say it precipitated the demise of the Science Faculty. Nevertheless, on 30 November 1882, the Committee on the Science Course recommended to Senate:

"(1) That as the College does not now possess sufficient teaching power in Science to warrant the offering of a degree in that department, the Science course and degree be for the present suspended, due provision being made for the graduation of those who have already entered upon that course.

(2) That as it is desirable that students should be able to enter upon a regular course of study embracing a study of those sciences in which we can offer instruction, and at the end thereof to obtain a degree; the classes of Organic Chemistry, Botany, and Practical Chemistry be introduced in the Arts Course as elective subjects.

(3) That as it is impossible at present to suggest with what subjects of the Arts Course the above scientific subjects should be made elective, a Committee be at once appointed to report on changes in the Calendar, including that referred to above.

[Senate] "agreed that the first recommendation be adopted, the third also adopted, and the second referred to the committee to be appointed."

Faculty of Arts, 1883

Through the period from 1863 to 1883, the Senate and the staff teaching the Arts Course were the same persons. When the Law school was established in 1883, however, the need to represent it on Senate forced the creation of a Faculty of Arts as a body separate from the Senate. Apparently the science program remained in the limbo to which it had been consigned in November, 1882, with some classes as electives in the Arts program.

Faculty of Pure and Applied Science, 1891-1906

On 9 March, 1891, MacGregor, the Munro Professor of Physics, "submitted a scheme for the organization of a new Faculty of Pure and Applied Science, to consist of the Professors and Lecturers in the respective subjects of the Science curriculum". Senate approved immediately, so it was obviously a matter that had already been discussed thoroughly.

Staffing the new faculty, and the quality of instruction therein, was a major problem, however. By September, at the beginning of its first year, MacGregor was appealing to Senate for "additional assistance in teaching in the department of pure and applied science ...". In October of the same year, Senate found that they would have to refuse the offer of an 1851 Exhibition scholarship, for 1894 and subsequent years, unless funds could be made available to improve the laboratory equipment and supplies.

It is evident that shortage of laboratory facilities is not a new problem at Dalhousie, and the report of the Senate Committee shows not only the problems but gives some interesting indications of the costs of operating laboratories a hundred years ago. It is reproduced here in its entirety.

"The Committee of Senate appointed to report on the action to be taken by the Senate with regard to the offer of H. M. Commissioners for the Exhibition of 1851, to place one of their Scholarships at the disposal of the College for the year 1894, and with regard to the hope expressed by the Commissioners to place a similar Scholarship at the disposal of the College in 1896, and thenceforth periodically, beg to report as follows:-

On examining the conditions of the award of said Scholarship, the Committee find that in nominating a candidate therefor, the governing body of the College would require to certify, among other things, that "he indicates high promise of capacity for advancing science or its applications by original research," and that the candidate would require to give a specific statement "of original research in which he has been engaged". It is obvious, therefore, that the acceptance of the present offer of the Commissioners; and the expectation of its periodical repetition are justifiable only provided the University can furnish facilities for original research in some of the departments of Science, the study of which the Scholarships are intended to promote.

Your Committee has therefore enquired into the present state of the Chemical and Physical Laboratories, and they find that the Directors of these Laboratories have never been authorised by the Governors to make greater expenditure on them than is necessary for conducting the ordinary University classes, that for many years at least they have had no grant from the Governors for adding to the stock of apparatus at their disposal, or even for replacing working material not absolutely necessary which has been exhausted, that the only additions to apparatus made in recent years were made by means of the fund raised by Professors Bayn and MacKenzie fifteen years ago, and of certain donations subsequently received, that the additional working material thus secured is now nearly exhausted and that, while at present some facilities for research in a few very narrow departments can be afforded to Students, unless more liberal support can be given to the Laboratories, it will, in two or three years, be impossible not only to provide these meagre facilities, but even to offer practical instruction of any kind.

Your Committee having asked the Professors of Chemistry and Physics for definite statements as to the expenditures necessary for maintaining the Laboratories in their present efficiency, and for making what they considered the most necessary additions thereto, would report that in their opinion, the annual expenditure of about \$100.00 or \$150.00 on each Laboratory, while extremely small as compared with the expenditure which is being made in other Canadian Universities for a similar purpose, would enable them gradually to increase their efficiency, and to afford greater facilities for original research. This would require an annual expenditure in all of \$400.00 to \$500.00, on Laboratories, which would make an increase of about \$300.00 or \$400.00 on the present annual expenditure.

Your Committee therefore conclude that, while the present state of the Laboratories is such as possibly to warrant the governing body in accepting the offer of the Exhibition Commissioners, for 1894, it would probably be necessary to refuse a similar offer if made in 1896, unless the Board of Governors can see its way to making an annual grant of \$100.00 to each of the Laboratories, and that, as other Canadian Laboratories are rapidly increasing their equipment, the periodical repetition of the Commissioners offer cannot be expected unless an additional annual expenditure of about \$100.00 or \$150.00 on each Laboratory can be provided for.

Your Committee would therefore recommend that the Letter from the Secretary of the Commissioners should be transmitted to the Board of Governors together with a strong statement of the Senate's opinion that it is of the highest importance both that the present offer should be accepted and that the periodical repetition of it should be secured, and with a recommendation that steps should be taken to provide the funds which would seem to be necessary to make such repetition probable.

Your Committee would further suggest that in the event of the Board's being able to make an annual grant to the laboratories, the expenditure of the grant should be placed under the supervision of the Senate."

Honorary Lecturers

Senate met the problem of staff by appointing "Honorary Lecturers", the same mechanism that had provided Honeyman as an unpaid professor for three years. The first batch of "Honorary Lecturers" was approved in April, 1896. Presumably they were to begin their work in the next academic year, although it is possible they were employed during a summer session. Included were:

Charles Archibald, M. S., who taught Mining
Alex. Dick, M.E. who taught Mining
H. W. Johnston, C. E. who taught Surveying and was also Assistant City Engineer.

The same Senate meeting that approved these lecturers also nominated Douglas McIntosh, who was doing Honours Chemistry, as a candidate for the 1851 Exhibition Scholarship, so the Governors must have found sufficient money to provide at least minimal necessary improvement in the laboratories.

At its next meeting, Senate approved the award of the B.Sc. degree to this same Douglas McIntosh and also to Donald Sutherland McIntosh, B.A., who was later to be Professor of Geology for many years.

Other Honorary Lecturers were added from time to time. In April, 1900, F. H. Mason and W. R. Askwith were appointed "to give courses of lectures without salary" in Mining and Metallurgy, "in place of Mr. A. Dick who is no longer resident in the city". Mason was the lecturer in Assaying. And in May, 1901, "Henry S. Poole, M.A., F.G.S. was appointed Lecturer in Geology without salary". Poole had been publishing reports on the geology of Nova Scotia since 1854, had been superintendent of a coal mine at Stellarton in the 1860's, and Inspector of Mines about 1880. From this list it is evident that the Faculty paid much attention to Applied Science, and that heavy emphasis was placed on mining. It is not clear whether, in this Faculty of Pure and Applied Science, we in Geology were considered pure or not, but with that heavy emphasis no doubt Geology was involved to some considerable degree.

School of Mines

The Faculty of Pure and Applied Science operated till 1906. Within the Faculty a School of Mines was set up in 1902 and, one assumes, began functioning in 1903, although it was still acquiring equipment for several years thereafter. At a Senate meeting on 25 Sept., 1902, President Forrest reported that the "movement for raising funds for the establishment of a School of Mines" had subscriptions for $40,520, that public meetings had been held in Halifax, Sydney, and New Glasgow and would be held elsewhere, that "considerable canvassing had been done in ... Halifax", and it was hoped that $100,000 would be subscribed before the end of the year. In the event, it took somewhat longer to secure the necessary funds. In April 1904, the Governors engaged the Rev. James Carruthers to continue the canvas for the School of Mines, and in September of that year Senate was approving "the proposal to prepare a circular of information for the subscribers to the School of Mines". In the end, the campaign raised about $60,000.

To us of this generation, who have become accustomed to large expenditures, this sounds like a very modest effort, so it is of some interest to see just what it represents. At that time the currency was backed by gold, at $20.67 per ounce. The $60,000 subscription, therefore represented 2,903 ounces of gold. Today, the price of that gold would be about $1,643,000 so the citizens of Nova Scotia were, in fact, reaching deeply into their pockets to start their School of Mines.

Staffing and equipping such a school must have been a problem for a university that was unable, a year or two before, to find money for supplies for its Physics and Chemistry laboratories.

Extension Work in Mining Communities

In 1905, Senate looked into the need, and facilities, for extension work in mining in the different coal centres of Cape Breton, Pictou, and Cumberland, and then approved plans for schools at Sydney, North Sydney, Sydney Mines, Stellarton and Springhill. King's College was operating also in Glace Bay. Presumably this extension work was done in evening classes. In September, 1906, a lengthy report to the Governors indicated 175 students were enrolled in such classes: 74 in Mathematics, 80 in Engineering, and 56 in English.

My sources are not clear on this point, but this extensive extension work may well have grown out of a summer school operated previously. On 20 November, 1902, the Senate "decided to organize a Summer School in Geology & Mining to be conducted in Cape Breton during the coming summer, the subjects to be included being Geology, Mining, Metallurgy, Chemistry and possibly Electricity and Mathematics ...".

TABLE I

Matriculation Requirements

	1910		1917		1935
1	English	1	English	1	English
2, 3	Two of Latin, Greek,	2	A foreign language[1]	2,3	Two foreign languages
	French or German[1]	3	One[2] of: Latin, Greek,		
			French, German		
4	History and Geography	4	British History	4	History (British, Ancient,
			or Ancient History		or Modern)
5	Arithmetic and Algebra	5	Algebra	5	Algebra
6	Geometry[4]	6	Geometry	6	Geometry
		7, 8	[3]Two not already chosen:	7	Physics or Chemistry
			from British History,	8	Elective
			Ancient History,Trigonometry,		
			Chemistry, Physics.Another		
			foreign language; one not		
			already chosen of: Latin, Greek,		
			French, German		

1. For Science, French and German were compulsory.

2. One not already chosen.

3. "Those intending to take a course in Science or Engineering should elect Trigonometry and Chemistry."

4. After September 1912 including elementary Trigonometry.

3

FACULTY OF ARTS AND SCIENCE

In December, 1905, Senate agreed "to combine the departments of Arts and Pure Science in one faculty to be called the Faculty of Arts and Science and to make the department of Engineering a Faculty of Engineering".

This action concerning Engineering is somewhat surprising. Three years before, in May, 1902, a committee of Senate had urged upon Murray, the Premier of the province, the appointment of a commission to recommend a suitable system of technical education. The address at convocation in September of that year was on "technical education", and it is evident this was then a hot topic at Dalhousie, if not also in Halifax. In September, 1907, F. H. Sexton, who had been head of the Department of Mining, resigned to become "Director of Technical Education in Nova Scotia" and Professor MacKay was appointed to represent Dalhousie on the board of N. S. Technical College (of which Sexton became the first president). It would appear that during this five year period the matter of technical education had been discussed and resolved by establishment of the Technical College; the scheme of affiliated colleges came into effect in 1910. One would not expect that a "Faculty of Engineering" would be set up while the whole matter of engineering education in the province was being resolved.

Matriculation Requirements

Over a period of years, the emphasis within the Faculty gradually changed in response to changing external conditions and to developments within the academic disciplines themselves. In 1910, for example, the entrance requirement was junior matriculation (essentially completion of Grade XI in the Nova Scotia school system), and the requirement so remained for over 50 years. There were, however, gradual changes in the details of those requirements.

Matriculation Examinations

In recent years, administrators have had to grapple with the matter of standards of admission. The qualifications of students coming from different high schools are obviously different, and in some cases substantially so. The solution attempted has resulted in a gradual rise in the minimum average grade accepted as qualification for admission, but there is some reason to think that this has resulted also in a gradual inflation of grades in the high schools.

The problem must have been somewhat similar a hundred years ago. Students came from a variety of schools scattered across the province; nearly all had limited staff and facilities. It is probable also that some students came by way of private tuition and/or effort.

The matter of admission standards was handled, in the 1860's, by the "matriculation examination" procedure outlined above (page 10), where the candidate "presented himself to the Principal" for an examination that was largely oral. This procedure was eminently reasonable when the total student body was very small.

The matriculation examination was continued as an admission procedure, until at least 1939. By 1920 the total enrollment had increased to 677, and it was found advisable to conduct examinations at Amherst and New Glasgow as well as at Halifax. Alternatively of course, a prospective student could offer a certificate from Grade XI of Nova Scotia, or an equivalent certificate from other jurisdictions, such as a first-class teacher's licence from Prince Edward Island, for example.

The changing requirements for matriculation are shown in Table I, which reflects major reassessments of 1910, 1916 and 1933. For comparison the requirements of 1864 are given on page 10.

Comparison of the requirements shown in the table, and of those with the present, indicate changes in programs over the years, something of the compromises necessary to accomodate those changes, and differences in the importance attached by Senate to different fields and disciplines. In recent years, for example, accreditation and licensing agencies have required that the engineering program include at least a certain minimum of classes in the humanities and other non-technical disciplines. This is probably a reaction to the attitude of, say, thirty years ago that was summarized in the only half-joking: "Us engineers don't need no English!" It is interesting to note, then, that the calendar for 1911-12 carried, in addition to that shown in Table I, the information that Engineering matriculation required either French or German as well as English (Language and Literature) and all three required additional work over and above that required by other entering students.

You will notice also that for the prospective "scientist" in 1910, two languages were compulsory for matriculation and, with minimal modification, that requirement remained for many years. Of course, this was because there was emphasis upon languages in the undergraduate program. In 1911, the program required "three classes in German or French" and "two in *each* of English, French or German", so the student simply could not escape both foreign languages. As late as 1947, two foreign languages were required of all degree students. By contrast, despite official bilingualism, languages are now essentially ignored by science students.

There has also been decreasing emphasis upon history. At least until 1935 it was a compulsory subject for matriculation. Although there had gradually been some change in the periods of history considered to be acceptable, it is probable that British History was the option most frequently offered, for that was a compulsory subject in the schools, beginning about Grade IV. It was then not possible, as it is today, for a science student to arrive at the university completely ignorant of the development of the British legal and parliamentary system from which ours is derived. (In fact, it seems to be possible now for such a student to arrive completely ignorant of anything that happened in the world prior to 1498, and outside of Canada since that time.)

The algebra and geometry requirements have been substituted by "Mathematics 441" of Grade XII. This follows from the change to "senior matriculation" as the minimum matriculation requirement in 1966, and the level of mathematical knowledge required has been increased substantially. The 1911 requirement in geometry, for example, was Euclid's Books 1, 2 , 3 and 4, to which Book 6 was later added. Many topics now required, e.g. determinants, were not introduced at all at that time and, as late as 1940, (when admission was still from Grade XI) analytical geometry and calculus were not introduced until the second year of the university program in mathematics.

Common Entrance Examining Board

All the colleges had the same problem of assessing the qualifications of prospective students. This led to a proposal, in November of 1930, for a Common Entrance Examining Board. It would provide a common basis for appraisal, although obviously it would leave the different institutions free to set their own standards of admission based thereon.

Program Requirements

The program required of a student studying for the B.Sc. degree has changed gradually over the years. The requirements for 1911, 1917 and 1935 are shown in Table II, which also includes for comparison the program for the same degree in 1880.

At first glance, the program for 1911 appears to be very different from that of 1880. Some differences are real: the rather surprising disappearance of Latin, for example. There was also a very considerable change in the Mathematics requirement by 1911. In 1880, two classes in Mathematics were required and, unless the student elected to concentrate on Chemistry, an additional three were required. By 1911, with a requirement for six classes from Group A, it would have been possible, however unwise, for a student to offer only one class in mathematics. In languages, on the other hand, there is little difference: at least two classes in German were required in 1880, with an option for two more. By 1910 it would have been possible to offer as many as six, but the practice appears to have discouraged this. If one offered three classes in German under item 1, then two classes each in English and French would be expected under item 2, and there was still an option under item 4c. In other disciplines, also, differences may be more apparent than real: botany and zoology had become biology, for example, and inorganic and organic chemistry were no longer listed separately.

By 1917 changes were occurring. The emphasis on languages was declining. German or French, as a requirement, had been reduced to two classes and an option under Group 4c - where Latin and Greek had been reinstated. By 1935, this had been further reduced to a possible one class in each, and this remained the situation for many years. Now (1990), the requirement is reduced to one class in "languages and humanities", which may also be the required "writing class". The latter requirement is the response of the university to the demonstrated inability of our students and graduates to write acceptable English. One may note, in passing, that for the *B. A.* degree, in 1935, History I and Mathematics I were required, as well as "one class in Physics, Chemistry, Geology or Biology". This is still possible under the current rules (1990) but is not a requirement. Languages are now no longer required for the B.Sc. degree, nor is Mathematics required for the B. A. degree.

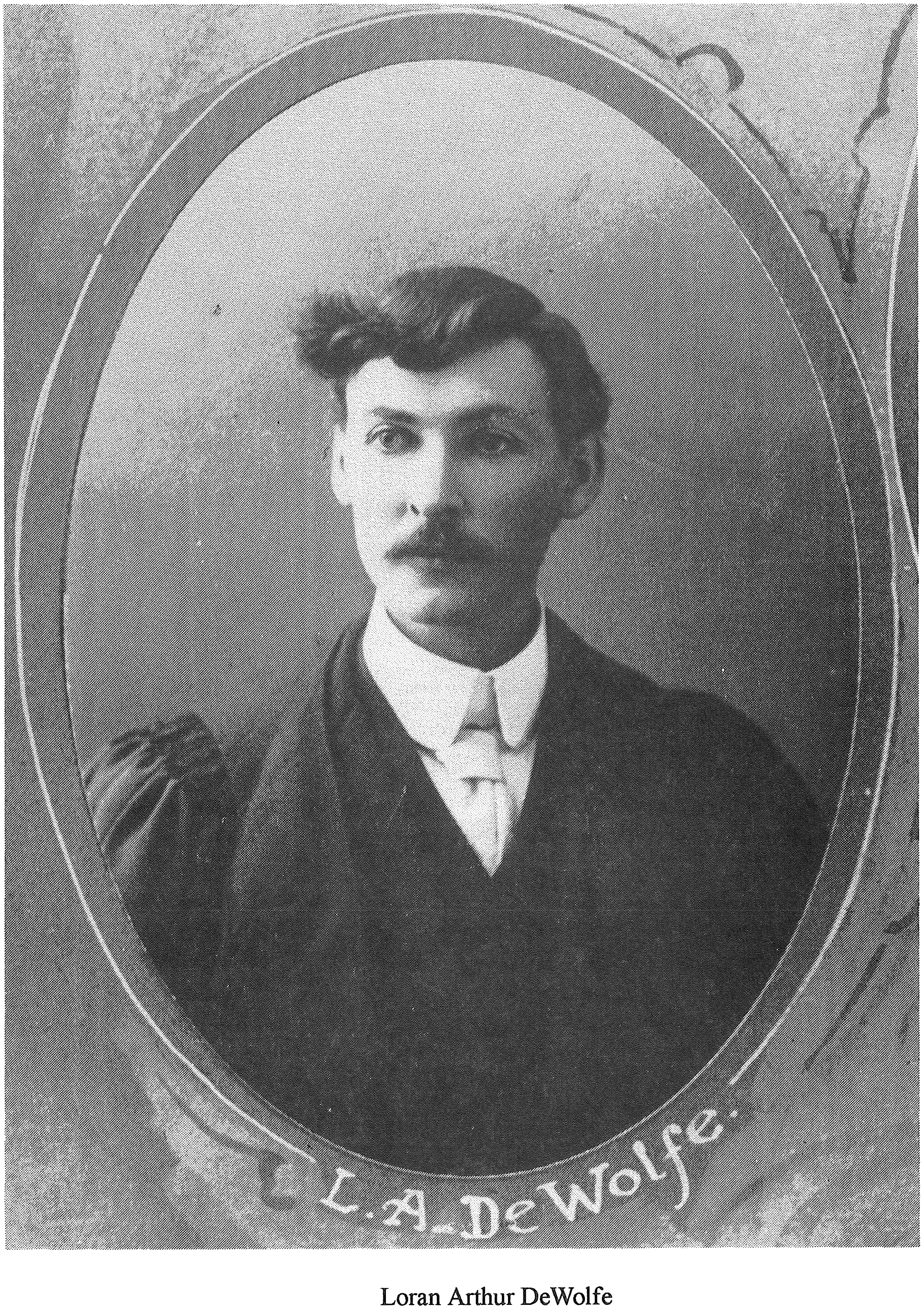
The elective classes, under item 4 of 1910, remained essentially the same, with only minor changes, for nearly 50 years, although the specification differed in form. The minimum of six classes in the sciences in

TABLE II

Degree Requirements

1880	1911	1917	1935
Three classes in French. One class in Rhetoric.	1. Three classes in German or French.	1. Three classes in German or French.	Two classes in French or German or one class in each.
Two classes in Latin and Two classes in German or One class in Latin and Three classes in German	2. Two classes in each of English, French or German.	2. Two classes in each of English, French or German.	Two classes in English.
Two classes in Math	3. One class in each of Math,Physics, Chemistry, Drawing.	3. One class in each of Math, Physics, Chemistry, Drawing.	One class in each of MAth, Physics, Chemistry, Geology or Biology.
Two classes in Chemistry Two classes in Physics Two classes in Geology One class in Biology			
	4. Ten classes: At least one from each group. Not more than four from Group B and C "taken Together".	4. Eleven classes: At least one from each group. Not more than four from Group B and C "taken together".	Ten classes: "At least seven from not more than three of the departments of Science and Mathematics.
	A. Math, Physics, Chemistry, Geology, Mineralogy, Astronomy, Biology, Physiology.	A. As in 1910 with "Mechanics" added.	Drawing may be offered as one of these classes."
One class in Logic, Ethics & Political Economy	B. Philosophy, Education, History, Political Economy.	B. As in 1910 with "Education" deleted.	Two classes from: Languages,History, Economics, Political Science and Philosophy.
C. English, French, German.	C. English, French, German, Latin, Greek.		Optional: Three classes Math, with Chem. Lab, Optics & Astronomy OR Three lab classes in Chemistry
Total: 21 classes	Total: 21 classes	Total: 19 classes	Total: 20 classes

Note: 1. French 1, German 1 not counted "unless corresponding second class subsequently taken".
2. Engineers could offer Drawing instead of three electives in Group A.



Loran Arthur DeWolfe

First M.Sc. Graduate, 1903

1910 went up to seven in 1917, and remained at that figure. This magical number is still with us in the current requirement for "at least seven credits beyond the 1000 level", and the three "departments of Science and Mathematics" of 1935 have become the required three "major" and "non-major" subjects.

M.Sc. Degrees

Although M.Sc. degrees did not appear till 1903, the M.A. had been awarded at least as early as April 1869, when five B.A. degrees and one M.A. were conferred. Two more M.A. degrees were awarded the following year. The procedure seems to have been that the holder of a B.A. degree could submit a proposed thesis topic for approval. Thereafter the candidate proceeded with the work, usually, but not necessarily, at the College. When completed the thesis was examined by a committee appointed for each by Senate. On December 2, 1879, (i.e. during Honeyman's regime) Senate approved the proposal of Richmond Logan, B.A., for an M.A. thesis on: "The Harmony of Scripture and Geology". The thesis was presented on 9 March, 1880, and approved a month later. (Reading the Scriptures as allegory, the late Dr. Ian MacKinnon of Pine Hill, who was for years an active member of the Dawson Club, long maintained a casual interest in the same theme.) An M.A. was also awarded in April, 1909, to W. S. Brodie, who had previously been "Principal of the Glace Bay schools", but I have not been able to discover his topic.

The first M.Sc. in Geology was awarded to Loran Arthur De Wolfe, in April, 1903. He spent his whole life in education, at the Nova Scotia Teacher's College and in government, and was a major player in the development of the educational system of the province. I have not been able to find the title of this thesis, but in 1904 he published a lengthy paper on "The Structure and succession at North Sydney and Sydney Mines, C.B." which may be derived from that thesis.

According to a list of graduates in the calendar for 1907-08, DeWolfe received the second Master of *Science* degree awarded by Dalhousie. The first, in 1898, went to Ebenezer H. Archibald for work in Physics. He went on to Harvard and thence to the University of British Columbia, where he was head of the Chemistry department from 1920 to 1927.

4

GEOLOGY PROGRAM OF WOODMAN, 1902-1909

With the departure of Honeyman in 1882, instruction in Geology was reduced to lectures in Mineralogy given by Lawson, the "Professor of Chemistry and Mineralogy", who was so described until his death in 1895. This seems to imply that there was no other instruction in Geology, and the minutes of Senate meetings do little to contradict that impression. Following the formation of the Faculty of Pure and Applied Science in 1891, however, courses were regularly offered in civil, mechanical, and mining engineering, and surely the latter, at least, must have included some Geology. We have seen that Poole was appointed a lecturer in Geology in 1901. When the School of Mines was established in 1902, its fourth year included classes in Geology, taught by Poole and by Edwin Gilpin, who was then the Inspector of Mines. About this time it must have become apparent, even to a parsimonious Board of Governors, that it was simply not practical to run a faculty and a School of Mines using unpaid, volunteer, part-time staff. At the Senate meeting of 25 September, 1902, "The President reported that Dr. Woodman had been appointed to the Chair of Geology and Mineralogy". Thus began the modern department, which was operated continuously since that time. As might be expected, Woodman took an active part in the affairs of the School of Mines.

Joseph Edmund Woodman arrived in 1902, as a brand new D.Sc. from Harvard. He was already familiar with Nova Scotian geology, about which he had been writing since 1899, and he had written his doctoral thesis on the Moose River gold district of Halifax county. He was then 26 years old, and apparently he also had the enthusiasm and energy of the young, for he proceeded to organize a program that is recognizably patterned after that at Harvard, remained the basic program in the department for sixty years, and imposed a heavy teaching load upon himself.

The calendar for 1903-04, the first into which he would have had much direct input,lists five classes:

1. Elementary General Geology - the usual initial survey class.
2. Advanced General Geology.
3. Economic Geology - which included industrial minerals and building stone.
4. Geology - Research Course.
5. Mineralogy - which had at least two, and sometimes three, two-hour laboratory periods per week.

At this time the University offered "special" courses, which covered a "more limited range of subjects than for the ordinary course", and were begun after completing the work of the first two years from Grade XI matriculation. It may be of some interest to see how this was done 90 years ago, at the beginning of the life of the modern department:

First Year:

1. Latin or Greek
2. The classical language not taken as 1, or French, or German
3. First English
4. First Mathematics
5. Junior Chemistry

Second Year:

1. The same language as 1 from First Year
2. Language of subject 2 of First Year
3. Second English

4.+ 5. Any two of Mathematics, Chemistry, Junior Physics, Junior Philosophy, Geology. If Physics and Philosophy not taken now, they must be taken in a subsequent year.

The "undergraduate taking the Special Course in Geology ... must take Elementary Geology and Junior Physics in the Second Year, and German during the First Two Years. In the Third Year, candidates are required to take Mineralogy and Advanced and Economic Geology. In the Third and Fourth Years they must pass in addition, in Biology, Second Mathematics, Senior Chemistry, Practical Inorganic Chemistry, and Senior Physics. In the Fourth Year, special lines of study will be taken up with the instructor in the Research Course, equivalent in amount to at least two courses, and involving original field work, reading, and one or more theses". From the context it appears that the "theses" were approximately what would now be called term papers.

At the end of the Fourth Year, there were examinations:

"(1) A sight translation of a portion of some geological memoir in German and one in French.

"(2) The History of Geology. Books recommended: Lyell, Sir C. - *Principles of Geology,* 11th Ed., vol. 1, chapter 7 and 2; Geikie, Sir A. - *The Founders of Geology;* Zittel, K. von - *History of Geology and Paleontology;* White, A.

D. - *A History of the Warfare of Science and Theology in Christendom,* vol. I, esp. Chapter 5. Some of the original papers read in connection with other topics may be available also for this.

"(3) Advanced structural and dynamical geology, and the geology of Canada, including both reading and field work done in various courses.

"(4) Economic Geology, metallic and non-metallic; including (a) theories of the formation of coal and petroleum, (b) genesis of veins and vein ores, (c) the economic geology of some region studied especially in the course.

"(5) Special topics of the fourth year. This will be in part an oral exposition and defence of a thesis, given at the last seminar conference of the term."

Two years later, in 1905-06, the class offerings show that Woodman was now in full stride, and the general form of the present program was already in evidence:

Geology 1 - General Geology. Tu, Th, 12:00-1:00; Lab: M, W 9:00-11:00. Field on Saturdays throughout autumn. (In field season, lab only one day per week.) "The course attempts a general survey of the science. Chemistry 1 or its equivalent must have been passed, and Physics 1 is recommended. No textbooks are required but a course of reading is followed, embracing citations from general works and original papers, and practice is given in abstracting literature. The excursions, about nine in number, deal with existing phenomena, and with the structural features of the region. No member of the class will be allowed to pass who has not satisfactorily completed the field and laboratory work. Students aiming at Distinction will be assigned special tasks."

Geology 2 - Physiography. (First Term) Tu, Th, 4:00-5:00; Lab: Tu, Th 2:00-4:00. Especially for those who look forward to teaching Science. "Essential [objective] is the replacement of the usual empirical treatment of descriptive geography by a rational physiographic method, the understanding forming the basis for memory work ..."

Geology 3 - Geology of Canada. M, W, F, 4:00-5:00; Field work one day or two half-days per week during the open season; library and laboratory work during winter.

First term: Combined field work (surveying and mapping) and problems in "dynamical geology". Second term: Geology of Canada, "and upon this as framework are laid studies of many of the large problems of genesis and history". A short period of laboratory work in paleontology. Field work of first term plotted on large scale and elaborated into a report. Also a thesis based upon library work.

Geology 4 - Engineering Geology. Friday 10:00-11:00; Field work as in Geology 3. Special for engineers and required for degree in civil engineering. Lectures on: "methods of surveying; geology of engineering structures; weathering and soils; stones for building and decoration; cements; abrasives; fuels; lubricants; water supply; harbours and coasts".

Geology 5 - Advanced Physiography. (Second Term) Tu, Th, 2:00-5:00. Thesis on a special problem chosen by the student "and these problems and others will be discussed at weekly conferences with the instructor. Opportunity will be found for the publication of any papers upon Canadian physiography, which are of sufficient merit and interest".

Geology 6 - Mining Geology. M, W, F, 11:00-12:00. "... Geological relations and genesis of ore deposits. Much reading of original papers is done, and a thesis must be prepared during the second term, upon a topic studied especially in the field or library."

Geology 7 - Economic Geology. M, W, F, 11:00-12:00 (In alternate years with Geology 6.) Non-metalliferous deposits and water supply. Special emphasis on coal. In Geology 6 and 7, Nova Scotia deposits treated in detail.

Geology 8 - Summer Field Geology. Six weeks at the end of the college year. Selected areas throughout the province. Ten days at the beginning on detailed structural studies in a limited field. All the time is spent on field work. Before October 15, a report on the field work (or a designated part) and the field notebooks must be handed in.

Geology 9 - Research Course. Reading and conferences on *one* subject. Minimum ten hours per week.

Mineralogy 1. Tu, Th, 10:00-11:00; Lab: W and F, 2:00-4:00. Crystallography; Optical Mineralogy - minerals and rocks under the microscope. Half of the course is on determinative mineralogy, and about 130 species are studied in the laboratory. Blowpipe tests are used, but the stress is on field identification. Textbooks: Dana's *Textbook of Mineralogy,* 1902 ed. Brush and Penfield, *Determinative Mineralogy and Blowpipe Analysis.*

The absence of prescribed texts in all classes other than mineralogy is a note-worthy feature. This practice continued in Geology 1 and several other classes at least as late as 1972. The "practice ... in abstracting literature" is a sound idea, and is inherent in any process by which the student makes notes or a precis of a paper or book. But in later years there was no attempt to formalize this and it is probable that, for many students, "practice" became a matter of careful reading of specific papers or book chapters and of browsing through a few of the many other references suggested. One suspects that, with the advent of copying machines, students now build up thick files of copies of the references without the contents ever passing through their heads.

"Physiography" we would probably call geomorphology today, with some aspects of physical geology thrown in. We probably see here the influence of the ideas of William Morris Davis, who was at Harvard at that time and had been, in fact, one of those who had recommended Woodman to the governors of Dalhousie. It is to be noted, too, that Woodman was making some effort to demonstrate to school teachers that many of the features of geography they required their pupils to memorize did, in fact, have simple and logical causes: for example, the southeast trade winds striking the Andes Mountains produce the world's largest river on one side and the driest desert on the other. It is unfortunate that his message has still not reached everyone.

Dynamical geology, as the term was then used, included much of what is now called physical geology: earthquakes, volcanism and the interior of the earth, erosional and reconstructive processes; consideration of the resulting landforms, however, was included in geomorphology or physiography.

We speculated that Honeyman might have used local or regional geology to illustrate more general problems and ideas. Here, Woodman announced that he used the geology of Canada for just that purpose. But he also worked the reverse aspect and had his students making large-scale maps and reporting upon their conclusions therefrom.

The "summer field geology" class is still standard practice in American schools; one assumes that it was so also in Woodman's time and that he transferred that practice. Since then it has undergone many changes. Woodman's six weeks had vanished by the time of Douglas (p. 27) and been replaced by a determined effort to give the student practical experience in industry, with the Geological Survey of Canada, or with similar organizations.

From the above listing from the calendar, one can construct Woodman's class time table:

	M	T	W	Th	F
9:00	Geology		Geol.		
10:00	1		1		
11:00	Lab		Lab		
12:00	Geol. 6/7	Mineralogy	Geol. 6/7	Mineralogy	Geol. 6/7
1:00		Geol. 1		Geol. 1	
2:00		Geol. 2	Mineralogy	Geol. 2	Mineralogy
		Lab	Lab	Lab	Lab
5:00	Geol. 3	Geol. 2	Geol. 3	Geol. 2	Geol. 3

If one were naive enough to believe that Woodman attended every hour of every laboratory, this would amount to 12 hours of lectures and 12 hours of laboratories per week, to say nothing of all-day field excursions on Saturdays. Senate sometimes has strange ways of calculating class loads, but even the Senate, in its report of 1908-09, credits him with 21 1/2 hours of instruction per week.

The classes were small. That same Senate report lists the enrollments:

Geology 1 - 19	Geology 6 - 1
Geology 2 - 38	Geology 7 - ?
Geology 3 - 1	Mineralogy - 1
Geology 4 - 9	

It is evident that, except for the captive engineers and the survey classes, this was individual instruction, and when considering the class offerings we should avoid picturing lectures to large classes such as we have seen in recent years. Instead, the instruction would necessarily be very informal and, one supposes, very close to that of a tutor guiding the reading of his pupil. Formal examinations were prescribed (e.g. page 18), and presumably were held, but one might be forgiven for wondering if such examinations added much to the instructor's appraisal of the knowledge and ability of a student so well known to him.

Honours Course

It appears now that the "special" courses just described were the ancestors of our Honours Programs.

In 1911-12, the calendar was advertising Honours Courses: "An undergraduate who has passed at least *nine* classes of the ordinary Arts and Science course with sufficient credit is allowed to restrict his attention during his third and fourth years to a more limited range of subjects than that prescribed for the ordinary course by entering an Honours Course." It required not less than twenty classes and admission "will in ordinary circumstances only be granted to students who have attained a high standing in the classes preliminary to the Honours course selected". There were special Honours Examinations additional to the ordinary ones.

Fees

Tuition fees changed very slowly prior to the first World War, as did most other prices at that time. In almost fifty years between 1863 and 1912, the registration fee had only risen from six dollars to eight dollars each for five classes (or nine dollars each for less than five) plus an additional four dollars each for each laboratory or drawing class, i.e. 12 dollars each. There was an additional registration fee of five dollars for those taking more than one class, so the total for a student taking five classes would be $45, exclusive of laboratories. These increased fees were approved in December, 1908.

In 1911, classes began on September 15. Then, as now, it was possible to add or drop classes until September 25, i.e. 10 days after the beginning of classes. After that date, however, there was a charge of one dollar for each class added or substituted, and that charge would be 12 1/2 per cent of the class fee of eight dollars. One may wonder if our Registrar would now process 3798 class changes in five days, if such a charge were still in effect.

Woodman's Geological Work

Most geologists have a range of interests, usually more or less peripheral to the major effort of their work. This was equally true of the geologist of the turn of the century and, as is the modern case also, he might well move from one interest to another as his career developed.

Woodman's initial publications, and presumably his interests, were on shoreline processes in New Jersey, in 1896. That interest came to Nova Scotia with him, of course, and he wrote about shore development in the Bras d'Or Lakes in 1899 and again in 1913.

His major interest appears to have been the "gold-bearing series" in Nova Scotia. Although he had reported upon the "ore-bearing schists" of middle and northern Cape Breton in 1899, his doctoral thesis was on the Moose River gold district and he continued to publish on the Meguma rocks and their gold ores until 1908. This work included not only what one might expect concerning the distribution of the gold, but also consideration of the character of the Meguma and such matters as mining methods. In a paper on mining methods, in 1906, Woodman was participating in a then-current debate that had been started by Faribault, who was trying to persuade miners to abandon their policy of using inclined shafts to chase every little quartz vein and to sink vertical shafts instead. Woodman's last paper on the Meguma, in 1908, was a lengthy discussion of its probable age; he concluded that it was probably older than Cambrian.

By 1907, Woodman was working on the iron deposits of Nova Scotia, and he reported thereon for the Canadian Mines Branch in 1909. Apparently he continued this interest; in 1913, while he was Chairman of the Section on Geology and Mineralogy of the New York Academy of Sciences, he was discussing the Nova Scotian iron ores and metallurgical limestones.

Woodman's Departure

One supposes that Woodman resigned to go to greener pastures at the University of New York, but there are some unusual features about his resignation. The minutes of the Board of Governors for 1 Nov. 1906 record an increase in salary of $300 for Professor Woodman. His salary had been set at $1500 per annum from the beginning of 1904, so this was an increase of 20 per cent. This is an unusually large increase from a board not usually over-generous, and one might suppose that it was a reaction to other opportunities offered to Woodman. This would not be an unusual situation.

But the minutes of Senate report a series of items that lead one to wonder. On 2 May, 1903, Woodman was appointed curator of the museum and, a few days later, the minutes report ... "that the gift of $200 from the Alumni Association had been devoted chiefly to providing Geological Apparatus and Collections and a Storage Battery for the Physical Laboratory". During 1903 and 1904, equipment for the School of Mines was donated by Rand Drill Co., Truro Foundry and Machine Co., and probably also by others, such as the Alumni of Cape Breton who donated "$50 to the Department of Geology". In May, 1905, Sexton was estimating that "the entire cost of the establishment of the Mining Laboratory will be somewhere in the vicinity of $7,000," and it appears that the Committee on Laboratories, of which Woodman was a member

Foundry and Machine Co., and probably also by others, such as the Alumni of Cape Breton who donated "$50 to the Department of Geology". In May, 1905, Sexton was estimating that "the entire cost of the establishment of the Mining Laboratory will be somewhere in the vicinity of $7,000," and it appears that the Committee on Laboratories, of which Woodman was a member after September, 1905, was having some difficulty in providing the equipment necessary. In November of 1905, Woodman was a member of a committee of Senate appointed "to prepare a statement of the needs of the Engineering School and of the work which is now being done and which it is proposed to do" .... so they "could approach Mr. Carnegie". Also, "the committee was instructed to consider and report upon the advisability of approaching Lord Strathcona." Late in 1906, Senate came up with a scheme to give the excess over $6 of each laboratory fee to the department concerned, and that produced $32 for the Geology department that session. So Woodman was able, using another $50 from the Cape Breton alumni, to expend a total of $58.62, including $45 for a rock-slicing machine. He wanted another $175 for dust-proof storage for museum material. Equipment was obviously one of his problems.

At a Senate meeting on 1 February, 1908, "Professor Woodman raised the question of the status of the Geology Department". This was referred to a committee which reported, a week later, "that it was unwise to make any recommendation to the Governors at the present time". On 16 April, 1908, Woodman sent to the Board of Governors his resignation as Assistant Professor of Geology and Mineralogy, effective immediately, and the minutes of the Board record its acceptance. It seems probable that Woodman was concerned about his department, its equipment, and its future, and that his resignation may well have been a result of this concern and of frustration arising from lack of any visible progress toward correction of the problems.

Now the strange bits begin. Although Woodman had resigned in the spring of 1908, we find that on March 20, 1909, the Senate had a letter from the Governors that "enclosed a report prepared by Prof. Woodman respecting the re-organization of the Department of Geology and Mineralogy ...." This would not be surprising, if the Governors had sought the advice of the recently resigned professor. But such was not the case. For whatever reason, Woodman had evidently remained for another year, and his colleagues must have been aware that he was not intending to stay, for on 17 February, 1909, Senate had established a committee to consider "courses to be given next year in the department of Geology", and on 28 February Woodman again resigned, with effect from 8 March - one week later. The Board accepted his resignation again, and on 13 April, proceeded to authorize hiring of F. H. McLearn, as Woodman's replacement, at a salary of $1000 per annum. McLearn declined. On 28 September, the Board appointed D. S. McIntosh; all of which seems very straightforward.

However, the Secretary of the Board reported to the same meeting of 28 September that he had received from Woodman a letter "stating that he had contributed $525 as a salary for an Instructor in the Department of Geology and [the Secretary] was instructed to acknowledge receipt of the letter and to thank Professor Woodman".

Why was Woodman paying half the salary of his replacement? or was he paying all the salary of an assistant? In 1902 a system of ranks had been proposed. It included professors, assistant professors, demonstrators, teaching fellows, and lecturers - the latter with no salary "save class fees". The Board on 28 September, appointed McIntosh as Assistant Professor of Geology and Mineralogy, which rank he held until 1932. When the minutes of Senate, or the Calendars of the day, refer to him as "Instructor in Geology", it is apparently used as a generic term, for there was no such rank. It appears, also, that there was no such thing as the "student assistant" of today, and we are left to wonder about the events attending Woodman's departure and the arrival of McIntosh.

At that time it was the practice of Senate to include in its minutes a formal resolution and memorial on the occasion of the death or departure of one of its members. Such memorials tend to be laudatory, but that for Woodman seems to have been a succinct summary of his work and character:

"... as the first occupant of this chair [of Geology and Mineralogy] it fell to Professor Woodman to organize the new department of Geology, and this task he carried out successfully with characteristic energy and enthusiasm. The considerable collections now belonging to the department are in great measure the result of his work. Outside the class-room Professor Woodman was especially interested in the development of the mining industries of the Province. He took a leading part in the organization of local technical classes for miners, and was an active member of the Nova Scotia Mining Society. His report to the Provincial Government on the iron ore deposits of Nova Scotia embodies researches of permanent value ..."

Donald Sutherland McIntosh

5

GEOLOGY PROGRAM OF McINTOSH, 1909-1932

Following the departure of Woodman at the end of the session of 1908-09, Donald Sutherland McIntosh was appointed "Assistant Professor of Geology and Mineralogy" in September, 1909, at a salary of $1000. per annum. He had been awarded his B.Sc. by Dalhousie in 1896, from which he had already received his B.A. He received his M.Sc. from McGill in 1910. He had worked on the Geological Survey with E. R. Faribault and, after that, had been teaching at Baddeck Academy.

There is a little confusion here. Calendars of the day imply there was an hiatus of one year (1909-10) during which Frank Harris McLearn, B.E. (Mining) 1907, was the "Lecturer in Geology". The following year the calendar lists him as "Demonstrator" and it is true that, according to the Senate report for 1908-09, McLearn had taught Geology I in that year, at least. McIntosh had been appointed in September, 1909, and it is exceedingly unlikely that Dalhousie paid for both a professor and a "Lecturer" in such a small Department during 1909-10, even though the cost of the lecturer would be only the few dollars of "class fees" collected from the students in the class. Although it is possible that Woodman's contribution of $525 was payment out of his own pocket for McLearn's assistance in Geology I during 1908-09, it is more probable that the calendar listing McLearn as the teacher in the department was printed on the strength of the authorization by the Governors, on 13 April, 1909, of the hiring of McLearn, and in anticipation that he would accept the position, but this does not explain his listing for a second year.

Nor is it completely clear just what the class offerings were: One supposes that, on arrival in September, 1909, McIntosh would have had very little choice but to continue the classes previously offered by Woodman, for they would already have been listed in the calendar for that year, and students would have planned their programs on that information. For the next year, 1911-12 there were at least four, and possibly six, classes offered in Geology.

The calendar for 1911-12 lists:

1. General Geology: M-W-F from 10 to 11 a.m. Labs: Friday afternoon
2. As Geology 1, but with all-day labs on Saturdays.
3. a. Petrography - one afternoon per week on thin sections. Two hours lectures/week.
   b. Canadian Geology - geology and economic resources of the Dominion.
   c. Economic Geology
4. Mineralogy - Two lectures and 3 hours of labs per week. Determination of 200 minerals; crystallography; physical mineralogy.

This appears to total 7 hours of lectures and 15 hours of labs per week for McIntosh, but if Geology 3 was taught as three concurrent parts, and not as three parts in sequence, the total is 11 hours of lectures.

The all-day laboratories on Saturdays were conducted at Purcell's Cove, at least in the autumn. This was the main feature of McIntosh's class that was recalled by the late Harvey Doane, who was present as an Engineering student from 1908 to 1911. He also recalled that McIntosh understood, and accepted with some resignation, the gradual decrease in numbers in his class during the long walk to Purcell's Cove, on a Saturday when there was a major rugby game in the afternoon at Studley!

By 1931-32, the last year of the McIntosh regime, his classes of 1911 had undergone considerable expansion and bore a closer resemblance to the Woodman program:

Geology 1 - General Geology. M, W, F at 10:00; One afternoon lab per week.

Geology 2 - Canadian Geology. Tu, Th at 10:00; 3 hours of lab per week.

The texts: Coleman and Parks - Elementary Geology
Young - Geology and Economic Minerals of Canada
Moore - Mineral Resources of Canada
Geological Survey of Canada Reports

Geology 3 - Mineralogy and Petrography. 2 hours lecture and one afternoon lab. Mostly microscopy.

Geology 4 - Mineralogy and Economic Geology. 2 hours lectures and 3 hours lab per week. Mineralogy mostly blow-pipe analysis and determination of minerals by field techniques.

Geology 5 - Paleontology. One afternoon per week.

Geology 6 - Practical Geology. One lecture per week, plus field work (including magnetic surveys).

Geology 7 - Geological Chemistry. One lecture and 6 hours of lab per week. Mineral and rock analysis; application of chemistry to geological problems.

Geology 10 - Economic Geography. Tu, Th, Sat, 10:00. Not counted as an imperative for the Science degree.

Concerning the texts prescribed for Geology 2, Coleman, Parks, and Moore were all professors at the University of Toronto, and a later version of Moore's text (Elementary Geology for Canada) was the text in Nova Scotian high schools until about 15 years ago. Young's text was an early version of the Geological Survey's Economic Geology Report No. 1, which grew till, in the 1968 edition, it became huge, encyclopedic, telegraphic, and almost unintelligible.

This was obviously a considerable expansion over the early offerings by McIntosh and involved 14 hours of lectures per week. In some aspects, it resembles the program of Woodman, but a very notable addition is one full afternoon a week for paleontology, which had been essentially absent from Woodman's classes. Again one must assume that upon the framework of the geology of Canada was laid the "studies of many of the large problems of genesis and history", for there is no specific allocation of time for structure, geomorphology, or other items that would now be given specific classes. It is a bit difficult, also, to guess how economic geology might have been handled. One supposes that the usual discussion of ores and their genesis took place in the lecture periods, and that the laboratory periods were devoted primarily to mineralogy.

Space for the Department

It was during this period that the Geology department moved into the "new Science Building", which is now the eastern part of the Chemistry Building. This would have been a move from the Forrest Building, which had previously been the entire University plant, to the first building on the new Studley campus. Studley had been a farm, acquired by Dalhousie in 1912, and the original buildings, the "Murray Homestead", remained as a low rambling structure on the site of the forecourt of the present Arts and Administration building until 1952.

Old hands in the department may find some amusement in this item from the 1916-17 calendar:

"The new Science Building is designed to be ultimately a chemical laboratory only, but for a number of years it will be divided between the departments of chemistry and physics. For a short time it will house also the departments of Geology and Engineering ...... The Geological Laboratory contains a professor's study and a general laboratory for 50 students."

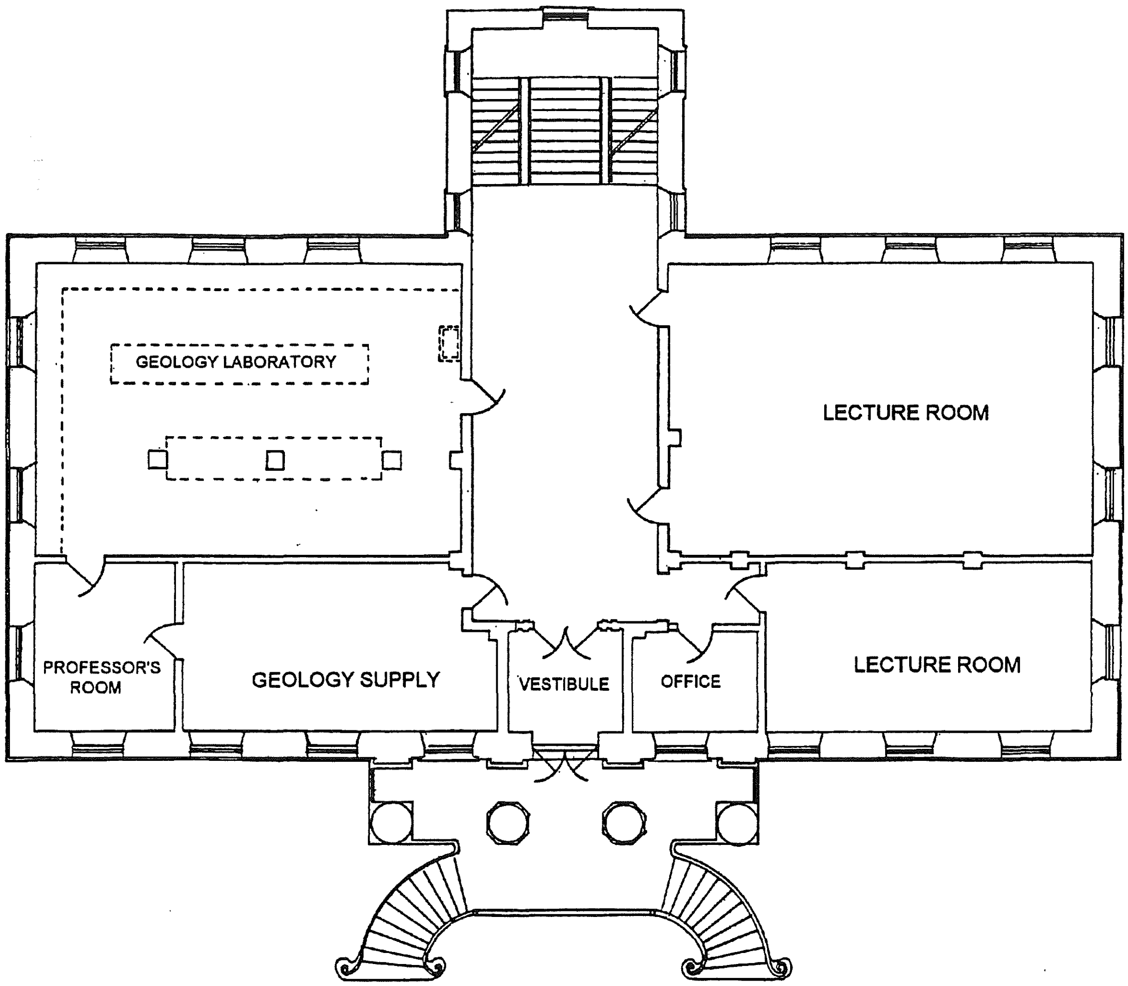
Those who were students between 1933 and 1945 will remember that the Chemistry department occupied the basement and three floors in the west half of the building, the Physics department had the basement and two floors in the east half, the Engineering department had one floor above the physicists, and Geology had the attic space above all three. No doubt McIntosh found his new study and laboratory very useful. In 1933, after his retirement, there were some renovations and improvements that moved the Geology department from the third floor to the attic, after which the "study" had a sloping ceiling with a skylight over the professor's desk, and one travelled from one end of the laboratory space to the other by a series of ramps over the pipes and ventilating ducts for the rooms below. Geology and Engineering moved out of these temporary quarters in 1945. Physics remained till 1962.

There is some evidence that the "temporary" quarters for Geology in that building really were so considered by the Governors. In 1920, the east half of the main floor of the Arts Building was assigned to the Geology department in the architect's plans for the building. That building was actually occupied as the Arts Building till 1952, briefly thereafter by the Law School,and is now the Faculty Club, but there is no indication that the Geology department ever was in the building.

Character of the Department

It is difficult to form an impression of the character of the department during McIntosh's regime. From such sources as Senate and Faculty minutes one concludes that McIntosh was not an active participant in their debates, but instead an individual who concentrated upon quietly instructing his classes and operating his department within the policies developed by his colleagues. He appears not to have been a member of committees and a "mover and shaker" as his predecessor had been. By implication, this is confirmed by Mr. Doane, who remembered McIntosh as an average kind of professor with no outstanding characteristics, good or bad. So also was he remembered by E. D. Haliburton, who was a young engineer in the Geology I class in 1915. On the other hand, Claude Howse, who was in the last classes that McIntosh taught, says he can still remember, after over sixty years, some parts of McIntosh's lectures and therefore considers that he must have been an excellent teacher. He describes "Toshie", as he was apprently known to the students, as "a gentle man, friendly but not familiar, with odd flashes of wit and humor". In those last classes taught by McIntosh there were four students: Howse became Deputy Minister of Mines in Newfoundland and a consultant for the Iron Ore Company of Canda; Percy Sheppard became a successful consulting geologist in British Columbia; and Helen Belyea had a remarkable career with the G.S.C. in Calgary, ending with an honorary Ll.D. from Dalhousie and the Order of Canada.

This suggests it is not wise to make deductions about ability from the minutes of Sentate. Although his successor, Douglas, was an active participant in the



Architect's drawing of ground floor of present Faculty Club, 1920.

affairs of Senate, his name appears in the minutes on only 12 occasions in 25 years, and four of those dealt with the operation of a single committee.

It may be of passing interest to people who stop at the "Lone Shieling", on their journey round the Cabot Trail, to know that it is built upon land donated by McIntosh.

McIntosh retired in 1932 after being the department for 23 years. In December, 1931, he applied for leave of absence because of illness, and the minutes of the Board of Governors record that "unless leave is given, he fears he will be compelled to resign. The President feels that the Department can carry on until the Christmas vacation, but that steps should be taken at once to look about for a successor as Professor McIntosh had intimated that he proposed to retire at the end of the year." The illness apparently was serious and sudden, for the Governors' minutes of April 7, 1932 record that "Miss Pelluet, in the Biology Department, ... had not only won a very good opinion from the Head of the Department, but has also very willingly replaced Professor D. S. McIntosh in his largest class in Geology at a moment's notice, and according to reports has been a most efficient teacher there." (The upshot of this was that Pelluet had her salary boosted from $2600. to $2800. per year.) Prof. A. E. Flynn, of N. S. Technical College took over some other classes.

McIntosh died on 20 July, 1934.

6

GEOLOGY PROGRAM OF DOUGLAS, 1932-1957

George Vibert Douglas, M. C., became the department when McIntosh retired. Although born in Montreal, he had been educated in English private schools. He had served with 17th Northumberland Fusiliers in Flanders from 1915 to 1919, had been Mentioned in Dispatches and awarded the Military Cross. He received his M.Sc. from McGill, but came to Dalhousie via Cambridge (where he had worked up the material he had collected during Shackleton's last Antarctic expedition, 1921-22) and Harvard (which he had left, without completing his Ph.D. thesis, to become chief geologist at Rio Tinto, Spain, in 1926). He had been Rio Tinto's representative during the exploration of the Rhodesia-Congo Border Concession in 1930 and 1931.

He was the first to hold the appointment as Carnegie Professor of Geology, which was established in 1933 with a gift of $125,000 from the Carnegie Foundation. This endowment was sufficient to provide a salary of $4,500. For comparison, the renovations "to provide suitable academic quarters for the department" cost a total of $1960, and in Nova Scotia the ministers of the Crown were paid $6,300 that year.

During the 25 years he was the department, there were only relatively minor changes in the overall requirements for the ordinary B.Sc. degree. There were, in consequence, relatively minor changes in the classes offered by the department and, although it was characteristic of Douglas that he looked for other ways of doing things, he made only such changes as adapted the program to his own abilities. He freely acknowledged that he knew very little paleontology, for example, and the class in paleontology taught by McIntosh became reduced to about a half-dozen exercises in the Geology 1 laboratory.

The exception, perhaps, was a course in Mining Geology introduced in 1940. It required four years from Grade XII, or from the first year Arts and Science of that time, and was: "designed to train those who wish to become mining geologists. It leads to the degree of Bachelor of Science and a Diploma in Mining Geology. The course is based upon the fundamentals of Engineering with the maximum amount of Geology and Chemistry which time allows."

Course Requirements

The course requirements for the B.Sc. degree at the beginning of Douglas's regime are shown in Table II, page 16, starting from Grade XI matriculation, of course.

The "special course" of 1903 had evolved into the "Honours Course" by 1911, and that program was still offered in the 1930's and thereafter with but very little change. Prerequisite was a sufficiently high standing in at least nine of the classes of the first two years. If you count the classes listed in Table II, you will see that 20 credits were required for the Bachelor's degree, and the total for the Honours degree was the same. This means that the Honours degree required no extra classes but only a much higher standard of performance than for the ordinary degree. Now, of course, the Honours degree requires a full extra year - a change that became possible when Grade XII became the matriculation requirement.

A degree with Honours also required special examinations in the subjects of the Honours course. They were held at the end of the final year, but a candidate could defer the honours examinations until a year after passing "the examinations in the ordinary subjects of the fourth year".

Degrees were awarded with "Honours", "High Honours" or "High Honours and a medal".

In Geology the preliminary classes were: Geology 1, Math 2 (Analytical Geometry and Calculus), Physics 2 (Mechanics, Heat, Light and Sound), Chemistry 1 *and* 2 (Inorganic. Labs included Qualitative Analysis). The required classes for honours were: Geology 2, 3, 4, 5, 6 or 7; Physics 4, Heat and Light; (Physics 5, Optics, and 7, Thermodynamics and Kinetic Theory of Gases, optional) and Chemistry 5, Physical and Colloids, and 7, Quantitative Analysis; Surveying 2; Mechanics 2, Engineering Mechanics, and 5, Materials of Construction.

In 1940, the class offerings in the Geology department were:

Geology 1 - General Geology. M, W, F at 10:00; Field work and lab: Tu or F, p.m.

Geology 2 - Mineralogy. Th at 10:00 and

George Vilbert Douglas, M.C.

Geologist, Shackleton Antarctic Expedition, 1921 - 22
Carnegie Professor of Geology 1932 - 1957

another hour. Lab: M, Tu, Th, 2:30-5:30. At least two afternoons.

Geology 3 - Petrology Lecture and Colloquium. Tu at 10:00-1:00. Lab: W, a.m. and/or p.m.

Geology 4 - Ore Deposits Colloquium. Th at 2:30-5:30

Geology 5 - Field Geology Conference. M, p.m. Lab: Th, a.m. and p.m.

Geology 6 - Advanced Ore Deposits. Conference and lab, M, a.m. and Tu, a.m. and p.m.

Geology 7 - Special Problems. Hours to be arranged.

Geology 8 - Experimental Geology. Hours to be arranged.

Geology 9 - Metallurgy and Geology. Hours to be arranged.

This remained essentially unchanged till about 1960.

Teaching Methods

On the face of it, Douglas had a tremendous teaching load. It involved at least 16 hours of lectures and tutorial discussions and nine hours of laboratories per week, plus the supervision of field and "experimental" projects. In addition, Douglas took an interest in Senate and Faculty affairs, was a member of the "Advisory Council" that was the original form of the "Voluntary Planning" system now operated by the Province, was the Provincial Geologist, and managed to maintain an active interest in many other things, such as the development of the Dalhousie Art Gallery.

The secret of his ability to do this probably lay in the small numbers in the classes, in his teaching methods, and in his ability to generate enthusiasm in his students. The Geology 1 survey class, for example, was the only one with formal lectures and laboratories, and it had a maximum enrollment of about 70, by 1955. The laboratories, in the fall term, were a field exercise that required the student to make a compass and pace map of the geology of the quarries at Purcell's Cove, after an introduction to the technique in Point Pleasant Park. Geology 1 was a required class for engineering students. He was thus able to ensure that there was an engineer in each of the groups of three or four students into which he broke the laboratory class, and that each contained one person who knew surveying techniques. Then, after a guided tour lasting one afternoon, during which Douglas enthusiastically explained the main features of the geology of the area, the observational evidence and the processes of reasoning from it, he gave the responsibility to the laboratory demonstrator, who was usually a graduate student. The laboratory exercises in the winter were of a more usual variety and also left to the demonstrator. In a different way, the laboratories in mineralogy and petrology were the responsibility of the three or four students in each. Douglas would explain a technique, such as a blow-pipe test or determination of an optical figure in the microscope, indicate suitable reference books, and leave the student to get on with the assigned specimens. This certainly taught the student how to teach himself (a very valuable skill) but, although Douglas was always available to help when the student was unable to overcome a difficulty, it was rather inefficient, because of the time that the student often wasted. The product also left something to be desired in many cases.

It was in the colloquia, Geology 4, 6, 7, and 8, that his enthusiasm had its effect. A student was assigned literature references to a topic (the origin of Sudbury ores, for example) and for three hours was the instructor in the class. But other students, who had perhaps been assigned a contrary view of the same topic, were encouraged to ask questions, and this led to extended discussion. Douglas usually managed to guide this so that, at the end, a question was under lively debate and the students were sent off to the library with appropriate references and each eager to prove his own point. As a result, students read rather widely and enthusiastically, learned to weigh and correlate evidence, and to make deductions therefrom. This method of teaching is very effective, but it is not the sloughing of work for the teacher that it appears to be: The instructor must anticipate all the channels the discussion may take and be prepared for them; at least for the first ten years, this requires about three times as much preparation as does a formal lecture. Nevertheless, Douglas managed to do this very successfully for 25 years, with only one sabbatical break.

Instruction in the field was a completely different matter. The formal class, Geology 5, might take the form of a specific small project; the genesis of the granite at Porcupine Mountain, on the Strait of Canso, as an example. This would be similar, in principle, to the present honours thesis, but much less elaborate. But Douglas also utilized his students on the field projects arising from his position as Provincial Geologist, and he gave academic credit (in Geology 5) for that work. Most projects involved plane-table mapping. One year, a student would be a rodman; the next, an instrument man; and finally the "geologist" in a small party. Every evening, the compilation of the day's work produced extended discussions, in which all participated because Douglas used them as teaching tools. The "geologist" produced the resulting report and map under Douglas' supervision and it was published under their joint authorship. Bearing professional responsibility for his work has a remarkable effect on the powers of concentration of the student! By this method, and by requiring that students learned Surveying in the Engineering department, Douglas effectively reduced Geology 5 during the actual academic session, to a paper formality. The Surveying class included a 10-day field camp, based at the N.S. Agricultural College at Truro and run as a combined effort of the local universities, in the same way that Crystal Cliffs was later operated. Because of inadequate facilities, women students were excused attendance there but were required to do instrumental surveys around the Dalhousie campus. The campus survey was a procedure that was later followed by all students in our Engineering department for about fifteen years before Surveying disappeared from the curriculum.

"Special Problems" is obviously a catch-all designation. The content of the class could, therefore, be modified somewhat from year to year to suit the interests of the two or three students in it. Generally it dealt with large scale tectonic problems; petrological, geophysical, and other matters were dealt with as they arose in relation to the main topic of discussion, and Douglas' standard colloquium technique was the method of teaching. Here were discussed such things as tidal disruption and planetesimal theories of the origin of the earth, radiometric ages, continental drift, isostasy, nappe development, undation and convection theories of orogeny. Here were discussed the papers of Jeffreys and of Wilson on thermal contraction and, had Douglas still been teaching in 1965, there would have been enthusiastic discussion of the papers of Wilson, Hess and MacKenzie on plate tectonics. As one who took that class I can testify that, coming out of the class to be a graduate student at Harvard, I was at least as well informed on the pros and cons of these topics as any of my classmates, and better informed than most.

As an aside, one cannot resist a comment about continental drift and the carefully nurtured myth that Wegener was ignored. Douglas required his students to read, and discuss at length, the papers from the 1928 symposium on continental drift held by the American Association of Petroleum Geologists (in which Wegener participated) and the papers of Du Toit, Jeffreys, and others, as well as Wegener's book on the *Origin of Continents and Oceans*. For the latter there was a choice of the French translation of the fifth German edition or the English translation of the third edition. It is true that Wegener did not convince his contemporaries, but an idea that is being ignored does not generate major symposia, nor multiple book editions and translations thereof.

Douglas was able to carry such colloquium discussions to some depth, and within the limited time available to him, because he did not have to take time to introduce elementary ideas. Anyone familiar with the *current* program in Geology who takes a look at examination returns from that period will be startled to find students in Geology 2, 3, and 4 (mineralogy, petrology and ore deposits) who were in the final year of a B.Sc. program, or even already held such a degree. This was a consequence of the degree requirements (Table II, page 16) which specified that a B.Sc., degree required one class in Biology *or* Geology. Douglas recruited his "majors" from those who chose Geology as their elective and from his captive audience of engineers, for whom Geology was a required class. In practice, the majority was drawn from the engineers, who commonly were already at the end of the engineering diploma program and who necessarily had a good grounding in Math, Physics and Chemistry. Furthermore, the list of classes *required* for an honours degree in Geology (page 26) ensured a good background in the basic sciences, and Douglas did not need to take time to provide it, as we are now required to do in our Geology classes. For example, a student who had learned about steel in Mechanics 5, by becoming familiar with the carbon-iron phase diagram, not only knew the reasons for the specifications for iron ores but required *no* instruction in how to read most of the phase diagrams in Bowen's *Igneous Rocks*. A student in Chemistry 5 had no difficulty, in petrology or ore deposits classes, with the behaviour of silica in super- and sub-critical water. The same student who read Jeffreys on mantle convection had no need for explanation of the thermodynamics of an adiabatic lapse rate in the mantle. All this must have provided Douglas with a substantial saving in time by utilizing the resources of other departments and by avoiding instruction that others provided quite capably.

"Metallurgy and Geology" was a series of special late afternoon lectures given by Dr. A. E. Cameron, who was Deputy Minister of Mines in the early 1940's and later president of N. S. Technical College. Initially this class dealt at length with the chemistry of the concentration and refining of copper as an example of the processes used in industry, and was not offered every year.

Douglas had his only sabbatical leave in 1950-51 and was replaced during that year by C. O. Campbell, who had received his M.Sc. from Dalhousie in 1941, had been the first manager of the mine at Walton, active in exploration in the province for many years, and was eventually a vice-president of U. S. Gypsum.

Space and Equipment

The first of what might be called modern equipment was acquired in 1947, with the purchase of a Phillips X-ray machine and a pair of Debye-Scherrer cameras. This was financed by a gift of $10,000 from Consolidated Mining and Smelting in 1945. The operation of the machine was outside Douglas's experience and it arrived in the middle of a session, so a graduate student was sent off to Toronto for a week of instruction from M. A. Peacock.

His thesis work at Harvard had involved Douglas in spectroscopy, and the next major instrument he acquired was a Hilger quartz spectrograph, about 1954. By that time, however, optical spectroscopy was not a fashionable technique. Although the instrument was used by a few graduate students as late as 1967, the room it occupied was eventually converted to office space and the instrument, itself, traded to the chemistry laboratory of the Manitoba Mines Branch.

In 1945 the department moved from its attic in the Chemistry Building to the south wing of the present day-care centre behind Kings. This building, shared with Engineering, had been a W.R.N.S. barracks during the war, and was a tremendous improvement on the previous accomodation. Douglas went away to do his usual field work during the summer. That was a mistake. The movers solved the problem of heavy museum cases by removing the drawers and dumping their contents in a great heap in the middle of the floor of the new "museum room". The cases fitted the room very well, but it took years to restore even a semblance of order to the mess of specimens.

