Diatom Biostratigraphic Correlation of Deep Sea Drilling Project Sites 270, 272, Ross Sea, Antarctica

by

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A senior thesis submitted to fulfill the requirements for the degree of B.S. in Geology, 1985

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4 March 1986

Michael Renz
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Dear Mike:

It is my pleasure to inform you that your Senior Thesis entitled "Diatom Biostratigraphic Correlation of some Deep Sea Drilling Sites in the Ross Sea, Antarctica" completed in 1985 has been given Special Mention by the Research Committee of the Department of Geology and Mineralogy. Your thesis is a very nice work of which you can be proud.

On behalf of the Research Committee I offer our congratulations on a well-done job and give you our best wishes for the future.

Sincerely,

R. Tettenhorst

R. Tettenhorst, Professor
for the Research Committee

RTT/cg

ABSTRACT

Drilling Sites 270, 272, and 271 of the Deep Sea Drilling Project, (DSDP) were intended to sample a thick continuous sequence of sediments in the Ross Sea. This objective was not achieved due to the fact that the requisite depths were not reached. Diatom assemblages from DSDP Sites 270 and 272 are used to determine the temporal relationship between these holes. Diatoms reported here from Site 270, represent the first pre-Pleistocene diatoms recovered at this locality.

Ages and diatom zonations of earlier studies of these sites are confirmed, although some revisions are made. A maximum age for the lower most portion of hole 272 is determined at 17.5 m.y., 1.7 m.y. younger than what had been previously accepted. A minimum age of 20.7 m.y. for the top of hole 270 is proposed here, which agrees with the ages derived from the foraminiferal studies of Leckie and Webb (1983).

A 3.5 m.y. gap separates the sections cored in Sites 270 and 272, as indicated by the Early - Middle Neogene diatom zonations of Weaver and Gombos (1981) and Harwood (in press) used in this study. This unsampled interval represents a significant data gap in the Early Neogene sedimentary record of this region.

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INTRODUCTION

Leg 28 of the Deep Sea Drilling Project began December 28, 1972 when the drilling vessel, Glomar Challenger departed from Fremantle, Australia on a southerly course for Antarctica. The cruise, which traversed along the Antarctic continental shelf eastward to the Ross Sea, produced a total of 16 holes at 11 sites and recovered 1404 meters of sediment. (Figure 1)

Of the 16 holes drilled, 4 are located in the Ross Basin. (Table 1) Sediments recovered from this area are important to the reconstructions of Antarctic glacial conditions because of their lengthy stratigraphic sequence dating to the Oligocene. Located between East and West Antarctica, the Ross Basin sites provide good evidence for the glacial histories of both areas (Savage, 1982).

Drilling Sites 270, 271, and 272 are located in the southeastern sector of the Ross continental shelf at a water depth of approximately 575 meters. The three colinear sites lie on a line bearing approximately 45 degrees North - Northeast and were chosen on the basis of the Eltanin siesmic sections. (Figure 2B) This series of holes was planned to sample a thick continuous sequence (1.5 meters) of gently dipping strata (1-2 degrees) that are truncated near the sea floor by an angular unconformity. (Figure 2A) The scientific objectives at these sites were (a) to investigate initiation and fluctuations of the Ross Ice Shelf and the Antarctic Ice Sheet, (b) to date the observed angular unconformity and (c) to sample a basement high at Site 270. (Figure 3)

If drilled to completion, each succeeding hole would penetrate the upper most strata of the hole preceding it; 270, 272, and 271 respectively. Unfortunately, only Site 270 was drilled to completion, at a subbottom depth of 422 meters. Drilling at Site 272 was prematurely terminated before reaching the estimated 600 meters required to overlap with hole 270, at a subbottom depth of 443 meters. Hole 270 was terminated before any significant depth could be reached, due to prohibitive concentrations of hydrocarbons and poor recovery rates (less than 7%).

PURPOSE AND OBJECTIVES

Correlations previously made of Sites 270 and 272, have been done using sonic profiles gathered during the cruises of the D/V Eltanin and D/V Glomar Challenger. (Figures 2A and 2B) Due to the inherent limitations of such application of sonic profiles, and the indistinct resolution of these particular profiles, correlations made as such, are tenuous.

Presented here is an examination of the diatom assemblages of DSDP Sites 270 and 272, to determine whether or not these two holes correlate biostratigraphically, and if not, to delineate the gap separating them.

Refinements of the stratigraphic column are an important aid in establishing both the Neogene historical continuity and the biostratigraphical framework of the Ross Basin. Diatom taxa reported from drilling hole 270 represent the first diatoms recovered below the Ross Sea Unconformity at this Site (McCollum, 1975). Included in the diatom flora reported from 270, is the highest latitude occurence of *Kisseleviela carina* in the Deep Sea Drilling Project. This discovery is an important step in establishing the paleogeographic range of this taxa.

Diatoms, foraminifera, palynomorphs and microplankton hold the greatest potential for improving the biostratigraphic resolution in the Antarctic (Leckie and Webb, in press). Studies such as presented here, will undoubtedly be important aids in deciphering the Tertiary history of this region.

METHODS AND MATERIALS

The techniques employed in recovering microfossils, will invariably, affect the results of a study. Each method of preparing a sample, will to some degree be selective for some specimens, while discriminating against others. Hazards such as sample cross-contamination and contamination from recent materials carried in tap water must be accounted for.

Detailed descriptions of the processes employed in this investigation are given in order to facilitate the accurate reproduction and verification of this study.

A total of 57 samples were processed using standard microfossil techniques and were examined by light microscopy. The samples were first divided into equal halves of approximately 2-cc each; one of which was placed in a clean, labled plastic sample bag, and stored for future use. The sample portions to be processed were placed in a clean mortar and broken into smaller fragments with a pestle. The fragmented sample was then transferred to a 200-ml beaker filled with 20 ml of $H_2 O_2$ (30%) and 20 ml of HCL (20%), covered and heated until the sediments disaggrated. If the sample failed to disaggrate after one hour of heating, it was removed from the heat and allowed to stand for 24 hours, after which time it was reheated. This process was repeated until the sample was reasonably dissociated.

Upon cooling, the samples were diluted with 100 ml of distilled H_2O, agitated, and then allowed to settle for 2-3 hours, after which time the water was carefully decanted off. Dilution and decantation were repeated.

until all of the HCL had been removed. Following this, the loose sediments were passed through 63 and 38 micron sieves, and the less than 38 micron fraction was caught in a clean 600-ml beaker. The material caught in the sieves was washed with copious amounts of distilled H_2O to insure good size fractionation. Following this, the 63 and 38 micron size fractions were placed in clean labled 30-ml bottles with enough distilled water to suspend them.

The fine fractions caught in the beaker were agitated to suspend the materials, then transferred to clean 50-ml test tubes and centrifuged for 3 minutes at 2200 rpm. After centrifuging, the samples were carefully decanted. This process was repeated as needed until the clays were removed, then placed in clean, labled 30-ml bottles.

Slides were first made of all the fine fractions (less than 38 microns). The bottles were agitated to suspend the sediments and then using a clean, disposable glass pipet, a portion of the material, large enough to cover it, was transferred to a 22 X 22 mm glass cover slip and gently heated until all of the water was evaporated. Care was taken not to let the samples boil, as to avoid cross-contamination by materials being projected onto other cover slips. The dry sample was mounted on a standard glass slide with Hyrax, and examined with a Leitz Orthoplan - 2 Pol light microscope at 800X. If evidence of diatoms was found after 12 traverses of the slide, slides of the 63 and 38 micron fractions were made and examined in the same manner.

All photographs were taken with a Leitz Orthomat automatic camera, and enlarged to approximately 1400X.

LITHOSTRATIGRAPHIC FRAMEWORK

The lithologic sequences of Sites 270 and 272 provide a depositional framework in which to interpret the diatom biostratigraphy. Glacial conditions and depositional environments as indicated by the core lithologies provide additional means by which the relationship of the two drilling sites may be determined.

Site 270

A 412 meter thick sedimentary sequence, plus 10.5 meters of basement complex were penetrated at Site 270. Five distinct units overlie the metamorphic basement complex which is correlated with the early Paleozoic Koettletz marble of the Transantarctic Mountains (Ford and Barrett, 1975). (Table 2)

The sedimentary units range from Oligocene to Recent in age. The lower most unit is a subaerial breccia composed of coarse granite fragments in chaotic array (Hayes and Frakes, et al., 1975). Two thin lenses of marine sandstones (Units 4 and 3) overlie the breccia, the upper most of which is a glauconitic sandstone which yields a Potassium/Argon date of 26.7 m.y. (Late Oligocene), (Leckie and Webb, in press).

Unit 2 is the thickest of the sequence; divided into 10 subunits totaling 365 meters. This unit is of glaciomarine origin and ranges from 26.7 m.y. in the Late Oligocene to approximately 20.0 m.y. in the Early Miocene (Leckie and Webb, in press). (Figure 4) Although the paleomagnetostratigraphic studies of Allis et al. (1975) indicate a constant rate of sedimentation, Leckie and Webb (1983) report evidence of both varying sedimentation rates and several small unconformities.

In the initial investigations of the diatom stratigraphy of the Southern Ocean, McCollum (1975) reports that Site 270 is barren of diatoms below the Ross Sea Unconformity but the bulk X-Ray studies of Cook et al. (1975) show cristobalite concentrations in the upper portion of Unit 2, which indicate the once abundant occurrence of diatoms. As a result of cristobalite cementation, the upper portion of this unit is marked by increased lithification. Unit 2 terminates with the Ross Sea Unconformity above which lies Unit 1, which is Pleistocene to Recent in age and continuous throughout the region.

Site 272

The deepest sediments recovered from Site 272 (Subunit 2C) resemble those from the upper portion of Unit 2 of Site 270 (Subunits 2A-2C). They are barren of diatoms, contain significant concentrations of cristobalite, and are well lithified. Only one major lithologic unit (Unit 2) is identified below the Ross Sea Unconformity in hole 272. Unit 2 is composed of 3 subunits totaling 410 meters and ranges from a proposed 19.2 m.y. (Late Early Miocene) to 0.66 m.y. based on the diatom zonations and extrapolations of sedimentation rates by Savage and Ciesielski (1983). (Table 3) Subunits are defined by the relative abundance of diatoms and ice rafted debris. An abrupt change in diatom taxa between subunits 2A and 2B indicate the existence of an unconformity (Savage and Ciesielski, 1983). (Figure 5)

Hayes and Frakes et al. (1975) postulate that 100 ± 40 meters of unsampled section lay between the uppermost strata of Unit 2 in hole 270 and the lowermost strata penetrated in Site 272. Although the lithologies of the two drilling sites offer no solid grounds on which lithologic correlations can be made, they do display some degree of affinity in the common occurrence of cristobalite and absence of diatoms, both being of glaciomarine origin. Dated biostratigraphic datums are needed to define both the temporal and spatial relationship of these two drilling sites.

