THE MINERALOGY OF THE FIFTEEN MILE STREAM GOLD DISTRICT

by

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Submitted in partial fulfillment of the requirements for
the degree of Bachelors of Science at Dalhousie University,
Halifax, Nova Scotia, May 1983

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THE MINERALOGY OF THE FIFTEEN MILE STREAM GOLD DISTRICT

Abstract

Comparison of two distinct tailings piles from two separate periods of operations, reveals that they are similar in mineralogy and lithology. The proportions in which the minerals and lithic fragments are present, differs significantly. The dominant minerals and lithic fragments depends upon the type of material that was mined on the two sites.

Ilmenite, magnetite, and pyrrhotite found within the slates and metagreywackes of this district contribute to the magnetic signature of the rocks.

Fine gold, observed in the tailings of one pile;

1. Reflects the original grain size of the gold.

and/or

2. Is a result of physical breakdown.

The source of this fine gold is thought to be quartz veins and/or metagreywackes.

Ilmenite found in metagreywackes is the dominant black heavy mineral at this gold mine and is found as discrete grains and at various stages of alteration.

Acknowledgements

I would like to take this opportunity to thank Dr. Marcos Zentilli for his guidance and support as my thesis advisor.

I am truly grateful to Craig Miller for providing me with the opportunity to make this thesis possible and for his critical comments, and enthusiastic encouragement.

Bob McKay is thanked for his patient instruction in the use of the microprobe.

Appreciation is extended to Ian MacEachern for his critical comments and discussions.

Financial support for this thesis has been kindly supplied by Pan East Resources Inc. of Toronto and the Natural Sciences and Engineering Research Council of Canada, through a grant (A-9036) supplied to Dr. M. Zentilli.

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INTRODUCTION

1.1 General Statement

In 1981, Pan East Resources Inc. of Toronto, as part of a regional gold exploration program in Nova Scotia, covered extensive areas along the Eastern Shore with an airborne VLF-EM/ magnetometer survey. The results of this survey demonstrated that around all known gold occurrences, including the Fifteen Mile Stream gold district within the survey area had higher magnetism than the surrounding rocks(See Fig. 1). Findings from subsequent follow-up work in 1982 at the Fifteen Mile Stream district indicated that concentrates panned from one of two known tailings piles in the area contained appreciable black magnetic minerals and fine gold (See Fig. 2). When the mining history was investigated it was inferred that the fine gold and the black heavy minerals may have a common association. In addition, heavy mineral concentrates panned from the two tailings ponds show distinct mineralogical differences. This thesis investigates the mineralogy of material from the two tailings ponds and rocks from the mine dumps, and attempts to determine if a relationship exists between the black magnetic minerals and gold.

1.2 Objectives of the Thesis

The objectives of this thesis are:

1. To document the mineralogy of the tailings and the predominant rock types in the dumps.
2. To determine if a relationship exists between the black magnetic minerals and the gold.

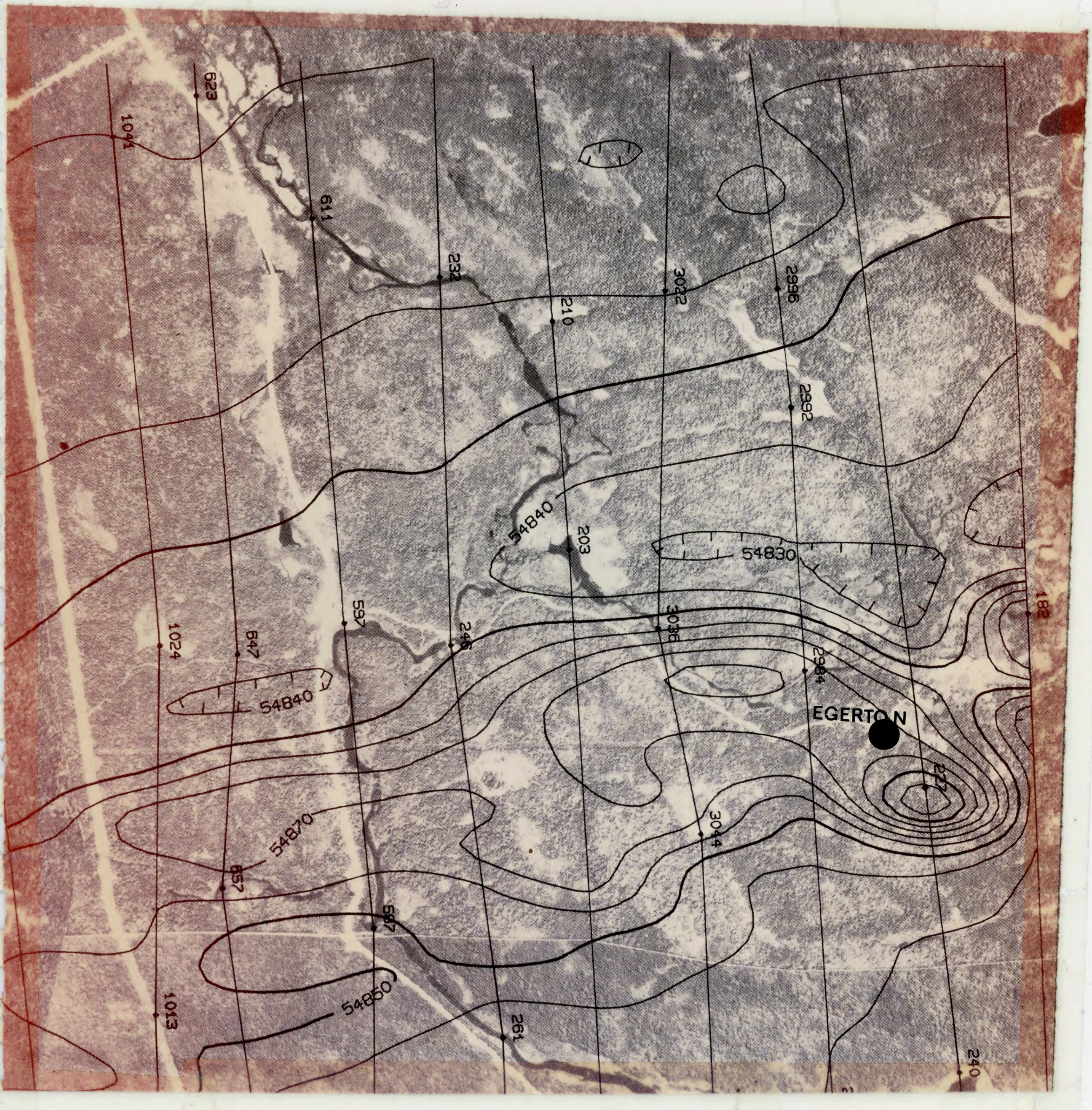


Fig. 1 Aeromagnetic Map of Fifteen Mile Stream Gold District

Scale: 1:20000

MAGNETIC INTERVAL

250 — 50 — 10 gammas

Fig. 2 Panned Heavy Mineral Concentrates: Gold and Black Heavy

3. Explain the mineralogical difference between the two tailings ponds.
4. Determine the character and composition of the gold.

1.3 Location and Physiography

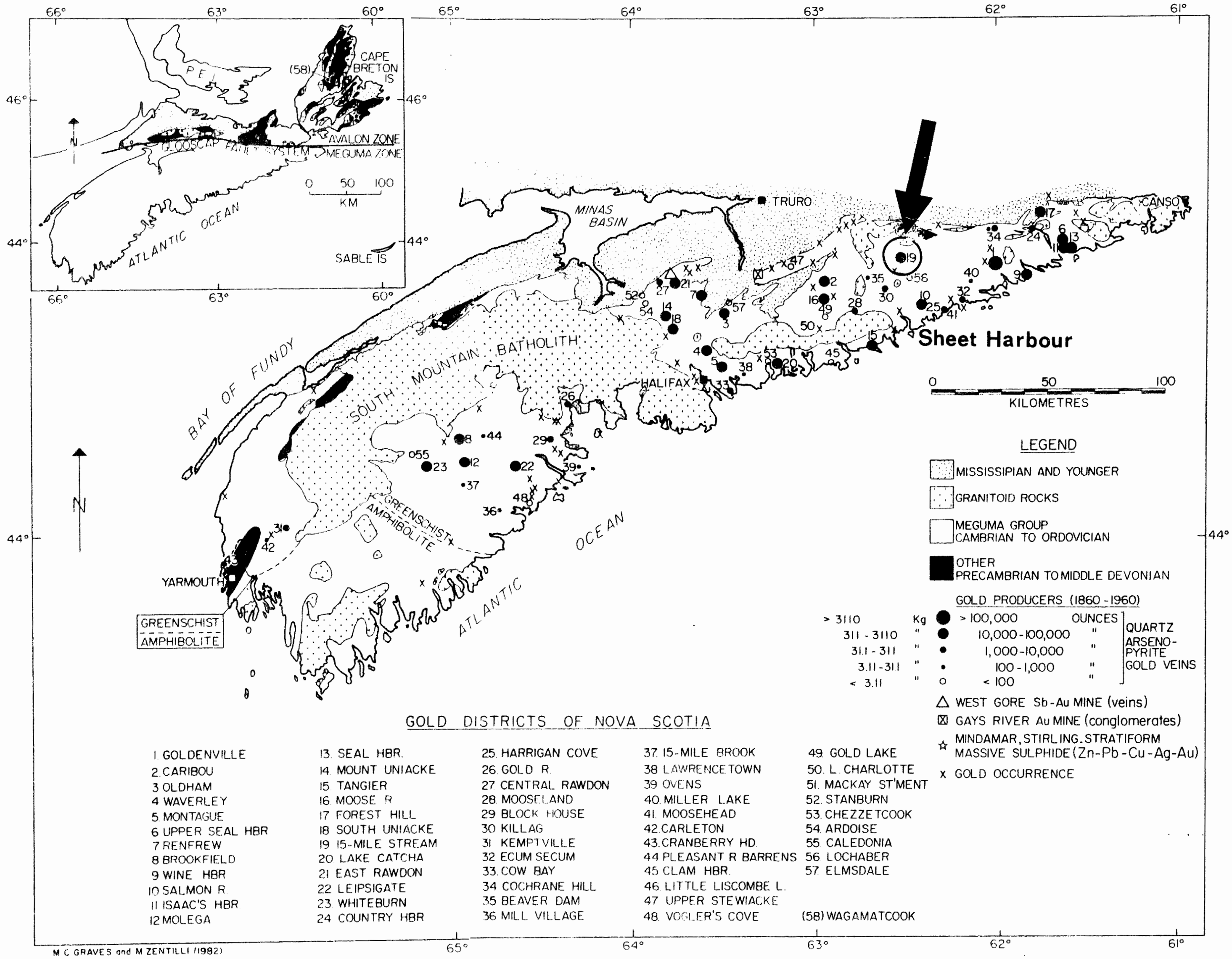
The study area, $45^{0}08'$N latitude, $62^{0}31'20$W longtitude is located in NE Halifax County, Nova Scotia, within the Liscomb Game Sanctuary(See Fig. 3), approximately 32km N of Sheet Harbour, a major community and former seaport along the Eastern Shore of Nova Scotia. Access is via a road leading north from Sheet Harbour to Lochaber Mines at which point the road becomes a well maintained gravel road which continues north to Trafalgar through the sanctuary. Approximately 20km N of Lochaber Mines, the Sloan Lake Road leads east towards the study area only 5 km away from this intersection.

The Fifteen Mile Stream gold district occupies a topographic low through which flows Sloans Brook, or Fifteen Mile Stream as it was called on older maps. The area is overlain by 1 to 3 metres of till and drainage is poor, resulting in numerous swamps. The old mine site is overgrown with alders. There is very little outcrop in the study area.

1.4 Previous Studies

Most of the work in the study area has been related to mining, development or exploration activities for gold in this district. In 1973 J.E. Tilsley conducted an economic appraisal of the Egerton tailings and determined that the average loss of free gold to the tailings from the Egerton mill was .96g/ton milled, and calculated that 14.88g/ton of gold was recovered on average.

GOLD DISTRICTS OF NOVA SCOTIA



M C GRAVES and M ZENTILLI (1982)

Fig. 3 Location Map for the Fifteen Mile Stream gold district.

Ian MacEachern is presently doing a BSc. thesis which relates to the character and distribution of gold in the till overlying the district.

1.5 Methodology

The mine site was visited in the fall of 1982. Representative rock types were collected from mine dumps (See Map 1) of the two separate workings: Egerton and McLean. In addition, five three-kilogram samples were collected from each tailings pond below the water table at depths greater than 0.4 metres to avoid oxidation effects.

Each individual sample of the tailings was washed and then dried. The dried material was sieved using brass sieves. Each individual phi size from greater than -1.0 phi to greater than +4.0 phi was weighed and then stored. The 2.75,3.75 and 4.0 phi fractions were selected for x-ray diffraction analysis (XRD) because:

1. At phi sizes greater than 2.75 phi, quartz, and lithic fragments were the dominant constituents and would have masked the detection of other components.
2. The black minerals were present in significant proportions in these particular intervals.

Gold and heavy-mineral-separate grains were placed in individual holes in epoxy grain mounts and hand polished for electron probe analysis.

The heavy-mineral-separates were analyzed by x-ray diffraction and electron probe techniques (EMP) at Dalhousie. Polished thin sections were made of the host rocks and the compositions analyzed by electron probe techniques.

Four 10 g samples of the heavy minerals were sent to the laboratories of Bondar-Clegg and Co. Ltd. in Ottawa for the analysis of Au,As,Cr,Ni,Pb, and Ti. In addition two samples of each representative rock-type from the two separate workings were analyzed for gold at the laboratories of the Technical University of Nova Scotia.

Scanning electron micrograph pictures were taken of several gold grains and heavy mineral crystals. X-ray photographs were taken of the gold. The composition of the gold was determined by electron probe analysis.

CHAPTER 2

REGIONAL AND LOCAL GEOLOGY

2.1 Regional Geology

The Fifteen Mile Stream gold district is underlain by rocks of the Lower Paleozoic Meguma Group. The rocks of the Meguma Group occupy a large portion of Nova Scotia south of the Glooscap fault, as well as the foundation of the offshore Scotian Shelf, (King and MacLean, 1976). A total thickness for this group has been estimated at over 10km, and the group occupies a total area of close to 125 x 10^3km^2, (Schenk,1978).

The Meguma Group consists of an interstratified sequence of quartz metagreywackes and slates, which have been subdivided into two formations. The basal Goldenville Formation is conformably overlain by the upper Halifax Formation. The boundary between the two can be sharp or gradational and has been defined on the basis of a slate to metagreywacke ratio of 1:1 (Schenk,1978). Figure 4 shows the distribution of the Goldenville and Halifax Formations in Nova Scotia.

The Goldenville Formation consists of thick beds of dark grey to green grey metagreywackes intercalated with different thicknesses of slates,argillites, and siltstones. The Halifax Formation is composed of thinly laminated black to light grey slates,argillites, and siltstones with intercalated metagreywackes. The abundance of the metagreywackes increases towards the base of the formation.

On the basis of scarce fossils, and K/Ar dating on detrital micas, the Meguma Group is believed to be Cambrian to Early Ordovician in age (Schenk,1978).

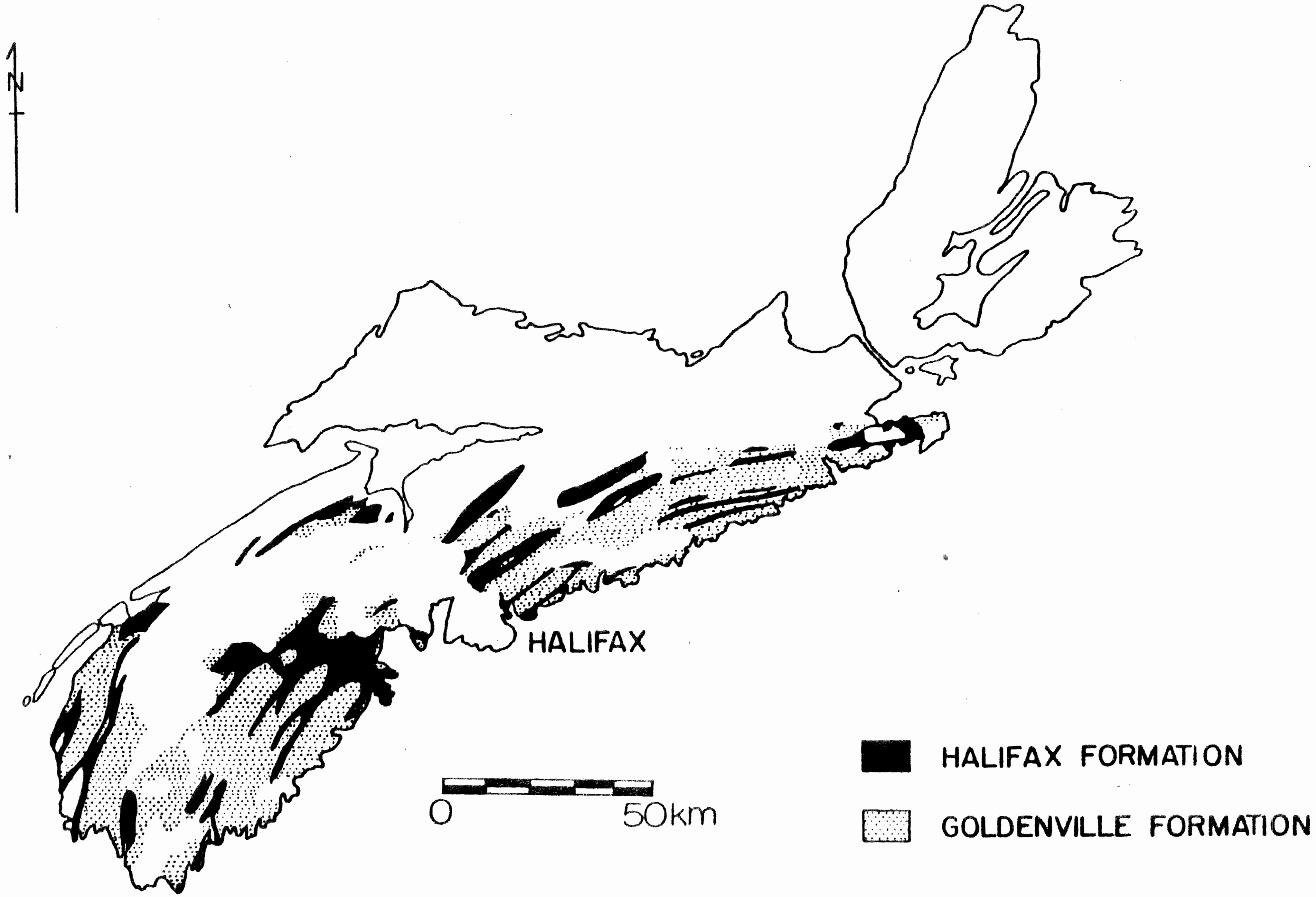


Fig. 4 Distribution of the Halifax and Goldenville Formations in Nova Scotia

From primary sedimentary structures and lithologic characteristics Schenk (1975,1978) has suggested that the group was deposited as part of a deep sea fan and an overlying continental rise. The source area is thought to be a deeply eroded metasedimentary and metaigneous terrain located to the present south-southeast (Schenk,1970,1978).

During the Acadian Orogeny the rocks of the Meguma Group were folded into a series of NE and E-NE trending anticlines and synclines with wavelengths in the order of 2 to 8km (Fyson,1966). A penetrative axial-plane slaty cleavage has been imparted to the slates and to a lesser degree the metagreywackes as a result of this deformation.

A large post-tectonic batholith of Middle Devonian to early Carboniferous age (Clarke and Halliday, 1980,Reynolds et al., 1981) intrudes the Meguma Group. The composition of the batholith ranges from granodiorite to monzogranite to adamellite (MacKenzie and Clarke, 1975,Smith, 1979).

The rocks of the Meguma Group have been regionally metamorphosed to the greenschist facies(Taylor and Schiller, 1976,Muecke,1979) during the Acadian Orogeny. In areas where the rocks are in contact with the South Mountain Batholith, thermal metamorphism is evident.

