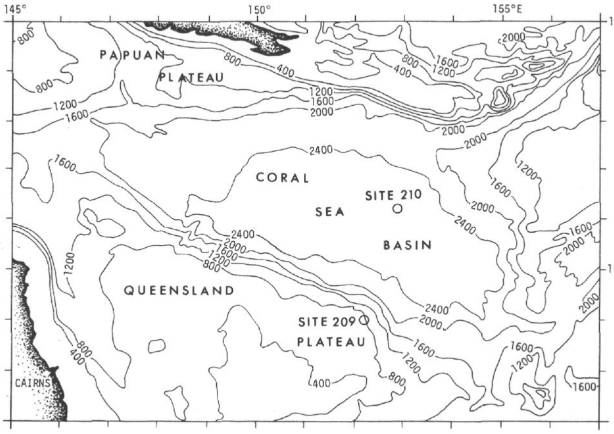
10. SITE 210

The Shipboard Scientific Party[1]

Location: Coral Sea Basin
Position: 13°45.99′S, 152°53.78′E
Water Depth: 4643 meters
Total Penetration: 711 meters



Contour interval 400 fathoms. (After Mammerickx, Chase, Smith, and Taylor, 1971. Bathymetry of the South Pacific, Charts 11 and 12: Scripps Institution of Oceanography, California.)

Summary: Graded cycles of silt and clay with interbeds of nannofossil ooze overlie a Miocene abyssal clay. Below this is an Oligocene sequence of clay-bearing to clay-rich nannofossil chalk and clay-bearing calcic nannofossil chalk which overlies the regional unconformity (mid Oligocene/late Eocene). Clay-bearing calcic nannofossil chalk grades downward, with increasing clay component, into clay nannofossil chalk to clay. The oldest dated sediment recovered is early Eocene in age.

BACKGROUND AND OBJECTIVES

General

Site 210 was initially proposed to investigate the age, history, and biostratigraphy in the Coral Sea Basin. Located roughly in the center of the Coral Sea abyssal plain, the nearest margin was sampled at Site 209 on the Queensland Plateau, and the presumed major source of sediment in New Guinea (Fly River region) is 450 miles to the west-northwest.

Prior to site survey, information was available in the form of some seismic profiling and sediment sampling which had been conducted earlier (see, for example, Ewing et al., 1970; Gardner, 1970) and preliminary location of the site was on the basis of these data. Site survey was conducted by the R/V *Kana Keoki*, and the site survey data provided the basis for final selection of the site.

Review by the JOIDES Panel on Pollution Prevention and Safety indicated that the site and drilling program were satisfactory with continuous coring, moderate drilling precautions, and standard abandonment procedures.

Site Survey

The region encompassing Site 210 was surveyed by R/V *Kana Keoki* in September 1971. The sea floor (Figure 1) of the Coral Sea Basin is quite flat with gradients generally less than 1 m/km. By contrast, the acoustic basement structure (Figure 2) is locally quite rough and the site is located over a basement high which has relief of 0.4-sec round-trip travel time. The basement relief is not uniform throughout the basin, but consists of a series of elevated structures such as those on the tracks to the survey area.

A short distance east of the site (Figure 3), a tilted block structure exposes some of the deepest sediments as a hill in the basin. Although the basin sediments are generally well stratified with two more highly reflective intervals, a near-basement "transparent" interval occurs which is generally conformable to the irregular deep reflector. Occasionally a deeper reflector is detected; normally steep

---

[1] Robert E. Burns, NOAA–Pacific Oceanographic Laboratories, University of Washington, Seattle, Washington, Co-Chief Scientist; James E. Andrews, University of Hawaii, Honolulu, Hawaii), Co-Chief Scientist; Gerrit J. van der Lingen, New Zealand Geological Survey, Christchurch, New Zealand; Michael Churkin, Jr., U. S. Geological Survey, Menlo Park, California; Jon S. Galehouse, San Francisco State College, San Francisco, California; Gordon H. Packham, University of Sydney, Sydney, New South Wales, Australia; Thomas A. Davies, Scripps Institution of Oceanography, La Jolla, California; James P. Kennett, University of Rhode Island, Kingston, Rhode Island; Paulian Dumitrica, Geological Institute of Romania, Bucharest, Romania; Anthony R. Edwards, New Zealand Geological Survey, Lower Hutt, New Zealand; Richard P. Von Herzen, Woods Hole Oceanographic Institution, Woods Hole, Massachusetts.

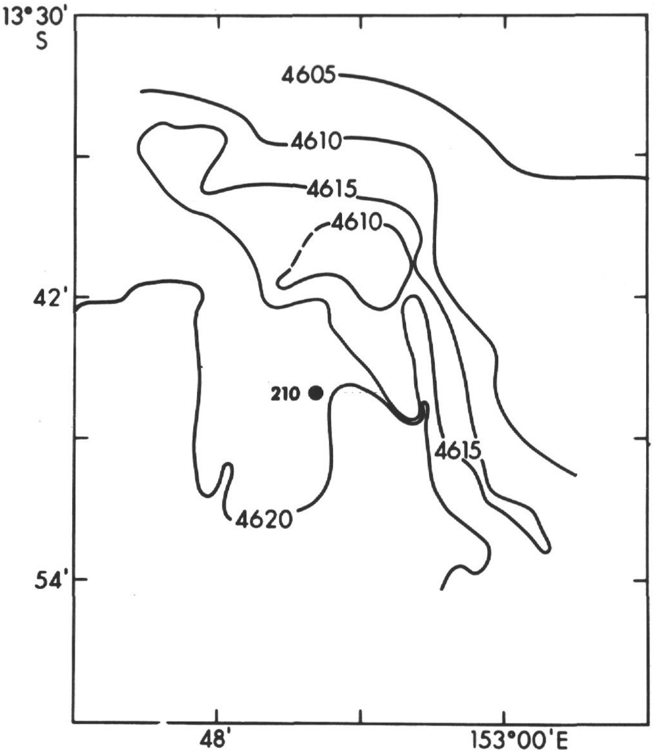


Figure 1. *Bathymetry at Site 210 (uncorrected meters). R/V* Kana Keoki *site survey, October 1971.*

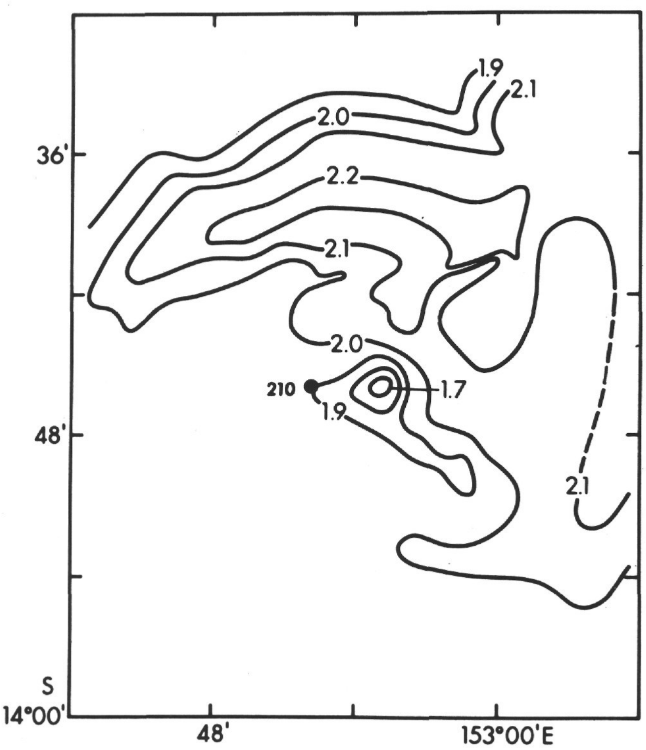


Figure 2. *Acoustic basement (seconds of reflection time) at Site 210.* Kana Keoki *site survey October 1971.*

slope problems are minimal. These patterns are most clearly seen in the profile in Figure 3 where deeper elements are uplifted.

OPERATIONS

Site Approach

The site approach track (Figure 4) shows very clearly the reflective patterns of the survey profiles. At low speeds (5 kt) for the initial site crossing and the beacon drop, the intermittent deep reflector is well defined. This profile shows more stratification than most in the area. This may be a function of the frequency output of the paired 5-cu in. and 30-cu in. air guns being towed. At the site the deep reflector rises to 0.8 sec subbottom. The transparent horizon conforms to this lower surface, and there are horizontal stratified reflectors above.

Sonobuoy

The on-site sonobuoy (Figure 5) does not present the same general appearance of stratified and transparent intervals as seen in the underway profile. The five principal reflectors picked in the sonobuoy record are, however, clearly correlatable to the underway records. Table 1 summarizes the sonobuoy data and initial interpretation.[2] The reflective horizons are generally weak to moderate in signal return suggesting that major boundaries are not involved or are obscured by structures and interference in reflections. Reflector 4 appears as acoustic basement at high speeds southwest of the site and is generally horizontal on the approach profile. Reflector 4 is clearest at low speeds as a rough acoustic basement. It can also be seen in the high relief region around Location 1000 on the approach profile. Reflectors 1, 2, and 3 are horizontal and generally regular reflectors in the "abyssal plain" section on all profiles, and they bound some of the previously described transparent intervals (Ewing et al., 1970).

Drilling Program

Fifty cores (Table 2) were attempted, and the first one was on deck at 0005 on 31 December. A continuous coring routine was followed down to 90 meters following which an alternating wash-and-core routine was carried out to 542 meters depth below the sea floor. With increased consolidation of the sediment by this depth, the wash and core procedure had become impractical, and continuous coring was resumed for the interval, 542 to 641 meters. With some apparent decrease in consolidation and a desire to reach basement, a wash-and-core routine was reestablished for the interval 641 meters to the bottom of the hole at 711 meters. Basement was not reached before the end-of-leg deadlin e forced conclusion of operations. The last core recovered was at 0200 on 4 January and the hole was abandoned at 1130 on the same day.

Four downhole temperature measurements were attempted at Site 210, using the retractable in-corer probe. One was successful and the other three were unsuccessful due to instrument damage during the operation.

---

[2] Final correlations of sonobuoy profiles using laboratory-measured velocities, other physical properties, and lithologic boundaries are presented in Part II of this Initial Report.

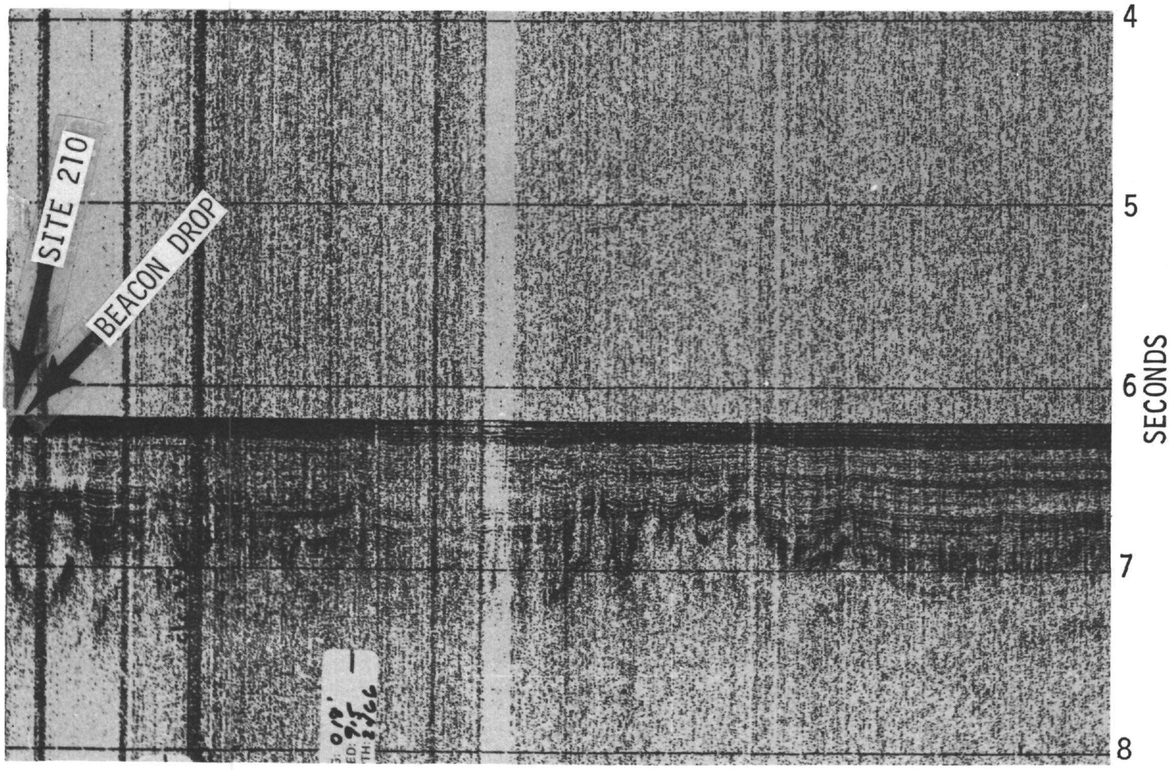


Figure 3. *Seismic profile on approach to Site 210.* Glomar Challenger.

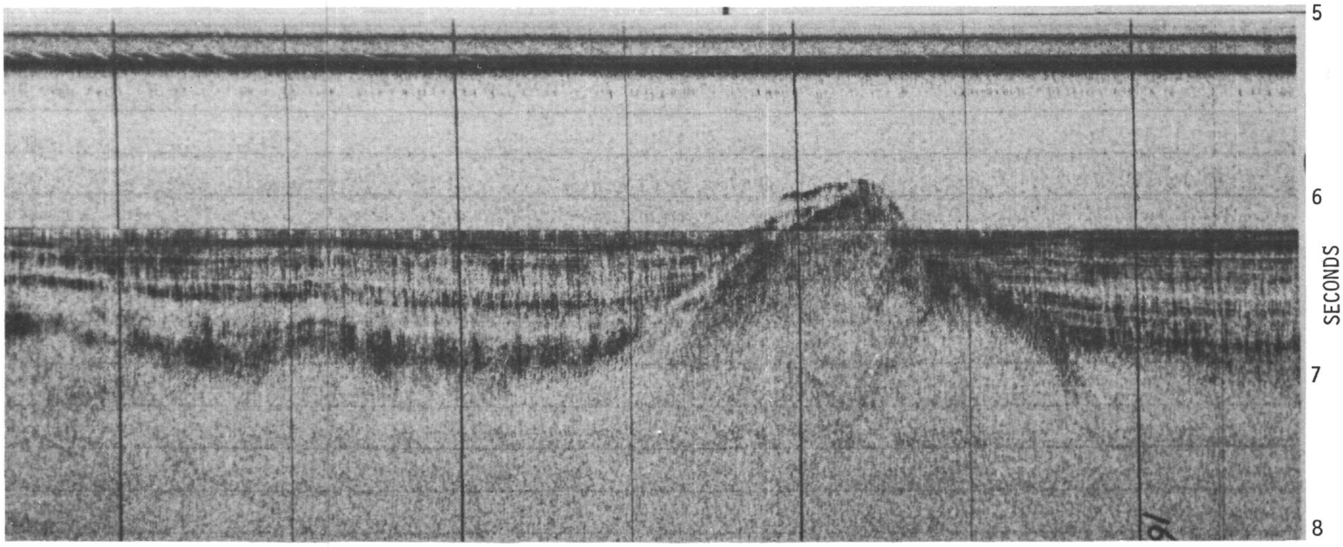


Figure 4. *Seismic profile departing Site 210.* Kana Keoki *site survey.*

LITHOLOGY

General

Hole 210, drilled in a water depth of 4650 meters, was continuously cored to a depth of 90 meters below the sea floor and semicontinuously cored from 90 to 711 meters. Fifty cores were taken and 262 meters of sediment recovered. Summaries of each core are given in Appendix F.

The cored sequence can be divided into five lithologic units. From top to bottom they are:

1) Unit 1 (0 to 470 m)—graded cycles of silt and clay with interbeds of nannofossil ooze (Pleistocene to mid Miocene).

2) Unit 2 (470 to 521.6 m)—clay (mid Miocene to early Miocene).

3) Unit 3 (521.6 to 540 m)—clay-bearing to clay-rich nannofossil chalk and clay-bearing calcic nannofossil chalk (mid Oligocene to late early Oligocene).

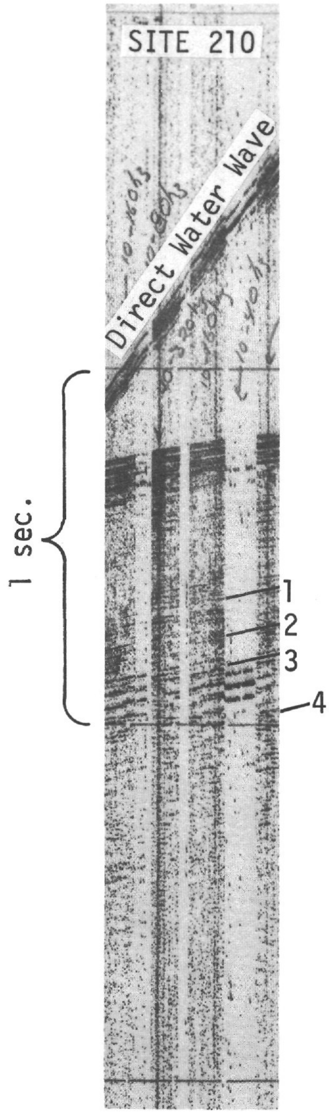


Figure 5. *On-site sonobuoy profile at Site 210.*

TABLE 1
Site 210 Sonobuoy Data

Reflector	Depth (sec)	Nature	Estimated Velocity Structure (m/sec)	Estimated Depth (m)
1	0.20	Weak, low frequency weak	1500	150
2	0.42	Weak/moderate, no low frequency	1500	315
3	0.52	Moderate, no low frequency	1600	395
4	0.65	Moderate/strong, good low frequency, general underway acoustic basement	1800	512
5	0.80	Weak/moderate, no low frequency	2000	662

4) Unit 4 (540 to 554.4 m)—clay-bearing to clay-rich calcic nannofossil chalk with minor chert nodules (early late Eocene to mid Eocene).

5) Unit 5 (554.4 to 711 m)—clay nannofossil chalk to clay (mid Eocene to late early Eocene).

Unit 1
(Graded Cycles of Silt and Clay with Interbeds of Nannofossil Ooze)

Approximately 1900 graded cycles of silt and clay averaging about 14 cm in thickness occur in Unit 1. These numbers were obtained from determinations in the portions of the cores that are relatively undisturbed by drilling and the total calculated by extrapolation for the disturbed cores and the uncored intervals. The bases of the cycles are generally olive black to dark greenish gray silt and are often in erosional contact with the underlying beds. Some of the bases are laminated and a few are cross-laminated.

Examinations of smear slides indicate that the basal sediments of the cycles are composed mainly of quartz, altered glass?, foraminifera, and feldspar. Minor constituents present in varying amounts include plant debris, chlorite, mica, clay minerals, pyrite, and other opaques, zeolites, nannofossils, ascidian sclerites, and various nonopaque heavy minerals (most commonly amphibole). Bulk samples from near the bases of about 15 different graded cycles were examined by X-ray diffraction, and the averaged results show that the main components of the crystalline phase are quartz (26%), calcite plus aragonite (22%), mica (21%), and plagioclase (17%). The subordinate components in decreasing abundance are chlorite, montmorillonite, kaolinite, amphibole, potash feldspar, and pyrite.

The middle portions of the graded cycles are generally greenish gray clayey silts to silty clays composed mainly of clay minerals and clay- and silt-sized detrital particles. Bulk samples from near the middles of about 10 different graded cycles were examined by X-ray diffraction, and the averaged results are similar to those from the bases of the cycles. Calcite plus aragonite (29%), quartz (24%), mica (29%), and plagioclase (14%) again compose about 85% of the crystalline phase. Subordinate components are the same as in the bases. Some of the middle portions, however, are noncalcareous.

The upper portions of the cycles are generally light greenish gray clays composed mainly of clay minerals, clay-sized particles, and nannofossils that are smaller and more corroded than in the biogenic interbeds between cycles. The darkness of the upper portions depends on the clay to nannofossil ratio. The more nannofossils present, the lighter the color. Some of the upper portions are mottled by burrows. X-ray diffraction of bulk samples from near the tops of three different graded cycles yielded results that are similar to those for the base and middle portions of the cycle. Quartz (25%), mica (22%), calcite (21%), and plagioclase (16%) compose about 85% of the crystalline phase. The subordinate components are also similar to those for the base and middle portions of the cycles except that pyrite was not detected.