DIATOM ZONATIONS

Site 270 Summary

The only previous study of the diatom assemblages of DSDP Dite 270 is that of McCollum (1975), presented in The Initial Reports of The Deep Sea Drilling Project, Volume 28. McCollum reports only Pleistocene taxa (of the *Cosinodiscus lentiginosus* Zone) from Unit 1 above the Ross Sea Unconformity. Presented here, is the first report of pre-Pleistocene diatoms from below the unconformity.

A total of 19 samples were examined from subunits 2A through 2D. (Figures 3 and 4, Table 4) Only one sample, 13-3 was found to contain any diatoms, although a few "ghosts" of diatoms once present were observed in chert fragments. The paucity of diatoms in this site is attributed to the diagenetic transformation of opal - A (diatom frustules) to opal - CT (low order cristobalite). The general level of preservation is good, though a relatively few taxa were identified. (Table 4)

The only age diagnostic species found was *Kisseleviela carina*. Koizumi (1983) uses *Kisseleviela carina* as a marker species in his diatom zonations of the North Pacific region, but the use of this zonation at such a low latitude is inappropriate. The diatom zonations of Harwood (in press) of MSST - 1 (McMurdo Sound Sediment and Tectonic Study) are applied instead. The location and good magnetostratigraphic correlations of this drilling site provide the most reliable Late Oligocene/Early Miocene diatom zonations for Antarctica. (Figure 6)

Core 13-3 lies within subunit 2A of this site, which Leckie and Webb determined to be within the Epistominella - Elphidium - Nonionella foraminifera assemblage zone. Correlating sea level fluctuations, as indicated by successions of foraminiferal assemblages, Leckie and Webb (in press) assign a minimum age of approximatly 20.7 m.y. to the top of this subunit. (Figure 4) The presence of Kisseleviela carina and the absence of Lisitzinia ornata and Rocella gelida indicate that subunit 2A is within the Kisseleviela carina Zone defined by Harwood (in press). (Figure 6) This is in agreement with the age assigned by Leckie and Webb (in press) to this subunit.

Site 272 Summary

The distributions of diatom taxa at DSDP Site 272 was first reported by McCollum (1975) along with 14 other drilling sites. (Table 5) The broad scope of this study and the volume of material examined in it, placed serious limitations on the degree of resolution to which the diatom stratigraphy could be refined.

Savage and Ciesielski, (1983) is the second, and most recent examination of the diatom flora of Site 272. This study is a distilled version of Savage's Masters Thesis (Savage, 1982) and reports a relatively low diversity of taxa from this site (Figure 5); therefore, samples at various intervals from subunits 2A through 2C are re-examined using the Revised Southern Ocean Neogene Diatom Zonations of Weaver and Gombos (1981). (Figure 7)

A total of 38 samples throughout Unit 2 were examined. (Table 6) The level of preservation in the interval examined was generally good, though the abundance of taxa varied. The lowest diatoms found in this site are coincident with the highest occurrence of cristobalite (opal - CT). (Table 6)

Core 3-2 was the highest sample examined from Site 272, and contained the marker species Denticulopsis hustedii, which ranged with varying abundance through Core 17-2. Nitzschia grossepunctata also occurs in this interval at 6-3 and terminates with Denticulopsos hustedii in 17-3. Weaver and Gombos (1981) define the boundary between the Nitzschia denticuloides and Nitzschia grossepunctata Zones by the simultaneous highest occurrence of Nitzschia grossepunctata and the lowest occurrence Nitzschia denticuloides. The lowest most joint occurrence of these species is found in 8-3, which is in agreement with Savage and Ciesielski, (1983), who assign the interval from 3-1 to 8-2 to the lower Nitzschia denticuloides/upper Nitzschia grossepunctata Zones. (Figures 5 and 8)

Actinocyclus ingens occurs in abundance from Core 3-2 to Core 17-3 where it abruptly terminates with Denticulopis hustedii. This faunal change is interpretated as an unconformity.

The first occurrence of McCollum's Coscinodiscus sp. 1 is coincident with the boundary between the Nitzschia maleinterpretaria and Coscinodiscus rhombicus Zones, of the late Early Miocene. (Figure 8) Weaver and Gombos (1981) assigned an age of 18.2 m.y. to the first occurrence of Coscinodiscus sp. 1, based on extrapolated sedimentation rates at DSDP Site 266. This age has since been revised by Leckie (personal communication to D.M. Harwood, 1984) to between 16 and 17 m.y. using correlations with calcareous nanno fossils and foraminiferal datum levels. The occurrence of Coscinodiscus sp. 1 continues down to Core 38-2, below which no diatoms were found. (Table 6)

An age of 19.23 m.y. is estimated for the bottom of Drilling Site 272 by Savage and Ciesielski (1983) based on an extrapolated sedimentation rate from the top of the *Coscinodiscus rhombicus* Zone, assuming an age of 18.2 m.y. for this datum. The revised age of approximately 16.5 m.y. proposed by Leckie (personal communication with D.M. Harwood, 1984), decreased the maximum age of this hole by 1.7 m.y. to 17.5 m.y.. This revised maximum age increases the temporal gap separating Sites 272 and 270. (Figures 5 and 8)

DISCUSSION

Correlations of DSDP Sites 270 and 272 based on sonic profiles proved to be of limited value due to indistinct resolution and the lack of good sonic datum reflectors. Lithologic correlations of these two sites is also limited as the relative homogenity of the sediments and subtle bedding features do not provide clear constraints on which lithologic units may be differentiated. If correlations based on lithology could be made, the widely fluctuating rates of sedimentation, coupled with inconspicuous paraconformities, provides for only very tenuous estimates of the temporal relationships between these drilling sites.

It has been suggested that the similar concentrations of low-order cristobalite in subunits 2A - 2C of 270 and subunit 2C of 272, may indicate some degree of affinity between these sections. Although the diagenetic transformation of opal - A (diatom frustules) to opal - CT (low - order cristobalite) is associated with general age and depth of burial parameters, the number of other factors involved with this transformation prohibit correlations based on this diagenetic feature.

The diatom assemblages examined in this report, display little similarity; of the 39 taxa reported, only 7 are common to both sites. These figures may change significantly as more taxa are discovered. The diatom zonations of Harwood (in press) indicate that Core 13-3 of Site 270 is within the Kisseleviela carina Zone of the Lower Miocene. (Figure 6) The upper limit of this zone is placed at approximately 20.7 m.y. which is in agreement with the age proposed by Leckie and Webb (in press) for this unit. (Figure 4)

The position of the Coscinodiscus rhombicus Zone (Weaver and Gombos. 1981), as proposed by Savage and Ciesielski (1983) is verified in this report, although the age of the datum level which defines the upper limit of this zone has been revised from 18.2 to 16.5 m.y.. This revision decreases the maximum age of the bottom of hole 272 by 1.7 m.y., placing it at 17.5 m.y..(Figures 5 and 6) This indicates a temporal gap of 3.2 m.y.. No reasonable estimations of the thickness of the sediments contained in this gap can be made based on extrapolated sedimentation rates, due to wide fluctuations in their values. Sediment representing the period from 17.5 m.y. to 20.7 m.y. is yet unsampled, due to the failure of DSDP Sites 270 and 272 to overlap. This data gap may present a serious impediment to the development of a complete glacial history of this basin, as it may contain evidence of significant depositional events.

The good agreement between the ages and zonation proposed in this report with those of other reports, lends support to their validity. Despite this apparent continuity, further refinements of the biostratigraphy in this region, may substantially alter the conclusions drawn here.

SUMMARY

Diatom zonations presented in this study confirm those proposed by earlier workers, though some revisions in ages are made. Using the ages indicated by the diatom zonation schemes for the Middle and Lower Neogene developed by Harwood (in press) and Weaver and Gombos (1981), it is determined that drilling at DSDP Site 272 failed to penetrate the upper most sediments sampled at Site 270. The period of time which this unsampled section spans is an estimated 3.2 m.y.; from 17.5 m.y. to 20.7 m.y.. No estimation of the thickness of the missing intervals can be made, as the sedimentation rates at these sites is uncertain.

Although the zonations proposed in this study agree with those of earlier investigations, their validity is somewhat tenuous, as much refinement in the biostratigraphy of this region is needed. The accurate delineation of the gap separating holes 270 and 272 is important, as it represents a serious data gap, which may contain information required for developing an accurate and detailed glacial history of this region.