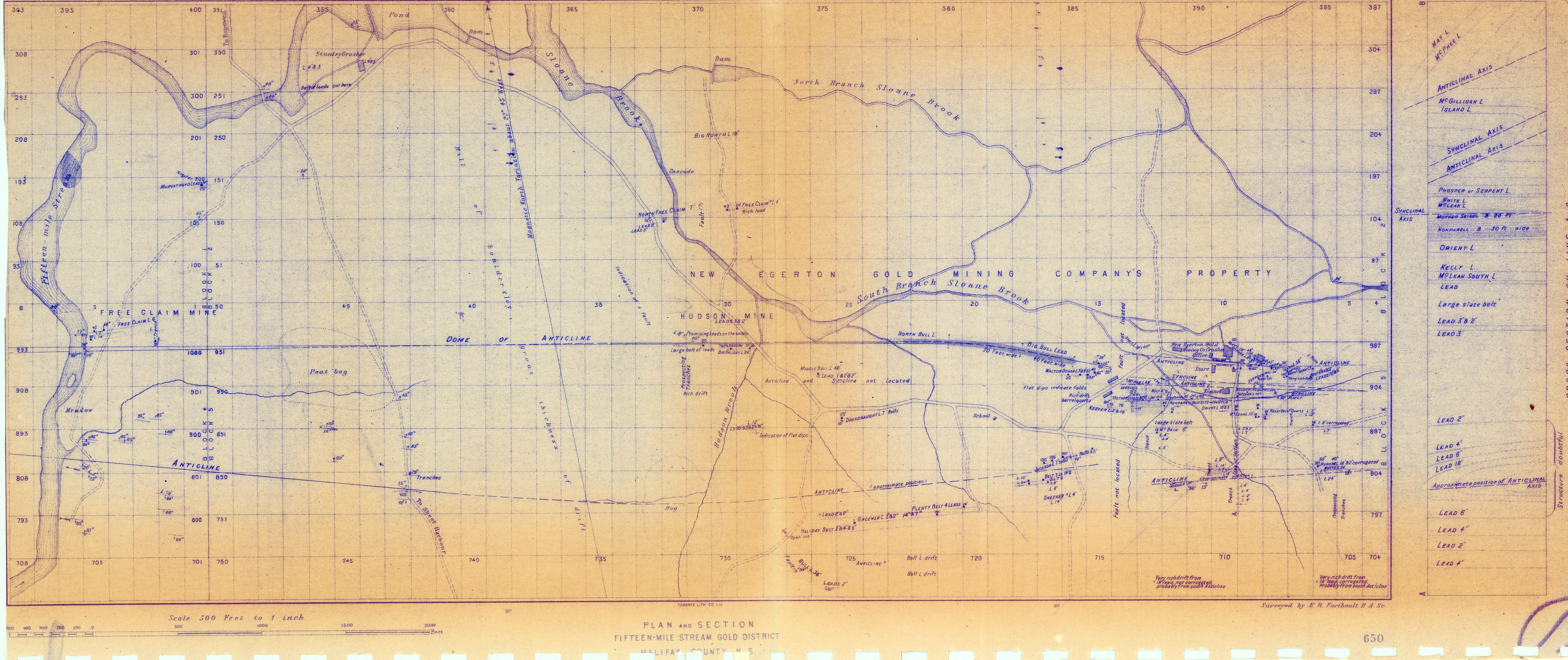
2.2 Local Geology

The gold deposits of the Fifteen Mile Stream Gold district are contained within the rocks of the Goldenville Formation. The district is located along the Waverley-Fifteen Mile Stream anticline; this anticline continues towards Moose River at which point it unites with the Beaver Dam anticline to form the Moose River-Beaver Dam anticline. The major anticline at Fifteen Mile Stream is composed of three minor folds. The two most northerly folds are separated by only 40 metres and plunge to the east at 30 degrees. Map 2 shows the location of the folds in the district. The northernmost anticline is exposed in the west end of the district along the eastern bank of Fifteen Mile Stream. The plunge of the anticline here is to the west at an average of 18 degrees. The east and west plunges of the major anticline meet and form a dome west of the Hudson Property (See Map 2 for location). Faults in the area run parallel or nearly parallel to the strike of the strata.

The quartz veins are of the interbedded class and lie within slate beds with metagreywacke walls. The distribution of the veins is related to the rock structure. The veins are usually found at the domes and on the limbs of anticlines (Faribault,1896). On the sharp, closely folded anticlines the veins are found close to the apex of the fold and generally curve over the anticline. Corrugated veins are common in this district, and are usually found near the apex of an anticline. These veins are usually parallel to one another and strike in a direction approximately parallel to the axis of the fold. Where the corrugations become enlarged over a significant distance they are called rolls. These rolls are favourable locations for gold mineralization. The major portion of the gold at Fifteen Mile Stream was mined from these rolls.

The rocks of this study area possess no effects of contact metamorphism. The nearest granites are 5km to the north, 10km south, and 13km west. There is no evidence of granites underlying the country rocks in the study area.

GEOLOGICAL SURVEY OF CANADA
1889



PLAN AND SECTION
FIFTEEN-MILE STREAM GOLD DISTRICT
HALIFAX COUNTY N.S.

650

19

Map 2 Plan and cross section of the Fifteen Mile Stream Gold District
Copied from E.R. Faribault

CHAPTER 3

HISTORY OF THE MINE

The following is a compilation of information that draws freely from Malcolm (1929,1976) and the assessment files of the Nova Scotia Department of Mines.

Discovered in 1867, Fifteen Mile Stream is one of the oldest gold districts in Nova Scotia. However, active mining was not initiated until 1879 due to the inaccessibility of the area and lack of a good crusher for the ore.

During the years 1867 through to 1874, efforts were directed towards prospecting large extents of ground. This resulted in the location of several areas of auriferous drift, and eventually several promising veins were discovered. In one particular location 20 veins over a width of 52m were uncovered, and in a second location 10 veins were uncovered over a width of 46m. Drift prospecting proved to be the most successful exploration method for locating other veins; the Jackson,Island,Bull,Orient, and Serpent veins, were discovered and mined to a limited extent during the next eight years. Map 1 shows the location of veins in this district.

In 1882 the Hudson Mine was opened in a new area 750m west of the previous mining operations. The Hudson ore-zone consisted of a belt of slate and quartz veins which averaged 14.2 grams of gold per ton. Gold was found in the slate as well as the quartz veins.

During the next 10 years the Egerton Gold Mining Company and its succeeding syndicate produced regularly. The ore came from several productive belts called the Harver,Mother Siegel, and the Nonpareil. These belts consisted of different widths of alternating slate and quartz veins. The Harvey, Mother Siegel, and Nonpareil belts together were 18.5m wide and 92.3m long. Mr. L. MacLean, who was underground foreman at the time, claimed that the slates in these belts contained finely disseminated gold quite distinct from the free gold adhering to slates. In a zone, three metres wide, including mixed slate and quartz, in the Mother Siegel belt, a value of 11.3 grams of gold per ton was obtained. The deepest workings in these belts reached 67m. Drifts between these belts were separated by only 4.5 to 6.1 metres of waste rock. As a result, pillars of ore were left between the belts to help support the workings. In 1896 the pillars were removed resulting in the partial collapse of the Egerton workings. It was then decided to reach the caved-in area by open-cut mining, which was thought to be the best method of gaining access to the remaining ore. In the spring of 1898 the open-cut workings encountered the old workings resulting in a substantial cave-in. Despite this setback, efforts to secure the caved area continued as the area was known to contain rich ore. W. Borlace (an English engineer) sunk a vertical shaft north of the Harvey and Mother Siegel belts in 1898. This shaft reached a depth of 56m where it was abandoned due to flooding problems.

In 1927 four diamond drill holes were drilled by the Huronian Belt Company; three of the four holes terminated in the old workings of the Harvey, Mother Siegel, and Nonpareil belts. Core recovery was poor due to inadequate drilling equipment. The drilling program was successful in locating a new mineralized zone north of the known ore zones; this zone to date has never been exploited. Interestingly, assays of the wall rock ranged from 2.56 to 4.16 grams of gold per ton over a one metre length. In areas of the core where gold was found, it was widely distributed and disseminated in character.

The Fifteen Mile Stream Syndicate dewatered the old workings in 1934 and sampled vein material. The results of these tests were not favourable and no further work was carried out.

The Egerton Mine records show that mining efforts were directed towards following visibly auriferous quartz veins. The material hoisted to the surface was hand sorted to remove waste rock.

The government of Nova Scotia, in cooperation with the federal government, took over the leases the the property in 1938 for the purpose of conducting a rehabilitation project. The objectives of the project were twofold: the first was to train older unemployed men to mine, and secondly to test the potential of the Fifteen Mile Stream gold district.

A preliminary survey of the area was conducted by G.V. Douglas of the Department of Mines in the summer of 1938. The purpose of the survey was to locate the McLean shaft. It was hoped that by extending the 27.7m(90') level east, a better idea of the structure in the area could be obtained. New surface buildings and a mine were erected by late 1939.

The McLean shaft and lead were dewatered late in 1939. A new shaft house was installed over the McLean shaft and this was connected to the mill house by a gantry containing a picking belt. The mill equipment consisted of a .9m by 1.5m Allis Chalmers ball mill with Atkins classifier, gold jigs, concentrating tables and blankets. The property was operated by electric power for the first time. Previous power to operate the mines had come from steam and wood.

Work during 1940 was limited to the 27.7m(90') level of the McLean lead. Figure 5 shows the extent of the workings carried out by the Rehabilitation Project at this level of the McLean during 1940.

Results of the east drift along the McLean and the east and north drifts along the Serpent indicated sharp anticlinal and synclinal folds. Only two anticlinal noses could be found. A report by Faribault (1903) indicated the possible existence of a third anticline in this area; however, the project did not confirm this.

The sharp structures were unpropitious for the mining methods of the time. At 1.13 dollars per gram ($35.00/ounce,US) the mining of ore from these structures was not economical. As a result it was decided to crosscut south at the same level from the main McLean drift, to explore further the structure of the area.

Mill tests were conducted on the C,E,A,Serpent, and Twin veins. Results of these tests are shown in Table 1, show that the A,C, and Twin veins gave fair values for gold, however the values were considered uneconomical at the time. Following the mill tests, further drifting encountered favourable ore but of limited extent in two areas. The first zone was located in the vicinity of the axis of a synclinal fold between the Twin west and the Twin south crosscut. The second promising location was situated in an area of a parasitic fold which was located on the north side of an anticlinal nose in the vicinity of the east Serpent drift.

The gold enrichments appeared to be irregular in distribution.

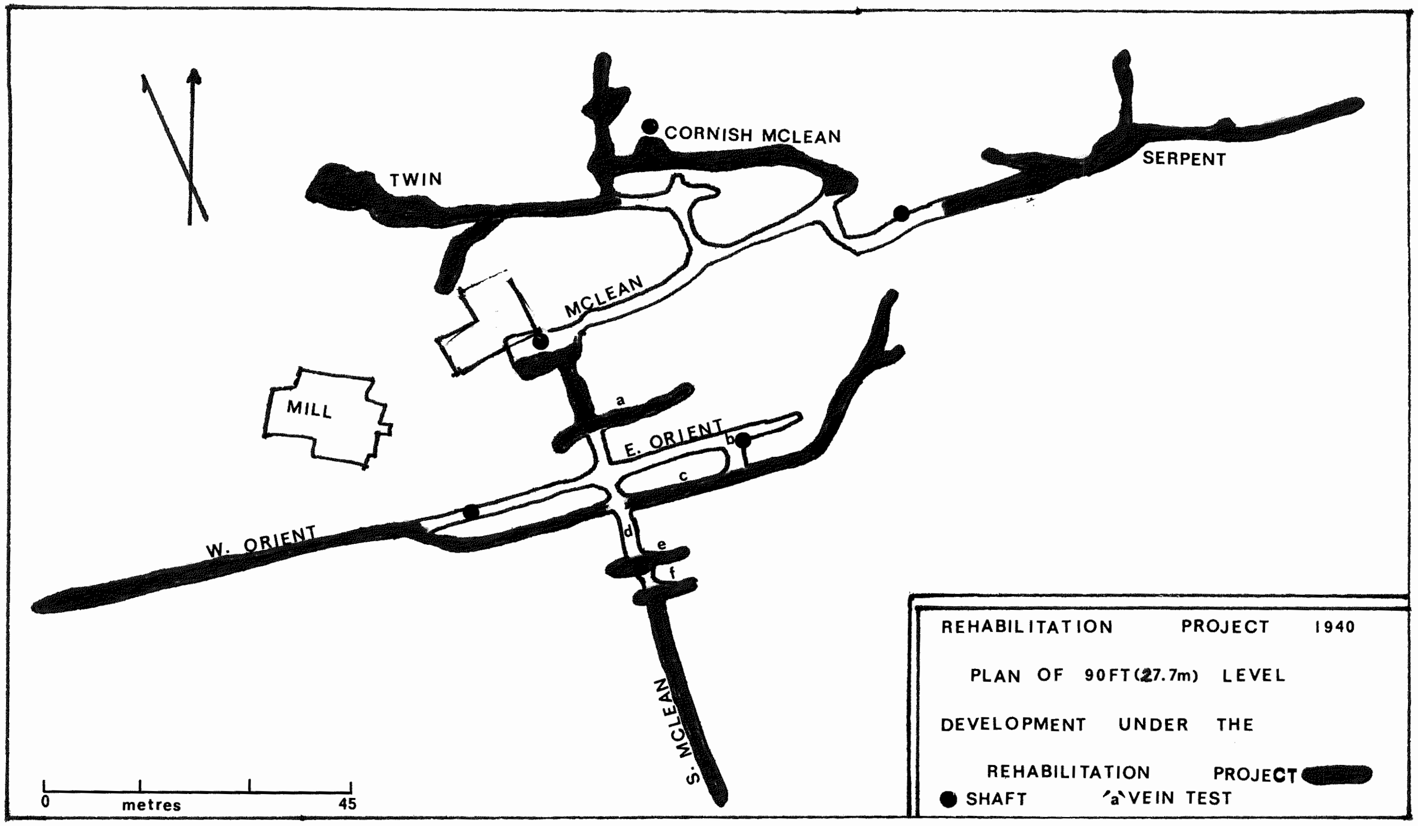


Fig.5 Underground plan of the 90' (27.7m) level during 1940. Darkened areas represent development under the Rehabilitation Project.

MILL TESTS FOR THE 1940 REHABILITATION PROJECT

Veins	Hoisted tons	Milled tons	Grams	Hoisted g/ton	Milled g/t
A	123	28	159.4	1.29	5.69
C	150	47	244.5	1.63	4.37
E	106	56	163.2	1.54	2.91
S	94	33	140.8	1.50	4.27
T	119	53	293.44	2.47	5.54
Total	592	217	1001.34	5.96	22.78

Table 1.*

---

* These values represent material taken from areas where the high grade ore had already been mined.

It should be noted that the promising Twin and Serpent leads were were on the footwall and hanging wall respectively of a large slate belt. In contrast, the McLean lead, which showed little or no enrichment was in metagreywackes.

During the following year, in 1941, the McLean shaft was extended to the 61.5m(200') level to explore further the structure in the vicinity of the McLean, Twin, and Serpent veins. Figure 6 shows the extent of workings carried out at this level. A total of 269m of drifting and crosscutting was completed on this level. The east and west McLean leads were stoped downwards for 18.5 and 20m respectively. The amount of visible gold in the east McLean was less that in the west. In addition, the Twin lead was stoped resulting in a total of 417 tons. Two diamond drill holes were drilled horizontally from the McLean for further structural information.

A portable 5-stamp mill was erected on the surface for the purpose of test-milling stockpiled ore. The ore used in this test consisted of material from the east and west McLean drifts, the east and west McLean stoped backs, and the Twin drifts. The results of this test are listed in Table 2.

Late in December of 1941 work was suspended when government funds were expended. World War II had begun two years previously and it was decided that the money needed for further development and improvement would best be spent elsewhere. Table 3 shows the total production figures for the Fifteen Mile Stream gold district.

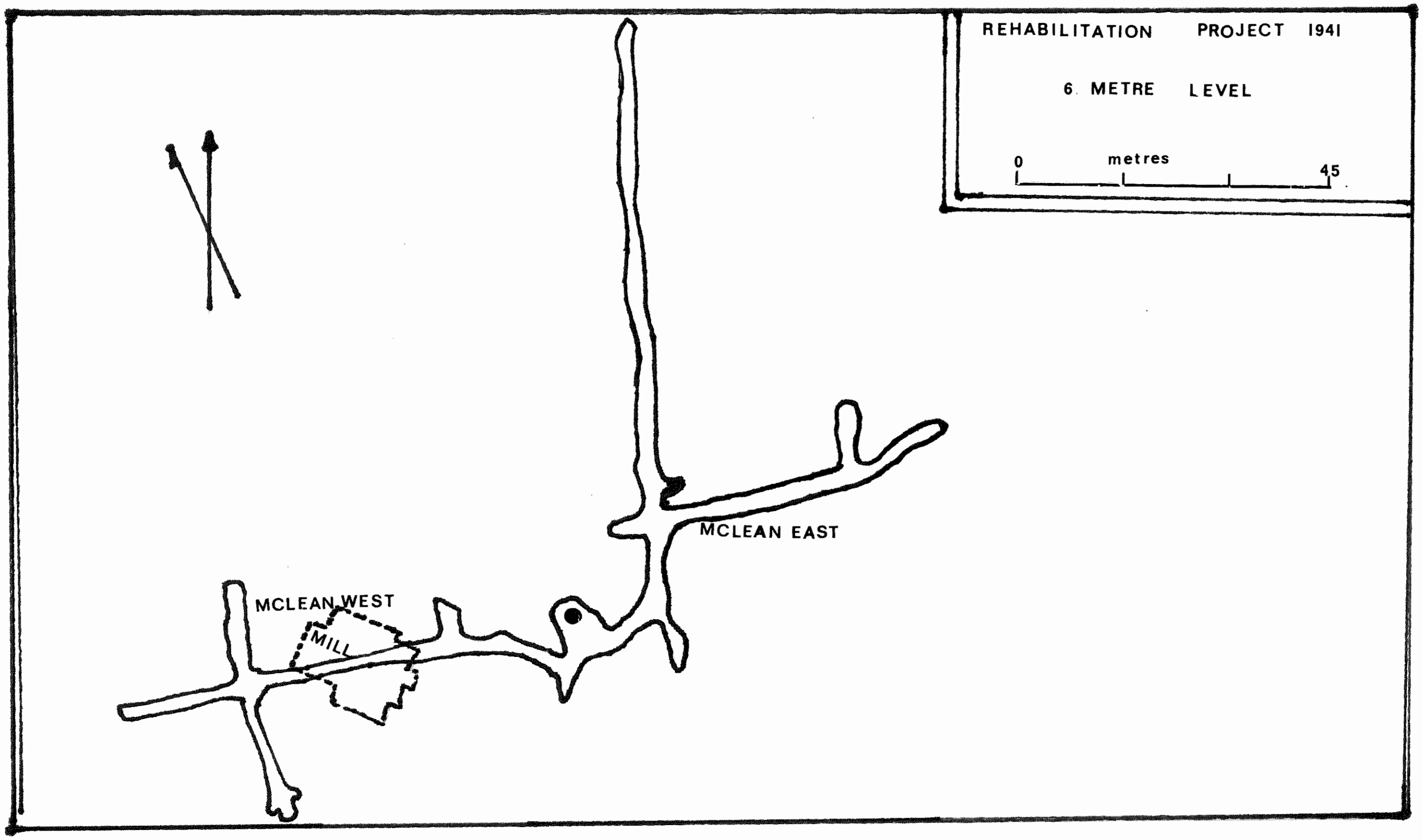


Fig.6 Underground workings for the 1941 Rehabilitation Project

1941 MILL TEST FOR THE REHABILITATION PROJECT

Tons Hoisted	Tons Sorted	%Sorted	Crude Gold produced /g	Grade g/ton
557	239	57	4960	20.75

Table 2

PRODUCTION AT FIFTEEN MILE STREAM GOLD DISTRICT

		OUNCES	
YEAR	ORE CRUSHED TONS	YIELD OF GOLD	G/TON
1883	83.00	46.879	.56
1884	107	88.706	.83
1885	898.00	424.763	.47
1887	829.00	398.250	.48
1888	2151.00	946.400	.44
1889	1417.00	786.450	.56
1890	3025.00	2304.787	.76
1891	4862.00	2549.425	.52
1892	2367.00	880.850	.37
1893	788.00	350.850	.45
1894	1173.00	508.300	.43
1895	4734.00	1976.700	.42
1896	6059.00	3323.750	.55
1897	9198.00	2856.900	.31
1898	3395.00	541.850	.16
1899	1660.00	355.800	.21
1900	- - - -	79.350	- -
1902	1983.00	323.050	.16
1903	1580.00	332.250	.21
1910	180.00	148.900	.83
1911	242.00	155.350	.64
1940	2615.70	209.743	.08
1941	359.90	160.611	.44

TABLE 3

CHAPTER 4

DATA AND DISCUSSION

4.1 Tailings

4.1.1 Grain Size Analysis

The tailings from the Egerton (prefix E) and McLean (prefix M) were sieved in brass sieves using 0.25 phi intervals between greater than -1.0 phi and greater than + 4.0 phi. The results are presented in Appendix I. The mean, median, and mode of the samples, determined from cumulative frequency plots (See Appendix I), are summarized in Table 4.

Generally the most abundant (modal) grain size for both tailings piles is between 2.25 and 2.50 phi; the exceptions are samples M4, and E3. Differences between the two tailings piles are evident, in that the mean grain size for the McLean tailings ranges from 1.95 phi to 2.43 phi, whereas the mean grain size for the Egerton tailings range from 2.08 to 2.45 phi. Therefore on average the McLean tailings are coarser.

