

Late Pleistocene - Holocene Benthonic Foraminifera From The
Northern Scotian Shelf

by

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fulfillment of the requirements for an Honours Bachelor of
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Abstract

A micropaleontological study was carried out on a core taken from latitude 45.30°N in St. Annes Basin on the northern Nova Scotian Shelf. Benthonic foraminiferal assemblages were defined in terms of abundance and dominance and were used to construct late Pleistocene - Holocene paleoceanographic trends and changes in bottom water mass characteristics. The results of this study indicate that a discontinuous glacial - interglacial record is present at this site.

Late Pleistocene glaciomarine sediments in the lower part of this core are dominated by an Elphidium excavatum f. clavatum - Cassidulina reniforme assemblage. This assemblage is typical of an ice - margin environment during which there was an influx of glacial meltwater. The presence of reworked Cretaceous foraminifera indicates that the ice front was in close proximity and was probably in contact with Tertiary - Cretaceous sediments near the basin during the peak glacial stage. The glaciomarine sediments are cut off abruptly by a thin turbidite sequence which also contains reworked Cretaceous species. The turbidite was preceded, or was proceeded, by the erosion of the latest glacial and early Holocene sediments.

Directly overlying the turbidite is an assemblage characterized by the presence of Brizalina subaenariensis and other warm water calcareous species. This assemblage occurs primarily in warmer, more saline bottom waters that occurred during a warm interval in the mid - Holocene (about 7,000 - 5,000 yrs BP) and in the warmer, more saline waters that are characteristic of basins on the Southern Scotian Shelf. The interval above this is characterized by an

increase in colder water calcareous faunas and agglutinated faunas which indicate a period of cooling from the mid - Holocene to present. The presence of a mixed fauna in the surficial sediments suggests a recent slumping of sediment in this basin.

INTRODUCTION

Foraminifera are a group of unicellular marine organisms belonging to the Phylum Protozoa. These organisms secrete a test which is often incorporated into marine sedimentary deposits. Benthonic foraminifera (bottom-dwellers) are basically sessile and occur in all benthic marine environments. Due to their sessile nature, most benthonic foraminifera are deposited "in situ" and are invaluable aids in both age determinations and in determinations of depositional environments (Haq and Boersma, 1978). On the other hand, planktonic (free-floating) foraminifera are not useful in this context as they may be transported for some distance before settling through the water column and being deposited. Many species of foraminifera are very sensitive to the surrounding environment (e.g. temperature and salinity) and thus benthonic forms are excellent paleoenvironmental indicators. Since they are valuable indicators of paleoenvironment, they are widely used to correlate small and large - scale paleoceanographic events during geologic time.

In order to obtain a good micropaleontological record, an area of relatively continuous deposition is required. Such areas can be found as intra-shelf basins occurring within the Scotian Shelf. These basins can provide an expanded Pleistocene - Holocene record due to the fact that they are characterized by relatively high sedimentation rates (Scott et al., 1984).

A previous study by Scott et al. (1984) provides a late Pleistocene - Holocene record for four principal oceanographic regions on the continental margin of eastern Canada. This work provided data for Canso and Emerald Basins, on the middle and

southern parts of the Scotian Shelf; the Notre Dame Channel, on the Newfoundland Shelf; and the Cartwright Saddle on the Labrador Shelf. The findings of this study indicate a period of turbid glacial meltwater and/or permanent ice shelf cover from 20,000 - 10,000 yrs BP, a cold water interval (similar to the modern-day outer Labrador current) from 10,000 - 7,000 yrs BP, a warmer interval from about 7,000 - 5,000 yrs BP, and an abrupt cooling period in the last 2,000 yrs (Scott et al., 1984). However, this study failed to provide a link between the Gulf of St. Lawrence and the Scotian Shelf.

In the present study of St. Annes Basin (fig.1), benthonic foraminiferal assemblages are used to construct late Pleistocene - Holocene paleoceanographic trends on the northern Scotian Shelf. These assemblages can be used to interpret changes in bottom water mass characteristics during the latest glacial - interglacial transition. The area of study is an important one since the basin is located close to the coastline and was in close proximity to the ice front during the late Wisconsinan glaciation. These findings (in conjunction with a concurrent study by J. Freeman) will show whether or not there is a link between the Gulf of St. Lawrence and the Scotian Shelf in paleoceanographic trends. This study provides data that contributes to the large - scale correlation of the effects of the latest glacial - interglacial transition on the continental margin of eastern Canada.

Brief palynological results are used to place this record in the proper chronological framework in the absence of absolute dates.



Fig. 1. Area map of the Northeastern Scotian Shelf indicating the general physiography of the area and the study site. Contour intervals are in metres.

PREVIOUS WORK

A detailed study of the subsurface benthonic foraminifera from St. Annes Basin has not previously been made. The surficial geology of this area has been documented by MacLean and King (1971) and surficial foraminiferal distributions have been summarized by Williamson (1983) and Williamson et al. (1984). Studies have been made of the oceanographic trends and foraminiferal distributions on other segments of, and the entire, Scotian Shelf. This includes work by Bartlett (1964a,b) Barbieri and Medioli (1969) Scott et al. (1984) and Medioli et al. (in press).

Studies have also been done on the distribution of dinoflagellates and pollen on the Scotian Shelf. This includes the work of Mudie (1980) Mudie (1982) and Scott et al. (1984). Other pertinent studies will be discussed where relevant.

PHYSIOGRAPHY AND SEDIMENTOLOGY

The continental shelf off Nova Scotia (see fig. 1) is topographically complex and is represented by three major physiographic zones (King and MacLean, 1976). These zones consist of: (1) an inner zone between St. Annes Bank and Cape Sable, which consists mainly of sands and gravel with some exposed bedrock; (2) a central zone consisting of isolated banks and basins, with well sorted fine to coarse sands covering the banks and clays and muds in the basins, and; (3) an outer zone consisting of wide, shallow banks covered with well - sorted sands and lag gravels (Williamson et al., 1984). The northeastern segment of the Scotian Shelf, including the area of this study, is the most topographically complex and highly dissected portion of the Scotian Shelf (MacLean and King, 1971). This area consists of the inner shelf along the Nova Scotia coastline, the central shelf region consisting of depressions (isolated basins) and isolated banks, and the outer shelf area. These features are all documented by King (1967b, 1970).

St. Annes Basin is an isolated basin located approximately 40km east of Cape Breton Island. High resolution seismics indicate that this basin is characterized by two principal depositional features. These features consist of the postglacial LaHave Clay and the proglacial Emerald Silt, which overlies glacial till overlying the acoustic basement. The LaHave Clay is generally a very dark grayish brown to dark gray clayey silt which may grade locally into silty clay and sandy silt (MacLean and King, 1971). This unit is variable in thickness and is absent in some areas. Underlying the LaHave Clay is the Emerald Silt. This unit consists of poorly sorted, very dark

grayish brown to dark olive gray clayey and sandy silt which grades into silty sand with some gravel (MacLean and King, 1971). In the study area a thin layer (approximately 3m) of LaHave Clay overlies the Emerald Silt (see core description in appendix).

Like other shelf areas, little sedimentation is presently taking place on the northeastern Scotian Shelf. The only places where sedimentation is presently occurring are in the shelf basins. However, seismic data and surficial foraminiferal occurrences indicate that erosion is presently occurring in parts of St. Annes basin.

OCEANOGRAPHY

Surface water circulation on the continental shelf off eastern Canada is dominated by three main water masses (fig. 2). Water is carried in a southerly direction by two main current systems: the Labrador Current, flowing over the Grand Banks and the Labrador Shelf, and the Nova Scotia Current, which flows over the inner Scotian Shelf (Scott et al., 1984). The third main watermass consists of the warmer, more saline Gulf Stream flowing in a northeasterly direction.

The Labrador Current is of Arctic origin. Most of the bottom waters are fed by branches of the West Greenland Current (Lazier, 1982; Scott et al., 1984). The surface waters originate in northern Baffin Bay, with a small component from Hudson Bay. The Labrador Current is split into two components as the Canada Current joins the West Greenland Current in the Baffin Bay - Davis Strait area. Here the current divides into the inner (inshore) Labrador Current and the outer (offshore) Labrador Current. The inner Labrador Current occupies depths of 0 - 300m from Labrador to the Northern Scotian Shelf. One branch of this current flows into the Gulf of St. Lawrence where it circles around Anticosti Island and enters the Scotian Shelf approximately over the area of study. This current flows across the shelf off Nova Scotia in a southwesterly direction and is manifest as the Nova Scotia Current (Williamson et al., 1984). The outer Labrador Current occupies depths of 300 - 800m in the same areas. Components of this current mix with the Gulf Stream and form a major bottom watermass off Nova Scotia, the Slope Water (McLellan, 1957; Williamson et al., 1984).

Bottom watermasses on the shelf are a derivation of the mixing of these major current systems. Local characteristics of these bottom waters are determined by the addition and mixing of precipitation, meltwater, and river runoff and mixing with warmer and more saline waters of the offshore Gulf Stream (Scott et al., 1984). As well as regional variations in watermass characteristics, seasonal fluctuations in watermass characteristics occur as a result of annual variations of insolation, precipitation and fresh water runoff (Scott et al., 1984). The bottom watermasses on the Scotian Shelf (fig. 2) have been documented by McLellan (1954), McLellan (1957) and Houghton et al. (1978). These watermass characteristics are summarized in table 1.

The waters in St. Annes Basin are dominated by the subsurface waters from Cabot Strait and the Gulf of St. Lawrence (see table 1). These waters are characteristically cold (0 - 4°C) and relatively low in salinity (32.3‰) (Williamson, 1983).

Table 1. Watermass Characteristics off Nova Scotia (from Williamson, 1983).

<u>WATERMASS</u>	<u>TEMPERATURE</u>	<u>SALINITY</u>
Subsurface water from Cabot Strait and St. Lawrence. Labrador current origin.	0 - 4°C	32.3‰
Surface water from Cabot Strait and St. Lawrence.	3 - 6°C	31.8‰
Slope waters - a product of the mixing of Labrador Current waters and Gulf Stream waters.	4 - 8°C	33 - 34‰
Waters of slope characteristics with maximum temperature and salinity	8 - 12°C	35‰
Deep Atlantic waters	4 - 6°C	34.5 - 35‰