SYSTEMATIC PALEONTOLOGY

Actinocyclus ingens (Rattray), Koizumi 1968, p. 207-208, figs. 5, 6

Actinopthychus splendens (Shadbolt), Ralfs in Pritchard, 1861

Actinopthychus undulatus (Bailey), Ralfs in Pritchard, 1861

Aulacodiscus brownii, Norman in Pritchard, 1969; Long, Fuge and Smith, 1964, p.97, fig. 12; McColuum, 1975, p. 525, figs. 5, 6

Arachnodiscus ehrenbergii, Bailey in Ehrenberg, 1849; Savage, 1982, p. 162, fig. 2

Cocconeis costa Krebs, 1983, p. 2, fig. 5; Harwood, 1985, pl. 6, figs. 5, 10, 11

Coscinodiscus appiculatus (Ehrenberg), Husted, 1930, p. 449-452, fig. 248; Hanna, 1932, p. 178, 179, fig. 1; McCollum, 1975, p. 547, figs. 1, 2

Coscinodiscus furcatus (Karsten), Hustedt, 1958, p. 113, 114, figs. 18, 19; McCollum, 1975, p. 577

Coscinodiscus marginatus (Ehrenberg), Hustedt, 1930, p. 416-418, fig. 223; Koizomi, 1968, p. 211, fig. 3, 4; McCollum, 1975, p. 571, fig. 2, 3

Coscinodiscus stellaris (Grunow), Hustedt, 1930, p. 369, fig. 208; McCollum, 1975, p. 551, figs. 1-3

Coscinodiscus tabularis (Grunow), Hustedt, 1958, p. 119, figs. 48-56

Coscinodiscus sp. 1 (McCollum), McCollum, 1975, p. 551, fig. 3

Denticulopsis hustedii, Shrader, 1973, pl. 3, figs. 28-34

Denticulopsis lauta, Bailey, 1854, p. 9, figs. 1, 2; Shrader, 1973A, p. 705, figs. 14-24

Distophanus speculum (Ehrenberg), Ciesielski, 1975, pl. 9, figs. 11, 12

Kisseleviela carina, Sheshukova - Poretskays, 1962. Akiba, 1980, figs. 1-2; Harwood, 1985, pl. 25, figs. 5-9

Melosira clavigera, Grunow in Van Heurck, 1882, Wornardt, 1967, p. 15, figs. 1, 2

Melosira sulcata, Grunow in Van Heurck, 1882; Harwood, 1985, pl. 5, fig. 13

Mesocena pappii (Bachmann), Ling, 1973, pl. 3, figs. 5, 6; Ciesielski, 1975, pl. 12, fig. 8

Nitzschia denticuloides, Shrader, 1976, p. 633, fig. 7, 8, 10; Gombos, 1976 p. 595, figs. 9-11

Nitzschia grossepunctata, Shrader, 1976, p. 633, figs. 1-4; McCollum, 1975, p. 535, figs. 9-10

Rhizosolenia hebetata, Harwood, 1985, pl. 3, fig. 6

Stephanopyxis grunowii, Grove and Sturt, 1888, in Schmidt et al., 1959, figs. 1-6, pl. 130

Stephanopyxis turris, Ralfs in Pritchard, 1861; Hustedt, 1930, p. 304-307, figs. 140-144

Trinacria excavata (Heiberg), Land in Schmidt's Atlas, 1959, pl. 96, figs. 6-8

Trinacria pileous (Ehrenberg), Hustedt, 1930, p. 885, fig. 529; McCollum, 1975, pl. 15, fig. 3

Trinacria racovitzae, Van Heurck, 1909, pl. 9, figs. 119, 120; Harwood, 1985, pl. 5, figs. 2-6

APPENDIX 1

Species range charts for Sites 270 and 272. Relative abundances are given according to DSDP Guidelines:

R = 1–2 whole or fragmented diatoms within 4 traverses at 400 X

F = 5–10 whole or fragmented diatoms within 4 traverses at 400 X

C = 1–2 whole or fragmented diatoms within 3 fields of 500 X

A = 3–10 whole or fragmented diatoms within one field of 500 X

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FIGURES 1 - 8

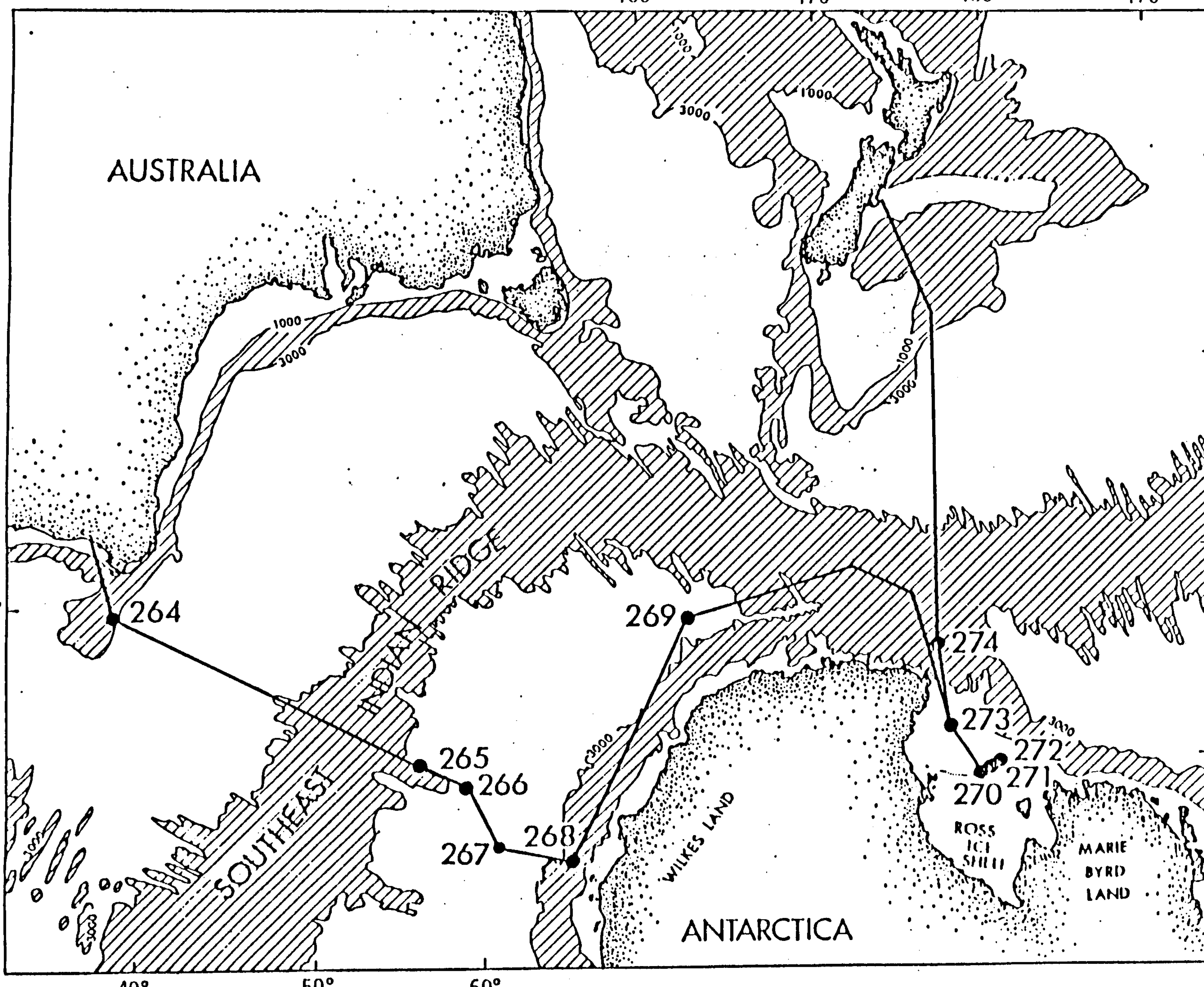


FIGURE I. *Location of sites drilled during Leg 28 in Antarctic waters south of Australia and New Zealand and in the Ross Sea.*