4.1.2 Mineralogy

4.1.2.1 X-ray Diffraction Analysis

The 2.75, 3.75, and 4.0 phi fractions of the tailings from each of the 10 samples were analyzed by x-ray diffraction (XRD). The results, summarized in Table 5 revealed that the mineralogy of the two tailings ponds is similar.

4.1.2.2 Visual Examination

A visual examination was performed on the 2.75 phi fractions in order to identify the constituents and to determine the abundances

STATISTICAL SUMMARY OF SIEVE ANALYSIS OF TAILINGS

Sample No.	Mean	Median	Mode	Skewness
M1	1.95	2.05	2.25-2.5	neg.
M2	2.42	2.40	2.25-2.5	pos.
M3	2.17	2.28	2.25-2.5 1.75-2.0	neg.
M4	2.43	2.47	3.0-3.25	neg.
M5	2.33	2.35	2.25-2.5	neg.
E1	2.25	2.18	2.25-2.5	pos.
E2	2.08	2.18	2.25-2.5	neg.
E3	2.14	2.13	1.75-2.0	pos.
E4	2.45	2.48	2.25-2.5	pos.
E5	2.28	2.28	2.25-2.5	norm.

Table 4.

neg. = negative

pos. = positive

norm. = normal

SUMMARY OF THE MINERALOGY OF THE TAILINGS PILES

quartz
calcite
muscovite
biotite
anatase
rutile
ilmenite
arsenopyrite
plagioclase
chlorite
magnetite
pyrite

Table 5

of the rock fragments and minerals in each sample. The results are presented in pie diagrams in Figures 7 and 8.

The 2.75 phi fractions consist of micaceous fragments of black and grey slates, angular fragments of metagreywackes, and subconchoidal fragments of quartz grains, anhedral to subhedral ilmenite, subhedral magnetite, tabular calcite, and micas.

From Table 5, it can be seen that the overall mineralogy of both tailings piles is similar. However, Figures 7 and 8 show that the proportions of the minerals and lithic fragments of the two piles differ. The McLean tailings possess less slate and quartz fragments and more metagreywacke fragments than the Egerton tailings.

4.1.2.3 Heavy Minerals

The 3.0 phi to 4.0 phi fractions were homogenized and 40 g samples were separated using the heavy liquid tetrabromethane (specific gravity 2.97). The technique used is described in Appendix I. The percentages of the heavy minerals per 40 g sample are shown in Figure 9.

The McLean tailings average 19.2% heavy minerals, and have a significantly higher proportion of heavy minerals when compared to the Egerton which average 9.8% heavy minerals.

The minerals present in the heavy mineral proportion were identified by XRD, and consist of quartz, rutile, anatase, tourmaline, micas, arsenopyrite, pyrite, ilmenite, and magnetite. Although the mineralogy is similar for both tailings piles, the proportions of the heavy minerals differ as determined by visual

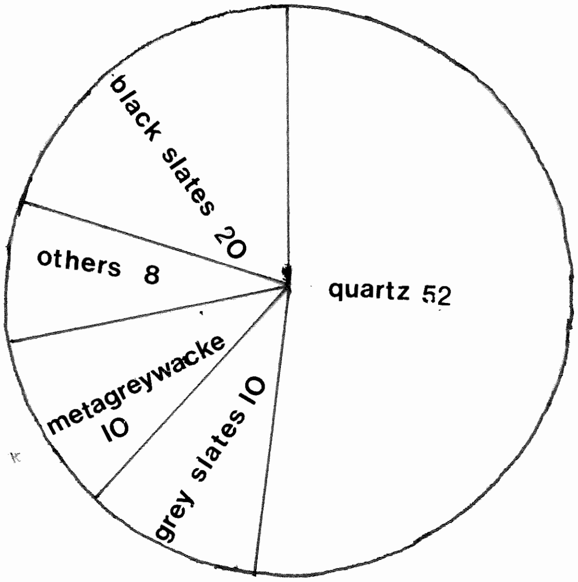


Fig. 7 Mean composition of the Egerton tailings

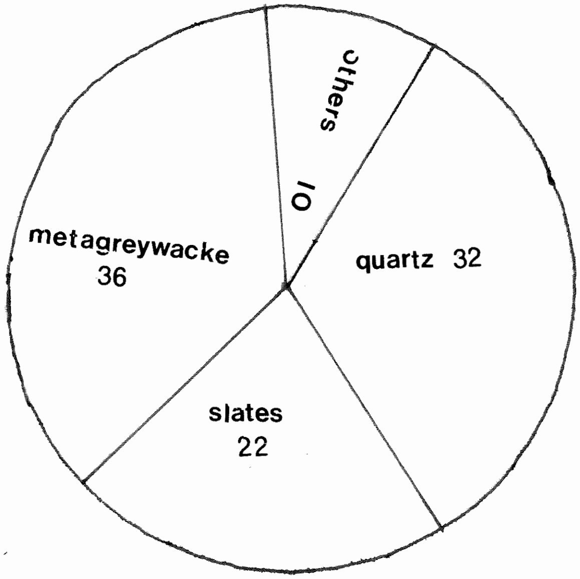


Fig. 8 Mean compostion of the McLean tailings

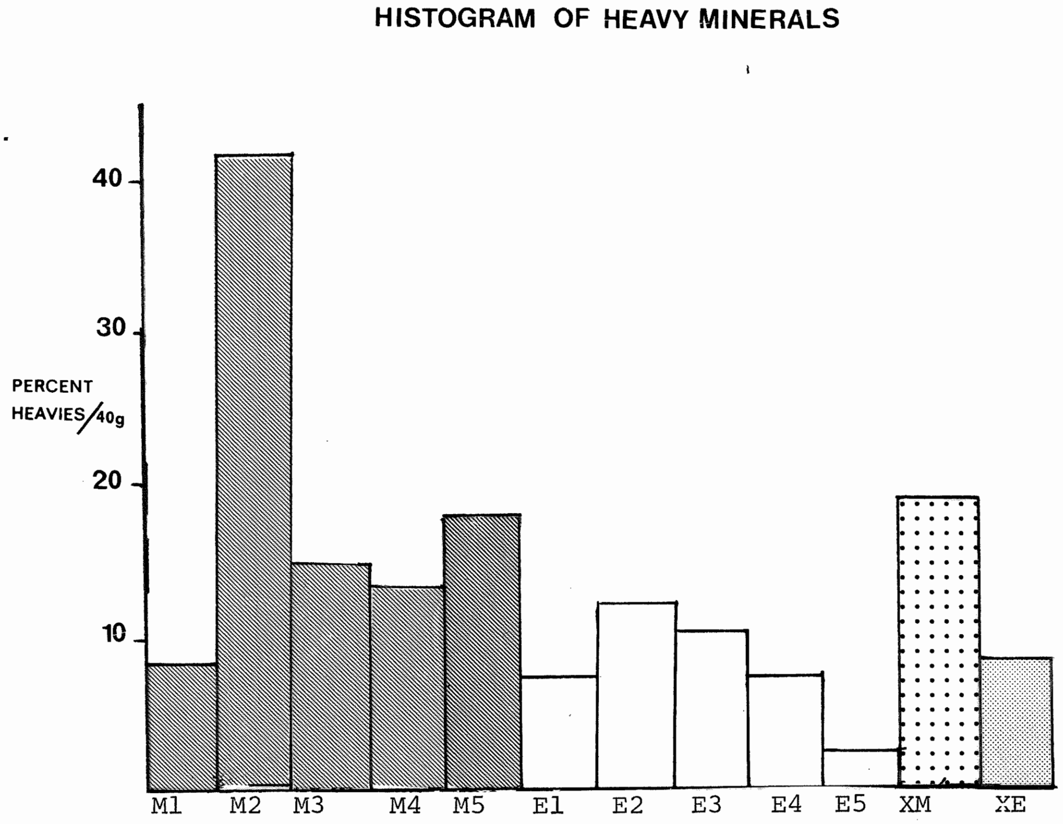


FIG. 9

The percentage of heavy minerals per sample

The shaded area represents the McLean heavy mineral fraction, and the white histogram the Egerton. The averages for each tailings pile are plotted at the right hand side of the histogram.

examination (See Figures 10 and 11).

In general the heavy mineral fractions consist of acicular turbid crystals of rutile and anatase, black to dark green crystals of tourmaline, subhedral black shiny ilmenite, black magnetite, quartz grains, fragmented arsenopyrite, and lithic fragments attached to heavy minerals. In addition, visible gold was observed in the McLean heavy mineral fractions but was rare to absent in the Egerton heavy mineral fractions. Minor amounts of galena are present in the Egerton heavy mineral fraction.

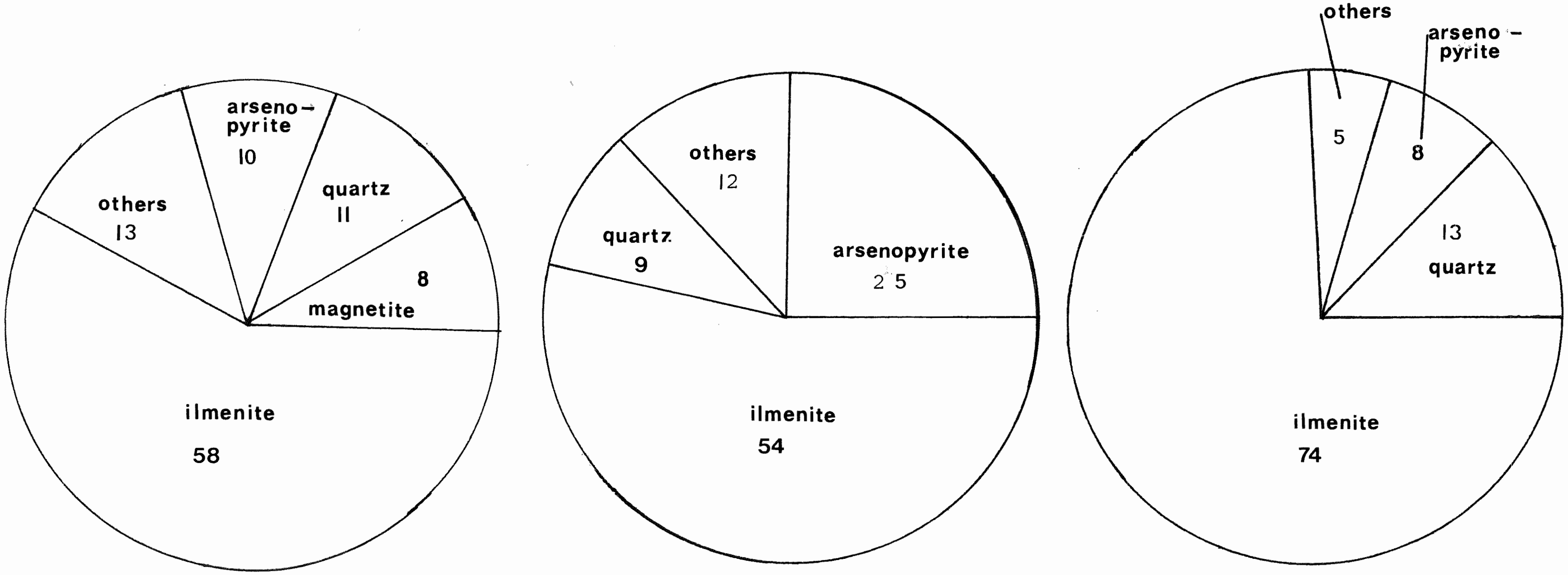
SEM photographs of some of the constituents of the heavy mineral fraction are shown in Figure 12.

Fifteen representative grains from each heavy mineral fraction were placed in grain mounts and analyzed by the energy method of EMP. Table 6 summarizes the results of this analysis. The findings of the EMP confirm the visual identification.

A magnet was applied to the heavy minerals in order to remove and identify the magnetic components of the heavy minerals. XRD analysis confirmed that ilmenite, which is supposed to be slightly magnetic was the dominant mineral. Magnetite was the only other mineral detected.

The composition of some ilmenite grains was analyzed by EMP; results are displayed in Table 7. The iron content was recalculated to include Fe^{3+}, using the Super Recal program. The results are plotted on a triangular diagram in the FeO-Fe_2O_3-TiO_2 system. Not all grains were able to be plotted on this diagram because the Fe^{3+} contents obtained were negative. (See Figure 13).

A solid solution can exist between hematite and ilmenite,



HM3 HM1 HM2

Fig. 10a Composition of the McLean heavy minerals

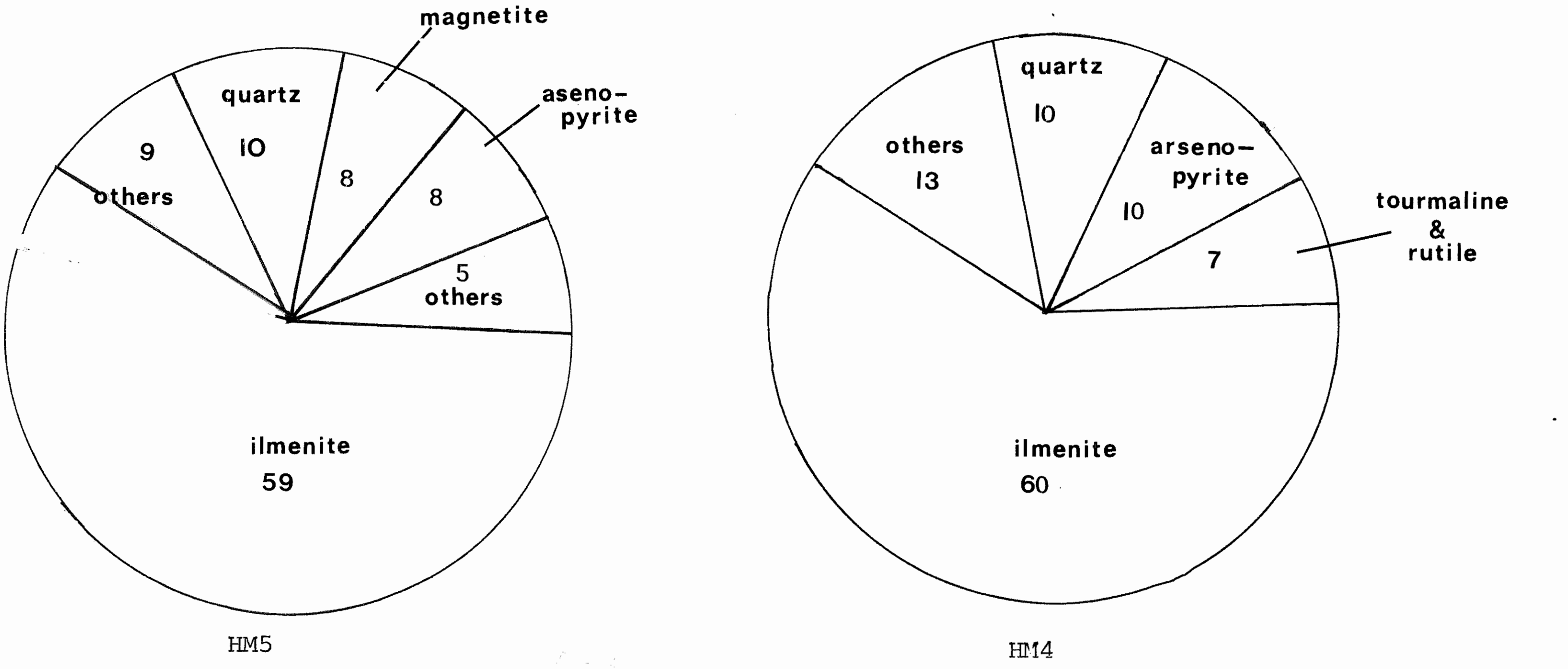
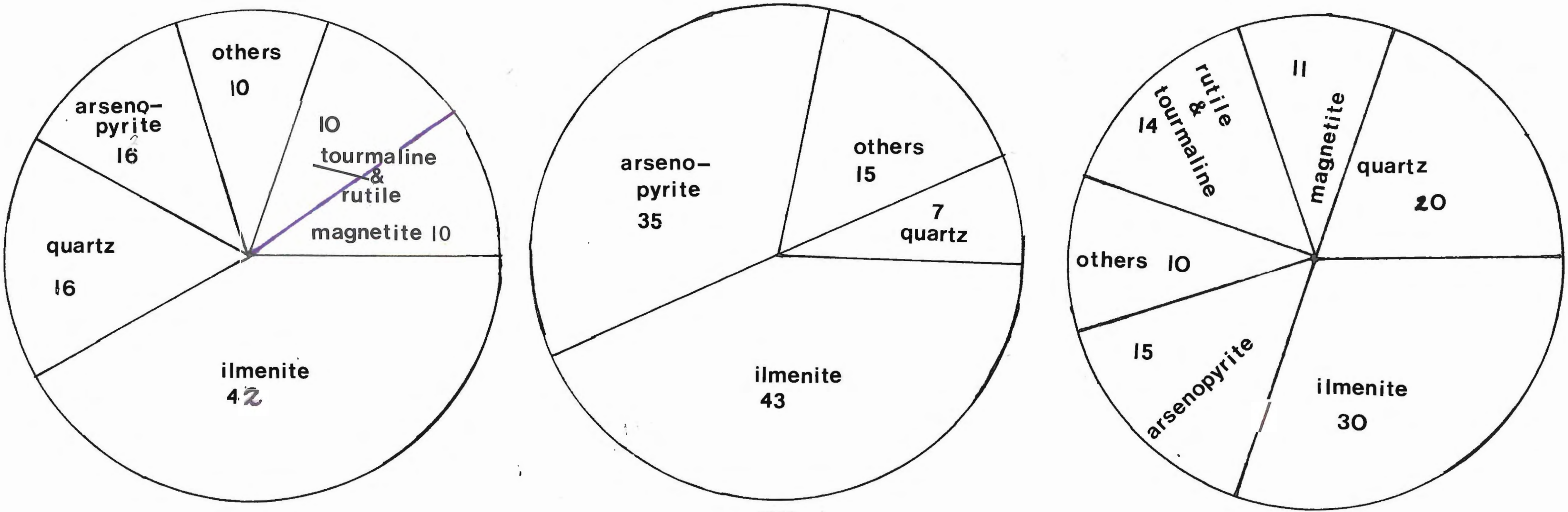
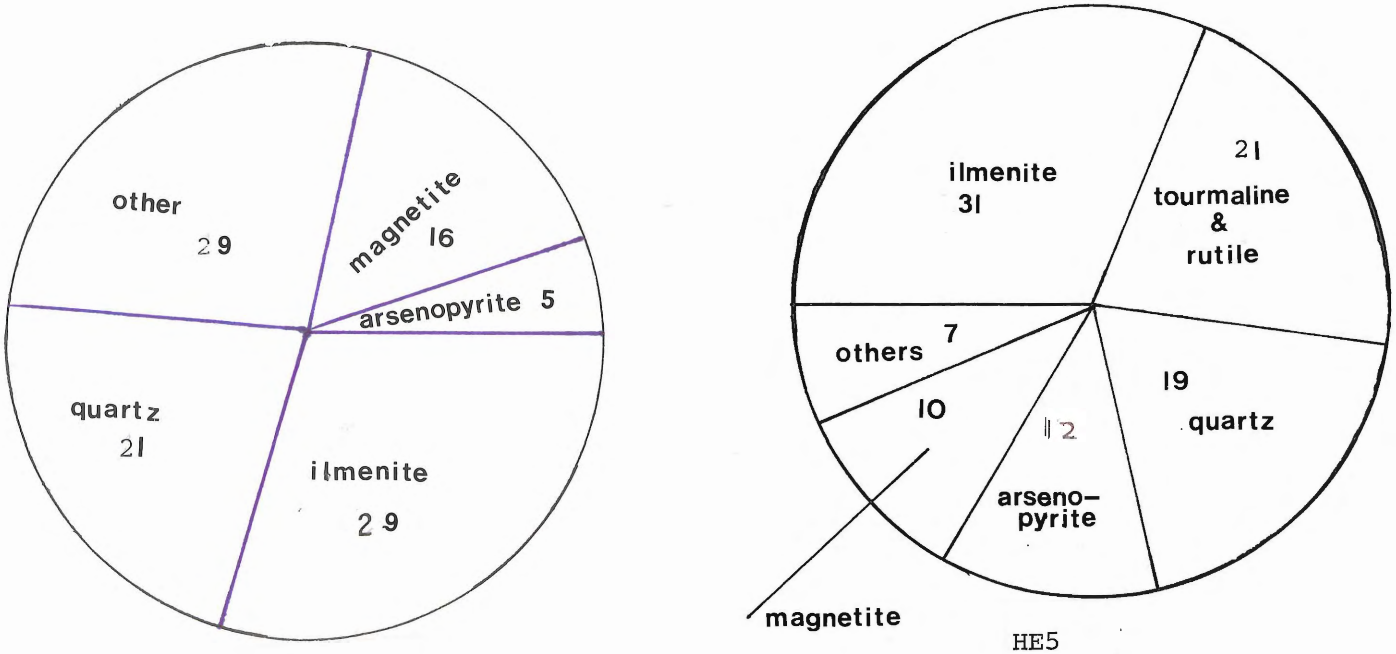


Fig. 10b Composition of the McLean Heavy Minerals



HE4 HE2 HE1

Fig. 11a Composition of the Egerton Heavy Minerals



HE3

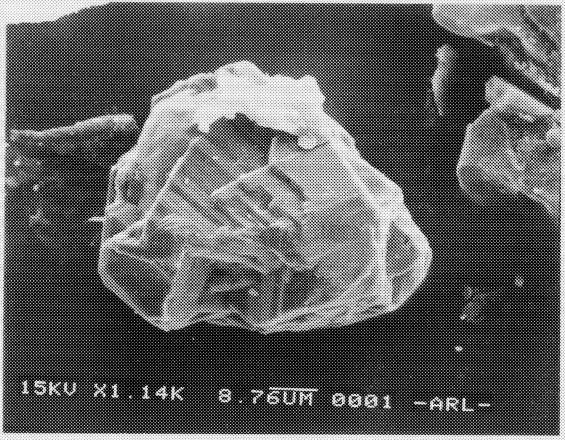
HE5

Fig. 11b Composition of the Egerton Heavy Minerals

Fig. 12 SEM photographs of heavy minerals.