The graded cycles of silt and clay are interpreted as turbidites because of: (2) the presence of grading upwards

TABLE 2
Coring Summary – Site 210

Core	Date	Time	Depth from Drill Floor (m)	Depth Below Sea Floor (m)	Cored (m)	Recovered (m)	Recovery (%)
1	12/31/71	0005	4653-4662	0-9	9	8.9	99
2	12/31/71	0140	4662-4671	9-18	9	9.0	100
3	12/31/71	0255	4671-4680	18-27	9	9.4	100
4	12/31/71	0430	4680-4689	27-36	9	0.0	0
5	12/31/71	0545	4689-4698	36-45	9	4.5	50
6	12/31/71	0655	4698-4707	45-54	9	7.2	80
7	12/31/71	0825	4707-4716	54-63	9	0.6	7
8	12/31/71	0945	4716-4725	63-72	9	6.6	73
9	12/31/71	1110	4725-4734	72-81	9	5.6	62
10	12/31/71	1235	4734-4743	81-90	9	5.2	58
11	12/31/71	1350	4756-4765	103-112	9	1.8	20
12	12/31/71	1515	4775-4784	122-131	9	6.0	67
13	12/31/71	1650	4793-4802	140-149	9	3.0	33
14	12/31/71	1825	4812-4821	159-168	9	2.3	26
15	12/31/71	1945	4831-4840	178-187	9	1.5	17
16	12/31/71	2120	4850-4859	197-206	9	1.0	11
17	12/31/71	2215	4868-4877	215-224	9	2.0	22
18	1/1/72	0020	4887-4896	234-243	9	0.5	6
19	1/1/72	0200	4906-4915	253-262	9	2.4	27
20	1/1/72	0330	4925-4934	272-281	9	5.5	61
21	1/1/72	0510	4944-4953	291-300	9	4.0	44
22	1/1/72	0645	4962-4971	309-318	9	6.3	70
23	1/1/72	0820	4981-4990	328-337	9	9.4	100
24	1/1/72	1000	5000-5009	347-356	9	9.4	100
25	1/1/72	1130	5018-5027	365-374	9	5.6	62
26	1/1/72	1310	5037-5046	384-393	9	0.0	0
27	1/1/72	1600	5056-5065	403-412	9	8.0	89
28	1/1/72	1740	5074-5083	421-430	9	7.7	86
29	1/1/72	1930	5093-5102	440-449	9	6.5	72
30	1/1/72	2125	5112-5121	459-468	9	4.0	44
31	1/1/72	2305	5130-5139	477-486	9	9.2	100
32	1/2/73	0055	5149-5158	496-505	9	8.3	92
33	1/2/72	0255	5168-5177	515-524	9	8.5	94
34	1/2/72	0520	5186-5195	533-542	9	5.4	60
35	1/2/72	0805	5195-5204	542-551	9	5.4	60
36	1/2/72	1130	5204-5213	551-560	9	7.2	80
37	1/2/72	1405	5213-5222	560-569	9	5.8	64
38	1/2/72	1615	5222-5231	569-578	9	4.0	44
39	1/2/72	1800	5231-5240	578-587	9	3.6	40
40	1/2/72	2020	5240-5249	587-596	9	8.4	93
41	1/2/72	2220	5249-5258	596-605	9	4.0	44
42	1/3/72	0025	5258-5267	605-614	9	2.9	32
43	1/3/72	0245	5267-5276	614-623	9	4.9	54
44	1/3/72	0545	5276-5285	623-632	9	4.5	50
45	1/3/72	0755	5285-5294	632-641	9	3.8	42
46	1/3/72	1110	5301-5310	648-657	9	8.7	97
47	1/3/72	1425	5318-5327	665-674	9	4.4	49
48	1/3/72	1800	5331-5340	678-687	9	5.6	62
49	1/3/72	2210	5345-5354	692-701	9	4.4	49
50	1/4/72	0200	5355-5364	702-711	9	9.4	100
Total					450	262.3	58

Note: Echo sounding depth (to drill floor) = 4650 meters;
drill pipe length to bottom = 4653 meters.

from coarser to finer detritus; (2) their highly terrigenous composition (especially the quartz, mica, plagioclase, plant debris, and heavy minerals; (3) the evidence of scour at the base of many of the cycles; and (4) the abundance of reworked shallow-water, benthonic foraminifera in the basal portions of many cycles as well as the occasional occurrence of ascidian sclerites, probably of shallow water, benthonic origin.

Several ungraded, parallel laminated (minor cross-lamination), fine sand, and coarse silt beds with sharp upper and lower boundaries occur throughout the interval. These may have been deposited by oceanic bottom currents. If so, the size of the detritus implies a relatively fast bottom current of about 1 knot.

The laminated bases of some of the graded cycles may have resulted from a succession of turbidity currents of subequal strength which successively eroded most of the previous graded cycle, eventually producing a "laminated base" comprised of the basal portions of many individual turbidites.

Using the same method of determination and extrapolation as for the graded cycles, it was calculated that approximately 800 interbeds of nannofossil ooze make up about 15% of Unit 1. They have an average thickness of about 8.5 cm and occur between graded cycles of silt and clay. It is often difficult, however, to distinguish clay-rich biogenic oozes from the upper nannofossil-rich portions of some of the graded cycles of silt and clay. Most of the interbeds are light greenish gray; but some are white and clay free whereas others are dark greenish gray and clay rich. Many of the interbeds are mottled by burrows (some *Chondrites* and *Zoophycos* types were recognized). Of the biogenic component of the oozes, calcareous nannofossils predominate with subordinate amounts of foraminifera. Although the interbeds are largely of biogenic origin, many may have been deposited by turbidity currents because of (a) the well-preserved nature of the calcareous nannofossils (the present water depth is 4650 m), (b) the evidence of considerable reworking (in some cases indicating that more than one source was being eroded), (c) the apparent size sorting in some beds, and (d) the presence of small but persistent amounts of ascidian sclerites of probable shallow water, benthonic origin.

Twenty-seven measurements of organic carbon (insoluble carbon remaining after treatment with HCl) were made on samples from Unit 1 and the average weight percent is 0.5. This average is about five times higher than the averages for the other units at Site 210. Organic carbon percentages at all the other sites on Leg 21 also averaged about one fifth that of this unit. These high percentages in Unit 1 are consistent with the hypothesis of turbidity current emplacement and relatively rapid burial of terrigenous and shallow water debris in the deep sea.

If all the graded cycles of silt and clay are turbidites, then turbidity currents carrying clastics were coming into the Coral Sea Basin at the rate of about 1 per 5000 years for about the past 10 million years. However, because some of the biogenic interbeds are probably turbidites, the overall frequency of turbidity current influx into the Coral Sea Basin is probably closer to about 1 per 4000 years for about the past 10 million years.

Occasionally throughout Unit 1 there are subordinate lithologies or sequences other than those already described. A 55-cm-thick bed of foraminiferal ooze occurs at about 140 meters (Core 13). Nearly 3 meters of interbedded nannofossil ooze and clay occur at 291 to 294 meters (Core 21). About 8.5 meters of nannofossil clay underlain by 40 cm of calcareous sandy silt occur at 347 to 356 meters (Core 24). About 2.7 meters of nannofossil ooze occurs at 421 to 424 meters (Core 28). About 2.85 meters of nannofossil ooze and interbeds of noncalcareous clay occur at 440 to 443 meters (Core 29). All but 50 cm of Core 30 are nannofossil ooze and interbeds of clay.

The main conclusion drawn from the above as well as from the distribution and size of nannofossil ooze interbeds is that about the lower third of Unit 1 is richer in biogenic components and the upper two-thirds is richer in clastics. The upper two-thirds of Unit 1 accumulated at a rate of about 70 meters per million years, whereas the lower third accumulated at less than half that rate (about 30 meters per million years).

The boundary with the underlying unit falls within an uncored interval of about a dozen meters and has been arbitrarily placed in the middle of the uncored interval.

Unit 2 Clay

Unit 2 is mainly composed of clay minerals and clay-sized particles and is subdivided into two parts:

Subunit 2A: 470 to 500.5 m. The sediment is mostly dark greenish gray, slightly to moderately mottled, semilithified, noncalcareous clay with subordinate silty clay. An X-ray analysis of a bulk sample at 480.1 meters shows that the crystalline phase is composed predominantly of mica (39%), plagioclase (21%), and quartz (18%) with subordinate amounts of montmorillonite (10%), chlorite, potash feldspar, and amphibole. The <2 micron fraction is enriched in montmorillonite (27%). A microscopic determination indicates that the mica is muscovite and the plagioclase is andesine. The upper 35 cm of the subunit contain two 5-cm-thick beds of lighter greenish gray foraminiferal and quartz-rich calcic silt. A 7-cm-thick carbonate bed occurs in the middle of the subunit at about 483 meters. The basal 1.3 meters of the subunit are olive gray, indicating an increase in brown-colored detritus and a transition to Subunit 2B.

Subunit 2B: 500.5 to 521.6 m. The sediment is yellowish brown to dark yellowish brown, semilithified, moderately but indistinctly mottled clay with subordinate silty clay. Rare small greenish gray patches occur. An X-ray analysis of a bulk sample at 503.7 meters shows that the crystalline phase is mostly montmorillonite (32%), quartz (19%), mica (16%), potash feldspar (15%), and plagioclase (12%) with minor amounts of chlorite and kaolinite. The 2-20 micron fraction is enriched in quartz (30%), potash feldspar (26%), and plagioclase (21%) whereas the <2 micron fraction is mainly montmorillonite (50%). Microscopically, the mica is muscovite and the plagioclase is andesine, as in Subunit 2A. One 15-cm band of pale orange to yellowish brown calcareous silt occurs just below 525 meters. It consists mainly of carbonate particles with a small proportion of calcareous nannofossils.

Unit 2 is interpreted as an abyssal clay because of the scarcity of biogenic sediment and the slow accumulation rate of 4 meters per million years. The contact with the underlying highly calcareous beds probably represents a disconformity or a highly condensed sequence (see Biostratigraphic Summary). The two lithologies are interbedded over about a 15-cm interval.

Unit 3 (Clay-bearing to Clay-rich Nannofossil Chalk and Clay-bearing Calcic Nannofossil Chalk)

The chalk of this unit is yellowish brown, yellowish orange, and yellowish gray. It is semilithified and moderately to intensely mottled with darker wisps throughout, giving it a "bird's eye maple"-like texture. Pinkish gray bands and patches occur in the lower part. Four insoluble residue determinations on samples from Unit 3 average 10%. This correlates well with two shore laboratory determinations of calcium carbonate 3 content which average 89%. An X-ray analysis of a bulk sample at 533.7 meters shows that the crystalline phase is almost entirely calcite (98%). The calcium carbonate-free residue of the <2 micron fraction is predominantly montmorillonite (74%) with subordinate clinoptilolite (12%), quartz, mica, plagioclase, and chlorite. Smear slide examination of the carbonate component of the sediment suggests that a significant proportion of fine nonnannofossil material is present. Scanning electron microscope examination shows this to be small rhombs of authigenic calcite. The exact nature of the boundary with the underlying Unit 4 is unknown because of a small gap in core recovery. However, the boundary lies within a few meters interval and represents a significant unconformity (see Biostratigraphic Summary) that is of regional extent. Here the unconformity appears to be angular.

Unit 4 (Clay-bearing to Clay-rich Calcic Nannofossil Chalk with Minor Chert Nodules)

The chalk is light olive gray to very light greenish gray with pinkish gray patches and lenses scattered throughout. Minor glauconite occurs in the lower two meters. Unit 4 is semilithified, moderately mottled, with a "bird's eye maple"-like texture as in the overlying unit. The carbonate consists of nannofossils and small calcite rhombs. Layering (? bedding) is inclined at about 20°. An insoluble residue determination on a sample from Unit 4 is 9%, whereas two shore laboratory determinations of calcium carbonate content average 81%. Bulk samples from 547.7 and 551.7 meters were X-rayed, and the results show that calcite (95%) is the predominant component of the crystalline phase with minor amounts of montmorillonite, quartz, mica, and clinoptilolite. The calcium carbonate-free residue of the 2-20 micron fraction is mainly quartz (34%), clinoptilolite (31%), mica (20%), and plagioclase (14%) whereas the <2 micron residue is predominantly montmorillonite (83%) with minor mica, quartz, clinoptilolite, and plagioclase. Chert occurs sporadically throughout the upper two-thirds of the interval as olive gray nodules up to 2 cm in diameter formed by replacement of the carbonate. The contact with the underlying unit is gradational; however, a distinct change in preservation of foraminifera occurs at the boundary. Foraminifera in Unit 4 are particularly poorly preserved, whereas they are moderately well preserved in Unit 5 (see Biostratigraphic Summary).

Unit 5 (Clay Nannofossil Chalk, Calcic Nannofossil Chalk, Nannofossil Clay, Calcic Clay, and Clay)

The major constituents of this unit are calcareous nannofossils, clay, and authigenic carbonate. The last has been identified by scanning electron microscopy. These three components are all present throughout in varying proportions leading to a proliferation of lithologic names (eight in all are indicated on the core summaries). The insoluble residue component of the interval, mainly clay minerals and clay-sized particles, averages about 45%. Most values are between 40% and 55%. These values compare favorably with shore laboratory determinations of calcium carbonate content, which average 53%, most ranging between 45% and 60%. Clay and clay-sized particles predominate in the lower part of the unit whereas calcite predominates in the upper portion.

Unit 5 is semilithified, but is not as hard as the two overlying units. From 627 meters to the bottom of the hole at 711 meters, short intervals of core have responded plastically to drilling. These softer segments are more common below 651 meters. Bedding dips at 5° to 10°.

The unit can be broadly subdivided into three parts.

Subunit 5A: 554.4 to 570 m. The sediment is mainly light greenish gray clay-rich calcic nannofossil chalk to nannofossil-rich calcic clay, moderately but indistinctly mottled. Foraminifera are sparsely distributed throughout. Bulk samples from 555.8 meters and 564.0 meters were X-rayed, and the results show that calcite (79%) is the predominant component of the crystalline phase with minor amounts of montmorillonite, mica, quartz, clinoptilolite, tridymite, cristobalite, and plagioclase. The calcium carbonate-free residue of the 2-20 micron fraction is mainly quartz (33%), clinoptilolite (25%), mica (25%), and plagioclase (14%) whereas the <2 micron residue is predominantly montmorillonite (55%) with appreciable amounts of mica (14%), cristobalite (14%), and quartz (9%). In the lower portion of Subunit 5A, darker fine-grained pyrite is present in minor quantities in burrows.

Subunit 5B: 570 to 665 m. Lithologically this subunit is similar to the above except that the color is very pale blue green to light greenish gray and fine pyrite is much more common in burrows. The burrows are mostly surrounded by pale purple patches containing more sparsely distributed pyrite. Bands several centimeters thick of the same hue are also common. The coarse fraction of the insoluble residue from a sample at 579.8 meters includes quartz, muscovite, andesine, and albite. Nine bulk samples at approximately 10-meter intervals were X-rayed from Subunit 5B, and the averaged results show that calcite (69%) is the predominant component of the crystalline phase with subordinate quartz (14%) and minor amounts of cristobalite, mica, montmorillonite, tridymite, and plagioclase. Cristobalite and tridymite with one exception are found only in the upper half of the subunit whereas quartz occurs throughout the interval. However, in the upper samples in which cristobalite and tridymite occur, quartz averages only 4% whereas in the lower half of the subunit quartz averages 26%. Combining the quartz, cristobalite, and tridymite percentages shows that the silica content is rather constant (averaging 23%) throughout the subunit with its various phases being significant variables. The calcium carbonate-free residue of the 2-20 micron fraction is mainly quartz (45%) with subordinate critobalite (21%) and mica (18%) and minor plagioclase, potash feldspar, tridymite, chlorite, montmorillonite, barite, pyrite, and clinoptilolite. The <2 micron residue is mainly quartz (37%), cristobalite (31%), and montmorillonite (23%). Both size fractions of the residues also contain cristobalite and tridymite in samples from the upper half of the subunit only. Foraminifera occur scattered throughout most of Subunit 5B but increase in frequency at 635 meters where foraminiferal-rich bands several centimeters thick appear, occurring at intervals to the base of the subunit.

Subunit 5C: 665 to 711 m. The chalks and clays of the basal subunit resemble those of the other two, but the burrows are filled with light olive gray sediment and pyrite is much less common than in the overlying subunit. The predominant colors of Subunit 5C are light bluish gray and light gray. Four bulk samples from the subunit were X-rayed, and the averaged results show that in the crystalline phase calcite (55%) and quartz (33%) predominate with minor mica, chlorite, montmorillonite, and plagioclase. The calcium carbonate-free residues of the 2-20 micron and the <2 micron fractions are predominantly quartz (73%) with subordinate mica (11%) and minor chlorite (5%). Plagioclase (11%) is significant in the coarser residue whereas montmorillonite (10%) is significant in the finer residue. No cristobalite or tridymite were detected in this subunit, unlike in the overlying subunit. Subunit 5C is foraminiferal-bearing throughout with foraminiferal-rich bands from 704 meters to the base.

Sequence of Geologic Events Interpreted from Lithology

Early-Late Eocene

Accumulation of detrital clay and biogenic pelagic sediment (nannofossils and foraminifera) took place in the late early Eocene to the middle Eocene as represented by Unit 5. The accumulation rate for the sampled portion of the middle Eocene averages 25 meters per million years, decreasing upwards. Accumulation continued into the early late Eocene with an increase in the relative proportion of the biogenic (mainly nannofossils) component of the sediment as represented by Unit 4. The provenance of the terrigenous detritus is probably a terrain of sedimentary or low-grade metamorphic rocks with some volcanics. The mineral assemblage includes quartz, muscovite, chlorite, and plagioclase (andesine and albite). The detritus could have been derived from either the southeastern Papua-Louisiade Archipelago region or from Queensland. The latter seems the more likely since the sediments in the lower part of Hole 209 (mid Eocene) are glauconitic as is the lower part of Unit 4 and also contain a significant terrigenous component similar to that in Unit 5. Further, it is suggested by Davies and Smith (1971) that metamorphism of the Mesozoic sialic rocks forming the core of the southeastern Papua-Louisiade region took place in the Eocene and that emergence of the metamorphics did not take place until late Oligocene to early Miocene. No turbidites have been recognized in Units 4 or 5. If they were present they must have been thin and subsequently have been destroyed by bioturbation.

Late Eocene-Early Oligocene

An angular unconformity represents most of late Eocene and early Oligocene time during which the older sediment (Units 4 and 5) was folded. Folding may be related to continued tectonism in the Owen Stanley Range in eastern Papua. Tectonism also took place at about this time in New Caledonia and possibly the Solomon Islands. In addition, slumped Eocene cherts occur near Port Moresby, Territory of Papua and New Guinea.

Early-Middle Oligocene

Deposition of nannofossil ooze at oceanic depths near the carbonate compensation level is represented by Unit 3.

Early-Middle Miocene

Deepening of the Coral Sea Basin and/or raising of the carbonate compensation depth resulted in the slow accumulation of abyssal clay at about 4 meters per million years as represented by Unit 2. Although quartz, muscovite, and chlorite are significant components in both this and the Eocene section, the terrigenous detritus in these Miocene beds differs somewhat from that in the Eocene section in that potash feldspar is present and plagioclase (andesine) is more abundant. These compositional changes may reflect a source change to the Papuan region. This view is supported by evidence of subsidence at Site 209 on the edge of the Queensland Plateau and the deposition at that site of predominantly biogenic sediments in the early to middle Miocene. Wherever the source of the terrigenous debris, its volume is insignificant compared to the terrigenous component of the overlying Unit 1.

Late Miocene-Late Pleistocene

Accumulation of graded cycles of silt and clay via turbidity currents took place in the early late Miocene to the late Pleistocene as represented by most of Unit 1. The largely terrigenous component of these turbidites probably was derived from New Guinea based on mineralogy and on the present bathymetry of the Coral Sea Basin (Winterer and Galehouse, 1968). At the present time turbidity currents enter the basin via the Moresby Submarine Canyon. Although the beginning of turbidite deposition in the Coral Sea Basin began in early late Miocene time, deposition of similar types of sediment in the Aure Trough in New Guinea (approximately 30,000 feet of sediment of early Miocene to late Pleistocene age) began very early in the Miocene with the sediment derived mainly from the Owen Stanley Range (Rickwood, 1968). The Aure Trough and the Coral Sea Basin may have been part of the same basin in the Miocene with the Aure Trough acting as a sediment trap for much of the detritus. Folding and uplift of the Aure Trough and many other areas of New Guinea from the beginning of the Pliocene onwards (Rickwood, 1968) provided additional source areas which accelerated the rate of detrital input into the Coral Sea Basin. As mentioned previously, the upper two-thirds of Unit 1 accumulated at a rate more than twice that of the lower third.

Because there is no evidence indicating a shallowing of the basin, the presence of considerable amounts of nannofossil ooze intercalated with the graded cycles of silt and clay indicates either a change in the compensation depth compared to conditions prevailing during the accumulation of Unit 2 or emplacement of the biogenic interbeds by turbidity currents. If, as previously indicated, some of the biogenic interbeds in Unit 1 are turbidites, turbidity currents may have been carrying debris into the Coral Sea Basin from more than one direction. In recent times the clastics were probably derived from the northwest via Moresby Submarine Canyon and the biogenics from the west and southwest via Bligh Canyon (for details of bathymetry, see Winterer, 1970). Earlier in the history of deformation of Unit 1, terrigenous debris was probably funneled through the Aure Trough, and the biogenic interbeds were derived from the Omatai Trough, Fly River Delta, Great Barrier Reef, and/or Queensland Plateau regions.

BIOSTRATIGRAPHY

General

The microfossils recovered from the 50 cores representing 711 meters of semi-continuously cored sediments indicate the presence of an incomplete late early Eocene to late Pleistocene sequence. Foraminiferal and calcareous nannofossil assemblages enable the distinction of four biostratigraphic units as follows: (1) Pleistocene to late Miocene (210-1-1 to 210-30-2); (2) Mid Miocene to early Miocene (210-31-1 to 210-33-5); (3) Mid Oligocene to late early Oligocene (210-33-5 to 210-34, CC);–Disconformity–(4) Early late Eocene to late early Eocene (210-35-2 to 210-50, CC).

1) The Pleistocene to late Miocene contains abundant to common, and well to moderately preserved foraminifera and calcareous nannofossils. Authochthonous and reworked assemblages (not older than Eocene) are present in varying amounts in many cores. Autochthonous taxa are made up primarily of tropical forms. Dissolution phenomena observed in foraminifera indicate deposition close to or even below the calcium carbonate compensation depth. The preservation of tests was probably enhanced by rapid sedimentation of the graded beds that prevented further dissolution.

2) The mid Miocene to early Miocene sediments largely lack microfossils, but small poorly preserved foraminiferal and nannofloral assemblages occur at several very thin and widely separated horizons. The nannofossils at the base of the interval are strongly corroded, thus suggesting that all of the interval was deposited below calcium carbonate compensation depth.