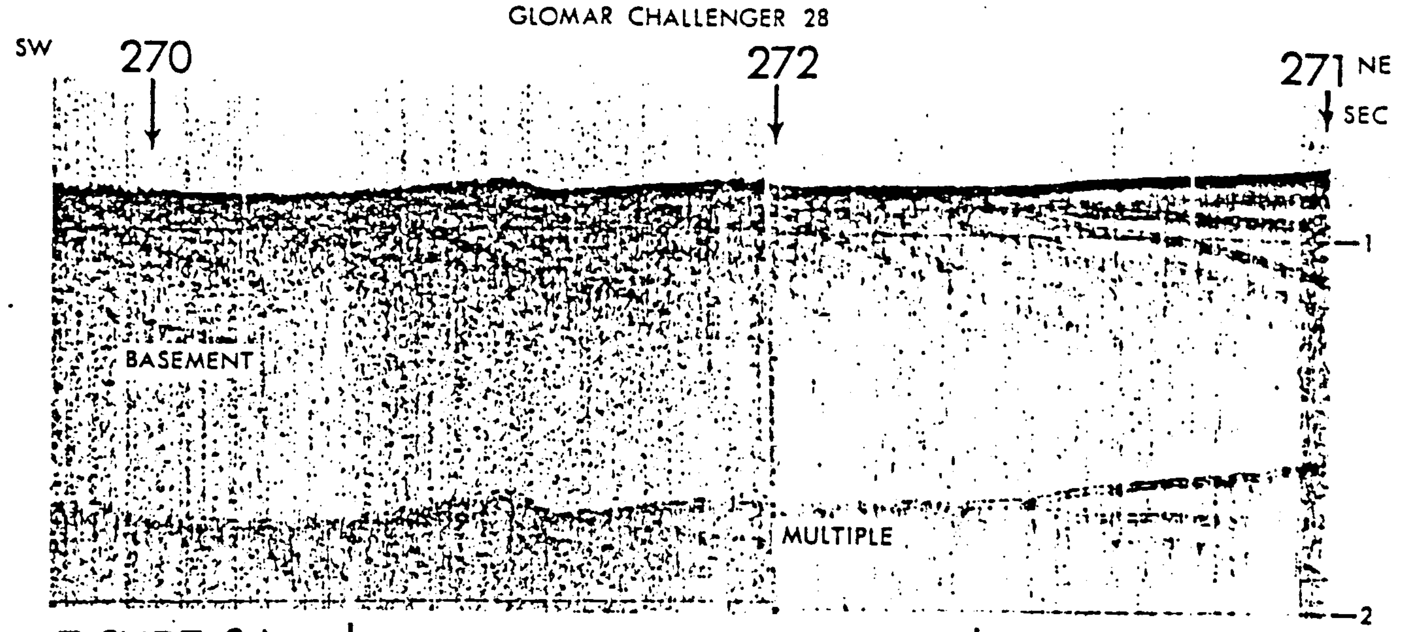


FIGURE 2A

~100 km

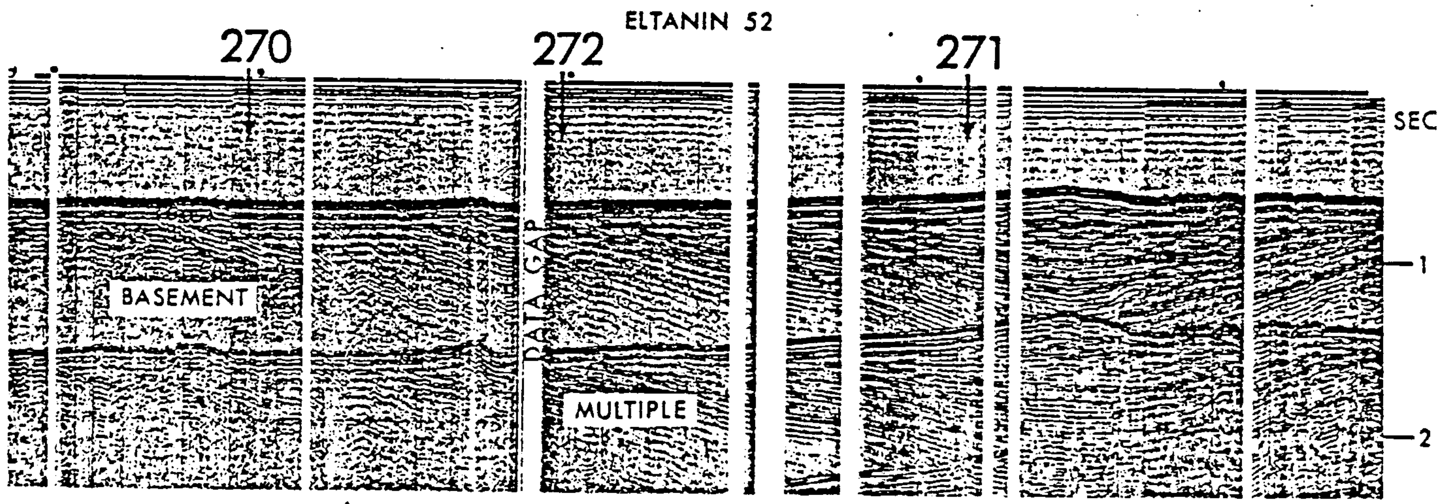


FIGURE 2B

~100 km

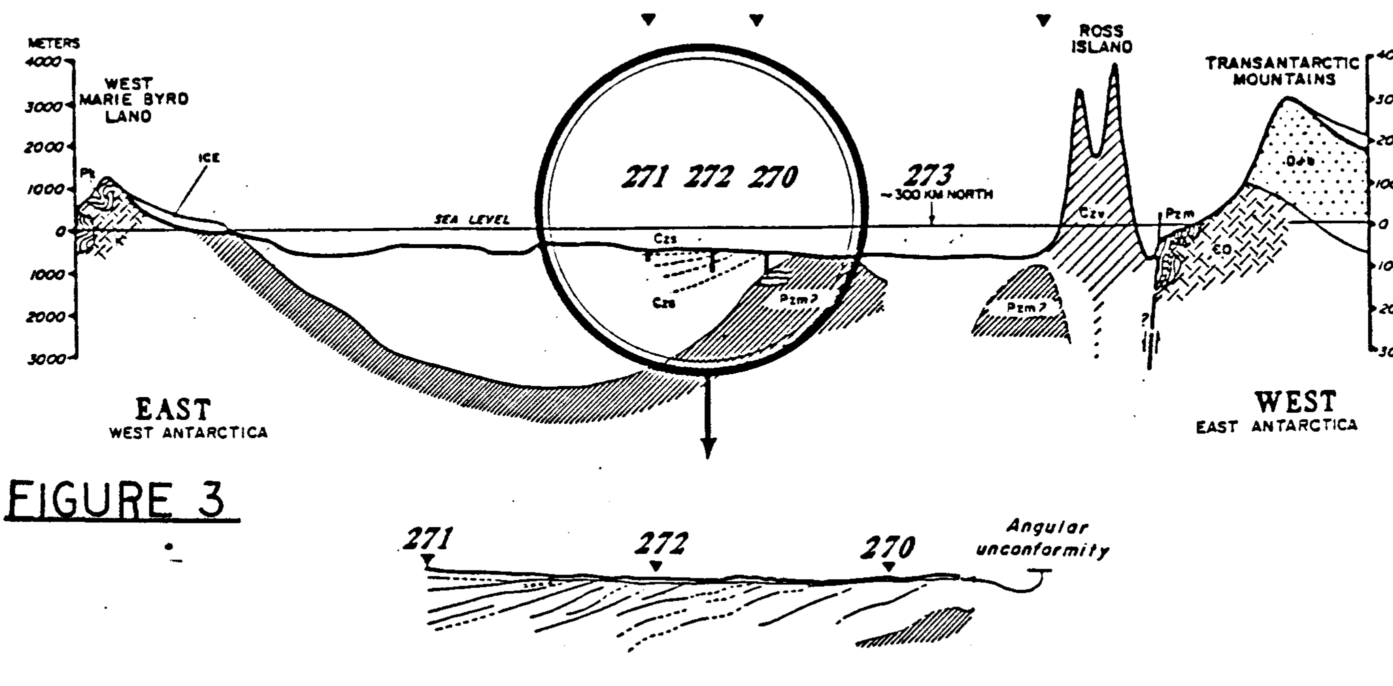


FIGURE 3

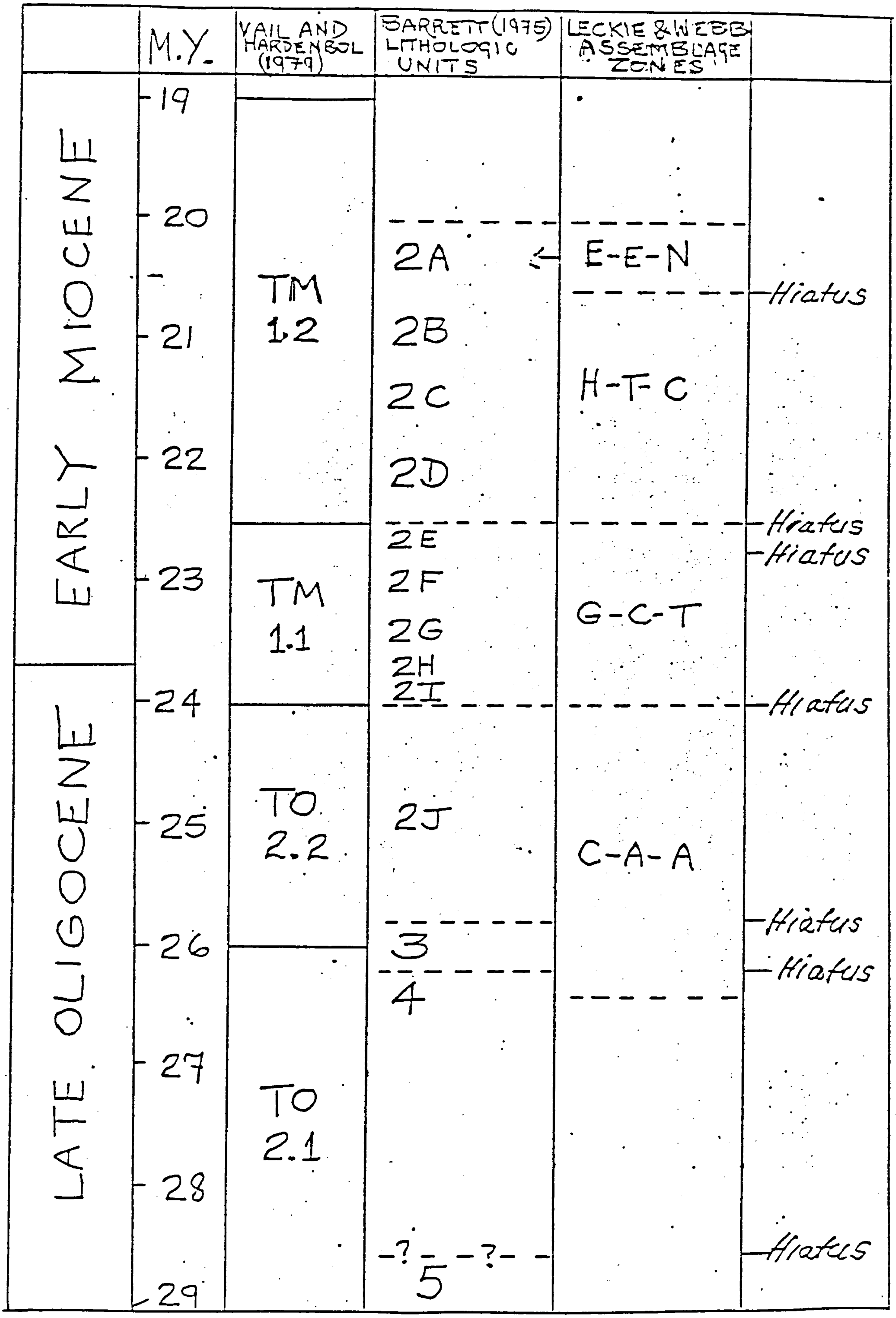


FIGURE 4 Foraminiferal zonations of 270

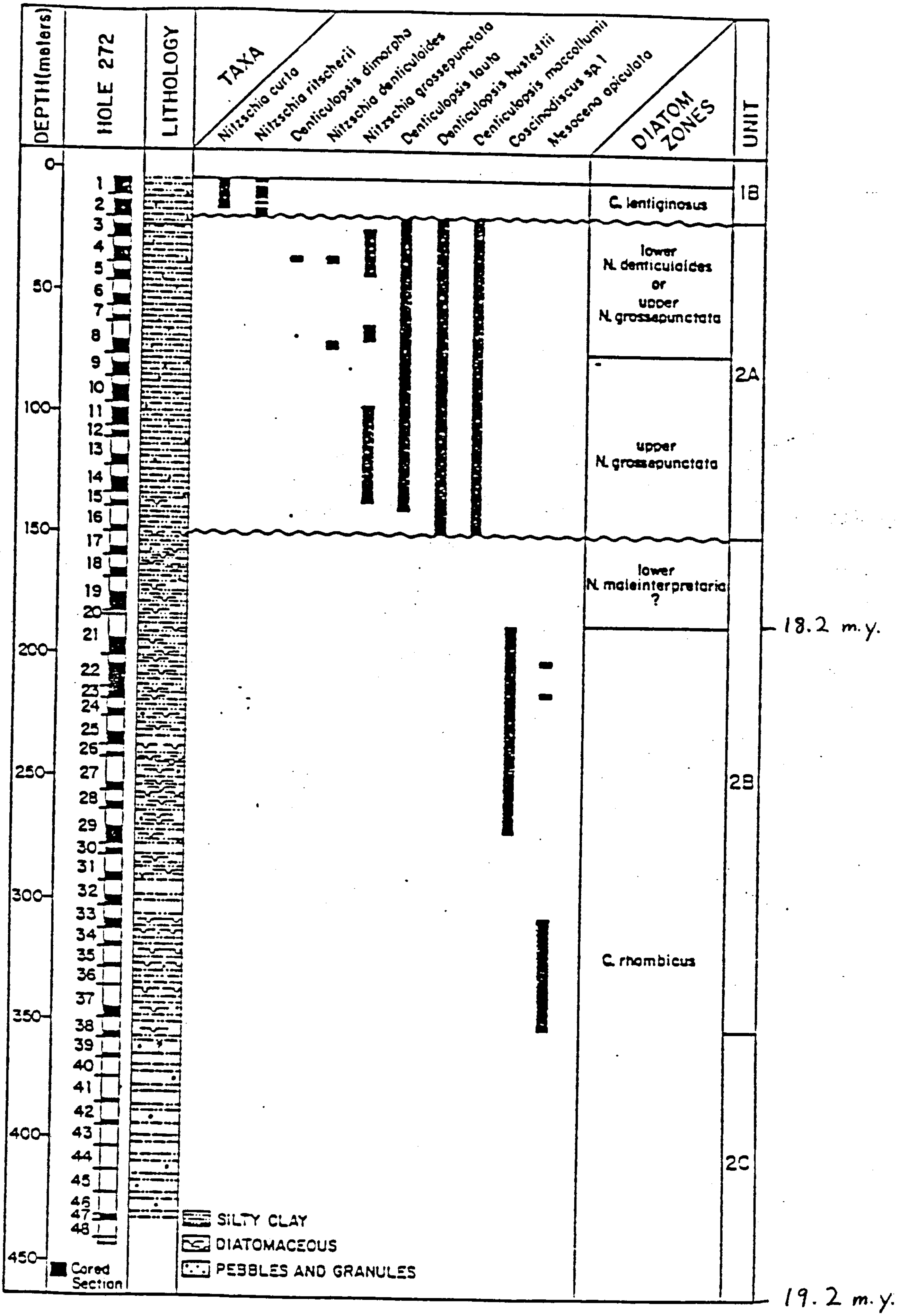