Tentative identification:

a) magnetite
b) tourmaline
c) magnetite
d) tourmaline
e) rutile or anatase
f) rutile or anatase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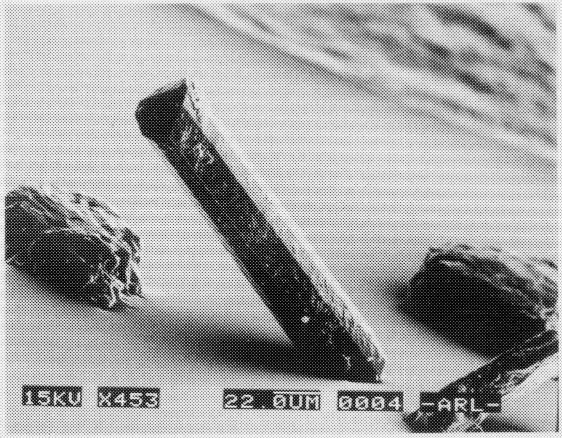
A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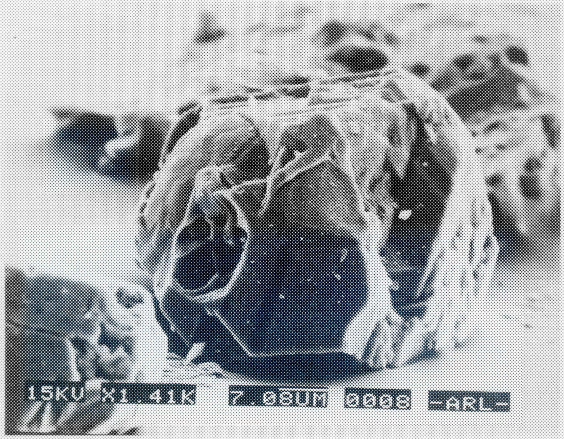
B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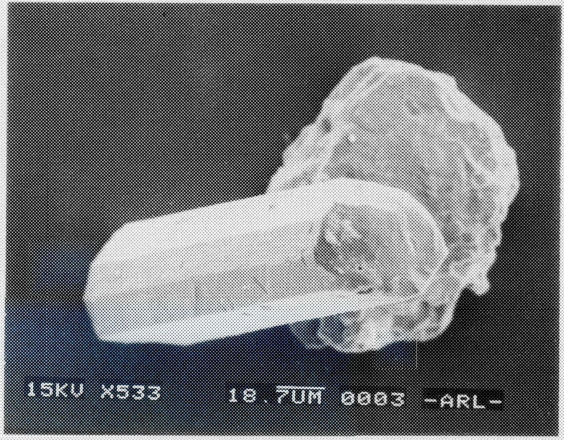
C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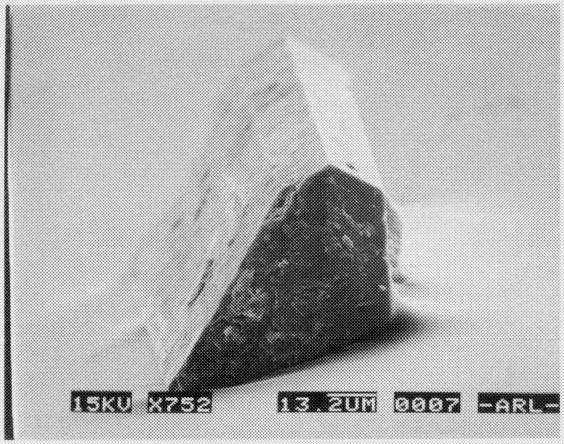
D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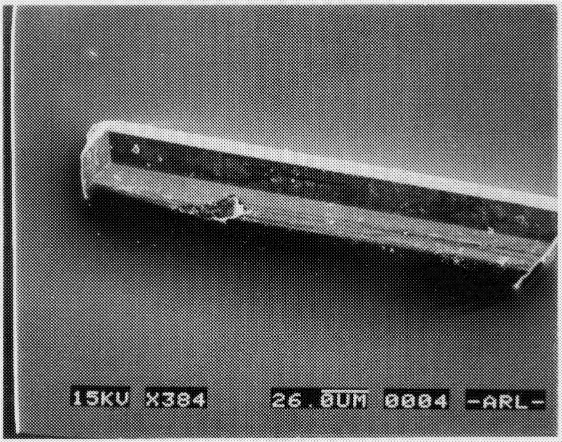
E


15KV X384 26.0UM 0004 -ARL-

F

EMP ANALYSIS OF HEAVY MINERAL GRAINS

McLean Heavy Minerals

Mineral	% of Occurrence
ilmenite	46
arsenopyrite	14
lithic fragments	27
others	13

Egerton Heavy Minerals

arsenopyrite	30
ilmenite	21
rutile, anatase	15
lithic fragments	12
quartz	10
magnetite	12

Table 6

This table represents mean values

ELECTRON PROBE ANALYSIS OF ILMENITE

Grain	TiO	FeO	MnO	SiO_2	Total
M1	51.41	44.56	2.97		98.82
M2	50.90	45.48	2.22		98.71
M3	50.45	44.49	2.43		97.36
M4	50.74	44.29	2.59		98.73
M5	52.67	41.05	5.38		99.16
M6	52.46	40.55	5.49	.16	98.56
E1	54.46	42.42	4.76		101.74
E3	54.59	42.42	5.24		102.25
E4	49.97	38.70	5.01	9.36	102.94
E5	54.32	42.96	5.04		102.32
E6	53.62	41.36	5.24	1.66	101.89
E7	53.71	37.10	4.53	.27	95.61*
E8	51.83	41.07	4.74	1.95	99.59
E9	50.76	39.24	4.76	2.36	101.12

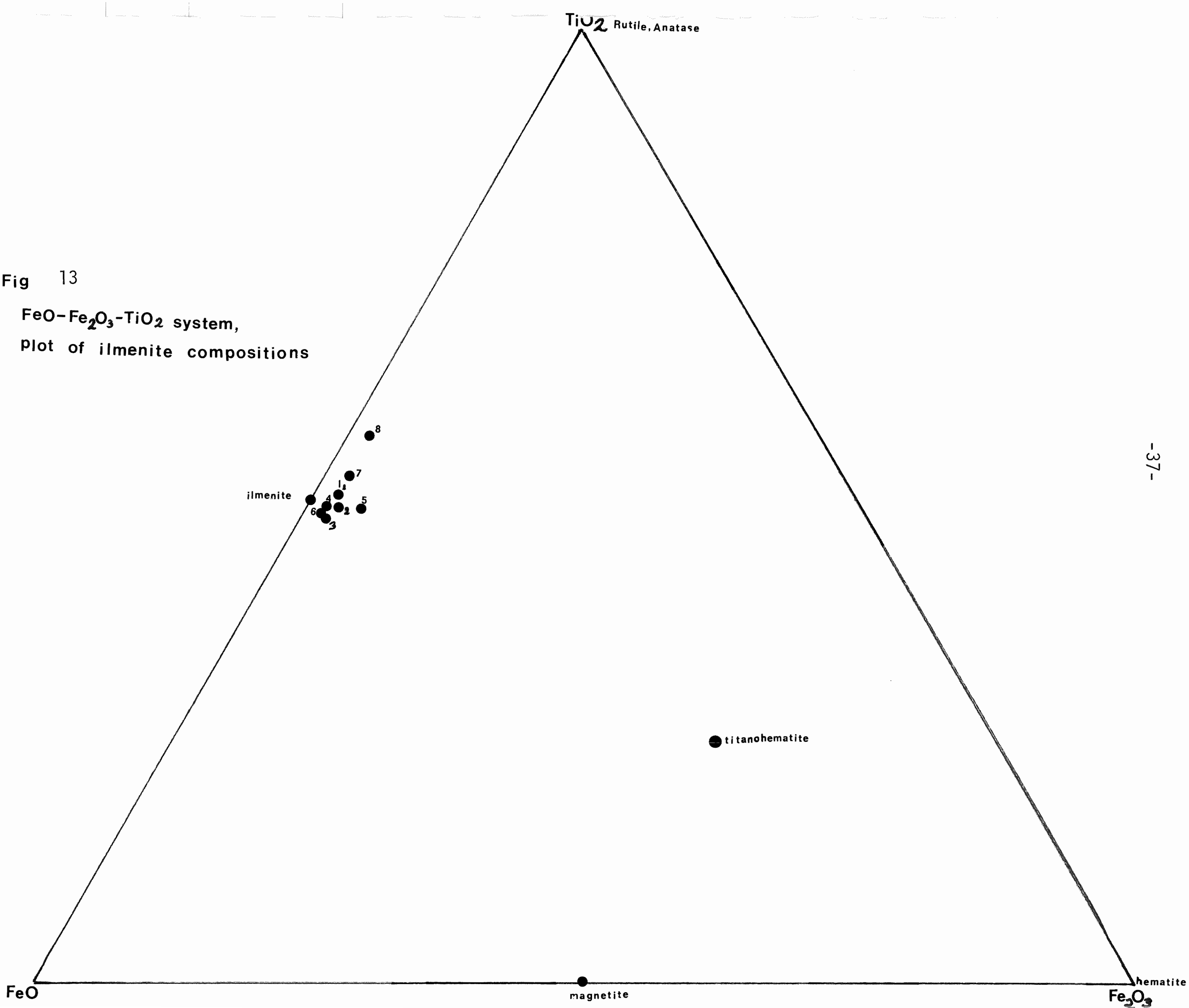
Table 7

*Total is low due to inclusion of mica

Fig 13

$FeO-Fe_2O_3-TiO_2$ system,

plot of ilmenite compositions



and the resulting mineral titanohematite is magnetic. However, as Figure 13 indicates, the mineral is ilmenite and not titanohematite.

It can be seen in Table 7 that some of the ilmenite grains contain mica and quartz inclusions.

Gold was a rare but visible constituent of the heavy mineral fractions from the McLean tailings and almost non-existant in the Egerton tailings. SEM photographs of the gold (Figure 14) reveal that some grains possess pitted surfaces, while other grains appear as flakes or finger-like projections. The latter type of gold grain shows no evidence of shape alteration. This type of gold grain is similar to those found in the fine material of the dump (See section 4.3 for further discussion). The grain size of the gold grains varied from 2.5mm to hundreds of microns in size.

The compositions of several gold grains were determined by the wavelength method of EMP analysis, and the results are shown in Table 8. The composition of the gold is relatively consistent, and is composed on average of 91% gold, and 9% silver.

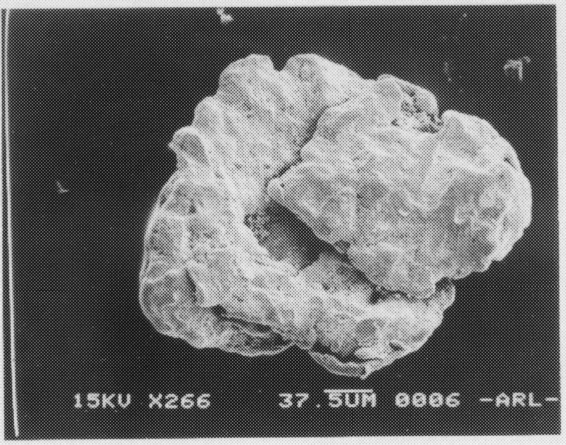
X-ray photographs shown in Figure 15 show the distribution of gold and silver within two gold grains. The elements appear to be homogeneously distributed.

4.1.3 Geochemistry

Two 10 g samples of the heavy minerals from each the McLean and the Egerton workings were analyzed for Cr, Ni, Pb,As, and Au, by Bondar-Cleff and Company Limited in Ottawa. The precision and methods of analysis are explained in Appendix I

Fig. 14. SEM photographs of gold grains.

a) two grains adhering to one another
b) pitted surface
c) close-up of a pitted surface
d) gold flake
e) gold flake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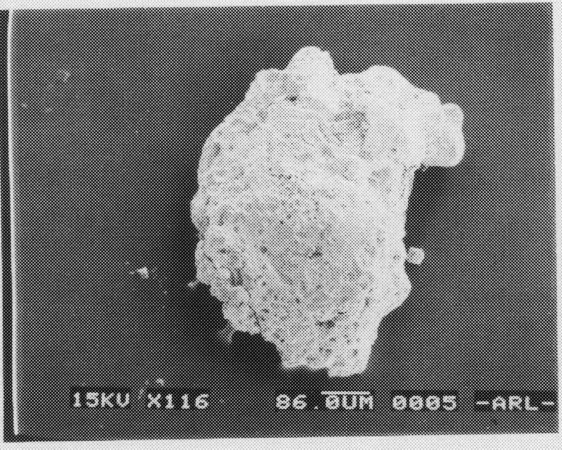
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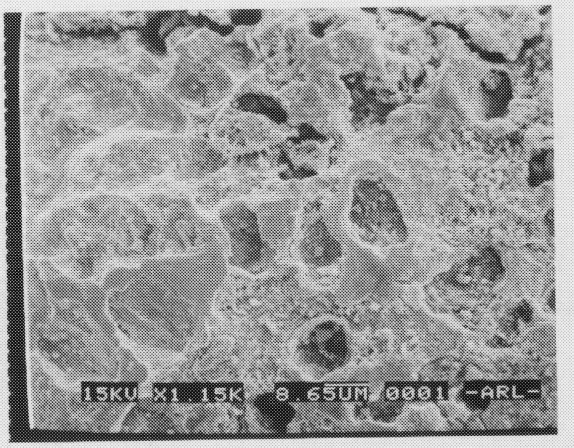
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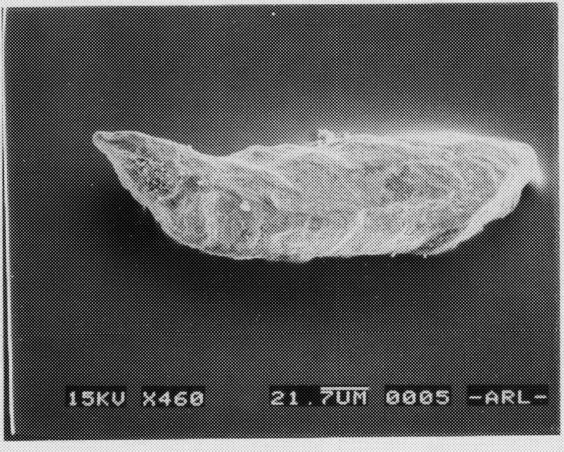
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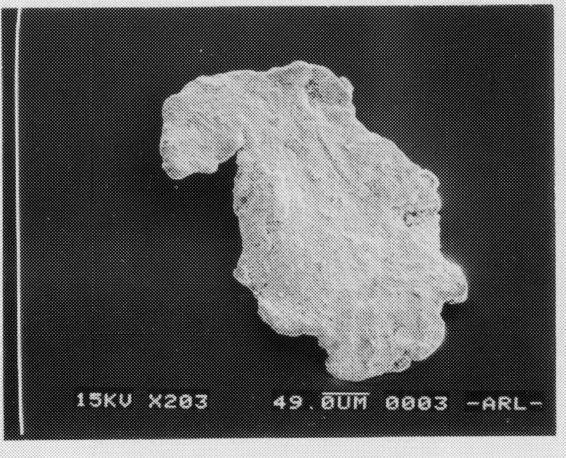
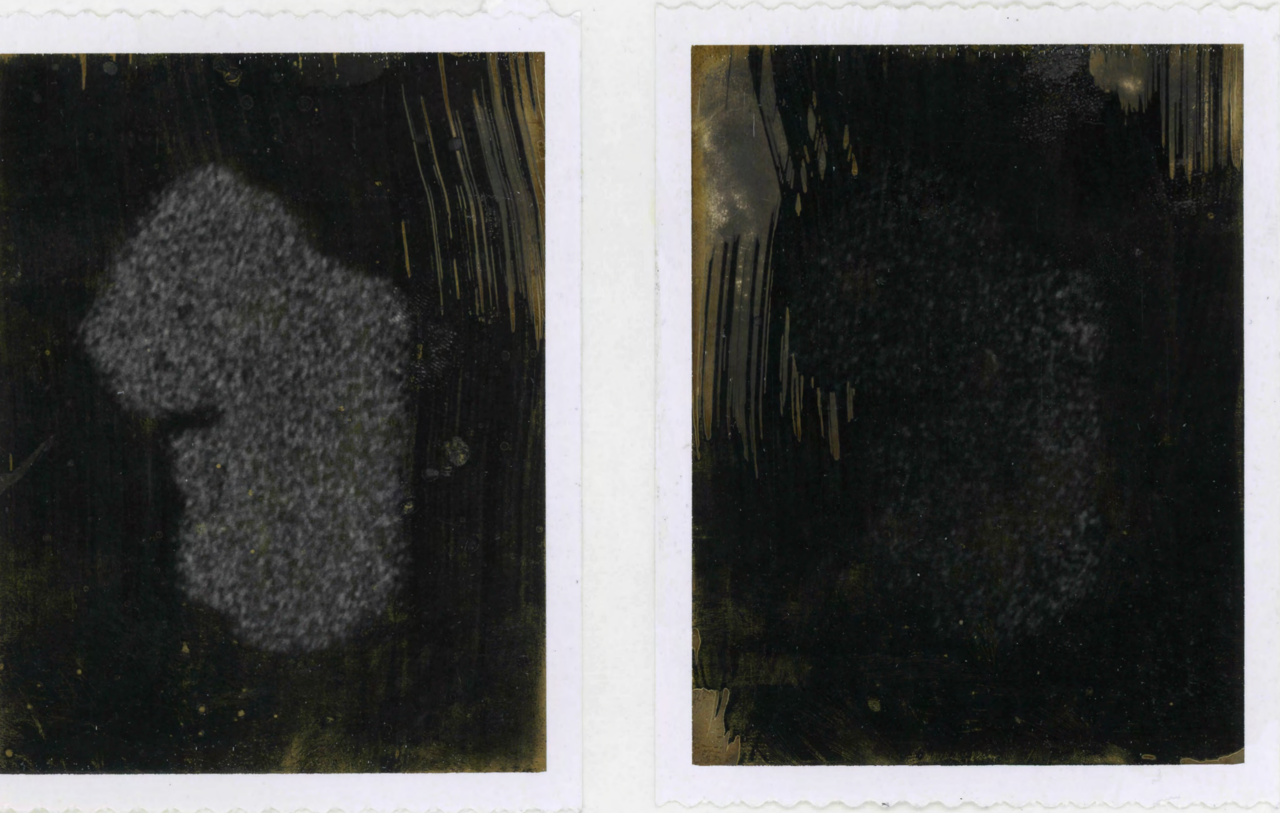

15KV X203 49.0UM 0003 -ARL-

COMPOSTIONS OF GOLD GRAINS FROM THE TAILINGS PILES

Grain	Element	Cu	Zn	Ag	Au	Total
1a		.41	0.0	9.13	92.39	102.03
1b		.48	0.0	8.78	90.10	99.35
1c		.36	0.0	9.04	91.94	101.34
2a		.54	0.0	6.48	93.87	101.05
2b		.50	0.0	7.80	90.11	98.41
3a		.52	0.0	10.44	88.98	99.93
3b		.39	0.0	8.64	90.43	99.46
4a		1.17	0.0	8.77	90.83	100.77
4b		2.83	.23	8.93	88.43	100.41
5a		.73	0.0	4.65	95.40	100.78
5b		.73	0.0	3.96	95.33	99.65
6		.36	0.0	8.98	90.95	100.29
7a		.23	0.0	4.87	92.11	97.22
7b		.26	0.0	5.62	91.86	97.74
8		1.28	0.0	8.33	88.92	98.53

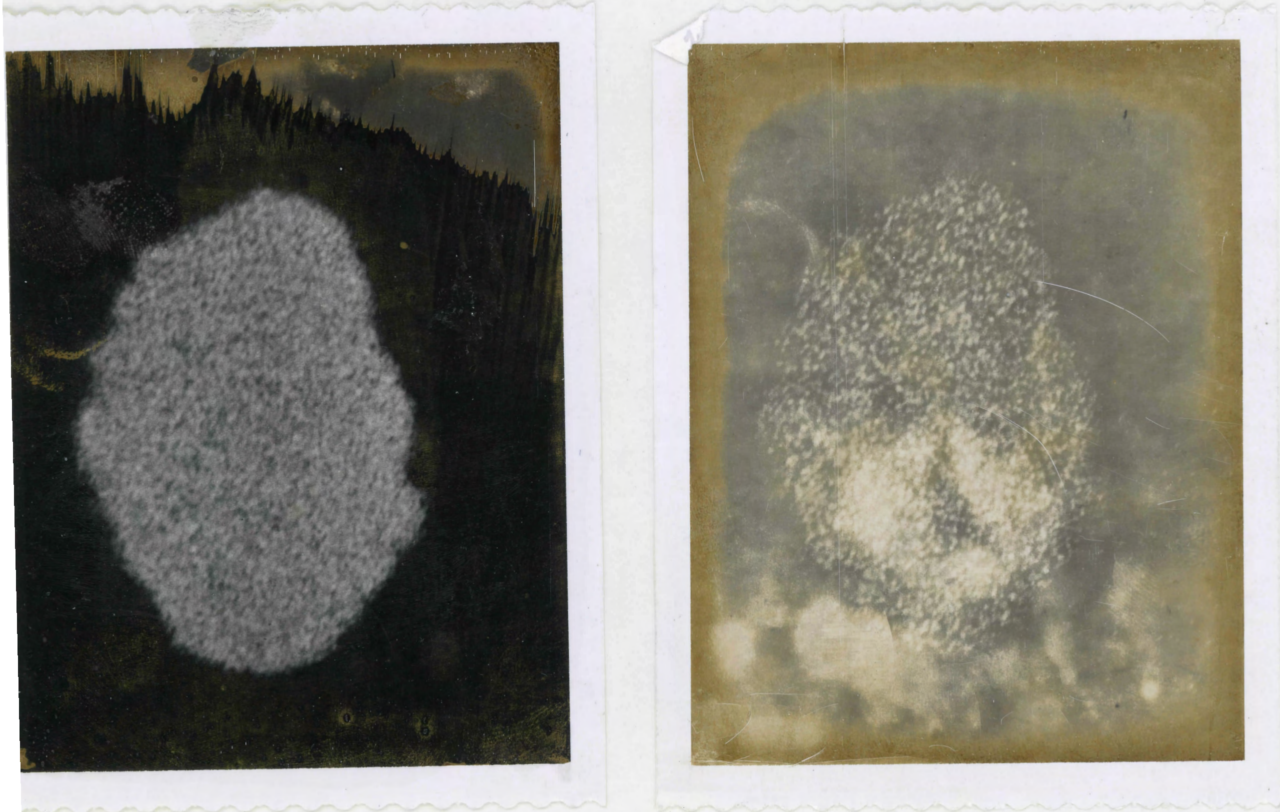
Table 8

* Several spots were probed per grain; a represents the center of the grain and b,c the edges of grains.