Library Facilities

The Macdonald library was begun in 1914, the second building on what was to become the Studley Campus. The law library and the Kellog medical library have long been separate entities, but the Macdonald remained as the main library for other faculties until the opening of the Killam in 1971. The Macdonald who was memorialized in the name of the library was Charles Macdonald, who had taught Mathematics for 38 years - from 1863 to 1901.

Prior to completion of the Arts and Administration Building in 1952 the first floor of the Macdonald library was used as office space. In the southwest corner were the offices of the President and his secretary, separated from the Morse Room, a meeting- and multi-purpose room that occupied the remainder of what was, in recent years, the map room. Students of the '30's and '40's would remember completing their registration documents in that room and taking them across the hall to the northeast corner of that floor, where the Registrar personally checked the record and registration of every student. In recent years that space was the Reserve Reading Room, but at that time the Registrar's staff occupied one half and the Business Manager and the Business Office occupied the other - the latter complete with a large cashier's cage such as was then standard in banks.

In those days there was a large and pleasant reading room on the second floor next to the stacks, which were NOT accessible to the students, as they have recently been. That reading room, in recent years, housed the science reference indexes.

Departmental libraries were a part of the system for many years and, as did other departments, Geology had its own small library. Until 1945 it was little more than some shelves in the professor's office. When the department moved to the former W.R.N.S. barracks behind King's in that year, a large room was set aside as a library. It had about 850 lineal feet of shelving and provided space for most of the texts and reference materials used in Douglas's classes. This included, for example, unbound but complete files of *Economic Geology, American Journal of Science, Journal of Geology, Quarterly Journal of the Geological Society of London,* and so on.

When the department moved to the Dunn Building, in 1962, that library was combined with those of the Engineering and Physics departments, and we acquired a professional librarian for the first time. That situation obtained until the Killam was completed and the Macdonald became the science library in 1971.

Student Affairs

When Douglas arrived in 1932, the country was in the worst stage of the great economic depression that had begun in 1929. Prices were very low, but so were wages - if one could find employment. While a student might finance an entire year at University for seven or eight hundred dollars, finding that much money was the real problem.

Although there are no statistics available, many students paid their own way in large part, with very little or no help from parents, and student loans guaranteed by government were still forty years or more in the future. Some especially able students did it on scholarships, and there is at least one record of a scholarship winner who voluntarily returned his scholarship so the money could go to the runner-up (a modern version of Sir Philip Sydney). It was also not uncommon for students who had some marketable skill to work and attend university in alternating years. One did not require a degree, for example, to teach in the ungraded "little red schoolhouse".

It was in these conditions that Douglas proposed to Senate, in January, 1937, that the University should set up an employment bureau to help students find work. It was approved in March. Douglas undertook to help find work in mining and related fields; W. P. Copp of the Engineering department, did the same for engineering and construction; and several other volunteers aided in fields where they had expertise. The successes, if any, of this effort are apparently not recorded, but it must have had at least some success for the scheme was revived in December of 1945 to help find employment for the student veterans.

This second incarnation of the employment bureau probably was of minor importance, for the Veteran's Association quickly set up its own scheme to find part-time employment for its members. On condition that the student maintained a specified academic performance, the Department of Veteran's Affairs paid academic fees, for a period determined by the length of the veteran's service in the armed forces, plus a small monthly living allowance. Many had families and required part-time work to supplement the allowance, hence their employment bureau. The scheme worked very well because they had available a large number of people skilled in a remarkable variety of fields. In the local newspapers, one of their more eye-catching classified advertisements had the display heading: "Feel like murdering your mother-in-law?" It went on to say that, although they had a number of people with appropriate experience, they had to draw the line somewhere, but they also had expert machinists, stenographers, people who could drive anything that moved, etc, etc. Their services were used extensively by the people of Halifax and Dartmouth, to the very considerable assistance of the students.

During the depression years, employment on graduation was also a serious problem. Gold mining was active, as it always is during an economic depression, but base-metal mining was greatly reduced and the petroleum industry did not really start in Canada till 1948. This meant that Douglas assisted where he could to introduce his students into exploration companies and any other field requiring geological knowledge. Because of their small numbers, most of his students had gained experience on his field parties, as outlined above, and it appears that he was able to find employment for most of them.

Dawson Club

The Dawson Club was established in 1932 as a group to discuss geological and other matters. Its first president was C. K. Howse, who subsequently was Deputy Minister of Mines in Newfoundland. Although it is primarily a student organization, until about 1965 it welcomed anyone who had an interest. Many of its members were then from outside the university and included lawyers, botanists, artists, clergy, and others, as well as those one might expect who were involved in mining or engineering in some way. One of the club's staunchest supports for many years was a customs officer. The non-student members supported the club through their membership fees and several of them, from time to time, added a few extra dollars for the good of the cause.

Students were encouraged to present their own work at the club meetings. This would include such items as the report the student had just completed on the previous summer's field work, a new solution to a problem, or some new technique the student had developed. The Geology I class required an essay on a subject of the student's own choice, and it was customary for the best two or three to be presented to a club meeting by their authors. This produced topics as varied as: the geology at Fleur-de-Lis, Newfoundland; tunnelling under Halifax harbour; the possible use of radar in exploration; and Milton's cosmogony as shown in Paradise Lost. Whether or not Douglas so intended it, this had the effect of giving the students experience in presenting their ideas to an audience and, simultaneously, exposing them and their abilities to interested people who might be able to help them.

Clara Dennis, a local amateur historian and one of the non-student members of the club, encouraged good performance by providing each year a book prize for the best student essay. After her death her brother, W. A. Dennis, provided an endowment so the Dawson Club could continue that practice in her name, and it was so continued so long as the essay was required as part of the introductory class in geology. Since 1901 the Canadian Institute of Mining and Metallurgy has conducted an annual national "Student Essay Competition", in which most of the entries are the rewritten honours theses of their authors. The quality of the Geology I essays is indicated by the fact that, in 1953, Yvette S. Pendle won the CIM prize in the petroleum and natural gas division and, in 1962, Malcolm A. Archibald did the same thing, for an essay on "The Formation of Salt Domes" that included the results of some experiments with scale models. In 1962 also, S.R. Stanford took the second prize in the geology division for an essay on "Wave Action on Large Granite Blocks"; this was an examination of the forces involved when 200-ton blocks of granite were moved by waves at Portugese Cove. In 1933 there was wide public discussion of the international trade in armaments, a topic that has been revived since the war in the Persian Gulf. The 1933 Geology I essay of E. S. Higgins was titled "Minerals and Munitions" and sub-titled "How War Can Be Made Impossible by Controlling the Minerals Essential to the Production of Armaments". It sufficiently impressed the editor of the Toronto *Saturday Night* that he published the essay in its entirety.

The club program was not limited to student performers, however. Until about 1968, visiting speakers and seminars were far less numerous on the campus than is now the case and the Dawson Club provided a small forum. So its members heard local professionals on topics as varied as the building of the Quebec bridge, international control of minerals, pitchblende deposits at Great Bear Lake, Roman mining methods, and the appearance of bone in thin section under polarized light. On several occasions Dr. G. P. Grant stirred up the group with a philosopher's view of

Presented to

for the best essay in
the Introductory Geology Class

in continuation of the practice of
the late
C l a r a   D e n n i s
Nova Scotia historian
who was, for many years,
a friend of the students of the
DAWSON GEOLOGY CLUB

Dalhousie University, 19

science, long before he was nationally known as a philosopher. The club has also heard from visitors including, for example: Whiteside and Shrock, from M.I.T.; Billings, from Harvard; Seilacher, from Tubingen; Ramdohr, from Heidelberg; and Wegmann, from Neuchatel.

In the last years of the Douglas regime, the Dawson Club also sponsored a memorial service for Einstein, as well as several symposia.

The participants were drawn from the local universities and the symposium topics included:

1952 The Nature of Reality
1953 The Nature of Evidence
1954 The Functions of a University
1957 Development of the Canadian Mineral Industry - Is it Safe and Sane?
1958 Effect of Recent Scientific Achievements on Education.

The Club president at the time of the last one was A. R. Berger, who has since become known internationally as the founder of AGID, the Association of Geoscientists for International Development, and as the editor of Episodes, the newsmagazine of the International Union of Geological Sciences.

In 1950, the Dawson Club was host for the first meeting of what has become the Atlantic Universities Geological Conference. The idea originated with Prof. D. J. McNeil, of St. Francis Xavier, and the participating societies at the first session were Acadia, Dalhousie, St. Francis Xavier, and N. S. Technical College. In the intervening forty years, the Technical College (Now the Technical University of Nova Scotia) has dropped out, but Memorial, Mount Allison, St. Mary's University, University of New Brunswick and University College of Cape Breton have been added. For a few years Ricker College, in Houlton, Maine, also was a participant. Conferences of this type have now become common among student societies across the country, but so far as I can discover this group started the practice.

The A.U.G.C. has retained the original format of a day devoted to papers on geological topics and another one or two days of field excursions. The papers are written and presented by the students themselves - not by imported leaders in the field. This has given the students experience in presenting their material before an audience of their peers. On many occasions when mining and petroleum companies were seeking new staff the audience included a substantial number of their representatives, who were appraising the potential of the students present or participating.

The representatives of industry considered that the idea of student papers merited encouragement. At the suggestion of R. M. Creed, the Canadian Society of Petroleum Geologists provided a trophy for annual competition. The Atlantic Provinces Inter-University Committee on the Sciences also provides a cash prize to the club whose representative presents the best paper at the conference.

A pleasant feature of the A.U.G.C. meetings is a dinner. This is provided by the host club, and the arrangements therefor are a considerable learning experience for those responsible for its organization. The after-dinner speaker is usually someone drawn from the local professional group but, in 1973, Paul Batson was able to persuade Don Herron, alias Charlie Farquharson, to attend and entertain the group.

From its beginning, an important feature of the Dawson Club program was the field excursions. Some were half-day affairs to visit local sites, such as the Dunbrack property near Musquodoboit Harbour, with its suite of copper and lead minerals, or Portuguese Cove and its display of contact phenomena. Others were all-day trips to see the Joggins section, for example, or visit mines at Walton, Malagash, Gay's River, or other locations. For these trips the students were fuelled with sandwiches, cookies, and an enormous communal kettle of tea prepared, if possible, over an open fire and presided over by Douglas. Many of these were very normal field excursions, but a portion had moments amusing and otherwise: The two members who became separated from the group during an underground tour at Walton, to the consternation and anger of the manager, were responsible for the club being banned from that mine for several years. There was a non-student member who went underground at Malagash and then discovered she was claustrophobic. She was a good soul, however, and suffered for three hours at the bottom of the shaft rather than disrupt the tour for others. The president of the club missed the first field trip of all to Grand Lake in 1932, as the result of a series of misadventures with a borrowed, and rather decrepit, car that was finally left in the ditch at Rockingham. He returned the next morning to find it stripped; fortunately the owner was an understanding individual.

Douglas - The Man

The available sources tell us very little about the character and personalities of McIntosh and Woodman, and not much more about Honeyman. Because many of Douglas's students and some of his colleagues are still active, however, it is possible to include here some comments about the man himself.

Something of his character is revealed by his attempts to get some help. By 1948 Douglas had recognized that he needed assistance and, in October, he wrote to Dean Wilson suggesting appointment of a professor of Mineralogy and Petrology. In December, President Kerr refused. The next day Douglas was writing to Kerr that "it is necessary that a man be secured, who has the adequate training, to give more time to these subjects than I can devote". Because no one else could see the need, he asked permission to raise the necessary $100,000 endowment himself, from wherever he could find the money. That permission was given, but there is no record that he succeeded in raising this large sum.

Douglas was ill for four months of the 1949-50 session and in May, 1950, he was again writing to Kerr that his work load was far too heavy for one man. If his request for another professor was refused, his only recourse would be to cut out graduate studies. It may be that Kerr considered that a bluff, for he agreed to discontinuance of graduate work; Douglas continued to have graduate students.

Douglas persisted. In December, 1951, he proposed that he should have a half-time assistant in Mineralogy, who would also work half-time at the National Research Council. N.R.C. considered this and rejected it, but the idea was picked up and eventually, in February, 1952, Kerr proposed to offer a half-time appointment to N. R. Goodman.

Accordingly, in 1952, Douglas finally received the assistance he had sought for four years, when Goodman joined the department as a part-time member. Goodman had received his B.Sc. and the Governor General's Gold Medal from Dalhousie in 1940. After service in the Army overseas, he had received his M.Sc. in 1946 and had been chosen as Nova Scotia's Rhodes Scholar for that year. He remained at Oxford, as University Demonstrator (= Assistant Professor) in Mineralogy, until 1952, when he returned to Canada to take up his responsibilities in the family business. Probably it was this circumstance, along with a desire to help Douglas, that led him to take over the instruction in mineralogy and petrology which, as indicated above, needed improvement.

Douglas retired in 1957. It is ironic that a man who had always taken pride in his physical condition should have died of a heart attack on 8 October, 1958, only sixteen months later. Colleagues and former students endowed the Douglas Prize as a memorial.

Goodman also resigned at the same time. His D. Phil. thesis at Oxford was on the origin of N. S. gypsum, and he has continued to act as consultant on evaporites to mining companies and U. N. organizations. Dr. Goodman has contributed the following comments about Douglas:

When one thinks back over the years to our college days we recall with feeling the professors we now perhaps consider as "characters". Just such a professor was Douglas. He was known as GVD to many and will so be referred to in the lines that follow.

It was a one man department but GVD gave eight separate courses plus the various research projects. His wide experience and phenomenal memory never made us feel short changed. His enthusiastic support and keen interest always gave a spirited atmosphere to the department and this made it a pleasurable place to be and to work.

Who can forget seeing a coatless GVD striding across Studley campus in mid-winter with his gnarled cane and his pipe? Everyone who ever took his class remembers his practice of striding into class and, regardless of outside temperature, throwing the window full open before starting one of his excellent lectures.

All his students will recall their first field trip to Purcell's Cove and the out-of-breath rush to the highest point only to find GVD sitting there smoking his pipe. After returning from World War II, I accompanied GVD on his Purcell's Cove outing and an older and wiser me took the hindmost spot; when GVD asked what had happened to me I explained that it seemed prudent to be sure all the ladies made it safely.

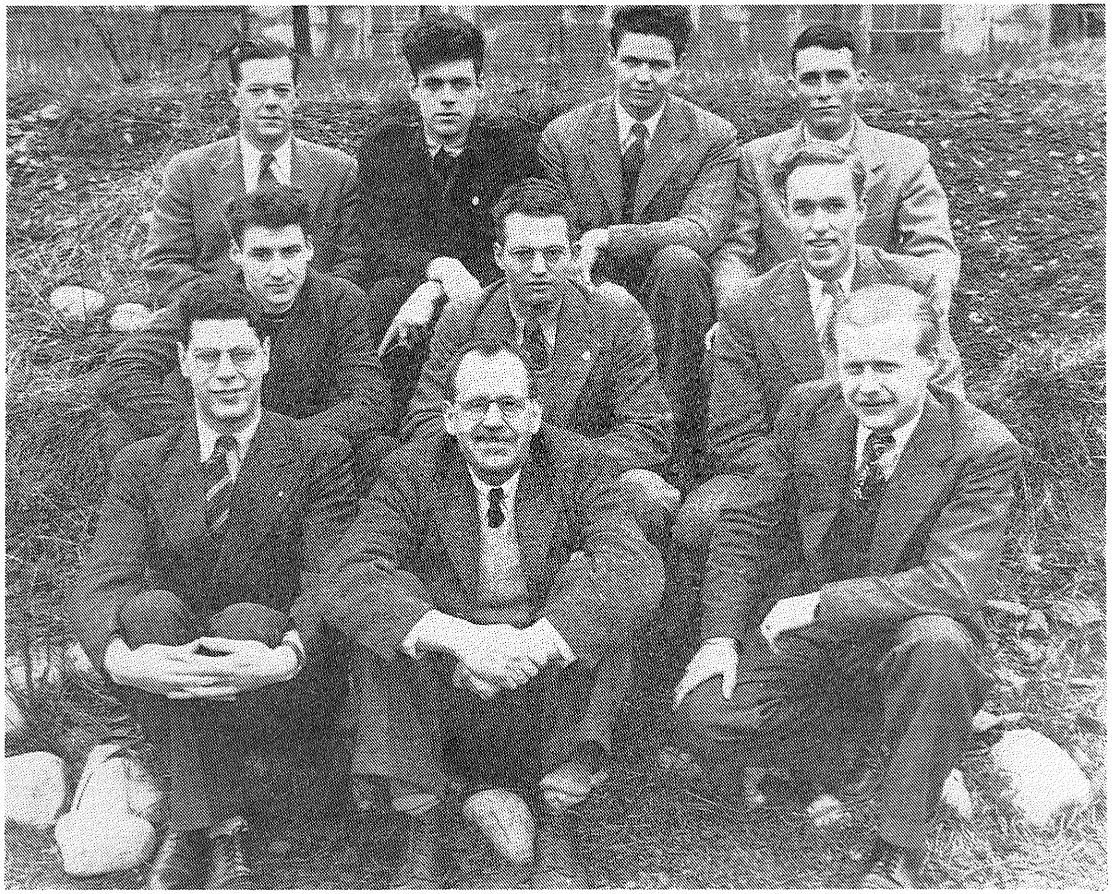
He was strong in his opinions but open to the ideas of others. A prime example was when he and I wrote a joint paper for *Economic Geology*. I arrived at the department on Monday morning and after my lecture said "Hello" to GVD. He said "I finished our paper over the week-end". He read it to me and when he reached the end he asked "Well, what do you think?". He was shaken by my "I don't agree". So he said "you write your thoughts" and going to my office I did just that. This is the only joint paper to my knowledge where the co-authors reach separate conclusions.

Widely travelled, his home was festooned with things picked up from many places. He treated senior students as if they were family and as such they were welcomed in his home, where they met many of his friends who came to visit from all over the world. I recall one morning in 1941 meeting Sir Hubert Wilkins, who had been shipmates with GVD on the 1922 Shackleton Expedition to Antarctica, and I heard Wilkins that morning discuss submarine travel beneath the Arctic ice, 17 years before *Nautilus* did it.

Many memories of GVD come to mind from our close contact during the 1946 Dalhousie-Labrador expedition. He never saved himself. The day we were to climb and formally name Mount Dalhousie he had hurt his back but insisted on making the 3000-foot climb. Step after tortuous step Clint Milligan and I watched him fight his way to the top.

He was a true leader but never held himself aloof. He took his full share of all duties and always did that little bit extra.

It goes without saying that the foregoing is written by a friend about a friend but it must be admitted that no one is perfect and GVD's strong opinions did give him an impatience with others and this sometimes made for difficulties with his colleagues.



DALHOUSIE MEMBERS OF LABRADOR EXPEDITION, 1946

Seymour Waterfield Dunlop Colin Smith
Chapman Bloomer Charles Smith
Goodman Douglas Milligan
Missing: Chaffey

Nordau Roslyn Goodman

Rhodes Scholar 1946

GVD was a strong character indeed. Strong physically and mentally and strong in his likes as well as his dislikes. Such was the character of GVD - he was a truly memorable "character" and this is meant with the deepest and most respectful of feelings.

The difficulties to which Dr. Goodman refers in his second-last paragraph could sometimes be serious or long continued. For example, Carleton Stanley was replaced as president, in 1945, by Dr. Alexander E. Kerr. This decision of the Board of Governors accompanied a very considerable controversy within the faculty, with very strong opinions forcefully presented on both sides. Douglas considered that Kerr was intellectually far inferior to Stanley, that the decision of the Board of Governors was unjust, and he so informed everyone in no uncertain terms. Whether or not Kerr's chief sin was that he replaced Stanley, this perceived injustice simmered in Douglas's mind for many years, and there are stories that Douglas frequently told Kerr, to his face, how incompetent Douglas considered Kerr to be.

As with any professor, his students and colleagues tell hundreds of anecdotes. Perhaps I may add one to the above comments by Dr. Goodman:

In 1947, when the then Princess Elizabeth was married the wedding service was broadcast by radio, and Douglas's children wanted to stay home from school to hear it. GVD thought this reasonable, so he phoned the secretary of the Halifax School Board to suggest that, because the wedding of our future queen did not occur every day, it was an historic event justifying a half-holiday for school children. The secretary claimed he did not have the authority to authorize such a thing. Over the next hour Douglas phoned, in succession, the Chairman of the School Board, the Mayor, the Minister of Education, the Premier, and the Lieutenant-Governor. The latter agreed that he had the authority and that it was a good idea. Two hours later the local radio stations were carrying the announcement of a half-holiday for the schools of the province.

Expeditions to Labrador

In 1946 and 1947, Douglas led exploring expeditions to the coast of Labrador. This was many years before oceanographic cruises were a common feature in the department, so the expeditions were a significant departure from the usual practice and a big event for the participants.

Douglas had pointed out to Claude Howse (He who had been the first president of the Dawson Club) who was then the Deputy Minister in St. John's, that Labrador is larger than the island of Newfoundland but that it was essentially unexplored. A. P. Low had discovered the iron deposits during his exploration of the interior for the Geological Survey of Canada in 1895-98; A. P. Coleman had reconnoitred the northern coast in 1917 and E. H. Kranck had examined coastal geology as part of a 1938 expedition led by V. Tanner, of Finland. Forbes had mapped the northernmost part in 1938 for the American Geographical Society, as a test of a technique of aerial photography. Otherwise it was essentially unexplored land and Douglas proposed a reconnaissance of the coast, from the Strait of Belle Isle to Hudson Strait, to supplement that of Kranck and to choose areas that merited further work.

In 1946, the group was organized as two sub-parties that could operate independently for short periods, if necessary, and each was capable of plane-table survey of areas that might merit such effort. The whole was transported in an 80-foot schooner, the *Thomas and Robert,* which came to Halifax to pick up the group. The captain was John Blackwood, who was thus embarking upon his 43rd season as a skipper on the Labrador coast. The wisdom of this choice became apparent when we discovered that, on some parts of the coast, the best Admiralty charts were the work of Capt. James Cook in the 1740's. "Skipper John" had an encyclopedic knowledge of the reefs that are not shown on the chart, a knowledge acquired by hitting them himself or by comparing notes with other skippers who had done so.

The members of the expedition were, in addition to Douglas:

No. 1 Party: N. R. Goodman, geologist; D. L. Chapman, M. C. Waterfield, instrument men; P. H. Bloomer, C. G. Seymour, rodmen; A. Mullett, Cook.

No. 2 Party: G. C. Milligan, geologist; J. D. Dunlop, Charles H. Smith, instrument men; Wm. Chaffey, Colin H. Smith, rodmen; G. Anstey, Cook.

Ship's Crew: J. Blackwood, master; M. Sturges, mate; R. Clarke, engineer; J. Hunt, Cook.

Patrick Douglas acted as photographer and general assistant to his father.

For travel, the two sub-parties acted as the normal watches of a ship at sea and Douglas spent much time doing "geology by telescope" from as close inshore as the skipper was willing to go. It is only now that one appreciates the terrible strain it must have been for the 74-year old skipper to keep the deck almost constantly from 4:00 a.m. through a working day that sometimes ended near midnight.

Stops were made to examine the geology

where Kranck had reported matters of interest, where it appeared that enquiry was merited, or where legend, rumours, or other local information required. At Forteau Bay, on the Strait of Belle Isle, for example, the coal that was reported inland turned out to be hornblende; the mica deposits reported inland from Cartwright proved to be unsuitable for mining, and the gold nuggets reported from Sacred Bay, Nfld., proved to be pyrite concretions the size of baseballs.

At many locations the stop lasted only one day or less. Each sub-party was assigned an area to examine, with definite objectives assigned and specific questions to be answered. At the end of the day each reported its discoveries to Douglas, who had himself been examining a third area. This sort of work produced, for example, the suggestion of chrome mineralization in the Nain lopolith, and destroyed the legend that a large synclinal fold in the basement gneisses at Saglek Bay was a part of the Ramah series.

Some other areas were actually surveyed by plane table. Ramah Bay and Rowsell Harbour were the major efforts of this type, because the Ramah series has a potential sulphur ore body: a band of pyrite up to 15 feet thick and with a strike length of nearly 5 1/2 miles. Another was at Anchorstock Harbour, where the volcanics of Cape Mugford overlie remnants of the Ramah series and the gneisses beneath it. On the north side of Rowsell Harbour, the expedition members climbed and named Mount Dalhousie, which rises almost straight out of the sea to an elevation of 2940 feet.

Occasionally the expedition also had its lighter moments, such as the impromptu variety program provided by its members for the staff at the Grenfell hospital at Cartwight. Or when Milligan, the meteorological expert, assured Goodman that there would be no rain to interfere with his tent camp on Paradise River. Milligan was correct; Goodman received three inches of snow!

In 1947, the expedition concentrated on three areas that had been chosen as a result of the work of the previous year. One party, led by Charles H. Smith, mapped an area near Makkovik. Milligan went back to Ramah Bay to extend the mapping of the Ramah series, and Douglas explored the lower end of the Kainairiktok River, which is between Makkovik and Hopedale. Again, all were transported from Halifax by chartered schooner and delivered to their assigned areas. They were picked up at the end of the season by the ship that carried mail and supplies on the coast.

Smith mapped several areas near Makkovik; whether a direct result or not, there was considerable exploration for uranium and molybdenum in that region in succeeding years. Douglas mapped the shores of Kainairiktok Bay and travelled about 12 miles up the river before he was stopped by major waterfalls. Milligan's party mapped about 20 square miles of the Ramah series by plane table.

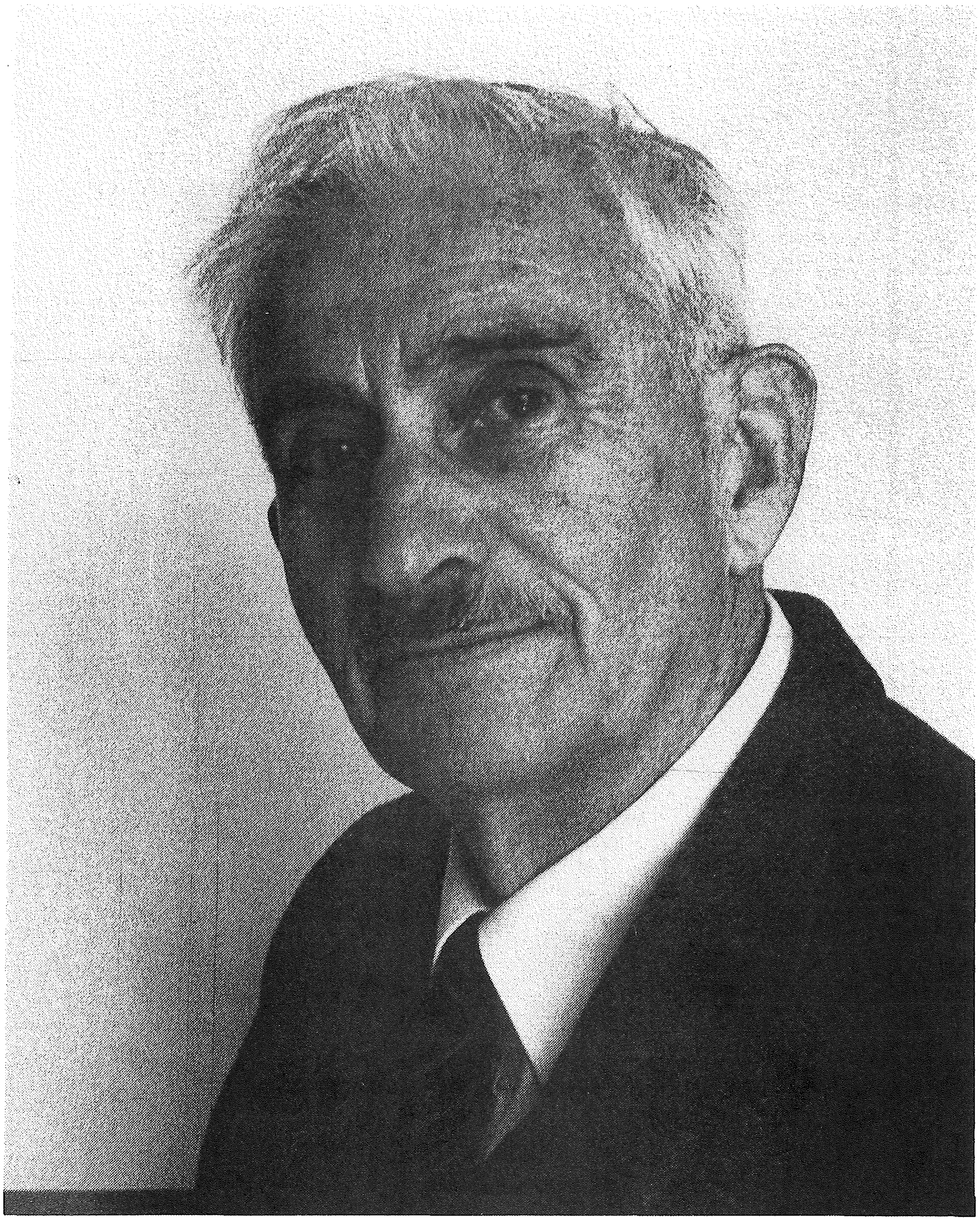
In 1947, the members of the expedition were:

At Makkovik: P. Harding, R. H. Hill, L. Lamont, R. Slipp, Charles H. Smith, F. H. Whidden, R. W. Young

At Kainairiktok: M. Marshall, J. E. A. MacDonald, R. W. Roome, D. S. Templeton

At Ramah Bay: H. M. Anderson, R. A. Cameron, W. L. Davison, H. W. Fielding, D. S. Harris, Z. Ikkusik, G. C. Milligan and I. Rich.

MOUNT DALHOUSIE



C. G. I. Friedlaender

7

GEOLOGY PROGRAM OF FRIEDLAENDER, 1957-1969

Carlo Gottlieb Immanuel Friedlaender replaced Douglas as head of the Geology department in 1957. A Ph.D. from Zurich, he had grown up in a "geological environment"; his father was an internationally-known volcanologist. He, himself, had worked as a mineralogist in Switzerland and in a number of other countries; most recently in Rhodesia. As is any educated Swiss, he was completely fluent in four languages and, as he said, "± passable" in two or three more, so he kept abreast of the important geological literature in several languages. (This was at the time when bilingualism was an issue in Canada.)

He was a rather reserved man, somewhat formal in manner, and educated in the German tradition, where the professor is head of the department or institute, is responsible therefor, and is given corresponding authority. To him, then, it was natural that he should make on his own the decisions for which he would be held responsible, rather than submit them to lengthy discussion with his colleagues. This was a time when the department was expanding and, although he was a competent administrator, this lack of consultation caused surprise, until his colleagues realized this "background effect" - and some never did. So there was opportunity for misunderstanding and conflict, and there was some.

A friend, who is now head of a department of the Swiss Federal Technical Institute, has explained to me that, in their system, he is given a sum of money to operate his department for a year, but how he spends the money is his own affair - he can spend it all in the machine shop if he wishes. Friedlaender was inclined to use the same system - to the benefit of the department, no doubt, but to the annoyance of the accountants in the Business Office, who found his expenditures did not fit neatly into their budgetary pigeon-holes.

(The reverse side of the Swiss system may be of interest. Although the department head has complete freedom to spend the allocated funds, he must be prepared to justify his use of the funds, at any time, to the university and to the Swiss equivalent of our Auditor-General.)

Dunn Building

Friedlaender arrived just before the influx into the university of the children born during and immediately after the Second World War. Enrollment in the universities was already rising and increased space was necessary. One of his first jobs was to deal with the space to be occupied by Geology in the Dunn building, which was already well past the preliminary design stage.

Sad to say, all involved seriously underestimated the problem. Even though the students who would crowd the building in the next few years were already in the school system, there was evidently no serious effort to predict the numbers to be expected in the classrooms and laboratories.

It is only fair, however, to point out that the designers were working to a specified upper limit on cost, if not on enrollment.

The building was donated by Lady Dunn, as a memorial for her husband, and the original gift was one million dollars, to provide space for Physics, Engineering, and Geology. Professor Theakston, who was then the "Engineer in charge of Buildings and Grounds" repeated to me the story, from C. D. Howe, the Chancellor, of how the architects explained to Lady Dunn that they were unable to fit the three departments into a building at that price. They recommended that one department should be removed. She thought that was a lot of money to house only one large department and one small one; how much would it cost for a building to house all three? -- About another $200,000. She looked down at her desk for a few seconds and then said, "All right, I'm prepared to go to one and a quarter million". Howe commented that, in many years in government, he had seen a lot of money spent, but never before had he seen a quarter of a million dollars spent as quickly. The final value of building and contents was $2,123,210.

The space for the Geology department was designed for a staff of three professors (i.e. for a future increase of 50 per cent) and with appropriate laboratory space. From the beginning, except for one small "seminar room" and a large lecture room shared with Engineering, it was intended that class instruction should be in the laboratory space. How bad were the estimates was demonstrated very quickly: the first Geology 1 laboratory class held in the new building overflowed the room designed for it. In subsequent years, even when that class was held on five afternoons a week, the room often was very badly overcrowded, and always was under-ventilated.

It is a marvel that the department was able to function in that building for as long as it did. By sacrificing space that had been intended for spectroscopy, photography, photogrammetry, museum, graduate students, library and, eventually, X-ray laboratory, and with cooperation from Engineering and Physics, accomodation was found for eight professors, two secretaries, and three additional classrooms.

Library

The library was one of the last rooms to be sacrificed in the Dunn building and with it went the whole scheme of departmental libraries. In the "New Science Building" of 1916, the Physics and Chemistry departments had occupied a joint library space, which was also used for seminars, and Geology had a small library space in its quarters under the roof. Geology took its library along in the move to the former W.R.N.S. barracks in 1945, and after the move to the Dunn building, Physics, Geology, and Engineering shared a common library space and a proper librarian, Miss Sylvia Fullerton.

Probably the removal of the library from the Dunn building was not seen as a catastrophe by the University Librarian. Departmental libraries *vs* a central library had always been a matter of discussion, if not dispute, and, no doubt, the accounting for books in unsupervised departmental libraries was always a headache. They operated on an honour system: the student borrowing a book signed the card from the back of the book and left it in a box placed for the purpose. On one occasion, at least, staff cleaning the King's residences at the end of the session returned over 50 volumes to the Geology library alone.

This accounting problem must have been greatly eased in the Dunn building, where a librarian was on duty and normal procedures were followed for issue and return of books. Fortunately also Miss Fullerton is the type of librarian who believes that books are for reading, the stacks continued to be as accessible to students as they had been in the departmental libraries, and students were encouraged to browse in them.

In principle, the move to the Macdonald library should have changed the situation very little. In practice, however, it appears that students from the Geology department now make much less use of the library than was the practice in the past.

Crystal Cliffs

During Friedlaender's regime also began the cooperative field school at Crystal Cliffs. It has always been recognized that field experience is essential to the geologist, and training has always included it. Honeyman and Woodman ran field exercises in the "summer session", and McIntosh also ran a class in "Practical Geology" that included magnetic surveys. Those surveys must have been something very new at that time. Douglas had made great use of field projects in Nova Scotia and Newfoundland.

Since its earliest days, the Geological Survey of Canada has employed students in its field parties, and many exploration companies do the same. This is a practice that makes us the envy of our colleagues in other countries, where students simply do not get such experience. Over each summer of two or three years, three months of living every day with the rocks in the field is a very valuable experience for the young geologist. But, as areal mapping gave way to geophysics and other indirect techniques of exploration, a student might spend a summer sampling brook water or carrying a magnetometer across swamps. Although this does very little to acquaint the student with the rocks, there is still considerable value to this practical experience. There is the disadvantage, however, that the employment opportunities and experience vary with the state of the economy and with Survey policy. In the late fifties, the exploration industry was in one of its periodic "slumps" and employment opportunities (and so experience) were scarce at a time when student numbers were increasing.

Some years before, the N. S. Department of Mines had organized a joint project with Massachusetts Institute of Technology at "Crystal Cliffs", near Antigonish. M.I.T. used this as a school to give their students field experience, and the province had aspects of its geology mapped under the supervision of the M.I.T. staff. About 1958, M.I.T. began withdrawing from the project and the province found itself with under-used facilities for which it needed customers. In April, 1959, Dr. J. P. Nowlan, the Deputy Minister of Mines, proposed the scheme of a joint field school for the Maritime universities, and provided a director and a subsidy for it. The first of the joint schools was held 19-30 May, 1959. The operating costs, initially, were paid by the participating universities and the Department of Mines, and by a small charge to each student. Later there were also contributions from oil and mining companies. Equipment (e.g. field instruments) was supplied by the universities.

The program at Crystal Cliffs went through a long evolution. For the first two or three years the director was W. L. Whitehead, who had also directed the M.I.T. operation. Instruction involved guided tours, up to a day in length, of areas that had been mapped by M.I.T. This was a "show and tell" process, where Whitehead did the telling and each student was then required to produce a written report thereon. It became apparent that this required, on the part of the student: a good memory, little understanding, and no observational ability. Thereafter, the program was changed to practical exercises in mapping. Representatives from each department met annually to decide on the program for that year. Accordingly, the program differed from one year to the next in response to the interests of the staff participating (particularly the more forceful ones), the quality and accessability of the exposures available, and the judgement of the staff about the efficacy of specific projects as teaching tools. Some were dropped because they were beyond the capacity of the students; others (e.g. plane-tabling exercises) were dropped because the benefits did not justify the time consumed. Finally, there evolved a set of exercises that illustrated a considerable range of geological features, was within the understanding of second year students, and within the limits of what students could survive for ten days of very long hours.

Two other important features should be noted. Although, at times when summer jobs were scarce, this was the only field experience that some students received, the school was held in the spring and intended to introduce the student to the field work on which he/she would be employed during the coming summer. A number of exploration companies were sufficiently appreciative of the benefits derived that they gave students permission to complete the field school, even though it meant that the student was late joining the summer field party. If that party were working in the sub-Arctic, this was a considerable concession in terms of cost and inconvenience to the company involved.

The second feature is this: Although no academic credit was given for the field school, and the students were driven hard, almost without exception they worked enthusiastically and to the best of their ability, despite crowded conditions and weather that was often thoroughly awful. It was rare, indeed, to find a slacker in the group.

Class Offerings and Staff Increases

In the early part of Friedlaender's regime there were only very minor changes from year to year in the requirements for the B.A. and B.Sc. degrees. Accordingly there were only minor changes in class offerings within the department during the first year or two. In 1957, Friedlaender took over the classes that had been taught by Goodman. Milligan arrived in the same year and he took over the classes of Douglas, in which he had been a student ten years before. It is hardly surprising, then, that for the first few years Milligan's classes bore a striking resemblance to those of Douglas!

Although the degree requirements changed little, additions to class offerings were required to correct deficiencies. As mentioned above, Douglas had included practically no paleontology in the program, and there was a related lack of emphasis on stratigraphy. These were the obvious and major deficiencies.

Friedlaender could do nothing about them immediately, but he did extend the class offerings somewhat by including advanced-level classes in mineralogy and petrology, which he taught himself. By 1959-60, he had also organized a class in Earth Physics, taught by Dr. J. E. Blanchard of the Physics department, as well as a class taught by Dr. A. E. Cameron, which is described at greater length below. Friedlaender then continued to add classes to his own teaching load, though several were offered in alternate years.

By 1961-62, he was offering a class in geochemistry and a class on volcanoes and volcanic products; this last was a class that merited more attention than it received: Our graduates were going out to work in mines that were mostly in severely deformed and metamorphosed volcanic rocks, but they had no real idea of the original characteristics of those rocks. In consequence, in their work many features were easily misidentified or misunderstood and, for the individual, the first encounter with modern volcanic rocks was often a shock. Friedlaender was familiar with volcanoes and their products - his father was a volcanologist and Friedlaender had spent his youth with volcanoes - and this class merited development into a larger program.

In addition to the matter of deficiencies in our class offerings, the influx of students in the early sixties also produced a need for increased staff.

It is perhaps worth pointing out that hiring policies then were different from those of today - a point that is apparently not always recognized when reviewing the practices of the time. During the depression years of the thirties, it was general practice in most organizations to hire only one member of a family. That spread the available jobs, and the support they provided, over as many families as possible. Dalhousie also did this, and there were only very rare exceptions. When Dr. Lothar Richter came to head the Institute of Public Affairs, for example, it was a distinct departure from the established policy to hire Frau Richter as a lecturer in German, and not necessarily seizure of an opportunity to hire an instructor at a minimal salary, as it has been sometimes considered. The policy of one employee per family continued until the sixties. Friedlaender's first attempt to correct the deficiency in the department involved a stratigrapher-paleontologist as a candidate for the position. But she did not wish to come to Dalhousie without her husband, and so neither could be hired.

The need for staff increases came in the later years of Dr. A. E. Kerr's term as president. If Dr. Kerr had not been hired especially to pinch pennies, he nevertheless did so, and it was no small feat for

Friedlaender to obtain the money to hire additional professors, or to hold onto the commitment till an appointment could be made. On another occasion, about 1960, the appointment of a stratigrapher had been authorized, negotiations had been completed, the candidate had agreed, but when Kerr was asked to make the formal offer of a contract he withdrew the authorization.

About 1958 also, and as the first addition, Friedlaender was able to get Dr. A. E. Cameron as a part-time instructor. In the 1940's Cameron had taught a special class in "Metallurgy and Geology" (page 28). Following his retirement from the presidency of N. S. Technical College, he had time to develop this into a spectacular project in "Examination of Mineral Properties". It was limited to senior or graduate students, and each chose some mine property or prospect as his year-long project; commonly it was a prospect with which the student had had direct field contact. Starting usually with surface information, the student obtained, or was supplied with, real data or, where necessary , with reasonable information which Cameron invented, and was then required to recommend the next of the successive stages of exploration or development. In this way, through various stages of geophysical "mapping" and (usually imaginary) diamond drill logs, the student outlined a mineral deposit. While Cameron and the student considered the mineralogy of the body, and from that the chemistry of the probable milling circuits and the cost of concentration, the data on the size and character of the deposit were used as an exercise in the mining engineering department at the Technical College. From the Technical College came back a mining method, mine layout, and cost estimates. The student could then consider whether his mineral deposit was a potential mine, and while doing so Cameron led him through the intricacies of the tax laws, transportation, smelting and refining processes, and marketing costs. So far as possible, he used actual data and, when I inherited some of the project reports after Dr. Cameron's retirement, I was surprised to find in them, for example, actual quotations from shipping agents for costs of freight on bulk concentrates in cargo lots to Antwerp for smelting. Not content with that, Cameron led the student through the business of establishing a company to operate the "mine" and, in one of the reports, I found all the necessary legal forms and documents properly completed. It was a most thorough and valuable exercise for the students.

Despite the difficulties, Friedlaender took steps to correct the obvious deficiencies and did manage to secure funds for several new staff appointments. The first was M. J. Keen, who came from Oxford via Cambridge, in 1961, to a joint appointment in Physics, Geology, and the newly established Institute of Oceanography. In the same year, H. B. S. Cooke arrived from Cambridge and Witwatersrand, and we had our first paleontologist. D. J. G. Nota came from Leiden and Utrecht in that year also. Nota's appointment was in Oceanography, but in those days its staff lived and operated with the closely related departments and Nota, as a sedimentologist, worked in the Geology department. He returned to the Netherlands after about two years.

By these various means, Friedlaender was able to increase the departmental staff by one (Cooke) the shared staff by two (Keen and Nota) and part-time staff by two (D. Loring of B.I.O., and Cameron). For the year 1963-64, the class offerings had been increased to:

1. General Geology (in two duplicate copies)	Milligan
2. Mineralogy	Friedlaender
3. Petrology	Friedlaender
4. Ore Deposits	Milligan
6. Advanced Ore Deposits	Milligan
7. Special Problems (Structural)	Milligan
8. Selected Topics in Canadian Geology	Milligan
9. Geochemistry	Friedlaender and Loring
10. Volcanoes and Volcanic Products	Friedlaender
11. Metallurgy	Cameron
12. Earth Physics	Blanchard and Keen
13. Sedimentology	Nota
14. Crystal Chemistry	Friedlaender and Loring
15. Advanced Petrology	Friedlaender
16. Paleontology	Cooke
17. Stratigraphy	Cooke
18. Introduction to Marine Geology	Cooke, Keen and Nota
19. Pleistocene Geology	Cooke

In 1963, Schenk came from Western Ontario and Wisconsin and, in the following year, took over Geology 1 while Milligan was on leave, as well as the stratigraphy class from Cooke, who was thus freed to begin Geology 20, an introduction to vertebrate paleontology.

In short, by this time Friedlaender had managed to extract funds, and find staff, to plug the major gaps in our class offerings and to expand considerably the scope of the department. The full-time staff was four; joint appointments, three; part-time staff, two.

These changes had more than covered the most glaring deficiencies - in paleontology and stratigraphy. They also marked the beginning of a trend toward increased depth and narrowed range in individual classes. The presence of the "Institute of Oceanography" on campus and of the Bedford Institute across the harbour was also beginning to influence the class program, which later developed a deliberate bias toward marine geology. By this time, 1965, Hicks had been president for two years and staff increases were easier to obtain than had been the case heretofore. Dr. Cooke had been Dean of Arts and Science since September, 1963.

Grade 12 Admission, 1966

After considerable discussion within Dalhousie, and with the other Maritime universities, successful completion of Grade 12 in Nova Scotia, or its equivalent, became the minimum standard for admission after September, 1966. For admission to the Science program the student required an average of not less than 60 per cent in (1) English, (2) Mathematics (Algebra and Trigonometry), (3) A language other than English, (4&5) Two of Physics, Chemistry, Biology, Geology, Geography, History, Ancient and Modern Languages.

This was a considerable change from one hundred years before when the entering student "presented himself to the Principal" to demonstrate his mastery of the first book of Euclid and his ability to read Latin or Greek, or both.

Coincident with the change in admission standards came a re-organization of the degree requirements. In a very general way, the content of the degree program remained the same, but the requirements were stated in general terms and the student had considerable freedom in the choice of classes.

The requirements before and after the change are compared below:

Before the change, for the *ordinary* B.Sc. degree, in 1964-65, the program from Grade 11 was:

(i) Two classes in English and two in French, or German, or Russian.

(ii) One class in Mathematics plus one class in any three of: Chemistry, Physics, Biology, or Geology.

(iii) One class in *one* of: Classical Literature (in translation), English, History, Economics, Political Science, Philosophy, Psychology, Sociology or a Foreign Language.

(iv) Seven other classes, each requiring a university class as prerequisite, from not more than three of the departments of Science, Mathematics and Psychology.

(v) Four electives, of which Mathematics 2 (Calculus) must be one if not already included in (iv). A student who was taking at least four classes in Geology might offer Drawing 1 and 2 (Engineering Drawing and Descriptive Geometry) and Surveying 1 and 2 as two classes in this group.

This made a total of 20 classes from Grade 11, was only very slightly different from the program of 1934 (page 16), and was fairly structured, in practice:

First Year	Second Year
1. English 1	1. English 2
2. Mathematics 1	2. Two classes in Science or
3. French 1, or German 1, or Russian	3. Mathematics
4. Physics 1, or Chemistry 1, Biology 1 or or Geology 1	4. Two remaining imperatives, which
5. A second science class or another language.	5. must include the foreign language if not previously completed

In the third and fourth years:

The remaining ten required and elective classes.

The Honours degree also required four years from Grade 11 and, in addition to all the requirements for the ordinary degree, the student must take at least five advanced classes prescribed by the department concerned and must also take two additional or special classes, one in the third and one in the fourth year. This made a total of 22 classes. To ensure that performance was higher than in the work of the ordinary degree, at the end of the programme the student was required to pass a comprehensive examination covering all the honours work. For this examination, and the five advanced and the two special classes the average grade could not be less than 65 per cent. For first class honours an average of 80 per cent was required. In Geology, the preliminary classes that must be completed prior to admission to the five advanced classes were: Geology 1, Mathematics 2 (Calculus), Physics 10 (Introductory), Chemistry 1 and 2 (Elementary Physical, and Analytical), Drawing 2 (Descriptive Geometry), Surveying 1 and 2. If the student was interested in paleontology, Biology 1 was required. In all this, one can recognize some features that had their origin as far back as 1910.

After the change in matriculation requirements in 1966, "subject groups" were introduced and the requirements for the Ordinary B.Sc. degree (now called *General* degree) were stated in terms of those groups.

A	B	C	D
French	Classics*	Economics	Biology
German	English	Political Science	Chemistry
Greek	History	Psychology	Geology
Latin	Philosophy	Sociology	Mathematics
Russian	*Including ancient history and philosophy		Physics
Spanish			

One can recognize in B and C the disciplines previously required in section (iii) of the requirements for the ordinary degree.

The degree requirements were stated in rather general terms, for a total of 15 classes:

For the first year: 2 credits from group D, 1 from group A, 1 in either B or C and 1 from any group.

For the second and third years: (a) 6 credits beyond the introductory level in the two subjects from group D or Psychology or Engineering. (b) 4 credits in subjects other than the two offered in (a). At least one to be beyond the introductory level.

Any B.Sc. program must include one class in Mathematics, one in English and one in another language.

One can see here a real reduction in the English requirement, from two classes to one, and a similar reduction in the language requirement. The reduction in Mathematics was more apparent than real; what had been the second year class in calculus was moved to the first.

Honours Program

The change in admission standards made possible a large change in the honours program. Instead of 22 classes from Grade 11 it now became 20 classes from Grade 12 and required four years, instead of the three required for the general degree. As before, a student's complete plan of study was to be approved, and supervised, by the department concerned. The comprehensive examination and the minimum average of 65 per cent in the advanced classes were retained.

At the same time "major" and "combined" honours programs were introduced as alternative options for the student, and these have remained to the present. This was possible because of the extra year now available.

For the *major* program, the 15 classes beyond the first year required:

9 credits beyond the introductory level in one subject, the *major*.

2 credits in a *minor* subject satisfactory to the major department.

4 credits not in the major field.

For the *combined* program, the 11 credits of the major and minor were divided more or less equally. To permit some flexibility and emphasis, a maximum of 7 could be in one subject. The 4 elective credits were further restricted and could not be in either of the two "major" and "minor" fields that had been combined.

In Geology, the new arrangements made it possible to provide four options, or streams, within the honours program, depending upon whether the student had an interest in geophysics, geochemistry, stratigraphy or economic (i.e. mining) geology. Certain "core" classes were common to all, and the differences lay in the choices recommended beyond that core. As an indication of the content of these new "streams", the suggested program for each for the honours major is shown in the Table III. Classes were now identified by a three-digit number.

The program for the degree with combined honours was similar, of course, but with the addition of other classes in physics or chemistry or biology, as appropriate. Suggested programs are shown in Table IV.

One may add here that these changes had been proposed seven years before. On 14 December, 1959, Dean Archibald, obviously prompted by Friedlaender, had written to President Kerr proposing to upgrade the undergraduate program in Geology. He argued that "if a good...Honours course [were in place] we could aspire to be the leading Graduate School in Geology in this part of Canada." This was intended to take advantage of the newly established Bedford Institute of Oceanography, and of other research institutions in the city.

Advice for Students

Questioning of established ideas and practice is always desirable and is perhaps a prerogative of the rising generation. In the mid-sixties, however, this practice became almost an occupation in its own right. To make the point by a slight exaggeration, it was almost as if the questioners assumed omniscience, that anything more than thirty years old was archaic, at least, and that it was probably, or necessarily, wrong. This left little room for the possibility that many systems and procedures had arrived at their present state through a process of evolution over many years.

TABLE III
Honours (Major)

	I Economic Geology	II Geophysics	III Geochemistry	IV Biological & Statigraphic
YEAR I	Geology 100 Language 100 English 100 (or elective) Mathematics 100			
	Physics 110	Physics 110	Chemistry 101	Biology 100
YEAR II	Geology 201 Geology 202 Elective (or English 100 if not already taken)			
	Chemistry 101 Mathematics	Physics 220 Mathematics 200	Chemistry 210 Physics 110 or Biology 100	Biology 201 Chemistry 101 or Physics 110 or Mathematics 200
YEAR III	Geology 301 Geology 302 Elective			
	Geology 304 Engineering 200	Geology 405 Physics 230 or Mathematics 200 or 227 or 206	Geology 305 Chemistry 230	Geology 303 Biology 321
YEAR IV	Geology 401 or 406 Geology 403 Geology 404 Engineering 210,211 Chemistry 210	Geology 303 Geology 304 Geology 451 or 401 Geology 452 Math 200 or 227 or 206, or Physics 230	Geology 303 Geology 304 Geology 401 Geology 454 Phys 220 or Bio 201	Geology 304 Geology 401 Geology 455 Geology 457 or 506 Chem. 210 or Phys. 220 or Math 200 or 227 or 206

TABLE IV

Honours (Combined)

	I with Physics	II with Chemistry	III with Biology
YEAR I		Mathematics 100 Language 100 English 100 or Elective Geology 100	
	Physics 100	Chemistry 101	Biology 100
		Geology 201 Geology 202 Elective (or English 100 if not already taken)	
YEAR II	Physics 220 Mathematics 200	Chemistry 210 Mathematics 200, 220 or 228	Biology 201 Chemistry 101 or Physics 110 or Mathematics 200
		Geology 301 Elective	
YEAR III	Physics 230 Physics 330 or 335 Geology 303	Chemistry 230 Chemistry 320 Geology 304	Biology 321 Biology 323 Geology 302
YEAR IV	Physics 310 Mathematics 200 or 227 or 206 Geology 305 Geology 401 or Geology 405 Geology elective	Chemistry 410 Physics 110 or Biology 100 Geology 454 Geology 305 Geology elective	Biology elective Chemistry or Phys 220 or Math 200 or 227 or 206 Geology 401 Geology 455 Geology elective
	Physics 220 - Heat, Sound, Light 230 - Electrical Circuits 310 - Intermed. Mechanics 330 - Electromagnetic Theory 335 - Electronics	Chemistry 210 - Inorganic 230 - Physical 320 - Analytical 410 - Adv. Inorganic (incl. Phase Equilibria)	Biology 201 - Principles Animal Biology 321 - Invertebrates 323 - Vertebrates Engineering 200 - Graphics 210, 211 - Surveying

The popular wisdom of the day promoted the idea of a broad general education, but commonly without any very careful definition thereof. A widely accepted corollary advocated almost limitless freedom of choice for the student in pursuit of this broad spectrum of knowledge. In the typically Canadian way there was, in this country, generally a compromise between the carefully structured programs of the past and the freedom of choice advocated by the extremists. Under the new rules at Dalhousie, the old, established programs were still possible with only minor changes, but a very wide selection was also possible for the student.

The spirit of the times discouraged coercion and closely structured programs. Those who should have known better acquiesced in this, and little or no guidance was provided for the students, other than the general rules on page 40, above. This meant that students were being left to make for themselves decisions influencing their entire lives, but without any basis of experience or judgement on which to make those decisions. Some students concocted programs on no better advice than that of the classmate at the next table during registration. The majority of programs, through accident or good luck, apparently were not unreasonable, but some programs had no coherent objective, plan, or content. It took a few years before the problem was widely recognized and a system of advisors was arranged to assist the student in organizing a course of studies.

In the Geology department the serious deficiencies of the system were avoided. Extending at least as far back as the days of Douglas, it had been the practice of students in the department to seek advice, and approval of their programs, from the professor. Perhaps it was just a custom passed on from one student to another, but our students did continue to do this. Initially, this was informal and the student sought advice where he would, but eventually a formal procedure was set up and the student was required to have approval of his/her program by one of two or three "undergraduate advisors".

Further Staff Increases

In 1966 there had been further staff changes. Nota had returned to the Netherlands in 1962, and that left a need for someone to teach about sedimentation and sedimentary petrology. At the same time, with the presence of the Institute of Oceanography on campus and the Bedford Institute newly established across the harbour, there was developing an increasing interest in marine aspects of geology. Accordingly, the next staff changes added strength in that direction.

D. J. P. Swift had been trained at Dartmouth College, John Hopkins University and the University of North Carolina. He came to Dalhousie in 1963 and remained till 1966, when he resigned and joined the Puerto Rican Nuclear Center as a marine geologist. Since then he has been on the staff of Duke and Old Dominion universities, and at N.A.S.A. While he was here he worked on sedimentation in the Bay of Fundy. That work has proven to be valuable in assessment of the problems associated with tidal power development.

D. J. Stanley was born in Metz, France, but educated at Cornell, Brown University and at the University of Grenoble. He came to Dalhousie in 1964, after experience with the French Petroleum Institute, Pan-American Petroleum Corporation, the Waterways Experiment Station of the U.S. Army Engineers, and the University of Ottawa. In 1966, under circumstances mentioned below, he left Dalhousie to join the Smithsonian, where he has been in increasingly responsible positions since.

R. A. Gees had been trained at Berne, had worked with consulting firms in Switzerland, and had been employed as a sedimentologist with Union Oil of California, before coming to Dalhousie in 1965. He returned to Switzerland in 1971, where he was Director of Water Resources for Canton Berne until he retired.

The Italians had recently had rather spectacular success at unravelling the complex geology of the Appenines through the use of microfossils and had thus demonstrated that micropaleontology could be a powerful tool. In so doing, they had developed a special competence in that field. F. S. Medioli, trained at Parma, came as a NATO Fellow, after a sojourn in Paris, to introduce micropaleontology into our program. He was appointed to the regular staff in 1966.

Alexis Volborth was the last staff appointment to be organized by Friedlaender. Volborth was originally from Finland, but came to us from Nevada, where he had been active in chemical analysis by neutron activation techniques, and his major effort here was to establish our neutron activation laboratory. That required very substantial funding from the National Research Council, and the active co-operation of their Atlantic Regional Laboratory, for the equipment was housed in a special room in its sub-basement. The laboratory and its use is described below (page 57).

"Special lecturers" continued to be added. In a sense this was a revival of the practice of eighty years before, when lectures were provided by interested local people who had the necessary expertise. The first was Dr. A. E. Cameron, who had taught a class in metallurgy as far back as 1940 and was now teaching "examination of mineral properties". By 1966 D. H. Loring had been assisting in geochemistry for several years also. Friedlaender now arranged for J. F. Jones, of the N. S. Department of Mines, to teach a class in groundwater geology and for Dr. B. D. Loncarevic, of the Bedford Institute, to come to work with Keen in geophysics.

The "Stanley Affair"

Dr. Daniel J. Stanley is a sedimentologist and had replaced Nota in 1964. He was an active, not to say aggressive, young man who enthusiastically promoted the study of sediments and, while he was with us, was the founding editor of the journal *Maritime Sediments*. He came to consider himself responsible for all matters marine within the department, and Friedlaender found himself with a burgeoning sub-department and a rather independent "head" thereof. From Friedlaender's view of his authority and responsibility for the department as suggested above (page 35), from personality differences between the two and, one suspects, from some gentle stirring of the turmoil by others in the background, there arose a conflict that caused some ill-feeling in the department and was won by neither of the disputants. Stanley's contract was not renewed and, in 1966, he went to join the Smithsonian. Friedlaender was replaced in due course by a "chairman", chosen according to the system that was, just at that time, being instituted within the Faculty.

Graduate Studies

The university has been awarding Master of Arts degrees since 1869, at least. In the late nineteenth century the award of the degree required that, subsequent to the award of a B.A., the candidate should submit a thesis on a topic previously approved. The required research and writing might be done anywhere, and whether or not additional formal class instruction was required was apparently left to the judgement of the candidate.

The first Master of Science degree was awarded in 1898, in Physics, and the first in Geology was awarded in 1903, to Loran Arthur DeWolfe. (Page 17) Both would have followed essentially the above procedure, and, in fact, the same general principles were followed for another fifty years. Although there was gradual elaboration of the procedural detail, and eventually the work was commonly done at Dalhousie, under more or less close supervision, there were no prescribed class requirements, public thesis defences, or supervising committees. In practice, it appears that most candidates took the opportunity to correct their deficiencies by the appropriate class work. The numbers of such theses were small in most years, if for no other reason than the small number of students in each department.

There was a sudden influx of students after the Second World War and enrollment continued to increase steadily thereafter, with rapid increases after about 1955. The increased enrollment produced a corresponding gradual increase in graduate students. That required some more formal recognition and arrangements, and a Faculty of Graduate Studies was organized in 1949. Professor C. L. Bennett seems to have been the individual to whom all new jobs were given (e.g. Advisor to Student Veterans) and he became the Dean of Graduate Studies. At first this was essentially a paper organization, with Bennett handling all the administrative details. This was also true for a time after Dr. Walter Trost became dean in 1956.

Trost set out to build up the graduate program. This involved, of course, assurance that the appropriate instructional staff, library and other facilities were available. Then, as now, the National Research Council was an important source of the financial support needed for research work and equipment.

Heretofore, in Geology at least, most graduate work had been field oriented and support had come from mining companies and provincial surveys, which benefited from the work and so were prepared to contribute toward the costs. Those direct costs might be relatively minor in some cases, but in others were very substantial indeed: a full mapping crew in the field for a full season or more and, in one case in later years, with a helicopter on charter for the full four months. Mining companies were usually given prior assurance that they would have an opportunity to see the thesis before publication. In theory, this provided an opportunity for censorship; in practice, theses never involved matters of tonnage and grade of reserves, the only matters that the companies normally considered sensitive, and they welcomed the results. Such theses ordinarily did not involve much silicate chemistry, because analyses were expensive and analytical facilities were not available locally. By 1960, however, the emphasis was beginning to change with the interests of new staff members, and as silicate chemistry and instrumental measurements became increasingly important, added laboratory equipment became necessary. Space for chemistry, X-ray, spectroscopic, and sedimentology laboratories was included in the design of the Dunn Building.

For graduate work, there was a gradual change away from the former sources of funds, and increasing reliance upon government support through the National Research Council and, later, the Natural Sciences and Engineering Research Council. The major exceptions have been the Cyprus and other deep drilling projects, (page 86) where government money was supplemented by substantial contributions from mining and petroleum companies.

Trost also needed graduate students to build up the program, and measures to support them were developed. Initially, the student was responsible for his or her own support. In practise, the department found, or helped to find, much of this. Employment as demonstrator in the department provided some income; a salary, and expenses for field work, was usually supplied by the organization supporting the thesis and the summer field work and this commonly met most of the student's living expenses the following winter. Certainly the student, in most cases, lived on a very restricted budget and for those who, unlike the geologists, were not employed by some company to do their thesis work, funding was a real problem.

Trost introduced the system of graduate scholarships to support such students. In its early stages, the scheme went through a number of variations devised to obtain the needed funds from a variety of sources within the university and elsewhere, to avoid complications caused by the taxation laws, and to correct anomalies within the scheme. One unfortunate early variant, for example, penalized the student who was able to find his own support, through summer employment perhaps, and was a direct invitation to the student to rely upon the scholarship scheme and its funds, which were always in short supply.

As the graduate programs developed it became possible to offer the Ph.D. degree, and departments gradually added this. The first such degree in Geology was awarded to Fabrizio Aumento in 1965, for a thesis entitled "Thermal Transformation of Selected Zeolites and Related Hydrated Silicates".

8

M. J. KEEN, 1969-1972

Until 1952, the whole staff of the department was one individual, and the question of departmental organization did not arise. In departments much larger than Geology, there was a department "head", usually the senior member of the departmental staff, who was responsible for the operation and direction of the department. Once appointed, an individual usually remained as head of the department until retirement.

No doubt there were several reasons for the changes that came to the system about 1967. Some are obvious. Even "large" departments had had a staff of only four or five, and relations were close enough that class programs as well as research problems and topics were well known to all members. Where there was judicious direction this could work well. Although research funds were trivial by today's standards, the work of Bronson and of Henderson in Physics, for example, received international recognition. If the department head was lacking initiative, judgement, or drive, however, the whole department could sink into somnolence. At a time, also, when enrollment was increasing and staff was being added to departments, it was probably too much to expect that young and ambitious new professors would be content to sit quietly for years, particularly in a department that was unaware of a changing world.

The Age of Chairmen

The system of permanent "heads" of departments was dropped and the responsibility for a department was given to an elected "Chairman". Within the Faculty of Arts and Science, the change occurred more or less gradually over a period of two or three years, and there was some initial experimenting about the duration of a Chairman's appointment. A short appointment does not really give a chairman time to bring major changes to fruition. On the other hand, an appointment for, say, six years gives a chairman adequate time to wreck a department. Practice has shown that, because of the short period of responsibility, a "chairman" does not impress his ideas and personality upon a department to the same degree as did the long-serving "head", but that an active and efficient chairman can begin programs or policies that, if meritorious, will continue under his successors.

Under this system, the department has had the following chairmen:

M. J. Keen	1969-1972
F. Aumento	1973-1975
M. J. Keen	1975-1977
D. J. W. Piper	1977-1980
P. E. Schenk	1981-1983
M. Zentilli	1984-1986
P. J. C. Ryall	1986-1989
D. B. Clarke	1989-1990

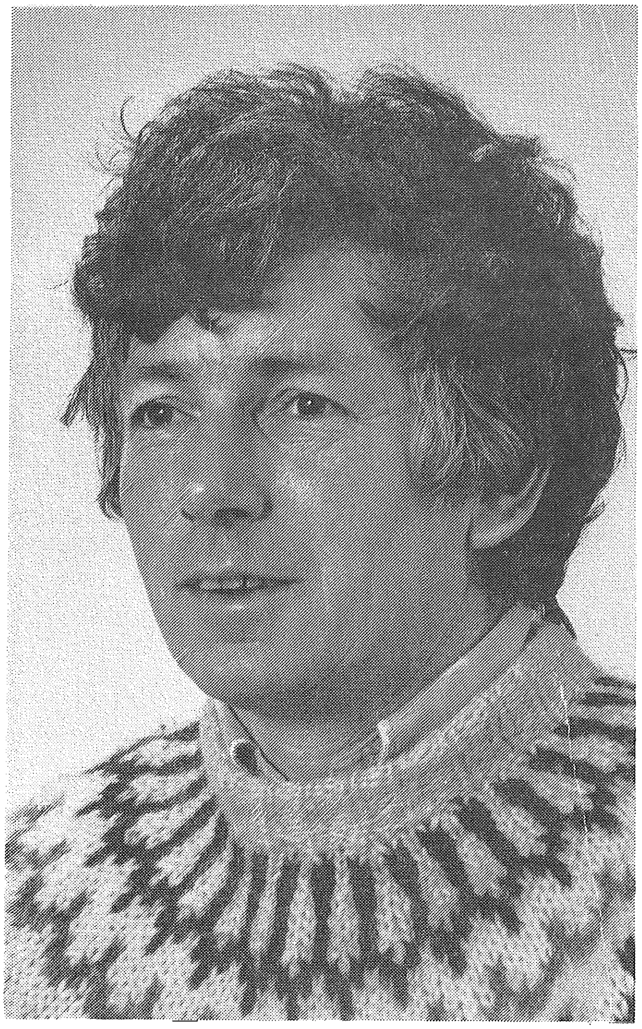
The programs offered by the department have been undergoing constant change during most of this 20-year interval. The long period of nearly constant class offerings, under Douglas, was followed by large additions and expansion, under Friedlaender, as student numbers increased and additional staff became available. Since then, starting with Keen, the class offerings have had minor changes nearly every year, and a major examination and re-definition of objectives about every six or seven years.

The initial changes were in the direction of increased offerings. In retrospect, it appears that each new staff member wished (or was encouraged) to teach an introductory and an advanced level class in his own specialty. In 1969-70, the department offered 22 classes. By 1971-72 we offered 42, some of which were the half-classes then becoming a feature in the Faculty of Arts and Science. That trend continued to develop:

1972-73	23 full classes	13 half classes
1975-76	26 full classes	8 half classes
1977-78	14 full classes	13 half classes
1983-84	4 full classes	22 half classes

It is clear that this matter got out of hand and that many herrings did not necessarily make a whale. The number has gradually been reduced to a more reasonable total.