FIGURE 5 Diatom zonations of 272 by Savage and Ciesielski (1975)

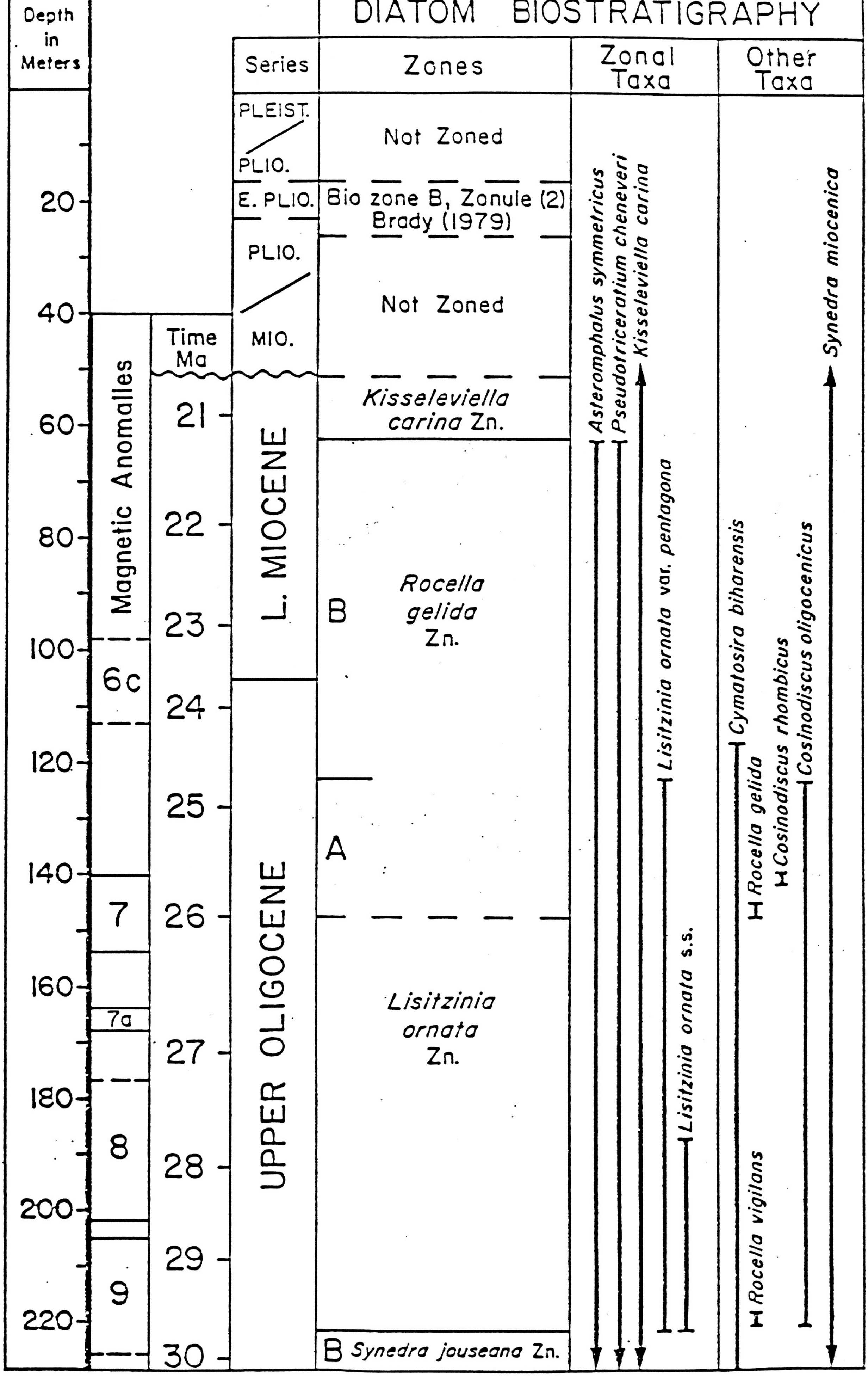


FIGURE 6 Diatom zonations of MSST-1 by Harwood (1985).

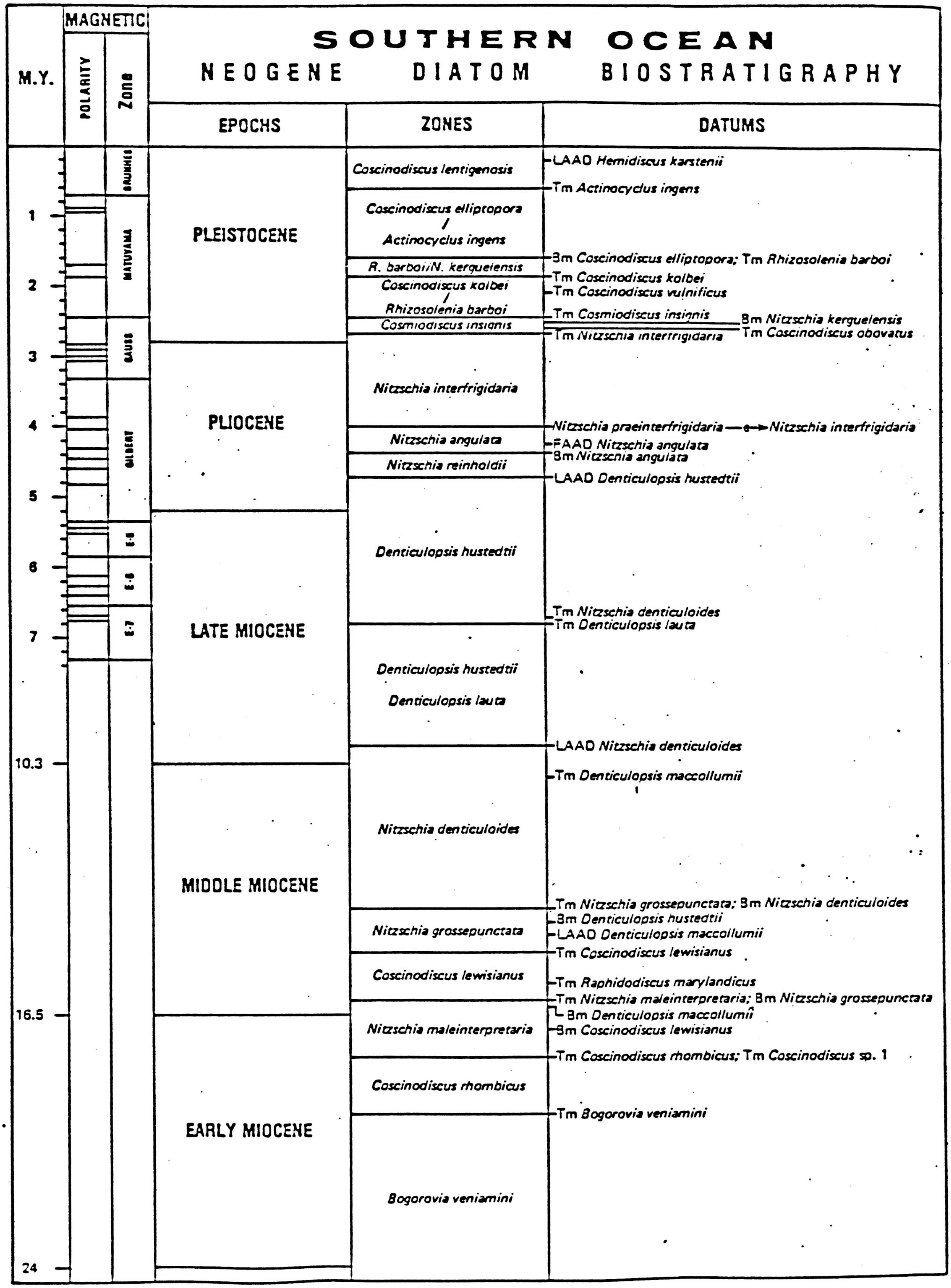


FIGURE 7 Diatom zonations of Weaver and Gombos (1981).