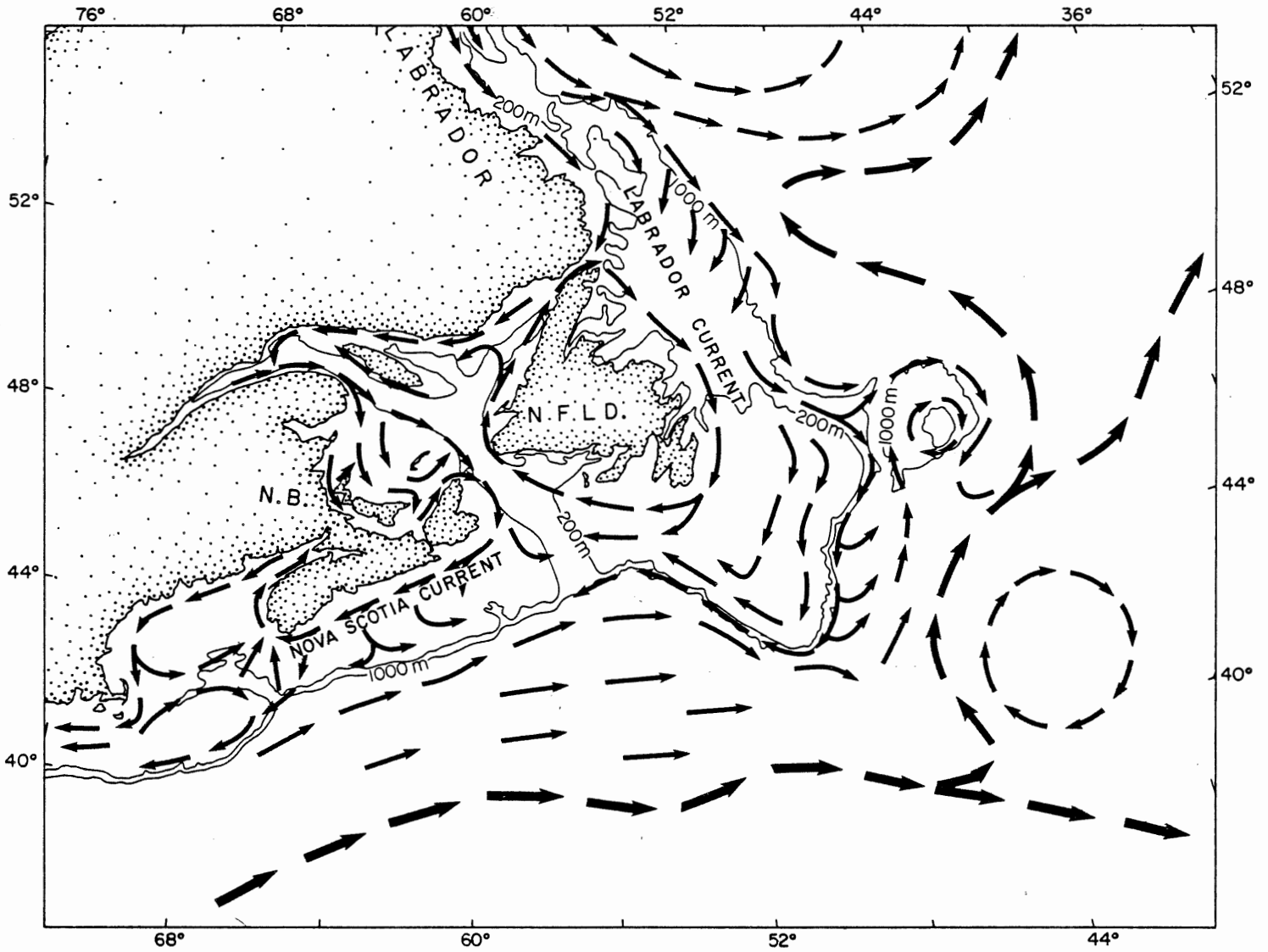


Fig. 2. Surface oceanographic current patterns presently occurring on the eastern margin of Canada (from Scott et al., 1984).

METHODS

The site for core 84-011-11 was selected on the basis of seismic reflection data (fig. 3) obtained by a Hunttec Deep - Tow seismic system. A 130cm trigger weight core and a 518cm piston core were both recovered and used in this study. These cores were collected by the Bedford Institute of Oceanography research vessel C.S.S. Dawson in April 1984. Upon completion of this cruise, the cores were split and x-rayed and kept in a cold storage room at 4°C until this study was made.

The first procedure of this study was to examine and describe both the trigger weight and piston cores. The core description was done on the basis of visual and x-ray observations. The description includes the type of sediment in the core (e.g. soft, silty mud), the colour of the sediment - based on the Munsell soil colour chart, and other noticeable features such as bioturbation or shell fragments (see appendix).

The cores were then sampled at 10cm intervals and at all interesting lithological or stratigraphic changes. These samples have a wet volume of 10 cc. The samples were then washed through a 500 micron sieve (# 35 mesh) and a 63 micron sieve (# 230 mesh). The 500 micron sieve retains the larger clasts, and the 63 micron sieve retains the foraminifera, sand fraction, organic matter, and passes the silts and clays. In many studies it is common practice to use a minimum size fraction of 125 microns or 150 microns (Schnitker, 1974; Streeter, 1973). Retention of material 63 microns and larger permits the presence of smaller species and juveniles which would otherwise be lost (Williamson, 1983). Schroeder (1986) has shown that there are marked differences in assemblages if only large size

fractions are observed.

In samples containing an abundance of organic matter, decantation was used to separate the lighter organic particles from the heavier sand and foraminifera. Those with large amounts of sand were dried, and flotation with carbon tetrachloride (specific gravity = 1.58) separated the heavier sand particles from the lighter foraminiferal tests. Wet samples that were estimated, by visual observation, to contain 2400 individuals or more were split using a wet-splitter (documented by Thomas, 1985) into one-eighth size samples. The reason for not splitting samples with less than 2400 individuals is that a count of 300 individuals should be obtained in order to accurately estimate species proportions within a sample (Williamson, 1983). A count of 300 individuals ensures that a species with an abundance of 1% of the total population can be realized with an accuracy of 95% (Douglas, 1978).

The samples that were dried and floated were counted dry whereas all other samples were counted in suspension. The samples were examined under a binocular microscope where the foraminiferal species were identified and the abundance of each species in a sample was recorded. This allows foraminiferal assemblages to be defined in terms of abundance and dominance. Data are presented in tables 2 and 3.

Specimens of fifteen of the species that are dominant and/ or of special interest were subsequently collected and photographed at the Bedford Institute of Oceanography with a Cambridge Stereoscan 180 SEM using Polaroid 55 N/P film (see plate 1).

RESULTS

Core 84-011-11 was taken from a water depth of 275m. This core contains both Holocene postglacial LaHave Clay (0 - 260cm) and proglacial Emerald Silt (275 - 518cm) with a fining - up turbidite sequence (260 - 275cm) separating the two. Huntec Deep - Tow seismic data [fig. 3] indicate that the area of study is characteristically complex in terms of sedimentation and erosion. The seismic record shows that the area from which this core was taken is presently undergoing erosion, as deduced from the short Holocene record. In contrast, a core (84-011-12) taken approximately two - thirds of a kilometre to the north shows an expanded (at least 8m) Holocene LaHave Clay section (Freeman, 1986).

Foraminifera

The results of the foraminiferal study are contained in tables 2 and 3 and summarized in Fig. 4. Total numbers of benthonic foraminifera in each sample are highly variable, ranging from 19 to 7020 individuals / 10 cc of sediment. The total number of species present in each sample also has a wide range, from 4 to 30 species / 10 cc sediment.

The two samples from the base of the core (516 and 510cm) are characterized by relatively high abundances of both individuals and species. These samples are dominated by Elphidium excavatum f. clavatum and Cassidulina reniforme. Islandiella teretis is co-dominant in this range. From 500cm to 261cm the assemblages are characterized by lower numbers (19 - 942 individuals / 10 cc) and a

lower diversity in species. This range is co-dominated by an I. teretis, E. excavatum f. clavatum and C. reniforme assemblage. These three species together account for 53 - 100% of each sample in this range. These samples are also characterized by the presence of Cretaceous foraminifera: Euuvigerina spp., Globigerinelloides spp., and Heterohelix spp.. The Cretaceous species are variable in total numbers per sample and are not usually dominant. However they do constitute 44% and 50% of the samples taken from the turbidite sequence at 261cm and 273cm respectively. Very low relative abundances (1 -12%) of agglutinated species are present in this range.

From 257cm to the surface of the core, the total numbers and diversity are highly variable. This range consists of Holocene LaHave Clay and can be subdivided into three principal foraminiferal assemblage groups. The segment from 257cm to 180cm is characterized by a high abundance of planktonic foraminifera with increases in Nonionellina labradorica and Globobulimina auriculata. Decreases in E. excavatum f. clavatum, I. teretis, and agglutinated species occur as well. This range is also marked by the appearance of Brizalina subaenariensis and Pullenia subcarinata.

The interval from 180cm to 10cm is characterized by a gradual increase in I. teretis and agglutinated species. Although agglutinated species are more common in this range, they never total more than 18% of any one sample. Decreases in E. excavatum f. clavatum, C. reniforme, B. subaenariensis, P. subcarinata, and planktonics occur here as well. N. labradorica and G. auriculata decrease slightly and then stay relatively constant in abundance until the top 20cm where they increase slightly. At a core depth of

140cm is a sample containing very high total numbers and a high abundance (72%) of Fursenkoina fusiformis.

The surface samples from both the piston and trigger weight cores contain an assemblage dominated by Brizalina subaenariensis. Co-dominant species at this level are Bulimina marginata, G. auriculata and N. labradorica. Agglutinated and planktonic species are both also present at the surface, but in relatively low abundances.

POLLEN

Since this paper is not of palynological nature, a complete quantitative analysis of pollen grains was not carried out. A total of eight pollen samples, taken from strategic locations in the core, were obtained and processed. Four samples were taken from the top 60cm of the core, two were taken just above the fining-up sequence, and two were taken from the glacial sediments below the fining-up unit. The samples were taken at these locations in order to provide a time stratigraphic correlation with terrestrial environments and for comparison with previous records (e.g. Scott et al., 1984). Processing methods for pollen are standard and are documented in Ogden (1959). Analysis of these samples was carried out by Dr. P.J. Mudie.

The sample from the surface contained an assemblage of recent pollen grains mixed with reworked pollen grains, indicating that the surficial sediments have undergone some reworking. The other samples from the top 60cm show pollen grains that indicate a recent environment. The two samples from just above the fining-up unit (200cm and 220cm) contain pollen that indicates a warming trend. Foraminiferal assemblages respond more quickly than pollen assemblages to warming trends (since the waters warmed before the atmosphere did) and the full effect of the mid - Holocene warm interval was not shown in these pollen samples. However, the trend towards warming could be detected by the presence of some warmer climate pollen grains. Mudie (personal communication) suggests that this part of the core correlates with the warm interval represented in the Casco Basin core (Scott et al., 1984) with an approximate age

of 6400 - 5500 yrs BP. The presence of Tsuga, which did not appear until about 8000 yrs BP (Miller et al., 1982), indicates that the sediments at this depth in the core are less than 8000 yrs old.

Two samples from the glacial sediments at 340cm and 420cm show rather few pollen grains, most of which are reworked Cretaceous specimens and some wood fragments. Mudie (1980) suggests that these indicate glacial conditions.

Seismics

A high resolution seismic profile (fig. 3) of the study area (fig. 1) indicates the close proximity of the ice margin during the late stages of the Wisconsinan glaciation (e.g. King and Fader, 1985). The sequence shown in this profile shows three distinct units overlying the acoustic basement. Directly overlying the acoustic basement is a glacial till facies. This facies is characterized on the seismic profile by a dense gray pattern of incoherent reflections. The till lacks any good reflectors due to a general absence of stratification and uniformity within the unit. Overlying the glacial till is a unit consisting of the proglacial Emerald Silt facies. This facies is highly variable in thickness, but shows strong reflector characteristics. The Emerald Silt can be subdivided into three basic seismic facies (King and Fader, 1985): (A) a unit consisting of high amplitude, continuous, coherent reflectors that occur mainly at the base of the Emerald Silt; (B) a unit consisting of medium to low amplitude, continuous, coherent reflectors that overlies facies A; and (C) a unit consisting of discontinuous, coherent reflectors which overlies facies B. This sequence is observable in the northern 2/3 of the seismic profile. The unit overlying the Emerald Silt consists of postglacial Holocene LaHave Clay (MacLean and King, 1971). This unit exhibits discontinuous coherent to incoherent reflectors.

A number of glacial and postglacial features can be observed across the seismic profile. At point B is a topographic high representing the farthest advance of the ice sheet. Southward along the profile, a thick sequence of proglacial marine sediments

(Emerald Silt) is observed. This sequence, as previously mentioned, is well stratified thus indicating the marine nature of the deposition of the sediments. This sequence continues southward to the area from which core 84-011-12 was taken. Here, the sequence is cut off by a highly disturbed sequence. This highly disturbed sequence is followed by an area of thick glacial till overlain by a thin layer (approximately 3m) of Emerald Silt which is overlain by a thin layer (approximately 3m) of Holocene LaHave Clay. To the south, this feature is cut off abruptly by another highly disturbed sequence. Then there is another thick Emerald Silt unit followed by another topographic high. As shown in the seismic profile, these features are discontinuous and highly irregular.