3) The mid Oligocene and late early Oligocene sediments contain foraminifera and nannofossils that are poorly preserved as a result of dissolution effects. This suggests deposition close to the calcium carbonate compensation level.

As in Sites 206 through 209, a disconformity separates the Oligocene sediments from those of Eocene age. At this site the latest Eocene and earliest Oligocene is contained within the unconformity.

4) The early late Eocene to late early Eocene sediments contain abundant but poorly preserved foraminifera and nannofossils, and at the upper part (210-35, CC to 210-40, CC) a rare and porrly preserved radiolarian fauna. No evidence of appreciable dissolution of the calcareous microfossils was noted, suggesting that deposition was above the calcium carbonate compensation depth. Eocene microfossils are represented by both tropical and temperate forms, which is surprising for the present-day latitudinal position of the site.

Foraminifera

Planktonic foraminifera in core-catcher materials from Site 210 indicate the presence of an incomplete late early Eocene to late Pleistocene sequence. Foraminiferal assemblages and characteristics enable division into three distinct biostratigraphic units as follows: (1) Pleistocene to late Miocene (Cores 1 to 29) assemblages containing both deep-water (lower bathyal-abyssal) benthonic foraminiferal faunas and unreworked planktonic foraminiferal faunas, in addition to reworked shallow-water (neritic-upper bathyal) benthonic foraminiferal faunas and reworked planktonic foraminiferal faunas; (2) An essentially barren interval between Cores 30 and Section 33-1; and (3) Oligocene to early middle or late early Eocene foraminiferal faunas (Cores 33 to 50) that show little or no evidence of reworking and which contain only relatively few benthonic forms.

Planktonic foraminifera indicate the presence of an unconformity between 210-33, CC and 210-35, CC representing at least the late Eocene (calcareous nannofossils show that part of the early Oligocene is also represented within the unconformity between 2210-34, CC and 210-35, CC). Otherwise, the foraminiferal sequence appears to be relatively continuous, although greatly complicated by strong reworking in the Neogene, by strong dissolution throughout much of the sequence, and by poorly preserved (often recrystallized) and sparse faunas, especially within the Paleogene.

Middle Miocene to late Pleistocene faunas are made up exclusively of tropical forms. Core-catcher samples examined can be readily placed into three categories as follows:

1. Well-sorted foraminiferal assemblages of small individuals that exclusively contain neritic and upper bathyal benthonic foraminifera such as *Quinqueloculina, Elphidium,* discorbids, *Nonionella,* and costate uvigerinids. Planktonic foraminiferal faunas are mostly composed of well-preserved (often delicate) small juveniles. Some samples also contain reworked planktonic foraminifera as old as the Eocene. This category is often associated with conspicuous plant debris and abundant mica, and is unquestionably almost entirely of reworked ("allochthonous") origin.

2. Foraminiferal assemblages containing various sized individuals that include: (a) unreworked planktonic foraminiferal assemblages made up primarily of solution-resistant forms such as *Sphaeroidinella* and *Globigerina nepenthes* and which also are commonly fragmented as a result of dissolution; and (b) deep-water (lower bathyal-abyssal) benthonic foraminiferal faunas such as *Melonis pompilioides, Pyrgo depressa, Globocassidulina, Eggerella, Pullenia bulloides,* and *Pleurostomella.* These faunas are unquestionably in place ("autochthonous") reflecting conditions within the sedimentary basin itself.

The high degree of dissolution of these faunas indicates deposition close to or below the calcium carbonate compensation depth. Preservation of faunas well below this level is possible because deposition of graded beds in relatively rapid succession prevents further dissolution.

3. Mixtures of the above two categories.

The Pliocene-Pleistocene boundary is marked in Site 210 by the first appearance of *G. truncatulinoides* in succession from *G. tosaensis* between 210-11, CC and 210-12, CC. The Miocene-Pliocene boundary occurs between Cores 24 and 25.

Foraminiferal assemblages of early Miocene age have not been identified at this site, but according to the nannofossils, sediments of this age are represented within the foraminiferal barren interval occurring between Core 30 and Section 33-1.

Paleogene planktonic foraminiferal faunas are represented by both tropical and temperate forms. Diversity is surprisingly low, considering the present-day latitudinal position and probably represents evidence for northward drift of the Coral Sea region since the Early Eocene. Foraminifera are very rare or preservation poor over the interval of the Oligocene-Miocene boundary as determined by calcareous nannofossils. Oligocene faunas (210-33, CC) are almost exclusively made up of *Catapsydrax dissimilis.* Preservation is poor, largely as a result of dissolution effects. This suggests deposition close to the calcium carbonate compensation level.

Late early Eocene to middle Eocene sediments contain abundant, although poorly to moderately preserved planktonic foraminiferal faunas of relatively low diversity. Poor preservation is largely due to recyrstallization and distortion of specimens. No evidence of dissolution exists, suggesting deposition above the calcium carbonate compensation depth. A distinct preservation change, however, occurs within the Eocene assemblages between 210-36-2, 68-70 cm and 210-36-3, 103-105 cm. Above this level, preservation is particularly poor while faunas below this level are moderately well preserved.

The boundary between early and middle Eocene sediments is marked by the last appearance of *Globorotalia crater* between Cores 41 and 42.

In summary, the middle Miocene to Pleistocene foraminiferal sequence indicates much reworking of shallow-water faunas to depths close to or deeper than the calcium carbonate compensation depth. The Oligocene and Eocene faunas contain no evidence of significant reworking. Oligocene faunas reflect deposition close to the calcium carbonate compensation depth, whereas Eocene faunas were deposited above this depth.

Calcareous Nannofossils

Nannofloras extracted from Site 210 samples, which represent 711 meters of semicontinuously cored sediment, indicate the presence of an incomplete late early Eocene to Pleistocene sequence at this site. The assemblages obtained, together with an intervening essentially barren interval, indicate the following age groupings which are arranged in downhole order:

1) Pleistocene to early late Miocene (210-1-1, 10 cm to 210-30-2, 41 cm) lithologic Unit 1.

2) Mid Miocene to early Miocene (210-31-1, 36 cm to 210-33-5, 51 cm) lithologic Unit 2 ("barren").

3) Mid Oligocene to late early Oligocene (210-33-5, 82 cm to 210-34, CC) lithologic Unit 3.

4) Early late Eocene to late early Eocene (210-35-2, 82 cm to 210-50, CC) lithologic Units 4 and 5.

As judged by the calcareous nannofossil content and preservation, the whole of this sequence was deposited at abyssal depths close to the calcium carbonate compensation depth; the nannofossil fraction having come from a warm-water environment which was largely, but not exclusively (especially in Unit 1), of an oceanic nature.

As in the sequences at Sites 206 to 209, an unconformity involving most of the Late Eocene plus the earliest Oligocene is present.

The deposition rates for this sequence, as based entirely on the calcareous nannofossil age determinations, are shown in Table 3.

TABLE 3
Deposition Rates for Site 210

Interval	Meters per Million Years
Zone NN21 (Pleistocene)	49
Pleistocene (in toto)	70
Late Pliocene	75
Early Pliocene	ca 60
Late Miocene	ca 24
Early and Mid Miocene	7
Oligocene	not determinable
Late Eocene	not determinable
Mid Eocene	25 (upward decreasing)
Site 210	13

The continuing high deposition rate during Zone NN21, the last 250,000 years, can be used to give a calculated average periodicity of emplacement for the youngest Unit 1 clastic graded cycles of one per 4,800 years. If the intervening nannofossil ooze beds are included, and some undoubtedly should be (see below), the periodicity rate is reduced to one per 3,500 years.

The samples taken for nannofossils from the interval 210-1-1, 10 cm to 210-12-3, 13 cm (Pleistocene) are distincly biased in favor of the nannofossil ooze interbeds and the lightest colored tops of the clastic graded cycles. Usually these lithologies contain abundant, moderately well preserved, diverse and common, moderately well preserved, low diversity, nannofloras, respectively. A few samples were also taken from the darker colored clastic lithologies, but these either lacked nannofossils or contained very rare to few poorly preserved (corroded) very low diversity (mostly either *Gephyrocapsa* or *Pseudoemiliania*) nannofloras.

Taxa present in this interval and considered to be more or less penecontemporaneous with deposition include *Ceratolithus cristatus, Cyclococcolithina leptopora, C. macintyrei* (unreworked top about 210-10-4, (88 cm), *Cyclolithella annula, "Doscoaster" perpelxus, Discosphaera tubifer, Emiliania huxleyi* (210-1-1, 35 cm; 210-1-1, 130 cm; 210-1, CC; and 210-2-2, 90 cm, *Gephyrocapsa caribbeanica* s.l. (base at 210-11, CC common and usually with cross-bar), *G. oceanica* (base at 210-7, CC usually with cross-bar), *G.* sp. (210-8, CC to 210-12-3, 13 cm range), *Helicopontosphaera kamptneri et aff, Pontosphaera discopora et aff, P. japonica, P. scuttelum, Pseudoemiliania lacunosa* (unreworked top about 210-5, CC), *Rhabdosphaera claviger, Sycphosphaera* spp., *Syracosphaera histrica, Thoracosphaera heimii,* and *T. perforata.* Also observed throughout were globostellate ascidian sclerites and "planktonic" microforaminifera—both having their highest occurrences in 210-1-1, 130 cm and their greatest abundance in nannofossil ooze from 210-5, CC. In many samples a distinct association between the relative frequencies of intact ascidian sclerites, microforaminifera, *Scyphosphaera* lopodoliths, *Thorasocphaera* nannospheres and, less obviously, large *Pontosphaera* discoliths was noted. This association of large nannofossils, which is particularly conspicuous in nannofossil ooze samples 210-1-1, 130 cm; 210-3-3, 50 cm; 210-5, CC; 210-6-4, 80 cm; 210-9-4 98 cm; and 210-10-4, 88 cm could be due to size sorting during deposition.

Other taxa observed in this interval and attributed to reworking include *Ceratolithus rugosus* (reworked in part?), *Chiasmolithus grandis, C. solitus, Coccolithus eopelagicus, C. pelagicus, Cyclicargolithus floridanus, Cyclococcolithina formosa, C. macintyrei* (reworked in part), *Discoaster asymmetricus, D. barbadiensis, D. brouweri, D. deflandrei, D. pentaradiatus, D. surculus, D. variabilis, Helicopontosphaera parallela, Micrantholithus basquensis*?, *Pseudoemiliania lacunosa* (reworked in part), *Reticulofenestra bisecta, R. placomorpha, R. pseudoumbilica, Spenolithus abies, S.* cf. *distentus, S. moriformis, S. neoabies, Zygolithus dubius*, and *Zygrhablithus bijugatus*. Almost all samples were found to contain at least a few specimens attributable to reworking from, as the above list indicates, mid Eocene and younger sediments. In most of these cases the source appears to be primarily, but not exclusively, of Pliocene age. In one sample, 210-1, CC, such reworking represents a substantial part of the flora. However, by way of contrast, Samples 210-1-1, 130 cm; 210-8, CC, and 210-10-4, 88 cm contain massive reworking from sediments mainly of early Miocene age. Clearly more than one source of reworking was being actively eroded.

A lithologic sequence such as occurs in this and the underlying Plicoene and late Miocene intervals is usually considered to result from episodic influxes of clastics with the intervening pauses allowing normal pelagic deposition to occur to a greater or lesser extent. However, in this particular case there are good reasons for considering a significant and perhaps major part of the biogenic interbeds, which represent about 20% of this interval, as having been deposited by the same method as the clastics. The grounds for this conclusion are that: (1) a very low accumulation rate for strictly pelagic sedimentation is expectable at the present 4650 meters depth of Site 210; (2) the calcareous nannofossils in the biogenic interbeds are surprisingly well preserved (e.g., uncorroded *Scyphosphaera, Rhabdosphaera, Syracosphaera*, perforate *Pontosphaera* etc.) whereas those in the upper parts of the most strongly clastic graded cycles are strongly corroded; (3) the consistent presence of reworking, occasionally massive, regardless of lithology indicates redeposition as probably does the occurrence in the biogenic interbeds of apparent size sorting (see above); and (4) the probably shallow sublittoral origin of the ascidian sclerites present, often conspicuously, in all but the most strongly clastic lithologies.

From the above, it must be obvious that accurate age and zone assignments in this and the similar underlying intervals are difficult to achieve. Clearly the observed bases of abundant taxa are the most reliable criteria to use but even these are at best going to be close approximations due to the general prevalence of more or less unfavorable facies. Equally clearly the tops of taxa known to be useful elsewhere are not going to be very reliable because of the problem of reworking. For example, Sample 210-1-1, 35 cm contains the highest occurrences of the taxa defining the tops of the NN15, NN16, NN17, NN18, and NN19 zones of Martini (1971) plus the highest occurrence of the still living index of his youngest, NN21 zone. However, despite this it is often possible, as has been done for the purposes of this report, to determine subjectively the "unreworked top" of a taxon based on an observed upward change in its consistency of occurrence and frequency. Accordingly the following approximate correlations are made, in downhole order, for this interval: 210-1-1, 10 cm to 210-2-2, 90 cm; Pleistocene 3/3, *Emilinia huxleyi* (NN21) Zone of Martini (1971); probably reliable; 210-2-3, 120 cm to 210-4, CC, Pleistocene 2/3, *Gephyrocapsa oceanica* (NN20) Zone of Martini (1971), low reliability (gap zone); 210-5, CC to 210-12-13, 13 cm, Pleistocene 1/3, *Pseudoemiliania lacunosa* (NN19) Zone of Martini (1971), probably moderately reliable.

The Pliocene to late Miocene nannofloras are essentially similar to those of the overlying Pleistocene (q.v.) except that a downward decrease in the quality of preservation and amount of reworking is evident. Despite this, the assemblages can, with relative ease, be correlated with the zonal scheme of Martini (1971) as indicated on the barrel summary sheets. The Plio-Pleistocene and early-late Pliocene boundaries sensu calcareous nannofossils are easily recognized, being based on the last continuous appearances of abundant unbattered *Discoaster brouweri* and *Reticulofenestra pseudoumbilica*, respectively. The same is not, however, true of the Miocene-Pliocene boundary nor of the age of the base of this interval, neither of which can be located accurately.

The mid Miocene and early Miocene nannofloras are represented by very small, poorly preserved assemblages which occur in thin horizons widely separated by barren clays. This information coupled with the essentially reworked nature of the calcareous nannofossils at 210-33-1, 31 cm and the highly corroded nature of the 210-33-5, 52 cm assemblage strongly suggest that deposition at this site was below the calcium carbonate compensation depth throughout early and mid Miocene. The coincidence of an abrupt change in both facies and flora at the base of this interval suggests it represents either a highly condensed sequence or an unconformity.

The mid Oligocene to late early Oligocene contains abundant but poorly preserved and not very diverse nannofloras which approximately correlate with the zonal schemes of both Edwards (1971) and Martini (1971). Spenoliths other than those of the *S. moriformis* type are very rare throughout.

The early late Eocene to late early Eocene nannofloras are abundant and diverse but poorly preserved. In containing taxa such as *Chiasmolithus gigas, Spenolithus furcatolithoides*, and *Triquetrorhabdulus inversus* these assemblages clearly have been deposited from a warmer (? tropical) climate than that indicated by age-equivalent floras from New Zealand, some 30° to the south. Despite this, both readily fit into the zonal scheme of Edwards (1971)—a rather surprising result.

Radiolaria

The single radiolarian occurrence at this site was recorded in Samples 210-35, CC to 210-40, CC in the stratigraphic interval between middle middle Eocene and early middle Eocene. Radiolarians are rare and poorly preserved.

Unlike the middle Eocene radiolarians encountered at Sites 206 to 208, which were of subtropical and temperate type, and which, due to the absence of the index species, could not be assigned to the zonation recently established by Riedel and Sanfilippo (1970) for tropical regions, the assemblages encountered at this site are similar in species composition to those commonly encountered in the tropics. The zonation established for tropical radiolarians is wholly applicable to them.

Sample 210-35, CC seems to belong to *Podocyrtis mitra* Zone (middle middle Eocene). The following species have been recognized: *Podcyrtis mitra, Lychnocanium bellum, L. splendens, Calocyclas turris, Theocampe mongolfieri, Thyrsocyrtis triacantha, Phormocyrtis striata, Lithochytris vespertilo.*

In Sample 210-36, CC radiolarians are so poorly preserved that they are impossible to identify, even at the generic level. The 210-37, CC to 210-39, CC samples are in the *Thyrsocyrtis triacantha* Zone. The assemblage is composed of *Thyrsocyrtis triacantha, T. hirsuta, Phormocyrtis striata, Theocotyle ficus, Podocyrtis aphorma, P. papalis, Calocyclas hispida, Lithochytris archaea,* etc.

In 210-40, CC only one species, *Theocampe* sp., was encountered.

PHYSICAL PROPERTIES

Bulk Density

As with earlier sites, GRAPE determinations of bulk density are plotted in the hole summaries. It must be realized that the upper part of the sequence cored at Site 210, consisting of graded beds of silt and silty clay interbedded with clays and oozes, is considerably more complex than the other sequences drilled on Leg 21. Consequently, we cannot attach any particular significance to discussions of the average density. Despite this limitation, however, the effect of compaction can clearly be seen between 50 and 100 meters below the sea bed, where the density rises markedly from 1.49 to 1.65 gm/cc into the range 1.7 to 1.8 gm/cc. Below this depth there is a steady increase in density downwards to the bottom of lithologic Unit 1 (430 m p = 1.94 gm/cc). Densities throughout this unit are generally a little lower than densities at comparable subbottom depths in the ooze sequences. This may simply reflect compositional differences. In detail, the GRAPE curves for this upper part of the sequence show the individual graded beds very clearly. In general, the upper part of each bed is noticeably denser than the basal part. This presumably reflects the increased porosity of the lower, coarser silt and fine sand layers.

In Cores 31 and 32 (lithologic Unit 2) the density drops into the range 1.69 to 1.81 gm/cc. These cores are almost entirely silty clay.

Below Core 32 (lithologic Units 3-5) the density rises abruptly to values greater than 2.0 gm/cc, as a consequence of the vastly increased carbonate content, and becomes surprisingly variable. Since this part of the sequence is lithified, the variation in density presumably reflects both changes in cementation and changes in composition. This is borne out by the strong correlation between variation in density with subbottom depth and the variation in carbonate content with subbottom depth (see Lithology section). High density is correlated with high carbonate content and vice versa.

Sonic Velocity

Above Core 23 the velocity is virtually constant in the range 1.49 to 1.65 km/sec. This is generally lower than the velocity in comparable ooze sections.

Below Core 23 the velocity becomes variable, but generally increases to rise abruptly to 2.0 km/sec with an increase in density at the top of lithologic Unit 3 (Core 33). In the lower oozes and chalks the velocity is in the range 2.07 to 3.03 km/sec and is very variable, as might be expected from the behavior of the density curve. A velocity maximum of 3.03 km/sec is reached in Core 36 below which the velocity generally but irregularly decreases. This corresponds to a general decrease in the amount of carbonate material, with the attendant decreases in hardness and density. However, unlike the density curve, there is no obvious correlation in detail between the carbonate curve and the velocity curve.

Thermal Conductivity and Heat Flow

Thermal conductivity was measured by the needle probe method on cores recovered from this site at subbottom depths up to 520 meters (Core 33). Below about 275 meters (Core 20), the cores were sufficiently indurated that a special long drill was used to create the hole required for the needle probe. In a few instances, this resulted in core fracture, which may affect the measurements. For the most part, no disturbance was apparent and reasonable values were obtained.

Values range from 2.1 to 3.6 m cal/°C cm sec (TCU), uncorrected for sea floor ambient pressure and temperature. there is substantial variation between cores and even between sections of the same core, which is most readily explained by the turbidite stratification. The variations probably reflect the proportions of carbonate (high conductivity) versus that of clay (low conductivity) in these sediments. The values show a general increase with depth, except below 450 meters where the reverse seems to be true. It is of interest to note that the values measured in the more indurated sediments below 250 meters depth are only slightly higher (10%) than most of those measured between 70 and 170 meters depth, suggesting that the water content of these sediments has not changed markedly with lithification.

A downhole temperature measurement at 54 meters gave a value of 7.16 ± 0.1°C. Combining this with a bottom-water temperature of 1.93°C, as measured within the drill pipe on the same lowering, results in a gradient of 0.097°C/m to 54 meters depth. The average thermal conductivity to this depth of 2.4 TCU gives a heat flow of 2.3μ cal/cm^2 sec, nearly twice the oceanic average and the highest measured on Leg 21.

SUMMARY AND CONCLUSIONS

Site 210 was drilled near the center of the Coral Sea abyssal plain above a section of relatively high and rough "basement" relief. The seismic profiles of the site survey and the site approach show an alternation of reflective and nonreflective zones in the upper 0.65 sec, suggesting stratified and homogeneous sediments resting on a rough basement. However, drilling penetrated five lithostratigraphic units, ranging in age from late early Eocene to late Pleistocene, and demonstrated that the alternation of patterns in the profiles is a product of turbidite spacings, calcareous content of the sediment, and lithification. The rough basement reflector under much of the basin is either the upper surface of a chalk horizon, or a high to low velocity transition downhole in the lowest clay/chalk unit.

Unit 5, from 554.4 to 711 meters, is a clay nannofossil chalk of late early to middle Eocene age. Sonic velocities within this unit decrease irregularly in response to the varying clay/calcite ratio, and produce Reflector 4—the deepest coherent reflector seen in the seismic profiles. Depth to true basement is uncertain, but is probably over 1 km subbottom based on faint indications in the sonobuoy profile. Unit 4, from 540 to 554.4 meters, is middle to early late Eocene in age and is a clay-bearing calcareous nannofossil chalk with minor chert nodules. Unit 3, from 521.6 to 540 meters, is a clay-rich chalk of late early to middle Oligocene age. Unit 2, from 470 to 521.6 meters, is a largely unfossiliferous abyssal clay of early to middle Miocene age. Reflector 3 corresponds to the boundary between Units 2 and 3. Unit 1, from 0 to 470 meters, is composed of approximately 1900 turbidite layers of silt and clay with intercalated layers of nannofossil ooze which may also have largely been emplaced by turbidity currents. Rare nonturbidite silty sand layers also occur. This unit ranges from early late Miocene to late Pleistocene in age. The increase in thickness of the nannofossil layers in the lower third of the unit gives rise to Reflector 2.