The reduction in class offerings has had several causes. In the early 1970's the department attempted to meet part of its responsibility to the community at large by offering evening classes. (See pp 46 and 65) These were aimed primarily at persons outside the university who had an interest in, or a need for, some knowledge of geology, but the classes could be used as credit for a degree. This offering was, in essence, an expansion of the previous participation of staff members in "prospector's courses" organized by the Department of Mines and the local branch of the Mining Society of Nova Scotia. Most of the evening classes were



M. J. Keen

F. Aumento

reasonably successful but enrollment gradually decreased. The geomorphology class, for example, had an enrollment of about 25 for several years, but it then dropped to about a dozen. Financial constraints of the 80's, however, eventually killed these classes, although their direct operating costs were not high. Evening classes are still offered at the introductory level, but they are intended primarily for students in regular programs who are seeking a science elective at a convenient hour. Class offerings were also reduced for good pedagogical reasons, by combining closely related offerings for example, as well as to reduce the class teaching load of staff members.

(In the late 1970's and early 1980's the university went through a period when "collegiality" was the buzz-word and nothing could be decided unless it had been discussed at length by several committees. The committees multiplied like microbes. Of course, nobody wants to spend time in classes that are not necessary or useful, but it might be interesting to see how the reduction in teaching load correlates with the proliferation of committees.)

Initially, of course, the increase in staff and in class offerings, under Friedlaender, was designed to fill obvious deficiencies in stratigraphy, paleontology, and geophysics. Those had been filled by the arrival of Cooke and Keen, in 1961, and of Schenk in 1963. This was followed by an increasing emphasis upon marine aspects of geology - a direct consequence of the presence of the institutes of oceanography at Dalhousie and Dartmouth - and the arrival of Gees, Stanley, and Swift, in 1964 and '65, to work in sedimentology, and of Medioli to introduce micropaleontology.

A deliberate decision, about 1970, to place further emphasis on marine geology implied further need for expertise in geophysics, because much marine work involves indirect, rather than direct observation. Geophysics is also an important part of the training of the exploration geologist, and so it is a part of our continuing production of graduates to work in mining and petroleum exploration.

In 1969, Keen became the first chairman and served until the end of 1972. He immediately introduced some minor administrative changes.

Departmental meetings had been held from time to time in the past, but now they were held weekly, so staff members could be kept informed of what had been done, what was about to be done, and could discuss both. The meetings were open to students, and some of them were active contributors to the discussions. Because Keen took the view that the meetings were designed to advise the chairman, he listened to the opinions expressed, extracted therefrom the consensus, and announced his decision. Although there seldom was unanimity, the decisions generally were such that all could live with them and thus he avoided the interminable discussions that might easily have developed.

He also introduced a departmental steering committee as a ready source of quick advice. Consisting of himself and two others, it naturally came to be known as the "triumvirate". Initially the two other members were Cooke and Milligan. Although the membership of the committee changed annually, Keen continued to consult those two also, probably because: (1) they were close to his office, (2) Cooke gave him sound advice, and (3) Milligan could be counted on to provide all the reasons why any proposed change would not work.

Program Arrangements, 1970

Minor changes in program offerings occur almost every year, and major revisions appear to develop naturally about every five to seven years. In preparation for such a review, in the autumn of 1970 Keen examined our situation and his summary is further summarized below:

1. a. We were teaching undergraduates who were: (1) using geology as an elective class, (2) taking classes not available at St. Mary's or N. S. Technical College, (3) meeting a requirement of some other program, e.g. engineering, (4) in a three-or four-year program in geology, for either a general or an honours degree.

   b. We were directing graduate students, including those who were supplementing their work in other departments, where their main interests lay.

   c. We were not reaching those in business, government service, or elsewhere who had an interest in, or a need for, some instruction in geology. That is, an evening program was needed.

   d. Nor were we reaching potential teachers of earth sciences in the schools.

2. The research program, which is the foundation for graduate studies, had a strong bias toward marine aspects, but the interests of individual workers complemented one another to a considerable degree. Several people were engaged in geophysical and petrological studies in Baffin Bay and on the Mid-Atlantic Ridge. In the latter case, the petrological work of Aumento also involved fission track dating of the rocks, which he did himself, as well as potassium-argon dating by Reynolds. The magnetic data from the Ridge led to study, by Hall, of the magnetic iron oxides in the rocks. That, in turn, involved Mossbauer spectrometry (in the Physics department) and

consideration of non-stoichiometry in the chemistry of the rocks. Volborth's neutron-activation laboratory was designed for that, and he could also measure uranium, thorium, and potassium - the sources of radiogenic heat that were involved in Hyndman's study of heat production in the Ridge.

In addition, Gees was studying sedimentation processes on the continental shelf and margin, and there was some work on Pleistocene deposits on shore.

Not all work was at sea, however. Schenk was working on the stratigraphy of Nova Scotia and of Morocco, (places that might once have been side by side) Muecke was involved with the metamorphic rocks of Nova Scotia, Clarke was working on basalts from Baffin Island and beginning the study of the South Mountain batholith on which he has since spent many years, and Medioli was busy with the taxonomy of his microfossils. In addition to many other duties, Cooke was working on the fossil vertebrates of East Africa, as part of the continuing study of early hominids by Leakey and others.

3. The academic staff totalled ten, and there were two post-doctoral fellows: R. H. McCorkell, a geochemist, and K. Aoyagi, from the Japanese Petroleum Company. There was a secretarial and support staff of eight.

There were close working relations with the Bedford Institute, the N. S. Department of Mines, and with the departments of Physics, Chemistry and Oceanography. From the Bedford Institute, B. D. Loncarevic was working with Keen on matters geophysical, B. R. Pelletier assisted with graduate work in marine geology, and D. H. Loring had been teaching geochemistry with Friedlaender for many years. J. F. Jones, of the Department of Mines was teaching hydrogeology and supervising graduate work in the same field. From the Physics department, R. Ravindra cooperated in theoretical seismology and P. H. Reynolds, with a joint appointment in Geology, was doing K-Ar age determinations. In Chemistry, O. Knop continued a friendly interest in mineralogy that dated back to the days of Douglas. In Oceanography, P.J. Wangersky's work in chemical oceanography and that of R. D. Hyndman, on heat flow in the Earth, were also of concern to the geologists.

4. In 1970, the department was operating four laboratories and setting up a fifth, but there were deficiencies in all, of course. The neutron activation laboratory needed additional equipment and the X-ray fluorescence equipment was becoming obsolete. The preparation of thin sections in our own laboratory had just begun and the rock-magnetism laboratory was still being assembled.

Other laboratories in the area were very generous and helpful, however. We had access to atomic absorption equipment at the N.R.C. regional laboratory, to gas chromatography in Wangersky's laboratory in Oceanography, and to scanning electron microscopes in the Anatomy department and at Bedford Institute. The N. S. Research Foundation permitted use of geophysical equipment for teaching. Obviously, the local scientists were getting maximum return on investment by sharing the equipment available.

The department had applied to N.R.C. for funds to purchase an electron beam microprobe, but there were no facilities at all at Dalhousie for study of stable isotopes, such as oxygen, carbon and sulphur.

5. In this review, Keen considered that the major deficiencies in the teaching program were: (a) lack of adequate classes in advanced mineralogy, for lack of a mineralogist; and in structural and mining geology for lack of competent staff. (b) lack of evening and summer classes that would reach outside the normal degree programs to school teachers and the citizens of Halifax. (c) a range of classes in geophysics, "environmental" geology, and geological engineering. (d) lack of instruction in geography. For a few years, Cooke, Milligan and G. Davidson (of the N. S. Department of Municipal Affairs) taught such a class, but it died of lack of support from Dalhousie, where the faculty seemed to consider it a subject fit only for the schools.

Out of this review came some changes. Several evening classes were offered as a service to interested members of the general public. For a few years Keen offered a class in applied geophysics, which attracted students in civil and mining engineering from the Technical College. As a service for teachers in the schools, the introductory survey class, Geology 100, was offered in the summer for several years and a class in mineralogy for one year.

When one invites criticism, you can be sure it will be provided. The majority of departmental meetings were open to the students, but usually had a full agenda. In April, 1972, Keen invited students to a meeting where class offerings were the only topic, and they had considerable criticism to offer.

Some were predictable: matters of work required and grading thereof; the reality of learning basic mineralogy in second year not matching the exciting expectations generated in first year; insufficient field instruction; and course content not matching that advertised in the calendar descriptions. Obviously some of these could be corrected without great difficulty - by some care on the part of the instructors. Others, e.g. field work, required both more time and more money than was assigned for the purpose.

There also were complaints that instructors operated in isolation and demanded amounts of work that were not realistic, when one considered that the student had to satisfy five instructors all operating in the same independent way. Discussion of this matter produced, from the students present, the interesting opinion that a total of 60 to 65 hours of work per week was not an unreasonable requirement.

There was also a complaint about "lack of depth" in the class material. Although this lack was ill-defined, it probably reflected two things: first, program requirements that prevented a student from following a pet interest so far as desired and, second, the real perennial problem of the background of the student. If that background contains little basic mathematics, chemistry, and physics then the presentation of geological material must be descriptive rather than quantitative and it cannot be pursued to any depth; the thermodynamics of metamorphic processes is not intelligible to someone who has neither calculus nor chemistry. This problem always leads to debate: if students are required to take extensive classes in other disciplines, they never get to geology; if they are taught the necessary basic science as part of the geology program, it is counter-productive; if they are not so taught, the program is superficial. Discussions in the department produced, as one extreme, the suggestion that students be required, in effect, to take a three-year degree in physics or chemistry before a final year almost exclusively geology and, at the other extreme, the staff member who argued that, had he been required to take extensive mathematics, he would have been an archaeologist instead. In practice in recent years, the department has generally met this problem by including in its class offerings additional material from the basic sciences sufficient to make the geology intelligible. So a class in paleontology or sedimentology may learn some statistics, and a class in petrology or ore deposition may learn some physical chemistry. It is never at all clear whether or not this produces real understanding, or only the illusion thereof.

Pigs in Africa

The reference on page 46, above, to the work of Dr. Cooke on fossil vertebrates in East Africa deserves a word of explanation because it was one of the items that, at that time, was making Dalhousie known beyond the three-mile limit.

The work of the Leakey family on the fossil remains of early hominids in East Africa is now well known. In 1969, Richard Leakey began investigations at Koobi Fora, on the east side of Lake Turkana (formerly Lake Rudolf). Five hominid specimens, including two skulls, were found beneath a tuff that came to be known as the KBS tuff, after Kay Behrensmeyer, the geologist in the party. Several paleontologists were then added to the project to work on different fossil animals, and Dr. Cooke was invited to deal with the fossil pigs because, as Leaky said in one of his books, Cooke was obviously the leading authority on fossil mammals of East Africa.

Initially this was a relatively straightforward project. Fitch and Miller, at Cambridge, assigned an age of 2.61 $\pm$ 0.26 million years to the KBS tuff, using the K/Ar method. The hominid fossils were therefore the oldest known, and the ancestry of humans was pushed well back toward three million years ago.

As the work on other fossils progressed, however, it became clear that something was amiss. The pigs found *below* the KBS tuff matched pigs from Olduvai and other areas that were about two million years old. Some other fossils, especially horses, also appeared nowhere else in Africa older than two million years. If the fossils were to be believed, the KBS tuff could not be more than two million years old, and possibly less. The problem involved not only the age of the tuff but the prestige associated with the oldest hominid fossils, correlation of them with other hominids, personalities, the generation of research funds, and a number of other things. In 1976, Fitch and Miller revised the age of the tuff to 2.42 $\pm$ 0.01 million years, by the $^{40}Ar/^{39}Ar$ technique, while another group, at Berkley, obtained 1.82 $\pm$ 0.04 million years by the K/Ar method. The controversy raged on for several years, produced several books and considerable ill will, as well as two other paleontologists who re-examined all the fossil data and eventually came to the same conclusion as Cooke: the KBS tuff could not be more than two million years old. In 1985 MacDougall, at the Australian National University, published an age of 1.88 $\pm$ 0.02 million years for the tuff, and in 1987 a laboratory at Berne obtained an age of 1.87 $\pm$ 0.04 million years from the residue of the original sample used by Fitch and Miller. This provided confirmation of the age obtained at Berkley and of the paleontology of Cooke, but no explanation of the 2.42 million year age obtained over and over again at Cambridge was then available. I am informed by Dr. Cooke that it now appears (1990) that the anomalous radiometric ages come from two groups of feldspars, one derived from the wall rocks and incorporated into the tuff along with the other, which was a part of the magma that produced the tuff. Anyone wishing to see more non-technical details of this affair can find them in MacDougall's report in Bull. Geol. Soc. Amer., vol. 96, No. 2, 1985, pp. 159-175, and in two books intended for a general audience: *Bones of Contention*, by Roger Lewin, Simon and Schuster, New York, 1987, and *Lucy*, by Don Johannson and Maitland Edey, 1981, also published by Simon and Schuster.

Staff and Equipment

Apart from matters that arise in the course of daily administration of the department, Keen had three main problems. They were: (1) the teaching program discussed above; (2) the staff to teach and to direct research; (3) the laboratory and office space to accomodate them. It took time, of course, as well as money, but deficiencies were gradually filled.

Academic staff was added. The retirement of Friedlaender in 1970 created a need for a mineralogist and igneous petrologist. Sixty percent of Canada is underlain by metamorphic rocks of the Canadian shield, where most of our mines are found and where many of our geologists work. It was therefore sensible to strengthen the teaching program in metamorphic petrology. By the autumn of 1970, Dr. D. B. Clarke had arrived from Toronto, via Edinburgh, as the igneous petrologist and Dr. G. K. Muecke had come from Alberta, via Oxford, as the metamorphic petrologist and geochemist. In his latter capacity, Muecke worked closely with Volborth. In 1970, also, Dr. J. M. Hall arrived from Wales, the University of London, and field work in Africa, to set up the paleomagnetics laboratory. To replace Dr. Gees, whose contract had not been renewed, Dr. D. J. W. Piper arrived from Cambridge in February of 1972, bringing his interest in deep-sea sedimentation, and in 1973 Dr. Marcos Zentilli came from Chile and Queen's to take over instruction in Economic Geology. Dr. Volbroth departed in 1972, to the University of California.

Laboratory facilities also received attention: Minor changes were made to increase seating capacity in the teaching laboratories in the Dunn building, the facilities for radiometric age determination were improved and the X-ray equipment was modernized. A microprobe, a scanning electron microscope, and the paleomagnetic laboratory were installed in the newly-built Life Sciences Centre. At the Atlantic Regional laboratory of N.R.C., the equipment for neutron activation analysis was modified. In cooperation with the Nova Scotia Museum, a shop was set up to make thin sections. Arrangements were made with the Physics department to share the services of two electronics technicians and of the instrument makers' shop, in return for a contribution toward their costs. The Nova Scotia Research Foundation cooperated by making some geophysical instruments available, and the research that was done at sea was done in ships of the Bedford Institute.

Following are outlines of the development of each of the main laboratory facilities and of the staff therefor. The chemistry and X-ray laboratories had been set up long before Keen became chairman, and others, such as the paleomagnetic, and neutron activation analysis facilities, were being developed at this time. The story of each is presented here in a brief summary rather than in the disjointed way that would result if a strict chronology were followed.

Teaching Collections

The teaching collections are obviously a very important part of the departmental operations and rock and mineral specimens are used in very large numbers in the teaching laboratories and class rooms. The quality and extent of such collections is therefore of great concern and the supply of suitable material can be a matter of continuing and considerable expense, because there is a steady consumption due to normal wear and tear in the teaching laboratories.

It is equally obvious that the teaching collections had their beginning with that of the department; Honeyman made extensive use of specimen material in his classes, although it is probable that most of his material came from the museum of which he was director.

Subsequent professors also added material when they could. It is of interest to note that the minutes of Senate for 17 Oct. 1898 report a gift from a Mr. J. Hewitt of a suite of minerals from the Gagnon mine at Butte, Montana. Some of that collection has survived to the present. And on 25 September, 1902, the President announced to Senate "that the Geological Collection of the late Dr. Honeyman had been presented to the College by Mrs. Honeyman and family".

The "Honeyman Collection" has had a checkered career since then. It includes a substantial number of fossils, many of them from the classic section at Arisaig and in some cases the type specimens of species first found there. It is therefore extremely valuable. For reasons now unknown it was physically transferred to the Nova Scotia Museum at some time in the past. This was probably a wise move because Dalhousie did not have the facilities to deal with such a collection. After the Geology department moved into the Dunn building, part of the collection was transferred back to Dalhousie and for some years was on display in our museum there. When the museum space was converted to offices, the Honeyman

Collection was again transferred to the N. S. Museum, where it now remains and where it is receiving proper curatorial care. The collection we are here discussing is NOT "Honeyman's Mineral Collection", which was given to the department by his great-grand-daughter, Beatrice Robb, about 1980. That is a commercial collection of minerals that Honeyman would have used as reference material, and of "blow-pipe" equipment that he would have used in identifying minerals.

Successive professors apparently added to the permanent collection as opportunity and funds permitted. Because Douglas did much of his teaching in the field, many of his laboratory exercises and much of his specimen material was derived from that field work. Very probably Woodman and McIntosh used a similar approach. Nevertheless, to obtain good quality museum specimens and material for class exercises it is also necessary to purchase from commercial suppliers, and all three made limited numbers of such purchases. Friedlaender also had a policy of buying each year a few excellent specimens for our museum. In class exercises, specimens of minerals, especially, are damaged or destroyed in the tests applied to them. When classes are large, the replacement of this material can be a significant annual cost.

From time to time private collections become available, but we have never been in a position to purchase. In March, 1960, for example, the late Frank Ebbutt, a well-known consulting geologist, offered his collection of about 1500 specimens showing characteristics of gold mineralization. It had been accumulated from mines all over the world and was worth far more than the ten thousand dollars he was asking, but that was a price much larger than the university considered it could afford.

Only rarely is one given specimen material in tonnage lots! In 1961, a field trip of the Dawson club to the Walton mine was shown a cavern in which were a great many large stalactites, stalagmites, and columns. The surface of each was covered with excellent large crystals of calcite, showing a variety of forms, and most were obviously of museum quality. George Kent, a graduate student who had been Geologist at Walton and was still monitoring developments there, had already made for the manager an appraisal of the value of the material as museum specimens. After some consideration of their possible commercial value, the mine manager concluded that he could not afford the loss of production that extraction of the columns would entail. He offered, instead, any we could remove in one day. The next week end, Kent and three other students, D. R. Grant, D. E. Lawrence and George Stewart, removed about 1500 pounds. They were very careful in their choice of material, and took great precautions to avoid damage to the specimens. Each university in the Maritimes eventually received some spectacular large specimens, as a result of their efforts.

As recounted on page 29, the museum collection was a complete mess in 1945 because the movers had dumped the whole thing in a heap when it was transferred from the attic of the chemistry building. There were some efforts to repair the damage, but Goodman says it was still a considerable mess when he returned in 1952. He and W. F. Take, a student who was an excellent mineralogist, were able to make some improvements, but it is probable the damage was never completely repaired. One suspects that, because the provenance of many specimens could no longer be known, they were gradually consumed in student exercises.

To be of any use, the specimens in a collection of rocks and minerals must be accessible to those who would use them. This requires that there be some sort of cataloguing and filing system. After 1957, as the teaching and reference collections grew, efforts were made to identify all the material and to catalogue it according to a system that Friedlaender set up. Unless new material is also catalogued immediately on receipt, and all material is stored systematically, however, any system breaks down. By 1972, the collections were again in such disorder that a whole new system of cataloguing, record keeping and storage was set up. This included an unusual provision for taking selected specimens from the material used for thesis research and incorporating them into the departmental collections. The objective was to ensure that important and representative samples should not be lost, while permitting destruction of the bulk of the rocks collected for thesis projects; some of those working collections amounted to tons.

No matter what system is used, museum and research collections have the same problem as do libraries and archives - they grow larger and require constantly increasing storage space. It appears also that most students, on completion of a thesis, wash their hands of their material and depart as soon as possible; very few have made the "required" selection of important and representative specimens, and thus large amounts of thesis material have accumulated. It is probably fair to note, also, that professors do the same thing. In consequence, sample storage is a perennial problem. In October, 1970, in addition to storage in the "catacombs" under the steps of the Dunn building, and in all the available and more accessible space in that building, there were samples stored in the basement of the Holy Heart Seminary on Quinpool Road, and at the Nova Scotia Museum. Since then storage space has been used, for various lengths of time, in different parts of the Life Sciences Centre, the basement of the Archives building prior to its conversion for the Mathematics department, in private garages, and in a warehouse on Barrington Street. Almost all of these were expensive buildings to construct, i.e. this is expensive storage space, and it would seem to be sensible not only to reduce the volume of material where possible but to house in less expensive locations at least that material not constantly required on short notice.

No matter how large the collection, or how well organized, it is useless if the material cannot be produced when and where it is required. The efficient operation of laboratory classes then puts very considerable demands upon the person responsible for the teaching collections, who must ensure that the hundreds of samples required for each class are available in good order where needed and are properly returned to storage after use. It is only the person who must sort them out who really appreciates how much disorder can be generated during an exercise by, say, 30 students each with 20 specimens.

The first custodian of the collections was Owen K. Watkin, who made many gallons of very powerful tea and prepared classroom samples during the years between 1958 and 1971. A former soldier, a former steward on CN liners and other ships, a very amateur painter, and a very lonely man, he was a character familiar to a generation of geology students. He was a victim both of a taste for Scotch whiskey (which he was not always able to control) and of the very low wages then paid by Dalhousie to staff lacking academic qualifications, but he conscientiously did his best to assist staff and students. His major job was to ensure that appropriate specimen material was available in good order for laboratory classes. It was during this period that enrollment in Geology 100, for example, approached 200 and a single laboratory class involved more students than the present total enrollment in that course, so he was kept busy. He retired in 1971, and died of cancer early in 1973.

He was followed by Donal Twomey, who had been trained as a technician in medical X-ray work. Accordingly, he was employed to do some X-ray photography, especially with cores from muddy sediments, as well as to look after the teaching collections of rocks and minerals. He resigned in 1974, and was replaced for the academic year 1974-75 by Gary Alcock.

The teaching collections are now the responsibility of Brant Laidler, who has, in his quiet and efficient way, been dealing with them since 1975. This has also involved the not inconsiderable matter of transfer from the Dunn building, a job he managed very efficiently.

Research collections, generally, are now in charge of Chloe Younger. As curator she has set up yet another recording and accession system for research materials used by staff and graduate students, and for the cores and other samples from such projects as the Deep Drill program in Iceland and elsewhere. In addition, she has also accomplished the considerable feat of reducing the chaos in the actual storage of specimens; something that was never really achieved after 1945.

Sedimentology Laboratory (by M. R. Gibling)

The sedimentology laboratory had its beginning with Dr. D. J. G. Nota, who was Visiting Professor of Marine Geology in 1961-62; he was supported by the then-new Dalhousie Institute of Oceanography. He began investigations of the near-shore sediments of the Scotian coast, out of which came the M.Sc. theses of F. J. Nolan and D. R. Grant. This work examined questions of provenance and size analysis of the sediments, and the first equipment obtained for the laboratory was for that purpose.

There was an hiatus before D. J. P. Swift and D. J. Stanley arrived in 1964. They enlarged the laboratory by expanding into the room previously allocated to photogrammetry, and added further equipment as well as a small reference collection of sediments and sedimentary rocks. This process was continued by R. A. Gees. Generally this involved addition of further equipment, such as mechanical sieves and particle counters, and improvement of the existing equipment.

By the time D. J. W. Piper arrived in 1973, most of the standard equipment of a sedimentology laboratory was in place, although the room was desperately overcrowded. There was some expansion into a basement room originally intended as a clean room for the preparation of thin sections, but the facilities remained very crowded.

During the 1980's, several new items of equipment were added to the departmental resources for sedimentary geology and paleontology. These included a mass spectrometer dedicated to analysis of C and O isotopes (D. B. Scott), a vibracorer for modern sediment studies (R. Boyd), and cathodoluminesence equipment for studies of cementation and diagenesis (P. E. Schenk). The fission-track laboratory (M. Zentilli) has been widely used in sedimentary studies. However, a noticeable trend was the tendency to use, through cooperative research, major expensive networks of equipment in locations across Canada, in Europe and the U.S.A. This trend reflected in part the great cost of high-quality equipment, a general decline in government subsidy of science and, perhaps, a growing interdisciplinary understanding. As has been the practice for many years, marine geoscientists at Dalhousie have continued to use Bedford Institute oceanographic vessels, sophisticated marine geophysical equipment (such as side-scan sonar and high-resolution seismic apparatus), and sediment dynamics monitors (the RALPH system developed at Bedford). Sedimentary petrographers have increasingly used regional facilities in Atlantic Canada (the electron microprobe and X-ray fluorescence) and the scanning electron microscope and X-ray diffraction laboratories at Bedford. Coal petrographers have used equipment at the Institute of Sedimentary and Petroleum Geology in Calgary, where geoscientists frequently have been willing to run sample suites as part of their routine laboratory system. There has also been greater emphasis on contract analysis at well-reputed laboratories (e.g. S isotopes, radiocarbon dates), thus obviating the necessity for the setting up of expensive laboratories at numerous locations; many institutional laboratories now draw a substantial proportion of their funding from contract work. In all these ways, our research has become more technical, with each department focusing on a few important pieces of equipment.

The Paleomagnetism - Rock Magnetism Laboratory (by J. M. Hall)

Initial establishment of this laboratory was a result of the interest being taken by the Department of Geology in the late 1960's in the then very exciting field of ocean crust geology. Work in this direction, led by Keen and Aumento, had involved cruises to the Mid-Atlantic Ridge at 45°N which involved the recovery, by dredging and drilling, of submarine volcanics, as well as extensive geophysical surveying. Studies of the magnetic properties of these basalts, of great interest at that time to the proper interpretation of linear magnetic anomaly patterns, was carried out by Ted Irving, then located at the Geological Survey of Canada in Ottawa. It was seen to be advantageous to have an in-house laboratory capable of dealing with the magnetics of the expanding sets of submarine rocks. For this reason, Hall joined the Department in 1970. He had previously been involved with the establishment of a paleomagnetism - rock magnetism laboratory at the University of Liverpool, U.K., and in addition, had a strong interest in the Fe-Ti oxide minerals responsible for the magnetism of igneous rocks.

With financial and logistic support from the University and the National Research Council a basic laboratory consisting of a Schonstedt analog spinner magnetometer, Dalhousie-built alternating field (af) demagnetizing equipment and Curie balance, and a Reichert Zeto-Pan Pol microscope set up for reflected light work, was established by 1972. A first refinement was in the installation of a special power supply for the af demagnetization equipment. Testing showed that transients in the mains supply resulted in spurious magnetizations in samples. This difficulty was overcome by the installation of 400 Hz motor generator set that, through its mechanical inertia, removed transients from the supply to the af coils. A major upgrading of the laboratory took place in the early 1980s, following a period of throughput of very extensive sample sets from the Deep Sea Drilling Project, Bermuda, Iceland, the Azores and the sediment section of the Pannonian Basin (Hungary). Upgrading involved the replacement of the Schonstedt analog magnetometer by a SSM-1a digital spinner magnetometer made by the same company. Over the same period the Dalhousie-built alternating field demagnetization equipment was replaced by a Schonstedt demagnetizer, incorporating reverse rotation to prevent the acquisition of rotational remanence by samples. A Schonstedt thermal demagnetizer was also obtained at this time, as was a viscous remanence magnetometer.

During the 1980's the laboratory was kept very involved in the magnetic characterisation of several thousand drill core and outcrop samples, largely from the Troodos ophiolite of Cyprus, which is a good constructional analog for in-situ oceanic crust.

At the present time it is planned to develop the laboratory in the direction of the measurement of acquisition and loss of viscous magnetization at temperatures from ambient of up to 300-400°C. The objective is to follow interest in the magnetization of the continental crust at depth, there being disagreement between the magnetization of outcrop samples from supposed mid-lower crustal rocks and the magnetization of the in-situ crust at depth as obtained from the inversion of long wavelength MAGSAT and other anomalies.

Preparation of Thin Sections

As early as 1883 Honeyman published the results of what he called "polariscopic examination" of the gold-bearing rocks of Yarmouth County. In fact, the Nova Scotian Institute of Natural Science purchased for his use an excellent, and remarkably refined, polarizing microscope, which is now in the possession of the Nova Scotia Museum. As mentioned on page 22, in 1907 Woodman spent $45 for a rock-slicing machine. Presumably this was for the preparation of thin sections and presumably, also, the sections were prepared by hand. Although I can find no descriptions of the techniques then used, as late as the 1950's, even in large laboratories, the standard procedure used only a rotating cast-iron lap for rough grinding, followed by hand finishing on a glass plate.

During all the years when McIntosh, Douglas and Friedlaender headed the department, such thin sections as were required were prepared by others. For many years the work was done by John Monteith, of the Royal Ontario Museum, and in later years by a laboratory in Victoria, B. C. By 1965, however, increased numbers of graduate students, and increasingly elaborate investigations, required thin sections in quantities that could not be supplied conveniently by shipping hand samples back and forth across the continent.

In 1969, Keen took steps to set up a shop to prepare thin sections. A few years before, Milligan had seen, and been greatly impressed by, the methods used at Landbouhochgeschule, Wageningen, Netherlands for making both normal and giant sections. When he offered a suggestion about the proposed shop, he was promptly given the job of organizing it.

At that time the Curator of Geology at the Nova Scotia Museum was also concerned about making thin sections, and a cost-sharing deal was arranged: Dalhousie provided the technician, the Museum provided the space, and the cost of the machinery was shared equally. The major machinery expense was a surface grinder (a standard machine in a tool-and-die shop) capable of grinding two surfaces parallel within 0.0012 mm per metre. This cost-sharing deal still (1990) obtains, and the sections required by the Museum have priority in the shop, although, in fact, at no time has the Museum required large numbers of sections.

Gordon L. Brown was hired in 1970 as the technician to operate the shop. Previously he had worked very briefly at N. S. Technical College, where he made sections of concrete, but he was not familiar with rocks. Through the cooperation of the University of New Brunswick and of the Geological Survey of Canada, he received instruction from their technicians on their techniques for making both thin and polished sections, and in our own petrography class he learned about the optics and appearance of minerals in thin section. Thus equipped, in November, 1970, he began to produce thin sections and to develop his own techniques on our equipment.

Normal petrographic sections presented no serious problems. On the surface grinder, up to a hundred samples at a time, sawn roughly to size, have a flat surface cut upon them and each is then cemented to a microscope slide. In a specially made jig, 12 sections at a time are thinned on the grinder to within 10 to 30 microns of the finished thickness. Because of the accuracy of the grinder, the sections are then of uniform thickness and require only final adjustment to standard thickness; this is done by hand on a glass plate. Although the surface grinder has been operating for twenty years in abrasive materials that would not be tolerated in a tool-and-die shop, it still retains its accuracy and continues to produce first class work. Brown has also been able, by slight modification of technique, to produce sections of halite and other soluble salts. The unique feature of this process is the jig that is used: it avoids the problems caused by differing thicknesses of the glass slides, a problem common to all other section-grinding machines.

By adapting the Dutch technique, Brown has also learned to produce sections of uniform thickness up to 10 cm wide and 20 cm long. So far as we know, there is only one other laboratory in North America where this is done as a routine procedure. Although each requires about half a day to complete, the resulting section shows in beautiful detail the complex structures and relations that are lost in normal sections because of their small size.

Geologists began the study of opaque minerals in polished sections about 1906, using techniques borrowed from metallography. In minerals, however, the polish was very poor and marked by pits, scratches and excessive relief between hard and soft minerals. By 1928, it had become clear that the relief problem could be beaten only by polishing on soft-metal (lead) laps, and techniques for this had been developed by Schneiderhohn, in Germany, and by Graton, at Harvard. Influenced, no doubt, by the work of his former classmates at Harvard, Douglas bought a polishing machine. His students attempted to make polished sections, but with very little success and, until Brown came upon the scene, polished sections required for classes and for research were made by Charles Fletcher at Harvard.

The quality of the polished surface is of importance for both the microprobe and for reflected light microscopy. In reflection microscopy it was early recognized that the contacts between hard and soft minerals are important locations for minute components of prime significance, which are not visible if the surface has high relief. Also, soft minerals, such as gold, within hard minerals, such as pyrite, will appear only as dark pits unless the surface is completely free of relief. Furthermore, any meaningful measurements of the reflectivity of the minerals requires that the reflecting surface be flat and normal to the axis of the microscope. Surfaces polished with cloth are commonly visibly spherical. On the microprobe, reproducible analyses are difficult to obtain where the mineral surface is rough, scratched, or pitted, so a "Durener" polishing machine using lead laps was bought as part of the unit when Clarke installed the probe in 1971. With this machine, the one bought by Douglas, and its duplicate, on permanent loan from N. S. Technical College, we had three machines available and a need for polished sections.

Brown quickly learned the truth of Graton's statement that "the operation of polishing mechanically on lead laps is an art, not a fool-proof process" and to appreciate the comment of Charles Fletcher that, even after polishing perhaps 100,000 specimens, his technique was still improving. Fortunately, Brown had the patience to put up with the differences of machines allegedly identical, and to interpret very slight changes in the condition and appearance of the laps. He has gradually learned to produce polished surfaces of very high quality: a scratch-free surface, essentially zero relief (on gold particles in pyrite, for example) and a surface that is almost flat. A casual test of one of his sections against an optical flat showed the surface to be approximately spherical and the departure from flatness to increase by about 3500 Angstroms (half the wavelength of red light) per millimetre. He has also learned to produce such surfaces on tuffs and other friable materials by using appropriate impregnating media.

It is very easy to develop an exaggerated opinion of the quality of one's own work. We have had, however, a sufficient number of graduate students and professors visiting from many other universities, the world over, that we now think we are justified in claiming that Brown's preparations are better than most, and the equal of the best.

For many years the thin-section shop was widely dispersed: the diamond saw was in the Dunn building, thin sections were prepared at the Nova Scotia Museum, on Summer Street, and the polishing machines were in the Life Sciences building. This situation was finally corrected in 1984, when Dr. J. M. Hall donated space formerly used for storage in the basement of the Life Sciences building. Brown was thus enabled to get all his equipment together for the first time. Production increased immediately, because many operations could then be performed simultaneously by utilizing the automatic features of the machinery. It became clear, however, that the lengthy third, and final, stage in polishing of sections was a serious bottleneck and a second "Durener" machine was added to that stage in 1988. A "Brot" grinding machine, capable of simultaneous grinding of 36 thin sections was installed in 1989.

Electron Microprobe Laboratory (by D.B. Clarke)

In the autumn of 1970, M. J. Keen, Chairman of the Department, applied to NRC for funds to buy an electron microprobe. In the spring of 1971, a grant of $60,000 was awarded for this purpose, and Dalhousie contributed a further $40,000. During the late spring and early summer of that year, Clarke and Muecke visited Ottawa and Dearborn, Michigan, to assess the Cambridge, MAC, and ARL microprobes. Also, Clarke alone visited the JEOL factory in Tokyo to inspect their microprobe, and the Cambridge Instruments factory in England to see their instrument. In July, an order was placed for a Cambridge MK. V electron microprobe, and with the help of some additional money from the Oceanography Department we also purchased an S-600 scanning electron microscope for micropaleontology.

In the autumn of 1971, with delivery imminent, Clarke and Joe O'Byrne (technician in Physics) interviewed several applicants for the position of microprobe technician. On the basis of his proven skills and professed interest in geology, Bob MacKay was hired and dispatched to the Cambridge factory for training. Late in 1971 our probe was delivered and installed on the third floor of the Oceanography wing of the Life Sciences Centre. Clarke and MacKay spent many months making the system operational. By today's standards, the operation was rudimentary. Our (circular!) polished thin sections were made in California. The microprobe had only two wave-length spectrometers (WDS) for which both peak and background positions had to be set manually and thus, for a mineral analysis involving ten elements, we had to make five passes through the entire suite of standards and samples. All sample positions had to be located, and repeatedly relocated, manually by means of X-Y drives on the sample stage. All the initial data reduction (mean peak and background counts) had to be done by hand calculator, entered on an IBM coding form, and then punched onto IBM cards for the EMPADR7 software running on the university mainframe computer. A typical cycle was to run the probe one day, process the data the next, so that the results of an analysis begun on Monday morning would be known on Tuesday afternoon. Even so, this tedious procedure resulted in an order-of-magnitude increase in productivity from one complete analysis per day by wet chemical techniques to ten per day by electron microprobe.

After establishing that our analytical results were satisfactory, we opened the lab for general use. Our first users were: Faculty - H. B. S. Cooke determining U in pigs' teeth from Africa; Graduate Student - C. Campbell from Physics taking secondary electron photographs of metals; Undergraduate Student - G. Berko for his Honours thesis.

Although we continued to analyze materials in much the same fashion for the first four years of operation, improvements did occur in the preparation of polished mounts and polished thin sections as Gordon Brown developed in-house capabilities. Then in 1976 we added an Ortec 159 eV energy-dispersive systems (EDS) which would allow the simultaneous determination of all major elements with atomic number 11 (Na) or greater. Collecting the EDS spectra was relatively easy, but reduction of the data was problematic. Die-hard WDS supporters refused to acknowledge that the data could be as good as WDS data, especially for Na-Mg-Al-Si where peak overlaps could be substantial. Considerable time was spent determining backgrounds and peak overlap corrections for our system, and in transferring the spectra to the mainframe computer via a modem to run on Dorian

Smith's EDATA program. During this time in 1976-77, Ian Gibson was a Killam fellow and was very helpful in getting many of the bugs worked out of the system. Once completely working, the EDS system returned analytical results to the probe user within about ten minutes after the analysis was made, and our production rate rose to about 50 analyses per day. The rapid return of analytical results to the lab meant that the user could assess the quality of data as work proceeded, and if re-determinations were necessary, they could be done immediately and not, as before, several days later.

Through the late 1970's and early 1980's, mechanical problems with the WDS system increased with broken spectrometer drives, counter windows, etc. The supply of replacement parts dwindled as Cambridge Instruments went out of the microprobe business. We increased our reliance on EDS, but the increased usage of the mainframe computer by others caused major headaches for the probe laboratory because the enormous size of the EDATA program put us at the bottom of the priority list for interactive users. Early in the morning, we could still get analyses returned to the lab within ten minutes, but as the day wore on, we waited hours for data to be processed, and our productivity dropped.

In 1981 Bob MacKay completed an Honours degree in Geology, thus dramatically confirming his stated interest in geology many years before. This was the final feather in his cap, after demonstrating that he was also a superb microprobe operator, maintainer, instructor, and computer whiz. Thus, after MacKay had spent 10 years in the job, Clarke declared him the best microprobe technologist in Canada (a declaration which is still true); in fact, the combination of MacKay on the probe and Brown preparing polished materials must be unsurpassed anywhere.

In October 1983 we moved the Cambridge Mk. V. EMP from the Oceanography wing to the Biology/Geology wing of LSC. Although the microprobe laboratory was never conceived as a regional facility, it nevertheless served the analytical needs of researchers in many universities in the Maritimes and beyond. As the 1980's progressed, the volume of work, lack of spare parts, and frustration with Computer Centre combined to produce a new application to NSERC for a new microprobe. This application stressed that ours was de facto a regional facility, and the application was signed by 14 researchers in five universities and local research institutions. In April of 1984 we received a new grant of $525,000.

This time, Clarke and MacKay made several shopping trips to assess the only two microprobes left on the market, CAMECA and JEOL. The machines were about equal in performance, but in the end we decided in favour of the proven technology of JEOL over a brand new technology developed by CAMECA, and placed an order for a JEOL 733 Superprobe. (Every product in the 1980's had either the prefix "ultra" or "super"). In the latter part of 1984 and early 1985 installation of the new instrument took place. The microprobe had four computer-controlled wave-length dispersive spectrometers, a Tracor Northern energy dispersive system, a computer controlled sample stage, and powerful in-house computing capabilities. Gone were the hand calculators, the manual settings of peaks, backgrounds, and sample positions, and the frustration with the Computer Centre. Our rate of analysis now increased to 100 per day, an increase of two orders of magnitude in less than two decades!

Throughout 1985, we ran our two microprobes side by side comparing the results obtained on the Cambridge EDS with those from the new JEOL WDS. Agreement was within analytical error for all elements. In the autumn of 1985 we formally opened the lab, now known as the Dalhousie Regional Electron Microprobe Laboratory (DREML) complete with an official NSERC-sanctioned Users' Committee representing Dalhousie, Acadia, and St. Mary's.

In January 1986, the last student to use the Cambridge microprobe was John Dickie, and the first to use the JEOL 733 was Lucy Kanary of TUNS. Later that year, we sold our old workhorse Cambridge probe to DOFASCO in Hamilton Ontario. Recently we have learned that it has now reached an ignominious end in the Department of Dentistry at the University of Western Ontario as a source of spare parts.

In 1987, a particularly heavy workload arising from a combination of university-based research and the demands of Mineral Development Agreement (MDA) work from the Nova Scotia Department of Mines and Energy resulted in long periods of continuous 24-hour per day operation. In June and July of that year we ran 24 hours per day for 7 weeks with only two minor breakdowns!

In 1989 the demand for quantitative analyses diminished as student numbers dropped and MDA agreements terminated. The Users' Committee decided to invest its earnings from users' fees and its funds from the sale of the Cambridge microprobe in a new Image Analysis system. We submitted an application to NSERC for $40,000 and are still awaiting the verdict.

Geochronology and Isotopic Studies (by P. H. Reynolds)

Potassium-argon (K-Ar) dating began here in 1970 following the arrival of P. H. Reynolds on campus the previous summer. Reynolds, then in the Physics Department, perceived an interest in the establishment of such a facility from, among others, F. Aumento who had recently successfully dated material from the Mid Atlantic Ridge by the fission track method.

An NSERC Equipment Grant was used to purchase an AEI MS10 mass spectrometer. This instrument was designed as a residual gas analyser and was never intended for use in K-Ar dating. Nevertheless, D. York at Toronto and G. P. Erickson at the University of B. C. had shown in the mid-1960's that it could be used to make the precise argon isotopic measurements required. Its relatively low cost, along with this proven track record, made the MS10 the instrument of choice for our laboratory. The mass spectrometer was first set up in a corner of Room B3 in the basement of the Dunn Building. The conventional way to fuse samples (to release the contained argon) was to use an RF induction furnace. We decided at the outset not to invest in our own RF unit but rather to use the one located down the corridor in B10 and owned by the Physics Department. To do this we had to design and build a portable vacuum system, with appropriate glassware attached, that could be mated with this RF unit for the few hours it took each time to complete a fusion. All these early fusions were done in molybdenum crucibles, the latter carefully crafted out of sheet stock by the late R. Heffler and others in the Physics Workshop. Potassium analyses in these early days were the responsibility of G. K. Muecke. This work was done in the Chemistry laboratory of the Geology Department (third floor Dunn Building) using the flame photometric method (a Baird Atomic flame photometer). The first student to complete a degree in K-Ar dating was E. E. Kablick (M.Sc. Physics, 1972); the title of his thesis was *K-Ar dating of slates from the Meguma Zone, Nova Scotia.*

In June 1972, the argon mass spectrometer was moved upstairs in the Dunn Building to Room 217 where it resided for the next 14 years. Towards the end of that year Wendy Cross (now Wendy Clay) was hired as a full-time technician in the dating laboratory. Also at that time, graduate student Vidos Stukas arrived on campus and began to work with Reynolds on the development of the $^{40}Ar/^{39}Ar$ dating technique. This method permits the analysis of much smaller samples than those required for K-Ar dating, does not require separate potassium analyses, and, most importantly, provides data that can be analyzed by the powerful age spectrum technique. Stukas' thesis on the *$^{40}Ar/^{39}Ar$ dating of the Long Range Dikes, Newfoundland* (M.Sc. Oceanography, 1973) ushered in for us a new era of geochronological research.

In 1974, a second argon mass spectrometer (a VG601) was acquired. Purchase of this instrument was made possible by an infusion of money from the "Deep Drill 74" project (Leg 37 of the JOIDES Deep Sea Drilling Project). For the next 4 years the VG601 ran alongside the MS10.

In 1978, a decision was made by Reynolds (then principally in the Geology Department) along with H. B. S. Cooke, D. B. Scott, F. Medioli and M. Zentilli to expand our operations into the stable isotope field. Specifically, we wished to study paleoclimates by examining oxygen isotopic variations in foraminifera. We also wanted to study the genesis of ore deposits through observed variations in the oxygen and carbon isotopic compositions of selected minerals. At this time, our VG601 instrument was considered expendable and so was "traded in" on a VG Micromass 602D double-collecting mass spectrometer. This unit was installed in the isotope laboratory in 1979 shortly after Keith A. Taylor replaced Wendy Clay as laboratory technician.

Major improvements were made to the old MS10 mass spectrometer during the early 1980's. All of the original electronic components were replaced and a modern (Apple II) computer-based data acquisition system installed. Much of this work was done by students supervised by B. E. Paton (Physics Department); Keith Taylor wrote the software package for the instrument.

In 1982, the Geology Department moved from its quarters in the Dunn Building to space made available in the Life Sciences Centre. Relocation of the isotope laboratory followed in two stages; the stable isotope mass spectrometer was moved in the fall of 1985, followed by the argon system in early March. The new laboratory, LSC 3124, a large room previously occupied by the Canadian Wildlife Service, provided ample space for both spectrometers and was a vast improvement over the cramped conditions that had prevailed in Dunn 217.

A substantial upgrading of the argon dating facility was accomplished in the late 1980's. Firstly, a high power laser was purchased, one that could be used to heat individual mineral grains (in a bulk sample or in a rock thin section) in order to release argon gas for age analysis. Then, in 1989, money was obtained from NSERC to purchase a VG3600 mass spectrometer. This instrument has an argon sensitivity some 200 times that of the old MS10, and is therefore capable of analyzing the very small amounts of gas released by the laser probe gas extraction method. We anticipate that the 1990's will be a decade of "small sample analysis" using laser heating techniques in conjunction with sophisticated, very high sensitivity, mass spectrometers like the VG3600.

Chemistry Laboratory

With the move into the Dunn building in 1960, the department had available, for the first time, a chemistry laboratory equipped to perform silicate analyses by the classical "wet" methods. The balance room for this laboratory provided an ironic twist on the design of the building. To ensure stability, the architect arranged that the table for the most sensitive chemical balance should be welded to one of the large steel columns extending from the basement to the top of the building. Apparently he forgot about the starting load on the freight elevator. The load is sufficient to deflect the column slightly, and the balance swung in response thereto everytime the elevator started up - to the considerable annoyance of the chemist.

In the beginning, of course, there was the matter of a chemist to operate the laboratory and of the funds to pay his salary and the costs of operation. At that time the standard analyses of rocks for the major elements were made by "wet" gravimetric methods - long established and classical techniques. A single analysis for the major elements required about three days, and commercial laboratories charged about $300 for one. Analysts competent to do good silicate analyses were scarce and Ahrens had just demonstrated that they were, in fact, very much scarcer than had been believed. Good analysts were also expensive. For this reason, there was no chemist permanently on the department's staff during the first few years in the Dunn building, and a succession of visitors used the laboratory for periods of a few weeks or months. They did analyses relevant to their work or interests, and my impression is that the analyses were for a rather limited range of elements. Included would be some work by J. B. Dawson, now at St. Andrew's, Scotland, who was here as post-doctoral fellow in 1963-64, and by Ackerman, who was here for a few months in 1964, while completing work begun elsewhere. Aumento, who completed his thesis in 1965, did his own chemical analyses, though the major thrust of his thesis was investigation of zeolite structure by X-ray methods. It seems probable that some of his work was done elsewhere, because I do not recall that we had a spectrophotometer at that time.

The first "permanent" chemist was Reijo T. Rantalla, who joined the department late in 1965. For the first time, analytical facilities for standard rock analyses were available on a routine basis. He was with us till December, 1967, when he joined the Bedford Institute.

He was followed by H. H. Majmundar, who was here as a post-doctoral fellow. I do not have definite dates for his arrival and departure, but by the spring of 1970 he was in San Francisco with the Division of Mines and Geology of the State of California. By that time, Parikh was with us.

Shirish Parikh arrived in September 1968. He had been hired on the recommendation of Majmundar to do "gravimetric and colorimetric analyses, preparation of standards for XRF and emission spectrometry," and he continued to operate the laboratory for twenty years. During that time the amount, and requirements, of the work changed considerably as more rapid analytical techniques were developed: atomic absorption spectrometry, electron microprobe, neutron activation, and others. The microprobe was available in the department after 1971 and techniques for whole-rock analyses by microprobe were available after 1981. A "regional" XRF facility became available at St. Mary's in 1983.

When the department moved to the Life Sciences building in 1982, the chemistry laboratory, of course, moved along with the other parts of the department. As mentioned elsewhere this involved no major problems except for fume hoods suitable for use with perchlorates, and that problem was solved through the cooperation of the Biology department.

For fifteen years, Parikh had done most analyses required by the department, and for most elements required therein, but the situation was changing. Some analyses in the past had been done by X-ray fluorescence on our own X-ray equipment, but now a more powerful instrument was available at St. Mary's. As a result many analytical requirements were met by using this new equipment. After 1983, Parikh's work was reduced to analyses of sulphur-rich rocks and to the determination of carbon dioxide and of water.

Increasing financial pressure raised the question whether this relatively limited amount of work justified the cost of a full-time chemist, and by 1986 his position was in jeopardy. In 1988, along with several other technicians, Parikh was laid off during three summer months and Ryall, the current chairman, helped to arrange for grant-paid employment for him in the Dentistry Faculty during the 1988-89 academic year. In his spare time during that year, Parikh cleaned up and "moth-balled" his laboratory, wrote an instruction manual, and trained a student to use the atomic absorption unit, but he could see the writing on the wall and resigned at the end of July, 1989.

Since that time the chemistry laboratory has been essentially inoperative.

X-ray Laboratory

In 1912, von Laue, Friedrich, and Knipping performed the classic experiment that demonstrated the regular arrangement of atoms in a crystal and, simultaneously, that X-radiation is an electromagnetic wave. Within a year, Bragg had used this discovery to show the structure of sodium chloride crystals, and X-ray crystallography was born.

As mentioned on page 28, our first X-ray equipment was purchased by Douglas in 1947, using $10,000 donated by Consolidated Mining and Smelting Company. It consisted of a Phillips X-ray generator and two Debye-Scherrer cameras. It is probable that Douglas intended this primarily as a tool for mineral identification, rather than for crystallographic investigations. It is probable, also, that it was not used extensively before Goodman's return to the department in 1952. Because of its electrical characteristics, it could be used only for techniques that involved photographic recording of the diffracted X-rays.

By 1960, X-ray techniques had so developed that photographic recording was no longer adequate and an electronic sensor was required. This was usually some variant of the Geiger or of the scintillation counter. In turn, such measuring methods require that the electrical circuits of the X-ray generator be very stable. For this the old Phillips machine was completely inadequate, and a new Siemens generator was installed when we moved into the Dunn building.

While the Siemens machine was used for research, the availability of the Phillip's generator, Debye-Scherrer cameras, and free labour was used to build up a collection of reference powder spectra of minerals from the museum collection. The idea here was that such reference films could be used for direct comparison in the identification of minerals. By this time, however, film recording of powder spectra was becoming obsolete and was being replaced by spectra measured by electronic counters and recorded on strip charts. In consequence, the addition of reference films stopped after 1970, when the free labour was no longer available, and the collection of films was gradually dispersed and lost. Friedlaender had also purchased a second-hand Guinier focusing powder camera from the Nova Scotia Research Foundation, but that was given only limited use. Aumento's thesis involved some work with a Buerger precession camera, and a little of that work was done on the Phillips machine.

The first major effort on the new Siemens equipment was Aumento's investigation of the structure of zeolites. For that he used the Siemens diffractometer, with its Geiger tube and chart recording, and he added to the equipment a furnace of his own design for heating his samples while they were in the X-ray beam. He also used a vacuum spectrograph, in addition to the Guinier and Debye-Scherrer cameras. Chatterjee and others later used the Siemens equipment for X-ray fluorescence analyses.

By 1970, the Siemens equipment was obsolescent, and the XRF component especially was in poor shape. It was given a thorough examination by Siemens technicians, and the decision made to replace it.

In 1974 it was replaced by a new Phillips generator. This has been used ever since for teaching purposes and for research work. The Siemens equipment was used for various purposes in the Physics department, until it was finally dismantled for scrap in 1992.

Shortly after the Phillips equipment was moved to the Life Sciences building in 1982, the National Research Council provided funding for an up-to-date XRF facility intended to meet the needs of this region. It was installed at St. Mary's University. As pointed out elsewhere (page 56) it also led to the departure of our chemist, and the demise of our chemistry laboratory.

Neutron Activation Analysis Laboratory

Dr. Alexis Volborth joined the department in 1968, from the University of Nevada. There he had been involved in neutron activation analysis and he proceeded to set up a laboratory here, using funds provided by the National Research Council.

Neutron activation analysis operates by exposing a sample to neutron bombardment to render its contained elements temporarily radioactive. The amount of any element present can be obtained by measuring the amount of induced radiation it emits and comparing that with the radiation emitted by a standard irradiated under the same conditions. By measuring both the energy levels and the corresponding intensity of the emitted radiation, the concentration of a number of elements can be measured simultaneously in a single specimen, and the specimen, of course, is not destroyed.

Because the source of the neutrons is a strongly radioactive metal, adequate shielding is required to prevent danger to the operator and to others. Because the department had, in the Dunn building, neither available office space nor a suitable place for the radioactive components, arrangements were made with the Atlantic Regional Laboratory of N.R.C. for housing Volborth's equipment in their sub-basement, and N.R.C. also made an office available to him.

The electronic equipment for measuring the radiation is moderately complex and required some time to assemble. Many of the components were supplied by Philips, who found themselves, at one point, flying technicians and replacement equipment by chartered aircraft from Amsterdam - no doubt with considerable effect upon their profit from the contract.

The laboratory became operational in November, 1970, two years after Volborth's arrival. It is my understanding that, by the time of his departure in 1972, Volborth had modified the equipment several times to improve it.

The laboratory was set up to measure in rocks the usual elements measurable by this method, but, in addition, could measure oxygen. It is the custom that chemical analyses of rocks report the metals as their oxides; the necessary oxygen is assumed to be present but is not measured. This was the time of the Apollo project in the United States and there was the question whether, in the absence of an atmosphere on the moon, the rocks there would contain the assumed amounts of oxygen. This laboratory was able to make the necessary measurements and, at one time, Volborth did do some work on samples returned from the moon, but I do not know the results.

Dr. Muecke joined the department in 1970, and cooperated with Volborth from that time until Volborth's departure. Thereafter, he continued to operate the laboratory with the assistance of Dr. Pillalamarri Jagam, who joined the department in 1972 as technician.

One assumes that the laboratory was used to analyze for the full range of elements for which it was capable, but I have no concrete information. It is probable that the microprobe, X.R.F., and the chemistry laboratory were used for many of the elements routinely included in rock analyses. A number of investigations, however, made extensive use of the rare earth elements, and it is my impression that the analyses for those elements were all done by neutron activation.

After the loss of Jagam at the end of 1980, the output of this laboratory was drastically reduced.

Previously there had been some discussion about moving the equipment to the Dunn building, and that discussion continued till the autumn of 1981, at which time the move appeared to be imminent. That move was then postponed. The "space consultants" rendered their report, and the department moved to the Life Sciences Centre in the summer of 1982. In the end, the neutron activation laboratory remained where it had always been.

The laboratory equipment continued to be modified and serviced. In February, 1981, for example, a year after Jagam's departure, the Faculty of Graduate Studies allocated $6700 for modules to complete a multi-channel analyzer on which $20,000 had already been spent. There was also, of course, a continuing maintenance expense to keep the equipment operational.

But there was no replacement for Jagam, and the laboratory was finally closed in 1983.

Dalhousie/GSC High Pressure Laboratory

Dr. Matthew Salisbury joined the department in May 1985, from the Scripps Institution of Oceanography, where he had been the Associate Chief Scientist for the Deep Sea Drilling Project, to become the NSERC/Petro-Canada Research Professor in the Centre for Marine Geology. This was the first of the new government/industry-funded research chairs to be filled in Canada and brought new strength in borehole geophysics and rock properties to the already growing capabilities of the Centre in igneous petrology, seafloor magnetism, seismic stratigraphy and micropaleontology.

Shortly after arriving at Dalhousie, Dr. Salisbury received a major equipment grant of $125,000 from NSERC to build a new research facility to measure the acoustic properties of rocks at extremely high pressures. Working with Harwood Engineering in the U.S., he built a major high pressure laboratory in a reinforced-concrete vault under the Life Sciences Building. The centerpiece of the laboratory is a 7-ton, hydrostatic pressure vessel with a 4" diameter x 16" long working cavity, capable of operating at pressures as high as 200,000 psi (approx. 13,800 bars). This is the largest vessel with this pressure rating in the world, making Dalhousie a world-class center for high pressure geophysical research.

Since it became operational in 1987, this laboratory has attracted graduate students and visiting scientists from around the world. The principal application of the equipment has been to measure the compressional and shear wave velocities of sound in rocks at pressures equivalent to those existing throughout the Earth's crust and upper mantle, in order to interpret seismic refraction and reflection data in terms of petrology. Since 1989, the laboratory has been jointly funded by NSERC and the Geological Survey of Canada and has been engaged in major studies in support of the Ocean Drilling Program and of Lithoprobe studies in the Kapuskasing Uplift, the Nickel Belt, Sudbury, the Grenville Front, the Cadillac-Larder Fault and the Meguma Zone.

Accomodation

Staff had been added also to departments other than Geology in response to increasing student numbers and to expansion of departmental programs. In the Dunn building, Engineering and Physics departments had been very understanding and had allowed Geology to expand into their space. But Engineering, for example, had found it necessary to cut up their large draughting room to provide laboratory space, and sheer numbers of their students made our use of their draughting room a problem. Our staff were also occupying their office space. Something had to be done.

When the Dunn building was designed, space was assigned for specific purposes. Geology had office space for three professors - allowing for a staff increase of 50 per cent. Rooms were assigned for photography, for spectroscopy, for photogrammetry, for a museum, and for graduate students, in addition to chemical and X-ray laboratories. Except for the chemical and X-ray laboratories, one by one these had been converted into staff offices. The last to go was the museum: the specimen cases were moved into the hallways and the room cut up for departmental offices and for storage. We were fortunate that the Fire Marshal had encouraged wide corridors when the building was designed, but we do not know his views on their use for museum display, and we were very careful not to enquire.

As early as 1965 it was clear that space would become a problem, and committees were formed to examine the requirements for a "Physical Sciences Centre", which would, of course, include Chemistry and other physical science departments, as well as those in the Dunn building, for they too were feeling the pressure of space. This project was discussed at intervals for several years and once reached the stage of very preliminary design sketches and estimates. Members of those committees will remember Milligan's comment that he would be retired before the building was finished. He has now been retired for five years and it is very clear he will be dead before there is a Physical Sciences Centre.

In retrospect it may be that ideas were a little too grand. There was a tendency to try to provide space for everything that an enthusiastic professor might want - a very large wave tank, for example, in which to study sedimentation. Apparently, there was also a tendency to make guesses about future enrollments, and these tended to be on the very generous side. Only in Geology was there a serious attempt - the work of Dr. Swift, later repeated by Dr. Cooke - to examine the statistics on school enrollments, and to project our future share of the student population. (It is a fact, too, that Swift's projections were remarkably accurate to about 1978.) It may well be that our enthusiasm for equipment, and exaggerated estimates of student numbers, went some way to pricing the building out of reach, apart from any question of priorities within the university.

By 1970, in addition to the Dunn building, we had staff offices and laboratories in the National Research Council's regional laboratory, storage space in Holy Heart Seminary on Quinpool Road, and were using laboratory facilities at the Bedford Institute of Oceanography and at the Nova Scotia Museum.

In 1971, several staff members and their graduate students were moved into the Oceanography wing of the new Life Sciences Centre as a temporary measure. (It was then still possible to speak of the Physical Sciences Centre as if it were a possibility just over the horizon.) This provided office and laboratory space for those people, at least; this was something not previously available.

9

F. AUMENTO, 1973-1975

Fabrizio Aumento took over as chairman on 1 January, 1973. He had received the first Ph.D. degree awarded in the department, in 1965.

It is probably fair to say that the major matter within the department during his term was the research effort put into Leg 37 of the Deep Sea Drilling Project, in 1974. For those not already familiar with it, the "DSDP" was an internationally supported project to obtain scientific information by drilling into any part of the floor of the ocean and in any depth of water. This work was done by a specially designed and very powerful oil-drilling rig fitted to a specially modified and equipped vessel, the *Glomar Challenger*, in such a way that the drill string passed through the bottom of the ship. Special arrangements were included to allow the vessel to pitch and roll without damaging the drill pipe, to compensate for the rise and fall of the vessel in the waves, to enable the vessel to maintain position above the hole being drilled in the ocean floor, and for many other special circumstances. Laboratory space was also included so initial examination of the samples from the bottom could be made while the ship was still at sea, or even on the drilling station.

The Deep-Sea Drilling Project

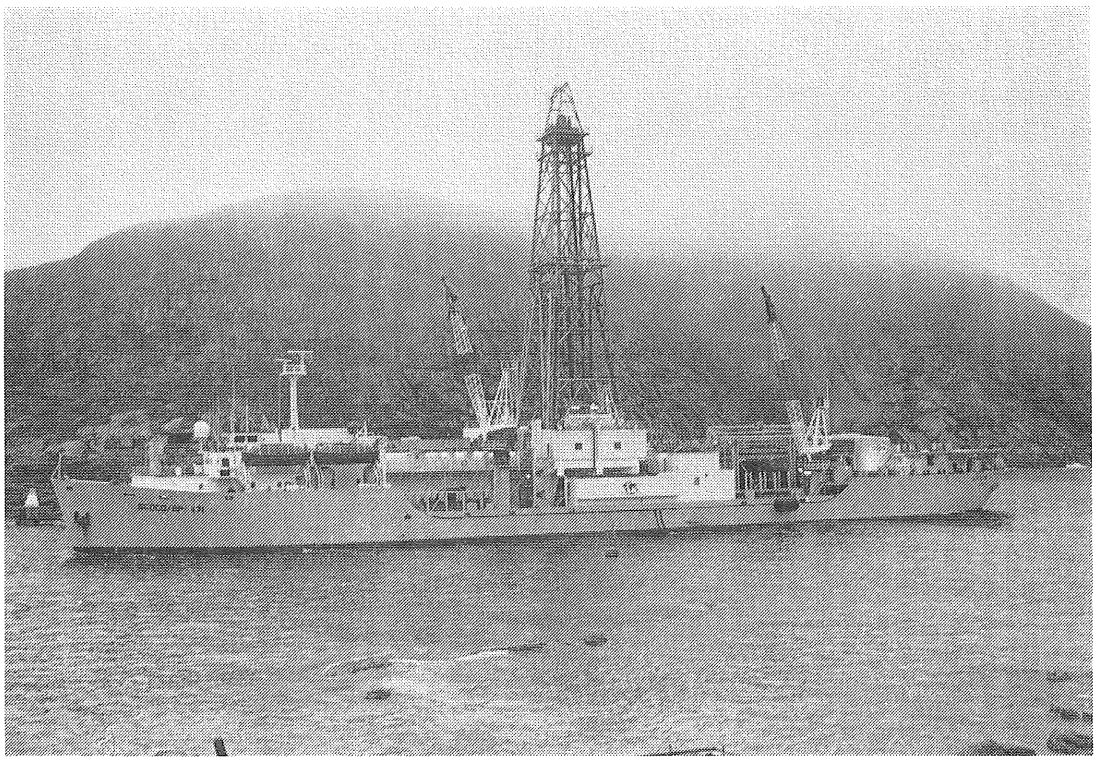
The initial work of the *Glomar Challenger* was designed to test the theory of sea-floor spreading. That theory postulates that new ocean floor is being generated by basalt volcanoes in the mid-ocean ridges, whence the resulting basaltic crust spreads laterally as additional new material is added in the centre of the ridge. The oceanic crust so formed is gradually buried by sediments washed off the land or derived from the plankton of the ocean above. It follows from this that the thickness of sediment should be least on, or near, the mid-ocean ridge and greatest at the margin of the ocean; that the age of the basalt beneath the sediments should be least at the ridge and greatest at the oceanic margin; and that all the ocean floor must be basalt and relatively young.

In general, these matters were tested by series of drill holes across each ocean. Naturally, the holes were located where careful previous work by other techniques had indicated the conditions likely to be encountered and the greatest probability of the maximum return of information from these exceedingly expensive exercises. You will appreciate that it is no small feat to control a drill bit dangling at the end of three or four miles of heavy steel pipe suspended beneath a ship in mid-ocean. You will further appreciate that, if the drill is pulled out of the hole, it is an immensely more difficult feat to put it back into a hole less than a metre in diameter in the middle of that ocean floor. For this reason, all the early work involved starting the hole in the sedimentary cover and then continuing to drill downward until the bit penetrated into the basalt beneath or the bit wore out, whichever came first. The ship then recovered the drill and moved to the next site. The samples recovered were examined for all the information that could be extracted from them.

The early drilling was successful in that it confirmed the youth of the ocean floor, its increasing age from mid-ocean ridge to oceanic margin, and the expected thicknesses of sediment above oceanic crust.

The hypothesis of sea-floor spreading had been invented, in the first place, to explain a pattern of symmetry in the earth's magnetic field on either side of mid-ocean ridges - a pattern vividly described as magnetic striping. It has long been known that molten rock, as it freezes, is magnetized by the earth's magnetic field, in the same way as is a steel ship during assembly in the shipyard. In both cases, the induced magnetism has the same direction as that of the earth's field at the site. In old rocks the magnetism will have the direction of the earth's field at the time the rock froze and this "remanent magnetism" will record that direction. Study of this paleomagnetism has indicated that, from time to time in the past, the direction of the earth's field has reversed, i.e. the magnetic north pole became for an interval the magnetic south pole. The reason is not understood. It was now suggested that, as basalt was injected into the median valley of a mid-ocean ridge and froze there, it would become a kind of magnetic "tape", recording changes in the direction of the earth's field, including reversals thereof. Because the rock was splitting in the middle of the median valley of the ridge to permit each new addition, and the fragments were spreading both ways from that centre, the resulting magnetic pattern would be symmetrical on either side of the ridge axis, as is observed to be the case in the "striping" pattern, and field reversals would provide especially useful and diagnostic time markers in the "tape".

A very proper question then arose: Is such a



Joides Resolution, ex Sedco BP471, is the successor to
Glomar Challenger and essentially similar thereto.
This ship was built by Halifax Shipyards.

mechanism adequate to explain the magnetic field observed from ships on the surface? Although it was realized that injection of molten rock into the median valley would generate submarine volcanoes, and volcanic products on the sea floor, in its crudest form the theory postulated a series of vertical dykes beneath the volcanoes, and that each dyke, in turn, split down the middle to make way for the next. In such circumstances, what intensity and direction of magnetization, and what thickness of magnetized rock is necessary to produce the observed field? Are such conditions met? While it is possible to calculate plausible possibilities, as with many geophysical problems there are more variables than there are simultaneous equations, and no definite solution is possible. To answer the questions, direct sampling of the basaltic oceanic crust is necessary, and the *Glomar Challenger* provided a possible tool.

In February, 1972, Dalhousie and the Bedford Institute proposed that a hole be drilled as near as possible to the axis of the Mid-Atlantic Ridge at 45°N as part of the Deep Sea Drilling Project, and that the primary objective should be to drill as deeply as possible into the basaltic crust.

There were good reasons for this choice of location. For several years the geologists of the Bedford Institute had worked with practically every known technique, on a strip of ocean floor about 100 km wide and crossing the Ridge at 45°N; Keen, Aumento, Hall, Hyndman and others (see above p..44) had participated in that work. As a result, that strip had become the best-known and most thoroughly explored piece of mid-ocean ridge anywhere. In 1971, there were attempts to drill into the basalt, using a small diamond drill lowered to the bottom and powered by the hydraulic pressure of the water above. The attempts were successful in that considerable experience and some short lengths of core were obtained.

During 1972 and 1973, the Dalhousie members of this group concentrated on deep drilling into oceanic islands; first into Bermuda and, in 1973, in the Azores. Bermuda is considered to be a volcanic island (now covered with coral products) that formed very early in the life of the present Atlantic Ocean. The Azores are parts of the present Mid-Atlantic Ridge high enough to protrude above the water and are, of course, volcanic islands. In 1973 the drilling in the Azores was directed by Dr. Hall, who was assisted from time to time by Aumento, Hyndman, and Muecke. Financial support came from: National Research Council of Canada, the Research Corporation, the International Decade of Ocean Exploration, and Empressa Insular da Electricidada (Ponta Delgada) S.A.R.L. The hole was 983 m deep and penetrated a geothermal area; the temperature at the bottom of the hole was 230°C. This was not expected, but is not surprising. (Since then a small power station has been built to utilize the volcanic steam.) This drilling in 1972 and 1973 used standard diamond drilling equipment and techniques, such as are widely used in exploration for mineral deposits.