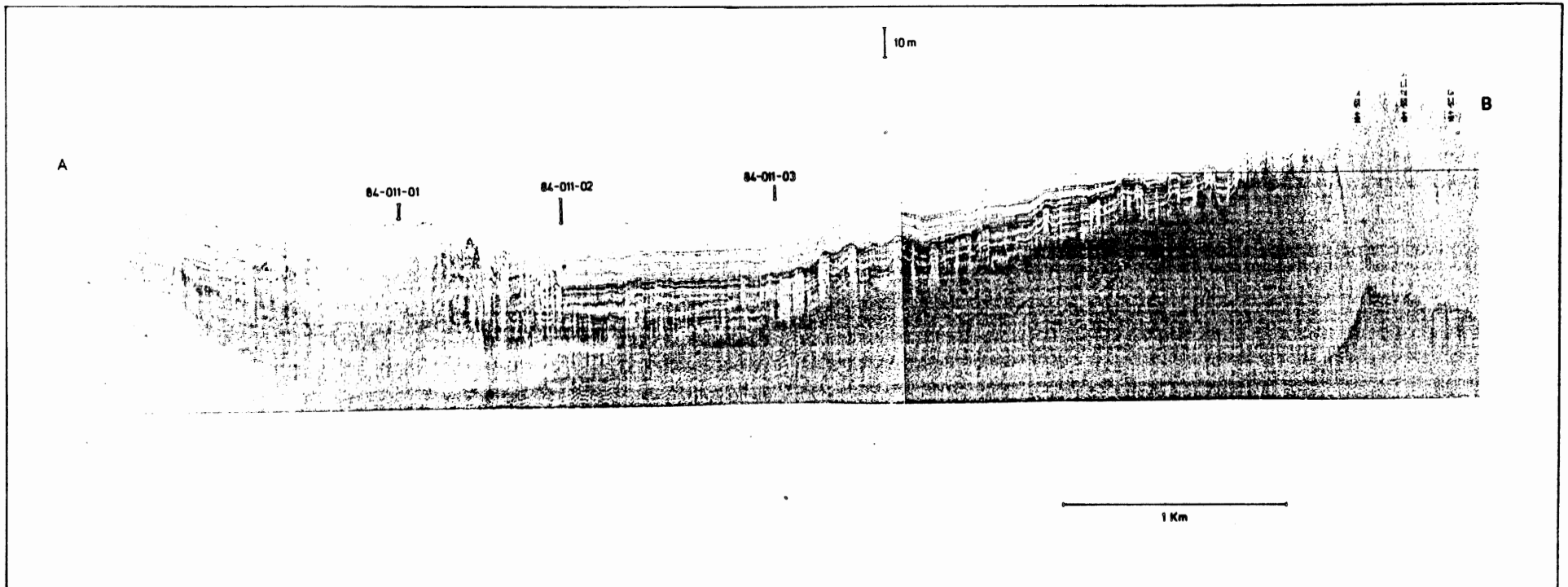


Fig. 3. Huntec Deep - Tow seismic record of the sediments in the study area. See fig. 1 for the location of points A and B. Note that the core numbers on the seismic record are in error. Cores 84-011-01, 84-011-02, and 84-011-03 on the record are actually 84-011-11, 84-011-12, and 84-011-13 respectively.

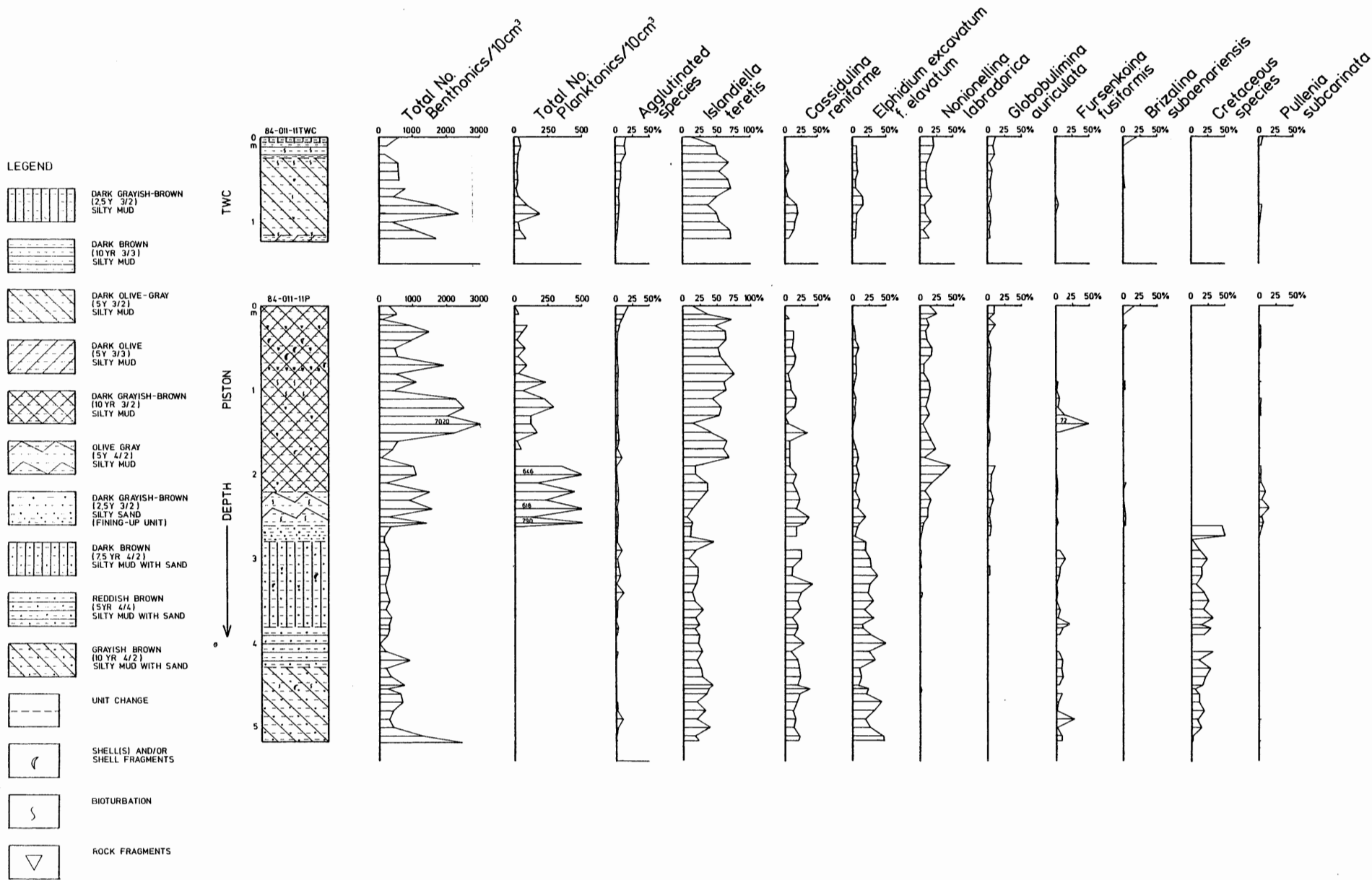


Fig. 4. Foraminiferal abundances and percentage occurrences of key species in core 84-011-11, St. Annes Basin. Dots on column represent percentages less than 1%.

DISCUSSION

The Elphidium excavatum f. clavatum - Cassidulina reniforme dominated assemblage in the glaciomarine Emerald Silt sediments, occurring in the lower 2.75m of core 84-011-11, is characteristic of a "warm" ice margin environment (Scott and Mediolli, 1980; Vilks, 1981; Scott et al., 1984). This environment was probably characterized by higher seawater temperatures than are currently found in glaciomarine environments in the Canadian Arctic (Scott et al., 1984). This fauna is found in all marine shelf sediments from the Labrador Shelf (Vilks, 1981) to the Gulf of Maine (Schnitker, 1976) and is widespread during a period from 16,000 to 12,000 yrs BP (Scott et al., 1984). This assemblage also contains a relatively high abundance of Islandiella teretis which is a good cold water indicator. The Cretaceous species present at this level are reworked; probably by direct glacial action in which floating ice was in contact with the exposed sediments of surrounding topographic high points. All these factors suggest the close proximity of the ice front during the time when Emerald Silt sediments were deposited.

This sequence is truncated by a 15cm thick turbidite sequence containing a high percentage of reworked Cretaceous foraminifera, and these species are a good indication that the turbidite consisted of reworked sediments rather than just a contemporary depositional fining up sequence. Overlying this turbidite sequence are the Holocene LaHave Clay sediments. The assemblage directly above the turbidite contains increases in Nonionellina labradorica, Globbulimina auriculata, and Pullenia subcarinata. The increases in

these species and the appearance of Brizalina subaenariensis and planktonic species indicate warmer, more saline waters during this period. The increase in planktonics is an indication of warmer, more saline surface waters and the warmer water benthonic species indicate that the bottom waters also experienced a rise in temperature and salinity. Further evidence to this warming period is a decrease in the colder water species. This assemblage probably represents the mid - Holocene hypsithermal, a warm interval from 7,000 to 5,000 yrs BP, with increases in bottom water temperature of 4 - 8°C (Scott et al., 1984). This sequence can be correlated with the faunas presently living in Emerald Basin and with the faunas in the warm interval shown in the Canso Basin core of the study by Scott et al. (1984). However, there are no early Holocene colder water faunas which are observed from most other cores in the area (Scott et al., 1984; Freeman, 1986).

The sharp proglacial - turbidite - postglacial transition indicates that erosion must have taken place sometime during the late glacial to early Holocene. This erosion was responsible for removing the late glacial and early Holocene sediments from this area. The thin turbidite sequence was probably deposited either just prior to or immediately following the erosional event. This turbidite most likely occurred as the result of sediment build - up on the small topographic high that is located to the south of, and close to, the study area. The sharp turbidite - postglacial transition indicates that sedimentation must have been occurring at the same time since there is no gradual transition from reworked faunas to the overlying faunas.

The warm water assemblage gradually disappears at 180cm core

depth. This transition represents a gradual cooling event due to the influx of colder Outer Labrador Current water at first and then by an influx of even colder Inner Labrador Current water. Additional evidence of this cooling event is supplied by an increase in I. teretis and agglutinated species, both of which are commonly found in the colder waters of the Labrador Current. The short sequence dominated by Fursenkoina fusiformis probably represents a short interval during which the environment was quieter, less saline, and highly anoxic. This species is presently found occurring mainly in deep estuarine environments in Eastern Canada (Scott et al., 1980).

The surficial assemblage of warm water calcareous species mixed with colder water agglutinated species is difficult to explain. Previous studies by Williamson (1983), Williamson (1985) and Williamson et al. (1984) on foraminiferal distributions on the Scotian Shelf, indicate that the surficial sediments of St. Annes Basin are characterized by an exclusively agglutinated fauna dominated by Adercotryma glomerata. These studies included three surface samples taken to the north and east of the study area (fig. 1, samples 1067 and 1068) within the same basin. Two other cores taken in close proximity to core 84-011-11 (cores 84-011-12 and 84-011-13) also show surficial assemblages marked by mixed calcareous and agglutinated faunas. A possible explanation for this occurrence is that the same topographic high that was responsible for the deposition of the turbidite sequence may have also deposited reworked warmer water calcareous species over the area of study. A local seismic event probably triggered the deposition of this slump. This must have been a rather small - scale event, since these calcareous species do not appear in the samples studied by

Williamson.

Rodriguez and Hooper (1982) found warm water calcareous faunas occurring in the Gulf of St. Lawrence to the north of St. Anne's Basin. This assemblage is dominated by Bulimina exilis, a relatively warm water species. This fauna is characteristic of the surface sediments of the Laurentian Trough at depths greater than 390m, with temperatures of 4.1 to 4.8°C and salinities of 34.5 to 34.9‰ (Rodriguez and Hooper, 1982). However, this fauna is different to that found in the surficial sediments in the area of study. This can be attributed to the isolated nature of St. Annes Basin and the fact that the bottom water masses of the Gulf of St. Lawrence cannot mix with the bottom waters of this basin because of the bank that lies between the two.