The lithostratigraphic and biostratigraphic records and the seismic profiles permit an interpretation of the basin's history. During early to late Eocene time clay, foraminifera, and nannofossils accumulated as a pelagic blanket at depths generally above the lysocline. Chert nodules appear in the later portion of this time interval and may be related to events producing the Eocene/Oligocene unconformity. At Site 210 the regional unconformity represents most of late Eocene and early Oligocene time. Dips in the beds of Units 4 and 5, the rough surface of Reflector 4, and the draped appearance of Reflector 3 suggest that disturbance of the basin floor, possibly in the form of folding, took place during this time gap. In late early to middle Oligocene time sediments were deposited below the lysocline and near the carbonate compensation depth. The abyssal clays of Unit 2 indicate either deepening of the basin below the compensation depth and/or raising of the carbonate compensation depth itself during early and middle Miocene time. During early late Miocene to Pleistocene time, deposition of Unit 1 took place.

Basin morphology and the mineralogy of the detrital sediment in the turbidite sequences of silt and clay (Unit 1) indicate New Guinea as the major source of this detrital sediment. Detrital material in Units 4 and 5 may have been derived from Queensland and show affinities to sediments in the lower portion of Site 209 (glauconite and terrigenous components).

REFERENCES

Davies, H. L. and Smith, I. E., 1971. Geology of eastern Papua: Geol. Soc. Am. Bull., 82, p. 3299-3312.

Edwards, A. R., 1971. A calcareous nannoplankton zonation of the New Zealand Paleogene: Planktonic Conf., 2nd Rome 1970, Proc., p. 381-419.

Ewing, J. I., Houtz, R. E., and Ludwig, W. J., 1970. Sediment distribution in the Coral Sea: J. Geophys. Res., v. 75.

Gardner, J. V., 1970. Submarine geology of the Western Coral Sea: Geol. Soc. Am. Bull., v. 81, p. 2599.

Martini, E., 1971. Standard Tertiary and Quaternary calcareous nannoplankton zonation: Planktonic Conf., 2nd Rome 1970, Proc., p. 739-785.

Rickwood, F. K., 1968. The geology of western Papua: J. Aust. Petrol. Expl. Assoc., v. 8, p. 51-61.

Riedel, W. R. and Sanfilippo, A., 1970. Radiolaria, Leg 4 Deep Sea Drilling Project. *In* Bader, R. G. et al., Initial Reports of the Deep Sea Drilling Project, Volume IV. Washington (U. S. Government Printing Office), p. 503-576.

Winterer, E. L., 1970. Submarine valley streams around the Coral Sea Basin (Australia): Mar. Geol., v. 8, p. 229-244.

Winterer, E. L. and Galehouse, J. S., 1968. Sedimentation in the Coral Sea Basin (abstract): Geol. Soc. Aust., Progr. Ann. Meeting, Canberra, 1968, p. 13.

NOTE CONCERNING THE APPENDICES

The appendices consist of tables of shore laboratory determinations of grain size, carbon content, and mineralogical composition, summary visual descriptions of the cores recovered from the site, photographs of the cores and, finally, an overall summary of the results of drilling at the site. The symbols used to represent lithology in the core summary forms are explained in Chapter 2 of this volume. The lithologic description of each core contains typical results of shipboard examination of smear slides of each lithology. In order to make the lithologic descriptions more complete we have also included many of the shore laboratory results. These are identified by being placed in square brackets.

APPENDIX A

Grain Size Determinations, Site 210

Core, Section, Top of Interval (cm)	Depth (cm)	Sand (%)	Silt (%)	Clay (%)	Classification
12-4,101.0	127.5	0.1	20.4	79.5	Clay
12-4,108.0	127.6	0.0	54.6	45.4	Clayey silt
12-4,117.0	127.7	0.1	71.3	28.6	Clayey silt
13-2,685.0	148.4	0.0	12.7	87.3	Clay
13-2,82.0	142.3	0.0	28.2	71.7	Silty clay
13-2,90.0	142.4	0.7	60.0	39.3	Clayey silt
32-6,24.0	503.7	0.2	19.5	80.2	Clay

APPENDIX B
Carbon-Carbonate Determinations, Site 210

Core, Section, Top of Interval (cm)	Depth in Hole (m)	Carbon Total (%)	Organic Carbon (%)	$CaCO_3$ (%)
1-2,99.0	2.5	1.9	0.4	13
1-2,112.0	2.6	1.9	1.3	5
1-2,105.0	2.5	1.2	0.9	3
1-2,117.0	2.7	1.6	0.0	14
1-3,50.0	3.5	0.4	0.3	1
1-3,55.0	3.5	0.4	0.3	1
1-3,70.0	3.7	1.2	0.7	4
1-3,117.0	4.2	1.4	0.8	5
1-3,130.0	4.3	0.9	0.7	2
1-3,137.0	4.4	1.6	1.2	4
2-6,25.0	16.8	1.8	0.7	9
2-6,46.0	17.0	1.4	0.3	9
3-3,19.0	21.2	1.9	1.3	5
3-3,24.0	21.2	4.1	0.2	32
3-4,66.0	23.2	7.1	0.7	53
10-4,88.0	86.4	9.8	0.1	81
10-4,97.0	86.5	10.1	0.1	84
10-4,107.0	86.6	0.0	0.1	0
10-4,116.0	86.7	11.1	0.1	91
11-2,32.0	104.8	7.9	0.4	63
11-2,42.0	104.9	8.7	0.3	70
11-2,49.0	105.0	8.6	0.2	70
11-2,52.0	105.0	0.6	0.2	4
11-2,55.0	105.1	1.6	0.6	8
11-2,60.0	105.1	1.3	0.3	9
11-2,67.0	105.2	1.2	0.2	8
14-2,73.0	161.2	4.8	0.2	38
14-2,82.0	161.3	0.4	0.3	1
14-2,88.0	161.4	0.4	0.3	1
14-2,95.0	161.4	1.0	0.5	4
21-1,72.0	291.7	8.8	0.1	72
24-6,131.0	355.8	3.0	0.2	24
32-6,24.0	503.7	0.2	0.1	1
34-1,76.0	533.8	10.5	0.0	87
34-4,123.0	538.7	10.8	0.0	90
35-4,118.0	547.7	10.3	0.0	85
36-1,72.0	551.7	9.2	0.1	76
36-4,36.0	555.9	6.5	0.1	53
37-3,100.0	564.0	8.1	0.1	67
38-2,73.0	571.2	7.4	0.1	60
39-2,38.0	579.9	7.9	0.1	65
40-3,38.0	590.4	6.1	0.2	50
41-2,59.0	598.1	7.0	0.1	58
42-1,52.0	605.5	5.9	0.1	48
43-4,87.0	619.4	7.2	0.1	59
44-2,95.0	625.5	5.6	0.1	46
45-2,103.0	634.5	5.3	0.2	43
46-4,61.0	653.1	5.9	0.1	48
47-3,26.0	668.3	4.7	0.1	38
48-2,51.0	680.0	5.4	0.1	44
49-2,79.0	694.3	5.2	0.1	43
50-4,127.0	707.8	3.7	0.1	30

APPENDIX C
X-ray Mineralogy Determinations, Site 210

Core	Cored Interval Below Sea Floor (m)	Sample Depth Below Sea Floor (m)	Diff.	Amor.	Calc.	Dolo.	Arag.	Quar.	Cris.	K-Fe.	Plag.	Kaol.	Mica	Chlo.	Mont.	Trid.	Clin.	Phil.	Pyri.	Amph.	U-1^a	U-4^a	Bari	Apat.	U-5^b
Bulk Sample																									
1	0-9	0.3	79.9	68.7	61.6	–	–	12.3	–	–	–	2.1	13.7	2.9	7.5	–	–	–	–	–	–	–	–	–	–
		4.7	80.8	70.0	2.3	–	–	31.4	–	–	18.6	5.4	34.4	5.3	2.6	–	–	–	–	–	–	–	–	–	–
		8.8	79.9	68.7	3.4	–	–	33.3	–	–	24.7	3.7	28.1	4.2	–	–	–	–	1.0	1.6	–	–	–	–	–
2	9-18	9.4	74.9	60.8	–	–	–	38.9	–	–	28.8	–	22.8	5.4	1.8	–	–	–	–	2.4	–	–	–	–	–
		12.8	73.3	58.3	–	–	–	43.5	–	–	36.4	–	12.7	3.4	1.1	–	–	–	–	2.9	–	–	–	–	–
		16.8	81.5	71.1	9.0	–	–	27.4	–	4.0	23.9	1.2	24.0	5.9	3.1	–	–	–	–	1.6	–	–	–	–	–
		17.0	83.9	74.9	11.6	–	–	23.5	–	–	16.2	2.4	29.2	5.8	8.2	–	–	–	–	3.1	–	–	–	–	–
3	18-27	21.1	79.7	68.3	3.9	–	–	42.2	–	–	23.4	2.1	18.5	4.8	2.7	–	–	–	1.1	1.3	–	–	–	–	–
		23.2	70.1	53.3	32.6	–	30.1	18.5	–	1.8	6.2	0.6	7.7	1.2	1.2	–	–	–	–	–	–	–	–	–	–
6	45-54	49.4	77.7	65.2	58.8	–	11.6	11.1	–	–	2.9	3.9	9.9	1.8	–	–	–	–	–	–	–	–	–	–	–
8	63-72	69.7	81.4	71.0	3.6	–	–	29.1	–	4.3	18.7	–	31.3	8.2	3.3	–	–	–	–	1.4	–	–	–	–	–
		70.2	66.0	46.9	26.4	–	54.3	12.1	–	0.7	3.3	–	2.1	0.6	–	–	–	–	–	0.5	–	–	–	–	–
9	72-81	73.8	57.2	33.1	77.0	–	14.3	3.6	–	–	2.5	–	2.0	0.6	–	–	–	–	–	–	–	–	–	–	–
10	81-90	86.0	80.4	69.3	7.2	–	–	31.8	–	–	22.4	3.1	26.7	6.3	2.5	–	–	–	–	–	–	–	–	–	–
		86.6	59.4	36.6	37.8	–	61.8	0.4	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
11	103-112	104.7	66.8	48.2	26.0	–	40.9	23.2	–	–	6.9	–	2.9	–	–	–	–	–	–	–	–	–	–	–	–
		105.1	75.3	61.4	6.8	–	1.9	32.2	–	–	33.1	2.1	17.2	4.0	0.2	–	–	–	–	2.4	–	–	–	–	–
12	122-131	126.1	85.5	77.3	9.7	–	–	24.9	–	5.1	13.2	4.4	31.6	6.3	5.0	–	–	–	–	–	–	–	–	–	–
20	272-281	273.3	80.0	68.8	9.2	–	–	30.0	–	6.6	19.4	12.1	9.3	–	13.4	–	–	–	–	–	–	–	–	–	–
21	291-300	291.7	60.4	38.1	92.7	–	–	3.2	–	–	1.3	–	2.8	–	–	–	–	–	–	–	–	–	–	–	–
		293.0	70.1	53.3	53.3	–	2.2	18.6	–	3.7	9.0	2.7	7.7	1.6	1.3	–	–	–	–	–	–	–	–	–	–
22	309-318	311.4	78.6	66.6	31.4	–	19.9	12.7	–	4.1	7.8	3.4	13.0	2.0	3.8	–	–	–	1.8	–	–	–	–	–	–
		315.1	82.7	73.0	5.2	–	–	26.8	–	6.1	15.8	1.4	29.8	8.2	6.7	–	–	–	–	–	–	–	–	–	–
		315.3	81.0	70.2	5.6	–	–	23.1	–	3.5	13.6	4.1	33.4	8.8	7.8	–	–	–	–	–	–	–	–	–	–
		315.5	69.5	52.3	72.8	–	–	7.2	–	1.3	2.5	5.0	8.3	0.9	2.0	–	–	–	–	–	–	–	–	–	–
23	328-337	329.3	72.6	57.2	45.1	–	–	23.1	–	5.0	11.7	2.2	9.9	1.3	1.6	–	–	–	–	–	–	–	–	–	–
		334.0	74.9	60.7	10.1	–	–	26.5	–	–	31.1	–	22.6	6.2	1.0	–	–	–	1.1	1.3	–	–	–	–	–
24	347-356	349.6	77.1	64.3	40.5	–	4.1	13.5	–	2.3	8.7	2.7	19.0	4.9	4.3	–	–	–	–	–	–	–	–	–	–
		355.8	73.3	58.3	24.8	–	10.1	15.3	–	3.1	19.1	–	13.0	3.0	3.4	–	–	7.3	0.8	–	–	–	–	–	–
25	365-374	365.8	73.3	58.2	51.1	–	–	6.5	–	–	12.4	–	5.8	1.9	13.6	–	–	8.0	–	0.7	–	–	–	–	–
		368.2	67.2	48.7	8.4	–	–	40.7	–	–	25.1	–	18.9	5.2	–	–	–	–	1.6	–	–	–	–	–	–
		370.6	70.3	53.6	9.0	–	–	22.5	–	5.2	27.1	–	27.5	6.3	1.6	–	–	–	0.8	–	–	–	–	–	–
27	403-412	407.1	72.2	56.5	3.0	–	–	33.5	–	–	31.5	–	14.7	5.0	3.2	–	–	–	7.8	1.2	–	–	–	–	–
		411.9	76.2	62.8	13.8	–	–	31.2	–	–	24.2	–	16.9	5.5	5.2	–	–	–	1.8	1.3	–	–	–	–	–
28	421-430	429.5	70.6	54.0	4.7	–	–	27.1	–	–	22.3	–	35.2	8.1	1.2	–	–	–	–	1.4	–	–	–	–	–
29	440-449	443.9	76.2	62.6	–	–	–	18.7	–	–	20.5	–	33.2	9.6	16.1	–	–	–	0.6	1.4	Trace	–	–	–	–
30	459-468	462.8	68.6	50.9	–	–	–	35.7	–	–	28.9	–	26.2	8.1	–	–	–	–	–	1.1	–	–	–	–	–
31	477-486	480.1	80.8	70.1	–	–	–	17.7	–	3.8	21.0	–	38.8	6.9	10.0	–	–	–	–	1.6	–	–	–	–	–
32	496-505	503.7	85.7	77.7	–	–	–	18.6	–	14.6	11.9	3.4	16.0	3.7	31.9	–	–	–	–	–	–	–	–	–	–
34	533-542	533.7	–	–	98.0	–	–	–	–	–	–	–	–	–	–	–	2.0	–	–	–	–	–	–	–	–
35	542-551	547.7	48.9	20.2	97.4	–	–	0.5	–	–	–	–	–	–	2.2	–	–	–	–	–	–	–	–	–	–
36	551-560	551.7	56.2	31.6	92.6	–	–	2.1	–	–	–	–	1.6	–	2.2	–	1.4	–	–	–	–	Trace	–	–	–
		555.8	65.8	46.6	78.9	–	–	4.0	2.3	–	1.5	–	4.6	–	3.3	1.8	3.6	–	–	–	–	Trace	–	–	–
37	560-569	564.0	61.5	39.8	78.2	–	–	4.0	–	–	1.5	–	5.2	–	8.7	–	2.4	–	–	–	–	Trace	–	–	–
38	569-578	571.3	63.9	43.5	82.4	–	–	3.7	3.7	–	1.0	–	3.5	–	4.5	1.2	–	–	–	–	–	Trace	–	–	–
39	578-587	579.8	–	–	81.7	–	–	2.4	9.0	–	–	–	2.2	–	1.5	3.2	–	–	–	–	–	Trace	–	–	–
40	587-596	590.4	–	–	63.0	–	–	3.7	18.2	–	1.1	–	4.1	–	7.4	2.5	–	–	–	–	–	Trace	–	–	–
41	596-605	597.5	–	–	73.9	–	–	4.6	12.6	–	1.8	–	2.4	–	2.0	2.8	–	–	–	–	–	Trace	–	–	–
42	605-614	605.6	–	–	68.5	–	–	6.6	15.9	–	0.9	–	3.1	–	2.9	2.1	–	–	–	–	Trace	Trace	–	–	–
43	614-623	619.4	57.6	33.8	65.7	4.7	–	23.0	–	–	–	–	3.0	–	3.6	–	–	–	–	–	–	Trace	–	–	–
44	623-632	625.5	–	–	65.7	–	–	26.6	–	–	0.7	–	4.4	–	2.7	–	–	–	–	–	–	–	–	–	–
45	632-641	634.5	55.9	31.2	55.4	–	–	33.2	–	–	–	–	5.7	–	–	5.7	–	–	–	–	–	Trace	–	–	–
46	648-657	653.1	57.2	33.1	67.7	–	–	22.7	–	–	–	–	4.6	0.7	4.3	–	–	–	–	–	–	–	–	–	–
47	665-674	668.3	61.6	40.0	54.4	–	–	34.2	–	–	0.8	–	5.4	1.5	3.6	–	–	–	–	–	–	Trace	–	–	–
48	678-687	680.0	59.0	35.9	61.3	–	–	28.4	–	–	1.1	–	5.3	1.5	2.5	–	–	–	–	–	–	Trace	–	–	–
49	692-701	694.3	59.0	35.9	62.6	–	–	29.2	–	–	1.2	–	4.3	1.7	1.1	–	–	–	–	–	–	Trace	–	–	–
50	702-711	707.8	62.9	42.0	40.6	–	–	41.9	–	–	1.3	–	12.0	4.3	–	–	–	–	–	–	–	–	–	–	–