The core obtained was investigated very thoroughly. In mineral exploration it is not uncommon for upwards of 150 kilometres of core to be drilled from a prospect in the space of three or four years, but the core is not analyzed in such great detail as was the case here. Although this work involved, in each case, only a single core a few hundred metres long, every lava pillow, dyke, or other rock unit was logged and the chemistry, age, physical characteristics (such as heat conductivity, magnetism, seismic properties) and several other related items, were all measured for many of the rock units. By 1974, this group was well prepared to handle the work and the material from the Deep Sea Drilling Project.

To drill a hole into the ocean floor is an exceedingly expensive operation. The mere matter of changing the drilling bit may well mean hoisting back into the ship several kilometres of drill pipe and then lowering it all back again, an operation that can easily consume 24 to 36 hours. The proposed hole was to be drilled into basalt and it was certain the drilling bits would be severely punished and would require replacement several times. Not only that; replacement meant putting the bit back into the original hole -a neat, but no doubt time-consuming, trick for which there was essentially no previous experience. And the daily operating cost of such a ship is tremendous!

For this reason, every effort must be made to extract from the operation every possible scrap of useful information. The original proposal to the JOIDES (Joint Oceanographic Institute for Deep Earth Sampling) panel had been for a hole at 45°N. But it was agreed, for example, that the weather would probably interfere there, and the location was moved to 36°N - the FAMOUS area, where scientists of French-American Mid-Ocean Underwater Studies were also investigating the median valley in great detail. In addition, to ensure that many aspects would be covered, and the maximum of information extracted, scientists who wished to participate in any part of the project were asked to submit proposals outlining the research they wished to undertake, and 30 such proposals came from Canada alone. In the end, the research workers represented the Bedford Institute, ten Canadian universities, the Woods Hole Oceanographic Institute, one American, one English, and one Japanese university, an American oil company, and the Academy of Sciences of the U.S.S.R. There was a total of 85 principal investigators. These people looked at topics as different as, for example: magnetism, magma sources, microfossils, alteration of sulphide minerals, uranium content of the rocks, and the effect of pressure on their melting temperature.

It was necessary to find money for the research itself and for coordination of the efforts of all into a meaningful body of work. There was, of course, considerable discussion and negotiation involved in that. In the end, the National Research Council took the unusual action of awarding to Dalhousie a negotiated research grant of $235,000. that provided for, and included, 19 individual or team research contracts for the Canadian scientists who were cooperating in the project, and made Dalhousie staff responsible for the research itself and for overall control of the program.

Five holes were drilled at four sites on a line extending about 170 km normal to the median valley of the Ridge. The first, and nearest to the Ridge, was lost after penetrating 333 metres into the basaltic basement, so another was drilled about 100 metres away from it; the latter penetrated 582 m into the basement. That hole, and the next one, required that the drill should re-enter the hole after worn bits were replaced, and that feat was accomplished ten times. The two more distant holes were "single-bit" holes, i.e. the hole was continued till the bit wore out and the hole was then abandoned; even then, basement penetration in excess of 100 m was obtained in both. Core recovery from the basement was not high - the maximum was 38% and the average 16% - but the cores produced some important surprises.

The major revelation was the variety of rocks found. The sediment of the ocean floor is called layer 1 and the basaltic crust beneath layer 2; that layer is sub-divided into 2A and 2B on the basis of seismic behaviour. The drill holes showed that layer 2A consists of old lava flows interlayered with soft sediment and volcanic rubble, rather than just old lavas; the seismic boundary between 2A and 2B is probably a diffuse horizon marking the level at which the sedimentary layers cease to be of importance.

The great inhomogeneity was also a surprise. Not only is there much greater variety of rock types than expected, but it was found difficult even to correlate between the two holes only 100 m apart. Also, instead of a few hundred metres of old lavas strongly magnetized in one direction, a great variety of directions was found and it became clear that the magnetic "stripes" measured from ships must be the integrated effect of a great variety of magnetic intensities, directions, and inclinations in rocks several kilometres thick. Furthermore, the simple theory predicts "basalt" in the basement; it did not predict the complex geochemistry that was found in the basalt. To explain that, some of the investigators postulated two different source magmas beneath the spreading Ridge instead of the one the simple theory predicted. Theory also said that the upper part of the basaltic crust is made of old lava flows expelled in the centre of the mid-ocean ridge and thence carried laterally. Gabbro and peridotite might have been expected at depth, but not within 400 m of the sea floor, where they were found.

In general, the operation was a successful one. There was the demonstration of a technique for re-entry of the drill into a hole in the sea-floor, with all the attendant engineering and technical details. As with many pioneering scientific efforts, it also answered some questions but posed a great many more.

The department did not embark upon the D.S.D.P. operation without serious thought and extensive discussion, beginning in the latter part of 1971. It was obvious that it would require a very considerable expenditure of time and effort by the active participants as well as additional facilities and technical staff. There was fear that all this would interfere with our primary duty of instruction and with the work of those who were not directly involved in the project. But as Aumento pointed out, in December, 1973, "as long as everyone involved shelved their smaller projects and were aware of the possible difficulties, no real problems should be encountered".

In the event, there was minimal disruption of undergraduate instruction, but the departmental resources were stretched to their limit. From a purely parochial point of view, the project left behind very little of permanent value in the way of staff or equipment.

The project did make Dalhousie widely known among earth scientists, however, because a large number of individuals and organizations from many countries were involved in the day to day work of planning and operations, and in the subsequent investigations. Furthermore, the whole Deep Sea Drilling Project has been set up to test exciting new ideas that were likely to change completely our understanding of processes in the earth. Consequently, the results of each operation were awaited with interest and they were published very quickly in the form of "Initial Reports", which had a large, world-wide circulation and were examined, analyzed, and discussed by geologists all over the world.

The Dalhousie people actively engaged in this project were: Aumento, Clarke, Hall, Muecke, Reynolds, Ryall; M. Fratta as geochemist, R. Iuliucci as curator, G. Johnson as computer programmer, T. Milligan as paleomagnetism technician, and K. Taylor as fission track technician.

This was not the only connection of Dalhousie staff with the D.S.D.P. Each voyage of the *Glomar Challenger* was described as a "leg" of the project. Leg 37, for example, began when the ship left Rio de Janiero to drill the holes mentioned above, and it ended about two months later at Dublin, Ireland. In 1971, before he came to Dalhousie, Piper had been a participant on Leg 18 from Honolulu to Kodiak, Alaska, via the west coast of the United States and Canada, and in 1973, a year after he joined Dalhousie, he was on Leg 28, to Antarctica. As part of the preparation for Leg 37, Hall was on Leg 34 in 1973, from Tahiti to Peru via the East Pacific Rise. Salisbury also was on that voyage, although he did not join Dalhousie till ten years later.

The Deep Sea Drilling Project was not the only activity during the two and one-half years when Aumento was chairman, although it undoubtedly was the major effort. Teaching and all the administrative duties attendant upon operating the department had to continue, of course. During Keen's regime, changes in procedures had set up a "graduate coordinator", supervisory committees, and other arrangements to formalize admission and supervision of graduate students and their research. Gradually other administrative duties were assigned, or assumed by individuals. There were individuals responsible for specific laboratories - the microprobe for example - and for specific duties: such as compilation of the department's annual report, reconciling the demands for laboratory, office, and classroom space, or for providing advice to students. Gradually, Aumento allowed these individuals (and committees?) more and more to act on their own discretion and without reference to him. This may have reflected confidence in the judgement of the individuals concerned, and apparently no major blunders occurred, but one has the impression that Aumento was beginning to lose touch with what some of them were doing on his behalf.

10

M. J. KEEN, 1975-77

In his first term as chairman, Keen's major problems were expansion of the program of teaching and research, the provision of staff and technicians to carry out that program, and finding the laboratory space and equipment with which to work. In this second term the program modifications were relatively minor, and the major problem was funding the operations of the department. Staff remained more or less constant, with changes only to provide replacement for those absent on sabbatical leave. Many major, but routine, matters required the attention of the Chairman.

Program Changes

During his first term Keen had led a rearrangement of the program, which resulted in a considerable expansion in its scope, a change in its emphasis and, of course, in the staff to do the teaching. As already mentioned on page 44, this had led to a great increase in the classes offered. By 1972, it was already evident that changes were necessary.

Major changes in class offerings do not occur quickly. It is possible to add or drop one class without much difficulty, but a major rearrangement, requires consensus on objectives and mechanism and that takes time, and discussion, to achieve. Even after agreement has been reached there is a substantial lead time before it can be implemented, because of the need to advertise the new class offerings in the calendar, on the one hand, and the need, on the other, to permit students in course to complete the programs on which they have already embarked.

Rearrangement of the program involves examination of a considerable number of factors. There are such fundamental questions, for example, as the role of the department: is it a school for training professional geologists? or is its aim to produce part of a general liberal education? or is it both? What is the role of our graduates in society, and do they appreciate the social and other effects of, for example, the mining communities their efforts will establish? How should training be done to meet the objectives these questions imply? There are also more immediate "technical" questions: What classes in the basic sciences, chemistry, mathematics, and physics, are needed as prerequisites for the geology program? From the scant records of departmental meetings, it appears that answers to this latter question ranged from "senior matriculation science" to "no prerequisites - if basic science needed, teach it in the class", to "strict prerequisites", at levels and with emphasis that reflected the individual professor's own background and interests. It is easy to see, then, how it takes some time to reach agreement and how agreement, when reached, will be seen by many or most as an unfortunate compromise. There was general agreement on a number of matters, however.

There was agreement that the program of 1972 had too many classes. There were suggestions that closely related classes should be combined; that there should be offered at the undergraduate level only those necessary to a minimum number of reasonable undergraduate programs; that in addition to reduction in numbers, some senior classes should be offered only in alternate years; that several 200-level classes should be integrated into one for which double credit would be given.

There was agreement also that our students needed the maximum of attention during the second year of their program, when they were learning foundation materials, such as mineralogy and petrology, and still needed careful guidance. There were suggestions that some modification of the English system of tutors would be useful.

There was agreement, in one form or another, for a separate "stream" for those students whose major was in the arts and humanities, and potential school teachers were specifically included here. For this stream the emphasis would be on such matters as geomorphology and the development of landscape, the importance of geology in history and economic development, and other "global" matters of importance to the general citizen. There were some suggestions also that the potential professional geologist should be separated from other scientists who might be taking geology classes to supplement a major in some other field. It was recognized, however, that this latter was not a major matter and that such students were probably quite capable of dealing with the appropriate classes in geology.

There was agreement in general, although not in detail, that "core" or foundation classes should be followed by "specialist" classes. That is, the "core" classes should deal with the topics required by every geologist and the "specialist" classes would permit some degree of divergence by the student into, e.g. stratigraphy, mineral deposits, or geophysics. The disagreements came over content of the classes and over the beginning and degree of specialization. All agreed that the core classes should include the tools of the trade, such as skill in surveying, mineral and rock identification, and photogrammetry, as well as theoretical aspects, such as petrogenesis. Disagreement came over emphasis: some wished to emphasize first the tools of the trade followed by more theoretical material; others would reverse the emphasis by early introduction of theory while still requiring the field and laboratory skills. In the event, it was usually recognized that photo interpretation is not learned overnight and that even a skilled surveyor cannot be taught plane tabling in one afternoon; as a result the emphasis fell upon the theoretical and upon such skills as could be taught in the indoor laboratory.

The beginning, and degree, of specialization is a matter that probably underlay much of the discussion about course programs. To staff members trained in North America, the idea of a student at the end of the second year referring to himself or herself as a geophysicist or a stratigrapher is ridiculous, if it implies anything more than the direction in which interest lies. The tendency is to wish to keep the program as general as possible as long as possible, and to encourage a special interest only in the final year of an honours program, if then. One can make arguments about breadth of foundation and background upon which to build the knowledge needed, and obtained, in later life. Those trained in Britain, however, where a degree of specialization began after the "eleven-plus" examination, tend to look with equanimity upon early specialization and to include early in proposed programs a number of "specialist" classes to enable the student to choose between alternative programs. One can argue that, though there may be some loss of breadth through this approach, the product is much better knowledge, pursued to greater depth than in the generalist program that delays specialization. It would be easy to over-emphasize the importance of this difference in viewpoints. I don't recall that the difference of approach was ever argued on its merits; it appears instead that the two viewpoints formed a part of the unstated, and perhaps unrecognized, body of assumptions upon which individuals based their suggestions about programs, which suggestions, in turn, produced very lengthy discussions.

There was also agreement upon the need for "synthesis" or "integrating" classes in the final year. This would include classes on plate tectonics, for example, or on economic geology, where the problems discussed would require the integration and application of knowledge obtained in the previous years from a variety of fields.

In July of 1975, Keen again raised the matter of course programs. Discussions during 1972-73 had resulted in some rearrangement of classes and in a considerable reduction in the number offered, but it was clear that too many classes were still being offered for the staff available to teach them. (When comparing teaching loads with those of, say, twenty years before, one must bear in mind that staff members were now expected to maintain active research programs.) This also raised the question of the primary interest of the department, which many undergraduates saw as research rather than their instruction.

The evening classes had been increased. An introductory survey class had been introduced in 1971 and taught by Keen, but there had now been added a full class on marine geology and geophysics, a half-class on environmental geology and another half-class on geomorphology, all at the 200-level. Half-classes at the 300-level had also been added in environmental geology and geomorphology. By 1975-76, Piper was involved in all of these evening classes, with assistance from Cooke and Zentilli.

The previous changes had tried one or two innovations. In the second year, three half-classes had been combined into a single one introducing paleontology, stratigraphy, sedimentology, and structure. The intent was to develop these topics in conjunction one with the other so their relevance, and their usefulness, one to the other would be displayed clearly and thus produce improved instruction. The idea has considerable merit but requires very careful coordination of the material presented. The instructors very carefully kept one another informed of what they had presented each week, but the coordinated planning was lacking and it is probable that, to the students, the various parts might as well have been presented under different class numbers. The scheme was dropped in 1976.

The new examination of the program brought about considerable changes. The "combination" class of the last paragraph was broken up into one on "sedimentology and historical geology" and another on "biostratigraphy". The 300-level evening classes were discontinued. What had been two full classes in structure five years before was reduced to a half-class, partly because the contents, particularly of the advanced class, had gradually been taken over by other offerings. There was also extensive re-numbering of classes and some rearrangement and re-allocation of content. "Systematic paleontology", for example, remained, under a new number, but "advanced mineralogy and petrology" appeared where previously there had been a class in "advanced igneous and metamorphic petrogenesis" together with another in "advanced mineralogy and crystallography". Where there had been two full classes and four half-classes dealing with geophysics five years before, there were now two half-classes labelled geophysics and a half-class called "physical properties of rocks". All this produced substantial reduction of teaching loads.

At the same time, the changes made it possible for students to follow their interests in one of several directions to an honours degree, or to combine an honours program in geology with physics or chemistry or biology. At the same time also, a "stream" for students in arts or other programs was possible through the evening offerings. Geology 101, and its predecessor Geology 1B, had always attracted many who sought only a science elective for a non-science program and the department now set up an additional class (102) designed deliberately for those in arts and the humanities. Scheduled for the late afternoon it proved useful to many students and to others as diverse as ship's captains, nurses from the hospitals, and public relations people from downtown offices. Consequent upon a rearrangement of the program at the Technical University of Nova Scotia (formerly N. S. Technical College), Geology 103B was introduced as a service class for students in Engineering.

In 1976 the "*Honours Field Trip*" was added. In concept, it is similar to a trip to Bermuda that Schenk used for many years to allow his class in carbonate petrology to study carbonates and carbonate deposition at first hand. The students, individually, pay part of the expenses and the trip is conducted outside the normal term time. It provides an opportunity for all honours students, at the beginning of their final year, to see directly rocks and processes in areas not available to them in the regular academic program or, indeed, within this country.

This has involved excursions on a variety of topics and to a wide range of places:

In	May	1976 to Western Newfoundland	and led by	Muecke
	May	1977 to Sudbury		Muecke
	Sept.	1978 to Quebec Appalachians		Zentilli
	Sept.	1978 to Bermuda		Schenk
	Sept.	1979 to Northwestern Scotland		Muecke
	Sept.	1980 Italian Volcanism		Clarke
	Sept.	1981 to California		Robinson and Muecke
	Sept.	1982 to Western Newfoundland		Jamieson and Gibling
	Sept.	1983 to U. S. Appalachians		Gibling
	Sept.	1984 to California		Robinson
	Sept.	1985 to Northern Quebec		Zentilli
	Sept.	1986 to Newfoundland		Jamieson
	Sept.	1987 to Nova Scotia and New Brunswick		Jamieson
	Sept.	1988 to Ontario (Grenville Front)		Culshaw
	Sept.	1989 to Newfoundland		Murphy
	Sept.	1990 to Nova Scotia		Zentilli

Leading such a trip involves preparation of guidebooks, and substantial administrative arrangements for funds, transportation, housing, etc. and can consume very considerable amounts of time. The students also are required to make a substantial contribution to the costs, and participation has not always been possible for every student who wished to do so. In recent years, also, funds for such trips have been scarce, and you will note they no longer go far afield.

Some Administrative Matters

In 1976 also, the "*Douglas Room*" was set up. It had long been the desire of Keen to have a common space where students, undergraduates especially, could gather. In his first term as chairman, by introducing some furniture into what had originally been a room for photogrammetry and later part of the sedimentology laboratory, he had generated such space, but it was very crowded and generally very noisy. In 1976, Dr. Goodman donated to the department his collection of journals in geology and mineralogy. At about the same time, a room next to the chairman's office was being vacated by the Deep Sea Drilling Project. Keen therefore proposed to put the journals and some tables in that room, call it the "Goodman Room", and make it a quiet place where students, especially honours students, could work. When this was proposed to Goodman, he suggested that it be called instead the "Douglas Room", to commemorate the former head of the department.

It became available in October, 1976, with Ross Douglas, a mature student and no relation of G. V. Douglas, in general charge. It received considerable use that winter, although some students tended to stake territorial claims on the desk space to the disadvantage of others, but it never did receive the amount of use that had been anticipated. Perhaps the fact that it was, in effect, behind the departmental office and out of the commonly travelled way of the students may have had an influence. It was assigned to a graduate student as office space in 1977.

When the department moved to the Life Sciences building in 1982, Goodman's journals, along with some others, were installed in a room across the corridor from the departmental office. This is one floor above the spaces occupied by undergraduates, so it is well out of their way and is never used by them. Even the designation of a Douglas Room disappeared.

Summer field experience has long been recognized as a very important part of the training of the young geologist. Students in this country have been blessed because exploration companies, the Geological Survey of Canada, and its provincial counterparts have, for over a hundred years, employed students in their summer exploration programs. Over a century the nature of the work has changed, of course. No longer is there the possibility that the student might walk from Winnipeg to the Rockies and back, as the young J. B. Tyrrell was required to do, and now one can hardly imagine a summer-long canoe journey powered by fish and bannock. Instead, it is more probable that the summer will be spent processing oil-well data in an office in Calgary, operating a magnetometer behind a ship in the Atlantic, or prospecting from a helicopter in the Arctic, but the work remains a very valuable method of providing relevant practical experience.

Availability of such experience, however, is subject to substantial fluctuation. Changes in the price of mineral products, uncertainty about taxation policies, or any one of many other factors will cause reduction in exploration budgets and in summer employment. Similarly, reduction in the budgets of governmental surveys will reduce the number of summer jobs available to students.

It then becomes necessary for a geology department to provide assistance to its students in their search for summer employment. Such assistance was one of the "chores" assigned by Keen to a staff member and at this time Zentilli had the job. For the students, he organized sessions at which he provided good advice on how to apply for a job: on what information should be supplied to the prospective employer, on where and to whom to apply, and on all the details that distinguish the successful application from the unsuccessful. When job opportunities were numerous this help was often sufficient. When they were scarce, Zentilli found himself using all the contacts he and the undergraduate advisor had within the exploration industry. Whatever may be said against the "old boy's network", it was often successful in finding employment for our students. At times when exploration was very drastically reduced, the best efforts of both Keen and Zentilli did not always succeed in finding summer employment for all our students, although usually our graduating students were all able to find employment.

Zentilli went one step farther than usual and asked employers to complete a brief form reporting, at the end of a season, upon the abilities and training of our students. This provided some information about gaps and weaknesses in our course programs.

From time to time when job openings were essentially non-existent, representatives of several oil companies continued to come and interview our students, even though they told us bluntly that a company might have only two or three vacancies to be filled from the whole of Canada. Their rationale was that they were looking to the future and were watching the students in course for the day when jobs could be offered. We were flattered to be told that we were the only department in the Atlantic Provinces that was being so visited every year. Several companies sent the same "recruiter" each year and these people did get to know the students individually. Also, they got to know the department and, in some cases, we found ourselves asking for, and receiving, blunt advice about what should be contained in our programme for students aiming at work in the petroleum industry.

An example of other administrative matters that required attention from time to time is a proposal for "twinning" of the department with a geology department in one of the developing countries. A. R. Berger, who graduated from this department in 1958, had founded the Association of Geoscientists for International Development (AGID) and it developed local organizations in many countries. AGID now proposed that it should help departments in developing countries by arranging assistance from others more fortunate.

Various methods were suggested. These ranged from such simple matters as exchange of publications and suites of samples, through provision of teaching materials to the counterpart department and assistance in the acquisition of basic equipment, to cooperative research projects and exchange of personnel.

This was discussed at a couple of departmental meetings. It was agreed that our most useful contribution would be through cooperative research projects, in which our facilities could be used on field problems pursued by students and staff of the counterpart department. The chemistry department's "Trace Analysis Research Centre" does considerable work in this way. Another possibility was exchange of senior or graduate students, and/or staff, for shorter or longer periods. Although it was agreed that such might be useful, it was also agreed that there should be "no commitment at this time", so nothing further happened.

Staff Changes

Because of the number of people hired in 1969 and 1970, and the fullness of time for some others, potentially almost half of the professors in the department were eligible for sabbatical leave in 1976 and 1977. Obviously the department could not be denuded of teaching staff. This problem was settled by arranging for three (Aumento, Clarke, and Hall) to go on leave in July of 1976, and for three more (Muecke, Reynolds, and Schenk) to go the following year. To lose even three would create serious problems, especially in the teaching part of the program.

Serious efforts to obtain replacements were therefore required. By December of 1975, the Dean of Arts & Science had agreed to authorize two temporary appointments, each for two years, as replacements for those going on leave.

Choosing replacements in these circumstances is not simply a matter of substituting two live bodies for three. One is replacing a considerable range of skills (a paleontologist, a stratigrapher, petrologists, etc.), and it is therefore necessary to find some way of rearranging the responsibilities of those not absent and to find also two individuals who will fill the gaps that then remain.

The gaps were filled by Dr. Warren Ervine and Dr. John W. Peirce. Peirce was a graduate of Dartmouth College, in New Hampshire, and of M.I.T., where he received his Ph.D. in 1977. After his two years at Dalhousie, he joined Petrocanada, in Calgary. Ervine received his Bachelor's and Master's degrees from the University of Toronto in Geological Engineering, and his Ph.D. from Stanford. He had worked at the University of California, San Jose, including some work for N.A.S.A.; at the University of Idaho; and at Waterloo before joining Dalhousie. After his sojourn at Dalhousie he remained in Halifax as a consultant.

We were fortunate also to have as Killam Professor, Dr. Ian Gibson, from Bedford College, of the University of London, who was of great assistance in rearranging the operations on our microprobe, as mentioned on page 153. He arrived in January 1977, and spent a year in the department, during which he also participated in teaching an advanced class in petrology.

In 1976, Aumento was awarded the Steacie Fellowship of the National Research Council. This supports the research of the Fellow for a year, and is considered as conferring a very considerable recognition and honour upon the recipient. The following year, 1977-78, Aumento was on sabbatical leave and he resigned in December, 1978 to join a consulting firm specializing on geothermal power.

Financial Pressures

The bulk of the money expended by a department in its routine operation comes from university funds, as anyone would expect. This is to be contrasted with funds that are expended on research and equipment therefor, which may be very substantial indeed but are usually obtained from sources external to the university. In the late 1970's the university funds budgeted annually for the Geology department were around $600,000. Of this amount, salaries consumed about 90 per cent and the balance paid for instructional equipment and its maintenance (metre sticks to microscopes), supplies (chemicals to carbon paper), travel, and the many other items that are the daily expenses of an operating organization. This budget did not include journals and books dealing with geology; such were covered by the acquisition budget of the libraries. This was also a time of high inflation rates, which had an especially severe effect upon university budgets. Not only does inflation produce pressure for compensatory increase in salaries, the major component of the budget, but the inflation in prices of instruments and other specialist or laboratory equipment commonly is several times the rate measured by the Consumer Price Index, which measures general trends.

At this time, Dalhousie was approaching the end of an extensive expansion program. The expansion reflected an increasing enrollment, which required increased physical space, and therefore buildings and the equipment for them. It reflected also an increase in course programs offered, with their attendant demands for increased staff in an increased number of disciplines. At this distance, one may reasonably ask whether the increased enrollment drove the increased offerings and physical facilities, or vice versa. At the time, it was generally considered that the anticipated increases in enrollment were forcing the extensive construction program.

The costs of the expansion program had exceeded the university's income and there had been extensive borrowing, over and above the capital funds provided from government and other sources. Apart from the need to reduce such borrowing, the interest charges on this unfunded debt were also becoming a factor in the university's annual budget. All this resulted in efforts to reduce expenditures on many minor items (e.g. lighting) which, in aggregate, amounted to substantial totals. It also resulted in the reduction, or removal, of expenditures that a few years before would have been considered normal. Staff and senior students were no longer taken to dinner to meet visiting lecturers, for example.

Funding for some important items was also being reduced. At a time when publishers were rapidly increasing the prices of scientific journals and books, the acquisitions budget for the library was beginning to be cut. In October of 1976, for example, the amount available for geological publications was $5950, and a departmental meeting in November agreed to cancel subscriptions to certain journals, sufficient to reduce expenditures by ten per cent.

Funding for large items of equipment is always scarce. Paying one or two thousand dollars each for sufficient microscopes, for student use in a large class, for example, can run into large amounts very quickly. Friedlaender was once able to persuade Zeiss to accept payment over two years for such a purchase, but such a deal is rare. At this time, in the late 1970's, the departmental budget for equipment, supplies, and current expenses was essentially constant for several years at about $65,000, despite the rapid inflation of the prices therefor, and this caused some concern for the chairman.

Funds for Students

The departmental chairman is not responsible for funding undergraduate students and his general responsibilities are limited to such matters as encouraging funds for scholarships and similar arrangements. There is, from time to time, an occasional competent student who has unusual financial problems, and the chairman may then be able to help by approaching sources out of the normal range. In the last twenty years, the general availability of student loans and bursaries has reduced this aspect of the chairman's duties.

The scholarship committee of the Faculty of Arts and Science has long provided assistance to very competent students, but the amounts available are always much less than the committee would like to have at its disposal. The scholarships are awarded almost entirely upon academic performance, and the academic cut-off for even the smallest scholarship requires very high standing. In general, scholarships are limited to the eight to ten per cent of the students in the University who have the best academic records.

Summer research grants for undergraduate students were provided for a number of years by the Atlantic Provinces Inter-University Committee on the Sciences (APICS). The awards provided a few hundred dollars, funds sufficient to be of assistance to students who were thus enabled to work during the summer in laboratories other than those of their own university. This was of considerable use in chemistry, biology, and physics, for example, but was of less importance in geology, where much summer work is in the field.

Although not a direct responsibility of the chairman, the scholarships, loans, bursaries, and other financial matters of the undergraduates do require a general oversight by the chairman.

Funding for graduate students is a major matter for the departmental chairman, however. Under the scheme of "graduate scholarships" introduced in the graduate faculty by Dean Trost, and continued by his successors, each graduate student is provided with a stipend, which may not be over-generous but does go far toward meeting living expenses while in course.

At this time there were some scholarship funds available to the graduate faculty, and they were generally awarded on academic merit. Imperial Oil, for example, provided Graduate Research Fellowships for competition. In 1975 they were worth $4000 per year for up to three years. The same company also provided University Research Grants, up to $6000, which also might be renewed for three years. At Dalhousie, the bequest of Mrs. Killam provided Killam Graduate Scholarships which, for 1976-77, were worth $6000. The Killam funds also provided Killam Post-doctoral Fellowships, which were worth $11,300 and a small grant toward research expenses. Similarly, the National Research Council provided Post-graduate Scholarships worth $5000, which were awarded in competition.

The major source of funds, however, is from moneys provided by the graduate faculty, the department, and a levy upon the N.R.C. operating grants held by the student's supervisor. The latter is provided by the provision in the grant that allows the grantee to employ a student to work upon the project. The departmental contribution is used to pay the student for work as a laboratory demonstrator or for some similar duty. The money available to the graduate faculty is, of course, university funds and subject to the same pressures as other budgetary items when funds are scarce. The annual negotiation between the graduate faculty and the departments could then become a time of stress, because upon it depended not only the stipend for each graduate student but the number of students that could be enrolled. There was a rough rule of thumb that the contribution from the graduate faculty should equal that provided by a department from its own funds plus the operating grants of its members.

There is a corollary effect from this. For example, in June of 1976 Keen sent a memo to members of the department pointing out that a substantial number of applicants wished to work with faculty who held only small operating grants. Such grants would be "completely killed" if the funds necessary to support students were removed from them. More good publications would produce increased grants but, in the meantime, students must be turned away or to other faculty who did have grants. Keen's suggestion to meet this need by a uniform levy on all grants did not meet with enthusiasm and, in August, it was agreed that "... when the potential supervisor cannot make the full contribution ..., then the Graduate Coordinator will negotiate with other faculty members, normally those whose interests are close to those of the student and supervisor."

For 1976-77, Schenk, in his capacity as graduate coordinator, proposed to extract sufficient funds to raise the stipends by ten per cent. This meant about $4600 for an M.Sc. candidate and just under $5000 for a Ph.D. student. There were lesser amounts for those who were working on "thesis only". For nine master's candidates, of which four were thesis only, and fourteen doctoral candidates (six, thesis only) the total was about $103,500, of which graduate faculty funds provided fifty percent. There were a few other candidates who had exceeded the time limit for completion of a degree and were receiving no support. The files are not explicit about Schenk's success, but we may reasonably assume that the final figures approximated his proposal.

Research Programs

For the first half of this century, the publications of the professor of geology were limited largely to reports on field work, in Nova Scotia and elsewhere. Woodman reported, for example, on glacial geology and shore development, but the major part of his work dealt with the gold and iron deposits of the province. McIntosh published very little, and that mainly on local geomorphology. Although Douglas aimed to produce one paper a year on matters general or theoretical (e.g. the nature of "replacement" in ore deposition), a very large part of his work outside the classroom involved investigation of geology and mineral deposits in many areas of Nova Scotia, and in Newfoundland, Quebec and Ontario.

When Friedlaender arrived there was some change. He published several papers on local mineralogy and petrology, but not on areal geology, as his predecessors had done. During his time, of course, several additions were made to the staff of the department, with consequent increase in the range of interests of the group. Nota introduced study of recent sediments, and this was enthusiastically continued by Stanley and Swift, who extended the study to the entire Scotian Shelf and the Bay of Fundy, work that was continued by Gees and his students. Keen had begun by seismic studies of the Scotian Shelf and Gulf of St. Lawrence and continued on to other work farther afield. Cooke initially continued work he had begun in Africa and, despite several years as Dean of Arts and Science, by 1971 was deeply involved in the stratigraphy of East Africa, as mentioned on page 45. Schenk by that time had been working for six years in the Windsor rocks and on the possible connection of the Meguma with Morocco. Milligan had published very little, although his memoir on an area of northern Manitoba proved sufficiently useful to require a second printing.

The increase in staff that came after 1970, and the deliberate decision to emphasize marine work, produced another change in emphasis and a still wider range of interests. This was a natural response to the presence of an Institute (as it then was) of Oceanography at Dalhousie and the Bedford Institute on the other side of the harbour.

As indicated above in Keen's 1970 review of the department, page 45, the research efforts of individuals complemented one another to a considerable degree although, in total, they covered a surprising range of topics:

Aumento was primarily involved in the petrology of the basalts of the ocean floors. This included not only the Deep Sea Drilling Project and work with the staff of the Bedford Institute on the Mid-Atlantic Ridge, but also the drilling on Bermuda and the Azores. Others became involved in related questions such as the magnetic history of the rocks, their age, their chemistry, the flow of heat through them and their alteration by sea water. All these are matters relevant to the genesis of oceanic rocks, but are also of relevance to the long or short-term interests of others in the department.

Although Beaumont's primary appointment is in Oceanography, he has maintained a close interest in affairs of this department. Beginning with a study of the effect of loading the earth's crust with the tidal water of the Bay of Fundy, he went on to examine the behaviour of the lithosphere and mantle under stress. This led, in turn, to important ideas on the formation of large sedimentary basins. These ideas, as well as questions of tidal effects in the solid earth and of long-term isostatic adjustment, involve the behaviour and "viscosity" of the earth's mantle - an important factor in the very basic question of convection in the mantle. At about this time, Medioli and Scott found that microfossils in marsh deposits provide a tool for accurate recognition of former sea levels, and thus for measurement of post-glacial uplift and subsidence, and rates thereof - just the sort of information Beaumont needed for studies of isostatic adjustment and behaviour of the upper mantle of the earth. This provided yet another cooperative venture between this department and others.

Clarke, by this time in 1977, had been investigating the petrology of anorthosites in Cape Breton, Tertiary dykes in west Greenland and Baffin Bay, crystallization of pyroxenes in silicate melts, and genesis of native copper in North Mountain basalt as well as kimberlites in the Arctic and copper-molybdenum-tungsten mineralization at New Ross. He was involved to some degree in the Azores drilling, but his major effort was a long-continued study of the South Mountain batholith. Some of the above items were peripheral to that, but he examined many aspects of the genesis of the batholith, including the behaviour of the trace and rare earth elements therein.

Cooke continued work that had been in progress for nearly 40 years on Pliocene-Pleistocene deposits of central and southern Africa - a subject on which he was a sufficient authority to make it the subject of a Du Toit lecture of the Geological Society of South Africa. But he and his students were now also investigating the Pleistocene and Recent deposits and post-glacial history of the Maritimes. Furthermore, as mentioned on page 47, Cooke had been using fossil mammals as tools to solve problems of correlation of early hominids in east Africa. It was hardly surprising, therefore, that he should be one of the editors of a major compilation on the evolution of African mammals, published in 1978. Such a background also made it reasonable that, as a vertebrate paleontologist and as an authority on the African deposits, he should be involved in two working groups set up by the International Geological Correlation Program to establish the Neogene-Quaternary boundary, and in a working group on vertebrates established by the International Union of Geological Sciences subcommission on the Mediterranean Neogene. Such interests, in turn, led to involvement with two deep holes drilled in the Great Hungarian Plain. Because a complete post-Miocene record was obtained, the major paleomagnetic polarity epochs could be recognized and correlated with the fossil record, and this brought Hall and our paleomagnetic laboratory as well into this collaborative effort with the Hungarian Geological Institute.

Hall joined the department only a few years after study of the magnetic field over the ocean had set off a revolution in ideas geological. His arrival and installation of a laboratory to examine the magnetic properties of rocks was therefore a timely and important addition to the staff and facilities of the department. As indicated above he was very involved, with several others, in the "Deep Drill" program in Bermuda in 1972, the Azores in 1973, the DSDP in 1974, in Iceland in 1978, and was the prime mover in several of these efforts. Of course, one wants to know not only what magnetic properties a rock possesses but why it has them. The work of Hall and his students accordingly has involved extensive investigation of the effects of heating, cooling, pressure, hydrothermal alteration, and submarine weathering upon the petrography and magnetic features of basaltic rocks. Although, in the early days, oceanic islands were considered to be anomalous features of the mid-ocean ridges, Iceland and the Azores came to be considered as valid samples thereof, and the drilling there was providing important information on the genesis of the oceanic floor. The drilling in Iceland was an attempt to penetrate to Layer 3 of the oceanic floor, involved people of many disciplines from Canada, the U. S., and the U.S.S.R., and may properly be called investigation of oceanic crust to a depth of three kilometres. As did others, Hall continued to work on matters that had occupied him prior to his arrival here, and his publications through the seventies included papers on the dykes of Mull, lavas of Libya and of the British Tertiary volcanic province, and of the Keewenawan of North America, as well as the basalt from several early D.S.D.P. voyages. As his work progressed, not only was the genesis of oceanic crust a major interest but increased attention was paid to the controls on rock magnetism; several theses and papers dealt with the changes caused by alteration of the mineralogy of the rocks. This required knowledge of the chemistry of the rocks as well, particularly the oxidation state of the iron therein; it was here that Mossbauer spectrometry and the cooperation of the Physics department, became of importance.

In 1977, Keen resigned and moved to the Atlantic Geoscience Centre of the Geological Survey of Canada at the Bedford Institute. During his two periods as chairman he had directed the department through a very considerable expansion, a change in emphasis towards greater research effort than before, and a change in the direction of that effort and of the instruction within the department.

Keen died very suddenly of heart failure on 8 January, 1991.

11

D. J. W. PIPER, 1977-1980

In the spring of 1977, Keen resigned to become Director of the Atlantic Geoscience Centre at the Bedford Institute of Oceanography, and David J. W. Piper was chosen to replace him. Piper's term began, as usual, at the beginning of the academic year on 1 July.

After due consideration, it was agreed that Keen should be replaced by someone, specializing in geophysics or sedimentary geochemistry, who would complement the existing program in marine work. By early July there was a short list of seven candidates, which eventually grew to twelve.

There seems to have been some vacillation about this appointment. The only information available comes from minutes of the departmental meetings, but they indicate that several of the candidates came for interviews during the summer and early autumn of 1977. In the ordinary way, the department would not advertise a vacancy without prior authorization by the Dean and the President. Nor would the Dean authorize expenditures to bring the candidates for interviews. Yet, on 21 February, 1978, the chairman reported on a meeting with the Dean and the Vice-President at which it appeared the appointment might not be authorized at all. There is no indication of the reason for this apparent reversal of intent, though perhaps it had the objective of reducing financial pressure by not replacing a professor who had departed. Whatever the cause, there was another reversal and Dr. Ian Reid, a geophysicist, was hired in April.

General Objectives

As Keen had done in 1969, Piper began with an examination of the department, its abilities, weaknesses, and future directions. There was probably no serious disagreement with his statement of general objectives:

a. To provide a high quality undergraduate education that both develops the minds of students and trains them for available jobs.
b. To provide geological education to non-geologists (including part-time students.)
c. To provide graduate level education in selected relevant geological fields that, taken together, cover a broad range of geological enquiry.
d. To carry out significant research.

There were, however, some difficulties to be expected. Already there had been financial pressure that resulted from the cost of Dalhousie's building program and expansion in the 1960's, when total enrollment in the university had gone from 3454, in 1967-68, to 6103 only four years later. In addition, in 1972-73 the university had budgeted for an operating deficit of $400,000, and in the interim the situation had become worse instead of better. Obviously there were going to be financial constraints on operations.

This would not be improved by an expected drop in enrollment. Predictions based upon enrollments in the schools of the Maritimes indicated there would be a reduction in students in the universities, reaching a minimum about 1982. Because government assistance to the universities is based on enrollment, this would further aggravate the financial problem. (In the event, the anticipated decrease in enrollment did not appear. An economic recession in 1982 induced some students to continue their training, rather than try to join the work force. At the same time, many mature students, employed or otherwise, were attending university to improve their qualifications or to broaden their educational background. The "age profile" of the student body changed significantly.)

A number of trends suggested that, in addition to decreased enrollment, there would be declining governmental support, in real terms, despite increasing numbers of dollars. This was at the time of high inflation consequent upon the imposition of high prices for Middle Eastern oil in 1973 and later.

In short, one could see the possibility of running a department with decreased real funds. This had serious implications for maintenance of laboratory equipment and for additions thereto, because inflation of prices for such items was at rates far above the general average. Furthermore, in a university a very large part of the operating expenditure is for salaries, and this raised the possibility of restraint on salaries as well. Staff throughout the university were beginning to get a little edgy.

There was discussion within the department about the appropriate policy to follow. In the end, the department continued to do as it had done before: develop cooperation as broadly as possible and rely on external organizations for assistance with teaching, research, and equipment, while striving to improve the

D. J. W. Piper

P. E. Schenk

quality of the programmes offered.

This was a continued application of the technique followed a hundred years ago, using the skills of people in the community, and was particularly useful for graduate programs. It made good academic sense, for many students were thus involved in research programs of the Bedford Institute and other organizations, and active senior scientists contributed to their direction and supervision. As a hundred years ago, also, there was no pay for such contribution, other than a small honorarium in some cases for lectures given and, perhaps, official recognition as an adjunct professor or as a research associate. It left the chairman open, however, to criticism that such outside contributions would not be necessary, if only he had pressed his case to the university administration with sufficient vigour.

The initial examination of future directions was followed, early in 1978, by another of the periodic detailed reviews of the content of the "core" classes of the undergraduate program. This one involved detailed, lecture by lecture, correlation of classes to eliminate needless duplication and to ensure that important matters were not omitted. That was followed, in turn, by an examination of the graduate program -- to which Piper devoted considerable effort.

Support for Graduate Students

As mentioned on page 17, above, M.A. and M.Sc. degrees had been awarded for many years within the Faculty of Arts and Science, or its various earlier incarnations. A Faculty of Graduate Studies was set up in 1949, and by 1978 it had grown to have a substantial body of graduate students. Initially it awarded only Master's degrees, but Ph.D. programmes were begun in 1955 and gradually added in one department after another. The Ph.D. program in Geology was authorized in 1965.

A graduate degree implies some rules or practices governing its award. In the nineteenth century a thesis was required, but the research work and writing could be done anywhere. Senate approved the topic of the proposed thesis and struck a special committee to examine it when it was submitted. Later there was a requirement for course work and for residence, but examination and approval of the thesis, whatever the formal requirement, was in the hands of the supervisor, for all practical purposes. Common sense required, of course, that the candidate cure deficiencies in background knowledge that became evident in the course of the thesis work.

Large numbers of students and the introduction of additional programs required greater formality. In 1967, for example, the general faculty requirement for a Master's degree was five classes, of which the thesis could count for three if the candidate already held a B.Sc. with honours; otherwise, the thesis counted as only one or two, at the discretion of the department. In Geology, four classes and a thesis were required, i.e. the thesis was considered equivalent to one class.

For the Ph.D., the candidate must already have a master's degree or, by the end of the second year of the program, have produced a publishable paper. There were formal examinations: a preliminary at least one year prior to completion of the thesis; the thesis itself must be defended in public and approved by a committee of five, including the Dean and an external examiner. In Geology, the candidate was also required to demonstrate ability in one language other than English.

In Geology, Keen had formalized the arrangements, as one of the first things he did when he became chairman. This involved committees to govern admissions, supervise the progress of the students and evaluate their performance. This was extended beyond the graduate students, and there were fairly elaborate arrangements for evaluating undergraduate honours theses as well.

Financing graduate students now became a more serious problem than in earlier days. When thesis problems were almost exclusively field oriented, there was usually a sponsoring agency that bore much of the cost. When Ross Weeks examined the age and genesis of an orebody at Quemont, for example, the owners of the mine paid him a salary during the summer and paid also for diamond drilling, analyses, and other expenses. As late as 1970 Quebec-Cartier paid in the same fashion the expenses for two years for a study of iron deposits in southern Labrador. A small stipend for demonstrating in a laboratory class during the winter was provided by the department to supplement the student's summer earnings.

As thesis topics became more "academic" and laboratory oriented, such external funding was not available. While a company geologist might well agree that knowledge of the alteration of basalt by water at high temperature and pressure was of importance and wide application, he would have difficulty convincing his board of directors that its direct importance to his company justified their payment of the costs. Gradually then, the department turned to the National Research Council to support the research work of graduate students. Later, this channel became the Natural Sciences and Engineering Research Council. Our immediate concern here is with "operating" grants, although there are a variety of other types of grants in support of research.

National Research Council (or NSERC) "operating grants" are made to support a specific enquiry and may be used to pay a stipend to a student working on the project. The university is expected to provide all the support services and equipment that would ordinarily be available in a department: secretaries, office equipment and supplies, "standard" laboratory facilities, reagents, etc.

The Faculty of Graduate Studies, under Walter Trost, its second Dean, set up a scheme to provide financial assistance to graduate students. The awards were called "graduate scholarships", on the argument that all graduate students were, by definition, of scholarship calibre. The students were required to do some teaching, generally as demonstrators in undergraduate laboratory classes. The funds provided to the department to pay demonstrators were combined with funds from the Faculty of Graduate Studies to provide the scholarships. Initially, need was also taken into account, so a student who had summer employment in the field or at a skilled trade had the scholarship reduced accordingly. This, of course, quickly removed the incentive for self-support.

As the system evolved, the sources of funds were broadened somewhat. A bequest by the widow of Isaac Walton Killam provided funds for "Killam Post-doctoral Fellows" and for "Killam Graduate Scholarships" separate from the regular scholarships and of higher value. The Killam scholarships were therefore awarded primarily on academic merit. The regular "graduate scholarships" were provided from departmental demonstrating funds, and moneys from the Graduate Faculty, as outlined above, together with money from operating grants made to faculty members by the National Research Council, and from research contracts made by faculty members with the federal Department of Energy, Mines and Resources, under that and any of the various other names by which it has been known from time to time.

This system has continued. At present (1990) funds available for stipends for graduate students come from the graduate faculty (ca. 40%), departmental funds for demonstrators (ca. 40%), and from N.S.E.R.C. and other operating grants (20%).

The duration of such support has always been a concern. It has long been agreed that qualified graduate students should be able to pursue their studies without interruption or undue financial pressure. When there were only three or four such students, the necessary arrangements amounted to consulting the students about their resources and arranging such supplemental aid as was possible. With the provision of a common, and specific, stipend, usually minimal, the question of the duration of such aid immediately became relevant. It is also generally agreed that good research should not be jeopardized by cutting off support, and that there may be circumstances that impede progress or prolong the work. At the same time, enrollment in graduate studies should not provide a lifetime sinecure. The solution has been to assure support for three years, in the case of a Ph.D. candidate, as the average time experience has shown to be reasonable for completion of a thesis. Support may be provided for all or part of a fourth year in exceptional cases. If the work extends beyond that period, the student is responsible for his/her own support unless the circumstances are most exceptional. This all assumes that the student will not be overloaded with other duties: a student employed as demonstrator in a class and then required as well to deliver three-quarters of the lectures the professor should have provided is a case in point.

It is worth noting, however, that between 1980 and 1987, the average M.Sc. student actually required 34 months, and the average Ph.D. candidate, 46 months, to complete the program.

Graduate Classes

The content of the graduate program was causing some concern. Graduate students were required to have five "credits" for a degree, and the thesis could count for up to three. By 1978, the department had changed the earlier practice, which gave the thesis only one credit in the M.Sc. program. The students now complained, however, that most were pressured into taking three courses, so the thesis counted as two credits, and that under such circumstances they had to struggle to handle the volume of work required. They were anxious to see the value of the thesis extended to the maximum three credits. There was probably some merit in their complaint, for the standard of performance required in an M.Sc. thesis, for example, was now considerably higher than it had been, say, 15 years before, and the amount of time-consuming laboratory work involved in most of them had increased greatly.

For a substantial number of the students the M.Sc. program was the training ground for a professional career.

A candidate for admission to the Ph.D. program must already hold a Master's degree. This caused confusion and concern for graduate students, especially for those who sought a Ph.D. degree and had been given to understand they had been admitted to that program in the beginning. They wondered (1) if the M.Sc. was being used as a test prior to admission to the Ph.D. program, (2) if the M.Sc. program really was good training for research, and (3) whether perhaps the M.Sc. was being used as insurance against a project that might not live up to expectations.

According to a committee of enquiry, the graduate students themselves saw the M.Sc. requirement as providing a training ground for research or for a professional career, and as a general broadening experience. Most apparently saw the M.Sc. as intermediate between the B.Sc. and Ph.D. degrees, but not as a stepping stone between them. Many also saw the M.Sc. student as a laborer sorting through data to advance the supervisor's own research project, but very few regarded an M.Sc. thesis as a reliable test of research ability. Faculty, however, recognized only too clearly that it is difficult to identify students of Ph.D. calibre from their undergraduate records. Performance in M.Sc. work then enabled judgement to be made on a more satisfactory basis.

The students also complained that the range and standard of available graduate classes was too low. Most such classes were available also to senior undergraduate students in the final year of an honours program, and occasionally also to senior students in a related discipline. The level of instruction tended to drop to cater to the undergraduate members of such classes. There were very few classes restricted to graduates only.

The desirable range of graduate classes required some thought. As is clear from the table below, the students came from widely different backgrounds and had different interests and objectives. Obviously it was necessary that each should fill any gaps in training that were revealed in the course of graduate work; it was sensible for a student to raise his or her level of knowledge of a subject and so stimulate a mature approach, and one hoped that few students took a class merely to gain a credit. No doubt many students, by their own efforts, repaired background deficiencies recognized by themselves or by their supervisor, but few appear to have had the determination of Chatterjee, who taught himself the calculus he needed to deal with the thermodynamics he needed to understand the chemistry of the metamorphic processes that were his real problem. Some suitable classes were necessary therefore, and they must either be sufficiently broad in scope to cover many needs, or sufficiently flexible to permit adjustment to the needs and interests of their members, year by year. It was not practical to have classes that each dealt with a restricted or specialized topic, for that would require excessive numbers of classes, each with negligible numbers of students.

Origin and Fields of Interest of Applicants to Graduate Program
May, 1978

Country of Origin	Enquiries	Applications	Area of Interest	
Canada	8	13	Economic Geology	8
U.S.A.	22	6	Petrology	7
U.K./Eire	6	1	Marine/Sedimentology	5
India	10	1	Geophysics	4
Pakistan	6	2	Geochemistry	2
Sri Lanka	4	0	Stratigraphy	2
Africa	3	3	Structure	2
Egypt/Iran	5	3	Micropaleontology	1
S. America	1	1		
Far East	2	1		
		31		31

An effort had been made in 1976 with the introduction of classes open to graduate students only. Prior to that time the only class so restricted was in Micropaleontology. The classes covered such topics as sedimentology and stratigraphy; geophysics; mineralogy, petrology and geochemistry; metallogeny. Few had been considered successful. Seminar-type graduate classes had been criticized for lack of scope, vigour, and effort. Some, such as the "Geophysics Seminar" and another called "The Mud Club" had appeared more or less spontaneously but had suffered from lack of faculty concern, reflected in the fact that few were available for credit.

Piper now proposed (February, 1978) graduate classes based upon a modular scheme. Each class would deal with one major and general topic in each term such as, for example, the Appalachian geology of eastern Canada. Influenced in large part by the interests and requirements of members of a class, both general and specific features of the chosen topic would be summarized and discussed by faculty or other local experts and by the students, who would each be assigned one or more subjects to investigate and report upon. In addition, students would be required to familiarize themselves with each subject discussed by the speakers, through prior reading, and to participate in the discussion of it. Class meetings were obviously intended to operate as a more or less informal discussion.

Such a scheme permits great flexibility and range of topics and interests, but does require a coordinator and may require cooperation from a number of other faculty members or invited visitors. It avoids the problem of a large number of classes each assigned to a limited topic, it can cater to a wide range of interests and preparatory backgrounds, and a subject can be followed to greater or lesser depth as the students' interest or need may require. It even permits a student, via term papers or private discussion, to follow a topic of interest parallel to, or in addition to, the formal class subjects. Properly handled, such a class also draws its members into active discussion of the topics before them, and develops skill and confidence in analysis and presentation of data and ideas. I speak from experience of classes so conducted by Billings and others.

Piper's proposal included provision for "short courses" of two to four sessions, each with one hour of lecture and one hour of discussion on a relatively restricted topic related to the main theme of a term's work. This appears to be the only feature of his proposal that has been generally used. This is unfortunate. In the last 15 years our undergraduate students, especially, have become so accustomed to being "lectured at" that they are commonly completely lost in a general discussion, where they are required to marshall, analyze and compare data and ideas. It is to be hoped the same is not true of our graduate students.

Early in 1980, there was approval of a scheme of three graduate-level seminars, each one year long and counting as a half-credit toward degree requirements. This was essentially an enlargement and formalization of the geophysics seminar and "Mud Club", and additions thereto. The Graduate Committee at that time recommended that tutorial-type graduate classes also be offered when a group of students so requested, but realized that success of such classes depended upon the availability and willingness of faculty members to teach them. The committee added certain requirements to ensure that such tutorials had content, scope, and rigor comparable to other graduate classes.

Marine Resources Program

A committee composed of Piper, Hall, Clarke and Zentilli had been seeking ways to add professors to the department by seeking funds from outside the university. In January, 1980, this committee proposed that the department should offer an honours degree in "marine resources geology", and use this program as a bait with which to seek external funding "for a petroleum geologist, a data handler, and a man interested in marine geotechnique". It was suggested that such a program might attract up to ten additional honours students per year. At that time there were about 20 potential honours graduates each year, so this would mean an increase of about fifty per cent.

The content of the program was discussed at a departmental meeting in February and approved, subject to minor amendments prior to its submission to the Curriculum Committee of the Faculty. The proposed program was aimed to provide "a thorough grounding in the basic sciences, a basic honours programme in Geology and a minor in Oceanography, or another science or mathematics. In addition, it emphasized courses in Oceanography, marine geology, and resource geology. It sought to provide a thorough academic background in these topics on which industry training programmes could build."

In due course, the program was approved by Senate, the Board of Governors, and the Maritime Provinces Higher Education Commission.

Preparing students for training in resource industries, particularly petroleum, was a laudable objective, but there was a large element of smoke and mirrors about this whole business. In the first place, it required no special approval. Any student who so wished could follow the proposal within the existing class offerings and regulations and, in fact, a few elected to do just that. In the second place, though presented for approval as a program requiring neither additional space nor staff, its objective, as stated internally, was "to attract external money for additional faculty positions..." It is one thing to fill a perceived gap by devising a program that may eventually require additional faculty, even though the need for current expansion is denied. Surely it is another thing entirely to invent a program for the avowed purpose of generating that need.

In the end, by the time the unnecessary approvals had been obtained it was clear that extra funding would not be available and the whole was allowed to die. It is still possible, of course, for any student who so wishes to follow the program.

Administrative Problems

Faculty Unionization

The dramatic increase in university enrollment during the 1960's, and the accompanying expansion in buildings, equipment, and staff had been financed in part by borrowing. By 1971, staff in Geology had stabilized at 12 professors and 6 special lecturers, but other departments were still expanding and some new programs were also considered necessary. The latter half of the 1970's was a period of severe inflation; costs rose rapidly and the financial situation of the university continued to deteriorate. By 1980, the interest charges on its debt were themselves becoming a serious matter and it was clear that considerable changes must occur. Staff of the university, in all capacities, of course expected salary increases that would, at least, compensate for inflation. When it became evident that reduction of class offerings, or even of entire programs, might become necessary, staff became seriously concerned.

Many years before, the faculty had formed an association that acted as liaison between professors and the university administration. Though the Association was consulted, and could offer advice and opinion, it had within the university no power other than that of reasoned argument.

In the changed circumstances, there arose a movement to convert the Faculty Association into a trade union, within the meaning of the Trade Union Act. This would establish the legal right of the Association to act as the sole bargaining agent for faculty members in matters of salary, terms and conditions of employment, and many other matters, under the terms of that act. Such authority would enable its members to exert some control on increase or reduction of staff and programs, in addition to that already possessed via Senate as the body that deals with matters academic. The Dalhousie Staff Association, representing mainly clerical staff, had become a union a few years before.

There was no unanimity about unionization, although it was a trend of the times and had occurred, or was being considered, at a number of other universities. Some saw a union as an appropriate device on the factory floor, but doubted that it was suited to the academic situation or that it could be transferred effectively. Others saw it as a mechanism that would not only exercise some control over salaries and other matters of immediate concern, but also over administrative policies and practices. Some may even have expected the union to be involved, at least indirectly, in day to day departmental affairs.

The question came to a vote in March of 1978, and unionization was approved by a very large majority.

As seems always to be the case, negotiation of an initial contract was very time consuming, and agreement was not reached until November, 1979. As is also to be expected, it was many months later before all the operational details were sorted out and administration of the contract was running smoothly.

During this period of over two years, the debate spilled over into other matters, and had some influence thereon. When there are differences of opinion on such other, but not related, matters, it is perhaps natural that the opposing views tend to be examined as being also the result of opposing views on this dominant question of unionization. Certainly this was one element in the difficulties that arose in the Geology department during 1979 and 1980 as, for example, when the Chairman was told that his judgement would be biased because of his opinions concerning the Faculty Association.

Departmental Concerns

At this time there were three matters which were of great concern to the professors in the department: Promotion and Tenure, Salary, and the duties of the chairman. In dealing with them, the department became embroiled in controversy.

The contract newly negotiated by the Faculty Association provided for large numbers of committees including, in each department, one to recommend upon promotion and tenure. Previously, such questions had been handled by a committee of the Faculty, considering the recommendations of the Dean and of the departmental chairman. The chairman, in turn, had consulted his colleagues - sometimes as a formal committee; sometimes informally; sometimes both. Whether or not a professor gets a permanent contract (i.e. tenure) or a promotion in rank is, of course, a matter of great importance to the individual concerned. So, too, is the committee that makes the relevant recommendations. In retrospect, it appears that there was, in fact, very little difference of opinion between the departmental committee and the chairman on the current cases involving promotion or tenure. It is symptomatic of the conditions at the time, however, that there were arguments and recriminations over who should make the recommendations: the committee, the chairman, or both; and over whether or not the chairman could be a member of the committee, or even attend its meetings.

Under the terms of the collective agreement negotiated by the Faculty Association in its role as union, salaries were decided on a complicated formula that attempted to evaluate academic qualifications, years of experience, and quality of work. The latter was handled via "merit points" and was an attempt to encourage good performance by means of an increase in pay as a reward. In the Geology Department, this matter of "merit" was also assigned to the committee that dealt with promotions and tenure.

Previously, such matters had been handled by the chairman and the Dean, and allowed considerable latitude to the chairman. Keen, for example, with their knowledge and approval, had given relatively small annual salary increases to senior professors so he might be able to provide monetary encouragement for good work by younger staff members, and also so he might raise the salaries of the very under-paid clerical staff. This has the appearance, of course, of a very autocratic, and potentially biased, procedure. The "work sheets" in the departmental files show, however, that individual performance was carefully evaluated and that there was a serious effort to apply a weighting to the research work, teaching performance, and other duties of each person.

Under the new system, "merit points" were the only source of flexibility. Degrees held by an individual and the years of experience were definite matters, easily determined, and agreed weighting for them was part of the collective agreement. Research programs and the quality of work therein are matters of judgement, however, and there were also differing views on the importance of research vs. teaching. As for teaching performance, every student or professor can instantly recognize a good teacher, but it is notoriously difficult to quantify this ability that separates the excellent from the mediocre. The mechanism used to assign merit points to an individual, with attendant results on pay and prestige, then became a matter of concern.

There were also different views about the intent of the provision for merit points. Some considered it an attempt to measure performance and reward it where appropriate. That implied an annual review and reassignment of points. Others considered this item, and the attendant component of salary, as something to which everyone was entitled, and there were proposals for distribution within the department so that those who did not get merit pay one year would receive it in the next. In one view, even persistent incompetence would be rewarded eventually. With a chairman who had been told his judgement was biased on these matters, there was room for discord.

Preoccupation with salaries led to the argument that professors should be paid for overtime. The argument had two components: (1) that the burden of laboratories in science classes created a heavier teaching load than in classes in the humanities, for example; (2) that field exercises in Geology were over and above even the normal laboratory classes. Laboratories in science classes had been a normal part of the teaching load for a century and, while no doubt they required more of the instructor's time than in, say, a history class, they could hardly be called overload teaching. To a large degree, the same could be said of field laboratories and excursions in Geology, although some were held on weekends. The field school at Crystal Cliffs and the Honours field trip of about ten days at the end of the third year were a different case, although a similar survey field school had been operated for years at Truro by the Engineering department.

All recognized that field experience is a necessary part of a geologist's training. The Honours field trip required detailed planning and considerable effort to administer, and several professors had conducted such trips as volunteers; Muecke had led three of them without receiving even thanks from the department. The Crystal Cliffs field school was another major project. It had evolved to a staff:student ratio of about 1:4, because experience had shown that, with students doing their first field work, this ratio was necessary to help them out of difficulties they did not even know they were in. Some considered this to be gross over-staffing and, in 1980, a department meeting decided that a ratio of about 1:7 would be sufficient. The school was always held in late April, immediately after the end of the spring term, when many were getting their summer research programs started, so some staff were always reluctant to participate. Although some people considered they were paid an annual salary to teach classes the department considered necessary, the majority considered Crystal Cliffs and the honours and other such field trips as "overload", for which they should receive extra pay, and were able to persuade the Dean and the President to agree. So far as can be deduced from the available records, the chairman agreed with the idea, but was concerned that the money involved would have repercussions on other important budgetary items. This also produced discord.

In addition to difficulties arising from promotions, salaries, and related matters, there was dissatisfaction over a number of other items. This led to inclusion of a list of "Departmental Sore Points" in the minutes of the departmental meeting of 27 May, 1980. Some of the items have been mentioned above, but also included were: (1) the arrangements for deciding upon classes and teaching assignments; (2) the importance or weight attached to research vs. teaching - a part of the debate over "merit points"; (3) the number of graduate students and their support; (4) "chores" assigned to faculty, such as the job of graduate coordinator, preparation of the annual report of the department, or arranging time tables and allocating space; (5) definition of the duties of the chairman and his relationship with faculty and the administration.

The first of these items is a little surprising. The usual procedure was departmental discussion of classes to be offered, after which the chairman sought the agreement of the obvious, or suitable, instructor for each class. Whatever the procedure used, the lists of teaching assignments for 1980-81 differed very little from previous ones, contained no surprises, and allocated the usual totals of classes to each individual. Perhaps this latter item was the problem.

Some other problems had been festering for some time. Support of graduate students has been mentioned above. Contributions from research grants to the stipends of graduate students had been routine for years. But in November, 1979, Piper was complaining to the Dean because the departmental budget had been essentially frozen for two years and large amounts of money from research grants were going into routine laboratory operations. In other words, research grants were funding facilities the university should have provided; the holders of the grants objected, of course, and criticized the chairman for not extracting more money "from the Dean". Some of the departmental "chores" were rather unpopular as well. The individual required to compile the annual report of the department, for example, found himself extracting from colleagues written contributions they commonly delayed or neglected as long as possible. The job could be time consuming and frustrating. To get rid of such administrative chores, an "administrative assistant" for the chairman was authorized in 1981. (This was certainly a great change from 1957, when all administration was handled by the head of the department, with the part-time assistance of a typist in the Engineering department!) The question of the duties of the chairman is discussed below.

A new chairman was needed in 1981. By Faculty rules, the chairman of a department is elected for a term of three years, and Piper's term would expire in June, 1981. There was also an impending retirement (Cooke, in 1981) and sabbatical leave for which replacements would be needed. Potentially there were as many as four vacancies to be filled. The procedure was started early in 1980 and the first position was advertised in March. Included was an invitation for candidates at the level of full professor - who were seen as potential chairmen.

The question of an "external" chairman was much discussed. That is, should the new chairman be chosen from the existing staff or should one of the new members yet to be hired be chosen to be the chairman? This whole business appears to have been very much confused. Such records as exist suggest that the department did not decide on the direction in which it should develop and then seek the appropriate staff. Instead, there appears to have been an additional objective of finding a chairman who would not only be advised, but dominated, by the department acting in committee of the whole. There was even a serious suggestion that the chairman should be merely the spokesman for the department so acting. (There was no mention of who would be held responsible for the department.) There were also proposals for changes in the structure of the chairmanship to suit the perceived character of the applicants, particularly the external ones.

The whole matter was further complicated by debate over a "rotating" chairman. It was proposed that the chairman should serve for a term of two years, or even only one, instead of the normal three-year rotation. To provide some continuity, and familiarity with the chairman's duties, it was further proposed that there should be an "associate-chairman", or "vice-chairman", who would work closely with the chairman and automatically succeed him. Not until late in November, 1980, was there finally agreement on an "internal" chairman, who would serve for two years and have an "associate" chairman to understudy him.

By that time the situation was such that Piper resigned from the chairmanship, and the department, effective the end of December - six months before the normal expiry of his term as chairman.

The causes that produced this situation no doubt were many. The major items of conflict were outlined above, but they are probably only the surface reflection of factors that were deeper. As suggested above, different views of faculty unionization, at a time when it was a dominant topic in the university, evidently led to distrust and disagreement over decisions made. To a bystander, also, it appears that personal differences probably were a factor, for there seem to be cases, according to our incomplete minutes, where individuals, having gained the agreement of the chairman, promptly reversed their views. It has been suggested, as well, that part of the problem was Piper's managerial style. At that time several staff members, at least, saw the chairman as a mere mouthpiece for the department, and they viewed Piper as something of an autocrat, even though, so far as our scanty records indicate, there was general agreement on the substance of most of his decisions. His decisions may have been wise, but their background may not always have been appreciated, and the reasons for the decisions could then easily be misconstrued. This situation could arise because Piper did not, generally, talk to people at length, and leading people by convincing them one by one is a very time-consuming business, as other chairmen have also discovered. An attempt to maintain his own research program as well as his administrative duties would leave little opportunity for such time-consuming processes and add to the problems caused by a natural reticence. No doubt another major factor was the staff's perception of the general attitude of the university's administrative bodies.

12

P.E. SCHENK, 1981-1983

Consequent upon Piper's resignation, Schenk became chairman on 1 January 1981, with the immediate job of reducing the internal discord and getting the department running smoothly again. Judging from remarks he made at his first staff meeting in his new capacity, it is probable that he did not truly appreciate the amount of time-consuming administrative detail ahead of him, but the staff wanted an end to turmoil and he had proposals designed to achieve this. In the discussions leading up to Piper's resignation, it was clear that some considered the proper role of the chairman to be merely a mouthpiece for the department acting as a committee of the whole, and that any kind of autocratic decision-making by the chairman would not be acceptable. Schenk realized that such a system was too cumbersome to work, that he would be held responsible for the department in any case, and that he would have to make his own decisions. He proposed, therefore, to delegate work and responsibility where he could, and to consult his colleagues on other than routine matters. Most matters of routine, in fact, would now be the responsibility of an Administrative Assistant to the chairman. Such a position was authorized for Geology in March, 1981, and Dianne Crouse was appointed in May. She had been secretary to the chairman since 1968.

Although regulations of the Faculty require that a chairman shall serve for three years, the department had decided during the autumn (page 79) that a two-year term was what was needed, and that there should be an "Associate Chairman" to work with the chairman and to succeed him. In December, the Dean had agreed to this scheme. During the discussions in the department, Zentilli had proposed a rotation scheme which came to be known as the "Zentilli Wheel". This scheme was now in operation and Clarke was the Associate Chairman, with Zentilli waiting in the wings as the next in the rotation. Clarke was on sabbatical leave during 1981-82 and was replaced temporarily by Milligan in December, 1981.

Staff Appointments

For Schenk the first major matter was staff appointments. Potentially there were four vacancies to fill: Replacements were needed: for Cooke, who was retiring in 1981, for Piper, who had resigned, for Clarke, who would be on sabbatical leave in 1981-82, and for Reid, whose contract was not renewed.

Staff appointments always require justification, but authority to hire new staff was becoming increasingly difficult to obtain, because of the financial situation of the university. The deficit the previous year had been over 1.7 million dollars and the total debt was increasing annually and at an increasing rate. Senate had already agreed that there should be no additional appointments, and the Dean was attempting to reduce expenditure by not replacing staff who departed. A strict policy of non-replacement would, of course, quickly decimate some programs, so essential staff had to be replaced in any circumstances. The Dean could also be persuaded that, in terms of costs at least, it was reasonable to hire two junior members to replace Cooke, a very senior professor near the top of the salary scale. (On the other hand, Cooke's departure would also be reflected in the level of support for graduate students, because of loss of the research funds he had attracted.) Funds for replacement of a professor on leave were another matter, however, and there was the matter of replacement of a sedimentologist and/or a geophysicist.