The seismic profile taken over the area of study (fig. 3) shows an area of discontinuous glacial and postglacial processes. The sequences shown in the profile are indicative of the glacial nature of the sediments and associated structures. The topographic high at point B represents the farthest advance of the ice sheet during the late Wisconsinan glaciation. The thick sequence of Emerald Silt sediments to the south of this represent proglacial marine sediments that were deposited during the late stages of glaciation. The marine outwash nature of deposition of these sediments is responsible for their well - stratified nature. The disturbed sequences, which lie to the immediate north and south of the core site, may be explained by a block of ice that broke off from the glacier and grounded on the area from which the core used in this study was taken. This ice block was present for a long period of time as indicated by the thick glacial till unit underlying the area. The edges of this block

were probably responsible for causing the disturbed sequences, possibly from the rising and falling of the block with the tides. The area underneath the block of ice probably represents a non-marine depositional environment, explaining the deposition of the thick glacial till unit. The fact that the well - stratified Emerald Silt facies is cut off at the approximate edges of the ice block indicates that it was present during the deposition of most of the Emerald Silt sediments.

Interpretation of the seismic data correlates well with the findings of the foraminiferal study. However, since the core only penetrates through the LaHave Clay and most of the Emerald Silt, a correlation can only be drawn for these two units. The faunas that were found in the core correspond well with the interpretation that the top unit is postglacial LaHave Clay and the underlying unit is proglacial Emerald Silt. As well, the turbidite sequence observed in the core corresponds well with the continuous reflection boundary shown on the seismic profile at a depth of about 3m. However, a stronger reflection contrast might have been expected between the Holocene and Wisconsinan sediments, as observed in most other places, even in the profile.

SUMMARY

The benthonic foraminiferal assemblages from core 84-011-11 were used to indicate changes in bottom watermass characteristics on the northern Scotian Shelf. These assemblages, along with the lithology of the sediments, indicate that a discontinuous glacial - interglacial record is present in this core. This record shows that a variety of sedimentological processes and oceanographic changes have occurred within the area of study. A short summary of these processes and changes represented in the core follows.

(1) The glaciomarine Emerald Silt was deposited as the ice front retreated. The bottom waters at this time were characterized by a varying influx of glacial meltwater. The temperature and salinity of these bottom waters is difficult to determine since no analogous present day environment has yet been discovered (Scott et al., 1984). Direct glacial reworking was occurring at this time as indicated by the presence of Cretaceous foraminifera and pollen.

(2) This glaciomarine sequence shows a gradual warming trend but is cut off before the Pleistocene - Holocene boundary by the short fining - up turbidite sequence.

(3) The turbidite sequence was deposited sometime during the late glacial or early postglacial (ca. 15,000 - 7,000 yrs BP). Two possible explanations exist for the absence of the late glacial - early postglacial record and the presence of the turbidite sequence: either an erosional event occurred which destroyed the late glacial - early postglacial record and was followed by the deposition of the turbidite sequence; or, the turbidite was deposited first on the Pleistocene Emerald silt, then sedimentation continued followed by

erosion of the sediments overlying the turbidite and then mid - Holocene deposition. The presence of reworked faunas indicates the reworked nature of the sediments.

(4) Following this, deposition continued with an assemblage of mid - Holocene warm water foraminifera and mid - Holocene pollen. The bottom waters during this time were characteristic of a slope - Gulf Stream mixture with temperatures of 7 - 10°C and salinities of around 34%.

(5) A gradual cooling followed this with the influx of Outer Labrador Current waters. These waters have temperatures of 2 - 4°C and salinities of 34 - 35%. (Scott et al., 1984).

(6) The bottom waters continued to cool with the addition of Inner Labrador Current waters. These waters are characterized by lower temperatures (0 - 3°C) and lower salinities (31 - 33%, Williamson, 1983).

(7) A small slump occurred as the result of sediment pile - up on the small topographic high to the immediate south of the study area (fig. 3). This slump is a possible explanation for the occurrence of reworked warmer water calcareous species that are mixed with the colder water agglutinated assemblage that is characteristic of the modern day environment in this basin.

On a larger scale, the interpretations of the seismic data can also be summarized. This summary is as follows:

(1) The glacier grounded at point B, on the seismic profile, during the peak of the Wisconsinan glaciation.

(2) A block of ice broke off from the glacier and was grounded directly over the area from which the core used in this study was taken.

(3) Simultaneously, the area under the block of ice was undergoing deposition of glacial till, the edges of this unit were being disturbed by slight movements of the ice block, and the proglacial Emerald Silt was being deposited around this area.

(4) The block of ice eventually melted or drifted away prior to the deposition of Holocene sediments. This is indicated by the thin layer of Emerald Silt that overlies the glacial till in this area.

(5) Relatively continuous deposition of the Holocene LaHave Clay followed.

The data obtained from the study of this area provide a record of the glacial - interglacial transition on the northern Scotian Shelf. Although part of the record was not preserved in this core, it can still be concluded that the area of study was subjected to the same general paleoceanographic trends as the rest of the continental margin of Eastern Canada.

SUGGESTIONS FOR FURTHER WORK

Although eight pollen samples from this core were examined in order to make large scale dating correlations, further analysis of more pollen samples could provide more precise correlations in dating. Accurate dating could be provided by obtaining Carbon-14 dates for specific intervals in the core.

Obtaining a core from the same area which contained a continuous late glacial - early Holocene would provide data for the segment that is missing from core 84-011-11. A core (84-011-13) taken just to the north of the core used in this study, has not yet been examined and may provide valuable information concerning the processes and changes that have occurred in this area of St. Annes Basin.

TAXONOMY

In this section taxonomic synonymies are presented for all 54 benthonic foraminiferal species that were recognized in this study. These are arranged alphabetically by genus. The references that were used for identification purposes are Barker (1960), Cole (1981), McNeil and Caldwell (1981), Vilks et al. (1982) and Williamson (1983). Generic names are in accordance with Loeblich and Tappan (1964).

Adercotryma glomerata (Brady)

Plate 1, fig. 1.

Lituola glomerata BRADY, 1878, p. 433, pl. 20, figs. 1a-c.

Adercotryma glomerata (Brady) LOEBLICH and TAPPAN, 1952, p. 141, figs. 1-4; VILKS, 1969, p. 44, pl. 1, fig. 15; GREGORY, 1971, p. 173, pl. 11, figs. 9-11; COLE, 1981, p. 29, pl. 4, figs. 5,6; WILLIAMSON, 1983, p. 208, pl. 1, fig. 16.

Brizalina pseudopunctata (Hoeglund)

Bolivina pseudopunctata HOEGLUND, 1947, p. 273, pl. 24, fig. 5, pl. 32, figs. 23,24.

Brizalina subaenariensis (Cushman).

Plate 1, fig 6.

Bolivina subaenariensis CUSHMAN, 1922, p. 46, pl. 7, fig. 6; WILLIAMSON, 1983, p. 218, pl. 3, fig. 11.

Buccella frigida (Cushman)

Pulvinulina frigida CUSHMAN, 1922, p. 12 (144)

Eponides frigida (Cushman) CUSHMAN, 1931, p. 45.

Buccella frigida (Cushman) ANDERSON, 1952, p.144, text-figs. 4,5,6;

WILLIAMSON, 1983, p. 223, pl. 4, figs. 4,5.

Bulimina aculeata d'Orbigny

Plate 1, fig. 4.

Bulimina aculeata d'ORBIGNY, 1826, p. 269, no. 7. BRADY, 1884, p. 406, pl. 51, figs. 7-9.

Bulimina elongata d'ORBIGNY, 1846, p. 187, pl. 11, figs. 19,20.

Bulimina elongata d'ORBIGNY var. subulata CUSHMAN and PARKER, 1937, p. 51, pl. 7, figs. 6,7.

Bulimina elongata d'Orbigny var. lesleyae ATKINSON, 1969, p. 534, fig. 6, no. 2. HAYNES, 1973, p. 119, pl. 10, fig. 6; text-fig. 24, no. 9.

Bulimina gibba FORNASINI, 1902, p. 378, pl. 10, figs. 32,34.

Bulimina gibba/elongata Fornasini and d'Orbigny. MURRAY, 1971, p. 117, pl. 48, figs. 1-8.

Bulimina elegans d'Orbigny. BRADY, 1884, p. 398, pl. 50, figs. 1-4.

Bulimina exilis Brady

Plate 1, fig. 5.

Bulimina elegans var. exilis BRADY, 1884, p. 399, pl. 50, figs. 5,6.

Bulimina exilis Brady. CUSHMAN and PARKER, 1940, p. 11, pl. 2, figs. 18-21; WILLIAMSON, 1983, p. 220, pl. 3, fig. 15.

Bulimina marginata (d'Orbigny)

Plate 1, fig. 3.

Bulimina Maginata d'ORBIGNY, 1826, p. 269, pl. 12, figs. 10-12;
WILLIAMSON, 1983, p. 219, pl. 3, fig. 3.

Cassidulina reniforme Norvang

Plate 1, figs. 13,14.

Cassidulina crassa reniforme NORVANG, 1945, p. 41, text-figs. 6e-h.

Cassidulina islandica Norvang. LOEBLICH and TAPPAN, 1953, p. 118,
pl. 24, fig. 1.

Cassidulina crassa d'Orbigny. NORVANG, 1958, p. 36, pl. 9, figs.
24,25.

Cassidulina crassa minima BOLTOVSKOY, 1959, p. 100, pl. 13, fig. 12.

Cassidulina bradshawi UCHID, 1960, p. 68, pl. 9, figs. 11,12.

Cassidulina subacuta (Gudina). FEYLING-HANSSSEN, 1976, p. 354, pl.
2, figs. 14-19.

Cassidulina crassa d'Orbigny var. reniforme NORVANG, 1945, p. 41,
text-figs 6c-h.

Cassilaminella subacuta GUDINA, 1966, p. 67, pl. 7, figs. 4,5; pl.
13, fig. 3.

Cassidulina reniforme NORVANG. SEJRUP and GUILBAULT, 1980, p. 79,
fig. 2f-k.

Cibicides lobatulus (Walker and Jacob)

Nautilus lobatulus WALKER and JACOB, 1798, p. 642, pl. 14, fig. 36.

Cibicides lobatulus (Walker and Jacob) CUSHMAN, 1931, 118k, pl. 21,
fig. 3; WILLIAMSON, 1983, p. 226, pl. 4, figs. 10,11

Cribrostomoides crassimargo (Norman)

Haplophragmium crassimargo NORMAN, 1892, p. 17.

Labrospira crassimargo (Norman) HOEGLUND, 1947, p. 11, fig. 1, text-fig. 121-125.

Cribrostomoides crassimargo (Norman). LESLIE, 1965, p. 158, pl. 2, fig. 2a,b; BARBIERI and MEDIOLI, 1969, p. 855, fig. 4; GREGORY, 1971, p. 176, pl. 3, figs. 1,2; WILLIAMSON, 1983, p. 209, pl. 1, figs. 6,7.

Cribrostomoides jeffreysi (Williamson)

Nonionina jeffreysi WILLIAMSON, 1858, p. 34, figs. 72,73.

Cribrostomoides jeffreysi (Williamson). BARBIERI and MEDIOLI, 1969, p. 855, fig. 4; VILKS, 1969, p. 45, pl. 1, fig. 17a,b; COLE, 1981, p. 30, pl. 6, fig. 6; WILLIAMSON, 1983, p. 209, pl. 1, fig. 12.

Cyclogyra involvens (Reuss)

Operculina involvens REUSS, 1850, p. 370, pl. 46, fig. 30.

Cyclogyra involvens (Reuss). LOEBLICH and TAPPAN, 1961, p. 290.

Genus Dentalina Risso, 1826.

Remarks: number of species, but none were differentiated.

Eggerella advena (Cushman)

Verneuulina advena CUSHMAN, 1922, p. 141.

Eggerella advena (Cushman) CUSHMAN, 1937, p. 51, pl. 5, figs. 12-15; WILLIAMSON, 1983, p. 214, pl. 2, fig. 3.

Elphidium bartletti (Cushman)

Elphidium bartletti CUSHMAN, 1933, p. 4, pl. 1, fig. 9; WILLIAMSON, 1983, p. 224, pl. 5, fig. 10.