APPENDIX C – *Continued*

Core	Cored Interval Below Sea Floor (m)	Sample Depth Below Sea Floor (m)	Diff.	Amor.	Calc.	Dolo.	Arag.	Quar.	Cris.	K-Fe.	Plag.	Kaol.	Mica	Chlo.	Mont.	Trid.	Clin.	Phil.	Pyri.	Amph.	U-1[a]	U-4[a]	Bari	Apat.	U-5[b]
2-20μ Fraction																									
1	0-9	0.03	78.0	65.7	–	–	–	37.0	–	–	27.9	2.0	23.9	7.5	–	–	–	–	–	1.7	–	–	–	–	–
		4.7	70.0	53.1	–	–	–	37.5	–	–	23.6	–	30.1	7.6	–	–	–	–	–	1.2	–	–	–	–	–
		8.8	72.8	57.5	–	–	–	1.2	–	–	98.7	–	–	–	–	–	–	–	–	0.1	–	–	–	–	–
2	9-18	9.4	71.3	55.2	–	–	–	38.8	–	–	28.0	–	24.9	5.4	–	–	–	–	0.9	2.1	–	–	–	–	–
		12.8	70.7	54.1	–	–	–	37.4	–	5.1	31.4	–	17.6	5.3	–	–	–	–	–	3.2	–	–	–	–	–
		16.8	72.8	57.5	–	–	–	32.0	–	5.2	27.4	–	24.6	7.7	–	–	–	–	0.5	2.5	–	–	–	–	–
		17.0	77.9	65.5	–	–	–	34.0	–	3.2	23.9	–	29.5	7.6	–	–	–	–	–	1.7	–	–	–	–	–
3	18-27	21.1	71.9	56.0	–	–	–	44.6	–	–	24.9	–	21.8	6.2	–	–	–	–	1.1	1.3	–	–	–	–	–
		23.2	71.7	55.7	–	–	–	58.9	–	4.8	19.5	–	11.8	1.9	–	–	–	–	2.1	1.1	–	–	–	–	–
6	45-54	49.4	65.2	45.6	–	–	–	53.8	–	5.5	17.0	3.5	17.5	1.7	–	–	–	–	1.0	–	–	–	–	–	–
8	63-72	69.7	66.0	46.9	–	–	–	28.4	–	4.5	20.3	–	35.8	9.7	–	–	–	–	–	1.3	–	–	–	–	–
		70.2	68.2	50.3	–	–	–	49.5	–	6.7	20.3	–	16.5	3.5	–	–	–	–	3.5	–	–	–	–	–	–
9	72-81	73.8	75.9	62.4	–	–	–	35.5	–	3.3	29.7	–	22.2	8.0	–	–	–	–	–	1.3	–	–	–	–	–
10	81-90	86.0	68.5	50.8	–	–	–	32.0	–	2.7	25.4	–	29.2	8.1	–	–	–	–	1.1	1.6	–	–	–	–	–
11	103-112	104.7	61.4	39.7	–	–	–	56.2	–	8.7	23.6	–	6.9	0.7	–	–	–	–	2.0	2.0	–	–	–	–	–
		105.1	68.9	51.4	–	–	–	29.7	–	5.2	30.2	–	23.3	6.8	–	–	–	–	1.3	3.4	–	–	–	–	–
12	122-131	126.1	70.2	53.4	–	–	–	33.6	–	5.4	21.9	3.4	29.4	6.2	–	–	–	–	–	–	–	–	–	–	–
20	272-281	273.3	67.3	48.9	–	–	–	28.5	–	6.6	19.6	–	35.4	9.5	–	–	–	–	0.5	–	–	–	–	–	–
21	291-300	291.7	73.0	57.8	–	–	–	37.8	–	11.4	24.9	–	20.1	5.7	–	–	–	–	–	–	–	–	–	–	–
		293.0	67.6	49.4	–	–	–	25.6	–	8.1	22.0	–	31.4	8.2	4.8	–	–	–	–		–	–	–	–	–
22	309-318	311.4	68.1	50.2	–	–	–	30.8	–	4.2	27.0	–	23.2	7.5	–	–	–	–	6.1	1.2	–	–	–	–	–
		315.1	59.6	36.8	–	–	–	52.5	–	9.3	22.3	–	10.8	1.4	–	–	–	–	2.6	0.9	–	–	–	–	–
		315.3	66.9	48.3	–	–	–	26.0	–	6.0	18.3	–	38.4	11.2	–	–	–	–	–	–	–	–	–	–	–
		315.5	66.7	48.0	–	–	–	45.1	–	7.1	17.1	2.4	24.4	3.9	–	–	–	–	–	–	–	–	–	–	–
23	328-337	329.3	57.7	34.0	–	–	–	46.7	–	9.4	24.8	2.6	13.3	0.6	–	–	–	–	0.8	1.7	–	–	–	–	–
		334.0	68.4	50.6	–	–	–	26.6	–	–	34.1	–	24.9	11.1	–	–	–	–	1.9	1.4	Trace	–	–	–	–
24	347-356	349.6	68.2	50.3	–	–	–	27.1	–	5.7	24.5	–	27.8	9.0	6.0	–	–	–	–	–	–	–	–	–	–
		355.8	67.3	48.9	–	–	–	16.3	–	4.4	18.9	–	11.8	38.6	–	–	0.6	8.3	–	1.1	–	–	–	–	–
25	365-374	368.2	62.9	42.0	–	–	–	31.7	–	–	21.7	–	33.6	11.6	–	–	–	–	1.4	–	–	–	–	–	–
		370.6	63.5	43.0	–	–	–	26.2	–	8.4	29.2	–	25.9	7.0	–	–	–	–	0.9	2.5	–	–	–	–	–
27	403-412	407.1	69.3	52.0	–	–	–	29.2	–	–	21.5	–	18.3	6.6	8.0	–	–	–	14.5	2.0	–	–	–	–	–
		411.9	71.3	55.2	–	–	–	33.2	–	–	25.5	2.4	17.2	5.2	11.9	–	–	–	3.4	1.2	–	–	–	–	–
28	421-430	429.5	59.4	36.6	–	–	–	22.6	–	–	21.1	–	39.1	13.4	–	–	–	–	0.8	3.1	–	–	–	–	–
29	440-449	443.9	62.2	41.0	–	–	–	19.9	–	–	20.9	–	42.4	13.8	–	–	–	–	0.6	2.4	Trace	–	–	–	–
30	459-468	462.8	58.0	34.3	–	–	–	25.3	–	–	23.3	–	36.2	13.8	–	–	–	–	–	1.5	–	–	–	–	–
31	477-486	480.1	66.9	48.2	–	–	–	24.0	–	5.6	27.5	–	31.5	10.0	–	–	–	–	–	1.4	–	–	–	–	–
32	496-505	503.7	75.6	61.9	–	–	–	30.4	–	26.0	20.9	3.0	17.2	2.4	–	–	–	–	–	–	–	–	–	–	–
36	551-560	551.7	66.9	48.3	–	–	–	34.4	–	–	14.3	–	20.4		–	–	30.9	–	–	–	–	–	–	–	–
		555.8	67.3	49.0	–	–	–	28.2	3.0	–	12.4	–	28.7	–	–	2.2	25.6	–	–	–	–	–	–	–	–
37	560-569	564.0	66.7	47.9	–	–	–	36.9	–	–	16.4	–	21.7	–	–	–	25.1	–	–	–	–	–	–	–	–
39	578-587	579.8	83.4	74.1	–	–	–	17.8	50.5	–	8.5	–	12.5	0.8	–	9.1	0.8	–	–	–	–	–	–	–	–
40	587-596	590.4	79.1	67.4	–	–	–	16.0	47.4	–	6.5	–	15.0	1.0	10.3	3.8	–	–	–	–	–	–	–	–	–
41	596-605	597.5	77.4	64.8	–	–	–	26.9	39.5	4.2	8.5	–	16.2	0.8	–	3.9	–	–	–	–	–	–	–	–	–
42	605-614	605.6	76.1	62.6	–	–	–	32.2	27.9	4.3	8.3	–	23.1	–	–	4.3	–	–	–	–	Trace	–	–	–	–
43	614-623	619.4	62.4	41.2	–	–	–	65.3	–	6.7	6.4	–	18.6	1.5	–	–	–	–	–	–	–	–	1.5	–	–
44	623-632	625.5	60.4	38.1	–	–	–	63.1	–	6.8	5.0	–	21.5	–	–	–	–	–	1.2	–	–	–	2.3	–	–
45	632-641	634.5	57.7	34.0	–	–	–	71.1	–	5.1	4.9	–	16.8	1.1	–	–	–	–	1.0	–	–	–	–	–	–
46	648-657	653.1	63.1	42.3	–	–	–	66.0	–	6.4	5.8	–	18.3	1.0	–	–	–	–	–	–	–	–	2.6	–	–
47	665-674	668.3	57.0	32.8	–	–	–	68.2	–	–	11.7	–	15.7	2.9	–	–	–	–	–	–	–	–	1.5	–	–
49	692-701	694.3	58.2	34.7	–	–	–	84.7	–	–	10.5	–	–	3.0	–	–	–	–	–	–	–	–	1.9	–	–
50	702-711	707.8	51.5	24.2	–	–	–	68.4	–	–	10.4	–	17.2	4.1	–	–	–	–	–	–	–	–	–	–	–
<2μ Fraction																									
1	0-9	0.03	82.4	72.6	–	–	–	14.5	–	–	7.5	5.7	21.2	6.6	44.5	–	–	–	–	–	–	–	–	–	–
		4.7	81.1	70.5	–	–	–	13.6	–	–	4.4	3.9	39.2	10.3	28.6	–	–	–	–	–	–	–	–	–	–
		8.8	80.6	69.7	–	–	–	13.3	–	2.0	–	3.5	35.3	8.3	37.5	–	–	–	–	–	–	–	–	–	–
2	9-18	9.4	79.1	67.3	–	–	–	12.6	–	2.5	–	4.4	38.5	8.2	33.2	–	–	–	0.6	–	–	–	–	–	–
		12.8	81.0	70.4	–	–	–	11.7	–	1.7	5.0	11.1	33.7	7.1	29.7	–	–	–	–	–	–	–	–	–	–
		16.8	80.3	69.2	–	–	–	16.0	–	1.8	8.1	3.9	27.9	8.2	34.1	–	–	–	–	–	–	–	–	–	–
		17.0	83.6	74.3	–	–	–	17.4	–	1.6	8.3	7.4	28.5	6.7	30.1	–	–	–	–	–	–	–	–	–	–

3	18-27	21.1	83.1	73.6	–	–	–	17.4	–	–	5.3	5.7	34.3	8.3	28.9	–	–	–	–	–	–	–	–	–	–
		23.2	81.5	71.0	–	–	–	12.4	–	1.8	2.6	14.4	23.0	3.9	40.5	–	–	–	1.3	–	–	–	–	–	–
6	45-54	49.4	80.8	70.0	–	–	–	15.0	–	1.4	2.5	28.4	27.1	2.2	23.5	–	–	–	–	–	–	–	–	–	–
8	63-72	69.7	83.8	74.7	–	–	–	19.0	–	2.1	9.9	4.2	28.2	7.4	29.3	–	–	–	–	–	–	–	–	–	–
		70.2	81.1	70.5	–	–	–	10.4	–	1.5	4.4	12.1	31.8	2.8	33.9	–	–	–	3.1	–	–	–	–	–	–
9	72-81	73.8	83.1	73.6	–	–	–	16.5	–	3.4	12.0	9.8	49.8	8.5	–	–	–	–	–	–	–	–	–	–	–
10	81-90	86.0	79.5	68.0	–	–	–	12.9	–	–	5.6	8.5	32.1	6.4	33.4	–	–	–	1.1	–	–	–	–	–	–
11	103-112	104.7	79.6	68.2	–	–	–	9.9	–	2.2	2.8	14.9	25.0	2.5	40.7	–	–	–	2.0	–	–	–	–	–	–
		105.1	76.7	63.5	–	–	–	10.6	–	2.7	6.7	6.8	28.2	6.9	38.1	–	–	–	–	–	–	–	–	–	–
12	122-131	126.1	82.7	73.0	–	–	–	19.3	–	4.3	7.4	8.2	20.7	2.6	37.6	–	–	–	–	–	–	–	–	–	–
20	272-281	273.3	80.1	68.9	–	–	–	19.6	–	3.8	8.9	3.8	23.3	6.0	33.5	–	–	–	1.2	–	–	–	–	–	–
21	291-300	291.7	82.4	72.4	–	–	–	17.8	–	3.6	7.8	8.3	14.2	4.1	44.1	–	–	–	–	–	–	–	–	–	–
		293.0	78.6	66.6	–	–	–	15.9	–	5.7	5.4	8.2	23.4	4.3	37.0	–	–	–	–	–	–	–	–	–	–
22	309-318	311.4	81.9	71.7	–	–	–	20.5	–	1.7	7.4	6.7	16.6	6.6	38.8	–	–	–	1.7	–	–	–	–	–	–
		315.1	83.7	74.5	–	–	–	14.6	–	3.1	3.4	23.1	11.9	1.6	40.9	–	–	–	1.5	–	–	–	–	–	–
		315.3	79.4	67.8	–	–	–	19.0	–	1.8	9.8	2.4	20.7	5.9	40.4	–	–	–	–	–	–	–	–	–	–
		315.5	80.8	69.9	–	–	–	10.9	–	2.3	2.7	24.3	12.9	1.1	40.9	–	–	–	–	–	–	–	–	4.9	–
23	328-337	329.3	79.9	68.5	–	–	–	12.0	–	2.6	3.0	24.9	10.9	2.6	44.0	–	–	–	–	–	–	–	–	–	–
		334.0	71.1	54.9	–	–	–	9.2	–	6.8	5.1	6.1	23.8	3.9	45.0	–	–	–	–	–	–	–	–	–	–
24	347-356	349.6	81.2	70.7	–	–	–	17.7	–	3.2	9.8	2.7	22.9	6.2	37.4	–	–	–	–	–	–	–	–	–	–
		355.8	81.0	70.3	–	–	–	6.8	–	2.9	5.4	–	7.0	3.4	64.6	–	–	9.9	–	–	–	–	–	–	–
25	365-374	365.8	76.0	62.4	–	–	–	1.7	–	5.5	5.9	–	5.7	2.3	71.2	–	–	7.8	–	–	–	–	–	–	–
		368.2	71.7	55.8	–	–	–	9.7	–	2.5	3.6	1.9	42.7	9.6	29.2	–	–	–	0.9	–	–	–	–	–	–
		370.6	84.7	76.1	–	–	–	7.6	–	2.3	4.6	–	23.5	6.8	53.4	–	0.9	–	0.9	–	–	–	–	–	–
27	403-412	407.1	74.0	59.4	–	–	–	13.6	–	–	5.3	–	18.7	6.3	54.2	–	–	–	1.8	–	–	–	–	–	–
		411.9	84.2	75.3	–	–	–	11.3	–	–	3.6	8.4	11.0	1.8	62.3	–	–	–	1.6	–	–	–	–	–	–
28	421-430	429.5	73.9	59.2	–	–	–	11.6	–	4.8	7.6	–	40.8	11.5	22.7	–	–	–	1.0	–	–	–	–	–	–
29	440-449	443.9	84.1	75.2	–	–	–	12.3	–	–	11.3	–	26.2	–	50.2	–	–	–	–	–	Trace	–	–	–	–
30	459-468	462.8	76.2	62.8	–	–	–	14.0	–	–	12.6	–	30.9	10.8	31.8	–	–	–	–	–	–	–	–	–	–
31	477-486	480.1	81.5	71.1	–	–	–	15.3	–	3.3	16.3	–	28.3	9.7	27.1	–	–	–	–	–	–	–	–	–	–
32	496-505	503.7	84.6	75.9	–	–	–	9.5	–	7.3	6.5	9.1	14.7	3.0	49.9	–	–	–	–	–	–	–	–	–	–
34	533-542	533.7	82.3	72.4	–	–	–	6.0	–	–	2.9	–	4.2	1.2	74.2	–	11.5	–	–	–	–	–	–	–	–
35	542-551	547.7	72.9	57.6	–	–	–	3.2	–	–	2.8	–	2.7	–	90.3	–	0.9	–	–	–	–	–	–	–	–
36	551-560	551.7	79.7	68.2	–	–	–	9.1	–	–	1.1	–	11.5	–	75.4	–	2.9	–	–	–	–	–	–	–	–
		555.8	84.5	75.7	–	–	–	7.7	28.6	–	1.8	–	10.6	–	41.7	6.5	3.2	–	–	–	–	–	–	–	–
37	560-569	564.0	76.5	63.3	–	–	–	9.6	–	–	0.7	–	17.0	0.8	68.8	–	3.1	–	–	–	–	–	–	–	–
38	569-578	571.3	81.2	70.6	–	–	–	6.8	34.7	–	2.0	–	8.9	0.8	43.0	2.3	1.6	–	–	–	–	–	–	–	–
39	578-587	579.8	85.4	77.2	–	–	–	3.3	66.0	–	1.4	–	2.4	–	16.6	10.2	–	–	–	–	–	–	–	–	–
40	587-596	590.4	81.6	71.3	–	–	–	4.1	56.3	–	1.4	–	1.7	–	26.6	9.8	–	–	–	–	–	–	–	–	–
41	596-605	597.5	82.7	73.0	–	–	–	8.9	62.2	–	1.5	–	2.3	–	16.9	8.2	–	–	–	–	–	–	–	–	–
42	605-614	605.6	81.2	70.6	–	–	–	12.8	55.8	–	0.9	–	3.6	–	20.1	6.7	–	–	–	–	Trace	–	–	–	–
43	614-623	619.4	63.9	43.7	–	–	–	77.7	–	–	–	–	3.1	–	19.2	–	–	–	–	–	–	–	–	–	–
44	623-632	625.5	61.4	39.8	–	–	–	75.6	–	–	–	–	5.1	–	19.3	–	–	–	–	–	–	–	–	–	–
45	632-641	634.5	57.3	33.2	–	–	–	76.9	–	–	–	–	6.7	–	16.5	–	–	–	–	–	–	–	–	–	–
46	648-657	653.1	60.1	37.6	–	–	–	63.7	–	–	–	–	8.7	2.2	25.4	–	–	–	–	–	–	–	–	–	Pres.
47	665-674	668.3	66.4	47.6	–	–	–	74.8	–	–	–	–	7.9	3.2	14.0	–	–	–	–	–	–	–	–	–	–
48	678-687	680.0	64.3	44.2	–	–	–	72.0	–	–	–	–	10.3	3.6	14.1	–	–	–	–	–	–	–	–	–	–
49	692-701	694.3	71.9	56.1	–	–	–	63.6	–	–	0.8	–	15.5	7.0	13.1	–	–	–	–	–	–	–	–	–	–
50	702-711	707.8	63.8	43.5	–	–	–	77.4	–	–	1.2	–	12.2	9.2	–	–	–	–	–	–	–	–	–	–	–

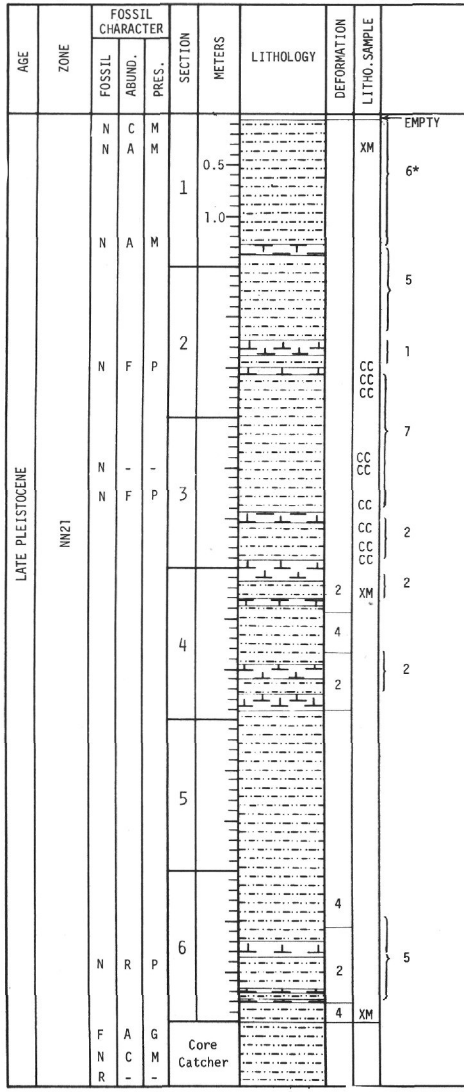
[a] Peak at 12.1 Å.
Peak at 3.14 Å.

[b] Peak at 7.12 Å.

APPENDIX D
Thermal Conductivity Measurements, Site 210

Core, Section, Interval Below Top (cm)	Thermal Conductivity (mcal/°C cm sec)	Standard Deviation	Ambient Core Tempera-ture (°C)	Remarks
1-3,70	0.002412	0.009030	21.50	
1-5,70	0.002276	0.008443	23.55	Repeat
2-3,75	0.002852	0.012824	20.64	
3-3,70	0.002347	0.007474	20.40	
3-5,70	0.002331	0.009682	21.33	
6-3,70	0.002379	0.012060	24.07	
8-3,70	0.002695	0.009504	23.06	
8-5,70	0.002558	0.005861	24.08	
9-3,70	0.002814	0.009778	23.16	
9-4,70	0.002818	0.007347	24.30	
10-2,75	0.002500	0.004362	21.67	
10-4,75	0.002716	0.008852	22.76	
11-2,80	0.003077	0.006794	21.24	
12-2,75	0.003010	0.009394	21.62	
12-3,75	0.002710	0.011006	22.60	
12-4,75	0.002717	0.007382	22.24	
13-2,75	0.002841	0.006038	21.01	
13-2,75	0.002851	0.009001	23.06	
14-3,75	0.002900	0.010254	22.75	
20-4,78	0.002420	0.006976	24.02	
21-3,82	0.002588	0.007547	24.71	
22-3,73	0.002733	0.005181	23.39	
22-5,66	0.003095	0.009423	23.87	
23-2,64	0.003332	0.005962	21.93	
23-4,64	0.002945	0.006008	21.57	
24-3,66	0.002823	0.007399	22.37	Drilled hole in firm clay
24-5,65	0.002955	0.006521	23.10	Drilled hole in firm clay
25-3,70	0.002884	0.004803	22.87	Drilled hole in firm clay
27-3,70	0.002940	0.007624	23.71	Drilled hole in firm clay
28-3,70	0.003472	0.007499	22.55	Drilled hole in chalk
28-5,74	0.003483	0.004373	22.67	Drilled hole in firm clay
29-4,60	0.003589	0.005649	23.24	
30-2,67	0.003348	0.010471	22.40	
30-3,0	0.003002	0.013605	19.89	
31-1,0	0.002927	0.004705	21.79	
32-3,89	0.002880	0.014372	23.06	
33-3,100	0.002657	0.003393	21.78	

Site 210 Hole Core 1 Cored Interval: 0-9 m



LITHOLOGIC DESCRIPTION

Graded cycles of silt and clay with interbeds of biogenic ooze.

Nearly 3 of the lower 4 m of Core 1 are so disturbed that individual graded cycles cannot be noted in detail. The less disturbed 6 m contain approximately 30 graded cycles with an average thickness of about 15 cm and a range in thickness from about 3 to 30 cm. Twenty-four of the cycles have silt bases, many in erosional contacts with the underlying beds. Most of the cycles are shades of olive gray and greenish gray. Usually the cycles are darker at the base and lighter at the top. The upper 47 cm of the core is yellowish brown.

Eleven interbeds of bluish white and greenish gray nanno and foram ooze were noted. They average about 11 cm in thickness and range from 2 to 20 cm.

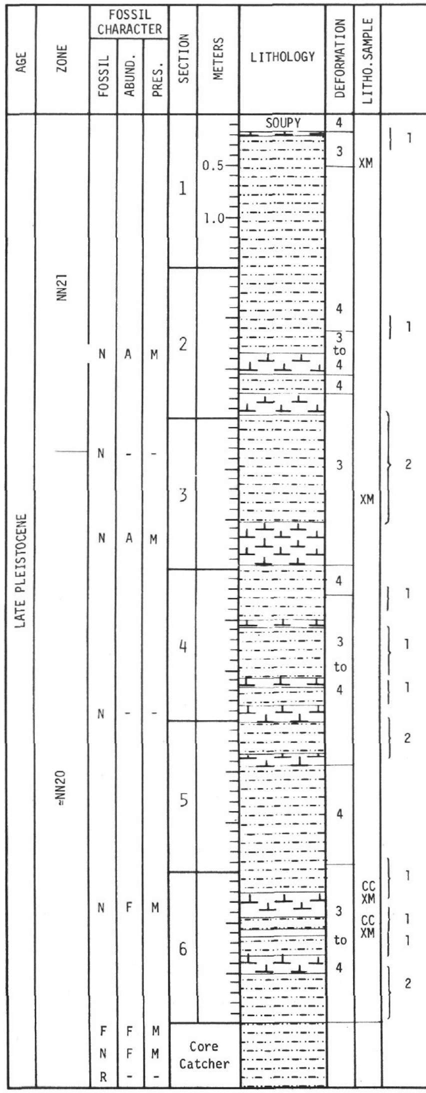
Generalized Mineralogy for Cores 1-30

<u>Graded cycles of silt and clay</u>:
Mainly subangular quartz and plagioclase, mica, and calcite plus aragonite. Calcareous material is mainly forams in the basal portions of the cycles and nannos in the upper portions. Minor constituents present in varying amounts include chlorite, altered glass?, plant debris, clay minerals, tunicate sclerites, amphibole, zeolites, potash feldspar, and pyrite.