Gold x400

Silver x400



Gold x500

Silver x500

Fig. 15
X-ray photographs of gold grains

The geochemical analysis as shown in Table 9 indicated a distinct elemental difference between the two heavy mineral fractions. The Egerton tailings have more Pb and Ni than the McLean, whereas the Cr values are comparable. The percentage of arsenic is much higher in the Egerton tailings. Despite the lack of visible gold in the Egerton tailings, the assay values for gold are only slightly lower than the McLean tailings.

4.2 Rocks

4.2.1 Lithology

The following rock types were found in the dump rocks of the district; grey metagreywackes, green-grey metagreywackes, grey slates, and black slates.

The slates of the district are characteristically micaceous or extremely brecciated and oxidized. This latter type of slate is full of sulphides, especially arsenopyrite.

Black slates constitute a large proportion of the Egerton dump rocks, and metagreywackes are prevalent at the McLean site.

4.2.2 Thin section description

Five polished thin sections of the representative host rocks in the area were observed in both transmitted and reflected light.

4.2.2.1 General rock description

Generally the metagreywackes consist of a medium grained matrix of subangular quartz, sericitized plagioclase (An0-4), laths of muscovite, biotite, intergrowths of biotite and chlorite, calcite, acicular tourmaline, opaques, and minor amounts of sphene and epidote.

The opaques include; chalcopyrite, arsenopyrite, pyrrhotite, ilmenite, magnetite, and pyrite. Pressure shadows exist around some opaques.

The matrix is deflected around angular to lenticular masses of recrystallized quartz grains. Muscovite, fragmented opaques, and acicular minerals (rutile, tourmaline, anatase) are included in these masses.

The slates consist of a fine grained matrix of quartz, plagioclase, muscovite, biotite, and chlorite. Magnetite is randomly scattered throughout the matrix, as is rutile and anatase. Ilmenite is present in small amounts. Relict layering is evident in the slates.

4.2.2.2 Ilmenite

Ilmenite is manganoan, containing 2.2-5.49 weight percent of MnO.

The mineral occurs as;

a) discrete anhedral coarse grains

b) coarse grains containing mica and quartz inclusions

c) heterogeneous aggregates of altered grains or amorphous masses of iron titanium oxide (determined from EMP to be ilmenite).

EMP also showed that the heterogeneous aggregates consisted of the following elements; Al, Ca, Ti, Mn, and Fe.

The mineral in most cases appears to overprint the matrix. A few cases were observed where the matrix swept around the heterogeneous ilmenite grains.

GEOCHEMICAL ANALYSIS OF HEAVY-MINERAL-SEPARATES

	Element	Cr ppm	Ni ppm	Pb ppm	Au ppm	%As	%Ti
Egerton	1	28	135	148	138	5.19	20.5
	2	30	62	265	106	4.46	14.5
McLean	1	14	4	93	153	.23	31.3
	2	41	3	92	122	.15	28.9

Table 9

4.2.2 EMP

The compositions of the sulphide minerals were analyzed using both the wavelength and energy dispersive methods of electron probe analysis. The results are presented in Tables 10 through 12.

There is no significant difference in the compositions of the sulphides between the two properties. Zinc, vanadium, and nickel are trace elements present interstitially in the pyrrhotites structure. These elements were not observed forming independent minerals.

4.2.3 Geochemistry

Ten rocks representative of the dump material were analyzed by the laboratory of the Technical College of Nova Scotia for gold. However results of this analysis were insignificant. Significant quantities of gold have been reported from assays of the host rocks of this area (See page 13). In addition MacEachern (1983) reports the finding of gold sandwiched within a fragment of metagreywacke.

4.3 Dump Fines

Dump material represents material that was mined, but had not gone through the milling process. This material was sieved in brass sieves between the intervals -1.0 phi and +4.0 phi.
Each phi fraction was weighed and the results were plotted in histogram form. (See appendix 1). The results of the sieve analysis revealed that this material is much coarser than the tailings. XRD analysis revealed that the mineralogy of the dump fines is similar to that of the tailings.

A significant amount of fine gold was separated from dump

ELECTRON PROBE ANALYSIS OF CHALCOPYRITE

Egerton Grain	Weight Percent S	Fe	Cu	V	Cl	Total
1	34.847	30.746	33.795		.03	99.49
2	34.978	30.692	33.905			99.575
3	34.980	30.501	33.429			98.910
4	35.065	31.160	33.296	.13		99.651
McLean						
1	35.466	30.940	34.340		.03	100.776
2	35.520	31.547	35.013	.033		102.113

Table 10

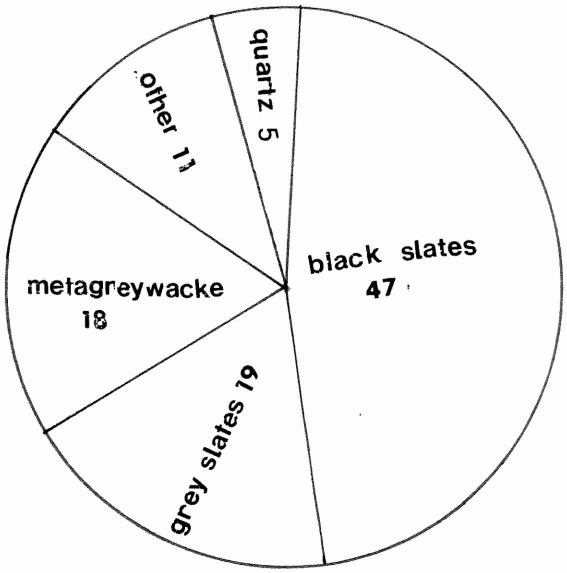
ELECTRON PROBE ANALYSIS OF PYRRHOTITES

Grain	Ni	S	Fe	V	Cr	Zn	Cl	Total
			weight percent					
Egerton								
1		39.440	59.431	.105	.083	.051		99.110
2		39.517	59.722			.048	.063	99.350
3		39.147	59.432			.125		98.704
4		39.630	59.025			.068		98.723
5	.073	39.191	59.980	.160				99.404
6	.04	39.396	59.157	.051		.182		98.826
7		39.607	60.574	.063	.051	.064		100.359
8		39.532	60.665	.128		.069		100.394
McLean								
1	.164	38.799	61.260				.052	100.275
2	.950	39.704	56.843				.080	97.577
3		39.574	63.365			.084	.034	103.057

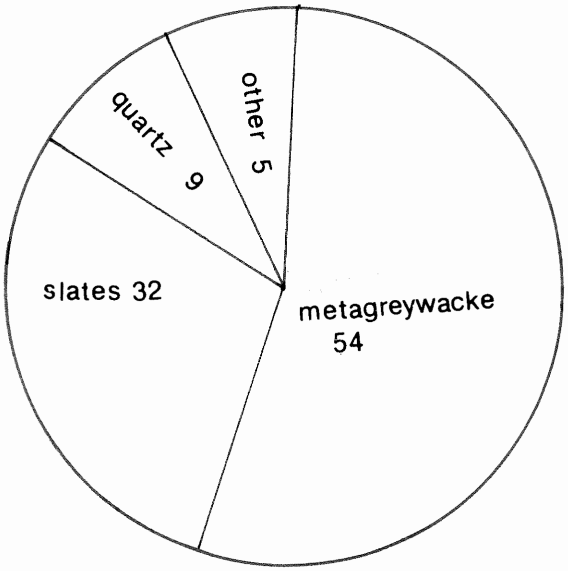
Table 11

fine material from the McLean property, and was rare in the Egerton dump fines. The shape and texture of the gold was similar to some of the grain types found in the tailings.

A visual inspection of the Egerton and McLean dump fines is summarized in Figure 16 . Note that the percentage of quartz in the fine material of the Egerton dump is much lower than in the Egerton tailings. The black slates are the major component of the fine dump material from the Egerton, and in contrast, metagreywacke is the major lithic fragment in the McLean dump fines.



Egerton dump fines



McLean dump fines

Fig. 16 Average compostions of the dump fine material

CHAPTER 5

INTERPRETATION AND DISCUSSION

5.1 Tailings

5.1.1 Mineralogy and Lithology

The mineralogy of the tailings is consistent with the mineralogy of the slates and metagreywackes. Therefore, the nature and composition of the tailings directly reflects the kind of material that was being mined.

It was determined based upon XRD,EMP, and visual inspection, that the minerals found in the two tailings ponds were essentially similar. The proportions of the components present in each pile were different. The Egerton tailings contained more quartz and slate fragments, and in contrast the McLean tailings contained more metagreywacke fragments. Mining at the two separate sites was carried out on different veins within different wall rocks. The majority of operations at the Egerton property were conducted on the Mother Siegel, Monpareil, and Harvey belts which consisted of alternating slates and quartz veins. Consequently the most abundant rock type in the Egerton tailings is black slates. In contrast the Rehabilitation Project concentrated mining efforts in the area of the McLean, Twin, Serpent, and Orient veins. With the exception of the Twin and Serpent veins the McLean and Orient were found within metagreywacke walls.

5.1.2 Heavy Minerals

Ilmenite, quartz, micas, rutile, anatase, tourmaline, arsenopyrite, pyrite, and magnetite constitute the heavy minerals (quartz, and micas were observed attached to some heavy minerals).

It was noted earlier that ilmenite was found mostly in metagreywackes, rutile, anatase, arsenopyrite, and magnetite predominately in slates.

The proportions of the heavy minerals differ between the two piles despite the similarity in mineralogy. The predominance of one mineral over another within and between the two tailing piles may once again be explained by the presence of a greater abundance of either the slates or metagreywackes.

Arsenopyrite, although only slightly more abundant in the Egerton heavy mineral portion than the McLean, is noticeably more plentiful in the dump rocks of the Egerton site. Here the mineral is found; within quartz veins, at the apex and limbs of folded slate beds and quartz veins, and the mineral fills brecciated portions of the slates. Contrastingly, arsenopyrite is found as subhedral to anhedral crystals within metagreywackes, and quartz veins at the McLean site. During the history of the mining operations at the Egerton property a fault was intersected at depth. The fault zone consisted of brecciated slates filled with sulphides. This fault provided a permeable barrier through which sulphide-bearing fluids could move, and subsequently crystallize. A large portion of operations were conducted in the vicinity of this fault, which could explain the larger proportion of the arsenopyrite at the Egerton site.

Ilmenite as described in section 4.2.2.1 was present in the rocks in three different forms. The first type was found in the matrix as discrete homogeneous grains, the second as grains containing quartz and mica inclusions and the third as heterogeneous altered aggregates.

Itaya and Banno (1980) have shown that in the pelitic schists of Sanbagawa metamorphic belt in Central Shikoku, Japan, sphene, rutile, and ilmenite occur as descrete grains, and in composite aggregates. Textural relationships, and the compositions of ilmenites suggested to them that the titanium-bearing accessories stable at the peak metamorphic conditions were sphene in the chlorite zone, sphene plus rutile in the garnet zone, and only ilmenite in the biotite zone. After the culmination of regional metamorphism,retrograde reactions took place giving rise to the formation of composite aggregates of rutile, sphene, and ilmenite. These aggregates represent the replacement of one titanium mineral by another.

They also found that the abundance of sphene was less than 1.2 modal percent, and it decreased further as the metamorphic grade increased. Rutile was present as .6 modal percent.

Ilmenite was not found in the chlorite zone, but was present in the biotite zone as composite aggregates with sphene and/or rutile , and as discrete grains.

Interestingly the MnO content of the ilmenite was high 1-9 wt%, and the Fe_2O_3 content was negligible. High MnO contents and low Fe_2O_3 contents were common in the ilmenites of this district. The MnO content of ilmenite decreased as the rutile/ilmenite ratio increased. The ilmenite present in aggregates always had higher MnO contents from the discrete ilmenite grains.

The Fifteen Mile Stream gold district is located within the biotite zone. Ilmenite is the most abundant heavy mineral as well as titanium mineral in these rocks. It is basically found as either discrete homogeneous or heterogeneous aggregates. If ilmenite is metamorphic in origin, the discrete grains could represent the stable titanium mineral in the biotite zone and the altered ilmenite grains could have possibly resulted from retrograde metamorphism. Electron probe analysis of the heterogeneous aggregates did not distinguish distinct sphene nor rutile minerals, however, the element analysis did show Fe, Ti, Mn, Ca, and Al. These aggregate ilmenite grains were the ones that did not fit on the FeO-TiO_2-Fe_2O_3 triangular diagram in Figure 13.

The alternate option is that ilmenite is detrital in nature. Evidence to support such an origin is weak.

Further petrological studies and electron probe analysis should be undertaken to clearly establish the origin of ilmenite.

5.1.3 Geochemistry

The geochemical analysis of the heavy mineral fraction revealed a significant difference in the As,Ni,Pb, and Ti contents between the two tailings ponds.

The greater As content of the Egerton tailings may be explained by the higher percentage of arsenopyrite as compared with that of the McLean tailings.

Similarily, high Pb values obtained from the Egerton site could possible reflect the presence of galena in the heavy mineral fraction. Galena was not observed in the quartz veins nor in the heavy mineral fractions from the McLean dump site.

The elements Ni was not detected as an independent mineral or minerals in the district. It, however was detected in the structure of the pyrrhotites, and it is known to substitute for iron. The higher Ni values in the Egerton heavy mineral fraction could therefore be explained by the larger proportion of pyrrhotite in the Egerton tailings.

The Ti-bearing minerals in this district are; ilmenite, rutile, anatase,biotite, and sphene in small amounts. Because biotite does not make up a significant percentage of the heavy mineral fraction, the Ti is mostly found in the form of ilmenite, rutile, and anatase. EMP, and visual inspection revealed ilmenite was the major contributor to the heavy mineral fraction at the McLean. Therefore the higher Ti values in these heavy mineral fractions may be accounted for by the significant abundance of ilmenite in the mineral fraction.

A multi-element scan conducted by Pan East Resources Inc. of Toronto in 1981, on the mine tailings from Wine Harbour, Mt. Uniacke, Goldenville, and Lake Catcha gold districts revealed that the titanium content of the tailings ranged from less than 1% to 5%. Its abundance in the tailings was third only to iron and arsenic. Titanium-bearing minerals appear to be of significant importance to at least some of the gold districts in the province.

5.2 Magnetic High

The rocks in the Fifteen Mile Stream gold district possess higher magnetism than the surrounding non-gold-bearing rocks (See Figure 1), especially in the vicinity of the two mining sites.

It has been assumed in the past that magnetite and pyrrhotite were the minerals responsible for the magnetic signature of the Meguma. XRD, EMP, visual inspection, and heavy mineral analysis showed that pyrrhotite, magnetite, and ilmenite are magnetic or slightly magnetic minerals that are concentrated within the slates and metagreywackes of this district, and contribute to the magnetic signature of these rocks. However ilmenite was significantly more prevalent than the remaining two magnetic minerals. It appears ilmenite may be a major contributor to the magnetic signature around this gold district. Further investigation needs to be undertaken to determine if this is the case in other gold districts in the province.

5.3 Gold

Coarse visible gold was sought by the mining operators during the history of the gold mining industry in Nova Scotia, because it proved to be the most economical form of gold. Fine gold (less than 1.25 phi) if present was often lost to the tailings during the milling process.

Fine gold has been detected in the McLean tailings as well as in the dump material. The possible sources for the fine gold include:

1. Quartz veins.

Quartz vein material, from the site, containing no visible gold was finely crushed in a mortar liberating a substantial amount of fine gold. (C. Miller, pers comm.).

2. Wall rocks.

As mentioned earlier in Chapter 3 , gold has been detected in the slates, and observed in metagreywackes (MacEachern, 1983).

Is the fine size of the gold its' original state or has it been broken down physically?

During the initial operation of the Rehabilitation Project a ball mill was used to crush the ore, later mill tests were conducted on stock piled ore using a portable 5-stamp mill. Perhaps the fine size of the gold particles could have resulted from the overcrushing of larger grains by the ball mill. If this is true then this type of grain should display pitted surfaces, flattened altered shapes, jagged and irregular boundaries. A few of the gold grains found in the tailings fit this description.

Even though ball mills tend to grind particles fine; ore and wall rock could have been processed by these mills releasing the gold within the ore and wallrock unaffected; save for liberating it from its source. Grains of this nature were also observed in the tailings, and were quite similar to those found in dump material that has not gone through the mill. This suggests that the grain size of the gold is original.

The Egerton heavy mineral fraction did not yield significant amounts of visible gold. Despite this fact, gold values obtained from geochemical analysis were only slightly lower than those obtained from the analysis of the McLean. If fine gold did exist in the quartz veins or host rocks the stamp mill crushing process was not successful at liberating it because this type of mill does not crush material fine enough. The "invisible" gold could possibly have been;

1. Contained within quartz or lithic fragments of the heavy mineral fraction.
2. As submicroscopic inclusions in sulphide minerals (Gureyev et al, 1969).
3. In solid solution with the sulphide minerals.

Schwartz (1944) and Sakharova (1969) have shown that the most favourable hosts for microscopic or submicroscopic gold are pyrite, arsenopyrite, and chalcopyrite. Experimental mineralogy has shown that gold is more soluble in arsenopyrite than pyrite or chalcopyrite (Springer, 1983) and perhaps "invisible" gold is found in arsenopyrite in this district. Using the wavelength method of EMP analysis for gold, four thin sections were probed. The results did not indicate the presence of gold within the arsenopyrite structure. This limited testing does not eliminate the possibility that gold does exist in this form at this site.

In summary the fine grain size of the gold in the tailings;

1. Reflects the original state of the gold.
2. Is a result of physical abrasion.

The source of the fine gold could possibly be the quartz veins and/or the host rocks themselves.

CHAPTER 6

CONCLUSIONS AND RECOMMENDATIONS

6.1 Conclusions

1. Comparison of the two tailings piles revealed that they are similar in mineralogy and lithology. However, the proportions of minerals and lithic fragments differs significantly.