Elphidium excavatum (Terquem) group

Plate 1, fig. 15.

Polystomella excavata Terquem, 1876, p. 429, pl. 2, figs. 2a-f.Elphidium incertum (Williamson) var. clavatum CUSHMAN, 1931, p. 20, pl. 7, fig. 10.Elphidium excavatum (Terquem) clavata Cushman, FEYLING-HANSEN, 1972, p. 339, pl. 1, figs. 1-9; pl. 2, figs. 1-9.Elphidium excavatum (Terquem). HERON-ALLEN and EARLAND, 1932, p. 439, pl. 16, figs. 22,23; WILLIAMSON, 1983, p. 224, pl. 5, fig. 9.Elphidium subarcticum (Cushman)Elphidium subarcticum CUSHMAN 1944, p. 27, pl. 3, figs. 34, 35.Eouvigerina spp.

Plate 1, fig. 16.

Remarks: Cretaceous species

Epistominella takayanaqii (Iwasa)Epistominella takayanaqii IWASA 1955, p. 16, text-fig. 4.Genus Fissurina Reuss, 1850.

Remarks: number of species, but none differentiated.

Fursenkoina fusiformis (Williamson)

Plate 1, fig. 7.

Bulimina pupoides fusiformis WILLIAMSON, 1858, p. 63, pl. 5, figs. 129,130.Bulimina fusiformis Williamson. HOEGLUND, 1947, p. 232, pl. 20,

fig. 3, text-figs 219 - 233.

Virgulina fusiformis (Williamson). FEYLING-HANSEN, 1964, p. 307, pl. 14, figs. 15-18.

Fursenkoina fusiformis (Williamson). LOEBLICH and TAPPAN, 1964; WILLIAMSON, 1983, p. 226, pl. 5, fig. 1.

Globigerinelloides spp.

Plate 1, figs. 17, 18.

Remarks: Cretaceous species

Globobulimina auriculata (Hoeglund)

Globobulimina auriculata HOEGLUND, 1947, p. 252, pl. 20, fig. 6; pl. 21, fig. 5; pl. 22, fig. 6; text-figs. 258-265, 268, 269, 271; WILLIAMSON, 1983, p. 221, pl. 3, fig. 17.

Gyroidina soldanii d'Orbigny

Rotalia (Gyroidina) soldanii d'ORBIGNY, 1826, p. 278, no. 5, mod. 36.

Gyroidina neosoldanii BROTZEN, 1936, p. 158.

Heterohelix spp.

Plate 1, figs. 19, 20.

Remarks: Cretaceous species.

Islandiella teretis (Tappan)

Plate 1, figs. 9, 10.

Cassidulina laevigata d'Orbigny. BRADY, 1884, p. 423, pl. 54, figs. 1-3.

Cassidulina teretis TAPPAN, 1951, p. 7, pl. 1, fig. 30a-c.

Islandiella teretis (Tappan) VILKS, 1969, p. 49, pl. 3, fig. 5;

WILLIAMSON, 1983, p. 219, pl. 3, fig 19.

Genus Lagena Walker and Jacob, 1798.

Remarks: number of species, but none differentiated.

Genus Melonis de Montfort, 1808.

Remarks: species not differentiated.

Nonionella turqida (Williamson)

Rotalina turqida WILLIAMSON, 1858, p. 50, pl. 4, figs. 95-97.

Nonionina turqida (Williamson). BRADY, 1884, p. 731, pl. 109, figs. 17-19.

Nonionella turqida (Williamson). CUSHMAN, 1930, p. 15, pl. 6, figs. 1-4; WILLIAMSON, 1983, p. 228, pl. 4, fig 13.

Nonionellina labradorica (Dawson)

Plate 1, fig. 8.

Nonionina labradorica DAWSON, 1860, p. 191, fig. 4.

Nonion labradorica (Dawson) CUSHMAN, 1927, p. 148, pl. 2, figs. 7,8.

Nonionellina labradorica (Dawson) Voloshinova, 1958, p. 142; WILLIAMSON, 1983, p. 227, pl. 4, figs. 14,15.

Genus Dolina d'Orbigny, 1839.

Remarks: number of species, but none differentiated.

Pseudopolymorphina novaealiae (Cushman)

Polymorphina lactea novangliae CUSHMAN, 1923, p. 146, pl. 39, figs. 6-8.

Pseudopolymorphina novangliae (Cushman). PARKER, 1952, p. 410, pl. 5, fig. 1.

Pullenia quinqueloba (Reuss)

Nonionina quinqueloba REUSS, 1851, p. 71, pl. 5, fig. 31.

Pullenia quinqueloba (Reuss). BRADY, 1882, p. 712; WILLIAMSON, 1983, p. 228, pl. 4, fig. 16.

Pullenia subcarinata (d'Orbigny)

Plate 1, figs. 11, 12.

Nonionina subcarinata d'ORBIGNY, 1839, p. 28, pl. 5, figs. 23, 24.

Pullenia quinqueloba is a junior synonym of this species (Scott, in press).

Pyrgo williamsoni (Silvestri)

Biloculina williamsoni SILVESTRI, 1923, p. 73.

Pyrgo williamsoni (Silvestri). LOEBLICH and TAPPAN, 1953, p. 48, pl. 6, figs. 1-4.

Quinqueloculina seminulum (Linne)

Serpula seminulum LINNE, 1758, p. 786, pl. 2, fig. 1.

Quinqueloculina seminulum (Linne). CUSHMAN, 1929, p. 24, pl. 2, figs. 1, 2; WILLIAMSON, 1983, p. 215, pl. 3, fig. 1.

Recurvoides turbinatus (Brady)

Haplophragmium turbinatum BRADY, 1881, p. 50.

Recurvoides turbinatus (Brady). PARKER, 1952, p. 402, pl. 2, figs. 23,24; WILLIAMSON, 1983, p. 209, pl. 1, fig. 17.

Reophax arctica (Brady)

Reophax arctica BRADY, 1881, p. 99, pl. 2, fig. 2; WILLIAMSON, 1983, p. 206, pl. 1, fig. 8.

Reophax fusiformis (Williamson)

Proteonina fusiformis WILLIAMSON, 1858, p. 1, pl. 1, fig. 1.

Reophax fusiformis (Williamson) BRADY, 1884, p. 290, pl. 30, figs. 7-11.

Reophax curtus CUSHMAN, 1920, p. 8, pl. 2, figs. 2,3.

Reophax scorpiurus BALKWILL and WRIGHT, 1885, p. 329, pl. 1B, fig. 5.

Reophax subfusiformis EARLAND, 1933, p. 74, pl. 2, figs. 16-19.

Reophax regularis HOEGLUND, 1947, p. 86, pl. 9, figs. 11,12; pl. 26, figs. 37-43; pl. 27, figs. 24-27.

Reophax scorpiurus (Montfort)

Reophax scorpiurus MONTFORT, 1808, p. 330; LOEBLICH and TAPPAN, 1953, p. 24, pl. 2, figs. 7-10; LESLIE, 1965, p. 169, pl. 1, figs. 6,7; WILLIAMSON, 1983, p. 207, pl. 1, fig. 9.

Reophax scottii (Chaster)

Reophax scottii CHASTER, 1892, p. 57, pl. 1, fig. 1; WILLIAMSON, 1983, p. 207, pl. 1, fig. 11.

Robertinoides charlottensis (Cushman)

Cassidulina charlottensis CUSHMAN, 1925, p. 41, pl. 6, figs. 6,7.

Robertina charlottensis (Cushman). CUSHMAN and PARKER, 1936, p. 97, pl. 16, fig. 12.

Robertinoides charlottensis (Cushman). LOEBLICH and TAPPAN, 1953, p. 108, pl. 20, figs. 6,7.

Saccamina atlantica (Cushman)

Proteonina atlantica CUSHMAN, 1944, p. 5, pl. 1, fig. 4.

Saccamina atlantica (Cushman). TODD and BRONNIMANN, 1957, p. 22, pl. 1, fig. 14; WILLIAMSON, 1983, p. 205, pl. 1, fig. 2.

Saccamina difflugiiformis (Brady)

Plate 1, fig. 2.

Reophax difflugiiformis BRADY, 1879, p. 51, pl. 4, figs. 3a,b.

Proteonina difflugiiformis (Brady). PHLEGER and PARKER, 1955, p. 2, pl. 1, figs. 4,5.

Saccamina difflugiiformis (Brady). TODD and BRONNIMAN, 1957, p. 52, pl. 1, fig. 15; WILLIAMSON, 1983, p. 205, pl. 1, fig. 3.

Spiroplectammina biformis (Parker and Jones)

Textularia agglutinans biformis PARKER and JONES, 1865, p. 370, pl. 15, figs. 23,24.

Spiroplectammina biformis (Parker and Jones) LACROIX, 1932, p. 5, fig. 1; Williamson, 1983, p. 211, pl. 2, fig. 5.

Textularia torquata (Parker)

Textularia torquata PARKER, 1952, p. 403, pl. 3, figs. 9-11;
WILLIAMSON, 1983, p. 212, pl. 2, fig. 4.

Trifarina fluens (Todd)

Anquogerina fluens TODD, in CUSHMAN and McCULLOCH, 1940, p. 288,
pl. 36, fig. 1.

Trifarina fluens (Todd). LOEBLICH and TAPPAN, 1964.

Triloculina trihedra (Loeblich and Tappan)

Triloculina trihedra LOEBLICH and TAPPAN, 1953, p. 45, pl. 4, fig.
10.

Trochammina globigeriniformis (Parker and Jones)

Lituola nautiloidea globigeriniformis PARKER and JONES, 1865, p.
407, pl. 15, figs. 46,47.

Trochammina globigeriniformis (Parker and Jones) CUSHMAN, 1910, p.
124, text-figs. 193-195; WILLIAMSON, 1983, p. 213, pl. 2, fig. 14.

Trochammina inflata (Montagu)

Nautilus inflatus MONTAGU, 1808, p. 81, pl. 18, fig. 3.

Trochammina inflata (Montagu). CARPENTER, PARKER and JONES, 1862, p.
141, pl. 11, fig. 5; WILLIAMSON, 1983, p. 212, pl. 2, figs. 12,13.

Trochammina lobata Cushman

Trochammina lobata CUSHMAN, 1944, p. 18, pl. 2, fig. 10; PARKER,
1952, p. 408, pl. 4, figs. 8a,b; SCHNITKER, 1971, p. 212, pl. 1,
fig. 18; COLE and FERGUSON, 1975, p. 14, pl. 4, figs. 5,6;
WILLIAMSON, 1983, p. 213, pl. 2, fig. 15.

Trochammina nana (Brady)

Haplophragmium nana BRADY, 1881, p. 50.