<u>Interbeds</u>:
Mainly nannos with varying amounts of forams, clay minerals, and clay-size particles.

*The numbers along the left margin of the Lithologic Description column refer to the number of graded cycles of silt and clay in the indicated intervals and the number of interbeds of biogenic ooze (in parenthesis). These same symbols are used through Core 30.

Site 210 Hole Core 2 Cored Interval: 9-18 m



LITHOLOGIC DESCRIPTION

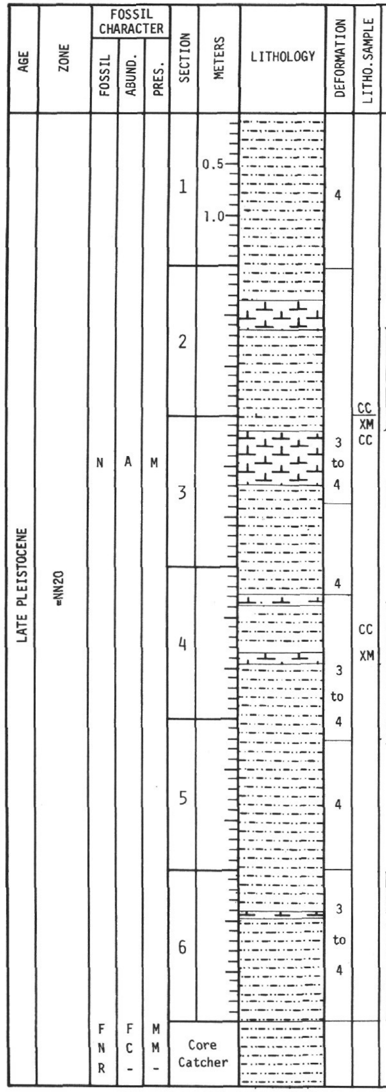
Graded cycles of silt and clay with interbeds of nanno ooze.

Nearly 2.5 m of Core 2 are so disturbed that individual graded cycles cannot be noted in detail. The less disturbed 6.5 m contain approximately 14 graded cycles with an average thickness of about 25 cm and a range in thickness from about 12 to 50 cm. Eight of the cycles have silt bases, many in erosional contacts with the underlying beds. The cycles are mainly shades of olive gray and greenish gray. Usually the cycles are darker at the base (olive black) and lightening toward the top.

Eleven interbeds of biogenic ooze (mostly nannos) were noted. They average about 19 cm in thickness and range from 3-42 cm. Most are light-greenish gray.

Mineralogy similar to Core 1.

Site 210 Hole Core 3 Cored Interval: 18-27 m



LITHOLOGIC DESCRIPTION

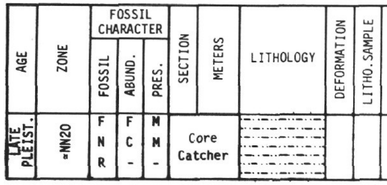
Graded cycles of silt and clay with interbeds of nanno ooze.

About 4 m of Core 3 areso disturbed that individual graded cycles cannot be noted in detail. The less disturbed 5 m contain approximately 14 graded cycles with an average thickness of about 28 cm and a range in thickness from about 7 to 58 cm. Ten of the cycles have silt to sandy silt bases, many in erosional contacts with the underlying beds. The cycles are mainly shades of olive gray and greenish gray. Usually the cycles are darker at the base (olive black) and lightening toward the top.

Five interbeds of nanno ooze were noted. They average about 28 cm in thickness and range from 7 to 50 cm. Most are light greenish gray.

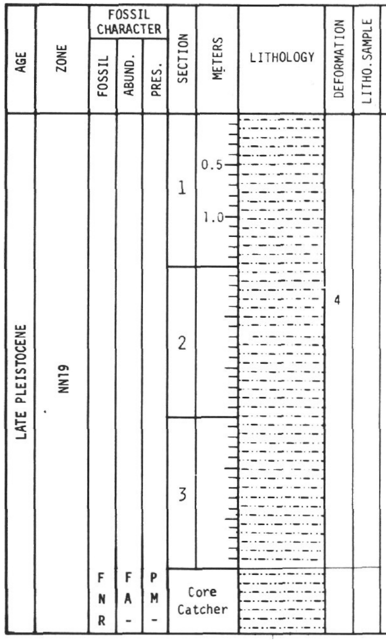
Mineralogy similar to Core 1.

Site 210 Hole Core 4 Cored Interval: 27-36 m



LITHOLOGIC DESCRIPTION

Site 210 Hole Core 5 Cored Interval: 36-45 m



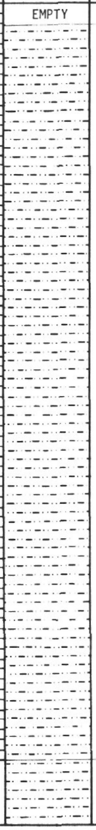
LITHOLOGIC DESCRIPTION

Graded cycles of silt and clay with interbeds of nanno ooze.

Core is too disturbed for any bedding details to be noted. Colors range from light greenish gray to dark greenish gray.

Mineralogy similar to Core 1.

Site 210 Hole Core 6 Cored Interval: 45-54 m

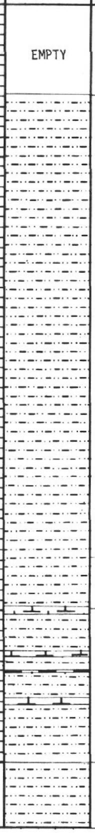


AGE	ZONE	FOSSIL CHARACTER			SECTION	METERS	LITHOLOGY	DEFORMATION	LITHO. SAMPLE	LITHOLOGIC DESCRIPTION
		FOSSIL	ABUND.	PRES.						
LATE PLEISTOCENE	NN19				1	0.5 1.0	EMPTY			Graded cycles of silt and clay with interbeds of nanno ooze. Core is too disturbed for any bedding details to be noted. Colors range from light greenish gray to dark greenish gray to olive black. Mineralogy similar to Core 1.
					2					
					3			4		
		N	A	M	4				XM	
					5					
		F N R	C C -	G M -	Core Catcher					

Site 210 Hole Core 7 Cored Interval: 54-63 m

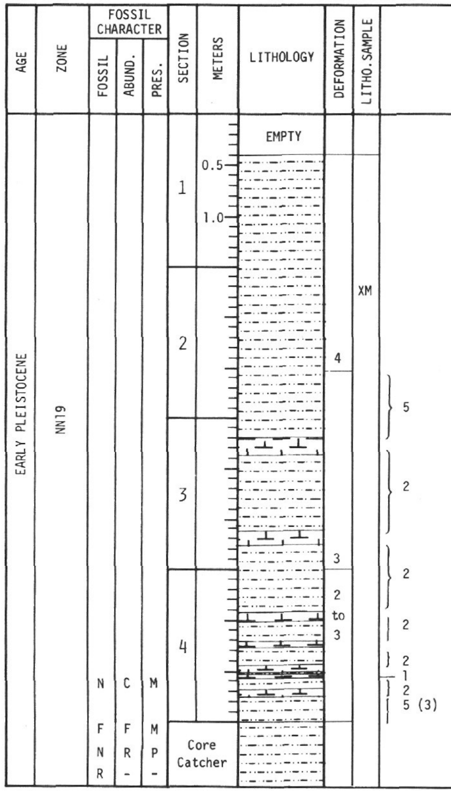
AGE	ZONE	FOSSIL CHARACTER			SECTION	METERS	LITHOLOGY	DEFORMATION	LITHO. SAMPLE	LITHOLOGIC DESCRIPTION
		FOSSIL	ABUND.	PRES.						
LATE PLEISTOCENE	NN19					0.5		4		Graded cycles of silt and clay with interbeds of nanno ooze. Core is too disturbed for any bedding details to be noted. Colors range from very light gray to dark greenish gray. Mineralogy similar to Core 1.
		F N R	A C -	G M -	Core Catcher					

Site 210 Hole Core 8 Cored Interval: 63-72 m



AGE	ZONE	FOSSIL CHARACTER			SECTION	METERS	LITHOLOGY	DEFORMATION	LITHO. SAMPLE	LITHOLOGIC DESCRIPTION
		FOSSIL	ABUND.	PRES.						
EARLY PLEISTOCENE	NN19				1	0.5 1.0	EMPTY			Graded cycles of silt and clay with interbeds of nanno ooze. The upper 4.6 m of Core 8 are so disturbed that individual graded cycles cannot be noted in detail. The less disturbed lower 2 m contain approximately 15 graded cycles with an average thickness of about 12 cm and a range in thickness from about 3 to 20 cm. Nine of the cycles have silt to silty sand bases, many in erosional contacts with the underlying beds. The cycles are mainly olive black to olive gray to dark greenish gray, becoming lighter toward the top. One pyrite-replaced worm burrow cast occurs about 85 cm above the base of the core. Four interbeds of nanno ooze were noted. They average about 4 cm in thickness and range from 2 to 6 cm. They are mostly light greenish gray to yellowish gray. Mineralogy similar to Core 1.
					2					
					3					
					4			4 3		2
		N	C	M	5			2 to 3	XM XM	3 2 3 5
		F N R	A A -	G G -	Core Catcher					

Site 210 Hole Core 9 Cored Interval: 72-81 m



LITHOLOGIC DESCRIPTION

Graded cycles of silt and clay with interbeds of nanno ooze.

The upper 2.1 m of Core 9 are so disturbed that individual graded cycles cannot be noted in detail. The less disturbed lower 3.5 m contain approximately 21 graded cycles with an average thickness of about 13 cm and a range in thickness from about 2 to 43 cm. The thickness of the graded cycles is much less in the lower 62 cm of the core. There 9 cycles average about 3 cm in thickness. The upper 2.9 m of the less disturbed portion contain 12 cycles averaging about 20 cm in thickness. Nearly all the cycles have silt to sandy silt bases in erosional contacts with the underlying beds. The cycles are shaded olive gray to dark greenish gray to greenish gray.

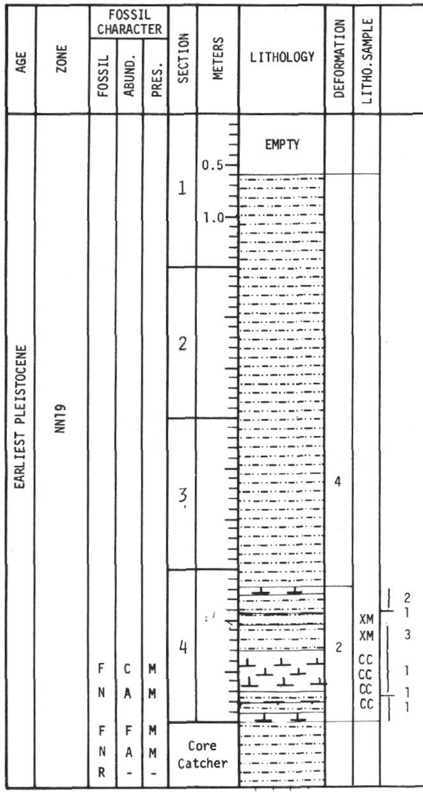
One pyrite-replaced worm burrow cast occurs about 45 cm above the base of the core.

Ten interbeds of nanno ooze were noted. They average about 8 cm in thickness and range from 3 to 17 cm. Most are very light gray and light greenish gray.

The disturbed portion of Section 2 contains a very light gray area of foram ooze which might be graded.

Mineralogy similar to Core 1.

Site 210 Hole Core 10 Cored Interval: 81-90 m



LITHOLOGIC DESCRIPTION

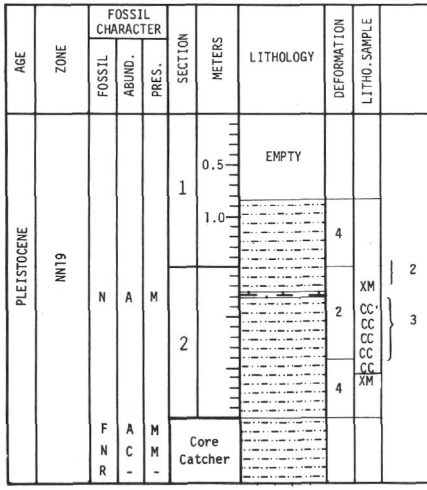
Graded cycles of silt and clay with interbeds of nanno ooze.

The upper 4 m of Core 10 are so disturbed that individual graded cycles cannot be noted in detail. The less disturbed lower 1.35 m contain approximately 9 graded cycles with an average thickness of about 12 cm and a range in thickness from about 5 to 38 cm. Seven of the cycles have silt bases, most in erosional contacts with the underlying beds. The thickest of the graded cycles is unusual in that it is composed almost entirely of nannos anf forams. The other cycles are predominantly of nonbiogenic constituents, mostly silty clay and clayey silt. Most of the cycles are olive black to dark greenish gray to light greenish gray.

Five interbeds of nanno ooze were noted. They average about 4 cm in thickness and range from 1 to 8 cm. Most are very light greenish gray.

Mineralogy similar to Core 1.

Site 210 Hole Core 11 Cored Interval: 103-112 m



LITHOLOGIC DESCRIPTION

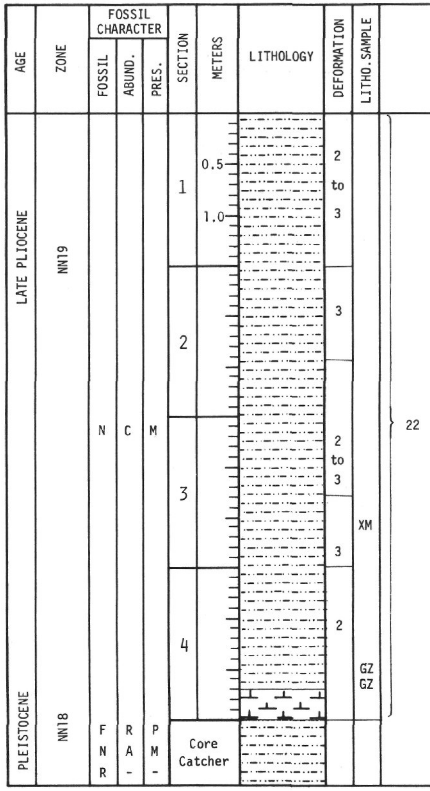
Graded cycles of silt and clay with an interbed of nanno ooze.

The upper and lower portions of Core 11 are so disturbed that individual graded cycles cannot be noted in detail. The less disturbed middle 0.9 m contain approximately 5 graded cycles with an average thickness of 17 cm and a range in thickness from 5 to 21 cm. All the cycles have silt to silty sand bases, most in erosional contacts with the underlying beds. The upper 3 cycles are much richer in biogenic constituents than most of the other cycles in the basin. They are greenish gray to yellowish gray. The two lower cycles are more typical, being mainly composed of noncalcareous detritus and ranging in color from olive gray to dark greenish gray.

One 5 cm thick interbed of yellowish gray nanno ooze was noted.

Mineralogy, except as noted above, similar to Core 1.

Site 210 Hole Core 12 Cored Interval:122-131 m



LITHOLOGIC DESCRIPTION

Graded cycles of silt and clay with an underlying bed of nanno ooze.

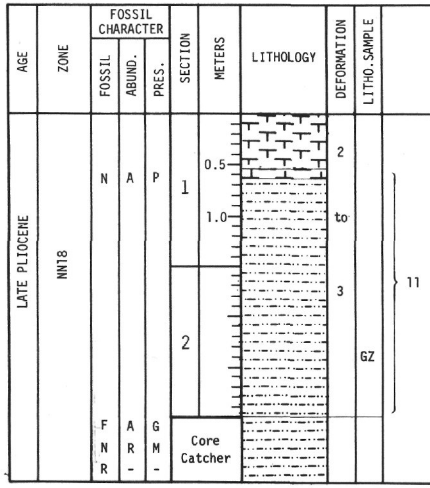
Approximately 22 graded cycles occur in Core 12. They average about 26 cm in thickness and range in thickness from about 5 to 110? cm. They all have silt bases, most in erosional contacts with the underlying beds. The cycles are olive black to dark greenish gray to greenish gray (darker at the base, lighter at the top).

Two pyritized worm burrow casts occur in Section 2.

One 30 cm thick greenish gray bed of nanno ooze occurs at the bottom of the core.

Mineralogy similar to Core 1.

Site 210 Hole Core 13 Cored Interval: 140-149 m

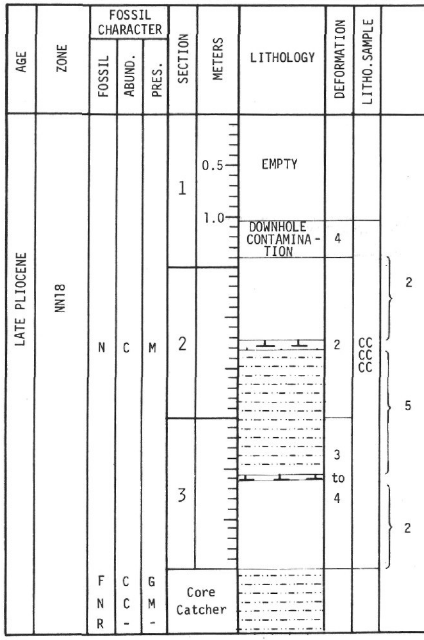


LITHOLOGIC DESCRIPTION

Foram ooze and graded cycles of silt and clay.

The upper 55 cm of Core 13 is very light gray foram ooze. Underlying this is a 10 cm bed of bluish white nanno ooze typical of the interbeds between graded cycles of silt and clay. Underlying these biogenic deposits are approximately 11 graded cycles averaging about 21 cm in thickness and ranging from about 2 to 40 cm. Four graded cycles in the lower 20 cm of the core average about 3 cm in thickness whereas the overlying 7 cycles average about 31 cm. Eight of the cycles have silt bases, most in erosional contacts with the underlying beds. The bases of the cycles are mostly olive black and olive gray grading upward into various shades of greenish gray.

Site 210 Hole Core 14 Cored Interval: 159-168 m



LITHOLOGIC DESCRIPTION

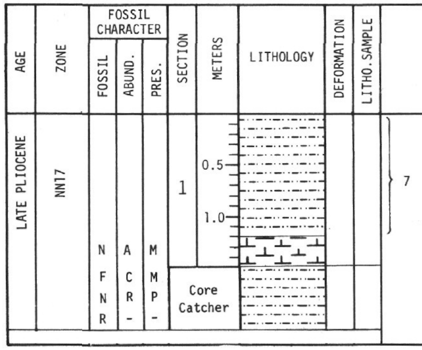
Graded cycles of silt and clay with interbeds of nanno ooze.

Approximately 9 graded cycles occur in Core 14 (the number is very approximate because interpretation is difficult in the more disturbed portions). They average about 33 cm in thickness and range from about 8 to 65 cm. They all have silt bases, most in erosional contacts with the underlying beds. The cycles range in color from a base of olive black or dark greenish gray to a top of various shades of greenish gray.

Two interbeds (3 and 8 cm thick) of light greenish gray nanno ooze were noted.

Mineralogy similar to Core 1 except much of the sequence is rich in zeolites.

Site 210 Hole Core 15 Cored Interval: 178-187 m



LITHOLOGIC DESCRIPTION

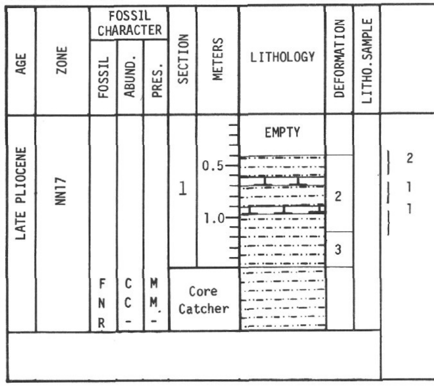
Graded cycles of silt and clay with an underlying bed of nanno ooze.

Approximately 7 graded cycles occur in Core 15. They average about 17 cm in thickness and range from about 7 to 28 cm. They all have silt bases, most in erosional contacts with the underlying beds. The cycles are olive black to olive gray at the base to greenish gray at the top.

One 28 cm thick light bluish gray bed of nanno ooze occurs at the bottom of the core.

Mineralogy is similar to Core 1.

Site 210 Hole Core 16 Cored Interval: 198-206 m



LITHOLOGIC DESCRIPTION

Graded cycles of silt and clay with interbeds of nanno ooze.

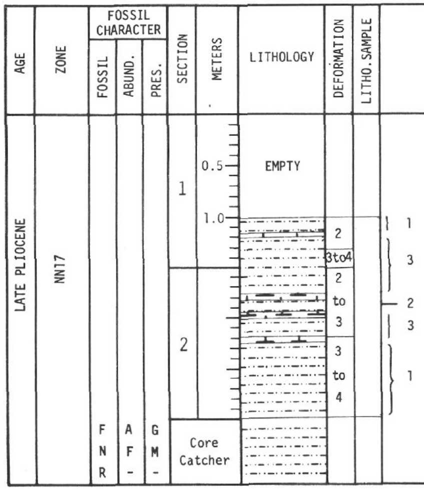
Approximately 4 graded cycles occur in Core 16. They average about 15 cm in thickness and range from about 4 cm to 21 cm. They all have silt bases, most in erosional contacts with the underlying beds. The bases are olive gray to olive black with the tops various shades of greenish gray.

Two 6 cm thick interbeds of light greenish gray nanno ooze were noted.

The lower 37 cm of the core is a dark greenish gray bed of nongraded silty clay.

Mineralogy similar to Core 1.