2. Ilmenite, found predominantly in metagreywackes, is the dominant constituent of the heavy mineral fraction, and metagreywacke fragments are the dominant lithic type at the McLean site. In contrast, magnetite, rutile, anatase (found mostly in slates), arsenopyrite, quartz, and black slate fragments are the prevalent components of the Egerton site. These differences may be explained by the following;

a) Mining operations at the two sites conducted on veins within different wall rocks.

b) A more selective choice of material for processing was made at the Egerton site.

c) The predominant heavy mineral (or minerals) in each tailings pile was dependent upon the most abundant lithic type of the same pile.

3. Geochemical comparison of the heavy mineral fractions between the Egerton and McLean showed essentially no difference in Cr values. However, Au, and Ti was more common in the McLean heavy mineral fractions, and Pb, As, and Ni were more common in the Egerton. With the exception of Au the existence of the remaining elements depended upon the presence and abundance of galena, arsenopyrite, and pyrrhotite respectively.

5. Fine gold reported in the heavy mineral fraction of the McLean tailings was liberated from either quartz veins, slate or metagreywackes during grinding by the ball mill. The fine gold can be recognized by its unaltered, flake-like shape, and its similar appearance to the gold found free in the dump material.

6. Despite the lack of visible gold in the heavy mineral fractions assay values for the elements proved only slightly lower in ppm at the Egerton site than the McLean. The gold could possibly have been located;

a) within the sulphides (particularly arsenopyrite) as submicroscopic inclusions or in solid solution with the sulphides.

b) within the quartz and lithic fragments of the heavy mineral fraction.

7. Ilmenite, magnetite, and pyrrhotite are the magnetic or slightly magnetic minerals in order of abundance, that contribute to the magnetism of the slates and metagreywackes of this gold district.

8. A clearcut relationship could not be determined between magnetite and ilmenite (black heavies) on one hand, and gold on the other, except to note that they may be physically concentrated with one another within the rocks of this gold district.

9. Ilmenite is a curious mineral that has been noted in the rocks of the Meguma at this site. It is present as unaltered grains and at various stages of breakdown. The author feels that it was not satisfactorily proven that this mineral was either metamorphic or detrital. Evidence appeared however to favour that ilmenite is metamorphic in nature.

6.2 Recommendations

Further work of this nature needs to be conducted in other gold mining districts in Nova Scotia to enhance the knowledge of gold in the province and aid in exploration for more potentially economical gold mines.

Ilmenite was found in the rocks of this district as the major heavy mineral of the metagreywackes. Its origin and nature are yet unclear. The author recommends that further investigation be undertaken to determine the origin and significance of ilmenite in these rocks, and to determine if the mineral exists in other portions of the Meguma.

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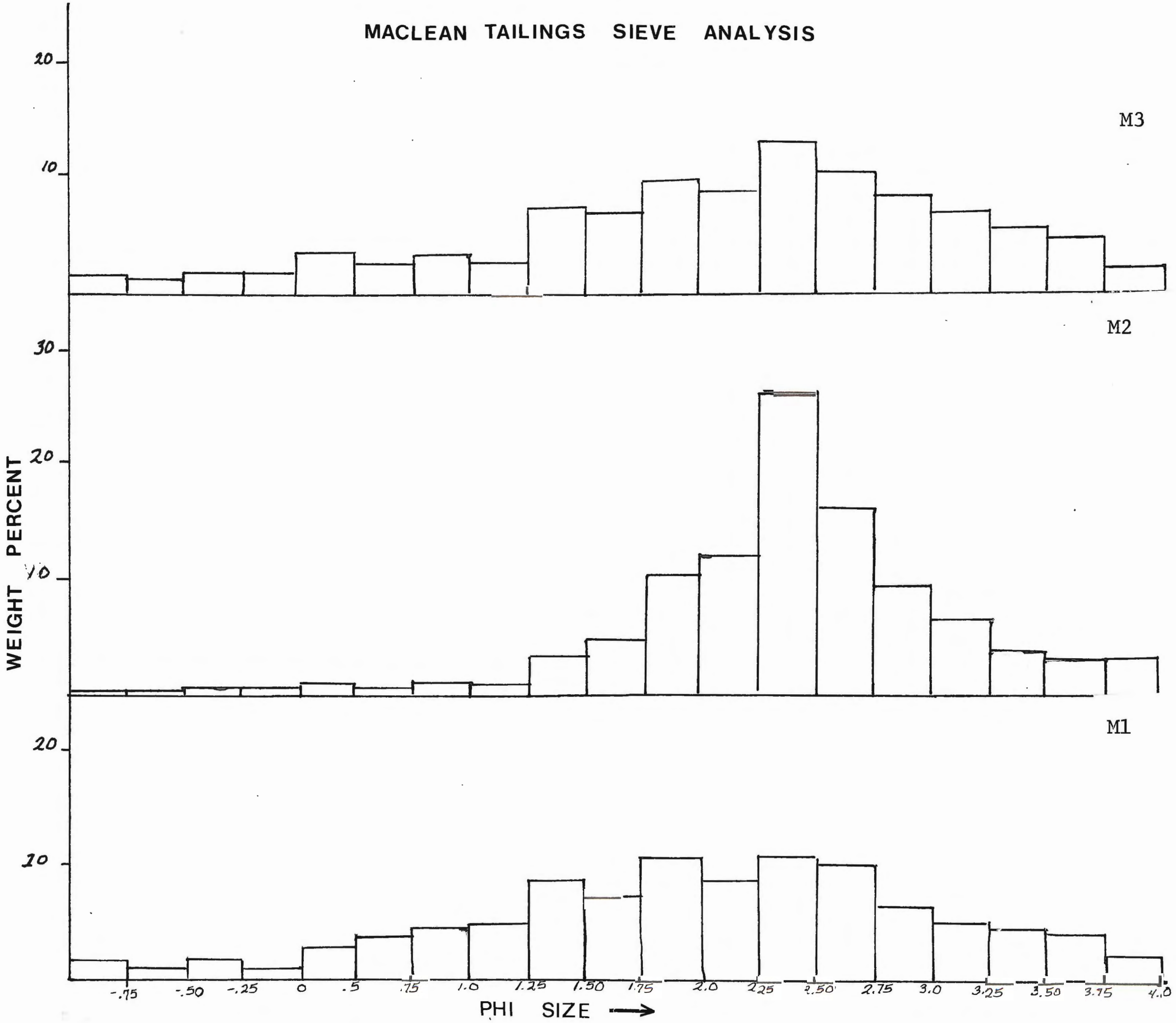
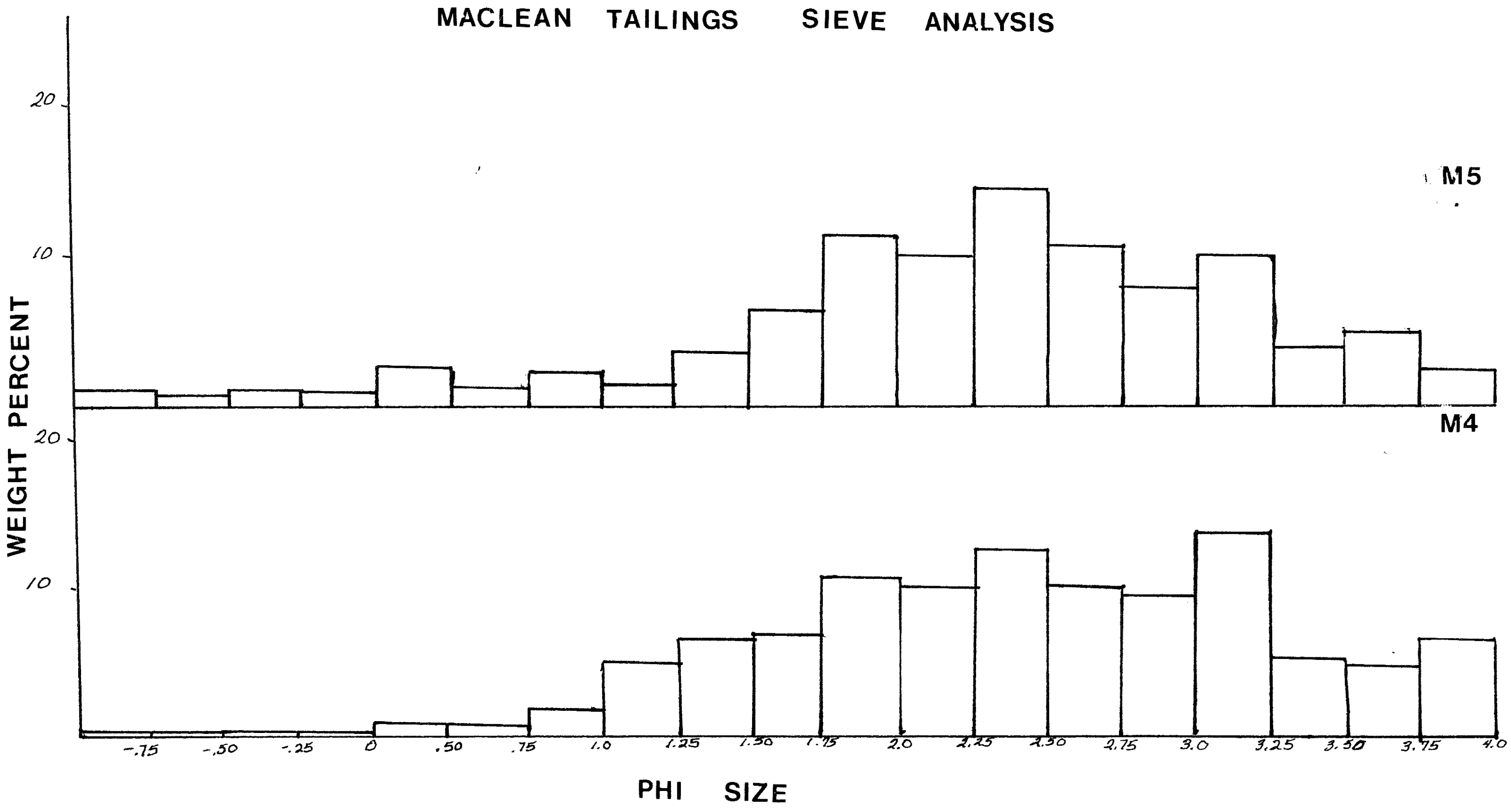
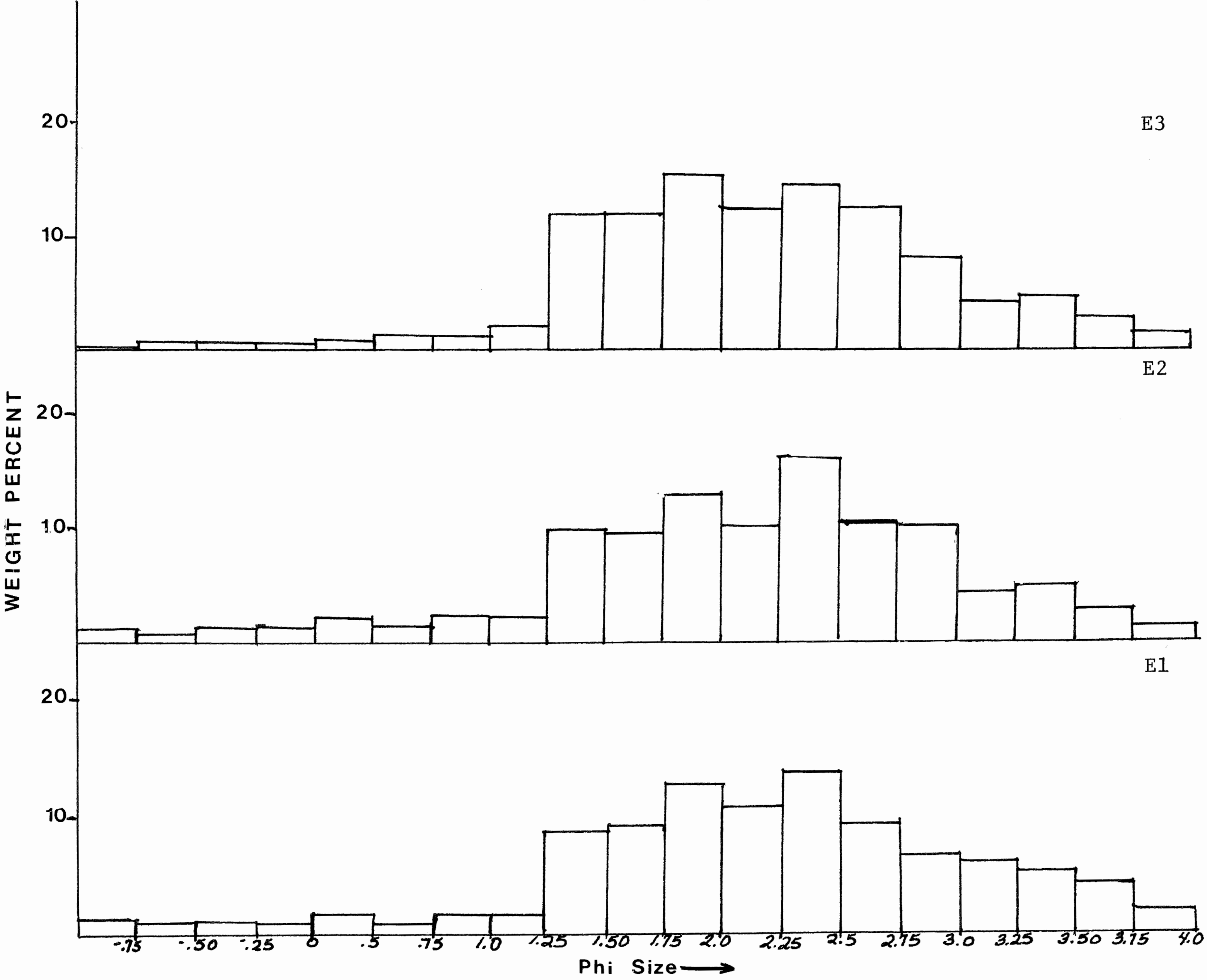
APPENDIX I

MACLEAN TAILINGS SIEVE ANALYSIS




MACLEAN TAILINGS SIEVE ANALYSIS

EGERTON TAILINGS SIEVE ANALYSIS



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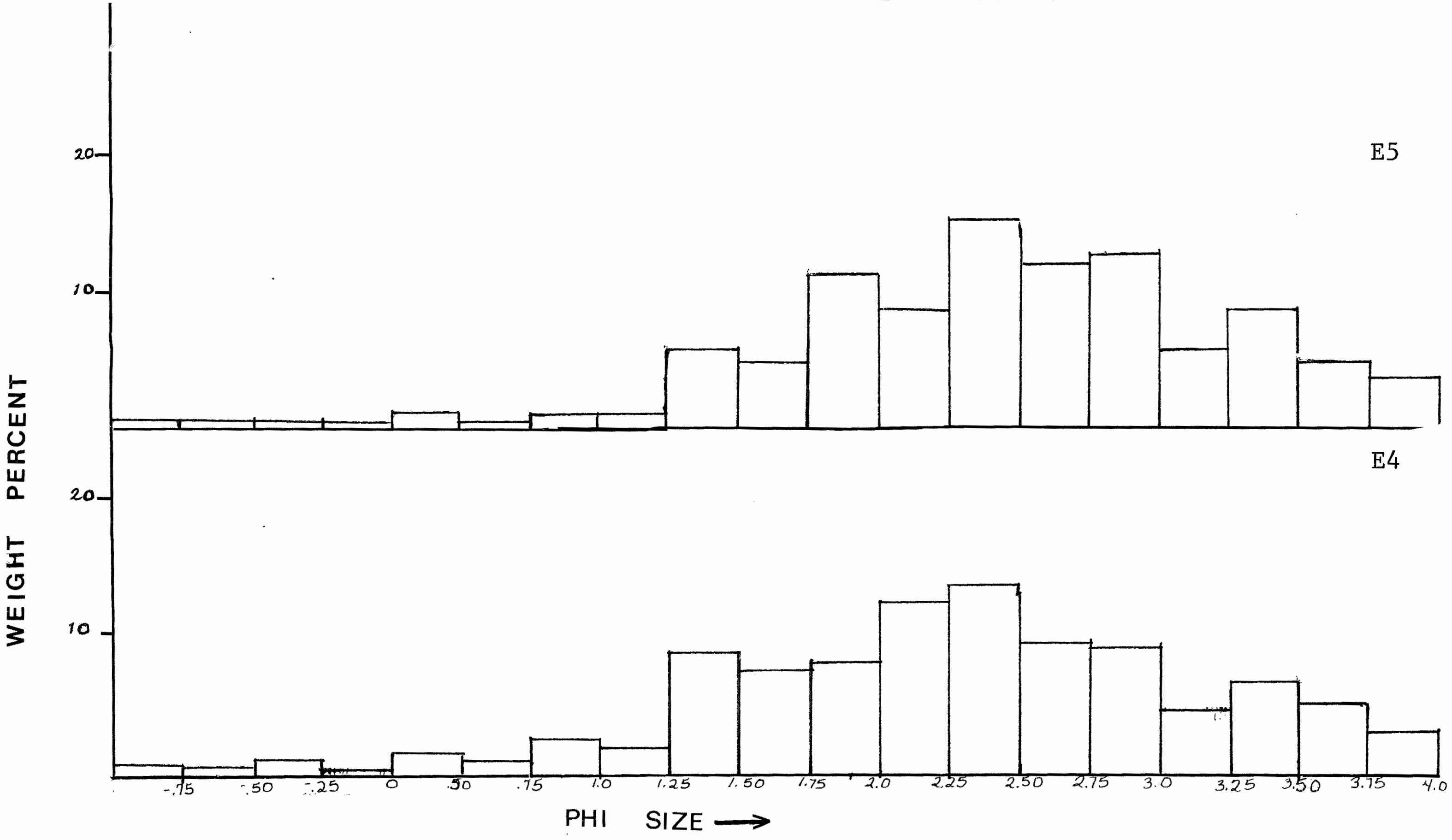
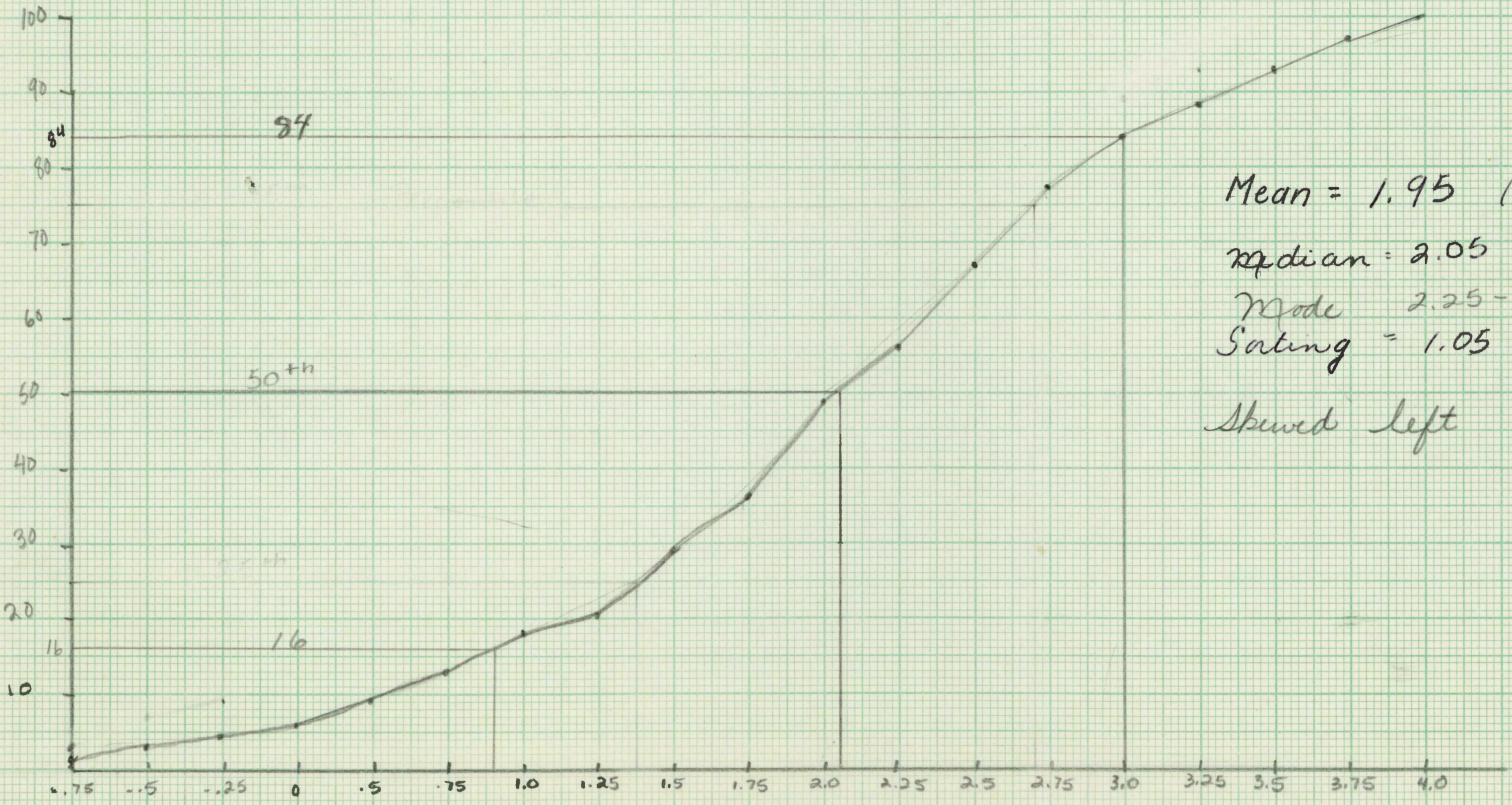