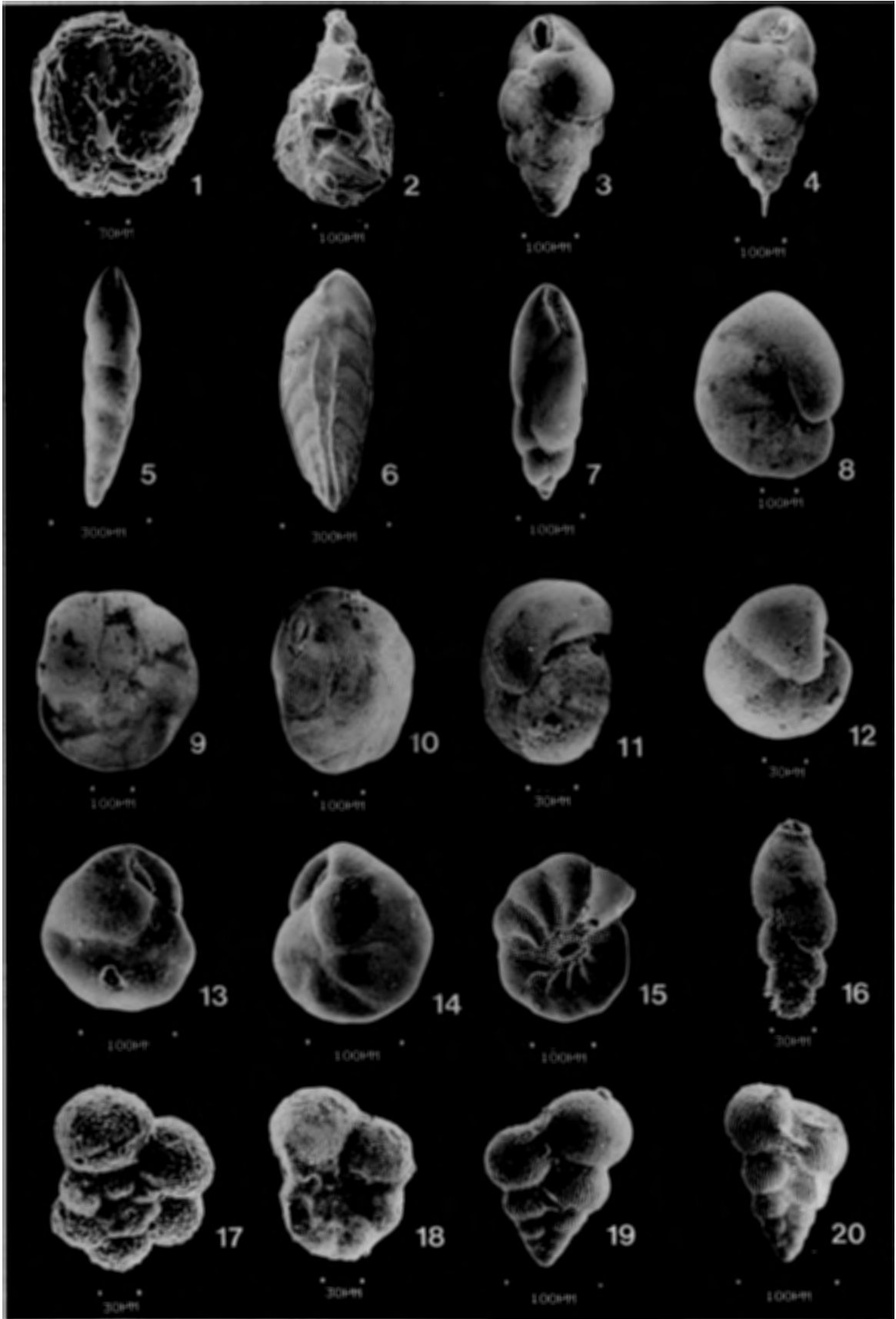
Trochammina nana (Brady) CUSHMAN, 1920, p. 80, pl. 17, fig. 1.

Trochammina nitida (Brady)

Trochammina nitida BRADY, 1881, p. 52.

Plate 1.

1. Adercotryma glomerata - side view.
2. Saccamina difflugiformis - side view.
3. Bulimina marginata - apertural view.
4. Bulimina aculeata - apertural view.
5. Bulimina exilis - apertural view.
6. Brizalina subaenariensis - side view.
7. Fursenkoina fusiformis - apertural view.
8. Nonionellina labradorica - side view.
9. Islandiella teretis - side view opposite to aperture.
10. Islandiella teretis - apertural view.
11. Pullenia subcarinata - apertural view.
12. Pullenia subcarinata - side view.
13. Cassidulina reniforme - apertural view.
14. Cassidulina reniforme - side view.
15. Elphidium excavatum f. clavatum - side view.
16. Eouvigerina spp. - side view.
- 17-18. Globigerinelloides spp. - side view.
- 19-20. Heterohelix spp. - side view.