Within the department there was considerable discussion about the replacements required. At this time there was still consideration of the proposed "Marine Resources Program" (page 76), which had been approved by the university and was awaiting consideration by the Maritime Provinces Higher Education Commission. It was therefore reasonable to bear in mind its possible requirements when deciding the qualifications needed in new staff members. Initially, and rather optimistically, it was hoped that five appointments could be made: one each in geophysics, structure or petroleum, and the sabbatical replacement, as well as two in the "marine position".

In the end, three replacement appointments were made: M.R. Gibling, R.L. Boyd and P.J.C. Ryall. Gibling arrived in September, 1981 and Boyd joined in January, 1982; Ryall was already here. Gibling came to us from Thailand, where he had been lecturer at Chiang-Mai University for three years. A graduate of Oxford, he had obtained his Ph.D. at Ottawa before going to Thailand. Boyd was delayed till January so he could meet his commitments as visiting professor at Louisiana State University. Prior to that he had been, for a short time, a research officer in the laboratories of the Royal Australian Navy, after completing his academic training at the University of Sydney. Ryall was already well known here: He had graduated from Dalhousie in Physics, taken his M.Sc. in Electrical Engineering at Alberta, and his Ph.D. in Geology at Dalhousie. After a year as a Killam post-doctoral fellow he had spent three years at Universiti Sains Malaysia and a further three years as a research associate at Dalhousie, where he had been considerably involved with related work at the Bedford Institute.

In connection with these appointments, it is appropriate to note that work in the "third world", it now appears, may operate to the subsequent disadvantage of an individual. The criteria for the award of tenure or of promotion include, in addition to four other major matters, an acceptable record of research and publication. It has been the view of committees handling promotion and tenure that, in "third world" countries, either: (1) research and the resultant publications are necessarily not up to North American standards, or (2) that there is no way of assessing the standards obtaining there. The practical effect of this, in the case of both Ryall and Gibling, was largely to ignore the work they had done during their three years abroad, to require that they demonstrate, as if from the beginning, an adequate research record, and thus to reward their services to the "third world" by delaying promotion and tenure.

Changes in Course Programs

Changes in class offerings and their content are constantly occurring in any department. They reflect the teaching experience of the instructors, changing ideas and emphasis within the discipline, and changes in the teaching staff. Major reviews seem to come every few years to correct perceived weaknesses or inefficiencies that have arisen over an interval.

Some changes are primarily housekeeping matters. For example, in January, 1981, the evening class, Geology 140, was split into two parts, 141A and 142B, and the content changed slightly to accomodate students from the College of Art and Design. This made it possible for such students to take 141A as an evening class in the first term and 200-level classes, such as geomorphology or environmental geology, in the second term. As another example, in December, 1981, and with the objective of improving the performance of second- and third-year classes, the department passed a motion restricting admission into second-year to those students who had an average of B- in their five first-year classes. In this case, a check on the records of the previous ten years showed that, had such a regulation then been in place, nearly sixty percent of our honours graduates for that period would have been refused entry into the second year, and some students who would have been excluded later went on to graduate work. The department therefore, in March, 1982, amended its previous action so that admission to second-year Geology classes would require a B- minimum grade in Geology 100 only, rather than in all five first-year classes.

Yet another housekeeping question is the quality of instruction; it is a matter of perennial concern, but its measurement is notoriously difficult. Promotions committees quickly learn that all professors are, at the very least, excellent teachers - an evaluation that many students, and common sense, would question. In the autumn of 1980, the matter of "merit" pay in the new salary scale gave added point to the question of the teaching ability of faculty members and, over the next few months, there were attempts to design a "class evaluation" procedure that would permit a statistical appraisal of students' opinions about the instruction they received. Although this scheme died sometime in 1981, it was revived again several years later and, since 1989, the students in the department have been asked to evaluate all their professors according to a standard questionnaire, and the statistics that result are used by promotion, tenure, and other committees that must appraise the quality of teaching performance.

Of very great importance is the actual content of the course program, and the arrangement of the classes through which that program is presented. This importance is attested in the preceding pages by the number of times the character and content of the program have been changed in attempts to meet what the department deemed was needed from time to time. The class offerings were again reviewed during 1980-82. In addition to any other reasons, such reviews seem normally to follow from a change of chairman, or from any other circumstance that also requires the department to look at its long-term objectives.

This time the review was given further impetus by financial pressure. As mentioned above, the financial situation of the university had led to budget restrictions. Because salaries form nearly 85 percent of the total budget, because the annual inflation rate was about 12 percent, and because the budget increase from the previous year was 4.7 percent, there was very real pressure to reduce other costs. In December, 1981, Geology was actively considering cancellation of evening classes as a cost reduction, and the classes in Physical and Historical Geology, Marine Geology and Geophysics, Geomorphology, and Hydrology were terminated at the end of that year. By 1982, the class in Environmental Geology was the only survivor in the evening program. (See pages 46 and 65)

Space Problems: The Move from the Dunn Building

Space in the department was a serious problem after 1963. Initially this was a simple matter, such as Geology 1 classes too large for the available laboratory space. That was solved by adding laboratory periods till they were held on every afternoon of the week. But as additional staff and classes were added, laboratory, classroom, and office space were also required. Some problems could be solved by scheduling changes, but office space could not be so provided.

For many years, solutions were found through the cooperation of the Engineering and Physics departments who allowed Geology to use some of their space, despite the fact that, as the number of students in the university increased, those departments were also expanding. Naturally, there were differences and disagreements over specific bits of space but, in general, both departments were very cooperative and helpful. As a result, Geology was able to house some staff in Engineering offices, though it usually meant that two professors shared an office and that they might be moved about from time to time. Some of our staff had joint appointments in Physics, Oceanography, or elsewhere, and had offices in the corresponding departments.

In addition, space originally intended for specific purposes was also used for staff offices. For example, Schenk, who occupied a room originally intended for photography, found himself sharing his office with all the traffic to the dark room. Someone else might get to his office past the x-ray machines, and so on.

In 1965, committees began to consider a Physical Sciences Centre, as mentioned above (page 59).

In 1971, some staff and their graduate students moved into the Oceanography wing of the newly completed Life Sciences building. Generally, these were people who were involved to a greater or lesser degree in marine aspects of geology - in the departmental slang, the "wet" geologists - and were therefore dealing with problems related to those of their new neighbours. Of course, one could not expect Oceanography to be delighted at parting with some of their new space but, again, relations were generally reasonably cordial. While it solved some of the space problem, this move effectively cut the department into two entities. In theory it should have made no difference; in fact, detailed day-to-day contact was lost and before long it was possible for graduate students to come and go in one group with their names barely recognizable to people in the other. Though it took a little longer, there developed also a tendency for staff to form two groups with different points of view and objectives.

The construction of a new building for the Provincial Archives meant that the Archives Building on the Studley campus would be vacated. In 1977 there was some consideration of that building as a home for Geology. It quickly became clear that the building had been designed for storage of paper, with very thick floors to carry the attendant weight. Apart from any questions of room layout, areas, or general suitability for a Geology department, the cost of installing the many pipes, conduits, and drains necessary for the laboratories would have been excessive.

The problem of accommodation for students became acute in 1979. Enrollment in second-year classes had been around 25 for several years. Although teaching laboratories in the Dunn building had been designed for about 15 students, it had been possible to cope with the problem by various devices. In 1979, the enrollment in second-year classes unexpectedly doubled to about 50. At first, this sudden growth was ascribed to many local causes - from quality of teaching to publicity about offshore exploration for oil - but it eventually became clear that geology departments across the nation had had the same experience. It continued in 1980, when second-year classes had enrollments up to 55 and, of course, the problem had now progressed into the third-year classes as well.

For some classes, such as third-year petrology, the difficulty could be overcome by running extra classes in the laboratories. For some others, extra space was not readily available and there was severe crowding. Classes could not be moved to larger rooms; they were already full. For two winters, students were doing exercises wherever they could find space, and one has vivid recollections of students sitting on the steps of the fire escape to write up their laboratory exercises. (They had reason to be thankful that Lady Dunn refused to have the appearance of her building "ruined by ratty old fire-escapes at either end" and insisted that walls be put around them.)

The departmental minutes record that in December of 1979 there were negotiations with Mr. Sykes, the Director of Physical Plant, and with Dr. Wangersky, then Chairman of Oceanography. Obviously a number of avenues toward more space were being explored.

Although Geology had an acute problem, it was not the only department in trouble. An introductory-level Chemistry class, for example, is a requirement for practically any science student and, with increase in the size of the student body, that department was also in very serious difficulties indeed. There were also problems on the Carleton campus, and many arts and humanities departments had been moved into houses between the two.

In May, 1980, there was brief discussion of the possibility that Geology might move into space in the

Dunn Building to be vacated by Engineering. It was discussion only and in December of that year the department was considering restricting the numbers in certain classes, as well as holding laboratory classes simultaneously in Rooms 221C and 221E.

In January, 1981, there was similar brief discussion of moving the neutron activation analysis laboratory to the basement of that building. Instead, by May, 1981, Engineering was asking that Geology vacate two rooms that were shared. By September of that year, several graduate students had been given space in offices vacated when the Provincial Archives moved away, and Geology was storing drill cores and other samples in the basement of the old Archives building. The following month, second year students had a meeting with the Dean and provided to him written complaints about the space situation and the conditions in which they were working.

It is obvious that efforts were being made to solve problems of accommodation by any adjustments and re-arrangements that did not involve major expense. Considering the increasingly serious financial situation of the university at the time, this is understandable. In 1981, this practice of piecemeal adjustments was abandoned and the university hired a consulting firm to advise on the most advantageous use of space within the university. This firm became known in the Geology department as the "space consultants".

With some reason, departmental staff were sceptical. They had seen previous examples of "consultants" who collected the work of university staff, compiled it into a report, and charged high rates for providing to the university administration the information it could have had for nothing by asking its own staff.

During his first year, Schenk had been trying to solve the day to day problems of accommodation, as well as to find a long-term solution. At this stage, in December of 1981, however, no one was prepared to authorize further changes until the report of the "space consultants" was received. They toured the department, in all its many locations, in February, 1982. To give them credit, at least the consultant's staff on the ground took their job seriously and insisted on seeing everything. They got into places, such as storage space in the sub-basement of Life Sciences, that most people in the department have never seen. They reported in March. One or two recommendations seemed to suggest moves for the sake of motion, but other suggestions were, on the whole, reasonable ones.

The "space consultants" recommended, among many other things, that Geology should move into the second and third floors of the Biology wing of the Life Sciences building. This would greatly increase the space available for teaching laboratories, and so solve a very critical problem, but did not provide enough space to bring the whole department together as a unit.

Naturally, the Biology department was not overjoyed to see the consultant's recommendation. One can understand their reluctance to release space that was only ten years old and carefully planned to meet their present and future needs. It is not surprising that they should have done their best to retain that space. Once this part of the recommendations had been accepted by the university administration, however, the Biology department generally cooperated in our move, although there were some further lengthy discussions about the eastern part of the third floor, and it was some months before all was agreed.

The main part of the move from the Dunn Building occurred during the summer of 1982, and required some liaison with the biologists. In addition to vacating their offices and individual research laboratories, the move required that they remove research equipment, such as their electron microscope for example. There was also some discussion about moving experiments already in progress - experiments with living things cannot be turned on and off readily.

The move also required that Geology install some dividing walls and that there be some modification of plumbing and electrical services to accommodate our x-ray equipment and the microprobe, but the changes really were not very extensive. The major problem was with the chemistry laboratory, where special fume hoods were of concern. Fortunately, the impending installation of the regional x-ray fluorescence unit at St. Mary's reduced the demand for analyses requiring such special hoods. There was available on the sixth floor a suitable fume hood and Biology agreed to make it available to Geology for the few cases in which it would now be required. The transfer of the Chemistry laboratory from the Dunn Building was made in October.

The detailed day to day supervision of the move was handled by Brant Laidler, as Owen Watkin had done during the move into the Dunn Building in 1960. He had carefully labelled all the furniture, specimen cabinets, and the hundreds of other pieces, large and small, each with its destination. He then provided the movers with lists specifying what should be moved when, and to where, and was himself on hand to ensure that delicate or other special equipment was handled properly. Largely due to his careful organization, things moved, and fitted, into their assigned places with minimal fuss or confusion.

It was some time before the move was fully completed. Some dry storage space was retained in the Dunn Building, along with the "catacombs" beneath the front steps, as well as the basement room used for crushers and a diamond saw. The "catacombs", of course, had ceased to be dry storage years before, when a crane had been set up on the platform of the front steps to lift a computer into the "penthouse" on the roof; the weight cracked the concrete, which leaked thereafter. Some storage space was still retained in 1990.

Dr. Reynolds was the last staff member to move his office from the Dunn Building, in 1985; at that time graduate students were still occupying the former X-ray laboratory, and honours students were still using the space in the penthouse in 1986. The Physics department converted the X-ray laboratory into their deparmtental office in 1991.

Centre for Marine Geology

After completion of the work of Leg 37 of the Deep Sea Drilling Project (page 60), the group at Dalhousie continued to drill deep holes into oceanic crust where it is exposed on land. Iceland exposes part of the actively spreading centre of the Mid-Atlantic Ridge and, in 1978, this group, in cooperation with others, organized into an International Research Drilling Project, investigated the youthful crust exposed there. By combining information from the surface exposures with that from a continuously cored drill hole two kilometres deep, a crustal section three kilometres thick was examined in great detail. The investigation was concerned not only with the sequence of events during the formation of this young oceanic crust, but also with changes that had subsequently occurred therein, and it involved some 30 investigators, faculty and students, from institutions in Canada, the United States, Iceland, Germany, Denmark, France, and the United Kingdom. In Canada, funds to support this work were supplied by the Natural Science and Engineering Research Council, the Research Development Fund of Dalhousie, and the Department of Energy, Mines and Resources. In the United States, the National Science Foundation provided funds through the University of Washington. In a similar way, there were contributions from the other participating countries and from N.A.T.O. Again, in 1982, and now known as the International Crustal Research Drilling Group, most of these investigators began a similar lengthy investigation of a thickness of about four kilometres of oceanic crust now exposed in southern Cyprus.

It is obvious that the organization and administration of such international projects is a lengthy and fairly complex operation. Although much less expensive than the Deep Sea Drilling Project, each of these holes involved expenditures of many hundreds of thousands of dollars, and the coordination of the activities of many people in many places, apart from the matter of raising the funds to pay the costs of the work.

In August, 1982, shortly after drilling had begun on the Cyprus project, Dr. Hall proposed the formation of an Institute of Marine Geology to handle future activities of that type, where he saw rapidly expanding opportunities for large scale research, international collaboration, equipment development, and advanced training. His proposal was based on the experience of the "Deep Drill" projects of the preceding decade and was obviously intended to deal primarily with similar projects in the future, by placing them under a formal organization within, but almost parallel to, the Geology department. At the same time, he proposed to include the activities of a group that was already working on matters marine or related thereto: Medioli and Scott, on ancient sea levels as identified by microfossils; Boyd on coastal processes; Gibling on coal, oil shales, and related sedimentary basins; and Ryall on equipment for drilling or other work on the ocean floor. To obtain funds from the Canadian International Development Agency (CIDA), the Cyprus project had included provision for instruction of geologists from "developing" countries, such as Argentina, for example; the proposed institute would continue this idea and include provision for training of "third world" geologists in marine geology. At that time, also, there was considerable exploration for petroleum offshore in eastern Canada; Hall proposed that the institute would develop participation with government and with industry in this exploration activity, not only locally but world wide, by sharing its expertise in matters marine.

This would involve expansion beyond work already in progress, and beyond the existing research interests within the proposed institute, to include bringing geologists from the petroleum industry to the department for up to a year (i.e. on "sabbatical" from industry), and to include also contributions to offshore development as consultants and by interaction with related groups in the area, e.g. the Bedford Institute. Hall considered that the proposed institute would permit rapid expansion and development of work in areas that do not fit readily into the departmental structure.

The proposal was presented to a departmental meeting on 19 October, 1982. In preparation therefor, Gibling, Hall and Jamieson had prepared a set of guidelines concerning the relationship of the proposed institute to the department. Although these included a number of administrative details, it was clear that the main thrust of the proposal was for a research arm parallel to the department and able to handle large amounts of funds in short-term projects. Members of the existing teaching staff who were members of the institute would have "joint appointments", would continue to meet their normal teaching and other departmental duties, and would be paid in the normal way from the departmental budget. In short, they would continue to operate as they had done in the past, would continue to get research funds in the usual way from NSERC or other sources, but their research would be coordinated through the institute when it was expedient to do so. Other members of the proposed institute would have no official departmental duties, would be paid from outside grants and similar sources (so-called "soft money"), and would be responsible only to the institute and only for research work within it. It was expected, however, that some teaching duties might be included in some cases, such as a visiting expert in petroleum exploration for example. The existing arrangements for graduate students would continue, but supervisors might include non-departmental members of the institute. There were also proposals covering departmental support staff and equipment, and availability thereof to the institute. The institute would have additional support staff of its own, who would have no departmental responsibilities. Because its proponents expected the institute to expand rapidly, additional space for it was a serious problem that was not resolved.

The proposal for an institute of marine geology did not get instant approval, and for this there probably were several reasons: For over ten years, since 1971 (page 59), the departmental staff had been partly in the Dunn Building and partly in Life Sciences. Each of the two groups had tended to develop its own collective ideas about departmental affairs and, it must be admitted, each to develop also some degree of suspicion of the motives of the other. It did not help, therefore, that the "joint appointees" to the proposed institute included all the group in Life Sciences, where the scheme had been born. In Dalhousie's administrative system an "institute" is a free-standing organization outside a faculty, as was the original "Institute of Oceanography" for example. Even with the proposed "joint appointments", an organization not only outside the department but outside the Faculty of Arts and Science was seen by some as institutionalizing and reinforcing the above division and, if the departmental duties of the "joint appointees" were to be retained, as creating serious administrative problems - as Oceanography had done when it was still an institute. There were also those who remembered that, when the department first emphasized marine geology, its members actually went to sea and they criticized much of the present research as marine only by association. As well, there were those who could see the possibility of concentration upon research work by those within the institute and a sloughing of their teaching duties upon other staff members. In this respect, one of the more realistic comments was that of Boyd, who pointed out that instruction that inspires students is not a transmission of "facts" but comes when students see or share the solution of real and relevant research problems.

A further departmental meeting, on 17 November 1982, sent Boyd and Clarke off to enquire about "institutes", "centres", and other administrative schemes functioning within Dalhousie, and to report upon them as possible alternatives to the proposed institute. Out of this came the "Centre for Marine Geology". Because a "centre" at Dalhousie is an organization set up, within a department, primarily to do research but with some participation in the teaching program, this met a number of the objections and suspicions mentioned above.

This was followed by lengthy negotiations about details of the administrative relations between the proposed centre and the department. As had been implicit in the "Stanley Affair" fifteen years before, there was still the very real possibility that establishing the Centre would gradually split the department into two parts. In April, 1983, this problem was met by a committee of the Chairman (Schenk), the Associate Chairman (Clarke), the Director of the Centre (Hall), and the Director of the Cyprus Project (Robinson), who examined the probable operations in some detail and developed guidelines for the mutual relations of centre and department. The chairman's objective here was to develop the centre as a focus for the department and its work, and to avoid any possibility of it becoming a disjunctive force.

The formal request to establish a "Centre for Marine Geology" went to the Vice-President (Academic) at the end of November, 1982, and was approved by council of the Faculty of Arts and Science in March, 1983, on the assurance that contract research, sponsored, for example, by an oil company, would not be permitted to dominate, or to deflect the Centre from what the council considered its proper role to be, and on the further assurance that the Centre would not make additional demands upon the Faculty for funds or space. (This was at a time when the university was officially under "financial constraint", a provision of the collective agreement with the Faculty Association that gave formal recognition to a serious financial situation and permitted reduction or cancellation of programs. Such "constraint" had been declared in October, 1982.) In May, 1983, the Board of Governors approved creation of the Centre.

The Centre is guided by an advisory board of fifteen members. The board consists of the Director and Associate Director of the Centre, and the Chairman of the Geology department, together with other representatives of the university, of the provincial and federal departments of mines, of the Atlantic Geoscience Centre at the Bedford Institute of Oceanography, of petroleum exploration companies, and of engineering firms.

In anticipation of eventual approval, Hall had convened a meeting early in December, 1982, to discuss sources of major funding. The proposed "budget" involved $2.35 million over three years and covered the existing research efforts in crustal drilling (Hall, Robinson), micropaleontology (Medioli, Scott), coastal processes (Boyd), "ocean engineering" (Ryall), and "sedimentary environments" (Gibling) *plus* a new "Marine Resource Geology" group. This latter was to have a senior and a junior petroleum geologist/geophysicist and one junior member to work on hydrothermal circulation and ore deposition - the latter would tie into projects such as that in Cyprus. Also proposed was a fairly detailed establishment for supporting staff, including a machinist, a computer programmer, an electrical engineer, post-doctoral and research fellows, secretarial and other assistance. A major part of this new support was a professorship, for which the endowment would come from a petroleum company or some other similar source. About half of the total $2.3 million was made up of Dalhousie salaries already committed to the "joint members" and of NSERC and other research grants already committed or that could reasonably be expected. The remainder it would be necessary to find from other sources.

Two professors were appointed by the end of 1985. Mobil Oil Canada provided funding for a professorship in marine geology, and Dr. Paul Robinson, who had joined the department in 1980 as a Killam professor and was the Associate Director of the Centre, was appointed the first Mobil professor. In addition, Dr. Matthew Salisbury, who had recently been Associate Chief Scientist of the Deep Sea Drilling Project, was appointed to a professorship provided by Petro-Canada and the Natural Sciences and Engineering Research Council of Canada. He was with the Centre till 1988, and was responsible for operation of a facility for investigation of the physical properties of rocks at high pressure and temperature. This unit was provided by NSERC and is the only one in Canada capable of accomodating substantial lengths of large (4-inch) drill core.

Research Associates and support staff were also added.

The Centre absorbed the operations its members were conducting when it was established.

Cyprus Crustal Study

During the first year or two, the major effort was the Cyprus Crustal Study. That involved about 120 scientists from Britain, Canada, Cyprus, Denmark, France, Germany, Saudi Arabia, and the United States. Tied to the study was a training program that saw geologists from Argentina, China, India, Nigeria, Philippines, Sudan, Uganda and Zimbabwe spend some weeks in Cyprus in 1982, followed by two months in Canada in 1983, in a two-part scheme designed to upgrade geologists and geophysicists from the national surveys of "Third World" countries.

As was outlined in our discussion of the Deep Sea Drilling Project (page 60), the theory of sea-floor spreading infers a large number of vertical basalt dykes beneath the basaltic rocks formed by the volcanoes of a mid-ocean ridge. The dykes are generated by molten basalt moving through fractures to feed the volcanoes on the sea bottom from a source below. Eventually the basalt in the fractures freezes to form the dykes. This further implies that, in old oceanic crust, there should be below the dykes the frozen residue of that molten basalt source; frozen at depth, it would be relatively uniform and coarse grained - the rock called gabbro. In the southern half of Cyprus, tipped up and exposed by past tectonic action, is just such a sequence of rocks - pillowed basalt, as observed on the modern sea floor on mid-ocean ridges, overlying a thick zone that is almost exclusively basalt dykes, in turn overlying the massive gabbro that forms the Troodos mountains. In addition to geological and geophysical re-survey of such parts as could be seen in surface exposure, the study included drilling through the complete sequence, a total of about 4.25 kilometres of core, and extensive geophysical logging of the drill holes by many different techniques. (One can drill through the sequence by starting in the top and drilling downward to the limit of the drill rig, which is then moved to where the dip of the formations would bring to the surface the rocks at the bottom of the first hole. By repeating the process, a core can be obtained through the whole assemblage of rocks.) The drilling began in the spring of 1982 and was completed in 1985.

Understanding of the processes that operated within this great thickness of rocks during their genesis was the major objective of the study. It has long been known that molten rocks go through complex chemical changes during slow cooling, with the production and later destruction of elaborate sequences of minerals, before the whole is completely frozen - a process called differentiation. Here was an opportunity to examine, on land, a section of ocean floor that would normally be completely inaccessible, and to investigate the processes from the effects they produced. Furthermore, recent observations in the oceans, particularly in the Red Sea, on the East Pacific Rise, and on the Reykjanes Ridge have indicated that sea water may circulate through the hot rocks on the sea floor and may even be involved in the deposition of metallic sulphides (i.e. of metal ores) in those rocks. Now, our word copper is derived from *cuprum*, the late Latin version of what the Romans called *cyprium aes*, the metal of Cyprus, and copper has been mined from the Troodos complex in Cyprus for 3,000 years. By drilling one of the cores from beneath an old mine, it was possible to examine the effects of circulating fluids and their importance in the genesis of the ores, in addition to the effects of the fluids upon other rocks in the complex. This study continued for about seven years altogether and, of course, produced a large number of papers in a variety of scientific journals.

Ocean Drilling Program

The Deep Sea Drilling Project was succeeded by another, and similar, international arrangement, called the Ocean Drilling Program, involving scientists from France, West Germany, Japan and U.S.A. Canada joined in 1985. Several members of the Centre for Marine Geology serve on advisory panels of the O.D.P. and all Canadian participation in the program was coordinated through Dalhousie until 1988. Members of the Centre who were involved in the Cyprus project have continued to pursue their interest in the generation and development of oceanic crust through a major project that is part of the Ocean Drilling Program. It involves workers from Belgium, Germany, and the United States, as well as the Canadian participants, who come from Acadia, Dalhousie, Laval, Memorial, Montreal, and Waterloo universities.

If the ocean floor is spreading, there must be some propulsion mechanism, and this is generally ascribed to a slow circulation of the earth's mantle dragging with it the crust above. This Canadian project is a part of the O.D.P. investigation of this driving mechanism, but is concerned with the chemical and petrological effects of mantle motion, rather than directly with the motion and with the forces driving it. For example, if hot material is rising from deep in the mantle in a convective circulation, it will generate a "hot spot" in the crust above the rising current. In turn, this will produce, in the crust, alteration and other effects that may give information about the mantle and its motion; it is these effects that the Centre is investigating.

Applied Micropaleontology

The micropaleontologists of the Centre have also been involved in a number of programs. As mentioned on page 41, the Italians had success in unravelling the complex geology of the Appennines by using microfossils, and these remnants of tiny organisms are widely used for a remarkable variety of purposes. Many of the organisms have been shown to be very sensitive to the salinity of the water in which they live, others to the temperature, and still others to other features. Consequently, deductions about a variety of conditions can be drawn from the presence of certain species or groups of species.

By examining cores of sediment from the Arctic Ocean, for example, Mudie and Scott at the Centre have shown that organisms from the Atlantic began to move into the Arctic Ocean about 300,000 years ago and that before then, the deep Arctic Ocean was isolated. It appears, also, that in Pliocene time (about 5 million to 1 million years ago) the Arctic Ocean was at least seasonally free of ice. Although that was a long time ago, it does put some perspective on the current discussions about global warming and indicates the problem of separating man-made effects from natural variations of such magnitude. This particular work also involved cores supplied from the U.S.S.R.

The correct identification of species is critical, if one is to use microfossils to make deductions such as those above. An attempt to use a group of fresh-water organisms, called thecamoebians, to deduce changes such as acidification of lakes, ran into difficulty because of uncertainties about definition of species. Medioli developed a technique for culturing two of these species in the laboratory and showed that many supposed species are simply the large variations that occur within the progeny of a single parent. Medioli has devoted much time to this matter, has been recognized as an authority on the taxonomy of the thecamoebians, and has published a major monograph thereon. He and Scott and their co-workers are also producing an atlas of recent bottom-dwelling foraminifera from the North Atlantic. Kaminski and his collaborators are preparing another of deep-water foraminifera; it is to be published by ELF-Aquitaine, the French petroleum company.

Microfossils have also been used to identify former shorelines. About 15 years ago, Scott recognized that certain foraminifera in modern salt marshes are very sensitive to elevation and to salinity, and he was able to correlate these species with the higher high water level reached by the tides in the marshes. He thus had a method for recognizing former sea levels, whether they are now on dry land or well beneath the sea. By use of radiocarbon dating, the age of such former shorelines can also be obtained, and thus by comparing the present position and the age of former shorelines one can infer the rate of uplift or subsidence of the land. The rate of such response to the removal of the Pleistocene glacial ice is a measure of the "viscosity" of the earth's upper mantle, a concern of geophysicists studying the mantle or the development of great sedimentary basins, and Scott's early work on former shorelines in the Maritimes was used for that purpose by Dr. Beaumont. By using marsh foraminifera it has also been shown that, in Carboniferous time, the Sydney coal field was a marginal marine basin and not a fresh-water swamp, a matter of some interest to those who must infer the distribution of high-quality coal, and plan the mining operation at Sydney.

It now appears that recognition of former shorelines from the zonation of marsh foraminifera is possible on a wide scale. Scott and his collaborators in South America have shown that a zonation similar to that in North America also exists there, and thus that marsh foraminifera can be used as sea-level indicators in both the northern and southern hemispheres. Obviously this will be of importance to those who require a knowledge of former distributions of the sea.

Scott's studies also led to the drilling of a 150-metre hole on Sable Island, designed to get a complete section of sediments deposited since the Pliocene. Because of its relevance in off-shore exploration, it was supported financially by Mobil Oil Canada, and by the Offshore Energy Research and Development Fund of the federal government.

Yet another endeavour of the micropaleontologists is comparison of paleoceanography of northern and southern oceans. Deep sea sediments generally contain little material derived from the distant land, but they do contain the fossil remains of organisms that lived on the sea floor and in the water above, all the way to the surface. Because the foraminifera and other minute organisms are sensitive to temperature, salinity, and other factors, the proportions of different species of fossils that have accumulated on the sea floor can provide information about such variables in the water column above. Some species have carbonate skeletons and the proportion of oxygen isotopes in the carbonate is also temperature dependent. By combining inference from the isotopic composition with data from the proportions of species and forms present, one can make deductions about past temperature and salinity of the oceans and even gain some information about possible current systems. This sort of information has been used to correlate changes in the oceans with advances and retreats of the Pleistocene glaciations - temperatures fluctuate with formation or melting of the glaciers, and discharging thousands of cubic kilometres of melt water into oceans obviously will change their salinity. This work has involved sampling in deep water in the Indian Ocean and the Antarctic as well as off New Jersey and in the Labrador Sea. Related work in the Arctic Ocean has been mentioned above.

Marine Sedimentology

The Centre has also been involved in the study of modern sediments, with the main objective of improving our understanding of the processes operating along shorelines and on the continental shelves, an understanding that is necessary before one can interpret correctly the ancient rocks. Most of the Scotian Shelf, for example, was covered by ice at the maximum expansion of the Pleistocene glaciation, and the sea-level was then a couple of hundred metres lower than at present. As the ice melted, it deposited on the Shelf the rock debris of all kinds and sizes that had been carried along in the ice. One would expect that, as the ice melted, the sea-level rose, and the sea gradually flooded across the Shelf, all those deposits would be reworked by the waves, and their original character destroyed. Such is not the case, and many of the glacial features of the deposits are preserved. A considerable part of the work of Boyd and his collaborators is an examination of the processes that produce such preservation on a continental margin where the sea is transgressing.

The major factors controlling sedimentary processes are probably the supply of sediment, the relative sea level, and the tectonic situation. On the Scotian Shelf the sediment supply is glacial deposits in place, and the relative sea level is gradually changing. To see other situations, Boyd and his co-workers examine also the Mississippi delta, where the river delivers abundant sedidment that is already partly sorted. As yet another location, where the tectonic situation should have an influence, they examine the rocks of the Exmouth plateau, off northwestern Australia, where the Cretaceous sediments were deposited during the break-up of the ancient Gondwanaland continent.

In these endeavours, of course, they investigate also the smaller features such as the sedimentary structures that develop on the sea bottom as well as the sedimentary sequences that appear as changes occur in the relative sea level. Improved understanding of such features and the conditions that produce them is of no little concern to those who must interpret ancient sedimentary rocks in the course of exploration for oil or minerals. Some of these studies have involved very detailed observations and measurements of sediment behaviour on the sea bottom.

Transgression by the sea also involves changes at the shore line, so Boyd and his students have been studying shore face erosion on the eastern shore of Nova Scotia. The processes involve erosion of the headlands and deposition of the resulting sediment in the tidal inlets and in valleys in the sea floor. This is very directly relevant for the local purveyors of construction aggregates, and to the public at large, as several unfortunate examples have shown in recent years.

Yet another project of the Centre investigates the opening of the modern Atlantic Ocean. If the ocean is being widened steadily by the addition of new crust at the Mid-Atlantic Ridge, then it must have been narrower in the past and there must have been a time when it did not exist. The petroleum deposits of Hibernia and the Scotian Shelf, for example, are in sedimentary rocks that were deposited in the newly formed ocean, so knowledge of the sequence of events and the character and location of the sediments deposited are of great practical importance, apart from the general scientific value that attaches to an understanding of the processes involved in the formation of an ocean. Following an extensive study of the rocks of the mainland, Schenk suggested about twenty years ago that southern Nova Scotia was adjacent to Morocco prior to the opening of the Atlantic, which began about 250 million years ago. Because "reconstruction" of that early sea includes not only the distribution and character of the sediments deposited in it but some knowledge of the depth of water and other features, this more recent study combined the efforts of Schenk, Gibling as sedimentologist, and Gradstein and Williamson as micropaleontologists. They are comparing the deposits of the Canadian east coast with those of Morocco and of Portugal.

This is an example of the type of research that worried the faculty council when the Centre was being set up. Because of its direct practical value, the project was initially supported by four oil companies: Mobil, Petro-Canada, Chevron, and Gulf. But at the same time it tested stratigraphic techniques developed by the Geological Survey of Canada and attempted to clarify a very important aspect of recent geological theory - the widening of the oceans. Obviously it is sometimes very difficult to draw a line between "contract" research, of immediate commercial importance, and "basic" research, designed to answer broad scientific questions, and the faculty council was greatly concerned that the Centre should not be driven by the interests of firms supporting "contract" research.

Summary

As is clear from the above outline of its activities, the Centre for Marine Geology has done many of the things it was designed to do. It has coordinated and managed a number of research programs and maintained some coordination between projects that involve a considerable variety of directions and disciplines. As Schenk hoped it would, it has provided a focus for the department in matters marine and geological, albeit not quite perhaps in the way that had been imagined when the decision to emphasize marine aspects was made by the department in 1970. The "joint members" have honoured their teaching responsibilities to the department and the research work of the Centre has been the basis for many graduate theses, supervised by its members, "joint" and otherwise. In a time of economic recession and of financial constraint within the university, funds available to the Centre are drastically reduced, and operations the size of the Cyprus study have not been possible. (It is an oddity of the bureaucratic system that the Centre is credited with one-third of the overhead charges for a project, whereas the department is credited with one-half. In consequence, some work actually done in the Centre has nominally been done by the department.) Consequently, there has been a reduction in demand for space, time, staff, and equipment. In addition, since the Centre was set up, there have been several different directors and chairmen and the relations between the Centre and the Department have changed, of course, with each change. All this has reduced the potential for friction, and calm discussion of problems has removed suspicions, as experience has shown they were not justified. Although other members of the department have continued to pursue their interests in matters non-marine, the possible serious split into two groups has not materialized.

At the same time, it is clear that the proposed role as a training agency has not really materialized, except in the normal way as part of the graduate program; nor has there been much further development of equipment for ocean studies. It appears that, after an initial effort, training of "third world" geologists has been a minor matter and that, in future, the training aspect is likely to be incorporated into normal courses, but as an enrichment by bringing outside specialists to provide concentrated laboratory classes, lectures, and seminars on specific limited topics. (See also page 75, for an earlier version of this idea.) The planned development of collaborative efforts with government laboratories has been reasonably successful, but because of the changes in the economic situation such collaboration with industry has been much less than had been desired.

INTERREGNUM, 1983

In 1980, the lengthy discussions about the chairmanship had resulted in the election of Schenk as chairman, and of Clarke and Zentilli as "associate chairmen". When Schenk's term expired at the end of June, 1983, one kick of the "Zentilli wheel" advanced Clarke to the chairmanship and made Zentilli the heir-apparent. The usual formalities were followed, Clarke was officially appointed by the Board of Governors, and he assumed his duties, as expected, on 1 July.

Clarke's tenure was brief. Almost immediately after he became chairman, his wife became very seriously ill. Clarke found that it was not possible to deal with this family emergency and, at the same time, devote to the chairmanship the attention it required, so he resigned. Fortunately, in mid-summer the pressure is not as great as when classes are in session, and the department operated on its own momentum for a week or two.

Medioli came to the rescue as acting chairman and dealt with the routine and recurring problems of the department while the machinery of a formal search committee was set up by the Faculty and reached its recommendation for a new chairman. As had, by this time, become more or less standard procedure in the Faculty, the department consulted itself and made a strong recommendation to the search committee, which agreed with that recommendation. Zentilli became chairman on 31 January 1984.

During this first term of the 1983-84 session there were some problems that are hardy perennials. There was the usual question of support for graduate students: the total amount of money available and how much would be provided by Graduate Studies; the number of students, and who would be supported from research grants and by how much. There was also the now perennial question of the amount of money available to the Library; although outside the control of the department, this is of interest because it has an impact on the books and journals available. There was also the continuing question of undergraduate class offerings, their content, and standards. This matter was referred to the curriculum committee, which had become, for practical purposes, a standing committee of the department. There was also consideration of appropriate classes, designed for graduate students only. It was recognized that there was a scarcity of such, although, of course, any supervisor could suggest to his/her graduate students appropriate reading to correct perceived deficiencies. Accordingly there was created a class called "Directed Studies"; the student would then be able to get course credit for such work.

There were two other matters that had now become routine problems, although they were certainly not intended to be so: space and budget cuts.

The critical problem of classroom and laboratory space had been solved by the move to the Life Sciences building in 1982, although the department was still in two different wings of that building. The immediate problem at this time was office space for graduate and honours students. Some space for this purpose was available in the Psychology wing of the building, and there was also a proposal to trade with Oceanography some of their space. This latter would not increase the space available but would rationalize its use and get all our people on one floor. Oceanography was not receptive to this idea. The problem of space was severe for others also, particularly for Chemistry, and there was a proposal that some laboratory classes should be run in the morning as well as in the afternoon, as had been done to cope with the influx of students immediately after the Second World War. It quickly became clear that, if this were done, all classes of the entire Faculty would have to be re-scheduled, and that project was abandoned as not immediately practical.

Budget cuts had now become a serious matter. The initial efforts to reduce expenditures had involved minor items; economies in services such as telephones, xerox costs, postage, and similar matters, which were annoying but, in aggregate, not very large. This had been followed by removal of evening classes and their attendant costs. The total budget for equipment, supplies and current expenditures had been about $65,000 for several years, although there had been one or two substantial increases above that figure for special cases. Changes in the salary scale to reflect length of service, inflation, and other factors had produced a steady increase in the cost of salaries. Although in 1982-83, for example, the total expenditure had increased by over two percent, inflation had been about six percent and the purchasing power of the money spent had therefore dropped considerably. It was then a real shock to the department to be told that for 1984-85 the budget must be reduced by five percent, approximately $45,000, or about half of the non-salary budget for the previous year.

There were also some non-routine matters. As he had hoped, Dr. Hall had succeeded in persuading industry to provide a professor to add to the staff of the Centre for Marine Geology, and in January, 1984, Robinson was appointed the first Mobil Professor. During this period also there was the formal recommendation that Matthew Salisbury should be appointed to a professorship funded jointly by NSERC and Petrocanada, although he did not actually arrive till April, 1985.

It is perhaps fortunate that the Acting Chairman at this time was Medioli, a man who likes to talk. It was now only three years since the uproar that had resulted in Piper's resignation, and memories of that period tended to linger. It was only three months since the Centre for Marine Geology had received final approval, and the department had been far from unanimous about that. Accordingly, there were among the staff lingering doubts and suspicions about objectives and motives. In his capacity as Acting Chairman, Medioli spent endless hours talking to staff members and, in the process, succeeded in reducing the tension, generating agreement, and improving understanding of the way in which departmental matters were likely to develop.

13

M. ZENTILLI, 1984-1986

P. J. C. RYALL, 1986-1989

The hiatus generated by the resignation of Clarke came to an end on 31 January, 1984, when Marcos Zentilli became chairman. The "Zentilli wheel" had operated as expected but there was now some departure from its schedule; in November it was proposed that Medioli and Milligan should be the associate chairmen.

Because of the nature of the problems involved, the discussion that follows covers both the chairmanship of Zentilli and the first term of his successor, P. J. C. Ryall.

Financial Problems

For the past ten years or so there had been increasing financial pressure on departments in the Faculty, and chairmen had found increasing resistance to their proposals and requests for operating funds. This resistance was the response of administrators to a continuing, and increasing, problem of debt carried by the University. At the end of the 1983-84 year, this amounted to 12 million dollars and its reduction had become imperative. The resulting pressure on departments, and their perception of the objectives of "the Administration", were the major matters during Zentilli's term as Chairman - and have continued to be so.

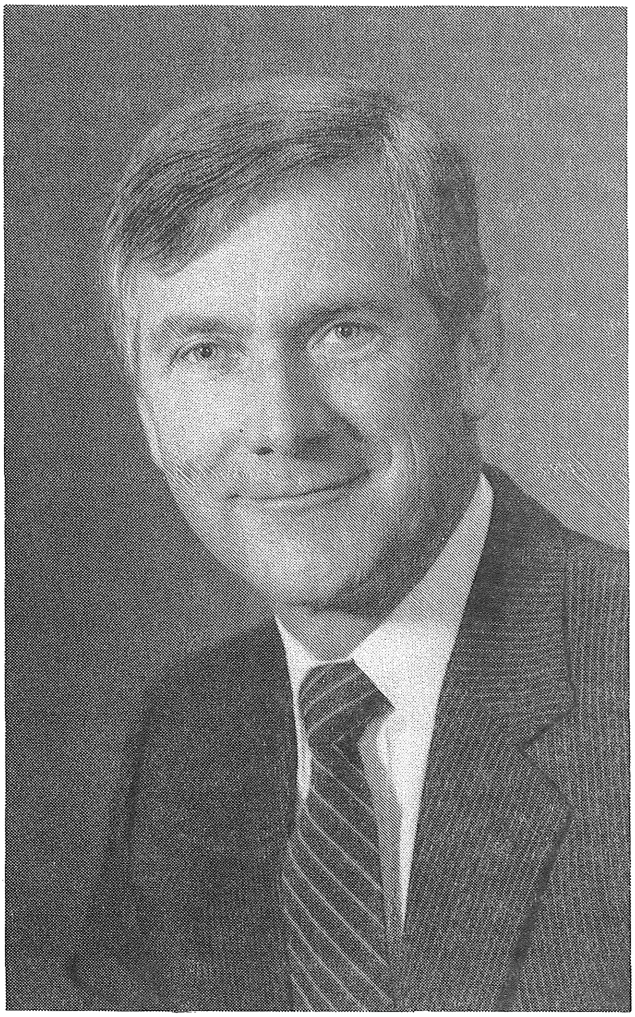
General Situation

The financial problems had their roots in increased enrollment in the University, increase in instructional programs and their ancillary activities; and in the buildings and other facilities necessary to accomodate them. There may be some room here for argument about cause and effect: did increased enrollment lead inevitably to increased program offerings? or did the introduction of many new programs produce increased enrollment? In either case, the programs and the students had to be housed and much building resulted.

Enrollment increased rapidly. In 1945-46 the influx of returning veterans had pushed total enrollment to just under 1000, and it reached a peak of 1374 in 1947-48. By 1964-65 this had doubled, and by 1970-71 the total was just over 5,000; that had doubled yet again by 1983-84. The Faculty of Arts and Science had maintained its historical proportion at 65 to 70 per cent of this total till 1976, but that had fallen to about 47 per cent by 1984.

When the Maritime Provinces Higher Education Commission was set up as an advisory body to separate the universities from governmental funding agencies, it adopted a funding scheme that is enrollment driven; this was, in itself, an incentive for increasing enrollments.

Enrollments for the years 1929-30 to 1990-91 are given in Appendix I. Some brief comments may be appropriate: (1) It is a common perception that women were discouraged from university attendance till very recently. This was evidently a concern of President Stanley, in the 1930's, for his annual reports include their enrollment in Arts and Science. The maximum he reported was 43% in 1929-30, falling to one-third in 1932-33, and rising again to 38% two years later. Possibly these changes show some reflection of the depression economy of that time. (2) The economy is certainly reflected in the drop in total student enrollments from the brief high of 1015 in 1931. (3) The peak enrollment in 1947-48 reflects the passage of veterans of the Second World War. The delay in the peak enrollment till 1947-48 is a result of the conditions of the 1930's and of the policies of the Department of Veteran's Affairs. In the years preceding the war, schooling in the Maritimes was compulsory only to Grade 8 and, in the midst of the Great Depression, many dropped out of school at that point to contribute what they could to the family income. The Department of Veteran's Affairs provided tuition and a small stipend to the veteran for a number of weeks equal to the time spent in the armed services. A soldier who had been both lucky and overseas for over seven years, as some had been, was then eligible for more than 364 weeks of support, or for ten academic years of thirty-six weeks each. In 1945, veterans were not uncommon in the high schools; there were even some pupils who had commanded companies or their equivalent in battle. It was a year or two before they appeared in the universities and much longer, of course, before some of them completed their training in medicine, law, and other professions. This certainly produced classes of unusual character. One recalls an



M. Zentilli

P. J. C. Ryall

afternoon as demonstrator in the Geology I class at Purcell's Cove in 1945; that small laboratory class (The whole Geology I enrollment was only 29) included one student who had served in the engine room of destroyers on convoy duty in the North Atlantic, one who was the sole survivor of a bomb-disposal squad of ten men, and one who had commanded an infantry battalion in action.

The influx of students in the sixties is fairly obviously the impact of the greatly increased birth rate immediately after the war, the so-called "baby boom", but annual increases of 20 per cent in 1969 and 1970 are probably not be explained in that way. The continued growth from 8,300 in 1975 to 10,000 in 1985 was at an average annual growth rate of about two per cent, which probably reflects population change in this area. The next time there is a proposal for a Physical Sciences Centre (the one that has been discussed since 1965), it will be the duty of someone to examine these figures again carefully to see how much of the increase is demographic and how much is changing perception of the need for university education. In 1965, Dr. Swift showed that there was a parallelism between the numbers of male students in Grade 3 in the schools and the numbers enrolled in Geology some years (10 years?) later. On this basis, of children already in the school system, he predicted our future enrollment in Geology. His calculations were repeated a few years later by Dr. Cooke; their predictions were remarkably good to about 1982. It was commonly expected, on demographic grounds, that university enrollments would drop considerably after 1982, but that did not occur. Instead, growth continued at a rate of about two per cent per year. There was also an increasing proportion of part-time and mature students. Some were *very* mature, such as the man in Geology 104/105 who was in a B.A., program at the age of 68.

Full- and Part-Time Enrollments

	Arts and Science			University Total		
	Full Time	Part Time	Percent Part Time	Full Time	Part Time	Percent Part Time
1963-64	1540	53	3.3	2273	125	5.2
1964-65	1774	121	6.8	2632	134	4.8
1965-66	1885	134	6.6	2817	168	5.6
1973-74	3423	847	19.8	6375	1170	15.5
1974-75	4052	916	18.4	6784	1394	17.0
1975-76	3522	813	18.7	7079	1267	15.2
1983-84	3475	663	16.0	7813	1624	17.2
1984-85	3641	650	15.1	8051	1661	17.1
1985-86	3664	714	16.3	8154	1839	18.4

Increasing numbers of students required increasing numbers of teaching and support staff, and increased numbers of both programs and students required additional building space and equipment. Consequently there was an extensive building program that began with the Arts and Administration building in 1951 and continued at an increased rate with the Dunn building in 1960, followed by Howe Hall, the Weldon law building, the Tupper building, the heating plant and service tunnels, Life Science Centre and the purchase of the Fenwick building and other smaller structures; all by the end of 1972. Dalplex and additions to the Dental building came later. There were also expensive changes to administrative arrangements, such as the computerizing of the Registrar's and Business Office records.

No doubt all this was necessary, but during the early part, at least, of the presidency of Dr. Hicks there was, in addition, a rather relaxed attitude toward expenditures. Staff members from the days of Dr. Kerr recall that he pinched the pennies, and generally had money in hand before it was spent. At the departmental level, small expenditures such as travel costs for field trips simply were not reimbursed nor, for example, was there provision for entertainment of visiting speakers. This latter meant that the families of the staff met such interesting people as Duncan Derry, Paul Ramdohr, Marland Billings and E. Wegmann and had the fun of taking Adolf Seilacher to his first curling game. (His opinion: "Probably no one but a Scot would think of hurling 20 kilos of granite across a pond.") As another example, on his return journey from summer work in Manitoba in 1959, Milligan collected samples from nine mines discussed in his classes. They were: Lynn Lake, Flin Flon (Manitoba), Mesabi (Hibbing, Minn.), White Pine and Calumet (Michigan), Elliott Lake, Falconbridge, Hallnor (Timmins) and Lake Shore (Kirkland Lake) in Ontario. This involved considerable extra driving and expense, but no reimbursement was available. With the arrival of Hicks, these and all similar costs became payable by the department. Visiting lecturers were entertained in downtown restaurants and a couple of students and one or two staff members were invited also to meet the visitor. These examples, in themselves, are small matters; but the same relaxation extended to almost everything from class materials to computers. Dr. Keen, on more than one occasion, recounted how, when asked to advise on the purchase of a computer, he and his colleagues chose the most powerful and expensive one they thought Dalhousie could be persuaded to buy and then looked for reasons to justify it.

As the size of the operation increased, so too did the annual expenditures:

Annual Expenditures and Accumulated Debt

Year Ending		Operating Expenditures	Enrollment	Expenditure/ Student	Accumulated Operating Deficit
30 June	1962	$ 2,399,000	2259	$ 1,062	$ 130,000
	1963	2,878,000	2150	1,339	314,000
	1964	3,613,000	2398	1,507	484,000
	1965	4,861,000	2766	1,757	1,015,000
	1966	6,185,000	2985	2,072	1,267,000
	1967	8,409,000	2962	2,839	1,338,000
	1968	11,681,000	3064	3,812	1,566,000
	1969	13,765,000	3509	3,923	3,224,000
	1970	17,676,000	4222	4,187	3,738,000
	1971	21,767,000	5086	4,280	3,921,000
	1972	26,731,000	5776	4,628	4,007,000
	1973	29,848,000	5918	5,044	3,616,000
	1974	32,800,000	6352	5,164	3,419,000
	1975	38,752,000	8178	4,739	4,419,000
	1976	45,573,000	8346	5,460	4,798,000
31 March	1977	37,705,000	8564		4,811,000
	1978	51,972,000	8603	6,041	4,306,000
	1979	56,272,000	8585	6,555	3,347,000
	1980	63,164,000	8478	7,450	4,677,000
	1981	72,813,000	8632	8,435	5,622,000
	1982	84,889,000	8938	9,498	10,404,000
	1983	83,410,000	9261	9,007	11,527,000
	1984	90,587,000	9437	9,599	12,618,000
	1985	95,931,000	9712	9,878	7,772,000
	1986	99,263,000	9993	9,933	8,015,000
	1987	103,215,000	9785	10,548	8,169,000
	1988	107,909,000	9995	10,796	8,353,000
	1989	114,294,000	9980	11,452	8,325,000
	1990	121,263,000	10321	11,749	8,132,000
	1991	127,855,000	10395	12,300	7,837,000

Data on expenditures and debt were supplied by Financial Services.
Enrollment figures are those supplied by the Registrar and differ from those of the Business Office. See note to Appendix I.

The operating expenditures do not include research costs, capital expenditures or other similar charges. According to this table the cost per student fluctuated erratically. Over the years the accounting procedures, and the methods of presenting financial information, have been changed, and the major fluctuations coincide approximately with the times when considerable changes were made. It is probable that the larger fluctuations are due to the inclusion of some capitial and similar items that were not recognized when the table was being compiled. The operating expenditures, then, should be considered as indicative of the amounts involved but not as exact figures. Figures for the operating deficit are consistent with those obtained from other sources.

The initial response to increased financial pressure was to reduce expenditures that were general, campus-wide, and not directly academic. In 1972 control of budgets and budget expenditures was centralized and an "Advisory Committee on Planning and Coordination" was set up to advise on administrative systems, e.g. management information. In 1976, lighting was reduced in most buildings and there was a publicity campaign to promote conservation of electricity; some steps were also taken to reduce the cost of heating. According to the University News for February, 1975, the consumption of fuel oil had gone from 1,750,000 gallons in 1969-70 to 3,600,000 in 1973-74. The effect of the OPEC increase in oil prices had been to raise the fuel bill from $490,000 in 1972-73 to $630,000 a year later. Gradually, items of routine maintenance were postponed to save money, and classrooms and buildings became a bit shabby. In our climate, masonry takes severe abuse and the walls of some buildings began to show serious deterioration before maintenance could be postponed no longer and repairs were made. Gradually also the work of repairs and alterations was turned over to the Physical Plant department, presumably on the argument that work done "in house" was done at cost. But in the absence of any competitive control on costs or efficiency, costs soon became nearly double the quotations of even notoriously expensive outside contractors.

By 1976 there were beginning to be economies that had long-term academic implications. Prior to 1966, books and periodicals were a part of the budget of a department. Thereafter, for a number of very good reasons, such funds were handled through the Library. In November, 1976, the Librarian warned of the probability that some journal subscriptions would have to be cancelled, and Geology prepared a priority list to indicate the journals the department considered could be spared. Other departments were doing the same thing. The departmental records do not state how many journal subscriptions were cancelled on this occasion, and again in 1981, 1984 and 1987, but there have been cancellations of a substantial number of those used relatively infrequently. At the same time, the librarians of the local universities must be given great credit for their cooperative efforts to avoid unnecessary duplication of serials on one hand and, on the other, to ensure that necessary journals are available at one or other of the local institutions. Although such cooperation is to be applauded, it should be recognized that there are distinct disadvantages involved as well: For example, Dalhousie, in effect, provides for the whole region such very expensive journals as Chemical Abstracts, Nuclear Physics, and Physical Review, for each of which the annual subscription is around $10,000, but there is no contribution toward such costs from the other institutions that use them.

A large part of our research equipment has been bought with non-university funds. The money for such equipment has come from contract research and from external grants for research. In both categories, a substantial part comes from federal agencies, such as the Medical Research Council, and the Natural Sciences and Engineering Research Council. Included are items as small as a camera, costing a few hundred dollars, and as large as an electron microprobe or a nuclear magnetic resonance spectrometer, which cost about a million dollars each - to say nothing of the cost of the facilities to house them, which may equal the cost of the equipment and must be paid by the university. The small and relatively inexpensive items are bought out of grants made to an individual for a specific investigation. Many of the large and expensive items are bought with money provided specifically for that purpose by the granting agency, or as part of the cost of a project designed to develop a particular area of research or of expertise. For a number of years, the latter were funded by the National Research Council through "Negotiated Development Grants".

Agencies of government have been under financial pressure also. In 1975, the National Research Council suspended Negotiated Development Grants for that reason, and in 1985 the President of the Natural Sciences and Engineering Research Council was complaining that he had applications for grants for equipment totalling $99.5 million and that he had absolutely no funding for this purpose. In the same vein, in the last ten years or so, the funds available nationally for research grants to individuals have been about one-third of the totals sought by individual researchers.

It is not possible to charge overhead and similar costs to research grants awarded by NSERC, so the university has sought to offset some of its budget deficiencies by charging overhead costs to other research contracts held by individual staff members. This process causes conflict because administrators consider it reasonable that an individual should pay toward the cost of the university facilities used for contract research, while the individual sees this as a reduction of the research work by siphoning off funds that should be used to pay the direct costs thereof.

When operating funds are scarce, one seeks to increase revenue as well as to reduce expenditures. An obvious method is to increase tuition charges. In May, 1930, H. M. Tory, the President of the National Research Council, complained to convocation because, of 15,000 children entering the schools, half had disappeared before high school and only 125 emerged as university graduates. In Nova Scotia today, according to the Department of Education, of 14,360 children who entered the schools in 1973, 10,777 graduated from Grade 12 in 1986. Statistics Canada reports that Nova Scotian universities awarded 5,284 Bachelor's degrees in 1989 and that, in that year, there were, in the whole of Canada, 28,373 university students whose home province was Nova Scotia. It is obvious that university students are, of necessity, an elite group. Nevertheless, tuition charges are increased with great reluctance because, when egalitarianism is the theory if not the practice, such an increase is always unpopular and goes against a long-standing tradition of making education available to anyone of ability.

The following table shows the annual tuition cost for a student taking the normal class load in Geology, as an example of the costs in Faculty of Arts and Science:

Tuition Fees

1867	$24	1969	$610	1981	$ 977 + 750 if a foreigner
1887	36	1971	720	1983	1150 + 1000
1907	41	1973	720	1985	1570 + 1700 (1435 if returning student)
1927	110	1975	731	1987	1693 + 1700
1947	221	1977	815.50	1989	1831 + 1700
1967	600	1979	765	1991	2479 + 1700 + 525 for health insurance

1. To give some perspective to these figures, one may note (page 6) that, in 1881, the annual salary of Dr. Honeyman, as Director of the Provincial Museum, was $1200, for a man of widely recognized ability and great experience. The $36 fee is three percent of $1200 and, at that ratio the salary corresponding to the 1989 tuition fee is $61,000.

2. A "foreigner" is a student who is not a Canadian citizen or landed immigrant. It is a comment on our recent nationalism to note that, in 1947, there was a similar supercharge in professional courses, but for a student from "countries outside the British Empire". Geology has had students from southeast Asia, Iran, and elsewhere, and for some this extra fee has been a very serious problem.

In 1984 the Student's Council and the University agreed that, for a period of three years, tuition fees should not increase at a rate greater than four per cent per year and, for a further period of three years at a rate not greater than the change in the Consumer Price Index. In return, the Council agreed to make a contribution of $150,000 per year to the five-year "capital campaign".

Annual budgets have always been a matter for negotiation, but the procedure was changed somewhat about 1980. In prior years, it appears that the common procedure was for the departmental chairman to present to his Dean his estimates of the funds required to operate his department for the coming year. Those estimates would include the expenditures requested by members of his department for special or specific purposes. The Deans, or their equivalents in other parts of the University, in turn presented such accumulated requests to generate the budget for the whole. At each step, of course, there was discussion of the need and the justification for each proposed expenditure.

In the end, the budget allocation to each faculty was made by dividing the revenue available to the university. In a crude way one might describe that revenue as the total of student fees, endowment income, and such money as the President could extract from corporation and government grants. It was this process of combination of "wish lists" that produced the widespread belief that departmental problems would be solved, if only the Chairman would pound the desk and "get more money from the Dean". The Dean, of course, would increase available funds in the same way, and the President could draw upon the limitless funds of government, by the same process.

A "budget envelope" system was introduced in 1982. In principle it is very similar to the Swiss system mentioned on page 35; that is, a department is allocated a sum of money, which can be spent as the department sees fit. The same is true of the budget "envelope" of a faculty. At a time when both expenditures and deficits were escalating, the budget "envelope" was probably a sensible administrative device for exercising some control on expenditures. Under that system a budget is generated by imposing, from above, limits based upon available revenue, rather than by accumulating wishes from below. In practice, of course, there is some negotiation of special cases and circumstances, but the general effect is to force all concerned to arrange their needs in order of priority and to spend accordingly. In 1982-83, for example, the budget "envelope" for Arts and Science was set at 4.76 per cent above that for 1981-82. With salaries forming over 70 per cent of the total budget, and increasing at about 12 per cent per year, it was necessary for the Faculty to make drastic cuts in other budget items, find additional sources of revenue, or both. Salaries are not an item in the budget "envelope" of a department, so for them the pressure of reduced revenue came directly upon non-salary items. Such pressure quickly separated the essential from the merely desirable.

At the Faculty level, when funds increased at a reduced rate, there was a restraint on spending, as one would expect. Salaries are set by negotiations outside the Faculty and have risen at rates considerably greater than has the total budget of the Faculty. Although there are mechanisms in place to take some account of this when setting the budget base for the Faculty for each year, the overall effect has been to exert pressure not only upon the funds available for salaries, but also upon moneys available for supplies and current expenses, for student assistants, and for part-time faculty. The latter is an important item for some departments, such as English, where there are many sections in a class. Accordingly, the restraint on spending has been most noticeable on the non-salary items.

While research equipment may come from external agencies, teaching materials (such as laboratory specimens) and supplies (such as laboratory glassware and chemicals, office materials, printing, and many other items) do not. Here is where the restraint on non-salary items really falls. Serious reduction of funds for supplies and current expenses is daily, and clearly, visible and is, therefore, a constant irritant to all concerned, and especially to those involved in day to day operations.

The Faculty of Arts and Science got a new Dean in 1980. After one year of budget making, he arranged for a "Financial Advisory Committee" to assist. It was set up early in 1982 and functioned till 1985, when it became obvious that financial matters, such as costs of departmental programs, were inextricably involved with academic matters, such as content and presentation of programs. The committee was then transformed into a "Financial and Academic Planning Committee".

The main purpose of the committee of 1982 was to advise the Dean on financial allocations within the Faculty, but the Dean, of course, was also looking for additional funds to allocate. In this he showed some ingenuity and great persistence, for some avenues could not produce immediate results and required negotiations that stretched over several years. For example, there had grown up a considerable exchange of teaching services by professors between Dalhousie and the Technical University. Negotiations with TUNS reduced the transfer payments, over three years, from $400,000 to $160,000 in 1982-83 and to less than $29,000 by 1984-85, a not inconsiderable annual saving to Dalhousie. Another approach involved salary adjustments for professors with activities outside the university. One whose income from outside affairs exceeded the salary of a full-time professor could generally be persuaded to agree that professorial duties were not getting the professor's full-time attention. Some cases had received publicity and were well-known to the public; others were not. All were adjusted, more or less amicably, and rules for the future were established.

By various means, alumni/ae were encouraged to donate to the Faculty. In 1982, the total so raised was $12,000, which is not much in a budget of $18 million, but it was 40 times what had been donated the previous year. This has continued to be a useful assistance of about $20,000 per year in unrestricted funds, and on several occasions has been the source of money for high-priority non-space capital items, such as microscopes and computer terminals.

A major matter was negotiations with King's. In the daily classes there is no distinction between Dalhousie students and those from King's, and most professors do not know, or care, to which institution their students belong. There are definite contracts, however, concerning what classes will be taught and how many professors will be paid by King's, as well as a number of other matters. It seemed clear that changes over many years had resulted in substantial subsidies to King's students, and there was lengthy re-negotiation of the contracts to correct this.

There were also continual attempts to persuade the Maritime Provinces Higher Education Commission to amend its funding formula. The funding recommended by the Commission has several components, all more or less reflecting enrollment and attempting to reflect differences in costs. The formula, for example, distinguishes between the costs of graduate and undergraduate teaching and, in the latter, between costs of Arts and of Science students; a B.Sc. student is considered to cost twice as much as a B.A. student. This may seem like an exercise in trivia but, in 1984, students in Psychology, even those in B.Sc. programs, were being reported as B.A.'s, and it was estimated that the Faculty would gain an increase of $100,000 in revenue, if the Psychology students were correctly reported as science students. Detailed examination of an example in the Geology department, had also shown that, even for that one undergraduate class, about 14 per cent of the actual cost, exclusive of office and similar overheads, was not considered instructional cost by MPHEC. Furthermore, for the Commission, some programs simply did not exist. Although students were crowding into the classes in

Computer Science, initially that program was not approved and was therefore not funded, and, as a further example, it was not till about 1985 that the program in Costume Studies was recognized by MPHEC. Because of this sort of experience, Dalhousie refused to operate a Ph.D. program in Clinical Psychology until MPHEC had agreed to suitable funding arrangements. Although the formula assigns higher costs to graduate than to undergraduate students, it takes no account of the overhead and other costs of the research work of graduate students. The attempts to get the formula changed were not particularly successful. With granting agencies such as the Natural Sciences and Engineering Research Council, however, there was a little more progress.

By 1982, program changes had already occurred as a result of financial pressure, and it was obvious that more serious changes must occur. In Geology, all but one of the evening classes were cancelled at the end of the 1981-82 session to save the salaries of the demonstrators involved. Other departments increased the size of sections in multi-section classes, or cancelled classes, or did both. In March, 1982, after the actual cancellation of 26 classes in the Faculty, the Financial Planning Committee recommended that funds for inter-university sport should be reduced and that the funds for the Art Gallery be used instead to support undergraduate classes. This brought coals of fire upon the head of "the barbarian in the Dean's office".

While it was obvious that there must be serious changes in academic programs, perhaps extending even to the elimination of some, there was a very serious problem: which programs? by how much? by what mechanism? and who would put the bell on the cat? Faculty Council devoted much time to these questions.

Faced with the real problem of advising the Dean on the production of a budget that would permit changes, the Planning Committee considered a number of possibilities:

(a) A constant percentage increase or decrease to all departments. This has the superficial appearance of equity but would penalize departments that were growing rapidly or were heavily affected by the rate of inflation in the price of consumable materials and laboratory equipment.

(b) Zero-based budgeting - the idea that one starts each year from a "clean slate" and identifies the valid objectives of each department and then establishes the budget that would be necessary to fulfill those objectives at minimum costs. In principle, this would permit major shifts in funds to accomodate changing requirements and educational aims of departments and of the university. In fact, to be effective, the method requires a great deal of information and detail, and its flexibility is lost when the salaries of tenured faculty members must be considered in the calculation.

(c) Individual negotiation between Dean and chairman. Even though the optimum allocation of funds might conceivably result, it is very unlikely that faculty could ever be convinced that such had occurred, and serious morale problems and discontent would be the result.

(d) A base budget increase to each department of a constant percentage of budget, plus an adjustment fund and a development fund. Departments would apply for money above their base budget to either or both of these funds. Flexibility and equity would be possible, but the process is open to various forms of gamesmanship and would be very time consuming -- a matter of concern when hiring is to be done.

(e) Priority ranking of departments into slow, medium, and fast growth of budgets. The majority of departments would receive a common percentage increase in funds while a small minority would receive a slightly larger or slightly smaller increase. "Slow growth", in the circumstances, would be equivalent to contraction. This is really a variant on (d) above, but would eliminate the time-consuming application process. It is straightforward and would permit adjustments for growth or other priorities from year to year. When this scheme was adopted in 1982 it was recognized that there would be "immediate and strong protests and anyone connected with the allocation of departments to categories would be reviled by the unsuccessful humanities departments as incurable Philistines, by the unsuccessful science departments as hopeless "raffia weavers" and by the unsuccessful social science departments as unmitigatedly reactionary. The "Philistine-reactionary-raffia-weavers---[could]-expect to receive considerable hostile comment on their decisions---". The response to the recommendation about the Art Gallery is an example of such reaction.

The Planning Committee chose the last method. It attempted, first, to identify any important anomalies in funding of departments, such as had resulted from pressure of numbers in Mathematics and in Computing Science. It then considered five criteria as the basis for priority ranking of departments: (1) past trends in student enrollment, and (2) anticipated employment opportunities for graduates; together these might indicate future demand for teaching services in a particular discipline; (3) quality and effectiveness of teaching; (4) quality and quantity of scholarly and research output. The last two are notoriously difficult to measure, and open to very subjective judgements. At that time this was recognized as a serious problem. Senate subsequently ordered periodic appraisal and, in response Arts and Science set up arrangements to review the programs, facilities, and performance of every department on a five-year cyle. This began in 1986-87 and, because the review committee is drawn from outside the department and includes a member from another university, has done something to provide an informed evaluation by disinterested parties.

Much of the preceding two paragraphs has been drawn, almost verbatim, from a document prepared in September, 1982, by the then chairman of the Financial Planning Committee, Dr. Lars Osberg, to whom I am indebted for permission to make these extracts.