Site 210 Hole Core 17 Cored Interval: 215-224 m



LITHOLOGIC DESCRIPTION

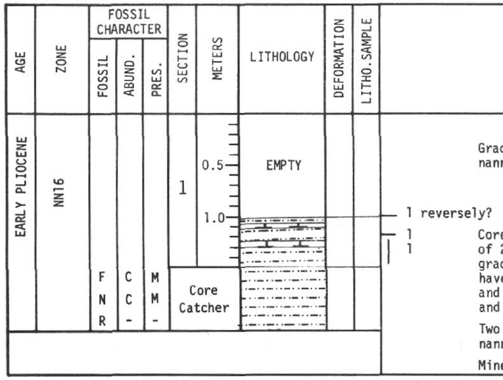
Graded cycles of silt and clay with interbeds of nanno ooze.

Approximately 10 graded cycles occur in Core 17. They average about 17 cm in thickness and range from about 2 to 75 cm. They all have silt bases, most in erosional contacts with the underlying beds. Most of the bases are dark greenish gray grading upward into various lighter shades of greenish gray.

Four interbeds of greenish gray to light greenish gray nanno ooze, were noted. They average about 5 cm in thickness and range from about 3 to 7 cm.

Mineralogy similar to Core 1.

Site 210 Hole Core 18 Cored Interval: 234-243 m



LITHOLOGIC DESCRIPTION

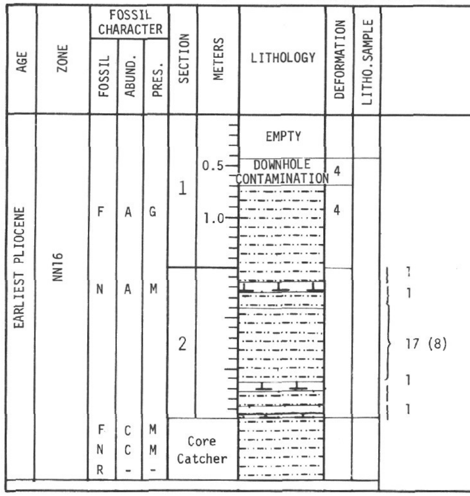
Graded cycles of silt and clay with interbeds of nanno ooze.

Core 18 contains two normally graded cycles of 20 and 13 cm thicknesses and 1 reversely? graded bed of 5 cm thickness. The normal cycles have silt bases grading upward into clayey silt and silty clay. The bases are dark greenish gray and the tops greenish gray.

Two 5 cm thick interbeds of light greenish gray nanno ooze were noted.

Mineralogy similar to Core 1.

Site 210 Hole Core 19 Cored Interval: 253-262 m



LITHOLOGIC DESCRIPTION

Graded cycles of silt and clay with interbeds of nanno ooze.

The upper 25 cm of Core 19 is downhole contamination. The underlying 80 cm is highly disturbed and mixed silt, clay, and ooze. The lower 1.5 m of Core 19 contain approximately 21 graded cycles averaging about 5 cm in thickness and ranging from about 1 to 17 cm. The cycles have silt bases, some in erosional contacts with the underlying beds. The cycles are various shades of greenish gray (darker at the base, lighter at the top).

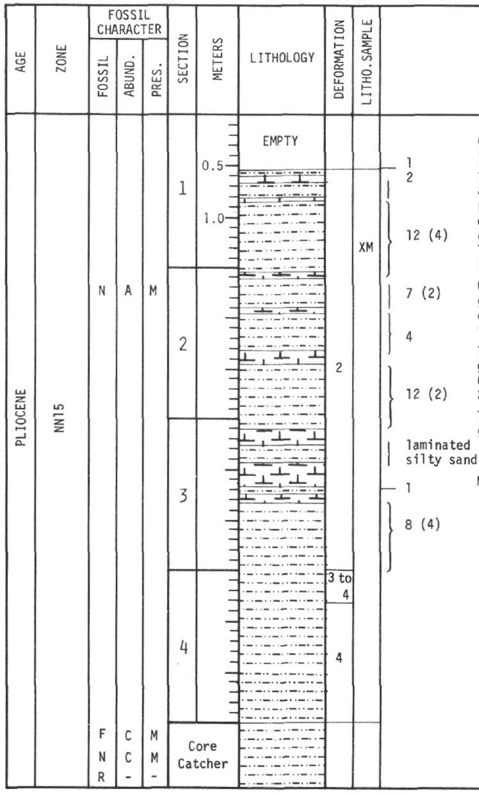
One 3 cm thick grayish olive bed of cross-laminated silty sand occurs 90 cm above the bottom of the core.

A 2 cm chunk of pyrite occurs 40 cm above the bottom.

Twelve interbeds of light greenish gray nanno ooze were noted. They average about 2 cm in thickness and range from <1 to 8 cm.

Mineralogy similar to Core 1.

Site 210 Hole Core 20 Cored Interval: 272-281 m



LITHOLOGIC DESCRIPTION

Graded cycles of silt and clay with interbeds of nanno ooze.

The upper 4 m of Core 20 contain approximately 47 graded cycles averaging about 5 cm in thickness and ranging from about 2 to 18 cm. Most of the cycles have silt bases and many are in erosional contacts with the underlying beds. The cycles are mostly shades of greenish gray (darker at the base, lighter at the top).

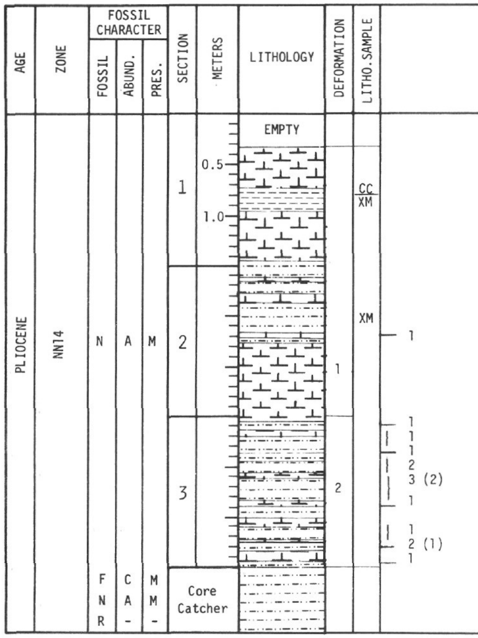
One 17 cm thick bed of medium gray and greenish gray laminated and cross-laminated silty sand composed mainly of quartz and forams occurs near the middle of the core.

Twenty interbeds of white and light greenish gray nanno ooze were noted. They average about 6 cm in thickness and range from <1 to about 23 cm.

The lower 1.5 m is so disturbed that individual graded cycles cannot be noted in detail.

Mineralogy similar to Core 1.

Site 210 Hole Core 21 Cored Interval: 291-300 m



LITHOLOGIC DESCRIPTION

Nanno ooze and interbeds of clay.
Graded cycles of silt and clay with interbeds of nanno ooze (semilithified).

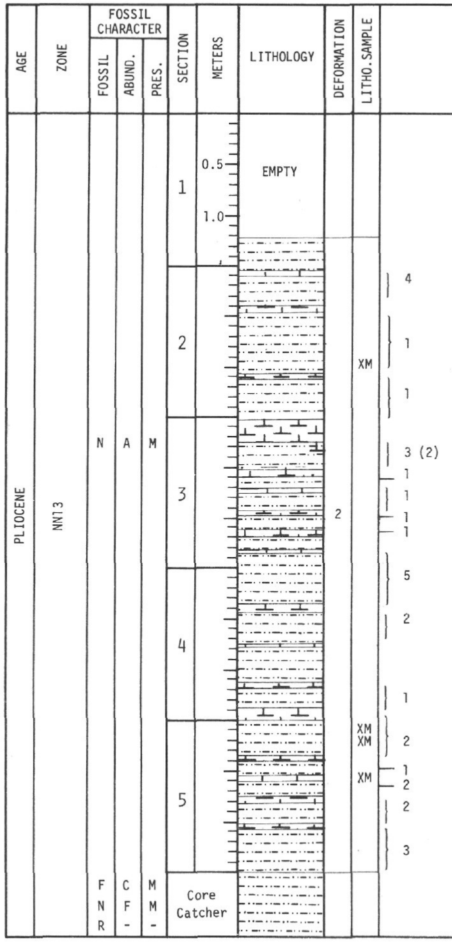
The upper 2.7 m of Core 21 are mainly bluish white nanno ooze (chalk) with 5 interbeds of greenish gray very slightly to moderately calcareous clay and silty clay. The clay beds average about 15 cm in thickness and one of them is graded. Much of the nanno ooze and clay are burrowed (*Chondrites*).

The lower 1.5 m of Core 21 contain approximately 13 graded cycles averaging about 7 cm in thickness and ranging from 2-15 cm. Seven of the cycles have silt bases, some in erosional contacts with the underlying beds. The cycles are olive gray or dark greenish gray at the bases and lighter greenish gray at the top.

Eleven interbeds of bluish white and light greenish gray nanno ooze were noted. They average about 4 cm in thickness and range from about 1 to 11 cm.

Mineralogy similar to Core 1.

Site 210 Hole Core 22 Cored Interval: 309-318 m



LITHOLOGIC DESCRIPTION

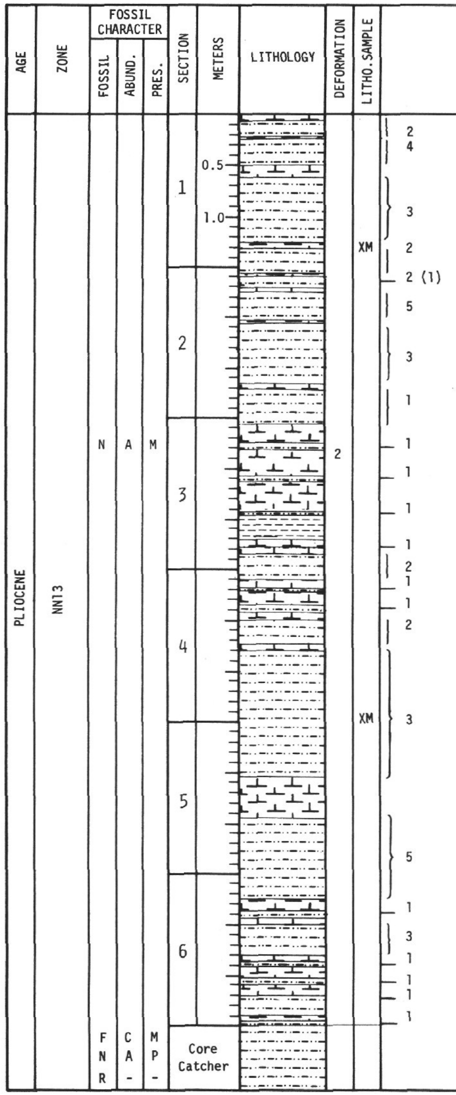
Graded cycles of silt and clay with interbeds of nanno ooze (stiff to semilithified).

Approximately 31 graded cycles occur in Core 22. They average about 14 cm in thickness and range from about 4 to 55 cm. About half have silt bases, many in erosional contacts with the underlying beds. Almost all are shades of greenish gray (darker at the base, lighter at the top).

Nineteen interbeds of mainly greenish gray and light greenish gray nanno ooze were noted. They average about 6 cm in thickness and range from about 2 to 23 cm.

Mineralogy similar to Core 1.

Site 210 Hole Core 23 Cored Interval: 328-337 m



LITHOLOGIC DESCRIPTION

Graded cycles of silt and clay with interbeds of nanno ooze (stiff to semilithified).

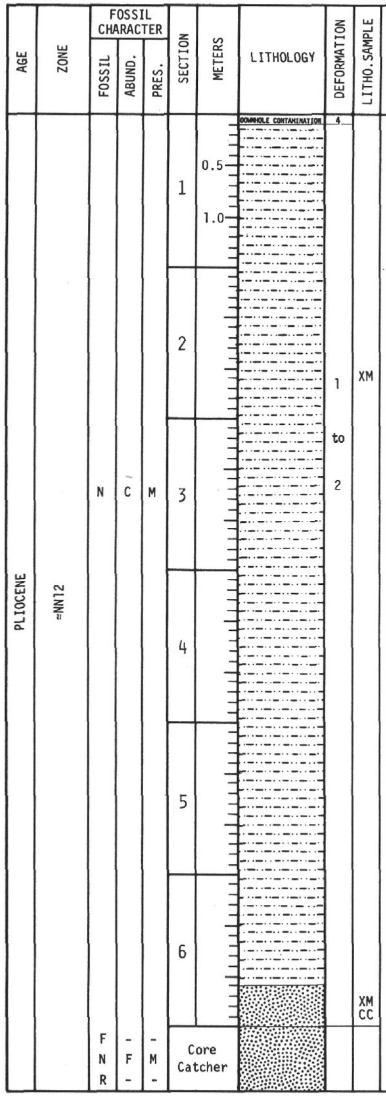
Approximately 48 graded cycles occur in Core 23. They average about 12 cm in thickness and range from about 2 to 74 cm. About two thirds have silt bases, many in erosional contacts with the underlying beds. Almost all are various shades of greenish gray (darker at the base, lighter at the top).

One graded cycle about 2 m above the base of the core is particularly rich in forams and is laminated and cross laminated(?).

Twenty-five interbeds of nanno ooze were noted. Many are slightly to intensely burrowed (some *Chondrites*). Most beds are light greenish gray to greenish gray. About one third are bluish white and light bluish gray, including the thicker beds. The overall average thickness is about 10 cm and the range is from about 2 to 40 cm.

Mineralogy similar to Core 1 except that some of the graded cycles are zeolite rich.

Site 210 Hole Core 24 Cored Interval: 347-356 m



LITHOLOGIC DESCRIPTION

Nanno clayey silt to Nanno silty clay.

Calcareous sandy silt.

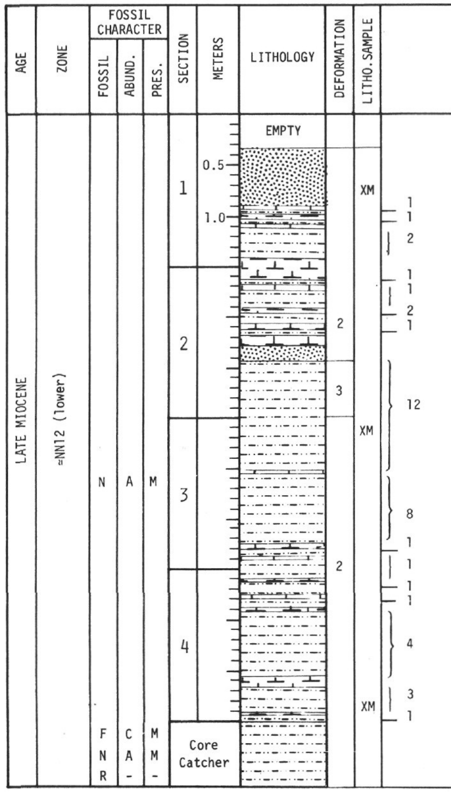
(stiff to semilithified)

The upper 8.5 m of Core 24 consist mainly of nanno clayey silt to nanno silty clay. Some portions are richer in nannos and more properly called nanno ooze. Whereas other portions are poorer in nannos and more properly called silty clay and clayey silt. Megascopically, the clay is homogeneous and no grading was detected. Color is greenish gray to dark greenish gray.

Pyritized globs (worm burrow casts) are found in Sections 3 and 4 (one in each).

Underlying the upper beds with gradational contact are 40 cm of thinly laminated olive gray calcareous sandy silt.

Site 210 Hole Core 25 Cored Interval: 365-374 m



LITHOLOGIC DESCRIPTION

Silty sand and sandy silt.

Graded cycles of silt and clay with interbeds of nanno ooze.

(stiff to semilithified)

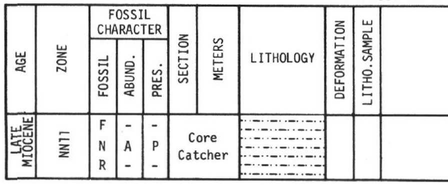
The upper 53 cm of Core 25 is laminated and cross-laminated olive gray silty sand mainly composed of altered glass?, quartz, feldspar, and forams. About 1.35 m further down is a 15 cm thick bed of laminated light olive gray calcareous sandy silt.

The rest of Core 25 consists of graded cycles and interbeds of nanno ooze. Approximately 42 graded cycles occur, averaging about 10 cm in thickness and ranging from about 3 to 22 cm. Nearly half have silt bases, some in erosional contacts with the underlying beds. Most of the cycles are shades of olive gray and greenish gray (darker at the bottom, lighter at the top). Two of the graded? cycles appear to be laminated in their lower portions.

Sixteen interbeds of mostly light greenish gray and greenish gray nanno ooze were noted. They average about 6 cm in thickness and range from about 2 to 24 cm. Many are worm burrowed with worm burrow casts of the overlying lithology (some *Chondrites* types and *Zoophycos?* types).

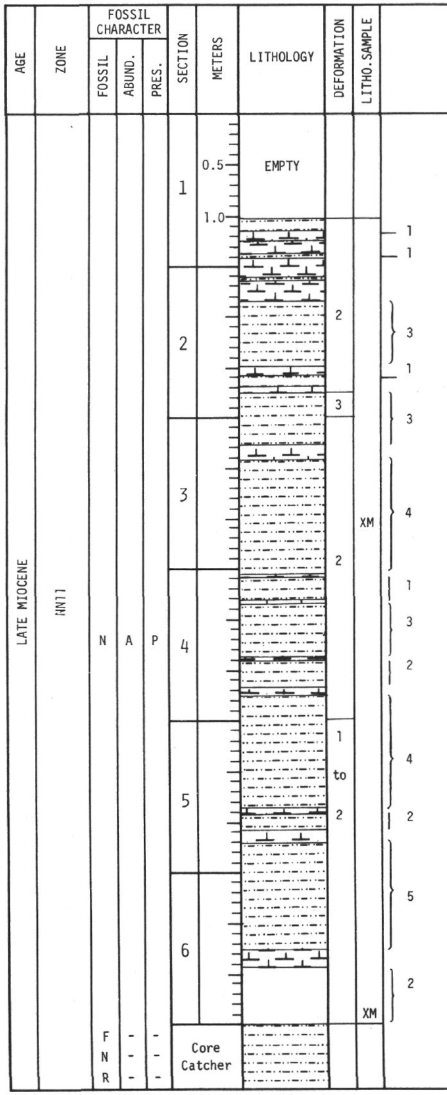
Mineralogy similar to Core 1 except as noted above.

Site 210 Hole Core 26 Cored Interval: 384-393 m



LITHOLOGIC DESCRIPTION

Site 210 Hole Core 27 Cored Interval: 403-412 m



LITHOLOGIC DESCRIPTION

Graded cycles of silt and clay with interbeds of nanno ooze.

(stiff to semilithified)

Approximately 32 graded cycles occur in Core 27. They average about 17 cm in thickness and range from about 2 to 65 cm. Nearly all have silt to fine sand bases, many in particularly evident erosional contacts with the underlying beds. Most of the cycles are shades of greeenish gray (darker at the base, lighter at the top).

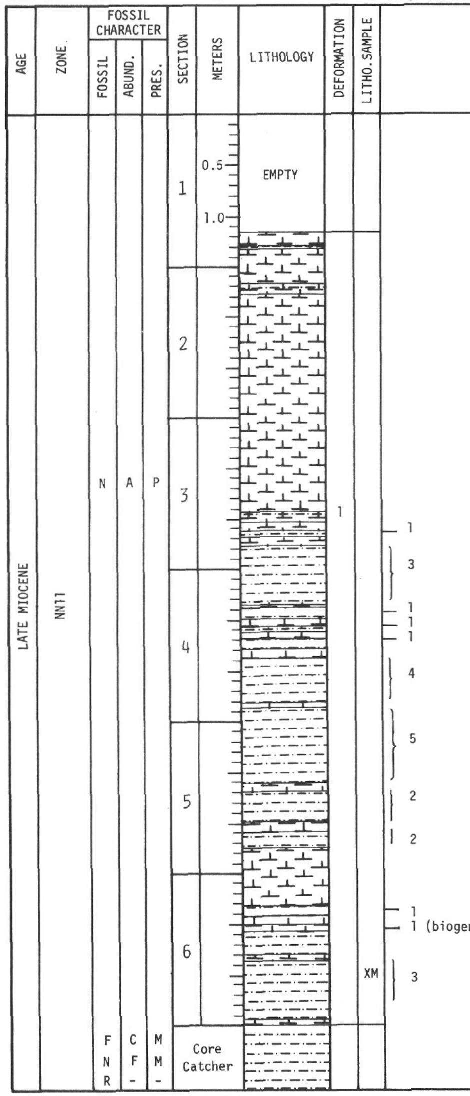
The thickest graded cycle(?) has a 12 cm thick sandy silt base that is laminated and cross-laminated. About 6 other cycles have laminated bases, one of which is also cross laminated.

The upper portions of some of the cycles are burrow mottled.

Fourteen interbeds of light greenish gray, greenish gray, and bluish white nanno ooze were noted. Many are slightly to intensely burrowed (some *Chondrites* and *Zoophycos* types). Burrow casts are often a mixture of the host lithology and the overlying lithology. The interbeds average about 10 cm in thickness and range from about 2 to 21 cm.

Mineralogy similar to Core 1.

Site 210 Hole Core 28 Cored Interval: 421-430 m



LITHOLOGIC DESCRIPTION

Nanno ooze.