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APPENDIX

CORE 84-011-11 TWc

DEPTH IN CORE 0-100 cm

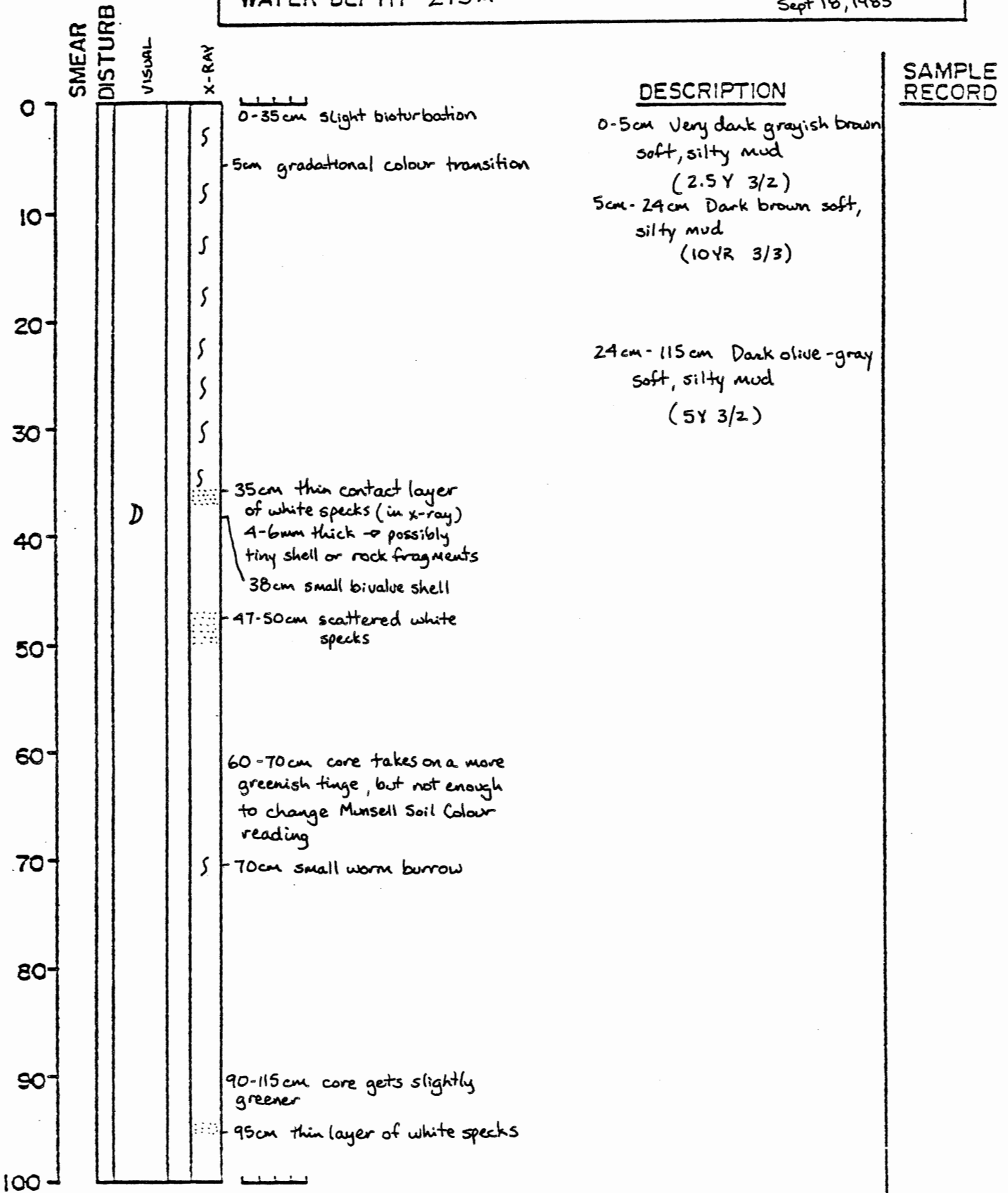
LOCATION ST. Anne's Basin

Lat. 45°46.11 Long. 58°38.86

WATER DEPTH 275 m

Described by: B. Souchen

Sept 18, 1985

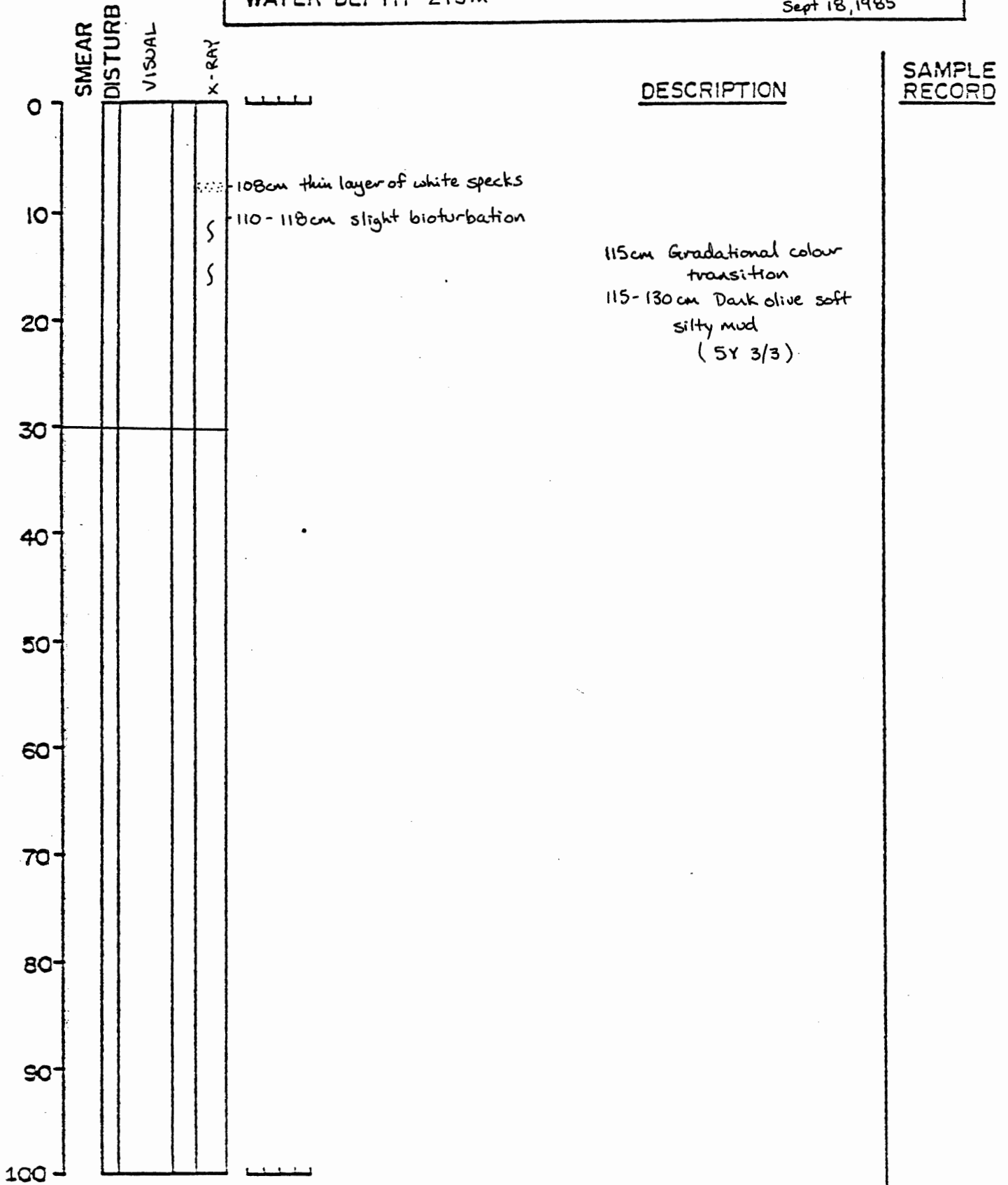


General comments: Munsell Soil Colour Chart used
Distinct Organic odour

CORE 84-011-11 TWC
LOCATION St. Anne's Basin
WATER DEPTH 275 m

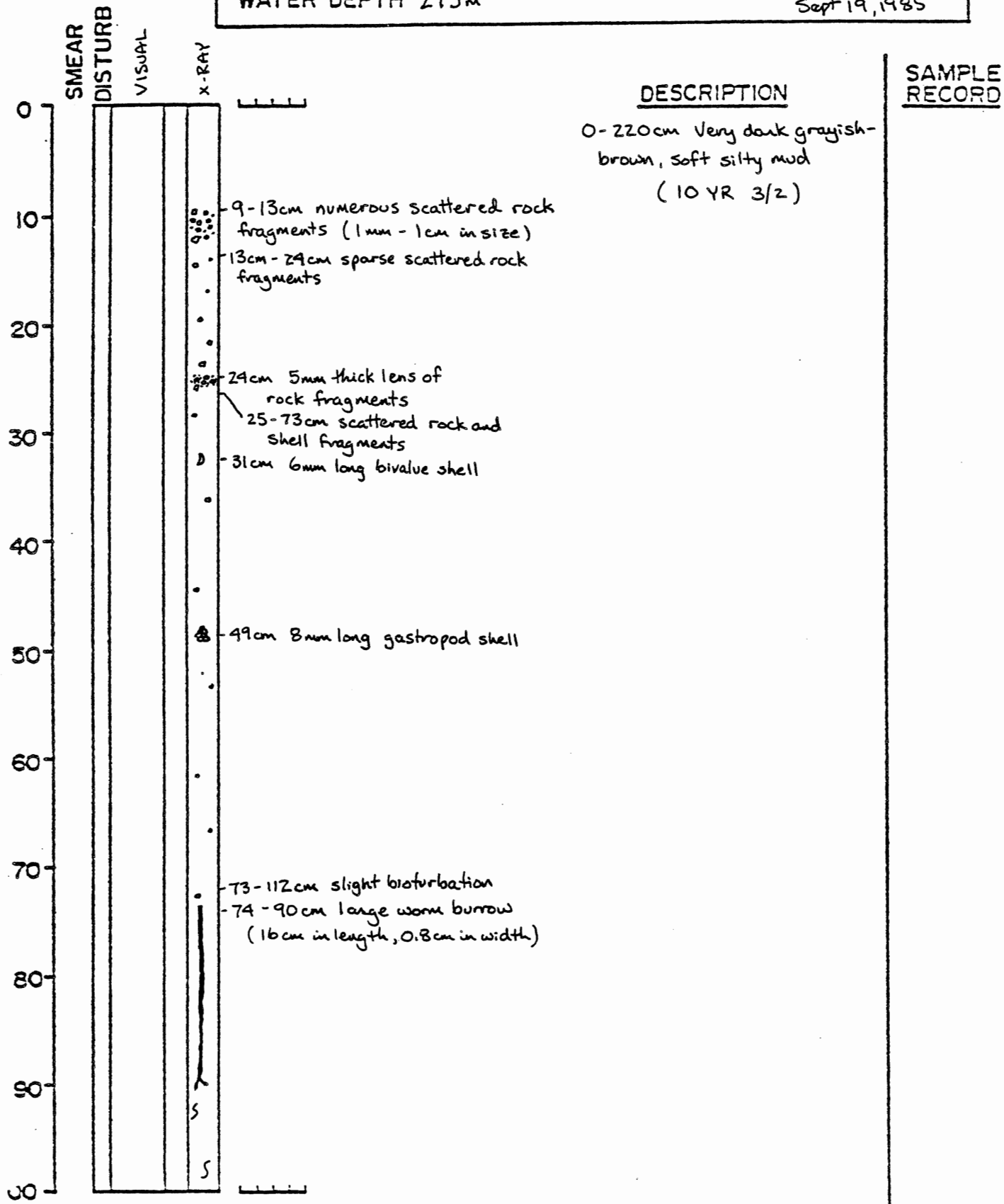
DEPTH IN CORE 100 - 130 cm

Described by: B. Souchen
Sept 18, 1985



General comments: Munsell Soil Colour Chart used
Organic Odour

CORE 84-011-11P DEPTH IN CORE 0-100 cm
 LOCATION St. Anne's Basin Described by: B. Soxchen
 WATER DEPTH 275 m Sept 19, 1985

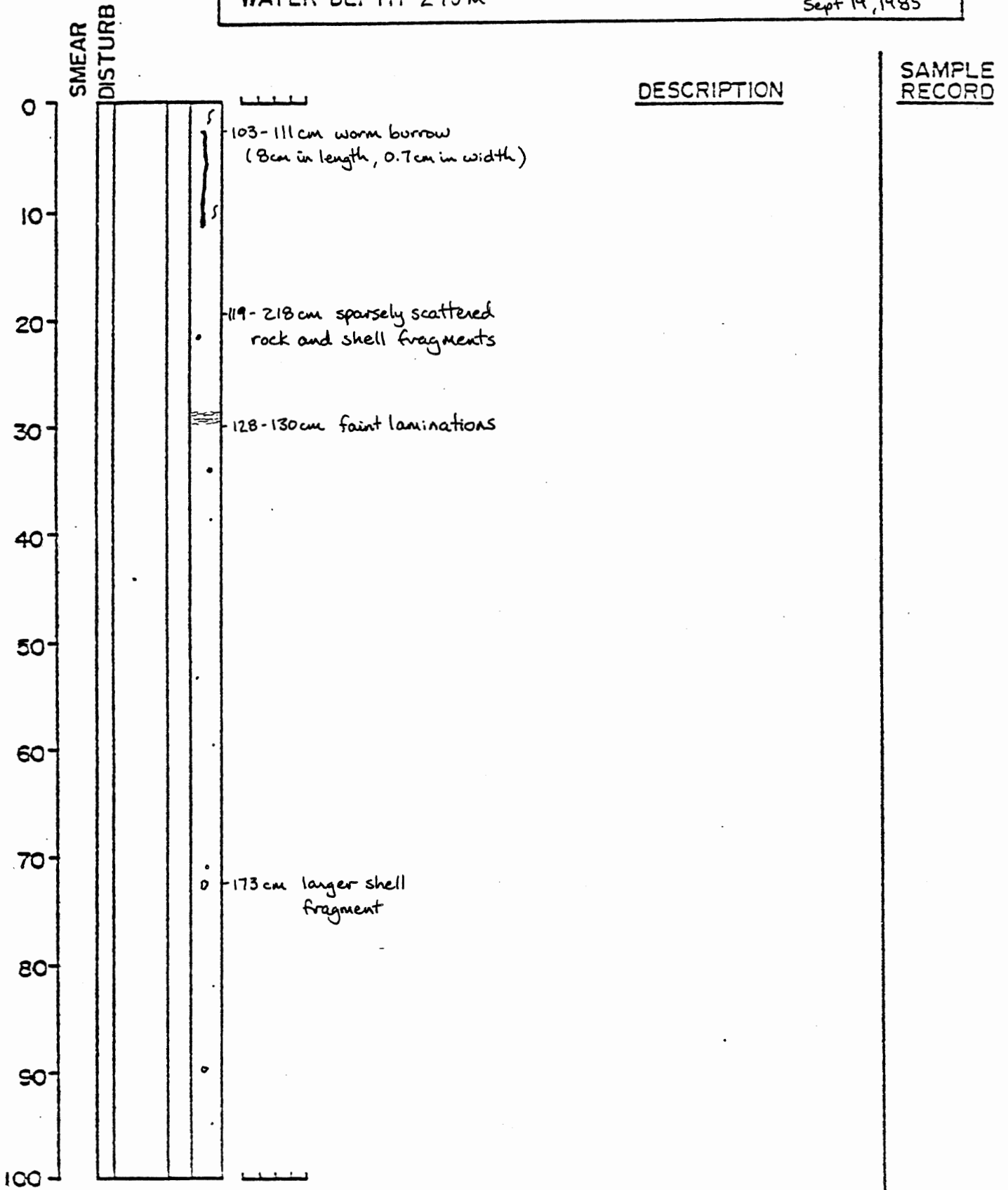


General comments: Munsell Soil Colour Chart used
 Organic Odour

CORE 84-011-11P
LOCATION ST. Anne's Basin
WATER DEPTH 275 m

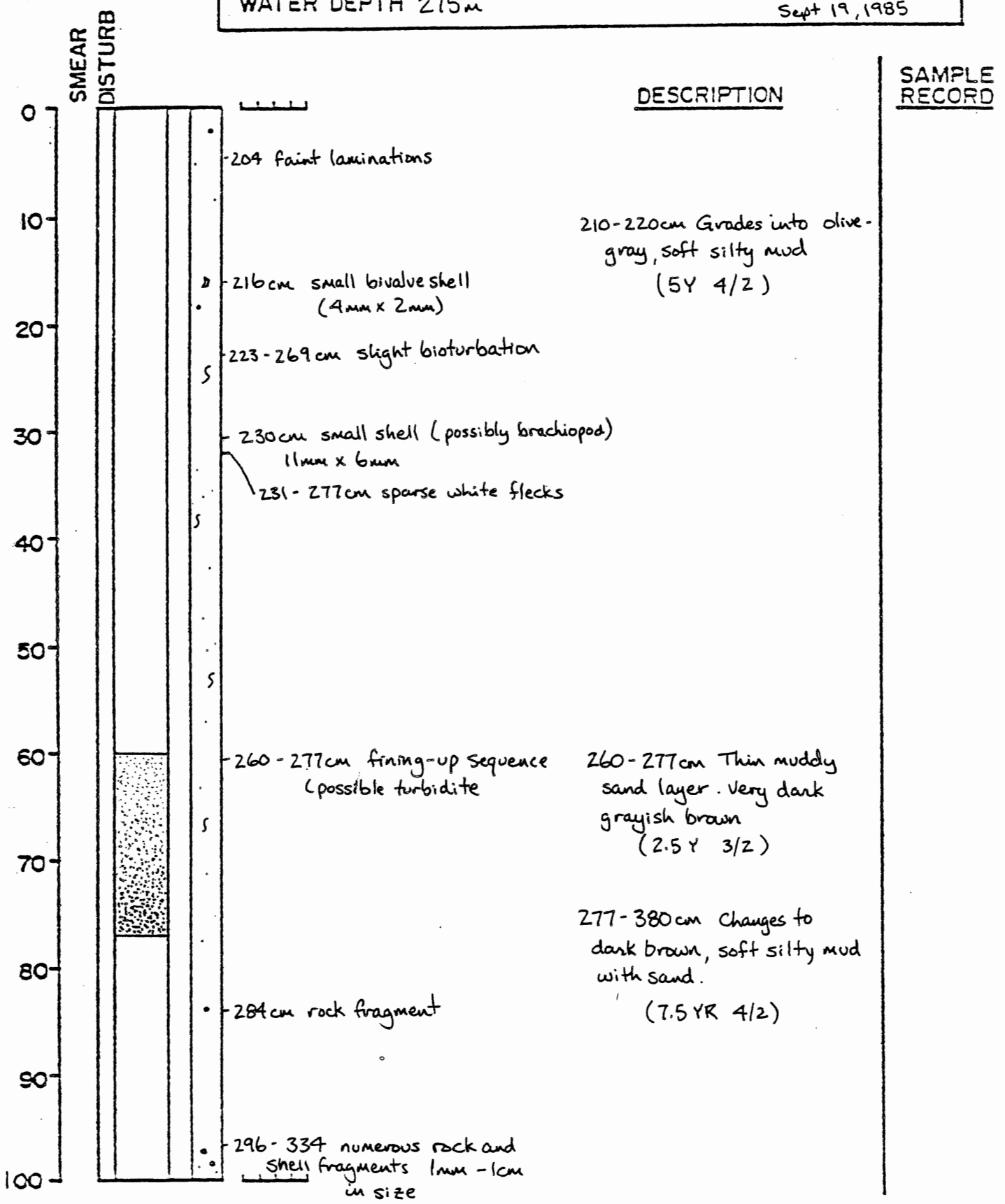
DEPTH IN CORE 100-200 cm

Described by: B. Souchen
Sept 19, 1985



General comments: Munsell Soil Colour Chart Used
Organic Odour

CORE 84-011-11P DEPTH IN CORE 200-300cm
 LOCATION St. Anne's Basin Described by: B. Sauchen
 WATER DEPTH 275m Sept 19, 1985