The university, as a whole, had a "redistribution" and a "development" fund; i.e. scheme (d) above. These funds were used to meet pressing needs and to adjust inequities between the different faculties. The Redistribution Fund was used to construct new programs, to rectify past inequities, and to adjust to serious changes, e.g. large increases in enrollment in a particular program. Once awarded, the money was built into the budget envelope for subsequent years. The Development Fund was used to pay for discrete projects, e.g. re-equipping of a laboratory, and the money could be awarded for one to three years. If for three years, the amounts declined annually. No doubt there was considerable jostling and discussion between various deans in the process of distributing these two funds, both of them much smaller than was desirable.

Application of the above criteria by the Planning Committee proved useful but difficult. In practice, the budget constraints were so severe that the Committee did little or no planning and, instead, found itself reacting each year to a crisis situation. For 1982-83 the budget was 4.7 per cent larger than that for the previous year, but *thereafter* the budget base *decreased* and the efforts of the Committee were concentrated upon achieving that reduction without wrecking any, or all, departments. In general, this meant ranking the needs of the departments and then punishing those of high priority less severely than the others. Salaries are the largest budget item; the other is "equipment and supplies". We may look briefly at these to see something of the problem.

How the Savings Were Made

Even when the overall budget allocation is increased, a reduction in the "salaries" component will be necessary unless the budget increase equals the salary increases already established by the various collective agreements with the staff unions. In 1983-84, for example, full replacement of retiring and departing faculty members would have required an *increase* in the budget in excess of nine per cent. In the collective agreement with the Faculty Association there is provision for reduction of staff by voluntary leave, early retirement, and other measures, prior to a declaration of "financial constraint" and a freeze on new appointments or on filling of vacancies. Even under full constraint, the budget would have required an increase of over six per cent. When the budget for the year was finally set it was for $20,007,225, an increase over the previous year of 9.6 per cent. In the event, the expenditures in Arts and Science for that year were $19,744,097.

The accumulated debt of the university had reached $11.5 million by 31 March, 1983. The Maritime Provinces Higher Education Commission had in its regulations a provision which required, in effect, that Dalhousie deal with its deficit or the Commission would do it for us. Drastic measures were required and, for 1984-85, the budget envelope for Arts and Science required a reduction of about five per cent - approximately one million dollars. As can be seen from the table on page 94, there was a reduction in the debt, but the problem continued to be serious. The budget for 1986-87 may be used as an example of the requirements and of the process.

The budget for 1986-87 for the Faculty of Arts and Science was presented to the University Budget Advisory Committee in April, 1986. In doing so, D. D. Betts, the Dean, pointed out that, during the five years from 1981-82 to 1986-87, the Faculty's base budget had been reduced by over two million dollars, and that for the 1986-87 year he was required to reduce it by three per cent.

The operation can be summarized:

Base reduction, 3%	$670,000
Redistribution levy	222,000
Carried forward from 1985-86	77,000
Total reduction required	$967,000

In this table, the $77,000 carried forward represents the amount by which the Faculty had overspent its budget in the preceding year. The practice of carrying forward a deficit or surplus was relatively new, and is an incentive to economy, because money saved in one year can ease the burden in the following year. The redistribution levy was used to help generate a fund to deal with inequities or abnormalities between one faculty and another. In this case, there was a small gain in the process, because the redistribution fund allocated $225,000 to Arts and Science. It was spent:

To increase stipends for part-time faculty	$ 22,000
To increase stipends for student assistants	70,000
To increase funds for teaching materials and supplies	88,000
For two replacement positions	45,000
	$225,000

At that time it appeared that the target reduction might be met, except for some replacement appointments considered essential.

Actual savings identified	$787,000
Potential savings (terminations, leaves, etc.)	178,000
	965,000
Replacement appointments	(226,000)
	$739,000

Experience had shown that, each year, there was a fairly constant percentage of resignations, requests for leave, and other permanent or temporary losses of staff. In April, some of these could still be anticipated and could be considered as "potential savings".

Our prime interest here is in how the "actual savings" were identified. These were:

1.	Non-replacement or partial replacement of five regular faculty (retired, resigned, on leave).	$327,000
2.	Reduction of part-time faculty by the equivalent of 32 full classes.	139,000
3.	Reduction of technician's positions, or recovery of salary from grant/ contract funds in three departments.	34,000
4.	Decrease 3 sections to 2 in all engineering classes, and reduce number of classes at TUNS.	43,000
5.	Non-replacement of 7.5 faculty on limited term contracts.	82,500
6.	Defer 7 faculty appointments by 2 to 6 months; deferred and lower level replacement appointments of instructors and administrators.	34,000
7.	Increased income.	50,000
8.	Appoint 2 Senior Killam Fellows and	29,000
	1 Killam Professor.	49,000
		$787,500

There were increased budgets for several departments.

Not included above were some savings in salaries that resulted from the employment of University Research Fellows. This scheme was introduced a few years before by the Natural Sciences and Engineering Research Council as a device to assist research in the universities. Under the scheme, the full salary of the Fellow is paid by NSERC for the first five years of the appointment, subject to a review after three years, and then at a decreasing rate for a further five years, but only if the Fellow is then on a tenure-track appointment. (The Fellow normally has had two to five years of experience as a post-doctoral fellow before appointment as URF, so a tenure-track appointment immediately after the three-year review is permitted.) The university is required to make up the difference and to provide full salary after the tenth year. This provides an able research worker and a very considerable saving to the university. Although the Fellow cannot be required to teach, he/she is permitted to teach one full class and, it appears, most Fellows are willing to do that, so there is a corresponding reduction in staff requirements. The fellowships are awarded in national competition and Dalhousie at one time had about a dozen. On a per capita basis this was equalled only by the University of Toronto; not only did this represent a considerable monetary saving but it indicates something of the quality of Fellows that Dalhousie was able to attract. The first URF at Dalhousie was Dr. David Scott in the Geology department.

Effects of Salary Savings: One should note that the "savings" identified in the above table come not from reduction of salary rates, but from staff reductions. Apart from the obvious effects upon the individuals concerned, some of the results can be a bit surprising. Examples of the results, expected and otherwise, are mentioned below.

To save on support staff, departments used a number of devices. Some paid their technicians out of research grants, others laid off their technicians during the summer months; still others arranged the work so the staff could be employed only part-time, and some cooperated so clerical staff could be shared part-time between two departments. In some departments it was possible to reduce the number of student assistants in laboratory and other classes, but there is a limit to this and it is really not practical where enrollment in a class is increasing. For similar reasons, it is possible to convert full-time to part-time work for a technician only where the work is seasonal or where the work load is actually decreased by technical or other changes, such as the removal of obsolescent equipment or procedures. Obviously cost reductions by these methods cannot be large, as the above table shows.

In the same way, reduction of teaching staff, either full- or part-time, has very definite limits and consequences. In November, 1983, for example, the School of Business Administration proposed to make a class in English a requirement in their program, as it is for all students in Arts and Science. This would obviously result in increased numbers of students in the English department, which was already removing sections from its first-level classes because of loss of part-time instructional staff, - and thereby increasing the number of students per section. In December, the department reported that removal of its budget for part-time staff would remove 11 sections of English 100, so it was obviously not practical to add more service classes for Business Administration. This was not unique; the French department reported they would need to cancel 10 half-sections and the mathematicians

TABLE V

Yearly Expenditures in the Geology Department in Current Dollars and Adjusted for Consumer Price Index
(1986 = 100)

			Salaries - Budgeted				Actual Expenditures						
	Authorized	Expended	Academic Incl. Lecturers	Lab. Assistants	Support Staff Incl. Tech'ns	Fringe Benefits	Total Salieries Paid	Teaching Materials	Equipment	Special Approp.	Equip. Suppl.Curr. Expend. (excl. bks.)	Total excl. Books	Books & Period.
1970-71	303 833	340 737	139 875	13 600	32 600	16 548	200 921	36 820	41 063	51 471	129 354	330 274	10 463
	980 266	**1 099 149**	**451 209**	**43 871**	**105 161**	**53 380**	**648 131**	**118 774**	**132 461**	**166 035**	**417 270**	**1 065 300**	**33 751**
1971-72	318 735	331 014	179 800	16 100	49 388	18 647	256 208	39 235	24 668	(1 071)	62 832	319 040	11 974
	991 170	**1 037 663**	**563 637**	**50 470**	**154 821**	**58 455**	**803 161**	**122 944**	**77 329**	**3 357**	**196 966**	**1 000 127**	**37 536**
1972-73	359 804	395 412	198 900	16 000	58 200	19 880	310 636	37 461	27 938	46	65 445	376 081	19 331
	1 077 253	**1 183 863**	**595 507**	**47 904**	**174 251**	**59 281**	**930 044**	**112 158**	**83 646**	**138**	**195 942**	**1 125 986**	**57 877**
1973-74	408 271	420 783	220 010	16 000	74 583	24 998	337 641	36 365	32 483		68 848	406 489	14 294
	1 134 095	**1 168 851**	**611 144**	**44 445**	**207 177**	**69 439**	**937 899**	**101 015**	**90 231**		**191 246**	**129 145**	**39 706**
1974-75	460 912	462 924	267 193	16 000	100 146	28 739	381 776	33 603	32 307		65 910	447 688	15 236
	1 155 184	**1 160 226**	**669 666**	**40 101**	**250 996**	**72 028**	**956 845**	**84 219**	**80 971**		**165 190**	**1 122 040**	**38 186**
1975-76	498 002	531 708	320 671	16 750	108 437	35 133	445 857	41 747	22 695	504	64 946	510 804	20 904
	1 126 680	**1 202 936**	**725 486**	**37 895**	**245 328**	**79 485**	**1 008 707**	**94 448**	**51 345**	**1 140**	**146 934**	**1 155 643**	**47 293**
1976-77	558 137	* 397 356	332 092	17 000	113 568	38 977	* 354 952	* 27 201	* 18 202		* 42 403		
	1 175 046	**836 553**	**678 100**	**35 790**	**239 095**	**82 058**	**747 280**	**57 266**	**32 005**		**89 271**		
1977-78	573 914	591 509	319 107	17 000	125 500	44 461	501 736	57 491	+ 30 724	1 558	89 773		
	1 118 731	**1 153 028**	**622 035**	**33 138**	**244 637**	**86 668**	**978 034**	**112 067**	**59 890**	**3 037**	**174 994**		
1978-79		625 952											
		1 119 771											
1979-80		713 374	362 358	33 660	164 229	58 825	619 073				94 301		
		1 169 466	**594 029**	**55 180**	**269 228**	**96 434**	**1 014 874**				**154 592**		
1980-81	693 920	769 998	429 326	29 623	185 378	58 538	702 865				68 281		
	1 032 619	**1 145 830**	**638 878**	**44 082**	**275 860**	**87 110**	**1 045 930**				**101 609**		
1981-82	818 424	835 087	450 687	34 816	193 569	59 354	738 426				112 890		
	1 084 005	**1 106 075**	**596 936**	**46 114**	**256 383**	**78 615**	**978 048**				**149 523**		
1982-83	849 233	831 806	446 960	33 514	201 211	63 590	745 275				96 837		
	1 014 615	**993 794**	**534 002**	**40 041**	**240 395**	**75 974**	**890 412**				**115 695**		
1983-84	920 540	916 053	495 516	35 458	231 029	75 865	837 868				109 115		
	1 040 158	**1 035 088**	**559 905**	**40 065**	**261 050**	**85 723**	**946 743**				**123 294**		
1984-85	938 959	938 495	516 328	37 782	248 232	83 623	885 965				84 689		
	1 016 189	**1 015 687**	**558 796**	**40 890**	**268 649**	**90 501**	**958 835**				**91 654**		
1985-86	993 111	961 696	527 921	35 635	266 146	87 838	917 540				75 212		
	1 034 491	**1 001 767**	**549 918**	**37 120**	**277 235**	**91 498**	**955 771**				**78 346**		
1986-87	985 550	987 489	550 555	34 151	279 400	85 358	949 464				71 050		
1987-88	1 038 435	1 039 660	623 709	34 047	285 831	95 480	1 039 067				51 969		
	994 669	**995 843**	**597 422**	**32 612**	**273 768**	**91 456**	**995 218**				**49 776**		
1988-89	1 057 349	1 068 871	684 630	29 384	252 212	105 098	1 071 324				60 846		
	973 618	**984 227**	**630 414**	**27 057**	**232 237**	**96 775**	**986 475**				**56 028**		
1989-90	1 147 828	1 154 385	745 877	25 134	268 980	112 171	1 152 162				67 047		
	1 006 867	**1 012 618**	**654 278**	**22 047**	**235 949**	**98 396**	**1 010676**				**58 813**		
1990-91		1 240 576	785 275	26 834	294 126	120 717	1 226 952				75 043		
		1 038 114	**657 118**	**22 454**	**246 124**	**101 016**	**1 026 713**				**62 796**		

* 9 month year to March 1977

+ Incl. 19823 "MPHEC Equip."

said they would lose 30 half-sections if their part-time staff were removed. Already, nearly a year before, in February, 1983, there had been a recommendation that, in such classes, priority be given to students from Arts and Science, with a rider on the recommendation that said, in effect, that if another faculty needed service classes it should pay for them.

At about that time in 1983, also, Mathematics, Statistics, and Computing Science reported that because of reduction of faculty they would be able to handle, in 1983-84, only 75 per cent of the first-year students they had in 1982-83. Because of the requirement that all science students must have a class in mathematics, such a reduction would affect all B.Sc. programs. This produced a recommendation that the minimum entrance level be raised from "60 per cent to 70 per cent Grade 12 average", because it was estimated this would cut the registration by about a quarter. No doubt this would have desirable academic results, but one hardly expects academic policy to be determined in this way, and that a reduction in staff should result in a change in entrance requirements. The change, however, did not produce the expected results. Perhaps the more severe entrance requirements created a perception of improved, and so more desirable, academic standards; perhaps the improved standards reduced the number of drop-outs; perhaps other factors were also involved, but the fact is that registration actually increased.

Equipment and Supplies. When salaries must be paid and there is a limit on funds available, reductions are made in the other budget items. In practice, the other budget items are maintenance, equipment, and supplies. There were some maintenance expenditures that were large, and raised the ire of many people because they were considered to be too large and of questionable merit. There were, however, a large number of much smaller non-expenditures that had cumulative effects. In November, 1979, for example, Piper was complaining to the Dean because already the maintenance and equipment budget had been essentially frozen for two years. Many small economies had been introduced, but there was no way to deal with long-term deterioration of teaching materials or of equipment, and no way to provide for new equipment, such as microscopes for teaching laboratories or a new copper tube for the x-ray machine. There were no funds to replace obsolete equipment in 1982-83. In 1983-84 the initial Faculty budget for equipment and supplies (but not for non-space capital items) had an increase of 6 per cent. The departments of the Faculty estimated the minimum necessary at 19 per cent, and their chairmen complained loudly.

This was a common problem. To get an opinion that would not be biased by self interest, Betts had set up a committee from outside the Faculty. Its chairman was Prof. Rozee, from the Faculty of Medicine, and he was asked to estimate the funds needed for science teaching equipment. In June, 1983, this committee made an interim report that described the situation as "deplorable". In this it was echoing a report of the Royal Society of Canada on the situation across the whole nation. In July, 1983, the Rozee committee reported that they considered an expenditure of $540,000 for science teaching was immediately necessary to avoid the threat of what they called "academic bankruptcy".

There was no money for non-space capital funds in the budget for 1983-84. By August, however, the Dean had managed to extract $150,000 from the President, presumably on the basis of the Rozee report. This money was allocated to the various departments; no doubt it was helpful but it was less than a third of the estimated requirements.

A year later the situation was similar. In its initial form, the budget for 1984-85 proposed about $330,000 for alterations and renovations and the same amount for non-space capital equipment. The departments of the Faculty had estimated they required $423,000, in three priority categories. In fact, all this was deferred for a year, because the campaign to raise capital funds would not be able to make those funds available till the following year.

This resulted in the appointment of Dr. Kwak, of the Chemistry Department, as Assistant Dean, to concentrate upon the business of non-space capital funds. By December, 1984, the President had been persuaded to authorize $40,000 towards the $75,000 in items the departments considered "high priority". Half of the amount came from $20,000 in unrestricted funds donated that year by alumni of the Faculty, so their individual contributions, collectively, had had a considerable effect.

Departmental Expenditures -- The economies forced by the financial problems of the university were borne, ultimately, by the individual departments or equivalent units. The actual expenditures by the Geology department are shown in the following tables and graphs. (Table V)

This table has required some effort to reconcile the data from different sources, nearly all of which disagreed on details. The disagreements apparently reflect different accounting procedures and different needs of those for whom the accounts were prepared. Some comments about sources and content are necessary:

1. Total Expenditures (column 3) to the end of 1975-76 includes "books and periodicals". It is not clear why the accounts retained this item; the budget for books and periodicals was transferred to the Library in 1966. This column also <u>excludes</u> "recoveries", after 1980.

2. Salaries paid to Support Staff (column 6)

includes "recoveries" after 1985-86.

3. Expenditures for Equipment, etc. (column 12) also includes "recoveries" after 1980.

4. "Total Salaries Paid" probably includes fringe benefits in most years, but the practice appears to have varied, and it is not always simple to reconcile the available figures.

5. For 1970-80, (columns 4 to 7) salaries are as shown in the appropriate budget items. After 1980, salaries shown are actual expenditures.

6. Since 1977, the academic year ends on 31 March. The "year" 1976-77 was thus only nine months long.

7. The figures for 1970 to 1977-78 are drawn from "Detailed Financial Reports" of the Business Office, which reports are held by the University Archives. Figures for 1978-79 and for 1979-80 are not available there. The figures for 1980-81 and subsequent years were supplied by the Geology department, and I am indebted to Alice Giddy, the department's administrator, for considerable overtime work necessary to extract and compile the information. Some figures have been compared, and some gaps have been filled, from the files of the Faculty of Arts and Science. Differences were reconciled as seemed most reasonable and appropriate.

8. It should be noted that the departmental expenditures here considered are only those paid by the Faculty of Arts and Science. Funds to support graduate students are not included. The very large sums paid for the Cyprus, Iceland, Deep Sea Drilling, and similar projects, as well as smaller sums paid from individual research projects, were administered by the university, but were not paid by it.

The total expenditures, in current dollars, are reproduced as a graph in Figure 2.

For the period 1970-76, where only total salary expenditures are known, it is assumed that actual expenditures for each salary category are proportional to the equivalent budget allocations.

In 1981, the department began charging research grants and other sources for such services as microprobe analyses, preparation of thin sections, etc. Such revenues were called "recoveries". In 1981 and succeeding years, the "recoveries" were used to augment the funds provided for equipment and supplies. After 1986, "recoveries" were also used to supplement the salaries of support staff. From 1983 to 1990, there was also a payment from the Technical University of Nova Scotia for a class taught there by staff of the department, and that payment was included in "recoveries".

Changes and trends are difficult to compare in a mass of figures, so that same information is repeated, as percentages, in Table VI and, as a graph, in Figure 3.

Recoveries "A" and "B" refer, respectively, to "recoveries" used for supplies and to supplement salaries of support staff.

The total expenditures, and the corresponding budget figures, adjusted from the Consumer Price Index, are also shown in Figure 2. The comparisons implied by the C.P.I. should be taken with a generous portion of salt. I am informed by Statistics Canada that there is no price index that measures the operational costs of a university, nor are there appropriate indices that describe the costs of components of such operation. In short, there is no way of objectively adjusting for the effects of inflation, when comparing annual expenditures by the university. In the mid-eighties, although the Industrial Product Price Index for scientific instruments and equipment was increasing by around 7 per cent per year, it was the common subjective view that price inflation for scientific equipment was 20 or 25 per cent. The price of books and technical journals was also increasing at a spectacular rate. At that time the C.P.I. was increasing at 10 to 12 per cent per year. Because salaries form 80 to 90 per cent of the departmental expenditure, adjustment for the Consumer Price Index may give some indication of the changes in purchasing power of those expenditures but, for reasons just given, the results must be treated with great caution.

In Table VII and Figure 4 are shown the budgets for books and for serials for the years following 1966. These figures were supplied by the Library and two things are to be noted: The expenditures for "books and periodicals", as charged to the department in Table V for the years from 1970 to 1976, bear little resemblance to the amounts budgeted by the Library for the same years, and there is no explanation readily available. The amounts budgeted are 69 to 83 per cent of the amounts charged.

One pernicious result of the budget process of former years was the widespread conviction that failure to overspend a budget in any year would result in its reduction the following year and, as Table V shows, overspending was systematic in the seventies. This may be at least a partial explanation of the above discrepancy.

There is another possibility. According to the "Profit and Loss Statements" for each faculty, it was apparently the practice of the Business Office at that time to charge to each faculty or other spending unit a portion of the building maintenance and other general university expenses. Those were pro rated on some basis so that, for example, Arts and Science was charged $28,000 in 1965 for maintenance of the portion of the Forrest Building then used by the Biology department and, on the other hand, was credited with $370,000 for teaching done for Graduate Studies. In a similar fashion, the above discrepancy may include charges for library costs, but, if so, I have not been able

TABLE VI
Yearly Expenditures as Percentages
Geology Department

	Total Expenditures	Salaries Paid	Equip. etc.	Salaries as Budgeted Total Sal. Budget	Academic	Lab Asst.	Support Staff	Fringe Benefits	Recoveries Used For Equip. etc.	Used for Support Staff	From TUNS
1970-71	330 274	200 921	129 354	202 623	139 875	13 600	32 600	16 548			
%		60.83	39.17		41.96	4.08	9.79	4.97			
1971-72	319 040	256 208	62 832	263 935	179 800	16 100	49 388	18 647			
%		80.31	19.69		54.71	4.90	15.03	5.67			
1972-73	376 081	310 636	65 445	292 980	198 900	16 000	58 200	19 880			
%		82.43	17.37		55.96	4.50	16.37	5.59			
1973-74	406 489	337 641	68 848	335 591	220 010	16 000	74 583	24 998			
%		83.06	16.94		54.45	3.96	18.46	6.19			
1974-75	447 688	381 776	65 910	412 078	267 193	16 000	100 146	28 739			
%		85.28	14.72		55.30	3.31	20.72	5.95			
1975-76	510 804	445 857	64 946	480 991	320 671	16 750	108 437	35 133			
%		87.29	12.71		58.19	3.04	19.68	6.38			
1976-77	397 356	354 952	42 403	491 637	322 092	17 000	113 568	38 977			
%		89.33	10.67		58.52	3.09	20.63	7.08			
1977-78	591 509	501 736	89 773	506 068	319 107	17 000	125 500	44 461			
%		84.82	15.18		53.48	2.85	21.03	7.45			
1978-79	625 952										
%											
1979-80	713 374			619 072	362 358	33 660	164 229	58 825			
%											
1980-81	769 998	702 865	68 281		429 326	29 623	185 378	58 538	1 148		
%		91.1	8.9		55.7	3.8	24.0	7.6	0.1		
1981-82	835 087	738 426	112 890		450 687	34 816	193 569	59 354	16 229		
%		86.7	11.4		52.9	4.1	22.7	7.0	1.9		
1982-83	831 806	745 275	96 837		446 960	33 514	201 211	63 590	10 306		
%		88.5	10.3		53.1	4.0	23.9	7.5	1.2		
1983-84	916 053	837 868	109 115		495 516	35 458	231 029	75 865	30 930		7 589
%		88.5	8.2		52.3	3.7	24.4	8.0	3.3		
1984-85	938 495	885 965	84 689		516 328	37 782	248 232	83 623	15 502		16 657
%		91.3	5.4		53.2	3.9	25.6	8.6	1.6		
1985-86	961 696	917 540	75 212		527 921	35 635	266 146	87 838	14 814		16 242
%		92.4	4.5		53.2	3.6	26.8	8.8	1.5		1.6
1986-87	987 489	949 464	71 050		550 555	34 151	279 400	85 358	1 326	15 000	16 699
%		91.5	5.3		53.9	3.3	27.4	8.4	0.1	1.5	1.6
1987-88	1 039 660	1 039 067	51 959		623 709	34 047	285 831	95 480	2 951	31 000	17 425
%		92.4	2.9		57.2	3.1	26.2	8.7	0.3	2.8	1.6
1988-89	1 068 871	1 071 324	60 846		684 630	29 384	252 212	105 098		45 300	17 999
%		90.6	3.8		60.5	2.6	22.3	9.3		4.0	1.6
1989-90	1 154 385	1 152 162	67 047		745 877	25 134	268 980	112 171		46 018	18 806
%		90.7	4.0		61.2	2.1	22.1	9.2		3.8	1.5
1990-91	1 240 576	1 226 952	75 043		785 275	26 834	294 126	120 717	12 411	49 008	0
%		90.4	4.9		60.3	2.1	22.6	9.3	0.9	3.8	

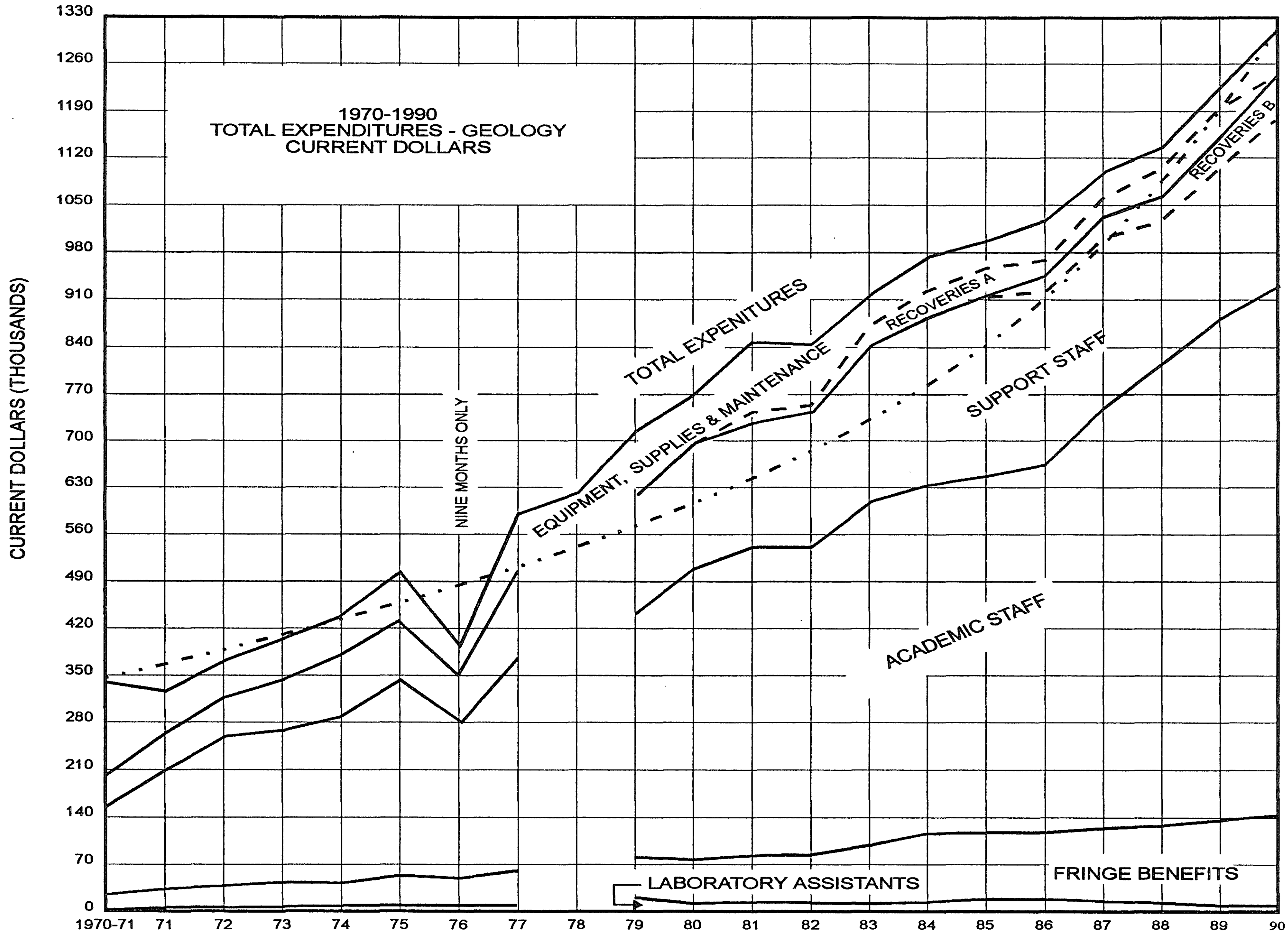

1970-1990
TOTAL EXPENDITURES - GEOLOGY
CURRENT DOLLARS
CURRENT DOLLARS (THOUSANDS)
1330
1260
1190
1120
1050
980
910
840
770
700
630
560
490
420
350
280
210
140
70
0
1970-71
71
72
73
74
75
76
77
78
79
80
81
82
83
84
85
86
87
88
89
90
NINE MONTHS ONLY
TOTAL EXPENITURES
EQUIPMENT, SUPPLIES & MAINTENANCE
RECOVERIES A
RECOVERIES B
SUPPORT STAFF
ACADEMIC STAFF
LABORATORY ASSISTANTS
FRINGE BENEFITS

Figure 2

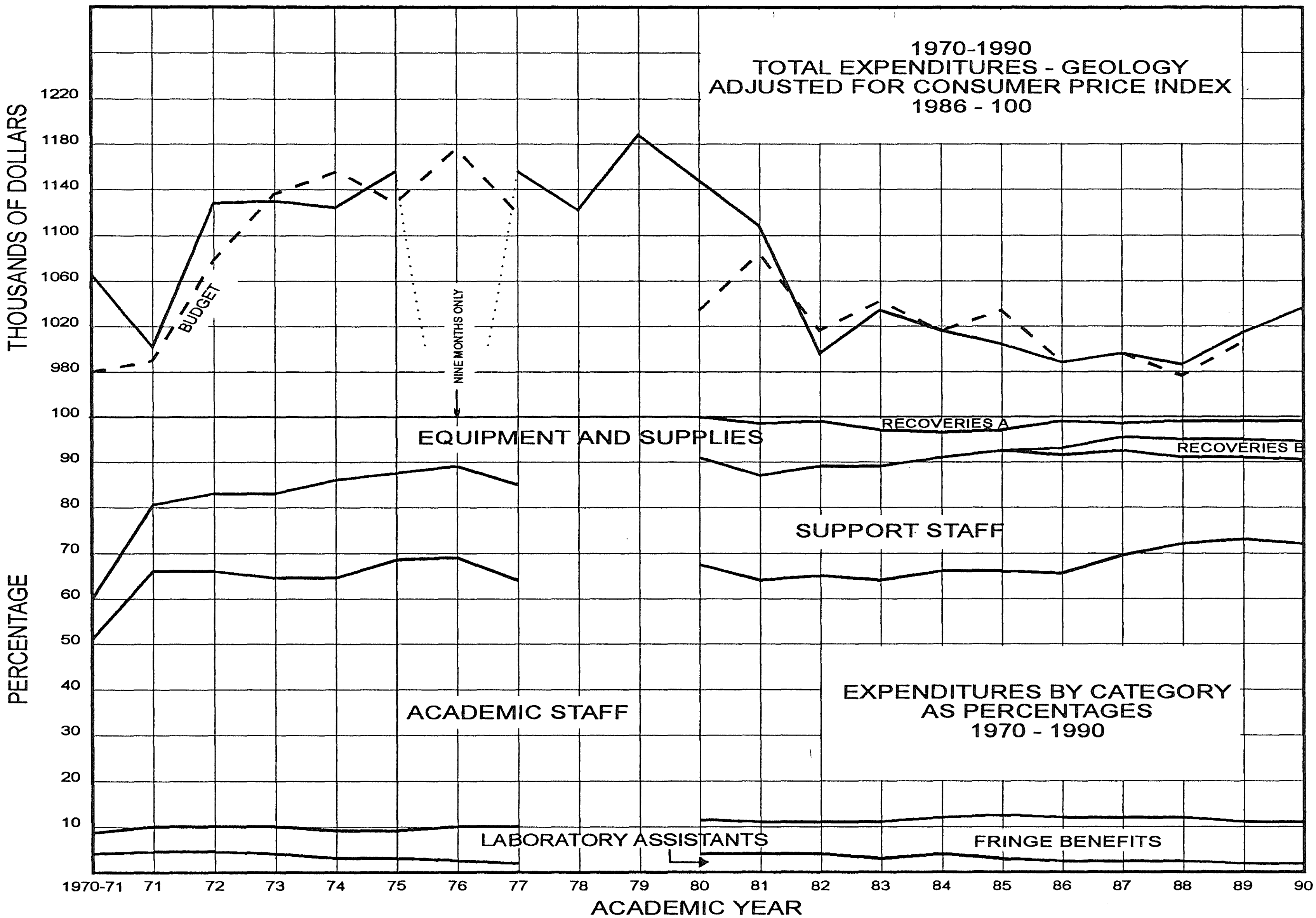

1970-1990
TOTAL EXPENDITURES - GEOLOGY
ADJUSTED FOR CONSUMER PRICE INDEX
1986 - 100
THOUSANDS OF DOLLARS
1220
1180
1140
1100
1060
1020
980
BUDGET
NINE MONTHS ONLY
PERCENTAGE
100
90
80
70
60
50
40
30
20
10
EQUIPMENT AND SUPPLIES
RECOVERIES A
RECOVERIES B
SUPPORT STAFF
ACADEMIC STAFF
EXPENDITURES BY CATEGORY
AS PERCENTAGES
1970 - 1990
LABORATORY ASSISTANTS
FRINGE BENEFITS
1970-71
71
72
73
74
75
76
77
78
79
80
81
82
83
84
85
86
87
88
89
90
ACADEMIC YEAR

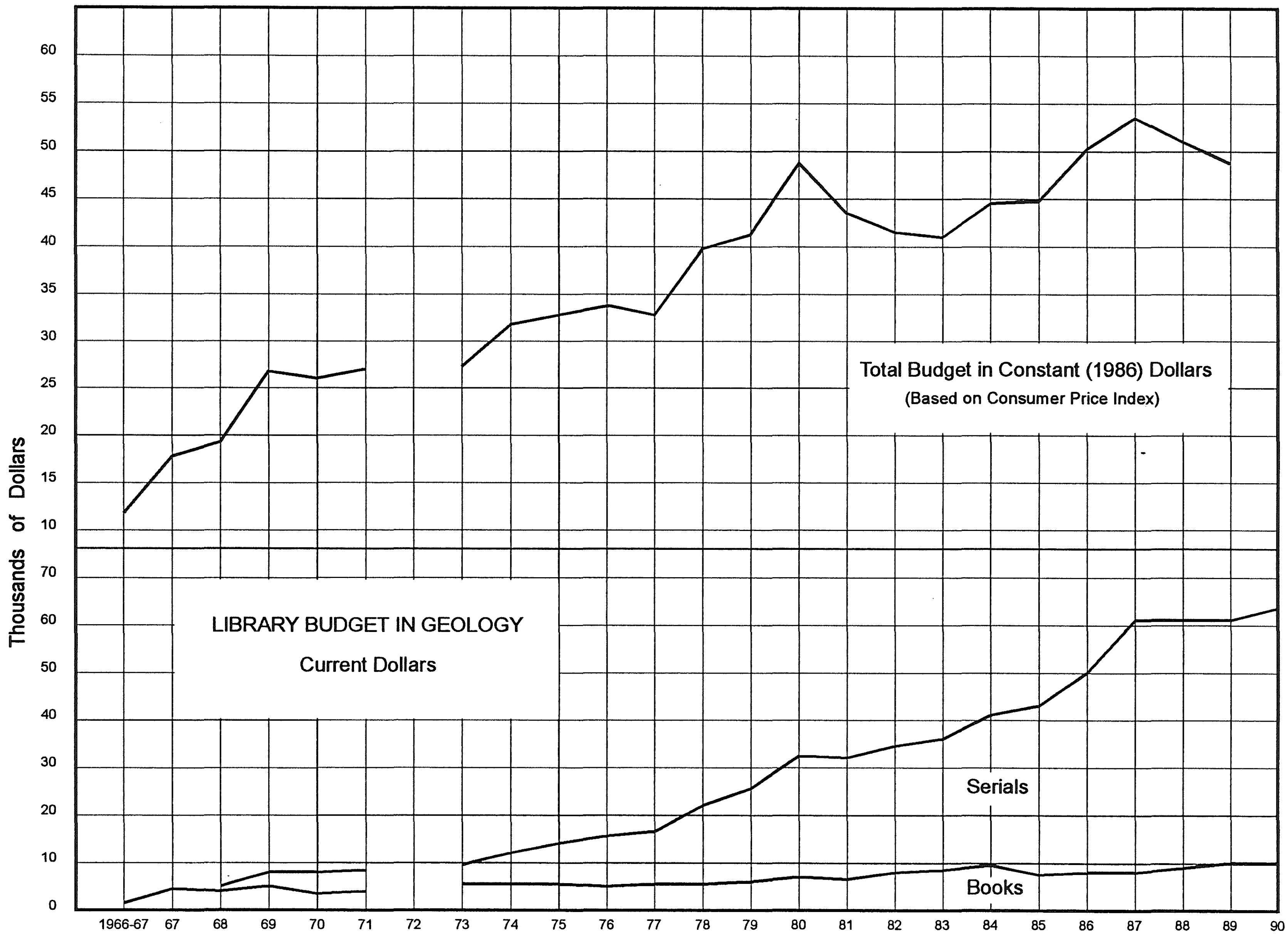
Figure 3

TABLE VII

Library Budget for Geology
(Supplied by Library)

	Geology			Geography and Maps			Oceanography		
	Books	Serials	Total	Books	Serials	Total	Books	Serials	Total
1966-67	3100								
67	5000								
68	3925	1575	5500						
69	5500	2500	8000						
70	4000	4000	8000						
71	5000	3500	8500						
73	5300	4500	9800	2500	600	3100	1000	400	1400
74	5300	7300	12600	2500	1100	3600	1000	1100	2100
75	5800	8600	14400	2500	1600	4100	2000	2500	4500
76	5250	10700	15950	2250	1900	4150	1800	3150	4950
77	5600	11100	16700	2400	1700	4100	3500	2600	6100
78	5600	16500	22100	2400	1900	4300	3500	3600	7100
79	6600	18500	25100	2900	2200	5100	3500	4700	8200
80	7500	25000	32500	3500	2900	6400	4000	5300	9300
81	6700	25800	32500	3100	3200	6300	3600	6200	9800
82	8500	26000	34500	3400	3100	6500	7300	6400	13700
83	8500	27800	36300	3400	3300	6700	7300	7000	14300
84	9600	31500	41100	3600	3600	7200	8200	7400	15600
85	7700	35100	42800	2900	4050	6950	6600	7425	14025
86	7700	42350	50050	2900	4620	7520	6600	8470	15070
87	7700	53000	60700	2900	6000	8900	6600	10000	16600
88	8700	52000	60700	2900	6000	8900	6600	10000	16600
89	9300	52000	61300	4820	5700	10520	7870	10800	18670
90	9750	53800	63550	5050	5900	10950	8250	11200	19450

The budgets for "Geography and Maps" and for "Oceanography" are included for information. Geology is a substantial user of the maps, and at one time was custodian of the collection. To a lesser extent, Geology also uses the Oceanography books and serials, but it is difficult to assign any reasonable figure to such uses.



Thousands of Dollars
60
55
50
45
40
35
30
25
20
15
10
70
60
50
40
30
20
10
0
Total Budget in Constant (1986) Dollars
(Based on Consumer Price Index)
LIBRARY BUDGET IN GEOLOGY
Current Dollars
Serials
Books
1966-67
67
68
69
70
71
72
73
74
75
76
77
78
79
80
81
82
83
84
85
86
87
88
89
90

Figure 4

to recognize them in the library accounts.

Sources of Additional Funds -- Some funds, additional to those described in the foregoing tables, were available from external sources. Generally, these were scholarships of various kinds, though some were donations for departmental purposes.

Scholarships came from a variety of donors and, though not easing departmental budget problems, they did ease financial matters for our students. Some were provided only once; others were offered annually; some were awarded externally; others were awarded by the university, although the source of the funds was external; all were awarded competitively; some, in national competition. For many years the two largest scholarships in Arts and Science were provided by General Motors and by International Nickel. Competition for them was keen and considerable prestige attached to the receipt of either one. Rebecca A. Jamieson received the Inco scholarship in 1974.

The scholarships available in 1991 to undergraduate students in the Geology department are listed below.

Amoco Canada Petroleum Company Ltd.

Awarded to a student in the fourth and final year of the Honours Geology Programme with at least a B- average, with a concentration in courses relating to petroleum exploration. 1991 value - $1,500.

Amoco Canada Petroleum Company Ltd. Undergraduate Scholarship in Geophysics.

Awarded annually to a deserving student in his or her fourth year of a degree in science with a major in geophysics, geological engineering, physics, engineering physics or applied mathematics. Students should have an interest in Geophysics, good grades, community/university participation and economic need. 1991 value - $1,500.

Canadian Institute of Mining and Metallurgy Earth Science Scholarship for New Brunswick Students

Awarded to a student entering second (2nd) or subsequent years in an earth science discipline. Applicants must have been born in New Brunswick or resided in New Brunswick for seven years, or have his or her immediate family resident in that province. 1991 value - $1,500.

Canadian Society of Exploration Geophysicists Award

Awarded to a student applicant who is pursuing a course of studies directed towards a career in exploration geophysics in industry, teaching or research.

Canadian Society of Petroleum Geologists Award

Awarded to an undergraduate student who has demonstrated outstanding competence in petroleum geology or closely related fields.

The award consists of a certificate and a one-year student membership in the Society.

Canadian Society of Petroleum Geologists Student-Industry Field Trip

Awarded to a third-year geology student who has an interest in petroleum geology, sedimentology and stratigraphy. The award consists of travel expenses and most field expenses for a trip to the Sedimentary Basin and Rocky Mountains of Western Canada.

Chamber of Mineral Resources of Nova Scotia Scholarship

Awarded to a senior student from Acadia University, Dalhousie University, St. Francis Xavier University, Saint Mary's University or Technical University of Nova Scotia in a geology or mining-related Bachelor degree programme. The selection is based upon the student's contribution to the development of the province's mineral resources sector as well as scholastic achievement. 1991 value - $750.

Chevron Canada Resources Scholarship

Awarded annually to a student of outstanding merit entering the final year of Honours Geology who is interested in oil exploration or production. 1991 value - $1,000.

G. V. Douglas Memorial Prize in Geology

Awarded annually to an outstanding student in first-year geology. This prize is awarded at the end of the first year. 1991 value - $400.

Geological Association of Canada Student Prize

Awarded annually to a student entering fourth year based on overall academic standing. The prize will consist of a one-year free membership in the GAC and one GAC "Special Paper" volume to be chosen by the recipient.

James L. Hall Scholarship

Awarded to a student who has completed first year with high academic standing and who is planning a career in Engineering or Geology. 1991 value - $400. (The award alternates between Geology and Engineering).

Michael J. Keen Memorial Award

This award was established to encourage greater participation of women in science. It will be awarded to a female student entering the second-year earth science programme who shows an interest in, and commitment to, the pursuit of a career in science and whose performance is of honours calibre. 1991 value - $1,000.

Mining Society of Nova Scotia Centennial Scholarship Medal

Awarded annually to the best all-round graduating student.

Natural Sciences and Engineering Research Council of Canada

University Undergraduate Student Research Award

These awards are available to full-time undergraduate students who do not have more than four terms of academic work remaining for completion of their major or honours bachelor's degree. They must have obtained a cumulative standing of at least second class (B) in their previous years of study. During the course of the work period, students must be exposed to research and development activities. These awards have a value of $800 per month in 1991 and are made for a maximum of four months.

Ross Stewart Smith Scholarship

Awarded annually to a qualified student entering the second year, one to a student entering the third year, and one to a student entering the fourth year. To be eligible for an award, students must show outstanding ability in Biology, Chemistry, Geology, Physics or Mathematics during their previous course at Dalhousie and intend to specialize in their chosen science.

University Medal in Geology

This medal is presented to the top First Class Honours graduate in recognition of superior achievement.

Scholarships awarded in memory of some individual are common. It is cause for sorrow, however, when such are awarded in memory of students who were actually in course, and we had two of them in the mid-80's.

David Barlow had completed his second year in the geology program in 1983. The son of a serving naval officer, he was himself in the Regular Officer's Training Program and attending summer training at the naval base at Esquimalt when the vehicle in which he was riding was struck by another and he was killed. The suggestion of a memorial scholarship was taken up by his classmates. They contributed as they were able, and collected from his friends, relatives, and shipmates, sufficient to endow a scholarship in his memory. It goes to a student in the second year who has a good academic record and demonstrated qualities of leadership. It was first awarded in 1984, and is customarily presented at the annual Dawson Club dinner.

In the same year, 1984, Ian Joseph MacEachern, an M.Sc. student, and Mark Anthony Ponsford, a very recent graduate, were killed by the collapse of a deep trench in which they were examining glacial till. Another recent graduate and their classmate, Gary Frotten, was trapped by the same collapse but survived. As in the Barlow case, contributions from classmates, friends, relatives, and companies and organizations with whom they had worked were sufficient to endow an annual award. To memorialize their interest in field work, this award goes to a student who has excelled in field school, who has completed the second year program in Geology with academic performance of honours calibre, and who has been an active participant in student activities. It was first awarded in 1986 and is customarily presented in the autumn during a day when the department conducts special programs dealing with safety in the work place.

It has been possible to have MacEachern-Ponsford award presented each year by the parents of the deceased, and they have appreciated the opportunity to meet the recipients.

In addition to scholarships currently available and listed above, various others have been offered from a variety of sources. In 1975, for example, Esso Petroleum (Imperial Oil) was offering Graduate Research Fellowships of $4,000 for up to three years, and University Research Grants up to $6,000 for one year, renewable for three years. Other companies also offered scholarships for competition: the Inco Scholarship was mentioned above; Gardner-Denver, Mobil Oil and Chevron Oil, also offered scholarships at various times. Until about 1978, the Atlantic Provinces Inter-university Committee on the Sciences (APICS) also offered small summer scholarships to enable a student to work in a research laboratory at a university other than his or her own, but this unusual scheme was of little help to Geology students, who normally sought fieldwork during the summer. The awards just mentioned are those identified specifically in the minutes of departmental meetings, and it is probable there were additional awards that escaped such listing. For example, for at least twenty-five years Imperial Oil has paid tuition fees for the children of its employees, provided such students maintain "scholarship standing", as certified by the university. Probably others do the same thing.

Non-scholarship Aid has come from time to time, from various companies that have made donations for general departmental purposes, without limiting the use of the funds. In November, 1976, for example, Imperial Oil gave $7,000. The year before, Amoco Canada donated $1,500 and continued to do so each year; this was so regularly used to support the "Honours Field Trip" that it came to be counted upon when budgeting for that trip. Mobil Oil and Chevron Canada, in the early '80's, also donated money that was used for purposes as varied as aerial photographs for field school, honorarium for an adjunct professor, assistance for a deaf student, and eyepieces for microscopes.

Reaction of the Department

During the twenty years covered by Table V, the total expenditure by the Geology department rose from $330,000 per year to $1,240,000. This is a 3.76-fold increase, and is an average annual growth rate of 6.8 per cent, which rate is shown by the smooth curve in Figure 2. The increasing departure of the total expenditure from that curve represents an annual growth rate of 9 per cent from 1970 to 1975 and again from 1977 to 1981. Thereafter the growth rate was reduced to an average annual rate of 4.5 per cent for the next nine year period.

During those years the common impression was that the budget was being severely cut each year, even though the number of dollars was increasing. When the numbers are reduced to percentages, however, the genesis of this impression becomes apparent. In 1971, roughly 20 per cent of the departmental budget was spent on "equipment and supplies" - all the things required for day to day operation of the department. By 1987, this had been reduced to just under 3 percent of the budget, and even with the addition of "recoveries" amounted to only 5 per cent. When one faces every day with one quarter of the supplies formerly available, one is constantly aware of the reduction, and it is the reduction - not the overall expenditure - that is the constant irritant. At the same time, inflation was reducing the value of the money and, even though one must be very cautious about applying the Consumer Price Index to these expenditures, Figure 3 suggests that there was a substantial reduction in the real value of the budget after 1979, despite the large increase in the number of dollars. Of course, the department had to adjust to the changing conditions.

Initially, financial pressure produced exhortations to be economical. As previously mentioned, there had been campus-wide reductions in lighting, and a publicity program designed to persuade people to shut off lights and other electrical items when not in use. At the departmental level, such appeals meant, in a general way, a return to practices that had been normal during Kerr's presidency. There were minor economies: items such as xerox charges, postage for reprints, and the costs of typing theses, previously paid from departmental funds, were now charged to research grants. Class material was reproduced on a spirit duplicator instead of by xerox, and there were many other similar small savings. By 1984 the department could no longer afford to be a "corporate sponsor" of the Mineralogical Association of Canada, and the Geological Association of Canada, and so saved $470 per year. Such economies were an inconvenience, but they produced no serious effect upon the department - other than irritation. Conditions gradually changed.

Services and Maintenance

Maintenance became a problem, and in November, 1977, a committee of the department was set up to advise on policy concerning research and teaching equipment, the maintenance and replacement costs thereof, and on the possibility of recovering some of the overhead costs of contract research. The maintenance problem can be considered to have two components: supply of materials for the teaching laboratories, and maintenance and/or additions to the equipment of the research laboratories, although, of course, the microprobe, X-ray, scanning electron microscope, and other research equipment is also used for teaching. "Supplies" includes office supplies, of course, and in the mid-80's they amounted to about $8,000 per year.

Supply and maintenance of teaching materials is a constant small cost. In introductory-level classes containing 75 to 100 students there is a steady small consumption of samples, and a more substantial consumption of printed notes and other instructional material that must be constantly replaced. In the same way, a petrology class consumes thin sections through breakage. One does not always appreciate that 15 samples for a class of 25 is 375 thin sections, and that a minor change in the content or presentation of such a laboratory class therefore may involve a considerable outlay for sections alone. In the early 1980's, they cost about $5.75 each, when made in our own shop (up from $3.30 in 1975 and $4.11 in 1977).

Teaching involves not only demonstration material but its presentation. Projection of photographic slides is now a hundred years old, but the material so presented, as well as the standard demanded in its presentation, is still improving. One mediocre projector is no longer adequate when several classes operate simultaneously and, although most instructors use many photographs and diagrams they have made themselves, a departmental teaching collection is necessary, and this, also, runs into money, if only for the cost of duplicating photos provided by the staff. This activity quietly stopped, as one of the small economies of the 80's.

"Presentation" of petrography via thin sections requires microscopes, and their supply is a perennial problem. Douglas had three; which were adequate for classes of only two or three. Friedlaender added more, from time to time, but when classes grew to 25 or more students there was usually some scrambling to arrange for adequate instruments for all. To accomodate the doubled class size in 1980, each microscope was used by four students and Schenk was seeking money for additional instruments. Anyone who has had a practical course in petrography recalls how the instructor had to describe "what you see right on the cross-wires" as instructor and student took turns looking down the microscope. About twenty-five years ago it became possible to put a TV camera on the microscope so the students could see on a monitor what was in the field of view. The department finally was able to acquire such a fine teaching tool in 1988.

Geology is also taught in the field. In the last twenty years there has been departure from the time-honoured mapping exercise at Purcell's Cove for beginning classes and a change to "show and tell" field trips. We are fortunate that there are excellent examples of many things within 100 km of Halifax, but the money available for transportation for such trips gradually decreased and it became necessary to assess a charge for each student participating therein, and the amount of the charge increased with time. In the autumn of 1986 it amounted to three dollars per student trip. This is equivalent to an additional small tuition fee and was not imposed without some thought.

Research laboratories are the second component of the maintenance problem. In the days of Douglas and his predecessors, when essentially all research work was field work, laboratories consisted of surveying instruments, a few petrographic microscopes, and little else. Douglas acquired X-ray equipment, and Friedlaender added a chemistry laboratory early in his regime. Keen and his cohorts went to sea at first, and for their work acquired a large amount of field equipment that was bought with external research funds. This was the time, in the infancy of Canadian oceanography, when development was very rapid and instrumentation and equipment become obsolete almost as soon as built. Gradually, both marine and terrestrial work in the department became more laboratory oriented and the variety of equipment increased; all required maintenance. Keen had an arrangement with the Physics department that made available the services of their electronics and machine shops in return for a contribution to their operating costs.

There were at this time, about 1982, eleven special facilities in the department. Their development was outlined on pages 48 to 58, but it is informative to list them, because we are not usually conscious of how they have accumulated in the last thirty years. The x-ray and chemistry laboratories were followed by the electron microprobe (which requires facilities for polishing the samples), neutron activation analysis (now dismantled), the scanning electron microscope, isotope geochemistry (which includes both stable isotopes and argon geochronology), paleomagnetics and, most recently, a facility to measure physical properties of rocks under high confining pressure. Fission track chronology, inclusion geothermometry, and cathodoluminescence do not require special rooms, but are housed in the offices of the professors who are doing such work. Several of the laboratories have technicians to operate them and nearly all require supplies and maintenance to keep them operating, so they are a continuing cost to the department, even though the equipment itself may have been bought with external funds. There is also a substantial cost to provide facilities to care for the collections of samples on which the laboratory work is done. This now includes continuing rental of warehouse space in downtown Halifax, an arrangement begun in 1984.

Finding the money for operation and maintenance was a constant problem for the chairman. In 1981, for example, the replacement of a copper x-ray tube was a problem. Because copper produces the x-ray wavelength most commonly used, the money must have been found somewhere, but the minutes of departmental meetings do not report the source. At the same time the department obtained $6,700, out of the $48,000 in the university's Research Development Fund, toward a multi-channel analyzer (for the neutron activation analysis system) on which $20,000 of research grant money had already been spent. The department also sought $2,000 for a point counter and proposed to provide the additional $2,000 required through contributions from individual research grants. Similar negotiations, and passing of the hat, were the source of funds for a word processor for the departmental office, but the one planned for the offices in the Life Sciences building had to be cancelled. Word processors used by individual staff members have been bought out of research grants. As pointed out above, there were *no* funds for non-space capital equipment, such as $6,000 for a research grade microscope, in the Faculty budgets for 82-83 and 83-84, and in 1984-85 only $40,000 was available to pay for the $75,000 worth of "high priority" needs of all departments. It is obvious from Table VI that the situation got worse.

Technicians

The department lost one of its technicians in 1981. Dr. P. Jagam, who operated the equipment for neutron activation analysis, resigned to go to Guelph. Technicians qualified to handle radioactive materials are not found on every street corner, and cost accordingly. Although there was discussion for about a year of a replacement for Jagam, he was not replaced. At the departmental level, this is the reality of the "reduction of technician's positions" quoted on page 100, above. Without him, the laboratory did not function and, although the equipment was maintained for many months, it was eventually dismantled. Although other factors were also involved, the loss of its operator was the major reason for loss of that facility.

This was not the only such loss. Drawing of maps and illustrations for publications was done for many years by whoever was competent and available.

Then Keen hired David Monahan as a full-time draughtsman. He was an excellent draughtsman who worked remarkably quickly, but he resigned in 1970 to move to Ottawa at the request of the Surveyor General, who had been greatly impressed by a perspective drawing of the continental margin that Monahan had prepared. He was followed by Jan Aumento, as a more-or-less full-time technician until December, 1975. Thereafter, for some years, there was a variety: Lata Hall did the draughting for the paleomagnetics laboratory, from 1978 till about 1988, but was paid from a research grant. Draughting for others was done by Douglas Meggison as a part-time employee. Initially we employed him for about three-quarters of his time, but by September, 1984 this was reduced to one-quarter time, and in 1987 his employment ceased. James Metlin was also employed briefly in 1979-80.

As early as November, 1979, individual research grants were being assessed $30 each as a contribution to the cost of draughting supplies, which amounted to about $1,000 per year. This was a departure from previous practice, which had provided this, and similar technical services, out of departmental funds.

A similar situation obtained in the thin-section shop. Until 1984 the equipment was scattered between the Nova Scotia Museum and two different locations on campus; consequently the operation was inefficient and the delivery of sections was commonly long delayed. Brown needed an assistant who could speed up the work by doing the operations that required relatively little skill. From 1981 to 1985 he had such a part-time assistant, who eventually could perform all the work except final adjustment of thickness of the sections. She was paid minimum wage, from money donated by an alumnus. In 1985 Brown received a replacement assistant, Karen Maxwell, who was paid from an NSERC infrastructure grant. That money ran out in 1988, and thereafter he had no assistance. The move of the shop in 1984 concentrated all operations in one room, so the situation was not as bad as it had been in 1981, but materials costs of about $4,000 per year still had to be met. In 1983 a charge for each section was introduced as part of the "recoveries" fund. Although the supervisor of the thin-section shop had argued for ten years that a small charge should be levied for each section, to provide a sinking fund for replacement of equipment, the department had been reluctant to get involved in the accounting required and users were, of course, reluctant to pay. So this new charge was a distinct innovation, in response to the financial pressure, and it achieved two things: It offset some of the cost of operation of the shop and it automatically put an end to requests for as many as 200 sections to support an honours thesis. The "Durener" polishing machine that was added to the shop in 1988 was purchased with funds from the microprobe laboratory.

A charge for microprobe analyses was also instituted about 1983. This served as a partial recovery of their costs, reduced their numbers somewhat, and, as with the thin sections, was a departure from past practice, where all such support services had been provided at departmental expense.

Despite a provisional agreement, in April, 1985, to cover part of technicians' salaries from research grants, and so reduce the cost of technical staff, it was necessary, in 1988, to lay off some people during the period May through July, but this process was not repeated.

Our chemist also had to be sacrificed. A "regional" XRF facility had become available at St. Mary's in 1983. Until that time Parikh had done the analyses that the department required, but thereafter, the more rapid XRF and microprobe techniques were generally used and his work was reduced to analyses of sulphur-rich rocks, and for carbon dioxide and water. Because of the financial pressure and this reduction in analyses, it became clear, in 1986, that his position might have to go. In 1988, he was one of the technicians laid off during the summer months to reduce costs. The department was reluctant to discharge a competent man who had given good service for 20 years, and helped to arrange for him a year's work in the Faculty of Dentistry. Parikh resigned at the end of July, 1989, when it was obvious he was a victim of financial pressure and technological change.

Some other technicians had always been paid out of research grants and it was possible to retain them only by virtue of continued grants from outside sources. In September, 1985, for example, Hall was seeking an NSERC infrastructure grant of $400,000, designed to fund 17 technicians and again, in 1987, he obtained a grant of $50,000 to support two or three technicians for three years.

Table VI shows that the "recoveries" from charges for probe analyses, thin sections, and other services have become a significant part of the departmental funds, and have been used to supplement equipment expenses and salaries of support staff. One might ask, of course, whether the previous practice was reasonable and whether the laboratory and other services provided for research work should be paid out of the budget of a teaching department. Initially the costs were minor and amounted to little more than the costs of draughting supplies and a few chemicals. Thereafter the practice continued and the costs "just growed", like Topsy, as numbers increased and research projects became larger and more elaborate. In this, the Geology department was in no way unique. It has always been clearly understood that National Research Council, and similar, research grants should be supported by the university through the provision of secretarial and other office support, accomodation, and the facilities normally expected to be present in a university. It has generally been accepted that the university should do the accounting involved, for example, and if a researcher wants specially-built x-ray cameras or high-pressure equipment, the university should provide the machine shop and labour, but the research grant should pay the cost of materials. It also seems only reasonable that the university should provide accomodation and operation, if a granting agency provides a major piece of research equipment. University administrators begin to look askance, however, when installing a million-dollar piece of equipment involves a cost of another million and the interest charges thereon, and they then begin to be concerned about other overhead items. During the 1980's, this led to considerable discussion, which resulted in agreement with some agencies that a portion of each contract research grant should be used to pay overhead costs, and the universities were only too happy to do the necessary accounting. By this means, very considerable cost relief was obtained. Such charges must be allocated with care, however: the overhead allowed on some projects is larger, if handled through the department, for example, than if handled through the Centre for Marine Geology, where the work is actually done.

Laboratory demonstrators are generally graduate students, - employed as part of their graduate instruction, or as slave labour, depending upon the point of view. Although their stipends are paid by the Faculty of Graduate Studies, a part comes from the departmental fund for demonstrators. You will note from Table V that, even in current dollars there was essentially no change in the amount available from 1970 to 1978, and in November, 1977, Piper was already complaining to the Dean that he needed money for demonstrators. One cannot now tell if this had an effect, but the amount was doubled in the budget for 79-80. The doubling of the number of students in 1980-83 produced an increased need for class demonstrators, but only modest increase in funding for them. In short, the department budget for demonstrators contributed to, but did not match, their cost. Because a substantial part of their stipends comes from individual research grants, Piper was justified in his complaint that research grants were being used indirectly to provide demonstrators - a charge more properly borne by the university directly.

Graduate Students

The support of graduate students was discussed at some length above (pages 73 to 74) and that discussion need not be repeated here, but it may be worthwhile to mention the procedure by which the support is allocated. There was a gradual increase in the number of graduate students as staff was added to the department, but by 1975 the numbers were beginning to stabilize and thereafter remained roughly constant. As mentioned on page 74, the practice that evolved provides to the student a stipend made up from funds of the Graduate Faculty, from the departmental budget for demonstrators, and from the NSERC, or similar, funds provided for the research project on which the student will be working. The share of each may differ slightly from year to year. The departmental budget for demonstrators is known, so allocation of funds is really a question of the amounts to be contributed by the Graduate Faculty and by the research grants of the students' supervisors. The allocation is made in several steps. Initially, the Faculty assigns to each department an amount well below that required to maintain the current body of students. The departments then negotiate that figure upward to provide for the students already present, and then for the students a department wishes to accept from those who have applied for admission. This is essentially scheme (d) outlined on page 98.

The scheme has the advantage that it permits flexibility. There is a small turn-over of students each year because of graduations and of casualties from various causes. Within the limits so set, the Faculty, at least, is able to admit outstanding applicants who would otherwise be lost, adjust numbers to take care of changes within departments and so provide for expansion or contraction thereof, and generally to adjust quickly to changing circumstances.

The scheme has the disadvantage that it is, for each department, a lengthy and frustrating procedure that requires negotiation and re-negotiation of the amounts to be contributed by each supervisor. Grant money allocated to a student's stipend is money not available for field or other expenses, so supervisors are naturally reluctant to part with it, even though it is agreed that the student deserves support from the project on which he or she is working. Continued reassessment of the amounts aggravates the perception that the research grants are being used to pay the university's expenses. Around 50 per cent of a stipend comes from this source.

The amount of the stipend has, of course, been adjusted for changing value of the currency:

Table VIII

Sources of Funding for Graduate Students
(Current dollars)

		1983	1984	1985	1986	1987	1988	1989	1990	1991
Teaching Asst.		33300	34200	37050	35100	34000	24000	26000	26000	25500
		29%	21%	24%	24%	20%	15%	17%	17%	18%
Grad Studies		38734	46150	55900	54100	61100	51866	55000	49000	30500
		33%	30%	36%	36%	37%	32%	36%	32%	22%
Grants		44666	77278	62900	60200	71119	88181	73480	76594	85621
		38%	49%	40%	40%	43%	54%	48%	51%	60%
Total		116700	157628	155850	149400	166219	164047	154480	151594	141621
No. Funded		13	18	17	15	18	16	18	15	12
Demo/$/Student		2561	1900	2179	2340	1889	1500	1444	1733	Hourly
FGS/$/Student		2979	2564	3288	3607	3394	3242	3056	3267	2541
Grants/$/Student	3436	4293	3700	4013	3951	5511	4082	5106	7135	
Scholarship		4	5	4	2	2	6	4	3	2
Dalhousie Funded		13	18	17	15	18	16	18	15	12
Unfunded		12	14	12	11	13	11	5	11	9
Total Students		29	37	33	28	33	33	27	29	23

	1967-68	1977-78	1987-88	1990-91
For an M.Sc. Candidate:	$3,000	$4,620	$10,200	$11,343
In 1986 dollars:	$10,869	$9,005	$ 9,769	$ 9,492
For a Ph.D. Candidate:	$3,600	$4,950	$11,200	$12,363
In 1986 dollars:	$13,043	$9,649	$10,727	$10,345

Killam scholarships, awarded on superior academic performance, are somewhat higher: In 1976, $6,000, and in 1981, $9,000, for example. They are paid from the income from a bequest. It is obvious that graduate students do not live in luxury.

It is rare, now, to have students financed on the old system, but there were two in 1981-82. One worked on a project of the Bedford Institute and was supported by it; the other was supported by the mine that employed him. In 1984, one was funded by the government of China, and in 1985 another Chinese student was supported by World University Service of Canada.

Academic Staff

During this period several professors came and went, and the straitened financial circumstances had some effect on hiring arrangements. In 1981 Senate had agreed that there should be no new appointments, and, to save money, the Dean was encouraging unpaid leave, early retirements, and reduced workloads with the equivalent salary reductions, as well as non-replacement of those who departed. The department was able to make a case, however, for the replacement of Cooke, Piper and Reid by Gibling, Boyd and Ryall, as was mentioned on page 80, and we received the replacements needed.

Paul Robinson was added to the departmental staff in 1980, as a Killam professor. His salary was paid from the proceeds of the Killam bequest and therefore did not come within the usual constraints of the Faculty budget. Later, he became the first Mobil Professor, and his salary then was paid by Mobil Oil Canada.

By the time Milligan retired in 1985, the financial pressure had increased. The department convinced the Dean that it had long needed a competent and up-to-date structural geologist and he agreed to a replacement, but only on the condition that the replacement should be a University Research Fellow, paid by the Natural Sciences and Engineering Research Council. This would provide a considerable cost saving because, at first, the university pays nothing and it is not responsible for full salary till after the tenth year. Although the Fellow is permitted to teach, this is primarily a research position and the candidate, of course, must be approved by NSERC. There was some objection from existing staff to this business of appointing staff by the back door, according to criteria set by NSERC, which are not necessarily those that would be used by the university. The first offer of a position, in March, 1985, was refused, and a month later the Dean had agreed that the replacement should be a regular tenure-track position. Such would, of course, be more attractive to the candidate and it enabled the university to apply the usual criteria when making its selection. By that time it was too late to make a suitable appointment for September and Brian O'Brien was hired as a one-year temporary appointment. N. Culshaw was hired as a permanent appointee a year later. He had graduated from University of Keele in 1970 and had had a wide-ranging experience with the British Antarctic Survey, in Malawi, in Manitoba and, after obtaining his Ph.D. at Carleton in 1983, with the Geological Survey of Canada.

It appears that, in this case, the financial pressure resulted only in delay of an appointment that was otherwise normal, although the initial requirement ruled out several well-qualified applicants who were not eligible for a University Research Fellowship.

David B. Scott was appointed in 1984. He was trained at the University of Washington and at Western Washington State College, and was awarded his Ph.D. degree in micropaleontology by Dalhousie in 1977. He continued to work with Medioli as a Research Associate till he was appointed as Dalhousie's first University Research Fellow in 1981 under the NSERC scheme mentioned above (page 100). Under that scheme, support is lost after five years, if the individual is not then on a tenure-track appointment and, because of the financial situation, Dalhousie was not at this time making any new appointments. As in the case of Milligan's replacement, there was some objection to making appointments on criteria set by NSERC, but it was recognized that Scott and Medioli formed a functioning team. The department, via the Centre for Marine Geology, undertook to find outside money (i.e. contract research, so-called "soft money") to pay his salary so the second professor of micropaleontology would not be a charge upon the university.

In this case, the financial situation of the university generated the unusual situation of a professor being required to find contracts that would pay his own salary.

Matthew Salisbury joined the department in 1985 in an appointment specially funded by Petro-Canada and the Natural Sciences and Engineering Research Council. He graduated from M.I.T. in 1968 and obtained his Ph.D. from the University of Washington in 1974. He had had a varied experience as a professor at State University of New York at Binghampton, as a researcher at the Smithsonian Astrophysical Observatory, and at Scripps Institution of Oceanography, where he was deeply involved in the Deep Sea Drilling Project. His major interest was the physical properties of rocks at high pressures and temperatures. In pursuit of this interest, he built at Dalhousie a laboratory where he was able to investigate the mechanical behaviour (sonic velocities) of rocks at pressures up to 200,000 p.s.i. (14,000 kg/cm^2). This facility was financed by NSERC.

Salisbury became Director of the Centre for Marine Geology on the resignation of Hall, in April, 1986.

Given the financial situation of the university, it was very unlikely that his position would become a tenure-track appointment and, when Petro-Canada withdrew its support, in 1988, Salisbury resigned and moved to the Bedford Institute.