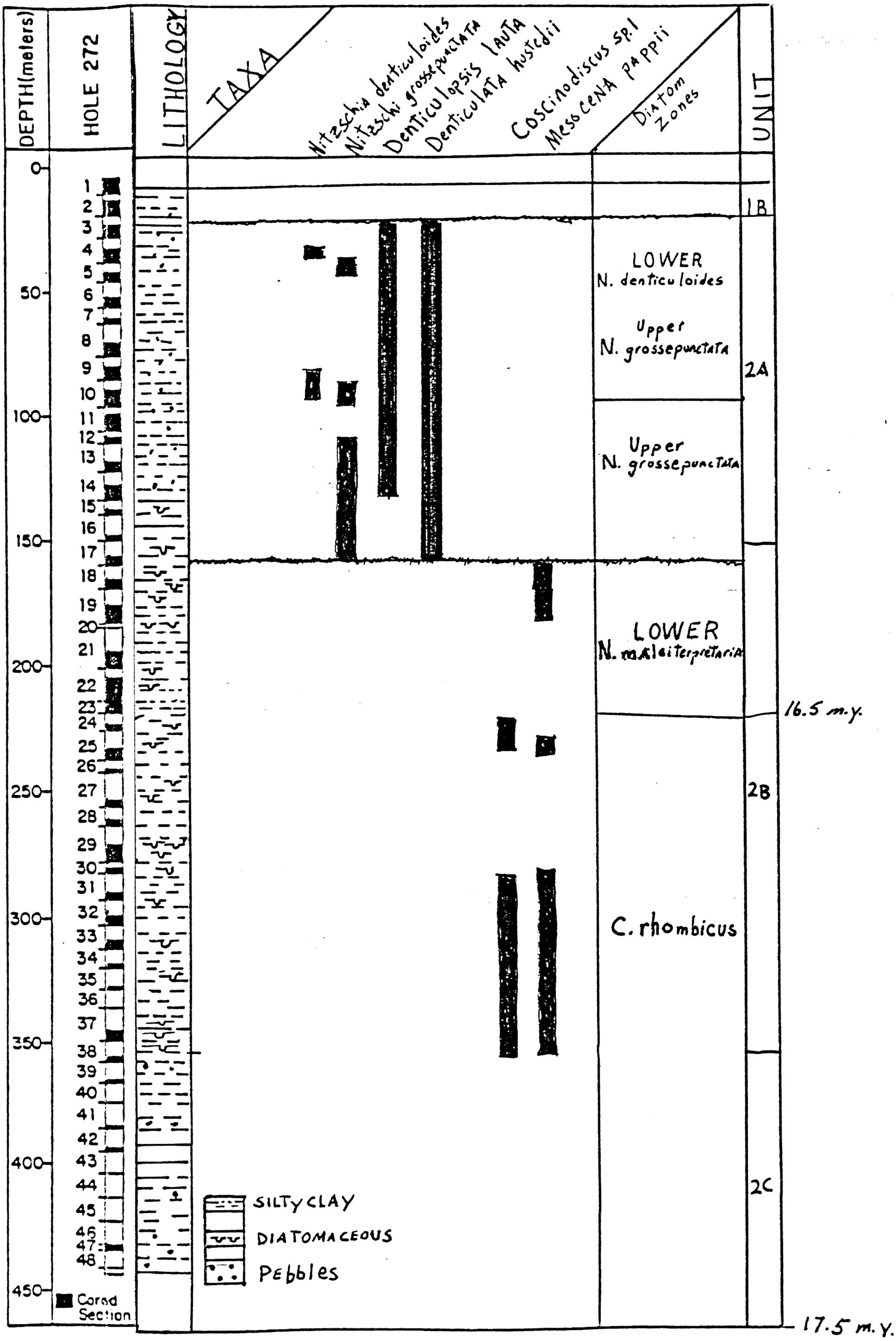


FIGURE 8 Diatom zonations of this study.

TABLES 1 - 6

Leg 28 Coring Summary

Hole	Dates (1972-1973)	Latitude	Longitude	Water Depth (m)	Penetration	No. of Cores	Cored (m)	Recovered (m)	Recovery (%)
264	22-23 Dec.	34°58.13'S	112°02.68'E	2873	215.5	15	142.5	65.2	46
264A	23 Dec	34°58.13'S	112°02.68'E	2873	158.5	4	38.0	33.2	87
265	30-31 Dec	53°32.45'S	109°56.74'E	3582	462.0	18	169.0	108.0	64
266	2-4 Jan	56°24.13'S	110°06.70'E	4173	384.0	24	219.5	145.2	66
267	6 Jan	59°15.74'S	104°29.30'E	4564	219.5	7	58.0	25.9	45
267A	7 Jan	59°15.74'S	104°29.30'E	4564	70.5	3	28.5	11.6	41
267B	7-8 Jan	59°14.55'S	104°29.94'E	4539	323.0	10	95.0	53.5	56
268	10-12 Jan	63°56.99'S	105°09.34'E	3544	474.5	20	189.5	65.6	35
269	18 Jan	61°40.57'S	140°04.21'E	4285	397.5	11	103.0	38.8	38
269A	19-21 Jan	61°40.57'S	140°04.21'E	4285	958.0	13	123.5	55.4	45
270	30 Jan-2 Feb	77°26.48'S	178°30.19'W	634	422.5	49	422.5	263.7	62
271	3-5 Feb	76°43.27'S	175°02.86'W	554	265.0	24	233.0	15.3	7
272	6-8 Feb	77°07.62'S	176°45.61'W	629	443.0	48	439.0	162.0	37
273	10 Feb	74°32.29'S	174°37.57'E	495	76.0	9	76.0	27.9	37
273A	11-13 Feb	74°32.29'S	174°37.57'E	495	346.5	29	256.5	55.5	22
274	16-19 Feb	68°59.81'S	173°25.64'E	3326	421.0	45	421.0	279.1	66
Total						321	3013.5	1404.9	47

TABLE 1

Unit	Lithology	Subbottom Depth (m)	Thickness (m)	Age
1	Diatom silty clay and sand-silt-clay with scattered granules and pebbles	0-20	20	Pliocene to Recent
		Angular unconformity		
2	Silty claystone with scattered granules and pebbles	20-385	365	Late Oligocene to early Miocene
3	Calcareous greensand	385-386	1	Late Oligocene
4	Carbonaceous sandstone	386-387.8	1.8	Oligocene
5	Sedimentary breccia with well-developed regolith	387.8-413.3	26.5	
		Nonconformity		
6	Marble and calcsilicate gneiss	413.3-422.5	9.2	Early Paleozoic ?

TABLE 2 Lithologic units of 270

Unit	Lithology	Subbottom Depth (m)	Unit Thickness (m)	Age
1A	Diatom silty clay with rare granules and pebbles	4.0-5.5	>1.5	Recent
1B	Diatom-bearing sand-silt-clay with common granules and larger clasts	5.5-23.5	18.5	Pliocene (Gauss?)
			Unconformity?	
2A	Sandy silty claystone with sparse to common clasts	23.5-145	123	Late Miocene to mid-Miocene
2B	Diatom silty claystone and silty clay diatomite with rare clasts	145-362	215	Mid Miocene
2C	Silty claystone with rare clasts	362->434	>72	Mid Miocene

TABLE 3 Lithologic units of 272

DSDP SITE 270

X = SECTION SAMPLED
O = CRISTOBALITE

	CORE AND SECTION	Cocconeis sp	Coscinodiscus sp	Chaetoceros sp	Distephanus speculum	Hemiaulus sp	Kisselevielta carina	Melosira sulcata	Rhizosolenia hebeta	Stephanopyxis grunowii	S. turris	Trinacria cacovitzae
	1-1											
	1-2											
	1-cc											
	2-cc											
X	3-1											
	3-cc											
	4-cc											
	5-1											
X	5-2											
	5-cc											
XO	6-1											
X	6-2											
	6-cc											
	7-1											
X	7-2											
X	7-3											
	7-cc											
	8-1											
	8-2											
	8-3											
	8-cc											
	9-1											
O	9-2											
	9-3											
	9-cc											
	10-1											
X	10-2											
X	10-cc											
	11-1											
X	11-2											
X	12-1											
	12-2											
	12-3											
	12-4											
	12-cc											
X	13-1											
X	13-2											
X	13-3	R	C	R	R	R	R	C	F	R	C	R
	13-cc											
	14-1											
XO	14-2											
	14-cc											
	15-1											
O	15-2											
X	15-3											
	15-cc											
	16-1											
X	16-2											
	16-3											
	16-4											
	17-1											
	17-2											
X	17-3											
	17-4											
	17-5											
	17-cc											
	18-1											
X	18-2											
	18-3											
	18-4											
	18-5											
	18-cc											
	19-1											
O	19-2											
	19-3											
O	19-4											
	19-5											