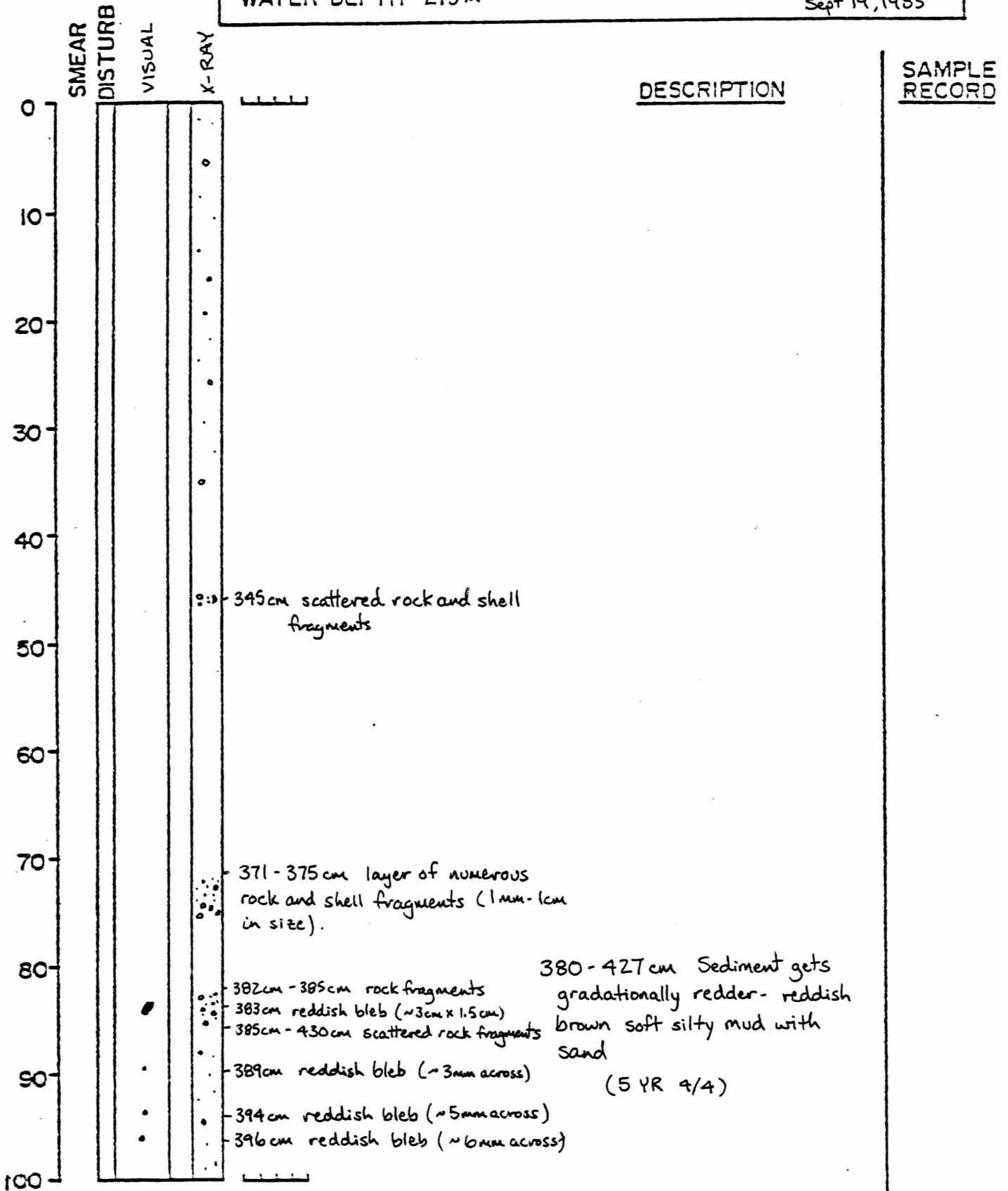


General comments: Munsell Soil Colour Chart used
 Organic odour

CORE 84-011-11P
 LOCATION St. Anne's Basin
 WATER DEPTH 275 m

DEPTH IN CORE 300 - 400 cm

Described by: B. Souchen
 Sept 19, 1985

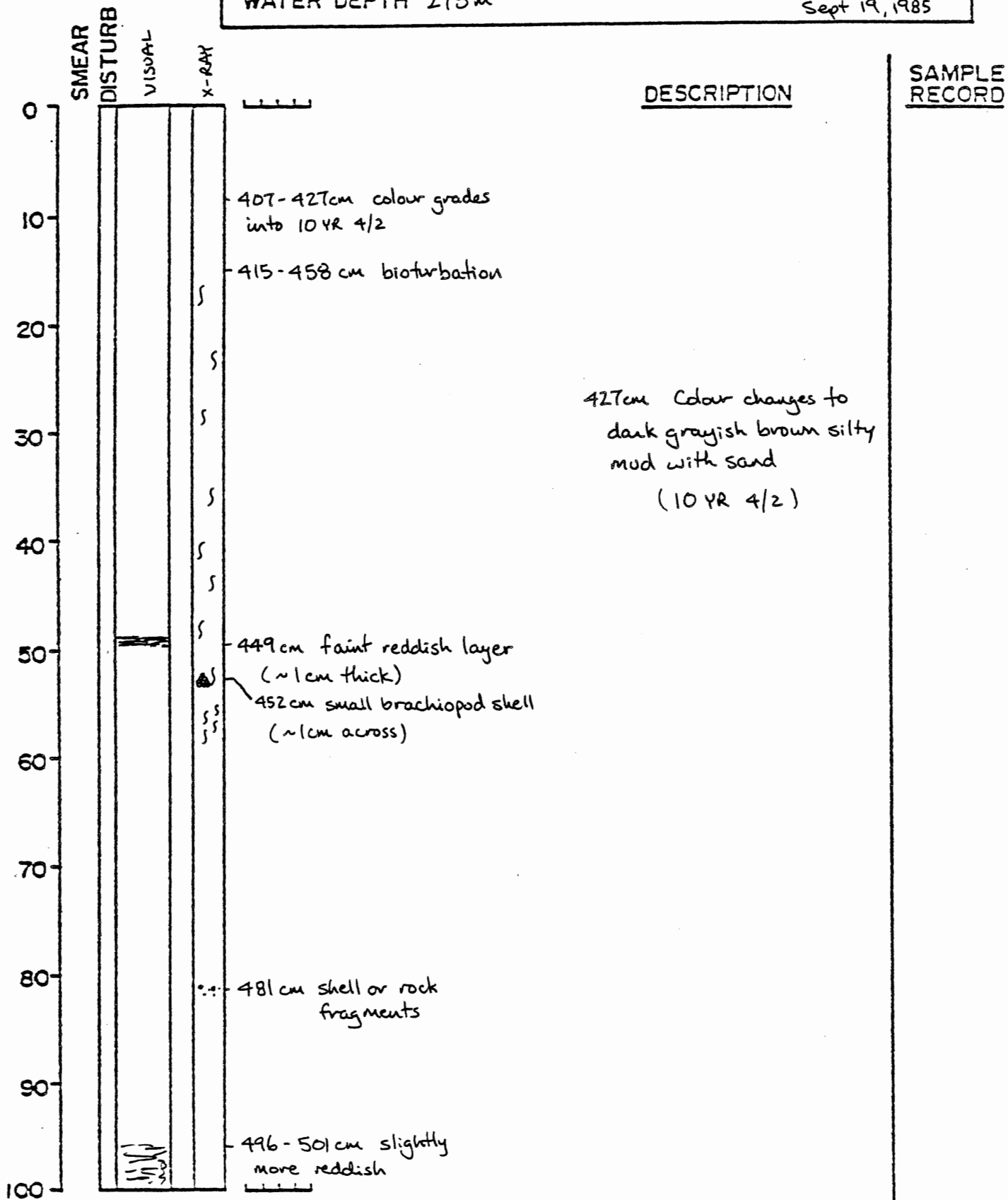


General comments: Munsell Soil Colour Chart used
 Organic Odour

CORE 84-011-11P
 LOCATION St. Anne's Basin
 WATER DEPTH 275 m

DEPTH IN CORE 400 - 500 cm

Described by: B. Souchen
 Sept 19, 1985

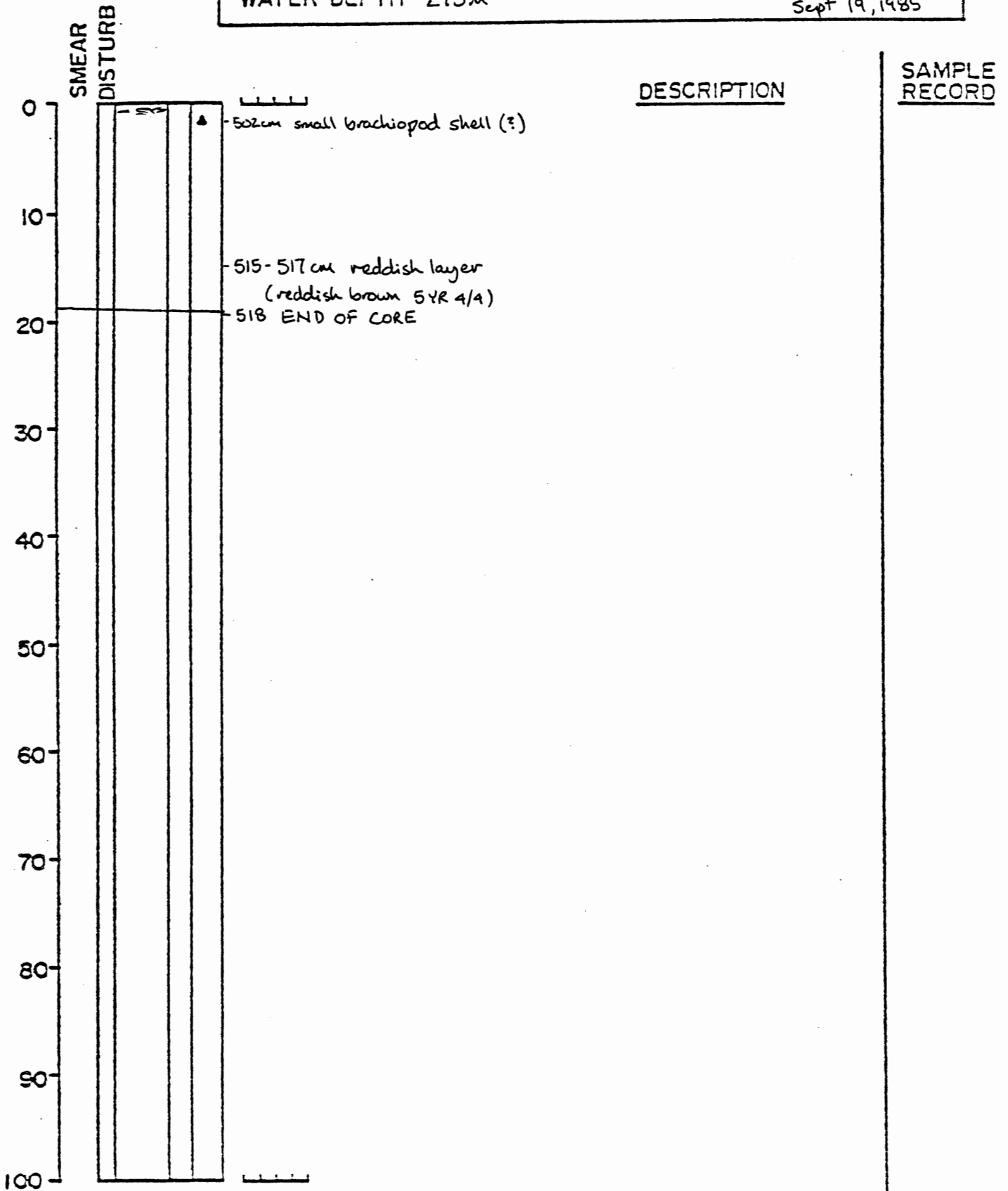


General comments: Munsell Soil Colour Chart used
 Organic Odour

CORE 84-011-11P
LOCATION St. Anne's Basin
WATER DEPTH 275m

DEPTH IN CORE 500-518cm

Described by: B. Souchen
Sept 19, 1985



General comments: Munsell Soil Colour Chart Used
Organic Odour