It appears that, in this case, the financial situation of the university cost the department a professor whose position could be continued only so long as an external organization paid for it.

Field Training

Field School -- There is universal agreement that first-hand experience with rocks in the field is an essential part of the training of all geologists. The training methods used are generally adjusted to the circumstances and therefore differ considerably from place to place. For well over 100 years, in this country, the Geological Survey of Canada, the equivalent provincial surveys, and the mining industry have all hired students as a large part of the staff for their summer explorations. For these organizations, this provides a distinct saving, because they need pay the exploration crews only during the short summer season. It appears that Canadian students are almost unique in having this opportunity to be paid while they learn, and although it is not usually so considered, it is clear that the geology departments of Canadian universities have been operating "Co-op programs" with government and industry for at least a century. At its best, a student may get up to four months of intimate contact with real geological problems in each of three field seasons, and students used to be encouraged to see governmental survey work one year, mining exploration in another, and petroleum exploration in a third. In recent years the character of the work has changed and the student may spend a summer carrying a magnetometer through the swamps or plotting well-logs in a Calgary office; the work is realistic enough, but the student may never see a rock. At its worst, when exploration activity is much reduced, the student may not get a job at all, and so gets no experience. Programs of instruction cannot be turned on and off like a light, so some minimum of field instruction must be incorporated into the educational program.

What is the minimum? A not-entirely facetious definition might be: the student should have on graduation the minimum experience that will leave the staff of the department with a clear conscience. Obviously that minimum will differ from place to place. For the last 30 years at Dalhousie, this has meant ten days at Field School, plus various brief field trips during the academic year, and, during the last 15 years, an additional two weeks at the beginning of the fourth year (the "Honours Field Trip"). Field exercises are costly, unless they can be operated directly out of the university; in Halifax and the immediate vicinity, for example. Anything else requires transportation, at least, and commonly involve costs for accommodation, meals and all the other incidental expenses. Even when shared with others the costs may be significant.

Sharing arrangements, through the joint operation at Crystal Cliffs, were mentioned above on pages 36-37. The cooperating departments were: Acadia, Dalhousie, Mount Allison, St. Francis Xavier, St. Mary's and, in later years, University College of Cape Breton and, for a few years, N. S. Institute of Technology. Initially, the Nova Scotia Department of Mines provided the facilities, donated the Director, a van and driver, a subsidy, and paid for $100,000 worth of liability insurance. Prior to 1970, the universities each contributed $100 toward the operating cost. After the first two or three years, the Director was Dr. J. D. Wright, the province's chief geologist, and, though he also enjoyed many alcoholic evenings, he did much to maintain a common-sense and practical emphasis in the training. When he retired in 1970, his successor announced that he had "no intention of being a wet-nurse for a bunch of students", and all the support from the Department of Mines except the insurance, was gradually withdrawn. The facilities at Crystal Cliffs were sold to St. Francis Xavier University, and thereafter, there was a modest, but increasing, charge for their use. When students became too numerous for Crystal Cliffs, it became necessary to move to the campus of St. F. X., where residence rooms and a dining hall were available at a cost less than that at Crystal Cliffs. For a variety of reasons, the cooperative arrangement gradually broke down: Acadia withdrew around 1975; Dalhousie, in 1984.

The instructional arrangements changed with time. The initial tours, guided by Whitehead, were replaced by mapping exercises, at selected locations. At first the students worked individually, or in small groups, guided by whatever instructor happened to be handy. This had the advantage that students from different departments got to know one another and were exposed to ideas other than those of their own professors. It had the disadvantage that the instructors did not know the background and individual abilities of students from other departments, which made instruction difficult, or even confusing. Eventually, the students were arranged in groups of three or four from each institution, and each group was assigned to an instructor from their own school, who was familiar with them and their background knowledge.

From time to time there were proposals that the school should be held in the autumn, instead of very early in May. In the beginning, such a proposal usually followed a spring session when the weather had been more than usually horrible, and certainly many sessions operated over snow, in icy winds off Northumberland Strait with or without snow flurries, and in rain only a little above freezing. There is no doubt that such weather greatly complicated the instruction, and it says much for the students that the majority maintained some sort of interest in the rocks in front of them, even when their teeth were chattering. The usual objections to an autumn session were: (1) the instruction was intended partly to prepare the student for a summer field season in industry and must, therefore, precede it; (2) it was unfair to require students to give up two weeks or more of their summer earnings by cutting their field season short; (3) after the move from Crystal Cliffs, accomodation was available at St. F. X. in May but not in early September; (4) although Dalhousie did not, some departments included the field school as the final part of a formal course, which had to be completed in May. Perhaps the changes in departmental staffs, and in their views of the field experience required, may have had an effect also. In 1984, Dalhousie withdrew from the joint school and held its field exercises at the Y.M.C.A. camp at Big Cove, during registration week in early September. A factor in this withdrawal was the perception that Dalhousie staff were doing most of the instruction; this may have been true, but Dalhousie on some occasions had a student contingent larger than all the others combined.

In addition to the operations described above, Dalhousie ran a field program in geophysical techniques after about 1970. In the beginning it was run as part of the field school program, or parallel with it. It has now operated as a separate entity for many years. Organization and financing arrangements are similar to those for the field school, but attendance is restricted to those who have had appropriate classes in geophysics.

Absolute costs vary with the enrollment. At times the numbers were very small: the last year that M.I.T. participated, the staff *and* students of the whole cooperating group were all fed in the home of the caretaker at Crystal Cliffs. Numbers generally increased thereafter. By 1975 the total attendance was about 70 and the maximum probably came with the widespread large increases in enrollments in 1980 and immediately thereafter. In 1981 and 1982, Dalhousie probably had 52 and 40, respectively, in attendance and, according to the Registrar, there were 59 in 1985, but there was a rapid decrease thereafter, and, in 1989, only 4 students attended the field school.

From the very beginning, the students were charged a portion of the operating cost of the field school, partly to remind them that it was not a free holiday. Memory says that, in the beginning, the charge was about $20, which was raised to $40 for a number of years. It rose to $50 in 1970 and had risen again to $70 in 1975, to $125 in 1980, and to $165 in 1982. In 1983, residence rooms were not available at St. F. X. for the first week of the field school and it was necessary to house people in local motels; that year the cost to each student was $200, but that was exceptional. Operating independently, Dalhousie charged its students $150 each in 1987, and $175 in 1989.

For several years, Chevron Canada Resources, through P. A. T. Haines, the staff geologist in charge of their training programs, maintained a close interest in the Crystal Cliffs field school. In the spring of 1983, that company donated $6,000 to it, and indicated that like amounts would be available in the next two years. Whether or not this was in anticipation of a possible reduction in training programs in industry, it was a handsome recognition of the value of the field school.

It is surprisingly difficult to find, in the departmental files, coherent data on the cost of the field exercises, or even on the numbers in attendance each year. Information from several sources has been used to compile the following table. Where the figures are suspect they have been given as approximations (~), but the table may serve as examples of the costs:

The department was required to stay within its budget and, starting in 1985, students were charged three dollars toward the cost of each field trip in each class they attended. The largest cost for an individual student came in the second year, when it amounted to $29 in 1986. For many years a similar charge had been made from time to time in some classes; usually it was twenty-five cents to a dollar toward the cost of gasoline or of rental of transport, and never was a serious matter. The charges now introduced, which Table IX shows were 32 per cent of the cost, were now considered to be serious, and the Faculty required that a department should notify each student, at the beginning of a session, exactly what charges would be made in each class.

For the Field School the range of costs is rather surprising. In 1974, the charge for board and lodging at St. F. X. was $7.00 per person per day; in 1975, this had risen to $8.25. Although transportation costs should have gone down in 1975, and there may have been an outlay for equipment and supplies, an increase from $34 to $68 is still remarkable. In 1986, charges for accomodation were also on a person/day basis, so it also surprising to find that, despite efforts to economize, the cost per student had risen by 21 per cent in two years, even when expressed in constant dollars. No doubt an increase from $8.25 to $15.00 per person per day for accomodation has some relevance! (The cost per student in 1987 would have been $148.64, but for the payment of $1,000 to a teaching assistant who was not needed in 1986.) It should be pointed out also that if, in 1986, the students had been required to provide the 63 per cent recovery of 1974, the net cost per student would have been $127.91, a reduction of 17 per cent, in constant dollars, but each student would have been required to pay $218. The charge for the Field School is, in effect, an additional tuition charge and a charge of that size the department probably did not wish (or dare) to make, because the staff were well aware that, for some of their students, the costs were already burdensome. In short, despite the financial pressure the department elected to bear the increased cost rather than increase the charge to the students.

"Overload" teaching is a cost item not included in the preceding discussion; the arguments advanced for such payments were outlined on page 78. The major part of the "overload" funds went to support instruction at the Field School; the balance went to the Honours Field Trip and to local trips that were a part of individual classes. In the first three years (1981-84) "overload" teaching at the Field School cost just under $11,000 each year out of a total "overload" budget of $18,400. Because of the increased financial pressure, the department reduced amounts allocated to the "overload" budget to $7,100 in 1984-85, and to $5,800 and $6,000 in the two succeeding years. Of this the Field School used $3,400 in 1984 and $2,030 in 1986. The reductions led a departmental meeting, in October, 1987, to decide that "all field school time will be paid as overload teaching, and other overload teaching in excess of two days will be paid, up to a ceiling of $3,000".

Once the "overload" was established as part of the departmental budget, it soon became clear that restrictions applied by individuals and by the department were more severe than anything imposed by the university. One member refused to accept the "overload" payment, another returned the money as a restricted gift, as did several others who accepted it because they were protected against liability only if the university was paying them for field work. Another individual had part of his share paid to the demonstrators in the Geology 1000 class, and yet another used part as a subsidy for the Honours Field Trip.

Bermuda Field Trip - Beginning in 1975?, Schenk ran a seven-day field trip to Bermuda each September. It was operated out of the Bermuda Biological Station for Research, came at the beginning of the student's final year, and was designed to give the students a chance to see, at first hand, carbonate deposits and processes they had been studying the previous year. For a few years this was a joint operation with a similar class from Memorial University of Newfoundland.

As an example, the cost of the trip in 1983 was about $8,700 - a price attained by utilizing group rates for air fares, which formed somewhat over 50 per cent of the charge that year. Because the following companies considered this a unique and useful project, the trip was supported financially for several years by Gulf Canada Resources, by Amoco Canada Petroleum Company, by Shell Canada Resources, and by Canadian Superior Oil Ltd. In 1984, however, all but two withdrew their support because of other financial demands, and the trip had to be cancelled.

According to Dr. Schenk, the students paid all the costs except those of the instructor. Even with the subsidy from industry, in 1983 this meant a direct charge to each of the six students of over $1,000, and five other students could not afford to attend. Without assistance, from industry or elsewhere, it was impossible to operate this field trip, and it has not been held since 1983.

Honours Field Trip - The general purpose and range of the Honours Field Trip was discussed above on page 66. Initially the trips were financed by the department, with a contribution from the students who took part. Attendance was voluntary. Initially also, it was possible to find money to pay for journeys to classical, though distant, places, but after 1980 this became difficult. In 1980, the eight students who took part in the 14-day trip to study Italian volcanoes each paid $750. This included transportation, food and lodging and was about half the commercial cost for such a trip, but it was still a major outlay for each student.

Thereafter, the trips generally have been in eastern Canada and to areas with which the leader was already very familiar. This reduced both travel costs and the time and expense involved in preparation and administration. The latter factors were of some importance and, in March, 1982, led a committee considering the future of the Honours Field Trip to comment: "At a time when we are streamlining the curriculum in an effort to save research time, it is unfortunate that the trip involves great time output". In September, 1982, the trip to western Newfoundland cost each student $72 and was subsidized by $1,500 from the department and $1500 from Amoco Canada Petroleum, who supported the field trip for a number of years. Camping reduced the costs of accomodation to the minimum. At about this time, also, the students began raising money toward the cost of the trip by

Table IX

COST OF FIELD EXERCISES

Class	Enrollment	Trips x Charge		Recoveries	Total Cost	% Recovery	Net Cost	Net Cost/ Student/ Trip	In 1986 Dollars
Field School									
1974	45		$ 60	$2700	$4250	63	$1550	$ 34.45	$ 86.34
1975	~30		70	2100	~4150	75	2050	68.33	154.59
1986	11		150	1650	3083*	43	2153+	195.73	195.73
1986 (Geophys.)	8		40	320	1896	17	1576	197.00	197.00
1987	11		150	1650	4285	38	2635	239.54	229.44
1986									
Geol. 1000	38	5	3»	570	1693	34	1123	5.91	
2100	14	1	5	70	295	24	225	16.07	
2110A	14	7	3	294	783	38	489	4.99	
2200	15	1	3	45	--	--	--	--	
3140A	12			0	168	0	--	14.00	
3300	16	3	3	144	432	33	288	6.00	
4150	7	1	3	21	157	13	136	19.43	
				1144	3528	32			

* Vehicles, $983; Lodging + food, $2175; Other, $645

+ Not including $2030 for 18 1/2 man-days of "overload teaching".

» The charge of $3 to each student for each trip began in 1985-86.

selling the food for a weekly "Geo-lunch" for staff and students. This contributed about $960 to the trip to the U. S. Appalachians in 1983. Of the 21 students who originally wished to go that year, 11 actually attended and the cost to each individual was about $250, including food and campground accomodation. The direct additional cost to the department was just under $4,200, which was reduced by a $1,500 donation from a staff member. Campground accomodation was also the case for the 1981 trip to California, but air fares were a substantial item and the students paid $450 each, including food and accomodation for ten days, even though Robinson arranged for the use of vehicles of his old department at the University of California, Riverside for both that trip and the one in 1984. In an attempt to reduce the cost to the department in 1984, invitations were extended to several geologists in Nova Scotia who might have been interested in participating at a price somewhat above actual cost. In 1985 the trip to Quebec had an unusual contribution of $500 from Brown Manufacturing, of Scarborough, Ontario, on condition that the money be used for a project that included a specific student, Steven Dudka.

In 1987, the Honours Field Trip was made compulsory for all honours students at the beginning of their final year, because the department considered that the benefits justified the cost. This meant, of course, that the department assumed responsibility for providing the trip at a cost that all students could afford, and raised also the question whether the student should (or could) be required to make a large contribution to the cost of what the university said was a compulsory part of the program for which tuition fees had already been charged.

Summary

The department felt the effects of the straitened finances in a number of ways: (1) There was a loss of technical staff: Jagam resigned and was not replaced; Parikh was overtaken by changing technology and by the budget reductions; Meggison, the draftsman, disappeared through gradual reduction of his working time. It should be noted, however, that while loss of technicians paid from infrastructure and research grants may be a problem, that loss is largely independent of the budget of the department or of the university. (2) Although there was much discussion, the replacement of academic staff who resigned or retired was delayed in one case, but otherwise was almost routine. Increases in staff, however, were not forthcoming. There developed the unusual situation of two professors paid by outside organizations and one paid by contract research. Eventually two of them were paid by the university and the third resigned when the external support was removed. To save money, leaves of absence were encouraged. (3) To meet its ordinary operating costs, the department had to charge for services, such as analyses, that had previously been provided at departmental expense, to introduce charges for student field excursions, and to make a number of other charges. Overhead costs were charged on research contracts. Such "recoveries" eventually amounted to six per cent of the total operating cost of the department, and to nearly 97 per cent of the non-salary expenditures. Some of this money went to supplement the salaries of support staff, but even then, three technicians were laid off during the summer of 1988, with attendant problems of morale. Although participants paid a considerable part of the cost of the Honours Field Trips, it was necessary to curtail them to some degree, and there was much concern expressed over possible reduction of field experience for students, because of rising costs of excursions and of field school. (4) There was pressure to increase the portion of individual research grants used for stipends of graduate students and for the equipment they used; the latter was, in large part, a result of the reduction, or complete absence, of funds for non-space capital equipment. (5) Evening classes were cancelled to save money, with one exception; it is not at all clear, however, that very much was really saved by this action.

Minutes of departmental meetings give the impression of much greater pressure than is implied by the preceding paragraph. In part, this is because of continuing discussion of many proposals (e.g. collection of laboratory fees) designed to provide money or reduce expenditures; in many cases, however, the proposals remained just that. There were also real problems (such as space for honours and graduate students, or Clarke's difficulties in processing his microprobe data in the mainframe computer) which indirectly reflected the financial situation in the university. If the Consumer Price Index in any way approximates the changing costs in the university, it is clear from the data in Figure 3 that, after 1979, the real purchasing power of the departmental funds declined each year. There was, then, the continuing frustration of using increased amounts of money to buy less and less each year, and each year to keep the department functioning effectively with less than was available the previous year.

Effect on Department

The perception grew that no senior administrator cared about the department or about the students and their instruction, and out of this perception grew frustration. For Zentilli, this was the major problem of his term as chairman. There were two related features of this problem.

The first aspect of the problem was the research program of the department. Because of previous cooperation with the Bedford Institute and other oceanographic organizations, as well as participation in the Deep Sea Drilling Project and in the projects in Bermuda, Iceland, and Cyprus, Dalhousie had become known internationally among those who dealt in geology beneath the oceans. The department also published a substantial body of work that was related, although it had a more classical approach and objectives. Nearly all the staff were engaged in these endeavours, directly or indirectly. In the climate of the time, the staff thought they saw an opportunity for the department to develop a position of leadership, or at least of importance, in marine aspects of geology, and were encouraged in this by previous success in obtaining support funds from industry and elsewhere. One motivation, of course, for pursuing such an opportunity was natural pride in developing a wide reputation for the department and for the individuals therein. Further motivation came because such a development would require continued active research programs, which would do two things: (1) enhance the reputations and professional careers of the participants; and (2) provide opportunities for improved instruction, particularly at the graduate level. Exciting research tends to spill over and stimulate undergraduate teaching, even if only by making the undergraduate student aware of the exciting work going on. Such spin-off could only be beneficial to the teaching program of the department.

The second aspect of the problem was the position of faculty members themselves. The Alumni Association tried to emphasize and stimulate excellent teaching by public recognition of good work. But the perception by faculty that a good research and publication record was critical for promotion, or even respect, was reinforced by the action of committees ruling upon promotion and tenure. Furthermore, research, and publication thereof, is essential if an individual is to develop a professional reputation, and with it the freedom to move elsewhere, either in academia or industry. Members of the Geology department had in front of them the example of one who, when there was no one else to do it, had deliberately concentrated on teaching, through lack of publications had destroyed any recognition in the profession and, through increasing lack of familiarity with current research, had become an incompetent teacher within a few years. Senate recognized in "1986 and Beyond", its report on academic planning, that continuing excellence of programs in the university was doubtful when resources were scarce, and faculty members recognized that non-replacement of staff would restrict research work by increasing their teaching load and administrative duties. (Committees were still multiplying.) It was plain for them to see that much restriction of research would be suicidal for their careers, in or out of Dalhousie. Even if they were willing to make such sacrifices for their students, it would be wasted, because the quality of instruction would go down from lack of space, equipment and support, to say nothing of any isolation from current scientific ideas as they developed. Although it might be argued that this is an exaggeration and a view that could be held only by someone preoccupied with research, consideration will show that the question is one of degree, not of substance.

Efforts to improve matters had produced little response: After a separation of eleven years, most of the department was in the Life Sciences building by the autumn of 1982, but in 1985 the Chairman was still attempting to get all the department together in the contiguous space that had been promised, and accomodation for graduate and honours students was still a problem. For some time, also, the department had argued that, because many graduates went to the petroleum industry, a petroleum geologist was needed, and that an isotope chemist was also desirable. In the current financial climate, neither was possible and the staff thought they saw slipping past an opportunity that had considerable future potential. Even the replacement of obsolete or worn-out equipment for undergraduate classes was difficult or impossible.

During the 1960's and 1970's, the university had seen rapid expansion of student numbers, of class offerings, and of programs. Various institutes, departments, schools and other organizations were formed, usually as the result of enthusiastic promotion by an individual. In an organization that derives its very name from the Latin *universitatem*, the whole world, almost any topic or field of investigation and instruction can be justified, and faculties and Senate may have devoted more attention to the justification than to demonstration of the need for, or usefulness of, these various organizations. In short, at that time, proposals for new, or expanded, activities received a sympathetic hearing.

All programs tend to grow. Growth brought increased capital and operating expenditures, and some of the money was borrowed. The amount of the total accumulated debt varied from year to year and, in the early 1970's was around 3 1/2 to 4 million dollars. There was a great increase, starting about 1980, and the total reached 12 million in 1984. Although faculty criticized the provincial government for not providing increased funding to the university, everyone finally came to realize that it was not possible to increase indefinitely the money for medical care, hospitalization, education, Sysco, highways, and other sacred cows, and therefore that Dalhousie would reduce its debt only by its own efforts. Even though, during the '60's and '70's, there had been sympathy for expansion, money for additional staff and additional building was now out of the question. Even money for supplies and equipment would continue in short supply.

Staff frustration was aggravated by recognition of probable deterioration on one hand, and their inability to do anything about it on the other.

There were, however, some changes that were driven by academic, rather than financial, concerns, and a new degree program resulted.

"Advanced Major" Program

A four-year "Advanced Major" program was introduced in 1984. It differs from the three-year program in that five additional classes of advanced level are required, and from the Honours program in the absence of an honours thesis and in somewhat lower grade requirements. The impetus for such a program was the recognition that three years from Grade 12 did not really provide training and standards comparable to the product of four-year programs offered elsewhere. Whatever may have been the case in other departments, students in Geology had recognized this some years before. When assessing their own abilities, students can be very objective, and many who recognized that they might not be able to meet the requirements of the honours program also recognized that the three-year general degree did not meet their needs. It was not uncommon for such students to add a fourth year, during which they did essentially all the work required for an honours degree. A few exceeded their own expectations and received an honours degree by certificate; others did not, yet they had covered the honours program at a somewhat lesser level of performance, and at a level of performance and knowledge much greater than that required for the general degree. This was NOT a "failed honours" program, and some who chose this route have subsequently been successful geologists.

Active investigation of the need for, and possibilities of, an "advanced major" program was entrusted to a special committee of the Faculty of Arts and Science in 1982. The committee examined the matter at great length, and reported in 1985.

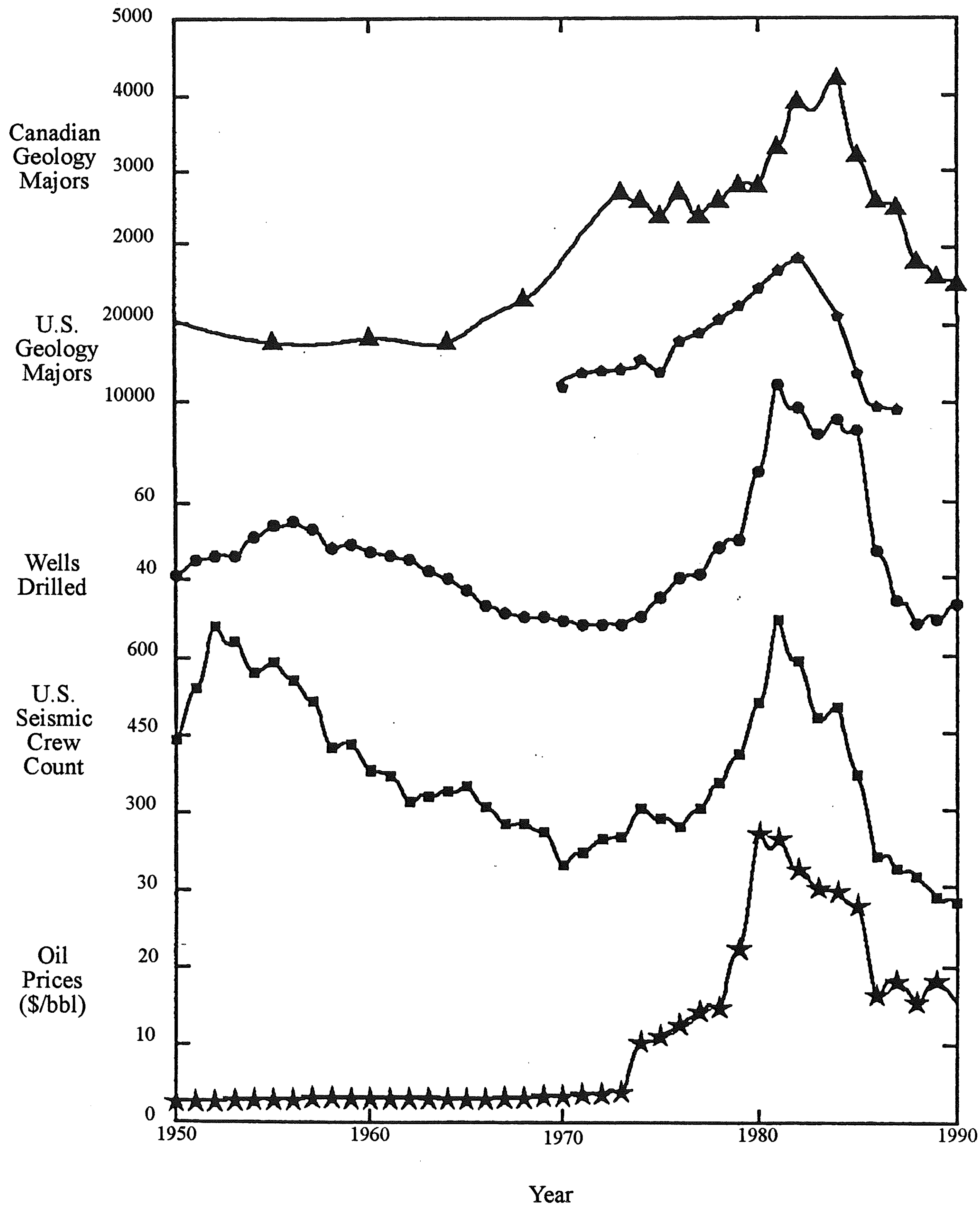
The program requires twenty credits and at least 12 of the 20 must be beyond the introductory level, at least 6 and not more than 9 of those must be in one "major" field, for example, and minimum grades are specified.

When the "advanced major" program was approved, the Faculty expected that it would become the standard program within a few years and that the three-year general degree would be offered no longer.

Enrollment Numbers

Zentilli's term as chairman expired in 1986. The selection committee appointed by the Faculty agreed with the recommendation from a ballot within the department, and Ryall was chosen as the new chairman. Clarke and Schenk were the Associate Chairmen. Ryall was faced by two major problems: a drastic reduction in enrollments and the severe financial constraints already discussed.

The reduction in student numbers was unusual, although there is always some fluctuation in student numbers from year to year, and substantial changes about every ten years. The common range of fluctuation has a number of causes, deriving mainly from the international character of mineral exploration and the fact that, for all practical purposes, the career opportunities for the majority of our graduates are in exploration in the petroleum and mining industries. It is true that graduates from the department work in many fields: We have M.Sc. graduates practising law ("I'll be the only corporation lawyer in Toronto who can talk to the mining people in their own language"), we have graduates in engineering, in government service, in manufacturing, and as corporate executives. It is also true that, for many students, their B.Sc. in geology turns out to be part of a liberal education which they take into a great variety of careers, as is evident from even a casual look at a list of our alumni and their present occupations. But the instructional program assumes that a student majoring in Geology is going to become a practising geologist, and nearly all students so regard it also. The enrollment then reflects not only the interest of individual students in the science, but their perception of the opportunities for a career therein, and those opportunities depend upon exploration activity in industries that are world-wide. A major change in copper production in, say, the Congo, or the introduction of a new refining process in Arizona, results in changes in exploration for copper in Canada; the change in the price of oil enforced by OPEC in the 1970's suddenly made hitherto useless rocks in North America into potential oil producers, with a consequent upsurge in exploration; the report of the Carter royal commission, in February, 1967, produced four years of uncertainty about the taxation laws of Canada, and exploration in Canada practically stopped until the matter was resolved in 1971. Figure 5, which was prepared by Dr. Ryall, shows the correlation between oil prices, exploration activity and student enrollments. Figures 6 to 10 show the numbers of students majoring in Geology at Dalhousie since 1932. (These figures represent actual individuals, not "Full Time Equivalents" or other statistical abstractions derived from class enrollments.) It takes some time for the word to spread to students entering the program, and a good case can be made that the severe drop in our enrollment after 1971 is a direct result of the cessation of exploration activity during the previous three years. It is hazardous



Canadian Geology Majors
5000
4000
3000
2000
U.S. Geology Majors
20000
10000
Wells Drilled
60
40
U.S. Seismic Crew Count
600
450
300
Oil Prices ($/bbl)
30
20
10
0
1950
1960
1970
1980
1990
Year

Figure 5

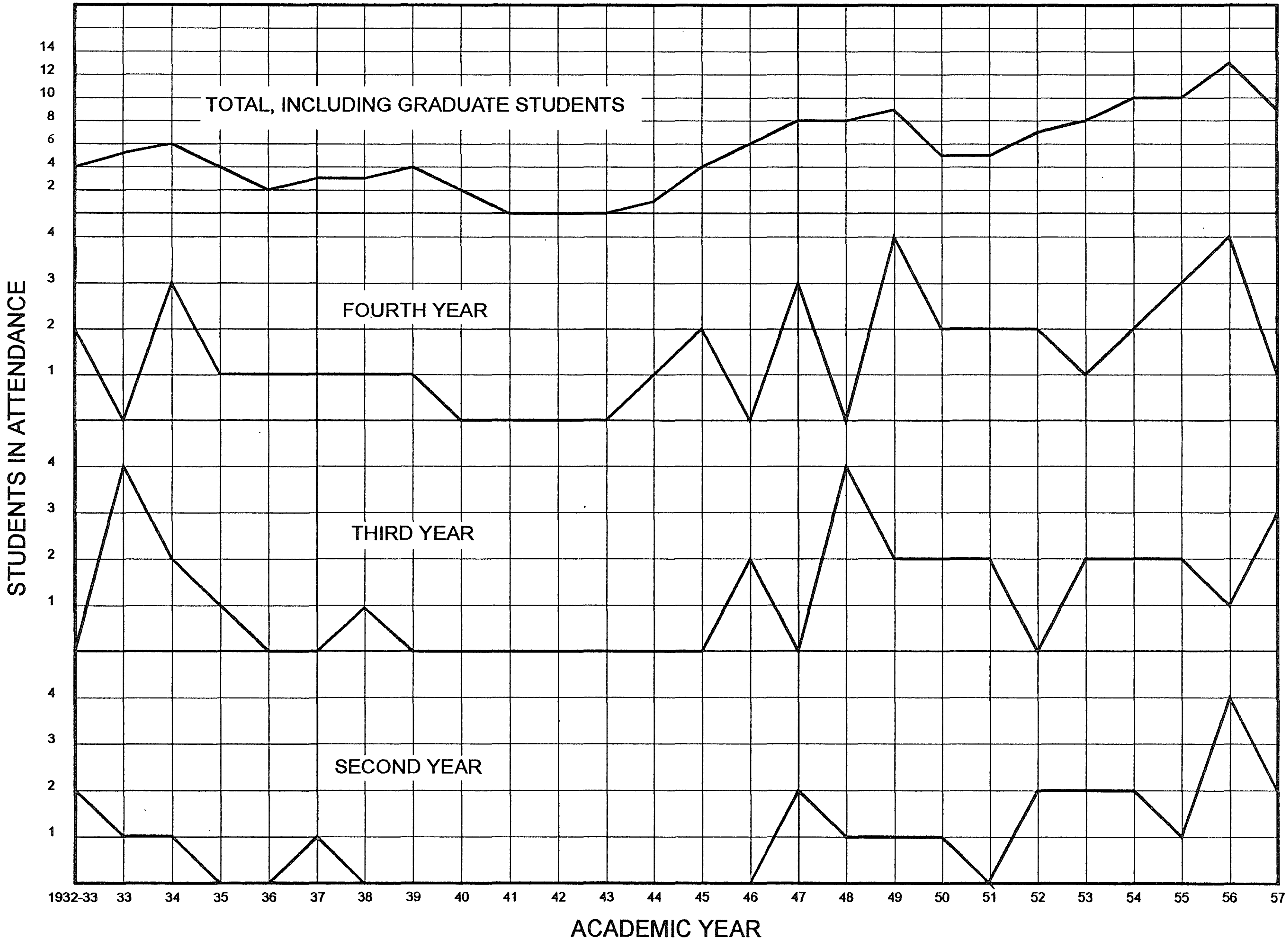


Figure 6. Students majoring in Geology 1932-1957

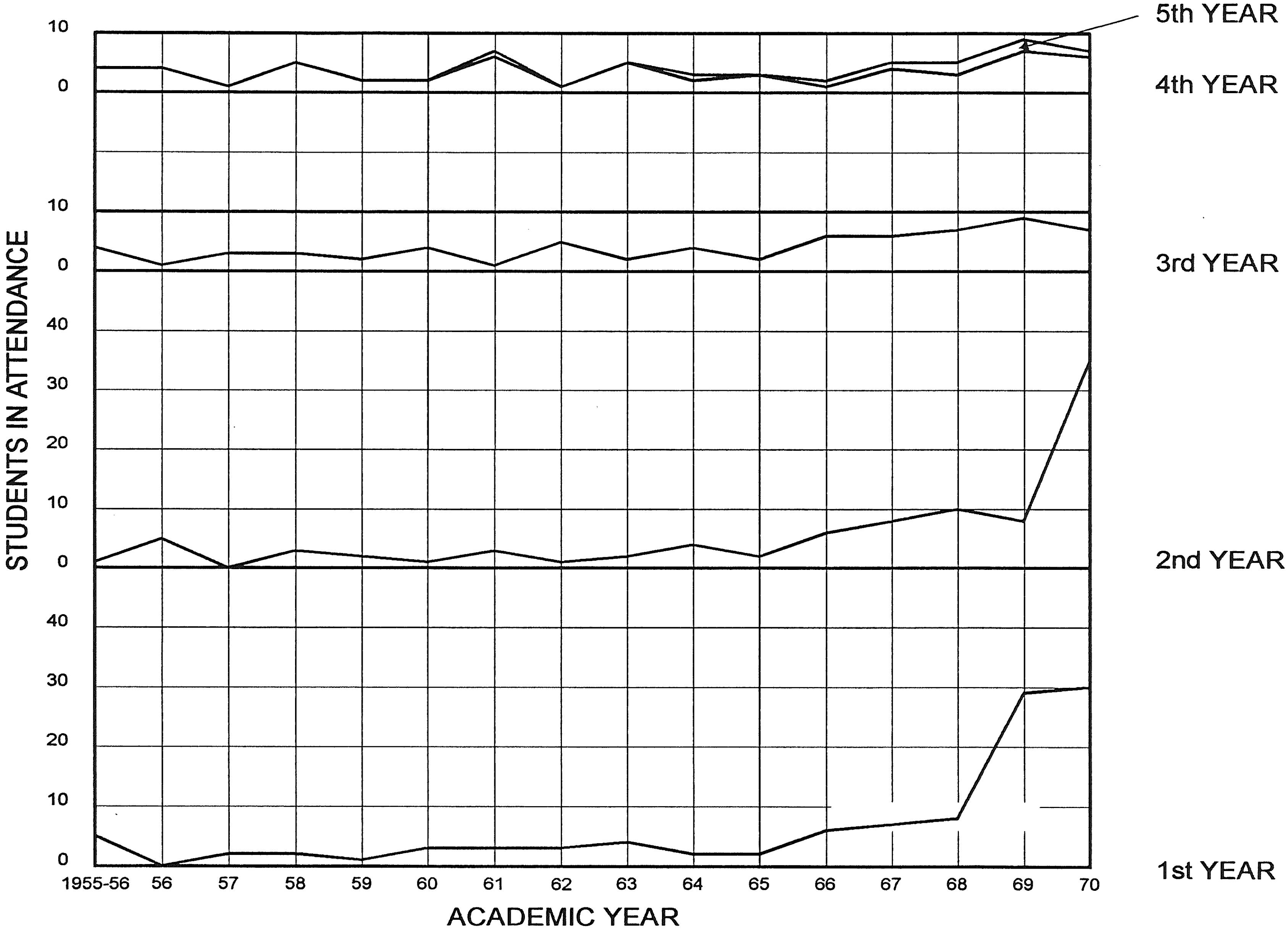


Figure 7. Students majoring in Geology 1955 - 1970 (by year of study)

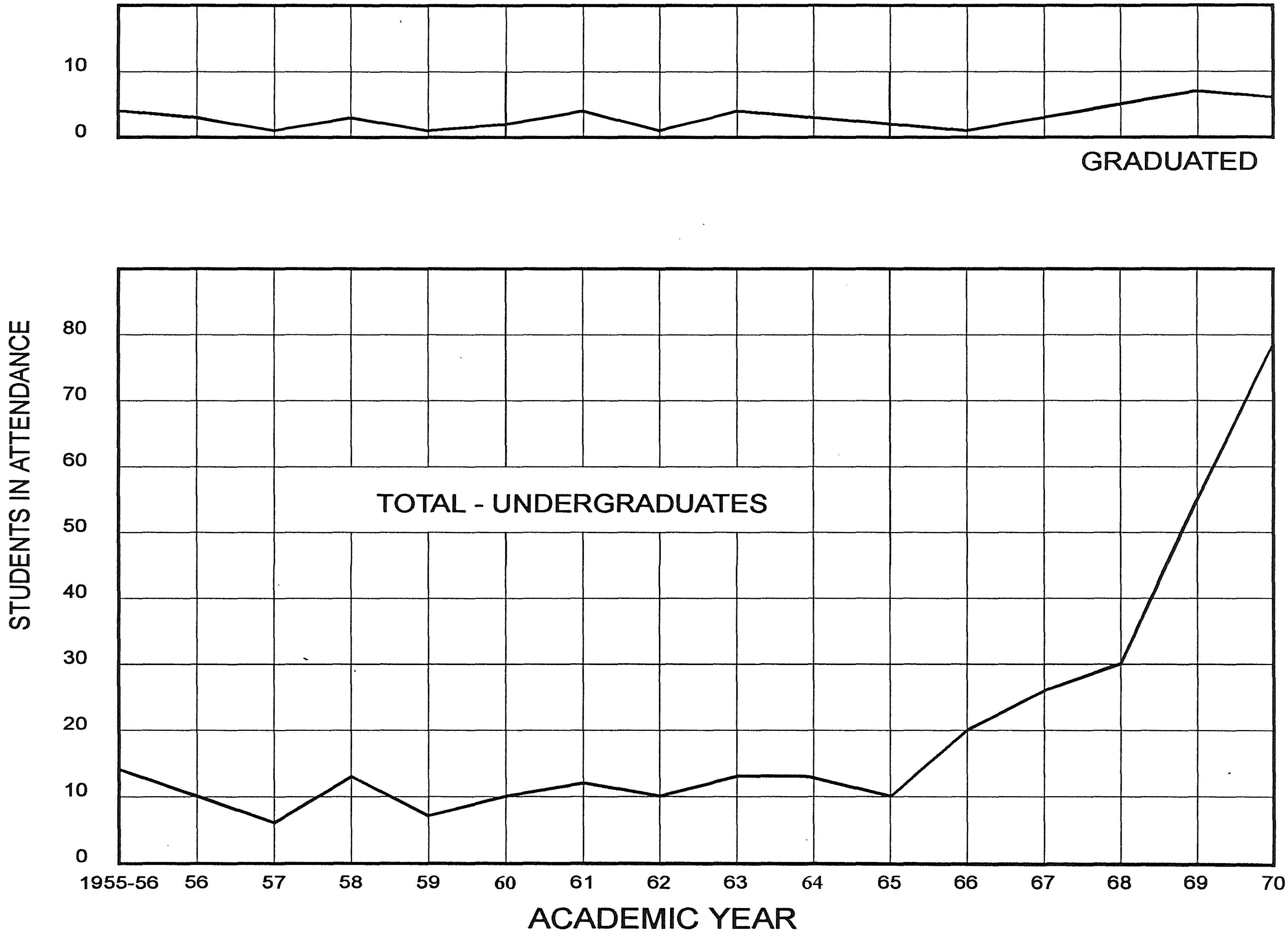


Figure 8. Students majoring in Geology, totals and graduating 1955-1970

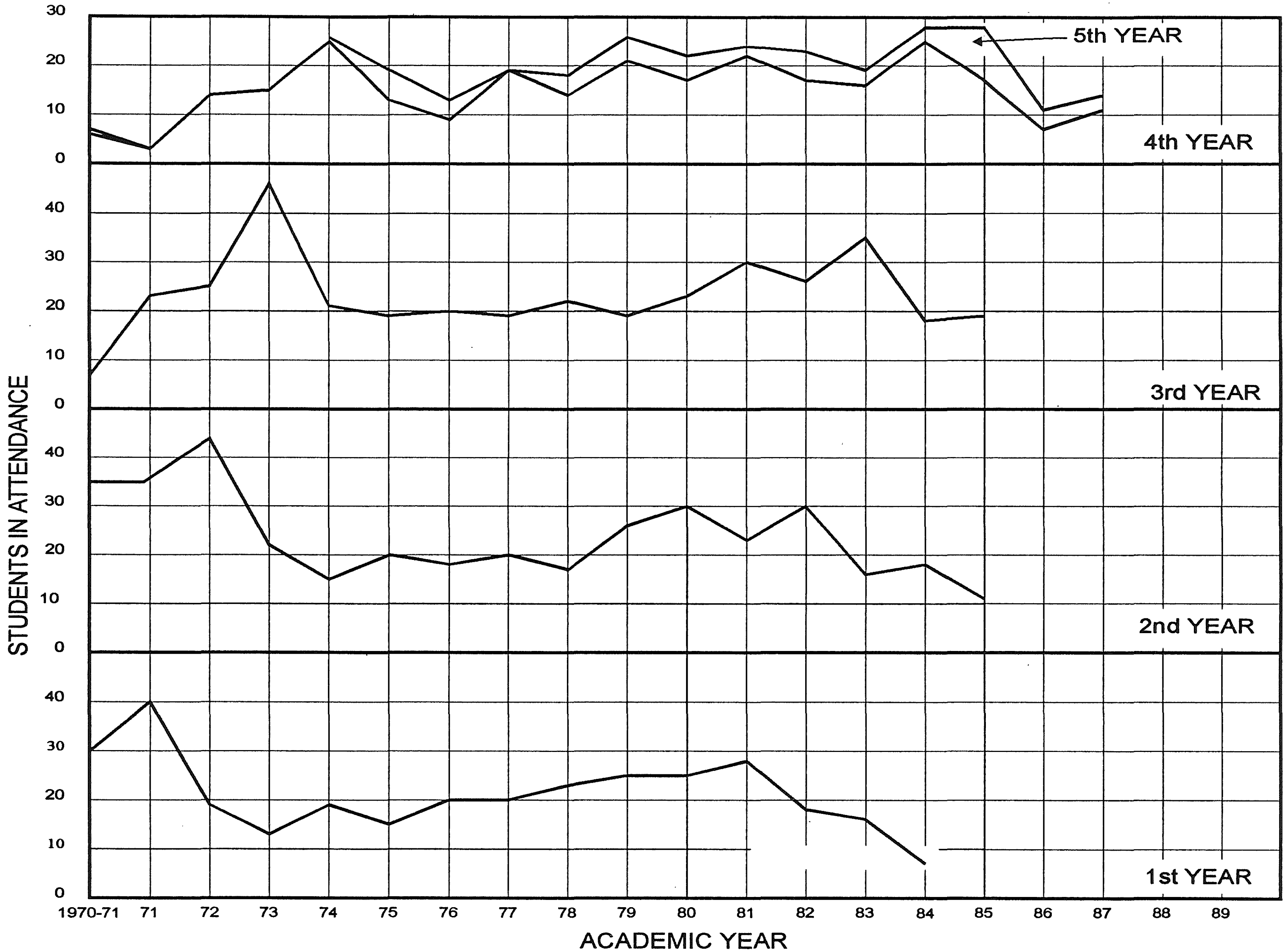


Figure 9. Students majoring in Geology 1970-1987 (by year of study)

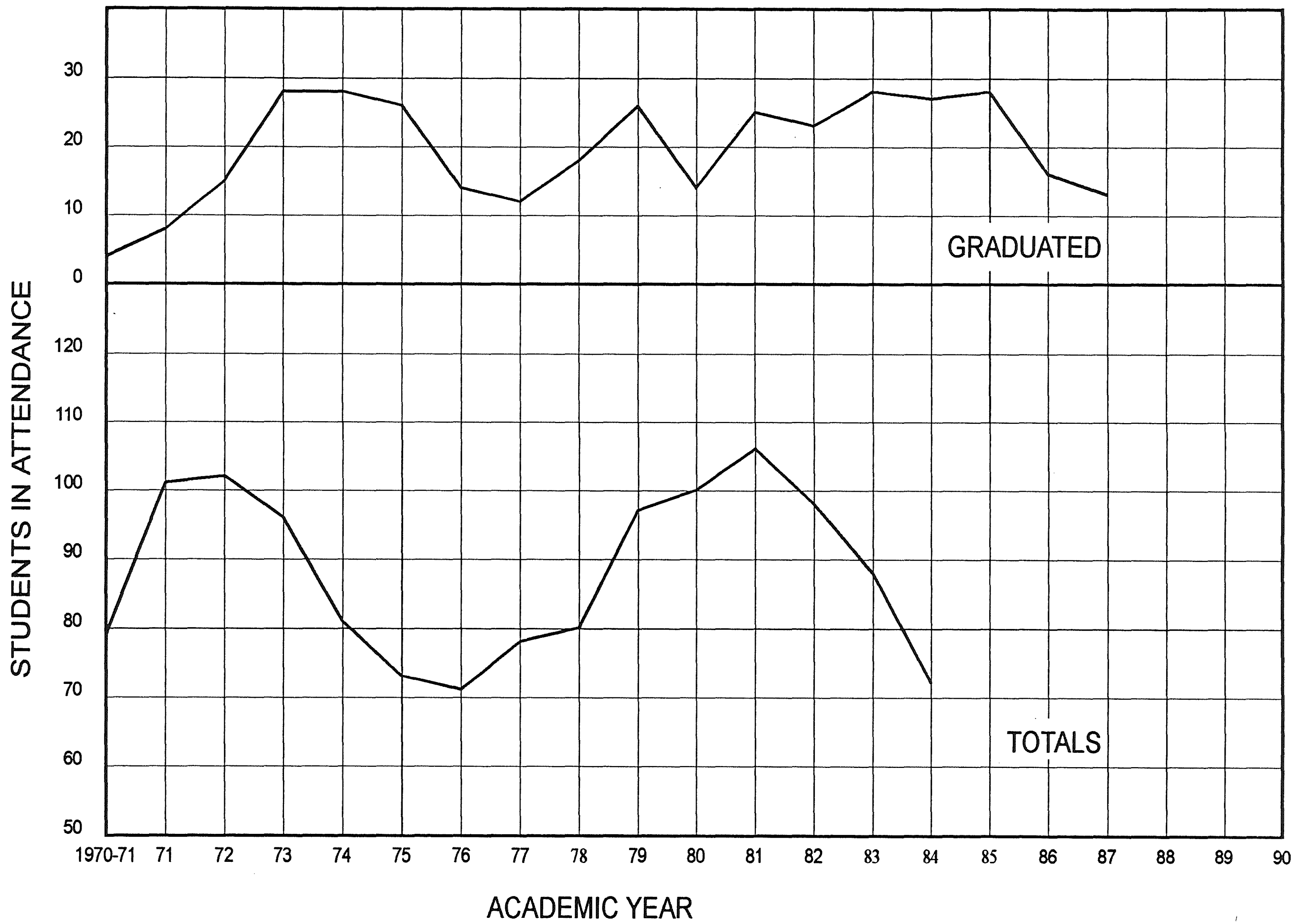


Figure 10 Students majoring in Geology, totals and graduates 1970-1987

to draw conclusions from the earlier years, when the departure of one student might reduce the enrollment by 20 percent, but it is probable that the increase from 1950 to 1956 reflects the nation-wide demand for geologists following the discovery of the Leduc oil field in Alberta in 1948. One may speculate about the cause of the drop in enrollment that began about 1981, and whether or not it was related to the economic recession that began about the same time, but it was a greater drop than usual and continued longer than usual.

Ryall tackled the problem of reduced enrollments by a campaign of publicity in the high schools and on campus, and by the introduction of additional classes, at an introductory level, designed as science electives for non-science students. This was, in effect, a recognition of the fact that Geology can be a very useful part of a liberal education, in Arts and Humanities as well as in Science, because it demonstrates the application of scientific methods and of the basic sciences to the world around us and to the everyday problems for which the country and its citizens must develop policies. In short, this was emphasizing an aspect of the departmental program that had not been stressed previously, even though it was known that many of our students did not make their careers in Geology. It was also contributing to the broad and basic training of potential leaders among our citizens, an objective the University had set out to achieve a hundred years ago.

This program had some success. The enrollment in introductory-level classes, which had been 65, and 1.5 per cent of the enrollment in Arts and Science in 1985, rose to 112, 2.6 per cent of enrollment in Arts and Science in 1988. In 1991, the enrollment in such classes was 350. This naturally had some spin-off as students exposed to the subject developed some interest therein, and the numbers in second year classes, i.e. the geology majors, increased from seven in 1988 to fifteen in 1991.

Class Offerings

Such students had available, in 1989-90 for example, a total of 5 full-year ("R") and 4 half-year ("A" or "B") classes beyond the first year level, a very considerable reduction from the 26 full-year and 8 half-year classes of 1975-76. The classes offered are shown in the following table:

		Lectures	Lab
2050B*	Geophysics	39 hrs.	26 hrs.
2100R*	Mineralogy & Geochemistry (incl. optical mineralogy and introd. petrology)	78	78
2110A*	Field Methods (+ 10 days Field School)	39	39
2200R*	Sedimentology and Biostratigraphy I (Sed'ology + introd. paleontology)	78	78
2410B	Environmental and Resource Geology (evening class)	39	0
3010A*	Igneous Petrology	39	39
3020B*	Metamorphic Petrology	39	39
3130B	Exploration Geophysics (for mineral exploration)	39	19
3140A*	Structural Geology	39	39
3300R*	Sedimentology and Biostratigraphy II (incl. micropaleontology)	78	78
4150R	Economic Geology	78	78
4200R*	Honours Thesis		
4270A*	Applied Geophysics (for petroleum and mineral exploration)	39	0
4280B	Marine Geophysics	39	0
4290A	Geodynamics (required for geophysicists)	39	0
4350A*	Tectonics (plate tectonics and study of a mountain belt)	39	0
4380A	Adv. Geochemistry (chemistry of ore formation and geochemical exploration)	39	39
4390B	Adv. Igneous Petrology	39 + project	
4400B	Adv. Metamorphic Petrology	39 + project	
4500R	Sedimentology and Biostratigraphy III (Sedimentary basins, etc.)	78	0

*Required class
Class numbers 2---, 3---, 4---, indicate classes normally taken in second, third, and fourth years respectively.

This program can be consolidated into subject groupings:

	In 3 years Lecture	Lab		In Honours Lecture	Lab
Mineralogy and Introd. Petrology	78	78			
Igneous and Metamorphic Petrology	78	78	+	78 + project	
Geophysics	78	45	+	78	0
Structure	39	39		0	0
Sedimentology and Paleo. and Stratigraphy	156	156	+	78	0
Field Methods (excl. Field School)	39	39		0	0
Economic Geology and related chemistry (4380A)				117	117
Tectonics and Geodynamics				78	0

The graduate program of the department underwent one of the periodical reviews in 1986 and the external reviewer, Dr. Norris of the University of Toronto, commended the "sensible decision to optimize - limited resources by streamlining the undergraduate year. [The preservation of] a high-quality professionally-oriented undergraduate program ... inevitably impacts on the graduate teaching and research activities of the department..." and was his reason for commenting thereon.

One may agree with the comment of Dr. Norris, but one may also wonder at the balance in the program and whether it is appropriate to the situation in which the practising geologist actually works. Where the students from the undergraduate program go primarily to exploration work, in mining or in the petroleum industry, geophysics and exploration geochemistry are certainly an important part of the student's training and will become more so as mineral and oil deposits become ever more difficult to find. The combination of tectonics and geodynamics appears to be a thoroughly modernized version of the "Special Topics" class of about 1940 (page 28), and certainly the practising geologist needs a good basic understanding of these topics if working in any field, but especially in the petroleum industry. The sedimentology-stratigraphy combination is a commendable integration of three sub-disciplines, and should develop in the student the desired understanding of their inter-relations, but one may wonder if, at 234 hours of lectures and 156 hours of laboratories, this has not grown a bit out of proportion to the other parts of the program. One may wonder, also, about mineralogy and petrology, the foundation of all practical geology, but for which the practising geologist has hand specimens only. For several decades, Dalhousie graduates have had a poor reputation as mineralogists. (A man who can sit on an outcrop containing 14 per cent lead without recognizing the galena in it, is not one to inspire confidence in his ability.) And without ability to identify minerals in hand specimen, the identification of rocks in the field becomes difficult or impossible. But in three years of training, of the 156 + hours of laboratories devoted to mineralogy and petrology, it seems only one term (39 hours) is spent on hand-specimen mineralogy and petrology. The petrographic microscope, to which many hours are devoted, is a classical tool of the petrologist, and the microprobe produces analyses quickly, but it is a fact that a geologist underground, or on a mountain top in the Yukon, may well be a thousand miles from either, and may see neither after graduation. Expertise with the microscope, or the ability to separate mid-ocean-ridge basalts from within-plate basalts by their chemical analyses is then irrelevant, although the ability to tell quartz from olivine may be crucial. By the same argument, the mine geologist who cannot recognize minerals cannot log drill core, and is in very serious trouble. One may ask then, whether preoccupation with the work of the professional petrologist has not reduced, or failed to develop, a skill essential to the future work of all our graduates, and whether some rearrangement of emphasis in the program would not have been desirable. It is worth noting, also, that after nearly twenty-five years of discussion, experiment, and change the curriculum has evolved to something very closely resembling that of about 1967.

The discussion above applies to the undergraduate program; the graduate program, in general, won the approval of the external examiner in the 1986 review already mentioned. Norris considered the department to be above average in its involvement in international research projects, such as International Geological Correlation programs, "circum-North Atlantic studies", and Andean metallogeny, in addition to the Cyprus and Ocean Drilling projects. He considered the department about average in size of NSERC operating grants held by its staff, but was impressed that "it must be one of the few departments across Canada in which 100% of the staff hold such grants", and he considered it "a quite remarkable achievement" that the total research funds captured by Geology were about 10 per cent of total research funds received by Dalhousie from outside agencies that year. He was impressed also by the degree of cooperation with the Department of

Oceanography and with the Bedford Institute, and also by the innovative use of federal government and industrial funding to increase the staff members. There were some recommendations that the department should consider limits on numbers of graduate students, should consider class requirements and class offerings for Ph.D. students, and should clarify responsibilities of staff for graduate teaching and supervision. The major criticism in the review concerned the lack of long-term planning in Arts and Science and in the Graduate Faculty, so that staffing of the department had become a matter of horse trading, with long range planning playing a lesser part.

The Chairman's second major problem was financial, but that was largely outside his control. Dr. Norris had been a member of the NSERC "site visit team" that had been at Dalhousie in January, 1982, when it was explained to the team that space consultants were about to advise on appropriate arrangements for accommodation for the department. It is not surprising that, in October, 1986, as the external reviewer, he found it "difficult to understand how after these planned changes, Geology ends up in the Life Science Complex in several wings and on several floors still in a highly dispersed state. There must be a better way to allocate space ...." This external examiner then quoted the opinion of two other external appraisers, Neale and Armstrong from the Geological Survey of Canada, in 1979: "Dalhousie's space is barely adequate in terms of faculty and enrollment but less than adequate when we consider that they are split between two widely separate quarters .... We recommend that administrators at Dalhousie take cognizance of the burgeoning state of geology and geophysics in this country and the importance it has assumed on their own campus in terms of student enrollment and research activity. They should contrast this with the inadequate facilities they provide and should take immediate steps to remedy this long ignored anomaly." The chairman and the department had to cope with this situation and its peculiar resolution. There had been some consideration of the possibility of adding another floor to the Psychology wing of the Life Sciences building, as a solution to the space problems of the Geology department. The discussion had been almost exclusively within the department itself, had been sparked mainly by proposed expansions of the Centre for Marine Geology, and apparently was based on a refusal to recognize, or to believe, that there was no money for such new construction. There was, in fact, little or no money even for re-arrangement within the space already occupied. During this period, the major construction within the department was the high-pressure laboratory for Salisbury, which was built in the basement of the common area of the Life Sciences building, where the thick walls offered containment in case of an accident, but the major part of that cost was borne by NSERC.

The financial pressure on even the day to day operations of the department continued to be a major problem, and the policy of supplementing budget funds by "recoveries" was continued.

14

REORGANIZATION OF FACULTY OF ARTS AND SCIENCE

The arrangement that had served since 1906 was broken up in 1988. During those eighty years, the Faculty had grown beyond all recognition; many departments had been added, and staff and student numbers had increased many-fold.

This sheer size had, in itself, caused some difficulties. A Dean was unable to be well informed about the careers and interests of all the members of the Faculty and about the wide range of subjects and disciplines they pursued. Although there were exceptions, it had happened that for many years the deans had been chosen alternately from a science department and from the humanities, and this probably gave some balance. In practice, of course, the Dean must be as even-handed as possible but, in practice also, the Dean will have a clearer understanding of the problems of departments with which he has familiarity than with those of others where the approach and the discipline are different. This could lead, on the one hand, for example, to relatively unimportant irritation because the Dean relied too heavily upon essentially meaningless statistics that he did not understand, and, on the other hand and much more seriously, to the belief that such lack of familiarity adversely influenced decisions about staffing, and about departmental directions and development.

About twenty-five years before, when the head of a department had some executive power, a Faculty Council had been set up to screen matters brought to the Faculty and to prevent control of Faculty business by any group of long-serving department heads. With the change to "elected" departmental chairmen each serving only three years, however, the situation had changed. Many committees had been set up over the years, and such committees tend to be long-lasting. Some, such as those dealing with scholarships, tenure, and libraries, had carefully defined and clearly understood objectives and responsibilities, and were effective; some were without any authority and had only vague reasons for existence. An intermediate group, such as the curriculum committee, had advisory responsibilities but their advice was channelled through Faculty Council, where it was debated, before presentation to the Faculty. Although, in theory, the Faculty, meeting as a whole, is the decision-making body, its members realized they could not be as familiar with a topic as were the groups that had discussed it at length and passed it on, and they came to see themselves as merely acting to rubber-stamp the decisions of others, and thus as powerless individuals remote from the actual operation of the Faculty. This did not generate either active participation or high morale. Furthermore, when matters of real concern were apprehended, such as reductions resulting from increased financial pressure, the system of committees and Council permitted endless debate before presentation to the Faculty, and unpleasant decisions could be, and were, filibustered for years. Even without deliberate delay, the procedure commonly consumed many months before a Dean had authorization to execute a policy so decided.

These two matters, lack of appreciation of academic ambitions, and administrative inefficiencies, were the main reasons for the suggestion that the Faculty should be divided. There was probably also some belief that the science departments benefited at the expense of the arts departments, which were, of course, seen by the science departments as benefiting at their expense. This could arise easily in a time of fiscal pressure when a department was required to operate on a constant, or even reduced, budget while another department got a substantial increase; this was especially easy if the "losing" department was not aware of, for example, substantial enrollment increase in the other.

A special committee to study the structure of the Faculty was set up by the President in the autumn of 1986. It consisted of the vice-president (Academic and Research), two members from the arts "side" of the Faculty, two from the science "side", two from other faculties (Business Administration and Medicine), and the Academic Vice-President of the Student Union. It consulted widely within the Faculty and with senior administration at Dalhousie and at a dozen other Canadian universities. It reported in May, 1987, with recommendations for the division of the Faculty. The new faculties were in operation in the autumn of 1988. Not only were the recommendations of the committee acted upon, it was probably the fastest development of a major policy change within the Faculty in some years.

The committee foresaw two main problems with a divided faculty; lack of coherence and increased cost due to duplication of staff. It made proposals to deal with those problems.

Loss of coherence is potentially a serious matter. To fulfill the requirements for a degree, students must take classes from specified groups or categories, some of which would be offered in the Science faculty and some in Arts. Separate faculties could easily develop in individual directions, with gradual loss of coherence and so with gradual loss of quality of academic programs and curricula. Presumably the extreme case would not be permitted to arise: where a student would be required by one faculty to take classes discontinued by the other. The committee considered the objectives and content of programs to be matters of policy, matters which should be carefully defined, matters which they described as "legislative" issues.

To meet this first risk of incoherence, the committee therefore proposed a "College of Arts and Science", which would be responsible for setting policy on degree programs and curricula, and for award of degrees. It was proposed that it should also be responsible for developing innovative interdisciplinary classes and programs. This would be the "legislative" body, and the separate faculties would be responsible for executing the policies so decided. Criteria and practices for promotion and tenure would be "College" responsibilities, as would matters of admissions and scholarships.

The second problem, increased cost due to duplication, the committee could not avoid but it sought to reduce the impact. Financial matters would require an administrator for each faculty, but it appeared that the administrator of the existing Faculty would soon require an assistant in any case. By housing the two deans and their staffs in the existing suite of offices, increased space requirements were avoided, though some renovation costs would occur. Some proposals for associate deans were modified when the division occurred. In the end, each faculty has a Dean, an Associate Dean, and an Assistant Dean. The latter deal exclusively with the problems of individual students and are part-time appointments, so their cost is very modest. There was also some duplication of faculty committees.

In the new Faculty of Science, the place of the Faculty Council was taken by a committee consisting of the Dean and the chairperson of each department. Initial experience with this arrangement indicates that a group with related experience and interests works more effectively and efficiently than did the former group with its wider range of interests and objectives.

We might remind ourselves, as well, that the recommendation for "innovative interdisciplinary programs", while currently fashionable, ignores the fact that the degree programs for the past 75 years have required an interdisciplinary content. During that time there has been a continuous increase in the variety of disciplines offered and so in the variety that a student can choose to incorporate into a program. In short, we need to remember that interdisciplinary training occurs in the head of the student, not in the course layout. One might cite as an example from this department the student who took the classes required for a degree in Geology, published papers in physical and organic chemistry, and, at last report, was retired from his position as research biochemist for a hospital in California.

15

ROYAL COMMISSION ON POST-SECONDARY EDUCATION

In 1983, the provincial government set up a royal commission to determine: present and probable future needs for post-secondary education in Nova Scotia; the impact of federal fiscal arrangements; the current organization and financial position of educational institutions; and possible opportunities for improvement, including rationalizing the administration of the universities by cooperation among them. The commission was titled the Royal Commission on Post-Secondary Education, and it reported in December 1985.

In their report the commissioners were critical of the lack of a minimum program for those in the high schools who planned to continue to the universities. Although the necessary courses are provided in the schools, they are not required of a student. Because neither sciences or mathematics are required, the high school student must rely upon guidance counselling (of which the commissioners were also critical) to ensure that he or she is not automatically barred from a large number of university programs by lack of the prerequisite knowledge. The commissioners were also critical of the ability of the high school graduates to express their ideas clearly, either verbally or in writing. In this matter of clarity of thought and of expression, they were not impressed by the graduates from the universities either!

The commissioners were equally critical of the universities for their acceptance of such students and for their acquiescence in such a state of affairs. Because they were also proposing a rather specific core program for the universities, the commissioners recommended that the universities, acting collectively, should "set tests of ability for all prospective students". In a sense, this would be a reincarnation of the Common Entrance Examining Board of the 1920's, but they specified only that there should be a test of "use of English (or French) to evaluate reading, writing, and reasoning, and another in Mathematics to test understanding of mathematical reasoning and ability to perform mathematical operation's at the appropriate level."

The primary objective of the university student, in the view of the Commissioners, should be the attainment of a liberal education, which they considered to be a "grasp of the relationships between the principal fields of human knowledge". To this end, they recommended that in the first two years of study there should be a core curriculum designed to introduce the student to those relationships and to develop the skill in analysis and logical reasoning upon which a life-time of further development could be built. They further suggested that completion of such a curriculum should be a prerequisite for award of a baccalaureate degree. In effect, they recommended a reinstatement of some aspects of program requirements of the 1930's.

The core curriculum would help to avoid the consequences of the absence of counselling for students in some university programs and of the quality of counselling in some others. The Commissioners were critical of two aspects of the existing arrangements: within the distribution requirements for classes students are free to "pick and choose with little guidance" so that "... students may graduate after having studied a very disparate set of subjects" with little or no coherent relationship between them; on the other hand, honours students "may have over-specialized ... in one discipline". (See also page 41). As one who advised undergraduate students for over 25 years, I have some sympathy with this complaint of the commissioners. As a practical matter, in an honours program in Geology a student generally had space for only one non-specialist class in each of three years, and as a further practical matter students were commonly reluctant to choose classes in fields such as history, philosophy, political science or economics.

The Commissioners also directed attention to the quality of teaching in the universities and to the importance the universities actually attach thereto. In the process, they defined "research" as of three types: *scholarship*, an extensive and profound knowledge of a subject, *basic* research = discovery, and *development*, which "assesses the implications and practical applications of known theories". They would assign most university research to the third type, but considered that "Scholarship" determines the content of all but the most specialized courses and is therefore most closely related to the essential teaching function of the professors. From this, they concluded that universities should not continue to emphasize "basic" research and "development" at the expense of teaching and "scholarship".

But apart from such matters, the members of the commission concluded that underlying *all* problems is "the lack of a commonly acknowledged sense of purpose among the faculty, students and administrators of our universities" and, instead, there is a stress upon the operational aspects of a university as opposed to its educational goals. They ascribed this to a lack of established priorities, without which "there can be no campus-wide sense of belonging to a corporate entity directed toward the accomplishment of specific academic tasks". This lack, in turn, was blamed upon the cumbersome governing structure of the universities (a structure designed to operate by consensus and compromise), and upon the proliferation of departments and specializations in recent years. The rigidity of the first delayed or prevented revision of priorities and reallocation of resources; the second forced administrations to adopt a managerial role. As a result, faculty members were not only divorced from administration but had no way of assessing the academic importance of what was going on in other departments or faculties. Because there were no agreed objectives, and no scale of importance by which to judge, all programs were equal and "any diversion of funds from a specific program then became an example of administrative tyranny and disregard for faculty interests". This is a fair description of the situation that caused difficulties for Piper and was the major problem for Zentilli as chairman of this department.

The commissioners expected that, in order to make the best possible use of the limited funds available, the universities would have to evolve a system capable of setting academic priorities and, thus, of restoring a sense of purpose to each institution. Because they also recommended that all the universities of Nova Scotia should be considered as a single provincial system, they also expected that each university, in establishing its own priorities, would first establish its most suitable role and position within that system. That, in turn, required some kind of mechanism to provide oversight, prevent useless competition, and ensure that the limited financial resources were used in some approximation of the most effective fashion.

They considered three possibilities for such a mechanism and recommended the formation of a Council of Higher Education. The provincial government accepted that recommendation, even though it would set up yet another bureaucratic layer and emasculate the Maritime Provinces Higher Education Commission insofar as its role in Nova Scotia is concerned. Events since then have shown that the commissioners were wise to reject the idea of voluntary cooperation between the universities. They rejected their third possibility, a resurrection of the University of Nova Scotia, because, among other things, they had serious doubts that it would operate effectively under MPHEC, and because they feared the development of intellectual uniformity and of a large bureaucracy preoccupied with governance.

Of course the commission examined the financial resources of the universities and the various sources of funding available to them. Out of this came a number of recommendations on administrative matters, e.g. that the annual grants from the province should be announced before the beginning of the year instead of several months thereafter. There were also recommendations for changes to the system of loans to students.

The recommendation that tuition fees should be increased to 50 per cent of "instructional costs" was perhaps not expected. The commissioners argued that, if society is to function at all, all citizens must be literate, numerate, and knowledgable enough to function in society. Free schooling is therefore a social necessity. Because their average lifetime income is substantially increased thereby, university graduates receive at least commensurate remuneration for their educational costs and should not expect to be subsidized by those who do not attend.