TABLE 4

Diatoms / Sample (Interval in cm)	*Actinocyclus ingens*	*Actinocyclus ehrenbergii*	*Actinoptychus undulatus*	*Asteromphalus parvulus*	*Aulacodiscus brownii*	*Chaetoceros actinochilus*	*Coscinodiscus apiculatus*	*C. lentiginosus*	*C. sp. 2*	*C. sp. 1*	*Cosmiodiscus intersectus*	*Denticula antarctica*	*D. hustedtii*	*D. lauta*	*Eucampia balaustium*	*Liradiscus sp.*	*Melosira sulcata*	*Nitzschia angulata*	*N. curta*	*N. kerguelensis*	*N. ritscheri*	*Rhizosolenia barboi*	*Stephanopyxis barbadensis*	*S. grunowii*	*S. turris*	*Trinacria excavata*	*T. pileolus*	Diatom Zones
1-1, 0						C									C			R	C	R	L							
1-1, 80						C									F				C	R	C							
1-1, 85-87				R				R										F	C		C							*C. lentiginosus*
1-1, 113															F													
1-1, 130-132		R																										
1-1, 145																												
1-2, 30-32																												
1-2, 80-82		R																										
1-2, 130-132																												
1-3, 30-32																												
1-4, 30-32																												
1-5, 70-72																												
1, CC																												?
2-1, 140-142																												
2-2, 140-142																												
2-3, 130-132									R																			
2-4, 130-132																												
2-5, 30-32																												
2, CC (25μ)																												
3-1, 38-40	R																											
3-1, 80-82																												
3-2, 27-29	R																											
3-3, 26-28																												Miocene ?
3-4, 30-32																												
3, CC (25μ)	R		R																									
4-1, 130-132	R									R		R	?	?			R									R		
4-2, 40-42												R	R	R												R		
4-3, 123-125	R											R	R				R									R	R	
4-4, 30-32												R	R	R												R		
4-5, 80-82												R	R	R												R		
4, CC (25μ)	R		R				R															R						
4, CC (38μ)	R																											
5-1, 77-79												R	R			R	R									R		
5-2, 30-32	R						R					R	R													R		
5-3, 30-32	R																									R		
6-1, 30-32	R											R	R	R												R		
6-2, 30-32							R						R			R										R		
6-3, 30-32																												
6-4, 30-32																												
7-1, 123-125																												
7-2, 80-82												R	R													R		
8-1, 30-32	R											R	R	R												R		
8-2, 30-32												R	R			R										R		
8-3, 25-27																												
8-4, 30-32	R											R	R	R												R		
9-1, 130-132																												
9-2, 10-12	R											R	R	R			R									R		
9-3, 67-69																												*D. lauta*
9-4, 111-113												R	R															*D. antarctica*
10-1, 9-11													R	R		R										R		
10-2, 0-2												R	R	R														
10-3, 108-110	R																									R		
10-4, 61-63	R											R														R		
10-5, 18-20																										R		
11-1, 15-17	R											F		R												R		
11-2, 65-67							R															R						
11-3, 74-76																												
11-4, 70-72												R														R		
11-5, 117-119												R														R		
12-1, 118-120														R												R		
12-2, 58-60	R											R																
13-1, 22-24	R											R	R													R		
13-2, 9-11	F											F	R			R	R									F		
13-3, 64-66												R																
14-1, 2-4	R						R					R	R				R									R		
14-2, 12-14	R											R	R													R		
14-3, 69-71	C											F	C													F	F	
14-4, 59-61	R												R	R												R		
14, CC (25μ)	R	R	R																						R			
15-1, 109-111													R													R	R	
15-2, 116-118	C											R	A	F														
16-1, 113-115	C											R	C	F												F	R	
16-2, 64-66	R																									R		*D. antarctica*
16-3, 60-62																										R		*D. lewisianus* ?
17-1, 96-98	R																									R		
17-2, 20-22												R														R		
17-3, 30-32												R														R		
18-1, 70-72					F		C																		R	R		
18-2, 20-22					F		C																			F		
18, CC (38μ)					R		R																			R	R	
18, CC (25μ)		R	R		R		R																			R	R	
18, CC (63μ)					R																					R		
18, CC					R																					R		
19-2, 35-37					R		R																			R		
19-3, 46-48																									R	R		
19-4, 30-32																										R		
19-5, 30-32																								R		R		
19-6, 130-132					R																	R		R		R		Early
21-1, 144-146					R					R														R		R		Miocene ?
21-2, 70-72										R														R		R		
21-3, 62-64							R																		R	R		
21-4, 116-118			R		R					R														R	R	R		
21-5, 30-32					R																		R	R		R		
22-1, 35-37																						R		R	R	R		
25, CC (38μ)							R										R											
25, CC (63μ)							R										R											
38-2, 120-122																								R		R		
38, CC (25μ)			R																						R	R		
39, CC (25μ)																												
40, CC (25μ)																												
40, CC (38μ)																												

TABLE 5 *Distribution of diatoms at Site 272* by McCollum (1975)

DSDP SITE 272

X = SAMPLE EXAMINED
O = Cristobalite

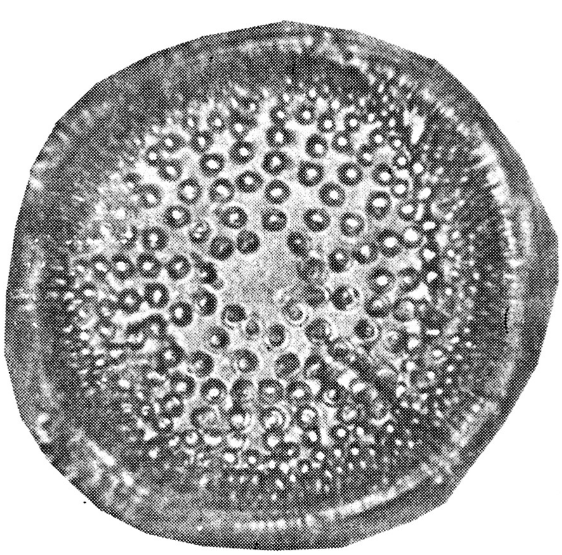
CORE AND SECTION	Sample	Actinocyclus ingens	Actinoptychus undulatus	A. splendens	Aulacodiscus brownii	Arachnoidiscus ehrenbergii	Chaetoceros sp.	Cocconeis costa	Coscinodiscus apiculatus	C. furcatus	C. marginatus	C. stellaris	C. tabularis	C. sp. 1 (McCollum)	Denticulopsis hustedtii	D. lauta	Hyalodiscus radiatus	Melosira clavigera	M. sulcata	Nitzschia denticuloides	N. grossepunctata	Rhizosolenia hebetata	Stephanopyxis grunowii	S. turris	Trinacria excavata	T. pileolus	T. excavitzale	Distephanus speculum	Mesocena pappii
3-2	X	C													R	C								C	F				
4-3	X	C													R	F				R				C	R	R			
5-2	X	F																			?			C	R				
6-3	X	C													C	R								F	C				
7-2	X	C													A	F					R			C	C				
8-3	X	F													F					R				C	F				
9-3	X	A																		R				F					
10-3	X	A							R						R	R					R			R	C	R			
11-3	X	C													C	R								C					
13-2	X	A							R						F	F					R			R	C				
14-3	X	C													C	R					R								
15-2	X	C									F										R			C	C	R			
16-1	X	F																						C					
17-1	X	A									F										R			F	R				
17-2	X	C													R									C					
17-3	X		C									F												F					
19-3	X		C		R		F												R					C	C	R	R		R
21-4	X		C		R		F				F	R	R						F				R	C	F			R	
23-3	X		C						R					R					C			F	R	C			R		
25-3	X		F		F		C		?		F			?					C			F		A	F	R		R	R
29-2	X		F	R						F	C	C							A				R	C					
30-1	X		C	R	F		C			F	C	C		R		R		F	A			C	C	A	C	F		F	F
30-2	X		C				C			F	C	C						F	A			C	F	C	A	F	R	F	R
32-2	X		C				C			F	C	C	R			R		F	A			R	F	A	C	R			F
33-3	X		C	R	F		F																						
34-1	X						C		R	F		C	R	R				R	A			R	C	A	C	F	R	F	C
35-1	X		C	R			C			F	C	F						R	A			C	C	A	C			F	C
37-2	X		C	R		R	C	R		C	C	C		R		R	R		A			R	F	A	C	R	F	F	C
38-2	X O		C	R		R	F	R		F	C	F	R	R			R	R	C				C	A	C	R	R	R	C
39-1	X																												
39-CC	O																												
40-CC	X																												
41-1	X O																												
42-1	X O																												
43-CC	X																												
44-CC	X																												
45-CC	X																												
46-CC	X																												
47-CC	X																												

TABLE 6

PLATES 1 - 3

Plate 1

1. *Actinocyclus ingens*, sample 3-2; 272
2. *Actinocyclus ingens*, sample 3-2 (low focus); 272
3. *Arachnodiscus ehrenbergii*, sample 37-2; 272
4. *Coscinodiscus stellaris*, sample 38-2; 272
5. *Coscinodiscus sp. 1*, (McCollum), sample 37-2; 272
6. *Coscinodiscus sp. 1*, (McCollum), sample 37-2 (low focus); 272



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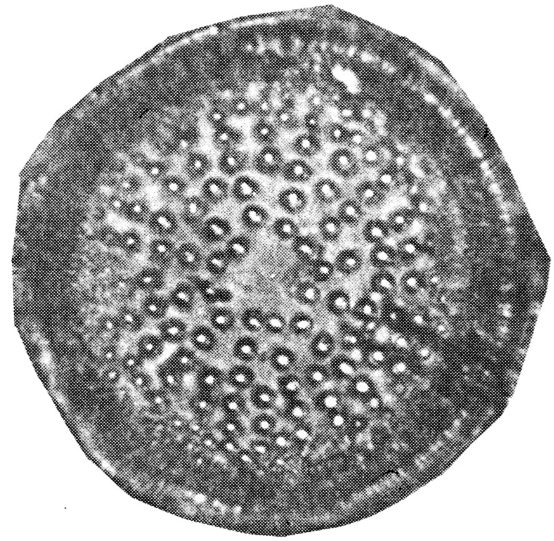

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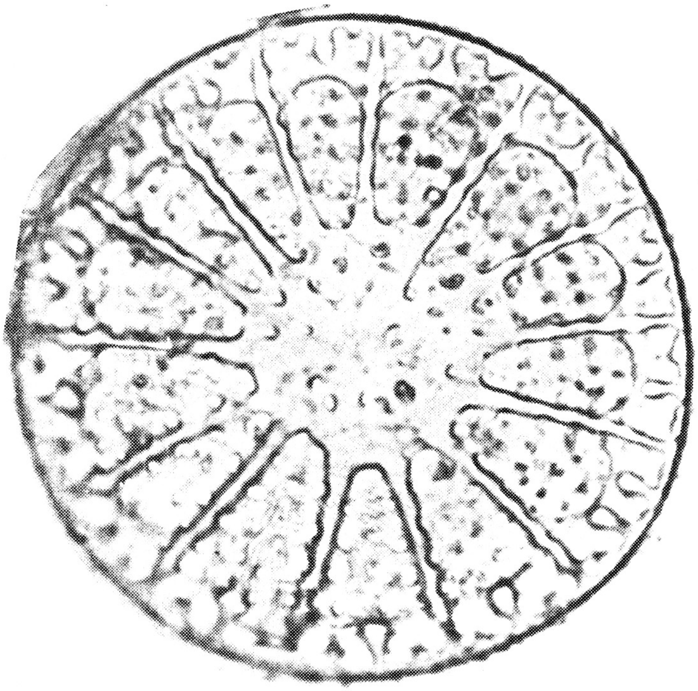

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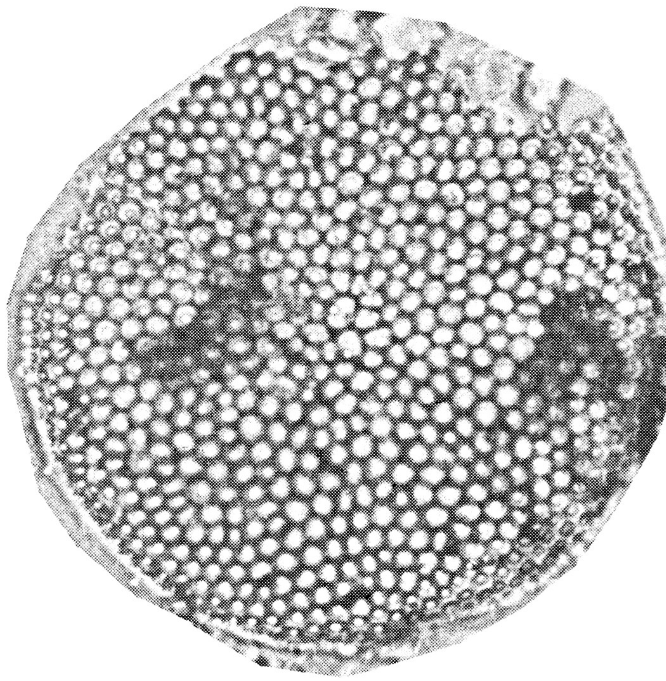


4.