Appendix 1

CW01 Cumulative Frequency



Mean = 1.95 (1.75-2.0)

median = 2.05 (2.0-2.25)

Mode 2.25-2.50

Sorting = 1.05

Skewed left

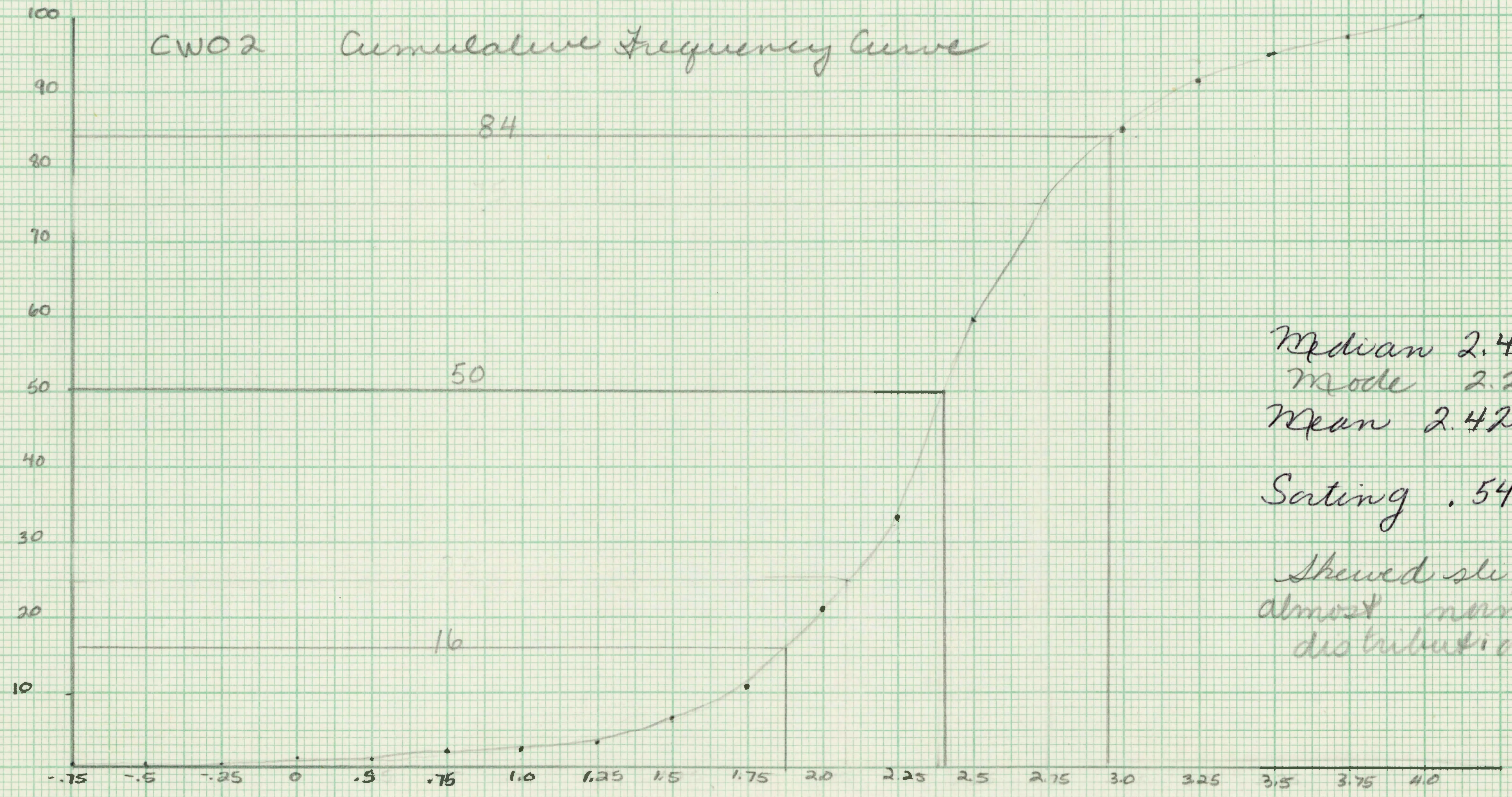
Fig 1a

.25 interval

.025 per square

NATIONAL 12-188 Made in U.S.A.

10 Millimeters to the Centimeter


CW02 Cumulative Frequency Curve

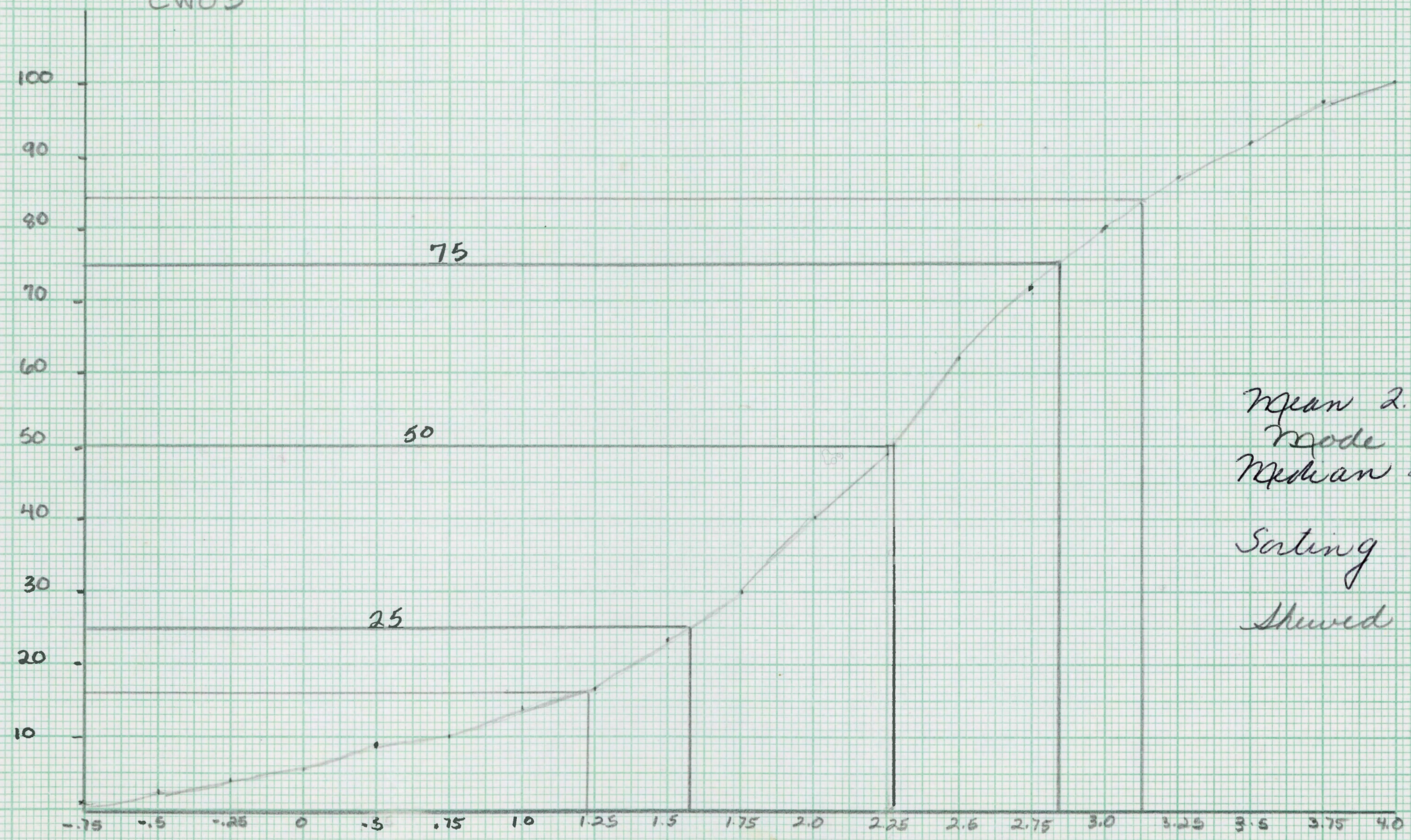
Median 2.40 (2.25-2.50)
Mode 2.25 - 2.5
Mean 2.42

Sorting .54

Skewed slightly right
almost normal
distribution

NATIONAL 12-188 Made in U.S.A.
10 Millimeters to the Centimeter

CW03



Mean 2.17 (2.0 - 2.25)
Mode 2.25 - 2.50 1.75 2.0
Median 2.28 (2.25 - 2.5)

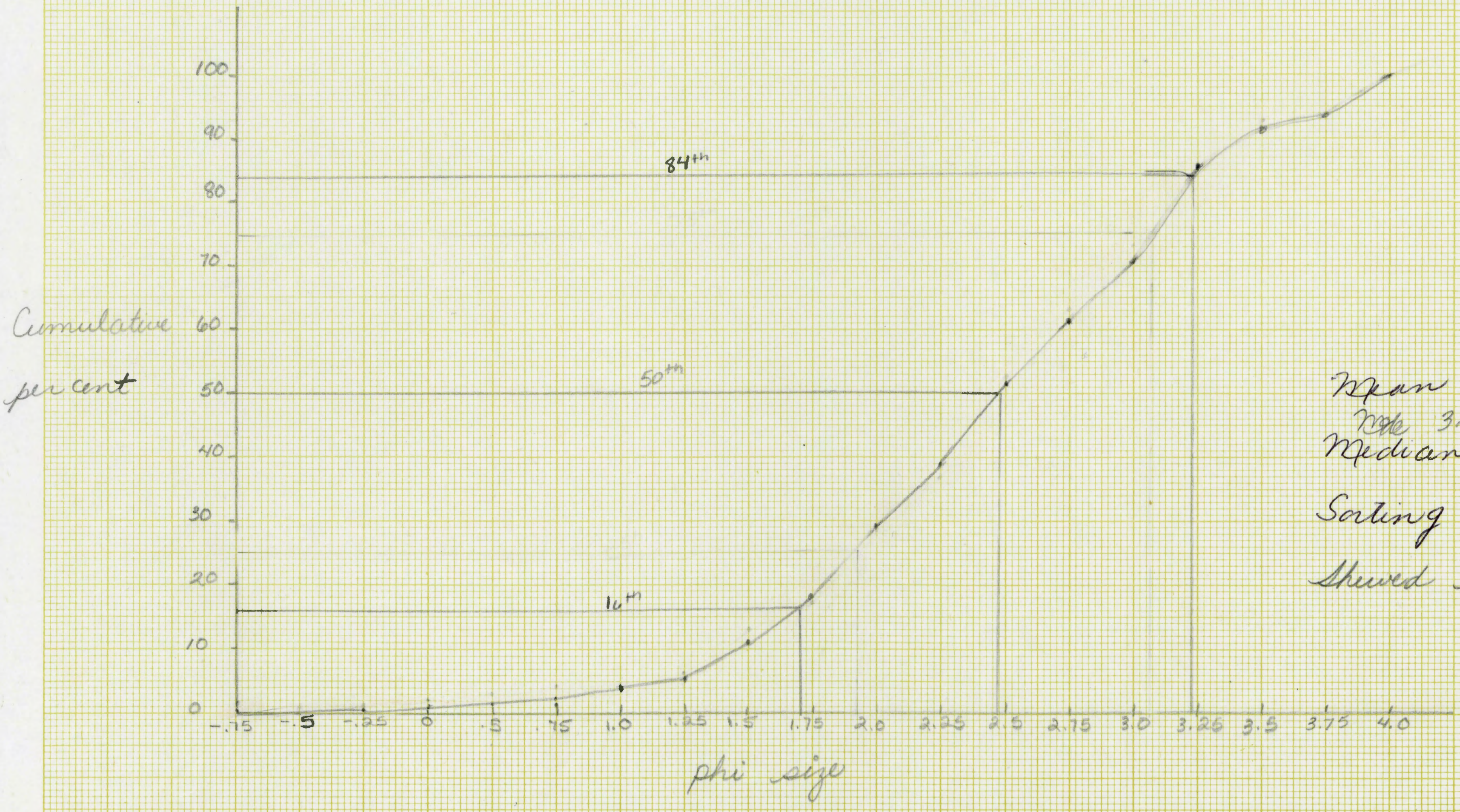
Sorting .96

Skewed left

10 Millimeters to the Centimeter
NATIONAL 12-188 Made in U.S.A.

Cumulative Frequency

CW04



Mean 2.43 (2.25-2.5)