The major recommendations, however, dealt with the proposed Council and its powers:

1. In the matter of long range planning there should be a specific role and mission statement from each university, derived from the overall long range plan of the Council. Dalhousie, and presumably the other institutions, has devoted many months to the formulation of a role and mission statement. There does not appear to have been any long range plan produced by the Council, so it is not clear whether the role so described is intended to fit into a plan, or whether it is a statement of what Dalhousie thought its role should be. Is the plan being generated from below upward? or is this statement designed to pre-empt any decision by the Council? One may wonder also if such a statement, generated, in effect, by a Committee of the whole university, in the effort to cover every matter will in the end be effective in none.
2. The Council should have control over funding available from the province to the institutions, and should establish uniformity of hiring procedures, pension schemes, etc. to provide for some mobility of staff within the system.
3. The Council should conduct periodic program reviews in each discipline within the system, and would have authority to set up or cancel programs on grounds of demonstrated need, academic performances, or cost-effectiveness relative to other programs. This authority over

> programs carries with it the corollary of control over specialization at specific universities, over duplication of programs, over a common core curriculum and exchange of credits, and over common entrance standards, in addition to a number of related accounting and reporting procedures.

Application of this authority has become known as "rationalization" and is the aspect that has received the most attention from the public. Uniform reporting of statistics and similar matters is not likely to cause conflict. Common entrance standards, and even a common entrance examination is likely to raise opposition in the Department of Education, on behalf of the high schools. But a common core curriculum will not get quick agreement, and concentration, other than in the existing specialties in medicine, law, and dentistry, will almost certainly produce strong opposition from all the institutions concerned. Several times in their report, the commissioners criticized the duplication and expense created by the universities each offering large numbers of very small classes in a single discipline. Although geology was not one of the examples used in their report, it is one of the disciplines that has had public exposure as a candidate for rationalization. It remains to be seen if the universities can be brought to cooperate to produce an efficient and effective program in geology.

16

SOME COMMENTS

At this point it is perhaps appropriate to summarize some of the events and changes of the past 125 years, and to look at what may be deduced therefrom.

Financing the University has always been a problem and money has almost always been in short supply. The College was established with public money and public money has always been a part of its support. Were it not for private benefactors, such as Munro, however, it would have died long ago, and without the endowments provided by others, such as Kellogg, Bennet, Dunn, and Carnegie, it would have been unable to do what has been accomplished. In addition to such major benefactors, very large numbers of more modest contributors have aided the work, by establishing the short-lived School of Mines, for example, as well as many small projects. In the last thirty years, however, and despite the generosity of such as Killam, the financing of the University has relied more and more upon the taxpayer.

The University has always shown some sensitivity to its constituency. In the last century it produced the lawyers, clergy, and pedagogues needed by the new nation; it absorbed the Halifax Medical School and developed it; it operated extension services in the industrial towns in the early part of this century and developed a different aspect of the same service with the Institute of Public Affairs in the 1930's; more recently, and closer to this department, the Institute of Oceanography and our Centre for Marine Geology are examples of many other specialist bodies.

But when government support began to increase rapidly in the 1960's, there were some who muttered about birthrights and pottage. In the event, however, the Maritime Provinces Higher Education Commission has served as a buffer between government and the universities, as it was intended to do. In Nova Scotia, governmental assistance was commonly less than that recommended by MPHEC, especially in the 1980's; but governmental control or interference in operations has been avoided.

It remains to be seen if this will continue.

Even with the substantial assistance of the taxpayers, expenditures by the University grew beyond its revenues. Whether all the expansion and expenditure was justified will probably be argued for some time, but by 1983 and 1984, the annual interest on the accumulated operating debt would have paid the total annual operating cost of a department the size of Geology. The measures necessary to bring the debt under control meant many economies and restrictions, some of which involved permanent loss, as when our chemistry and neutron activation analysis laboratories were closed.

For about thirty years the operating costs of the Geology department were met from the income from the Carnegie gift of 1932. Such research work as was done was financed by external contracts, mainly governmental. After about 1960, funds were provided for an enlarged teaching program, but funding for research was from external sources, and it continues to be so. When the money available increased at a rate less than the rate of inflation, difficulties resulted in both teaching and research programs. The expanded teaching program was generally maintained, despite wide fluctuations in undergraduate enrolment, but research suffered, especially that requiring expensive equipment and/or extended field expenditures.

After forty years or more of over-expenditures by government at all levels, and the near, or actual, bankruptcy of the country, it is hardly realistic to expect that universities will be rescued by the taxpayers. The universities will have to save themselves. In the case of Dalhousie this will probably mean the removal or reduction of some departments or programs. The need for such was fairly clear by 1982, but the necessary decisions were successfully filibustered.

It seems obvious that the cost of operating a university, or a department therein, is related to its size, and that a large university requires more money than a small one. Equally obviously this is why government assistance to a university is directly related to its enrolment.

Financial resources that are enrolment driven invite increased enrolments in the university, once the necessary staff and infrastructure are in place, and they also have repercussions even at the departmental level. In Geology, at least, except in a department full of incompetents, enrolments fluctuate in response to external causes, even though one might wish to believe otherwise. A large *increase* in enrolment in a department may add to the financial support of the university, but it creates a problem for the department because increased staff and equipment cannot be supplied quickly, and there may be a lag of several years before the staff and facilities are in place. When there is a large *decrease* in enrolment, the loss in support can be met only by small economies, because staff and equipment cannot be added and removed like an overcoat. Accordingly, the administrative staff of the university look upon an increased enrolment as increased revenue, but upon the necessary increased staff and equipment as a cost to be postponed or avoided; there is the attendant effect on class loads and teaching. When the cyclical reduction in enrolment occurs, it is considered as lost revenue, student:staff ratios are questioned, and departmental chairmen begin to be concerned about enrolments. There is also another factor; an instructor tends to look upon increased enrolment in a class as an endorsement by the student body of his or her performance and of the quality and content of the class. There are therefore two forms of subtle pressure to increase enrolment by increasing the number of classes and their size.

Although we deny that we admit incompetents, obviously some have slipped in, for the university has found it necessary to provide remedial classes in English and some other fields. To correct this there has been a gradual increase in the minimum grades acceptable for entrance; in turn, this has produced an inflation in the grades assigned by the high schools.

If not to be an invitation to mediocrity, enrolment-driven finances must be accompanied by some universal and objective criterion of the competence of the entering student.

Financial assistance based upon enrolments must also take account of differences in the costs of programs. Although student fees in medicine and dentistry are commonly about 25 per cent higher than in Arts and Science, those fees pay a much smaller part of the actual cost. In 1963-64, for example, student's fees paid 40.5 per cent of the costs in Arts and Science, but only 14.5 per cent in Medicine and 13.5 per cent in Dentistry.

Increased enrolments without staff increase also produce serious problems. Even when there is no increase in the classes offered, only very modest increase in student numbers can be accommodated without causing troubles. An increase from two to four students in a class causes no problem. Ten-fold increases, however, so increase the sheer labour as to make instruction a full-time occupation, and the expertise of the instructor begins to suffer through loss of knowledge of what is happening in his or her field. Although Douglas was an inspiring teacher, had various schemes of self-instruction for his students, and relatively small classes, he recognized by 1948 that the load had become more than he could handle. It took four years to get even part-time assistance for him. Thereafter, the initial additions to the staff filled obvious gaps and expanded the program offerings, but without much reducing the load on those who taught the original classes. Until 1973 there were individuals teaching at least four full-year classes, and commonly more, with steadily decreasing quality therein. It is to be hoped that Dalhousie will never again repeat such a situation. This should be considered very carefully during the rationalization by combination that is implicit in the 1985 report of the Royal Commission on Post-Secondary Education.

Undergraduate Education. Most people will pay lip service, at least, to the concept that a university graduate should be a person with general interests and broad understanding, who is capable of both clear expression and clear analytical thought, who has some degree of specialist knowledge, and who has the knowledge and ability to make the informed decisions and judgements, in areas outside that specialty, that are required of the mature and responsible citizen. In other words, the product of a liberal education, in the original sense of that term; in the colloquial expression of a hundred years ago, a "well-read person".

Undergraduate teaching has changed direction and emphasis as the University and the Geology department have developed. In the last hundred years the geology offerings have changed from a mere adjunct to Lawson's chemistry classes to as many as fifty students in each year of an essentially professional program.

Honeyman introduced a proper program in Geology for a very few students for a short time, but the College was training leaders for the colony and his work was really an adjunct to a liberal arts program. Under Woodman the beginning of the modern situation is recognizable and, although the liberal arts program was the emphasis within the College offerings, it is probable that his graduates could perform adequately as professionals in the field. McIntosh continued this. Both had captive audiences of engineers, including those in mining, but apparently very few, if any, professional geologists came out of their program. This may be more apparent than real, and may reflect a lack of definition between the work of the geologist and mining engineer. For example, as late as 1941 C. O. Campbell was both the geologist and the engineer responsible for opening the barite mine at Walton.

By the time of Douglas this was changing and he deliberately introduced a program designed to produce geologists to work in exploration and mining. A large proportion of his students who majored in geology did practise as professionals, though even some majors had careers in a variety of non-related fields. This is perhaps not so surprising, for both Douglas's instruction and the program requirements of the Faculty emphasized the importance to the individual of a wide range of background knowledge, and transfer into a related, or even non-related, field would be seen as nothing extraordinary.

With Friedlaender came increased numbers of students and staff as well as improved facilities, and the modern program had begun. For the first time, it was possible to enlarge the class offerings and to depart from specialization in geology as it is related directly to mining. Keen directed the program toward marine aspects and continued to enlarge it to fill gaps generated by that emphasis. He also continued a change in the character of the department to give increased emphasis to the research work of the staff. Subsequent chairmen maintained that direction and there were extensive and expensive research programs mounted in cooperation with the Bedford Institute, and by the Centre for Marine Geology and its antecedents. The department has continued to give emphasis to such research, but at a rate reduced by financial constraints.

Even when the overall program is aimed at professional training, the introductory-level classes have a proportion of "non-professionals", just as in the early days. After 1960 there was special provision of an introductory class for such students and, after 1970, there was deliberate expansion into several evening classes for the non-specialists. Most of the evening classes were cancelled as an economy measure in 1982, however. The number of students majoring in geology fluctuates from external causes and, in recent years, increased offerings of introductory classes, as the department's contribution toward a liberal education, have become an important part of the departmental effort.

The *Graduate Program* achieved respectable numbers after about 1960. An elaborate system of supervisory and evaluating committees was set up after 1970 and this produced improved standards for theses. Prior to 1965, thesis problems were field problems, with very few exceptions. In the early days of marine work this field emphasis continued and there were extensive geophysical and sedimentological surveys at sea. Gradually this changed. Although most research had as its basis a field problem, the character of the work changed and the field work was often little more than the collection of specimens to be given laboratory treatment. This, of course, is part of the development of geology away from its past as a descriptive science and toward a quantitative approach to geological questions. Increased staff, with a variety of interests and specialist skills, has led to research in a wide variety of problems, sub-disciplines and locations, including several international programs.

During Keen's chairmanship, the research program of the department had a theme that related the work of most individuals to one another, despite the apparent variety of their interests and efforts. Many have continued to pursue those interests but other directions have been added, so it is now not clear that there is a common integrating theme. Of course, it is characteristic of research that one cannot predict what will come out of it; after all, the whole field of radio astronomy came out of a malfunctioning experiment at the Bell Telephone laboratories. Yet the experience of such as the Geophysical Laboratory has shown that a common theme or integrating question can produce important results by providing relevant directions for research, and probably produces such results much more effectively than would the accumulation of the products of the random efforts of many investigators. Without equating ourselves with the Cavendish and Geophysical laboratories, it might be useful to consider some question as an integrating and directing theme for the research work of the department.

At Dalhousie such an integrating theme might well expand on that begun by Keen, who was taking advantage of our coastal position and the oceanographic facilities available. Since then a number of institutes, schools and programs have been set up at Dalhousie, T.U.N.S., and elsewhere in the Halifax area but most seem to be going each its own way. It would appear that there is a need, and an opportunity, for coordination of all these into a sensible, useful, and effective program concentrating upon the ocean in its many aspects. It might range from something as long term as the biology, geology, chemistry, etc. of the carbon budget, to something as short term as the physics, physiology, and design of a practical survival suit for fishermen.

Balance within the instructional program is a major problem, as is shown by the number of times the program offerings have been reviewed and amended in the last thirty years. In a department that is providing part of a liberal arts program, part of a basic science program and, at the same time, training those who will make geology their profession, it is obviously necessary to maintain a careful balance between all three. There is the parallel question of the balance between the instructional and research programs and the effort to be devoted to each. Obviously the department has devoted much time toward deciding what that balance should be. Apparently, also, the numerous changes over the years have reflected changing objectives as seen by the departmental staff at different times. No doubt additions to, or departures from, the staff will continue to produce such changes in the future.

In making such changes, it is necessary to consider whether providing many little bits of instruction provides education, i.e. whether an aggregate of herrings is equivalent to a whale. In the early 1970's, the department offered a large number of classes; in most cases, each dealt with a rather limited and specialized aspect of geology. Because there is a practical limit to the number of classes a student can attend, the large number offered tended to compartmentalize the training a student could get. If the objective is specialization, this outcome is desirable. If the objective is broad training, so the graduate can build upon it to accommodate the changes a lifetime will encounter, then this outcome is not satisfactory. It is not satisfactory because it does not give understanding of the inter-relations within the discipline, and with other fields. It follows, then, that the desirable approach is to avoid numerous narrowly specialized classes and provide instead a lesser number, each developing a broad theme, from which can be drawn lessons of general application. As a geological topic, the development of the Caledonides or the Himalayas and the causes thereof, for example, necessarily drags in data and questions from almost all sub-disciplines within geology. If taught with adequate opportunities for analysis and discussion, the result for the student is not detailed knowledge of one or more of those sub-disciplines, but an understanding of relevance, content, and limits. If there is a good foundation, the detailed knowledge, if later required, can be quickly built upon it - which is the proper objective of education. Suggestions for classes of this type were made on a couple of occasions (pp. 66 and 76) but were not developed. Some recognition of this situation by the department is implicit in the reduction in the class offerings since the early 1970's. It also reduces the teaching load.

It is also necessary that there be a careful consideration of the methods of instruction to ensure development of understanding and of analytical reasoning rather than mere absorption of current dogma. I find it difficult to discuss this without showing my prejudices, but I think we have gradually evolved a situation that has potential, if not actual, hazard. Because of the limited time available and the size of some classes, instruction is by lectures - a technique developed in the Middle Ages when only the instructor had access to books. Some of the lectures in this department are truly excellent examples of presentation of data, and of reasoning from those data to a conclusion. But it is the lecturer who does the reasoning and there is essentially no discussion. Thus the student gets no practice at evaluation of the data, consideration of alternative explanations thereof, and of other deductions therefrom. In short, the student absorbs what is presented, but does not learn to reason, and is therefore missing the most important part of education. We have arrived at this situation because a large amount of material must be presented; much of that is of an elementary nature, which either crowds out more advanced material or crowds out the discussion and reasoning that are an essential part of learning. Of the two, it is usually the latter that is expelled. It is possible to prevent this loss by insisting that the student get the elementary material from classes where it is already being taught. It would then not be necessary to consume valuable class time in Geology to introduce general or elementary concepts and skills that could have been learned already in, for example, Physics and Chemistry classes. Some examples were given on page 28.

There is another matter of some consequence. In science classes generally, instruction ignores the development of the ideas being presented. The legend notwithstanding, Newton did not discover the law of gravitation by being beaned by an apple; he was trying to explain Kepler's laws, and Kepler was trying to explain the observations of Tycho Brahe. But the law is presented to students as a bald statement describing gravity. It is not surprising that most students are not even aware that we do not know how gravity works. Introductory text books in geology now introduce plate tectonics in chapter one as an article of faith. Rarely is there even mention of the hundred years of observation, theorizing, and debate that led to the idea of plate tectonics. Students could be forgiven for thinking that the law of gravitation sprang full-grown from the head of Newton, like Pallas Athene from the head of Zeus, or that Hess and Wilson, if their names are even mentioned, had a revelation akin to that of St. John the Divine.

There is a serious consequence. Those who go on to do serious research quickly learn about the errors, uncertainties, and false starts in the explanation of data, and the development of conclusions therefrom. In general, our graduates and the population at large do not. It is then hardly surprising that people come to believe that "scientific" ideas are correct, but have no genesis; nor is it surprising that judges, managers, politicians, and others responsible for decisions on matters of fact, policy, or planning are bewildered by "scientists" who have alternative or opposing explanations of "scientific facts". Small wonder that policy decisions take forever - and at high cost. It is a problem easily solved.

Appendix I

Enrollments 1930-1990

	Arts and Science	University Total
1929-30	648	
1930-31	648	
1931-32	751	1015
1932-33	683	939
1933-34	632	926
1934-35	557	846
1935-36	538	855
1936-37	520	853
1937-38	485	818
1938-39	540	883
1939-40	542	
1940-41	478	
1941-42	405	
1942-43	452	
1943-44	436	
1944-45	479	
1945-46	849 + Jan.-July 1946: 123	
1946-47	1266	
1947-48	1374	
1948-49	1260	
1949-50	1077	
1950-51	976	
1951-52	891	
1952-53	878	
1953-54	863	1407
1954-55	907	1441
1955-56	930	1465
1956-57	978	1541
1957-58	1059	1608
1958-59	1127	1696
1959-60	1264	1820
1960-61	1498	2058
1961-62	1582	2259

Appendix I (Continued)

	Arts and Science			University Total					
	Full Time	Part Time	Total	Full Time		Part Time		Total	
1962-63	1372	104	1476	1974		176		2150	
1963-64	1540	53	1593	2273		125		2398	
1964-65	1774	121	1892	2632		134		2766	
1965-66	1885	134	2019	2817		168		2985	
1966-67	1770	154	1924	2777		185		2962	
1967-68	1768	170	1938	2875		189		3064	
1968-69	2049	209	2258	3285		224		3509	
1969-70	2497	276	2773	3921		301		4222	
1970-71	2984	452	3436	4574		512		5086	
1971-72	3330	542	3872	5148		518		5776	
1972-73	3299	628	3927	5169	*6149*	749	*1052*	5918	*7201*
1973-74	3423	847	4270	5421	*6375*	931	*1170*	6352	*7545*
1974-75	4052	916	4968	6784		1394		8178	
1975-76	3522	813	4335	7079		1267		8346	
1976-77	3488	839	4327	7196		1368		8564	
1977-78	3347	776	4123	7215		1388		8603	
1978-79	3207	732	3939	7013		1572		8585	
1979-80	3061	662	3723	6963		1515		8478	
1980-81	3047	689	3736	7072		1560		8632	
1981-82	3179	778	3957	7238		1700		8938	
1982-83	3347	749	4096	7584		1677		9261	
1983-84	3475	663	4138	7813		1624		9437	
1984-85	3641	650	4291	8051		1661		9712	
1985-86	3664	714	4378	8154		1839		9993	
1986-87	3613	677	4290	8005		1780		9785	
1987-88	3717	638	4355	8236		1759		9995	
1988-89	3730	650	4380	8283		1697		9980	
1989-90	4034	674	4708	8614		1707		10321	
1990-91	4128	716	4844	8755		1640		10395	

Note: These figures are drawn from Statistics Canada, the Registrar's office, Presidential reports, and some other sources for a few of the data. Figures from Presidential reports do not always agree with the others, and may include King's and/or other figures. Statistics Canada and the Registrar do not always agree either. Those shown in italics for 1972 and 1973 are from Statistics Canada, and indicate the size of the disagreement in some cases.

One would suppose enrollment would be a simple statistic to compile. In fact, the figure depends on the source. The following compares the above figures with those from the annual reports of the Business Office:

1961-62	2259 (above)	2581 (Business Office)
1962-63	2150	2883
1963-64	2398	3415
1964-65	2776	3713
1982-83	9261	9945
1983-84	9437	10241
1984-85	9712	10530

Appendix II - Class Enrollments

		1932	33	34	35	36	37	38	39	40	41	42	43	44	45	46	47	48	49	50	51	52	53	54	55	56	57	58	59	60	61	62	63	64	65
1	Introductory Geology	54	31	29	31	24	29	15	20	17	13	14	15	32	29	52	99	86	69	40	54	43	40	48	51	55	59	71	96	120	148	138	118	94	93
2	Mineralogy	3	7	3	3		6	6	3					1	4	6	7	8	6	4	3	6	7	5	22	40	4	10	7	9	10	6	9	6	5
3	Petrology	5	5	4	3		2	3				1			1	2	4	3	2	4	2	2	3	3	3	6	4	1	3	3	2	4	5	6	6
4	Economic Geology	4	2	5	6	3	3	5	4					1	6	3	6	7	7	3	2		4	2	4	5	2	5	3	6	2		6		4
5	Field Geology	1	1	3	2	1	2	1	4				1		2		2	2	4	3	2	1	2	2	1	2	3	3	2			1			
6	Advan. Economic Geol.	?	1	1	3			1	4							4		1	4		2	2		3	1	3	2	2	1	2	1	3	1		1
7	Special Problems			1	4			1	2	2					1	2	2		3		2				2	2	2	2	1						7
8	Experimental Geology			2	1	2	1		2	2			1		1	3	3		2											5		5			
9	Geochemistry																											5	1					2	
10	Volcanoes & Volcanic Products																					2	1	1	3	3			3	2				3	
11	Metallurgy - Exam. Min. Props.																							1	1	1	1	3	1	3	3	2		1	1
12	Earth Physics																												1		4	6	18	17	13
13	Sedimentology																														2				
14	Crystal Chemistry																																1		2
15	Advanced Petrology																																1		
16	Paleontology																														9	2		5	
17	Stratigraphy																														6	3	1	5	
18	Introd. Marine Geology																															1	1	4	1
19	Pleistocene Geology																																4	4	
124	Micropaleontology																																		1
	Total Arts & Science	684	602	525	538	520	485	540	542	478	405	452	436	479	849	1266	1275	1260	1077	976	891	878	863	907	930	978	1059	1127	1264	1498	1582	1476	1593	1892	2019
	Geol. I as % A & S	7.9	5.1	5.5	5.8	4.6	6.0	2.8	3.7	3.5	3.2	3.1	3.4	6.7	3.4	4.1	7.6	6.8	6.8	4.1	6.1	4.9	5.2	5.3	5.5	5.6	5.6	6.3	7.6	8.0	9.3	9.3	7.4	5.0	4.6

Appendix II (Continued)

		1966	67	68	69	70	71	72	73	74	75	76	77	78	79	80	81	82	83	84	85	86	87	88
100	Introduction to Geology	69	58	21	69	101	113	83	58	89	91	44	59	42	72	70	91	89	77	64	45	33	34	42
101	Introduction to Geology		21	39	114	101	108	82	59	72	67	40	27	24										
102	Introduction to Geography(69-70) Intro. Geology (77-81)				46	33	19						22	19	28	26	21							
103	Intro. to Geology -for Engineer											21	61	38	48	22	41	25						
104	Earth & Man I (After 1986: Earth and Society)																	30	30	38	24	36	31	33
105	Earth & Man II																	19	19	26	21	18	16	18
1066																								25
1200	Cosmos, Earth and Life																							12
140	Intro. to Geology (Evening program)						64	41	54	55	41	47	33	25	42	23								
141	Physical Geology																23							
142	Historical Geology																20							
	Total of First Year																							
	Enrollment, Arts & Science	1924	1938	2258	2773	3436	3872	3927	4270	4968	4335	4327	4123	3939	3723	3736	3957	4096	4138	4291	4378	4290	4355	4380
	Introd. classes, as % A & S enrollment	3.6	4.1	2.6	8.2	6.8	7.8	5.2	4.0	4.2	4.6	4.1	5.3	3.4	4.2	3.6	4.4	3.5	2.6	2.4	1.6	1.6	1.5	2.6
201A	Introduction to Mineralogy					45	47	52	35	29	34	29	23	21	47	53	47	3		1	1			
201B	Optical Min. & Petrology (201 to 1969)	7	9	7	9	42	51																	
202A	Invertebrate Paleontology (202 to 1969)	15	12	19	17	52	53	67			35													
202B						52	58	69	34	28	35	35	32	20	29	51	51	5		1				
203A	Field Methods					27	33	42																
203B	Intro. to Structural Geology					26	38	27																
204B	Elements to Geochemistry					15	29	22								52	44	2						
205	Introduction to Geophysics															24	15	39	23	38	20	22	15	17
210	Intro. Mineralogy and Geochemistry																48	35	32	20	20	14	7	
211	Field Methods																	45	31	38	14	16	23	9
220	Sedimentology & Biostratigraphy																	44	40	36	27	28	15	8
223	Biostratigraphy											37	33	21	36	43	40	2			1			
240	Marine Geol & Geophysics (Evening program)						45	31	20	21	28	23	13	11	23	15	9							
241	Environmental Geology (Evening program)								25	34	30	24	27	25	32	4	42	33	33	28	26	13	21	16
242	Geomorphology (Evening program)								23	20	38	29	23	21	22	11	21							
301	Petrology	2	7	6	4	8	18	20	25	26	19					23	27	33	31	25	26	16	8	12
302	Stratigraphy-Historical Geology	7	8	6	12	7	17	13	30	19	17					22	26	35	31	24	25	17	11	12
303	Structural Geology	7	7	8	7	4	101	6	1	18	17													
304	Ore Deposits		7		4	1	12	4	25	18	10													
305	Systematic Paleontology						13	11	30	16	12													
306A	Introductory Geophysics, "Expl'n geophysics" 1974, '75,						14	15	14	8	12													
306B	Plate Tectonics						12	16	18	11	6													
307	Tutorial							3	5	5														
310	Igneous & Metamorphic Petrology											26	24	19	16									
311A	Field Methods											25	26	24	16	18	32	23						
312B	Principles of Stratigraphy											23	24	23	18	24	31	23	39	23	12			
313A	Physical Properties of Rocks. After 1980, Gen. Geophysics											29	25	17	20	6	6	6	14	8	10	9	7	5
314B	Structural Geology											24	19	18	27	22	27	42	29	29	31	14	12	14
315	Economic Geology															34	31							
316	Sedimentary Environments																	57	43	24	12			
3300	Sedimentology & Biostratigraphy II																			17	18	16	9	
341A	Environmental Geology (Evening program)								29	17														
342B	Geomorphology (Evening program)								33	13														
401	Sedimentation, Sed'y Petrology			6	6	3	4	9	8	10	10	10												
403	Advanced Structural Geology		3		5					2	3	3												
404	Ore Deposits - Advanced Class	5				4		4		4														
405A	Principles Exploration Geophysics	3	5			6	2	1																
405B	Introd. Earth Physics (4005 till 1969)			3	9	5																		
406	Examination Mineral Properties	1	1	1	3	1	2	4																
407	Phase Equilibria & Petrogenesis					3	2	2	3		3	3												

Appendix II (Continued)

		1966	67	68	69	70	71	72	73	74	75	76	77	78	79	80	81	82	83	84	85	86	87	88
408	Advanced Mineralogy & Crystallography						1	5		5														
410	Research Project (Non-Honours Thesis)														1	3	1							
415	Economic Geology																	17	9	15	13		7	2
4155	Fossil Fuel Geology																					8		
420	Honours Thesis										8	9	10	8	15	7	8	15	13	12	18	10	11	8
421B	Statistics. After 1975, Siliclastic Sedimentology							1			1	6	6	15	16		17							
422	Introd. Vertebrate Paleo; After `75, Carbonate Petrology; After `82, Sedimentology						3					8	8	15	14	9	18	17		6				
423	Systematic Paleontology											7	5	10	5		13							
424	Advanced Mineralogy & Petrology											1	7	6	3									
425	Geochemistry											6	6	6	14									
426	Hydrogeology											3	11	7	10	5	14							
427A	Applied Geophysics											1	9	9	1	3	5	4	6	7	10	4	3	1
428B	Marine Geophysics											2	4	4			6	1	1	6	5	1	1	2
429	Solid Earth Geophysics - Geodynamics											2	1	1		1	1		2			2		
430B	Advanced Economic Geology											11	14	14	14	15	12							
431B	Marine Geology											6	1	1	3	13		15	17	9				
432	Advanced Structural Geology													1										
434A	Precambrian Geology																13							
435A	Appalachian Geology - Tectonics 82															9		13	15	18	24	14	6	5
436B	Pleistocene Geology																40	15	13	8				
437B	Micropaleontology															3		12	14	3	1			
438A	Advanced Geochemistry															4	11		15	11	14	17	6	
439B	Advanced Igneous Petrology															5		11		8		10		
440B	Advanced Metamorphic Petrology																6		9		11		5	3
445	Earth Physics								1	6	1													
450	Sedimentology - Biostratigraphy III																				10	11	5	3
451	Directed Reading																				3	4	5	
453	Hydrogeology				2	5	4			9	22													
454	Geochemistry			2	1	2	7	6	9	5	3													
455	Adv. Historical Geol. In 1975, Carbonate Petrology		2	4					1		10													
456	Micropaleontology		4	7	9	4	2	5	14	9	5													
457	Pleistocene	3		5	4		6		6		4													
458	Advanced Marine Geology			4	5	4																		
459	Analytical Geochemistry				1	2	2																	
460A	Isotope Geochemistry							2																
460B	Geochronology							1																
461A	Advanced Marine Geology & Geophysics						5	1	3	3	4													
462B	Marine Geophysics						3																	
464C	Pliestocene Biogeography								1											4	7	5		3
500	Topics in Paleontology							3																
501A	Sedimentology				1			4	4	2	2													
501B																								
502	Adv. Geophysics; 1973: Earth Science Seminar					1			1															
503	Hydrogeology					4					1													
504	Geochemistry				9	1	1	1	3		2													
505	Advanced Earth History									2														
506	Intro. Micropaleontology					2	3	2	1															
507	Pleistocene Geology			4	3		7				5													
508	Advanced Marine Geology			2	1	1																		
509	Analytical Geochemistry				8	1	4																	

Appendix II (Continued)

		1966	67	68	69	70	71	72	73	74	75	76	77	78	79	80	81	82	83	84	85	86	87	88
510	Petrogenesis								1	5														
515R	Economic Geology																		1	2			3	1
521B	Statistical Techniques; After `77 Siliclastic Sedimentology				6		3	3	3			1	2	1	1		2							
522A	Carbonate Petrology; After `82; Advanced Sedimentology		1								1	1	1	1	2	1		1		4				
523	Topics in Cdn. Geology		3					2					2											
524	Oceanic Igneous Rocks; 1978: Adv. Miner. & Petrology					4							2	3										
525	Geochemistry											2	1	2										
526R	Hydrogeology											2	3	5										
527A	Applied Geophysics												7	1	3	1	2	6	1	1	1	1	1	
528B	Marine Geophysics											1	4	2			3	3	1	2		1	2	1
529B	Solid Earth Geophysics											1	1	1			2		1			1		1
530B	Adv. Economic Geology											1				3	2	2	1					
531B	Marine Geology											5							2	5				
534A	Precambrian Geology																5							
535B	Tectonics																	5	2	5	2	1	1	3
536A	Pleistocene Geology																3	3	2	3				
537A	Micropaleontology																	3	1	3				
538A	Advanced Geochemistry																5		5	1			2	
539B	Advanced Mineralogy & Petrology																1	3		6		1		
540B	Advanced Metamorphic Petrology																				3		4	1
545R	Physics of the Earth						1		2		1													
554R	Advanced Economic Geology									2														
556B	Plate Tectonics									2	2													
560A	Isotope Geochemistry							2	2															
560B	Geochronology							3																
561A	Advanced Marine Geology & Geophysics							1	6	5	3													
600	Advanced Micropaleontology				3	2	1			1	1													
610C	Seminar: Sedimentology & Stratigraphy															3	3	5	2					
611	Research Topics in Micropaleontology											1						1			1			
612A	Seminar: Mineralogy, Petrology, Geochemistry															4	2	3		7	5	1	4	4
613C	Seminar: Geophysics																	1						
614	Advanced Topics in Geophysics												5		3									
615	Metallogeny											2					5	1						
616	Pleistocene; After 1986: Research Topics, Soft Rocks I												4									8	3	1
617	Research Topics in Soft Rock Geology II																				3	8	2	1
622B	Seminar: Mineralogy, Petrology, Geochemistry															4	3	3		5	5	1	5	6
625	Directed Studies																		2	1				5

MASTER'S DEGREES AWARDED IN GEOLOGY

1903	L. A. DeWolfe
1908	J. C. Hall (Geology and Chemistry)
1936	H. F. R. Belyea (M.A.), R. L. Milner
1938	R. L. Cunningham, J. H. MacLean
1940	H. N. MacDonald, W. R. MacQuarrie
1941	C. O. Campbell
1946	N. R. Goodman
1948	G. C. Milligan, C. H. Smith
1950	W. L. Davison, J. W. D. Johnston
1953	H. R. Peters
1954	W. A. Hogg
1956	E. A. Rowley
1957	N. J. Gass, A. C. Gourley
1958	F. S. Shea
1962	F. Aumento, G. R. Kent
1963	F. J. Nolan, R. M. Weeks
1964	R. G. H. Allen, D. R. Grant, D. J. Mossman, W. J. Palmer, R. C. Parsons
1965	R. Evans
1966	F. H. A. Campbell, I. McK. Harris, D. E. Lawrence, N. Silverberg
1969	Hsien-Su Chen, R. M. Creed, T. W. Hennigar
1970	M. W. Milner, Y. Turker
1971	D. A. Murray
1972	K. S. Choo, I. G. Park, J. McG. Stewart, R. F. A. Wilson
1973	A. F. Chinn
1974	D. F. Clark, J. Iqbal, C. B. McKenzie, G. K. Renwick
1975	H. J. Cross, A. J. M. Palmer, B. B. vonBorstel
1976	M. Alam, N. E. Barnes, M. H. Charest, M. C. Graves, P. A. McGraw, R. J. E. Parrott, D. M. Wightman
1978	K. A. Gustajtis, P. H. Newman
1979	C. T. Dale, E. J. Farley, Y. C. M. Liew, C. K. Miller, D. J. Secord, C. E. Ulriksen
1980	C. Q. Barrie, A. Cordsen, K. M. Fiess
1981	P. D. Bourque, P. W. Fralick, T. E. Lane, J. R. J. Letson, W. S. Okoth, J. M. Peckenham, C. A. Peterson
1982	M.-C. Blanchard, M. A. MacDonald, R. R. Stea
1983	O. J. H. Bonham, J. D. Cullen, A. M. DeIure, P. Doucet, A. A. L. Miller, I. Wolfson
1984	W. G. Shaw, B. J. Todd
1985	R. K. Hall, W. D. Smith
1987	D. J. Bird, C. E. Fitzgerald, C. A. Honig, V. H. Noguera, H. E. Plint
1988	M. Douma, S. L. Douma, L. J. Ham, G. A. O'Reilly, G. A. Prime, L. Richard
1989	K. C. Brown, B. I. Cameron, K.-A. Jenner, S. McLaren, L. P. M. Nicks, R. D. Trotter, A. Yule
1990	J. R. Dickie, A. M. Grist
1991	G. D. M. Cameron, M. J. Haggart, M. Hendricks, R. B. Laidler
1992	J. C. White
1993	X. Fu, G. Li
1994	S. A. Thibaudeau

DOCTORAL DEGREES AWARDED IN GEOLOGY

1965	F. Aumento
1970	A. K. Lyall
1971	M. R. Gregory, R. P. Sinha
1972	A. C. Grant, B. G. Langhus
1974	D. S. Rankin
1975	P. J. C. Ryall, C. F. Stehman
1976	N. I. Clausson, R. Dayal, G. H. Herb, E. Nielsen
1977	D. B. Scott, D. A. V. Stow
1978	O. Y. Abdel-Aal, C. R. Pride, P. K. Sarkar, V. J. Stukas, K. D. Sullivan
1979	M. Alam
1980	A. K. Chatterjee, D. M. Wightman
1981	A. E. Aksu, P. J. Mudie, D. J. Plasse, N. A. VanWagoner
1982	P. R. Hill, R. A. Stephenson
1983	S. O. Akande, J. Helgason, M. A. Williamson
1987	P. Elias, K. M. Gillis, C. E. Ravenhurst
1988	J. M. Mehegan, B. J. Todd
1989	M.-C. Williamson
1990	S. R. McCutcheon, V. Maksaev, A. T. Martel, W. G. Wightman
1991	M. Burke, J. H. Calder, Z. Huang, D. S. Kelley, E. A. Nkwate, T. R. Stokes
1992	F. M. G. McCarthy, J. Yang
1993	R. J. Ryan

WINNERS OF THE JAMES L. HALL SCHOLARSHIP

This scholarship was created by the widow of James L. Hall, in memory of her husband, who was a student at Dalhousie from 1919 to 1921, and by Dr. Elizabeth L. Hall, his sister. It is awarded, on the joint recommendation of the chairmen of the departments of Engineering and Geology, to a student who has completed the first year of residence at Dalhousie with high academic standing and who is planning a career in Engineering or Geology. Preference is given to students whose interests lie chiefly in the field of Mining Geology.

Since about 1965 the award has gone to a student in Geology and in Engineering in alternate years.

Very condensed outlines of the careers of the recipients are presented below. It is clear that, for many, the actual career differed considerably from that anticipated when a student. It appears also that those who chose the recipients were reasonably good judges of potential ability. There are gaps in the record. In some cases, these represent students who withdrew from the University and so did not use the scholarship. In a few other cases, our records are incomplete.

The scholarship was first awarded in 1939. The awards are listed below in chronological order:

1939 William Albert Messervey
B.Sc. & Dipl. Engrg., 1941, Dalhousie; B.Eng., 1943, N. S. Technical College.
Canadian General Electric: 1944-1952, Initially on electrical systems for the navy, then industrial systems; 1952-1970, specializing and then Manager, Paper Industry Drive Systems; 1970-1983, Manager, Drive Systems Engineering, Peterborough, Ont.
Now retired.

1940 William Ralph Lewis
B.Sc., 1941, Dalhousie; B.A.Sc., 1947, Toronto.
R.C.N.V.R.: 1942-1945, Electrical Lieutenant.
Dominion Steel & Coal Co. 1956-1968, Manager, Rolling Mills Division, Sydney.
Acres Canadian Bechtel: 1969-1970, Churchill Falls Powerhouse Project.
SNC Inc.: 1970-1982, Vice-President, Montreal.
SNC/Sandwell Ltd.: 1982-1986, Vice-President and Manager, Vancouver.
Now retired.

1941 George Clinton Milligan
Dipl. Engrg., 1941, B.Sc., 1946, M.Sc., 1948, Dalhousie; A.M., 1950, Ph.D., 1961, Harvard.
Cdn. Armd. Corps, 1941-1945.
Dept. Mines & Natural Resources, Manitoba: 1950-1957, Geologist.
Dalhousie University: 1957-1985, Assoc. Prof./Professor.
Now retired.

1942 Donald Archibald Burris
Dipl. Engrg., 1943, Dalhousie; B.Eng., 1945, N. S. Technical College.
Ingersoll Rand Canada: 1945-1950, Montreal; 1950-51, Service Rep., 1952-1960, Sales Rep., Toronto; 1961-1966, Manager, Pulp & Paper Equipment Division, Montreal; 1967-1975, General Manager, Sales, Montreal; 1976-1977, Western Manager, V.C.R.; 1978-1982, Vice-President 1983-1989 Consultant, Vancouver.
Now retired.

1943 Carl Maurice Little
Dipl. Engrg., 1944, B.Sc., 1945, Dalhousie; Licent. Roy. Acad. Music, London, 1952; Assoc. Roy. Coll. Music, London, 1952.
Canadian Broadcasting Corp.: 1952-1959, producer, radio music, Montreal; 1959-1965, producer radio music, Toronto; 1965-1975, national network supervisor serious music, Toronto.
National Arts Centre: 1975-1978, orchestra manager, Ottawa.
Little Gallery of the Arts: 1979-1980, co-founder and president, Ottawa.
Arts Connection: 1980-, Victoria, B. C.
Juror for international music competitions, including Oslo, Stockholm, and London.

1944 Arthur Ernest Burgess
Dipl. Engrg. & B.Sc., 1945, Dalhousie; B.Eng., N. S. Technical College, 1947.
Last known position: Technical Development Engineer, Ecology Protection Branch, Dept. Energy, Mines & Resources, Ottawa.

1945 Charles Haddon Smith
Dipl. Engrg. & B.Sc., 1946, M.Sc., 1948, Dalhousie; M.S., 1951, Ph.D., 1952, Yale.
Cerro de Pasco Copper Corp.: 1949, Geologist, Morococha, Peru;
Geological Survey of Canada: 1952-1964, Research Geologist; 1964-1967, Chief, Petrological Sciences Division; 1967-1968, Chief, Crustal Geology Division.
Science Council of Canada: 1968-1970, Science Advisor.
Department of Energy, Mines & Resources: 1970-1971, Director of Planning; 1972-1975, Asst. Deputy Minister (Science and Technology); 1975-1980, Senior Asst. Deputy Minister; 1980-1982, Senior Asst. Deputy Minister (Mines).
Canadian Commission for UNESCO: 1983-1989, Science Advisor.
Canadian Commission for World Energy Council: 1984-1990, Executive Director.
Royal Society of Canada: 1986-1990, Foreign Secretary.
Geological Survey of Canada: 1992, Coordinator, 150th Anniversary.

1946 Robert Alan Cameron
Dipl. Engrg. & B.Sc., 1948, Dalhousie; M.A.Sc., 1953, Toronto; Ph.D., 1956, McGill.
University of New Brunswick: 1952, Lecturer.
Imperial Oil: 1952-1953, Geologist, Edmonton.
Malartic Gold Fields: 1956-1957, Geologist, Halet, Quebec.
East Malartic Mines: 1957-1962, Chief Geologist, Norrie, Quebec.
McIntyre Mines: 1962, Exploration Supervisor, Toronto.
N. S. Technical College: 1962-1968, Asst. Professor.
Cambrian College: 1968-1969, Principal, Sudbury.
Laurentian University: 1969-, Assoc. Professor.

1947 William Borden Christie
Merchant Marine: 1938-1941, Radio Officer.
Dipl. Engrg., 1948, Dalhousie; B.Eng., 1950, N. S. Technical College; Post Grad. (Military/Political Sc), 1966, Imperial Defence College, London, Eng.
Royal Canadian Navy: 1941-1974. (On leave at Dalhousie/N.S.T.C., 1945-50). Last DND post, Asst. Deputy Minister (Materiel) as Rear Admiral.
Department of Supply & Services, Ottawa: 1974-1979, Director General, Shipbuilding & Marine Equipment.
Versatile Systems Eng. Inc.: 1980-1985, retired as President.
VSEL Defence Systems Canada, Ottawa: 1985-1989, President.
Retired 1989 Ottawa.

1948 Kenneth Fraser Marginson
Dipl. Engrg. & B.Sc., 1949, Dalhousie; B.Eng., 1951; M.Eng., 1965, N. S. Technical College.
Maritime Steel 1951-1953, New Glasgow, N. S.
Dalhousie University: 1953-1981, Asst. Prof./Professor. Chairman of Engineering Department, 1964-1978.
Marginson was serving in the engine room of S. S. *Jervis Bay* in 1940, when Capt. Fogarty Fagan won a Victoria Cross for sacrificing that ship to protect a convoy from the German battleship *Admiral Scheer*.

1949 Gordon H. Elop
Dipl. Engrg. & B.Sc., 1951, Dalhousie; B.Eng., 1953, N. S. Technical College.
Last reported position: with Canadian Westinghouse.

1950 Walter K. Hughes
Dipl. Engrg., 1951, Dalhousie; B.Eng., 1953, N. S. Technical College.
Standard Paving Inc.: 1956-1967, President, St. Petersburg, Florida.
Roper Aluminum Products: 1967-1986, President, Dartmouth, N. S.
Now retired.

1951 Charles Robert Zinck
Dipl. Engrg., 1952, B.Sc., 1956, Dalhousie.
E.M.I. Cossor: 1957-1960, Electronic Design Lab., Halifax/Dartmouth.
C.B.C. Television: 1960-1991, Systems Technologist, Halifax.

Now retired.
1952 Alfred R. Howard
B.Sc., 1954, Dalhousie; M.S., 1961, Yale.
City of Halifax: 1956-1965, Divisional Engineer.
City of Boston(?): 1965-1967, Transportation Planner.
Consulting Engineer, 1968-1972, Boston.
City of Boston(?): 1972-1986, Transportation Planning Director.
Howard/Steen-Hudson Assoc. Inc.: 1986-, Senior Engineer, Boston.
1953 John David Brown
Dipl. Engrg. & B.Sc., 1955, Dalhousie; B.Eng., 1957, N. S. Technical College; M.Sc. (Eng.), 1961, Imperial College, London; Ph.D., 1967, N. S. Technical College.
Geocon Ltd.: 1961-1964, Soils Engineer, Montreal.
Norwegian Geotechnical Institute: 1967-1969, Research Engineer, Oslo.
Technical University of N. S.: 1970-1980. Asst/Assoc. Professor.
Jacques, Whitford & Associates: 1980-, Principal, Dartmouth, N.S.
1954 Allison Edward Keddy
Dipl. Engrg. & B.Sc., 1955, Dalhousie; B.Eng., 1957, N. S. Technical College.
Last reported position: 15 Radar Squadron, Moosonee, Ont.
1955 Peter Arthur Fillmore
Dipl. Engrg. & B.Sc., 1957, Dalhousie; M.A., 1960, Ph.D., 1962, Minnesota.
University of Chicago: 1962-1964, Dept. Mathematics, Instructor.
Indiana University: 1964-1971, Dept. Mathematics, Assist. Professor/Professor.
Dalhousie University: 1971-, Dept. Math., Statistics & Comp. Science, Professor.
Canadian Math Society: 1973-75, Vice-President.
1956 Peter Alexander Clarke
Dipl. Engrg., 1957, Dalhousie; B.Eng. (Mech.), 1959, N. S. Technical College.
Last reported position: Senior Vice-President, Marketing, C.N.R., Montreal.
1957 David Malcolm Lewis
Dipl. Engrg., 1958, Dalhousie; B.Eng. (Mech.), 1960, M.Eng., 1965, N. S. Technical College.
Canadian Industries Ltd.: 1960-1962, Design Engineer, Brownsburg, Quebec.
Proctor and Gamble: 1962-1963, Project Engineer, R. & D., Hamilton, Ont.
Dalhousie U. & Technical University of Nova Scotia: 1963-, Asst. Prof/Associate Professor.
1958 Edo Nyland
B.Sc., 1963, M.Sc., 1965, Dalhousie; Ph.D., 1970, Univ. California, Los Angeles.
University of Alberta, 1970-, Dept. Physics (Seismology), Asst. Prof./Professor.
1959
1960
1961
1962 James Sealy Collins
Dipl. Engrg. & B.Sc., 1962, Dalhousie; B.Eng. (Elect.), 1964, M.Eng., 1966, Technical University of N.S.; Ph.D., 1973, U. of Washington, Seattle.
Bell Northern-Research: 1965-1968.
R. Larratt & Associates: 1973-1978, Victoria.
Royal Roads Military College: 1979-, Head, Dept. Engineering, Victoria.
1963 Michael William Milner
Dipl., 1962, N. S. Land Survey Inst.; B.Sc., 1967, M.Sc., 1970, Dalhousie.
Geological Survey of Guyana (CUSO): 1969-1971.
Dept. Indian & Northern Affairs: 1971-1973, District Geologist, Whitehorse.
Since 1973, consulting geomorphologist, specializing on placer deposits, Toronto.
1964 Dale Gordon Retallack
Dipl. Engrg. & B.Sc., 1965, Dalhousie; M. Eng., 1968, Ph.D., 1970, University of Manchester.
ALCAN: 1970-1977, Management of Industrial R & D, Arvida, Quebec.
Michelin Tires (Canada): 1977-1982, Production Management, Nova Scotia.
Dalhousie University: 1982-, Engineering Dept., Assoc. Professor.
1965 Hamid Khan
1966 Peter Oswald Brackett

Dipl. Engrg. 1966, Dalhousie; B.Eng., 1968, N. S. Technical College; M.Sc., ?, Toronto.
Last reported position: Manager, Advanced Development, Racal-Milgo, Sunrise, Florida.

1967 Henry Scott Swinden
B.Sc., 1970, Dalhousie; M.Sc., 1976, Ph.D., 1988, Memorial.
Conwest Exploration Co.: 1970-1973, Project Geologist, central, western & northern Canada.
Atlantic Coast Copper Corp: 1975-1976, Project Geologist, Gullbridge, Nfld.
Resource Consultants: 1976-1977, Senior Geologist, St. John's, Nfld.
Resource Associates of Alaska: 1978-1979, Senior Project Geologist, Fairbanks, Alaska.
Newfoundland Dept. Mines & Energy: 1979-, Senior Geologist, St. John's, Nfld.

1968 Colin Burgess McKenzie
B.Sc., 1971, M.Sc., 1974, Dalhousie.
Rio Algom: 1979-1982, District Geologist, St. John's, Nfld.
BP Resources Canada: 1983-1989, District Exploration Manager, Halifax; 1989-, Exploration Manager Eastern Canada, Corner Brook, Nfld.

1969 Josephine Marsden Durber
B.Sc., 1970, Dalhousie. R.T. (Haematology), N. S. Institute of Technology, 1975.
Pathology Institute, Halifax: 1970-1978, Lab Technician.
Camp Hill Hospital, Halifax: 1982, Chief Haematology Technician.
Presently retired to care for a handicapped child.

1970 Ronald John Sturk
B.Sc., 1972, Dalhousie; B.Eng. (Mech.), 1975, Technical University of N. S.
Canadian General Electric: 1975-1978, Manufacturing Management Trainee, Peterborough, Ont.
Exide Battery: 1978-1980, Manufacturing Engineer, Mississauga, Ont.
Industrial Containers Ltd.: 1980-1985, Plant Engineer, Brampton, Ont.; 1986-, Engineering Manager, Toronto.

1971 Peter Grey Aldous
B.Sc., 1971, Dalhousie; B.Eng. (Metal.), 1973, Technical University of N. S.
Sydney Steel Corp.: 1973-1974, Engineer; 1974-1980, Asst. Manager/Manager, Coke Ovens Dept.
Michelin Tires (Canada): 1980-1986, Production Management; 1986-1991, Financial Planner, 1991-, Quality Control, Granton, N. S.

1972 William Henry Woolford
B.Sc., 1973, Dalhousie; B.Eng., 1975, Technical University of N.S.
Guyana Geology & Mines Commission: 1975-1980, Inspector of Mines; 1980-1985, Senior Mining Engineer; 1985-1990, Manager, Mines Development; 1990-. Commissioner (Ag.), Guyana Geology and Mines Commission, Georgetown, Guyana.

1973

1974 Daniel James Stevens
B.Sc., 1975, Dalhousie; B.Eng., 1977, Technical University of N. S.; M.B.A., 1983, Queen's.
N. S. Power Corp.: 1977-1984, Staff Engineer/Project Engineer; 1984-1988, Project Head-Premises; 1988-, Senior Project Engineer - Transmission, Halifax.

1975 David Wallace MacMillan

1976 Richard W. Toews
B.Sc., 1978, Dalhousie.
Amoco Canada: 1978-1980, Exploration Geologist, Calgary.
Irvco Resources: 1980-1981, Exploration Manager, Calgary.
Placer Cego Petroleum: 1982-1990, Division Geologist, Calgary.
NOVA Corp.: 1991-, Supervisor, Reserve Studies, Alberta Gas Trans. Div., Calgary.

1977 Kevin Brian Langille
Dipl. Engrg., 1978, Dalhousie; B.Eng., 1980, Technical University of N. S.

1978 William Ashley Kay
B.Sc., 1981, Dalhousie.
Geological Survey of Canada: 1982-1991, Marine Seismologist, B.I.O., Dartmouth, N. S.
Xon Digital Communications: 1989-, President, Dartmouth, N. S.

1979 R. Ian Dempsey
B.Sc., 1976, Mt. Allison; Dipl. Engrg., 1980, Dalhousie; B.Eng., 1982, Technical University of N. S.
Maritime Tel & Tel: 1982-1985, Project Engineer, Halifax.
Seimac Ltd.: 1985-1988, Design Engineer, Bedford, N. S.

Maritime Tel & Tel: 1988-, Manager, Circuit Layout, Halifax.

1980 Karen Lynn Barry

1981 Terry Reginald Barnaby
Dipl. Engrg., 1982, Dalhousie; B.Eng., 1984, Technical University of Nova Scotia.
Rehau Industries, 1985-, Manager, Montreal.

1982 Thomas Sou-Young Wong

1983 Anil Kapoor
Dipl. Engrg. & B.Sc., 1985, M.D., 1991, Dalhousie.
Dept. National Defence: 1985-1987, Operational Research & Analysis Establishment, Ottawa, and Defence Research Establishments Pacific, Victoria, B. C.
Dalhousie Medical School: 1987-1991; 1992-, Surgical Resident, Winnipeg.

1984 Gordon Guy Check
B.Sc., 1989, Dalhousie; M.A.Sc., 1992, Technical University of Nova Scotia.
Jacques-Whitford: 1992-, Hydrogeologist, Dartmouth, N. S.

1985 Siu Ki Tsui

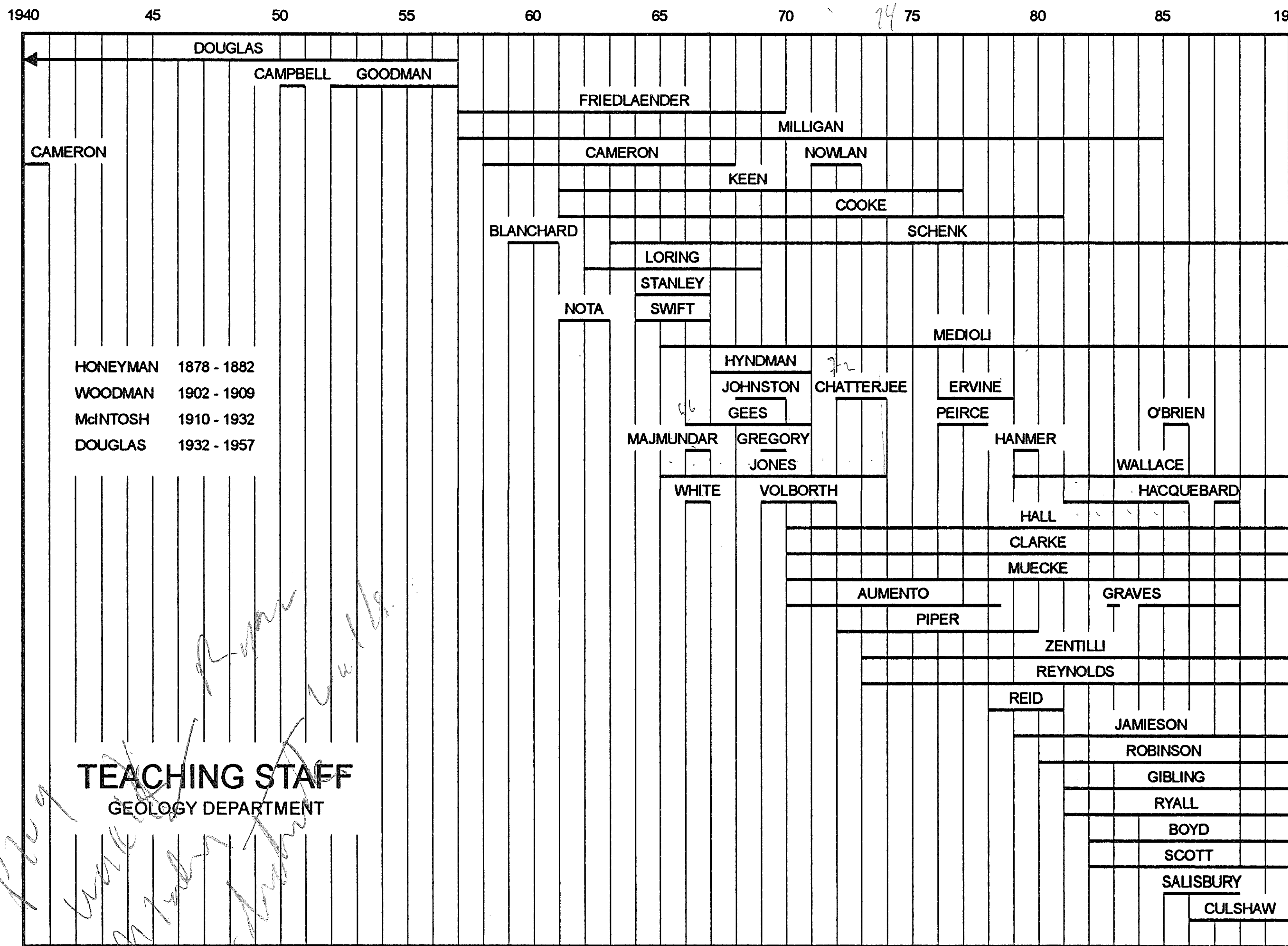
1986 Richard Douglas Trotter
B.Sc., Waterloo; M.Sc., 1989, B.Ed., 1990, Dalhousie.

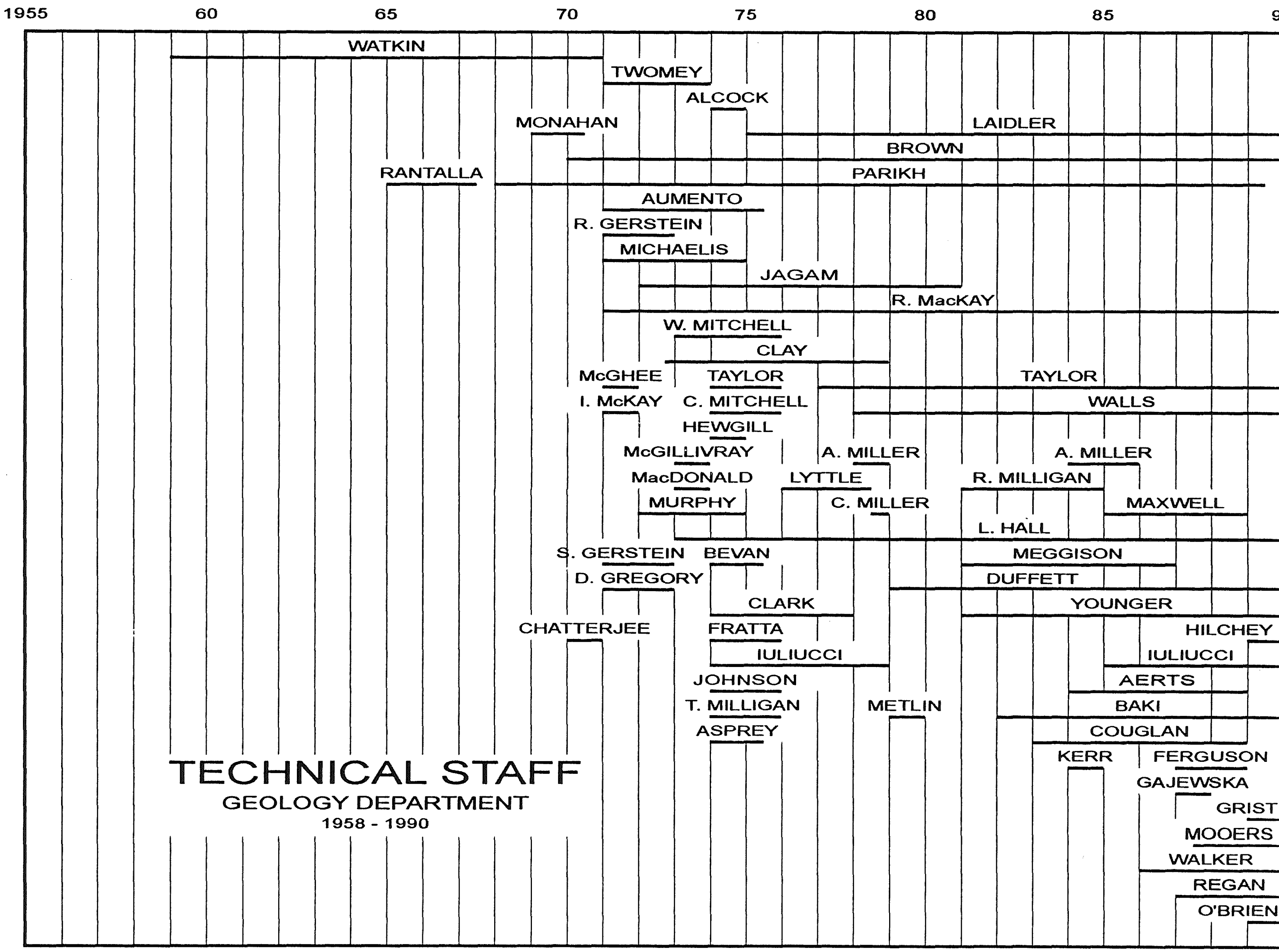
1987 Linda M. Robson
Dipl. Engrg. & B.Sc., 1989, Dalhousie; B.Eng. and Governor General's Silver Medal, Technical University of Nova Scotia, 1992.
Dupont: 1992-, Sarnia, Ont.

1988 Kenneth J. McKenzie
B.Sc., 1991, Dalhousie.

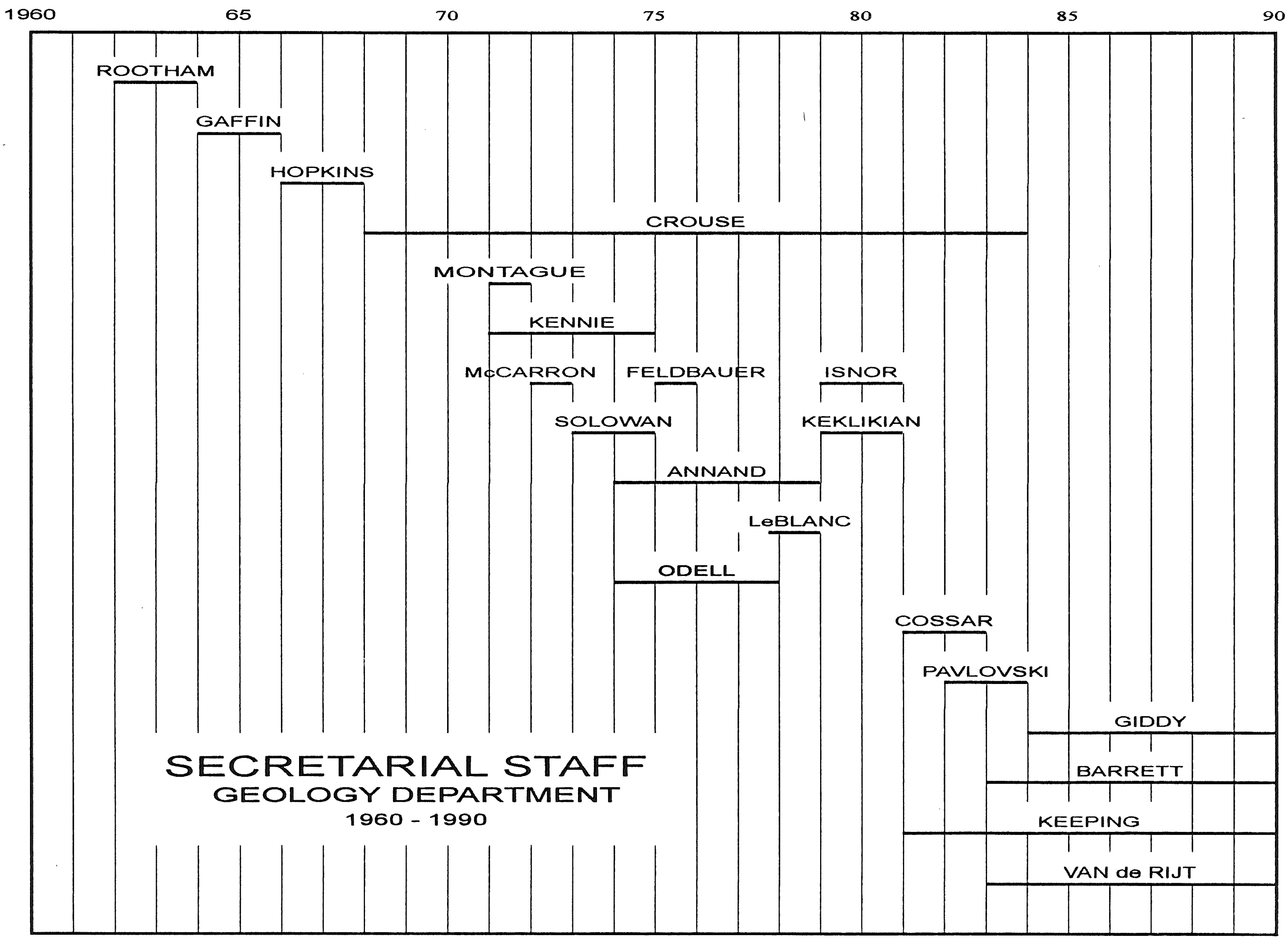
1989 John Wade Gates
Dipl. Engrg., 1990, Dalhousie.
Student at Technical University of N. S.

1990 Stephen Lloyd Grant


1940
45
50
55
60
65
70
75
80
85
1990
DOUGLAS
CAMPBELL
GOODMAN
FRIEDLAENDER
MILLIGAN
CAMERON
CAMERON
NOWLAN
KEEN
COOKE
BLANCHARD
SCHENK
LORING
STANLEY
NOTA
SWIFT
MEDIOLI
HYNDMAN
HONEYMAN 1878 - 1882
WOODMAN 1902 - 1909
McINTOSH 1910 - 1932
DOUGLAS 1932 - 1957
JOHNSTON
CHATTERJEE
ERVINE
GEES
PEIRCE
O'BRIEN
MAJMUNDAR
GREGORY
HANMER
JONES
WALLACE
WHITE
VOLBORTH
HACQUEBARD
HALL
CLARKE
MUECKE
AUMENTO
GRAVES
PIPER
ZENTILLI
REYNOLDS
REID
JAMIESON
ROBINSON
GIBLING
RYALL
BOYD
SCOTT
SALISBURY
CULSHAW
TEACHING STAFF
GEOLOGY DEPARTMENT


1955
60
65
70
75
80
85
90
WATKIN
TWOMEY
ALCOCK
MONAHAN
LAIDLER
BROWN
RANTALLA
PARIKH
AUMENTO
R. GERSTEIN
MICHAELIS
JAGAM
R. MacKAY
W. MITCHELL
CLAY
McGHEE
TAYLOR
TAYLOR
I. McKAY
C. MITCHELL
WALLS
HEWGILL
McGILLIVRAY
A. MILLER
A. MILLER
MacDONALD
LYTTLE
R. MILLIGAN
MURPHY
C. MILLER
MAXWELL
L. HALL
S. GERSTEIN
BEVAN
MEGGISON
D. GREGORY
DUFFETT
CLARK
YOUNGER
CHATTERJEE
FRATTA
HILCHEY
IULIUCCI
IULIUCCI
JOHNSON
AERTS
T. MILLIGAN
METLIN
BAKI
ASPREY
COUGLAN
KERR
FERGUSON
GAJEWSKA
GRIST
MOOERS
WALKER
REGAN
O'BRIEN
TECHNICAL STAFF
GEOLOGY DEPARTMENT
1958 - 1990

Appendix VI


1960
65
70
75
80
85
90
ROOTHAM
GAFFIN
HOPKINS
CROUSE
MONTAGUE
KENNIE
McCARRON
FELDBAUER
ISNOR
SOLOWAN
KEKLIKIAN
ANNAND
LeBLANC
ODELL
COSSAR
PAVLOVSKI
GIDDY
BARRETT
KEEPING
VAN de RIJT
SECRETARIAL STAFF
GEOLOGY DEPARTMENT
1960 - 1990

RESEARCH ASSOCIATES

As has been the custom for nearly a hundred years, the department has been assisted by the staff of other local institutions; especially, in recent years, by the staff of the Bedford Institute. They have been known by various titles, which have changed from time to time: special lecturers, research associates, adjunct professors. Commonly they have aided by supervision of graduate students, and some individuals, such as Dr. Charlotte Keen, have done so for many years. Those who taught formal courses have been included with the teaching staff, Appendix VI.

Those to whom the department is indebted for this assistance include:

S. M. Barr	P. S. Giles	L. Jansa	N. Munro
J. S. Bell	E. Gilpin	C. E. Keen	R. R. Parrish
C. Beaumont	F. Gradstein	L. H. King	H. S. Poole
J. Dostal	F. J. Hein	B. D. Loncarvevic	D. I. Ross
R. Falconer	P. R. Hill	J. Malpas	C. T. Schafer
F. Fillon	A. J. Hurford	J. I. Marlowe	J. Verhoef
			G. Vilks
			M. Williamson

INDEX