5.

6.

Plate 2

1. *Denticulopsis lauta*, sample 6-3; 272
2. *Denticulopsis lauta*, sample 6-3; 272
3. *Nitzschia grossepunctata* (fragment), sample 11-3; 272
4. *Nitzschia denticuloides*, sample 9-3; 272
5. *Nitzschia denticuloides*, sample 9-3; 272
6. *Nitzschia denticuliodes*, sample 4-3; 272
7. *Kisseleviela carina*, sample 3-13; 270
8. *Kisseleviela carina*, sample 3-13; 270
9. *Kisseleviela carina*, sample 3-13; 270
10. *Nitzschia denticuloides*, sample 8-3; 272
11. *Trinacria excavata*, sample 32-2; 270
12. *Trinacria excavata*, sample 32-3; 270

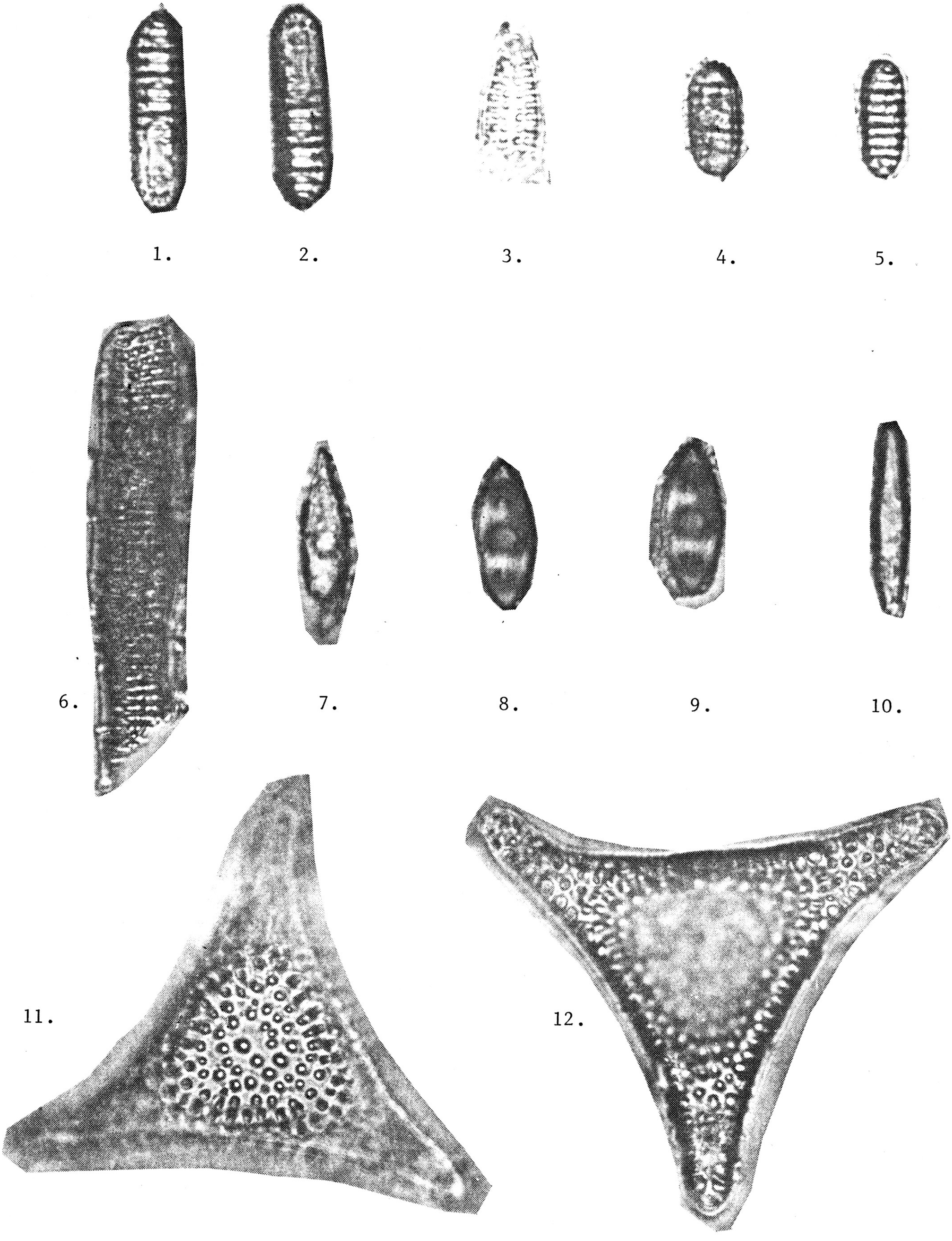
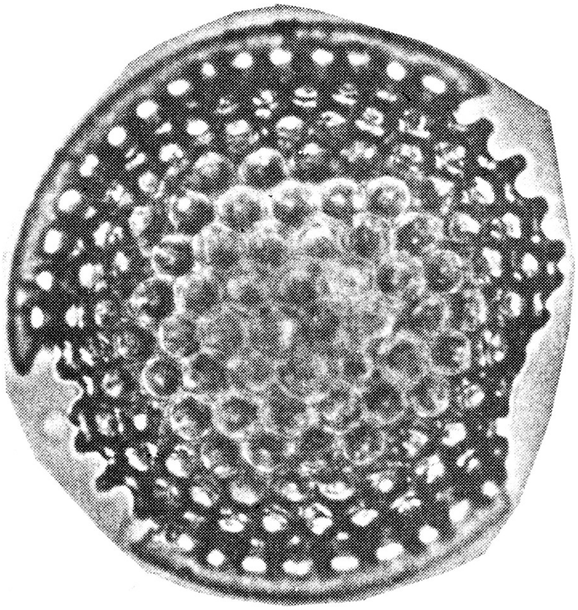

1.
2.
3.
4.
5.
6.
7.
8.
9.
10.
11.
12.

Plate 3

1. *Stephanopyxis grunowii*, sample 13-3, 270
2. *Distophanus speculum*, sample 13-2; 270
3. *Trinacria racovitzae*, sample 13-2; 270
4. *Melosira sulcata*, sample 38-2; 272
5. *Rhizosolenia hebetata*, sample 38-2; 272



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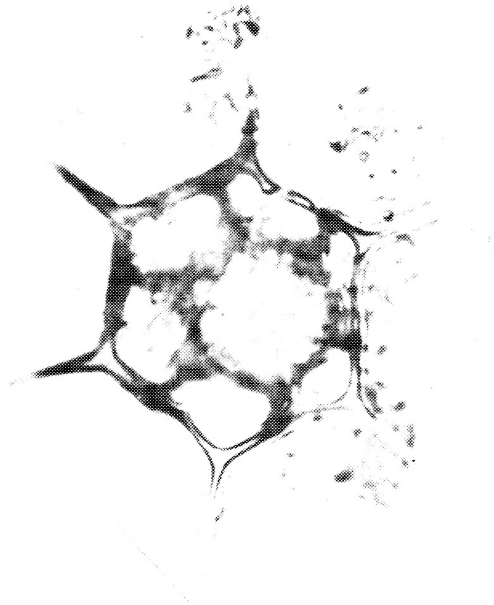

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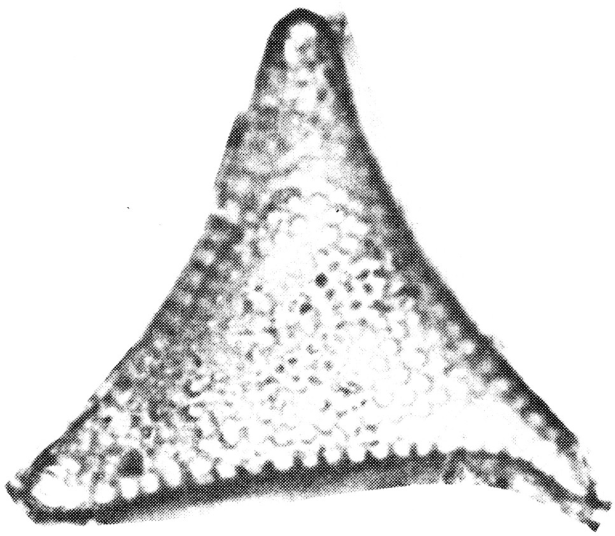
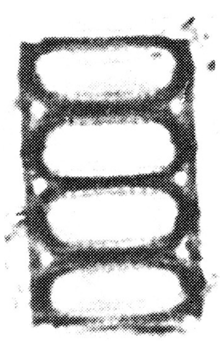
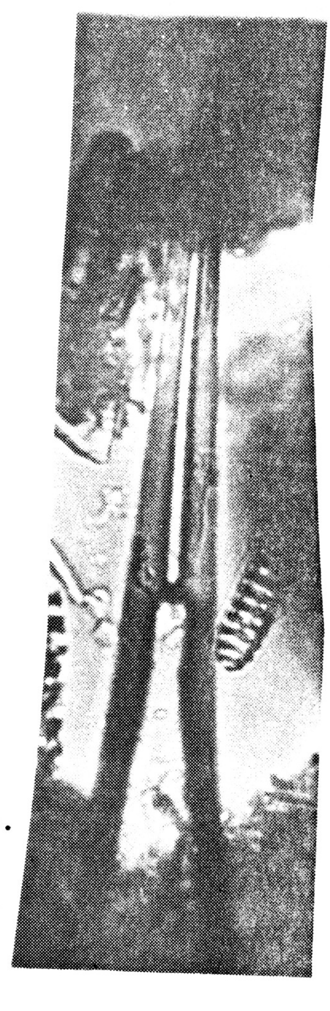


3.



4.



5.