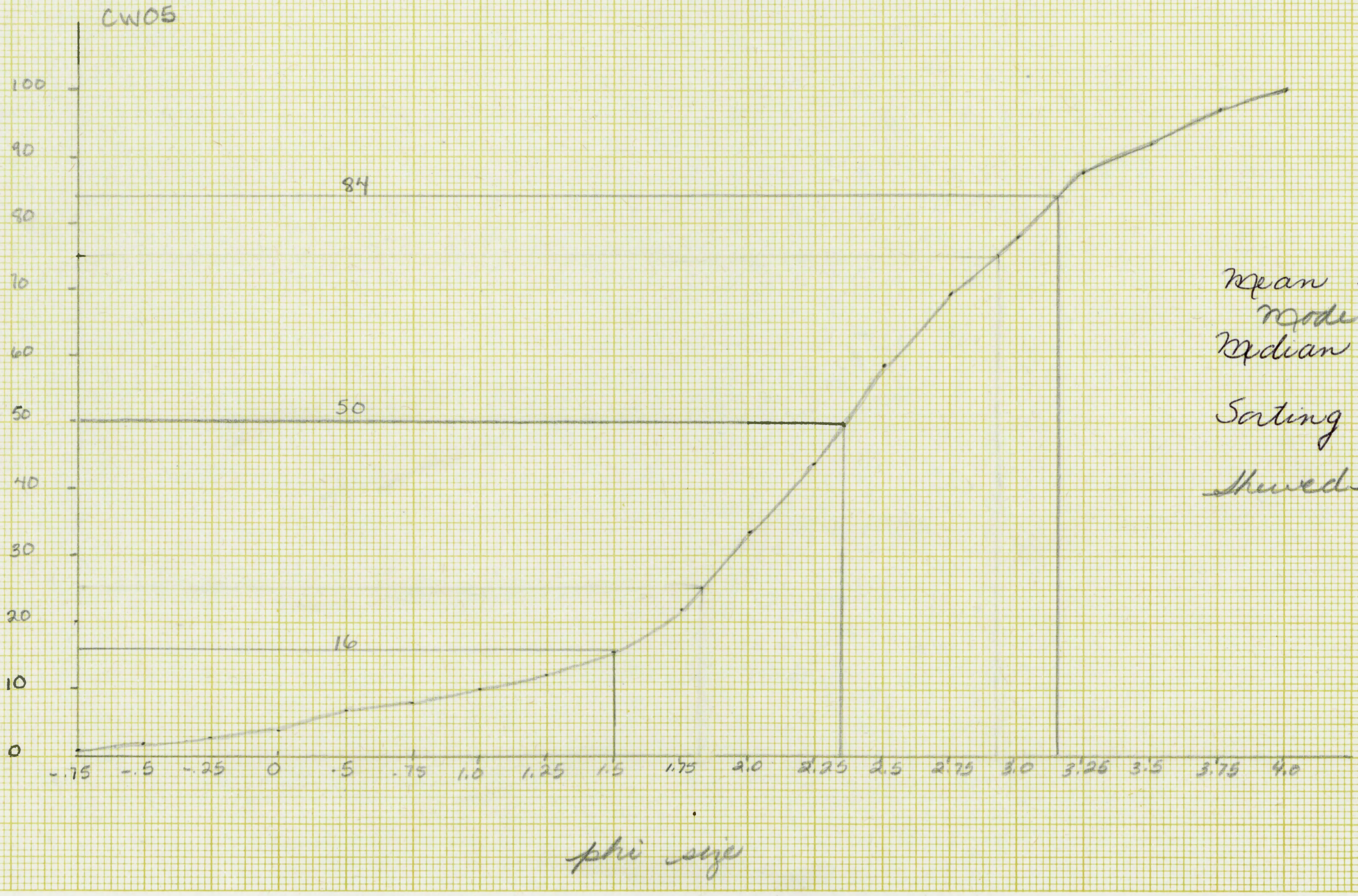
Mo 3.0-3.25

Median 2.47

Sorting .76

Skewed left

Cumulative Frequency

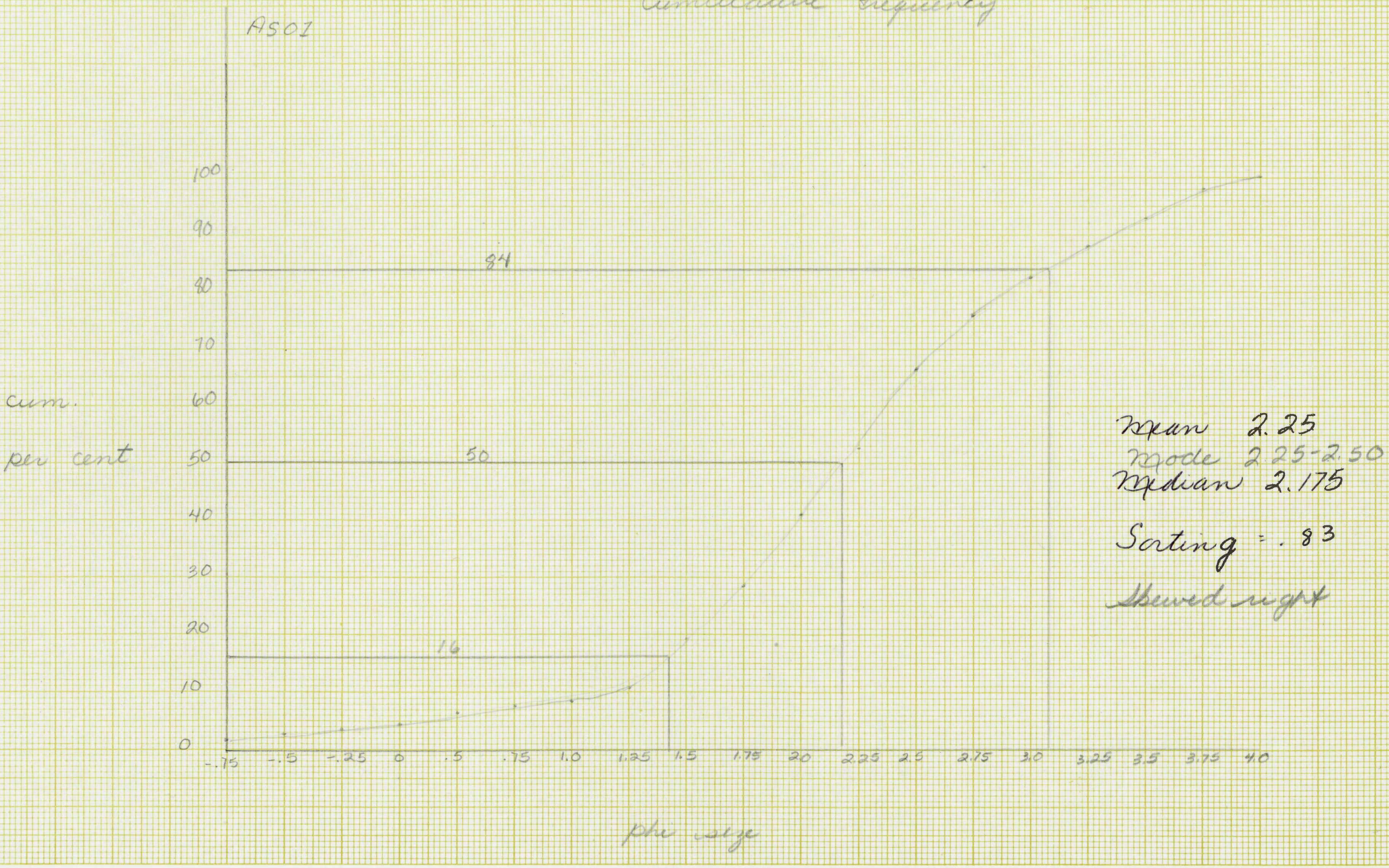


Mean 2.33 (2.25-2.5)
Mode 2.25-2.50
Median 2.35

Sorting .83

Skewed left

Cumulative Frequency

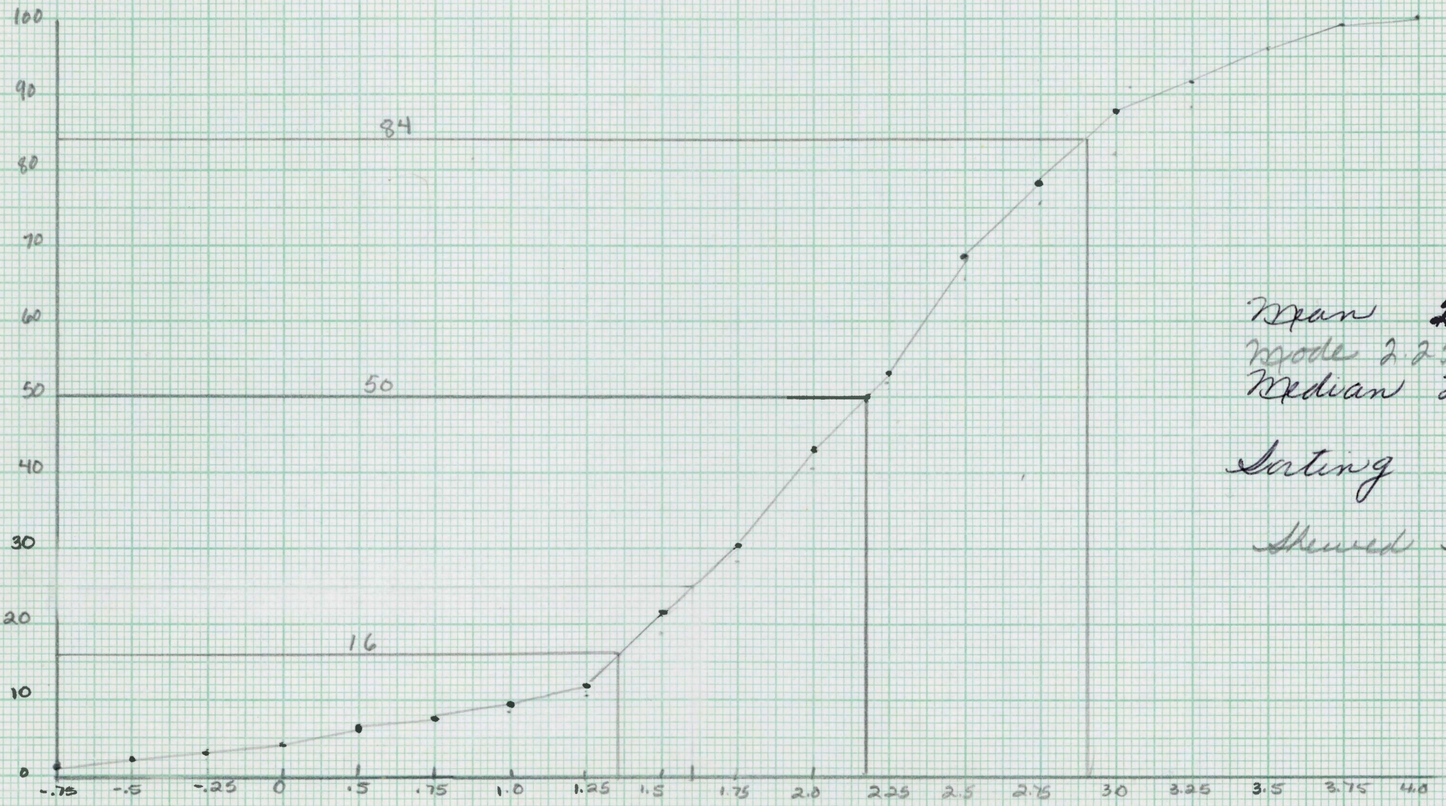


Mean 2.25
Mode 2.25-2.50
Median 2.175

Sorting = .83

Skewed right

AsO2



Mean 2.08 (2.0-2.25)
Mode 2.25-2.50
Median 2.175

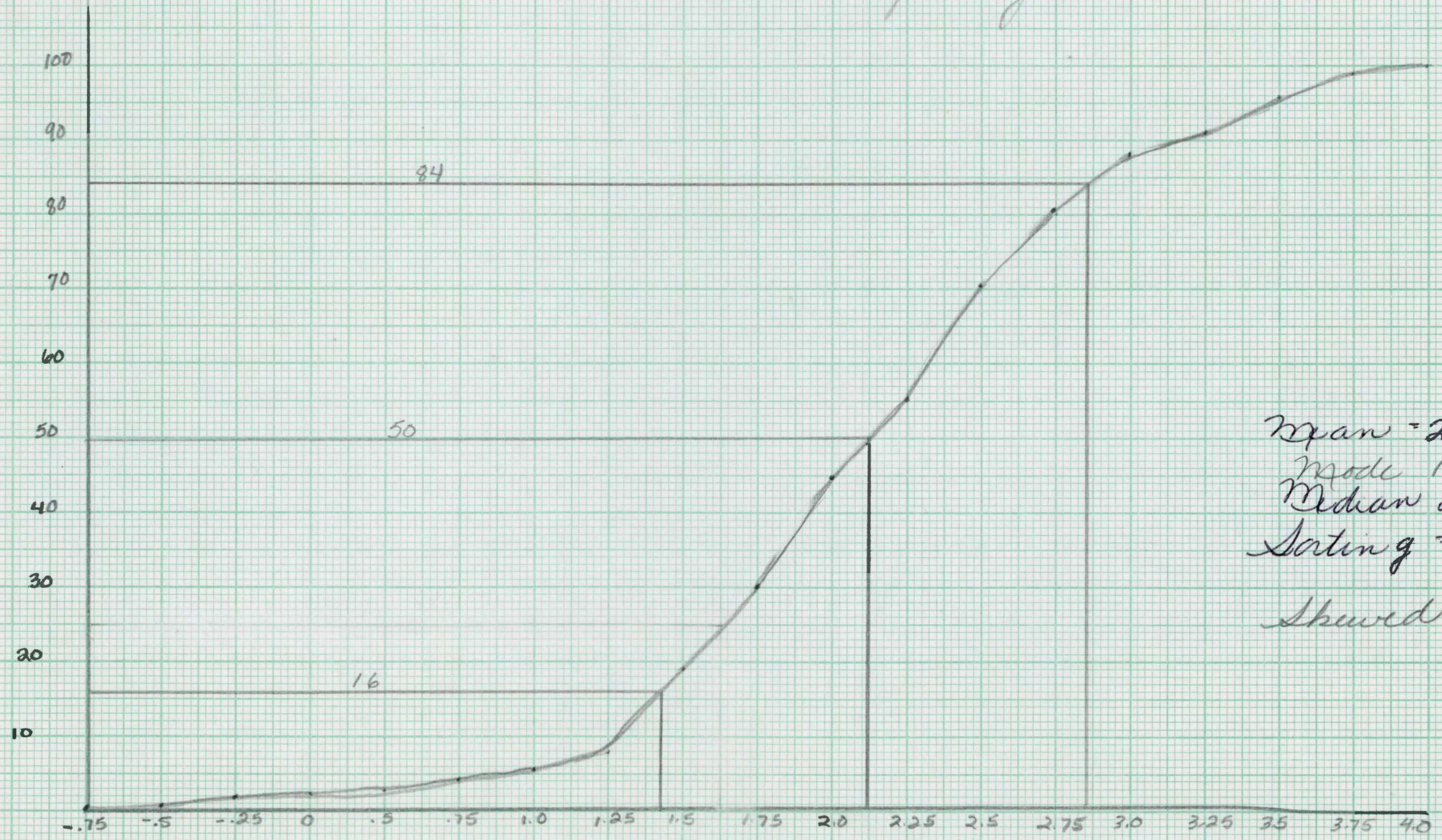
Sorting .73

Skewed left

NATIONAL 12-188 Made in U.S.A.
10 Millimeters to the Centimeter

AS03

Cumulative Frequency



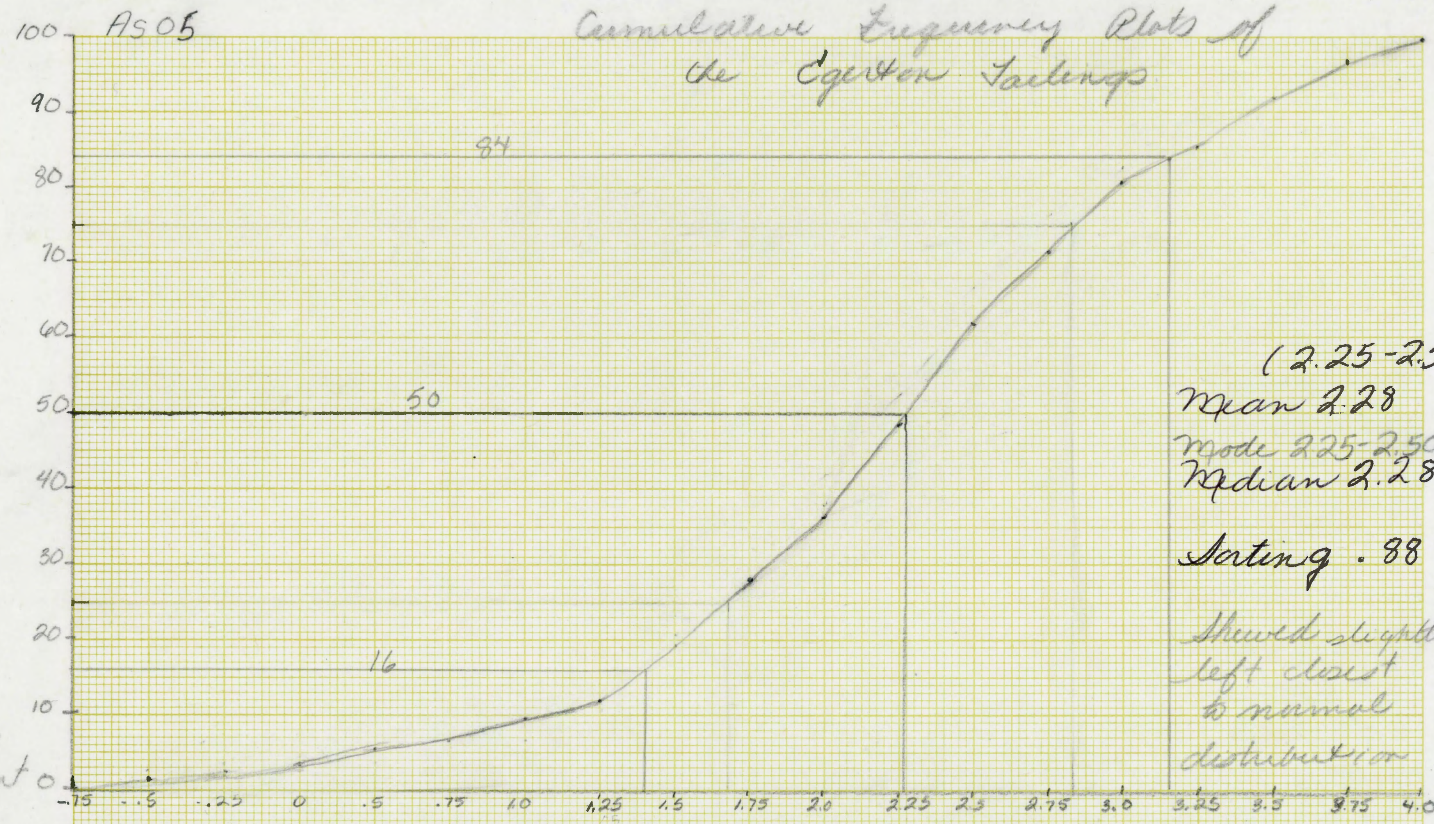
Mean = 2.14
Mode 1.75-2.0
Median 2.125
Sorting = .69

Skewed right

NATIONAL 12-188 Made in U.S.A.
10 Millimeters to the Centimeter

Cumulative Frequency Plots of the Egerton Tailings

AS 05



(2.25-2.5)

Mean 2.28

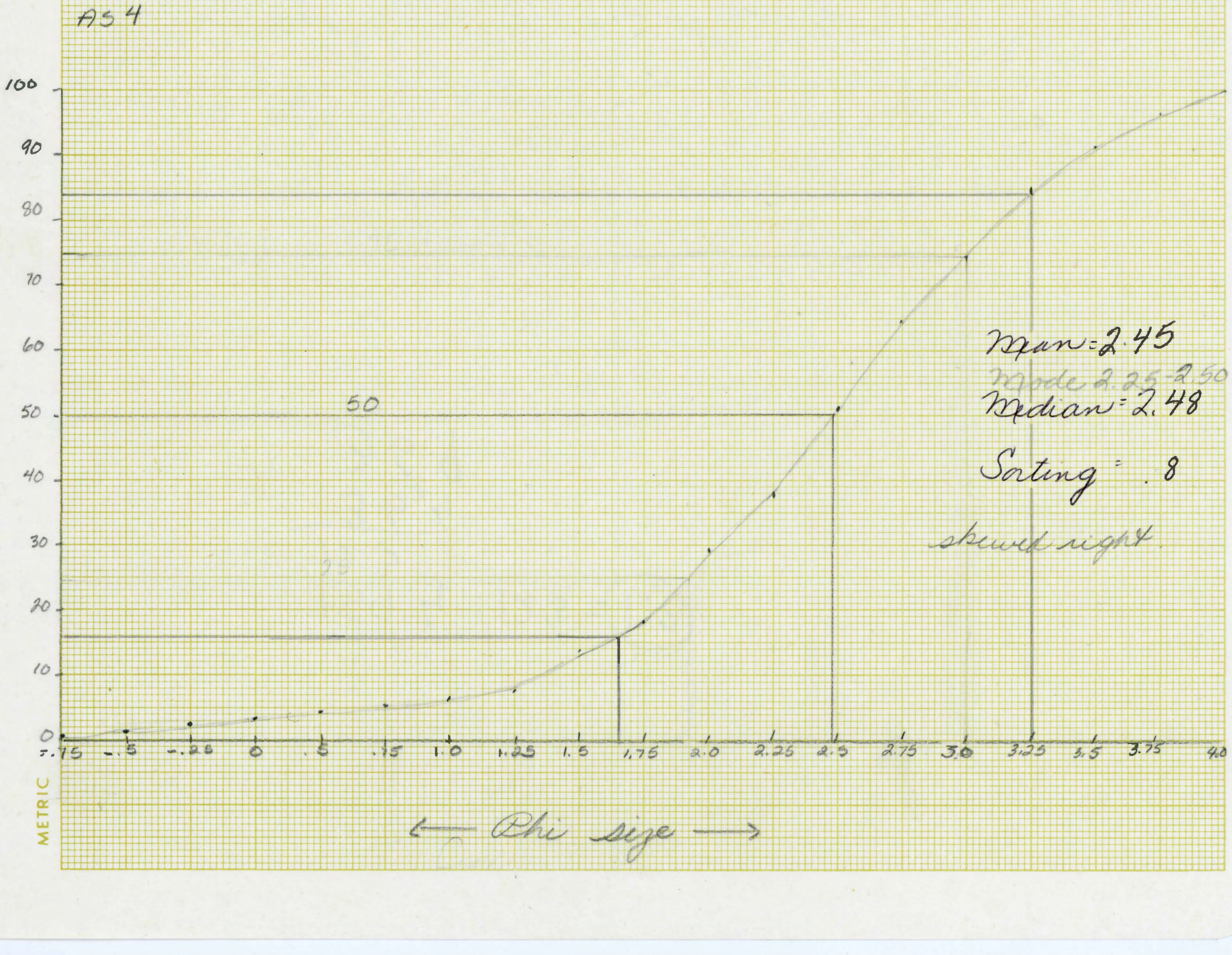
mode 2.25-2.50

Median 2.28

Sorting .88

Skewed slightly left closest to normal distribution

AS 4



Mean = 2.45

mode 2.25-2.50

Median = 2.48

Sorting: .8

skewed right

METHODS OF GEOCHEMICAL ANALYSIS

Pb, Ni, - 0.5 grams of sample leached in hot HNO_3-HCl for 2 hours, diluted to 10 mls with deionized water, final measurement by AA. Please note that this is not a total digestion therefore not all metal of interest may be liberated.

As - HNO_3-$HClO_4$ attack on 0.2 grams of sample. Arsenic is reduced with $SnCl_2$. Arsene gas is generated by adding Zn metal, this gas is passed through mixture of silverdimethyldithiocarbamate in pyridine. The final measurement is spectrophotometric comparison against standards of known concentration.

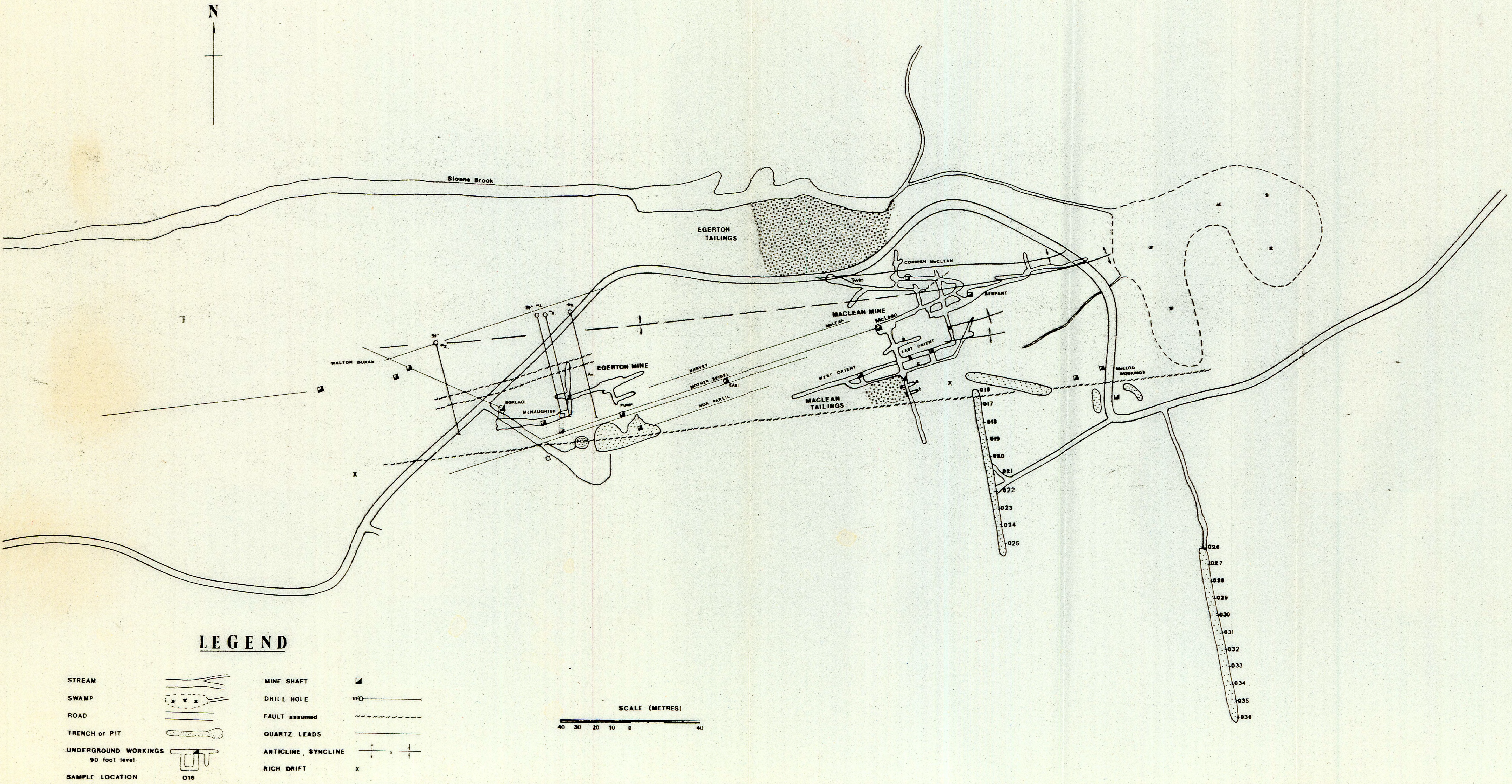
Au - 10 grams of sample (unless otherwise noted) are preconcentrated using fire assay lead collection procedure. The resulting precious metals bead is dissolved in aqua regia and final measurement is by atomic absorption.

Cr, Ti - 5 grams of material are pressed to form a pellet which is passed through X-Ray beam. Resulting fluorescence is measured, counts are compared to known standards

PRECISION OF ANALYSIS

Element	Detection Limit	Precision at Dl	10x DL	100xDl
Pb	2 ppm	-+ 100%	-+ 15%	+- 10%
Ni	2 ppm	+- 100%	-+ 15%	+- 10%
As	2 ppm	+- 100%	-+ 15%	+- 10%
Au (5 g)	5 ppb	+- 100%	-+ 15%	+- 10%
Cr	2 ppm	+- 100%	+- 15%	+- 10%
Ti	.01%	+- 100%	+- 15%	+- 10%

FIFTEEN MILE STREAM GOLD DISTRICT



after Faribault (1889) modified by C.K. Miller, L.J. MacEachern and K.A. McNulty