Graded cycles of silt and clay with interbeds of nanno ooze.
(stiff to semilithified)

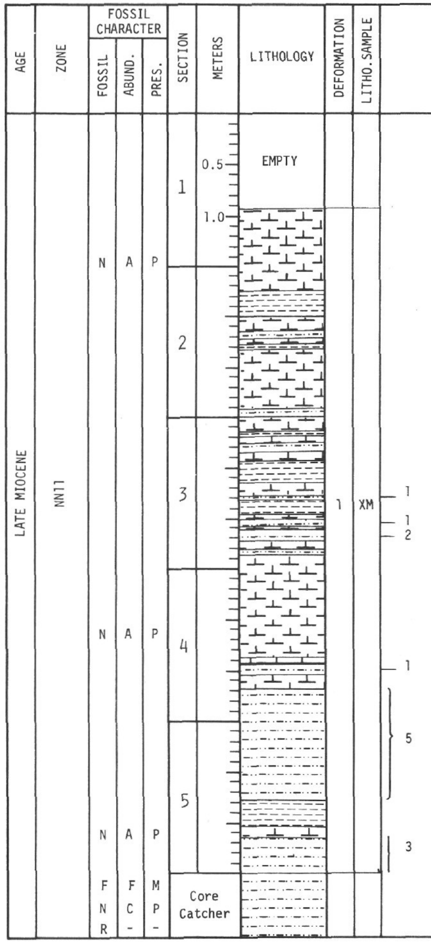
The upper 2.7 m of Core 28 are essentially very light gray to bluish white nanno ooze with some portions bearing clay and forams. One 2 cm thick bed of dark gray noncalcareous clay occurs near the top of the core. Burrowing is slight to intense in various portions of the ooze. Some *Chondrites* types occur.

The lower 5.1 m of Core 28 is mainly a sequence of graded cycles and interbeds of nanno ooze. Approximately 25 graded cycles occur averaging about 12 cm in thickness and ranging from about 3 to 28 cm. Nearly all have fine sand to silt bases in erosional contacts with the underlying beds. Most cycles are shades of greenish gray (darker at the base, lighter at the top). Some of the darker basal color is due to the presence of carbonaceous material. About 10 of the cycles have laminated bases (2 of which are also cross-laminated). These bases also show particularly good evidence of scouring the underlying beds.

Thirteen interbeds of nanno ooze were noted. Most are various shades of greenish gray, some are bluish white. Most are burrowed with about half containing *Chondrites* and several *Zoophycos*. The interbeds have a median thickness of about 11 cm and range from 3 to 57 cm.

Mineralogy similar to Core 1 except bases of cycles are more micaceous.

Site 210 Hole Core 29 Cored Interval: 440-449 m



LITHOLOGIC DESCRIPTION

Nanno ooze and interbeds of noncalcareous clay.
Graded cycles of silt and clay with interbeds of nanno ooze.
(semilithified)

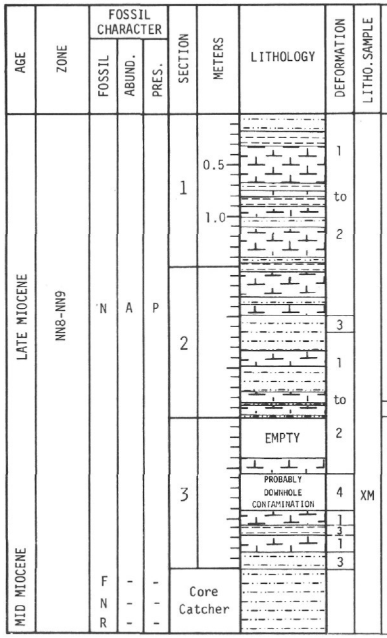
The upper 2.85 m of Core 29 are about 75 percent nanno ooze and about 25 percent composed of 7 interbeds of noncalcareous clay and silty clay (not obviously graded). The interbeds average about 12 cm in thickness and range from about 5 to 25 cm. The nanno ooze varies from white to greenish gray depending on the clay content (more clay producing darker colors). It is intensely burrowed in some portions (some *Chondrites*). The interbeds are dark greenish gray, some slightly mottled.

The lower 5.22 m of Core 29 are mainly a sequence of graded cycles and interbeds of nanno ooze. Approximately 13 graded cycles occur. They average about 12 cm in thickness and range from about 3 to 32 cm. Nearly all cycles have fine sand or silt bases, many in erosional contacts with the underlying beds. The cycles are mostly shades of greenish gray (darker at the base, lighter at the top). Several of the cycles have laminated bases.

One thick (106 cm) interbed of nanno ooze occurs as well as 4 thinner interbeds of nanno ooze which average about 10 cm in thickness and range from about 5 to 15 cm. Most of the ooze is light greenish gray and some is moderately burrowed. One 5 cm thick light bluish gray bed of recrystallized limestone occurs in Section 4.

Mineralogy similar to Core 1 except bases are more micaceous.

Site 210 Hole Core 30 Cored Interval: 459-468 m



LITHOLOGIC DESCRIPTION

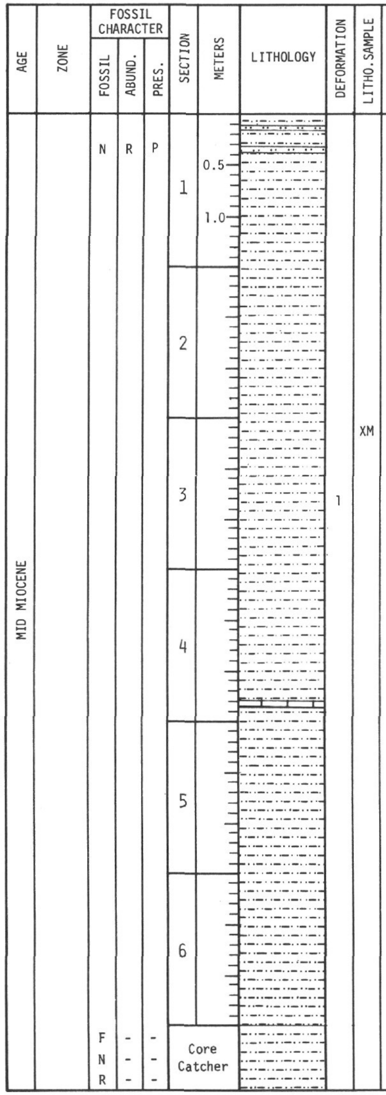
Nanno ooze and interbeds of clay.
Graded cycles of silt and clay with interbeds of biogenic clay.
(semilithified)

The upper 2.5 m of Core 30 consist of approximately 7 beds of calcareous biogenic clay and nanno ooze interbedded with approximately 7 intervals of non-graded calcareous and noncalcareous clay and silty clay. The nanno ooze is very light gray to light gray whereas the calcareous biogenic clay is darker (greenish gray to dark greenish gray). They are burrowed (some *Chondrites*), average about 19 cm in thickness, and range from about 5 to 37 cm. The interbeds are mostly dark greenish gray, average about 16 cm in thickness, and range from about 7 to 34 cm.

The middle 0.5 m of Core 30 contain approximately 5 graded cycles with two 10 cm thick interbeds of greenish gray calcareous biogenic clay. The cycles average about 6 cm in thickness and range from about 2 to 10 cm. They have silt bases, some in erosional contacts with the underlying beds. The cycles are mostly shades of greenish gray. Two have laminated bases.

The lower 1.1 m of Core 30 are intensely disturbed in some portions. The lithology is mainly light gray clay bearing nanno ooze interbedded with dark greenish gray clay and silty clay. The oozes are burrowed (some *Chondrites*) with burrow casts being dark greenish gray.

Site 210 Hole Core 31 Cored Interval: 477-486 m



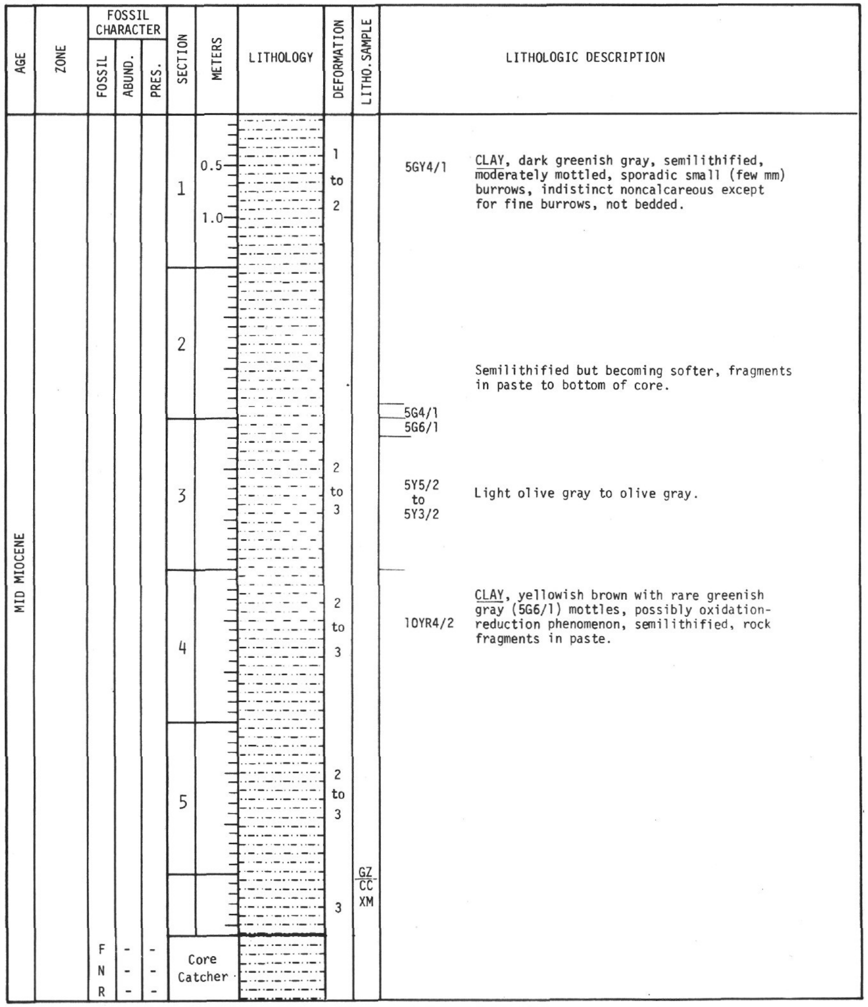
LITHOLOGIC DESCRIPTION

Clay
(semilithified)

Core 31 is composed almost entirely of dark greenish gray, slightly to moderately mottled, noncalcareous silty clay and subordinate silty clay.

The upper 35 cm of the core contains two 5 cm thick beds of lighter greenish gray foram and quartz rich calcareous silt. A 7 cm thick calcareous bed occurs in Section 4.

Site 210 Hole Core 32 Cored Interval: 496-505 m



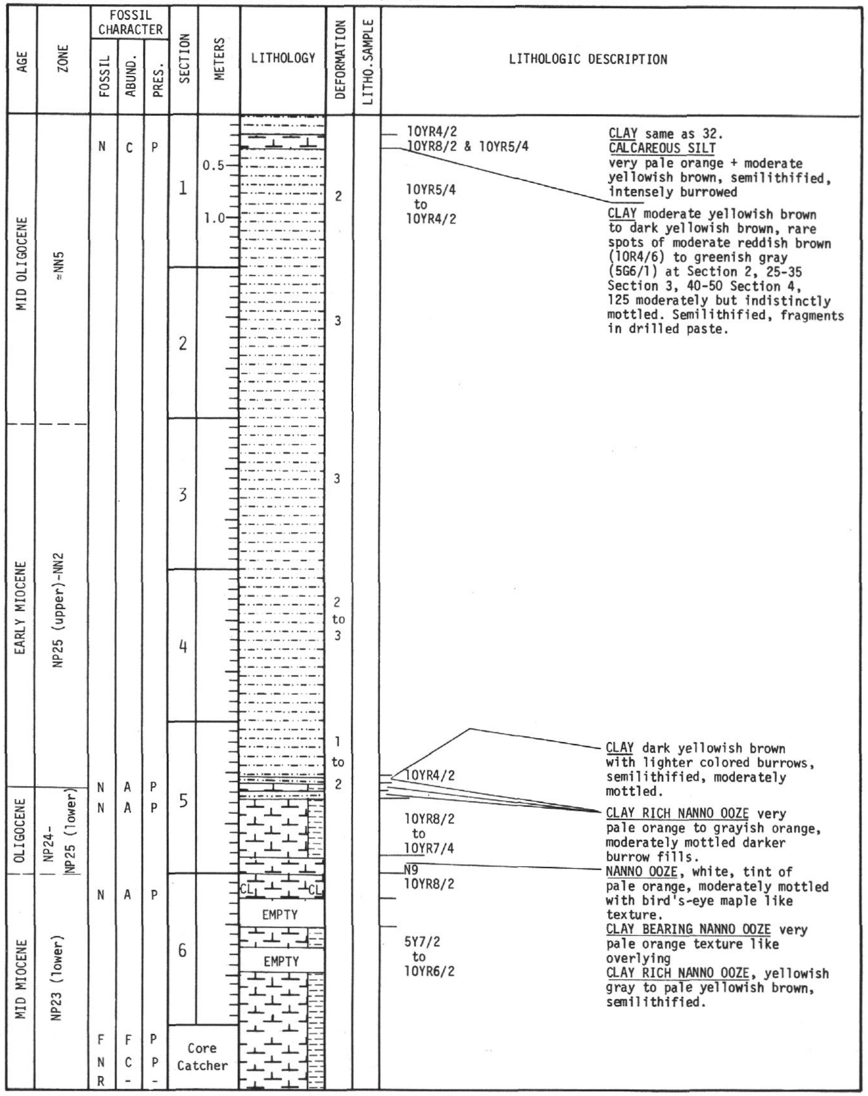
CLAY, dark greenish gray, semilithified, moderately mottled, sporadic small (few mm) burrows, indistinct noncalcareous except for fine burrows, not bedded.

Semilithified but becoming softer, fragments in paste to bottom of core.

Light olive gray to olive gray.

CLAY, yellowish brown with rare greenish gray (5G6/1) mottles, possibly oxidation-reduction phenomenon, semilithified, rock fragments in paste.

Site 210 Hole Core 33 Cored Interval: 515-524 m



CLAY same as 32.

CALCAREOUS SILT very pale orange + moderate yellowish brown, semilithified, intensely burrowed

CLAY moderate yellowish brown to dark yellowish brown, rare spots of moderate reddish brown (10R4/6) to greenish gray (5G6/1) at Section 2, 25-35 Section 3, 40-50 Section 4, 125 moderately but indistinctly mottled. Semilithified, fragments in drilled paste.

CLAY dark yellowish brown with lighter colored burrows, semilithified, moderately mottled.

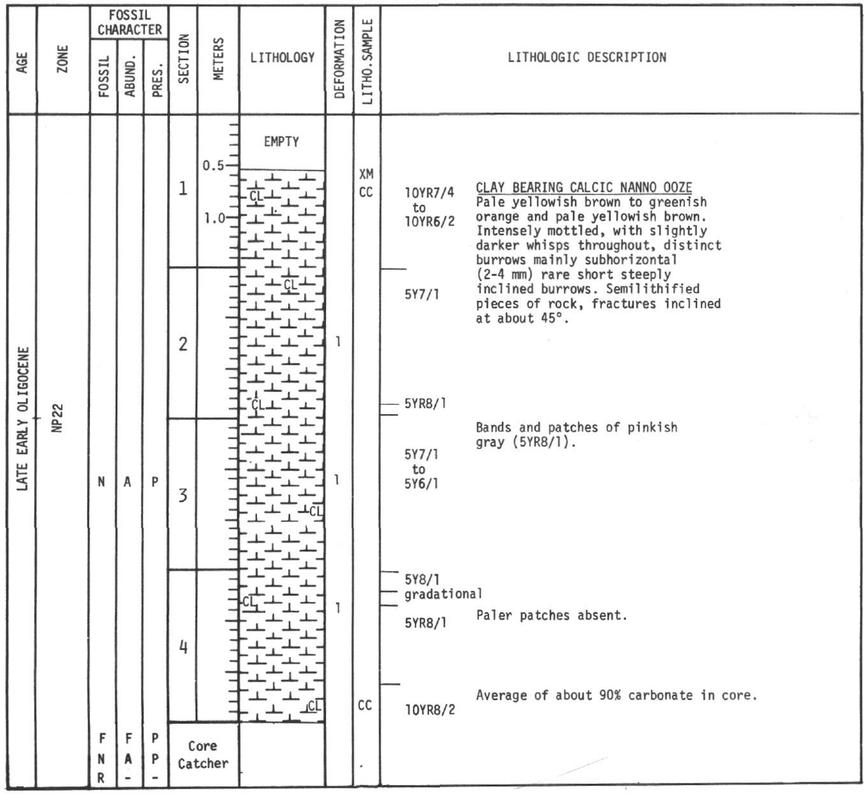
CLAY RICH NANNO OOZE very pale orange to grayish orange, moderately mottled darker burrow fills.

NANNO OOZE, white, tint of pale orange, moderately mottled with bird's-eye maple like texture.

CLAY BEARING NANNO OOZE very pale orange texture like overlying

CLAY RICH NANNO OOZE, yellowish gray to pale yellowish brown, semilithified.

Site 210 Hole Core 34 Cored Interval: 533-542 m



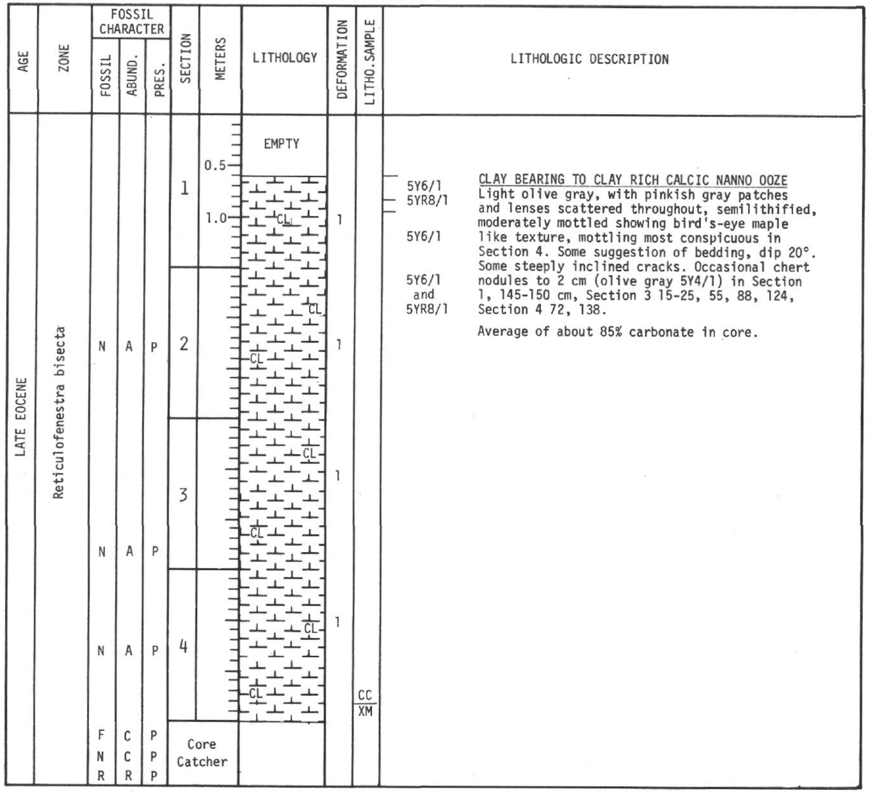
CLAY BEARING CALCIC NANNO OOZE
Pale yellowish brown to greenish orange and pale yellowish brown. Intensely mottled, with slightly darker whisps throughout, distinct burrows mainly subhorizontal (2-4 mm) rare short steeply inclined burrows. Semilithified pieces of rock, fractures inclined at about 45°.

Bands and patches of pinkish gray (5YR8/1).

Paler patches absent.

Average of about 90% carbonate in core.

Site 210 Hole Core 35 Cored Interval: 542-551 m



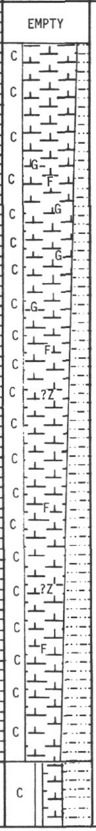
CLAY BEARING TO CLAY RICH CALCIC NANNO OOZE
Light olive gray, with pinkish gray patches and lenses scattered throughout, semilithified, moderately mottled showing bird's-eye maple like texture, mottling most conspicuous in Section 4. Some suggestion of bedding, dip 20°. Some steeply inclined cracks. Occasional chert nodules to 2 cm (olive gray 5Y4/1) in Section 1, 145-150 cm, Section 3 15-25, 55, 88, 124, Section 4 72, 138.

Average of about 85% carbonate in core.

Site 210 Hole Core 36 Cored Interval: 551-560 m

AGE	ZONE	FOSSIL CHARACTER: FOSSIL	ABUND.	PRES.	SECTION	METERS	DEFORMATION	LITHO.SAMPLE
LATE EOCENE	=Reticulofenestra hampdenensis - Discoaster tani nodifer	N	A	P	1	0.5 1.0	1	XM CC
		N	A	P	2		1	
MID MID EOCENE	Chiphragmalithus cristatus (upper)	N	A	P	3		1	
		N	A	P	4		1	XM CC
		N	A	P	5			
		F N R	- A VR	- P VP	Core Catcher			

LITHOLOGY



LITHOLOGIC DESCRIPTION

5Y9/1

grading

to
5GY9/1

grading

to

5GY7/1

grading

to

5G8/1

CLAY RICH CALCIC NANNO OOZE
Very light yellowish gray grading into light greenish gray, semilithified, moderately but indistinctly mottled, forams sparsely present from Section 2, 50 cm. Moderately to steeply inclined fractures with slickensides. Indistinct layering dipping at up to 15°. Bands with glauconite in Section 2 and top 15 cm of Section 3, possible zeolites Sections 3-5. ○○○

Average of about 75% carbonate.

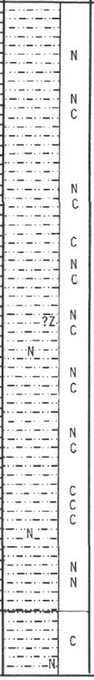
Calcic rich nanno clay.

Average of about 55% carbonate.

Site 210 Hole Core 37 Cored Interval: 560-569 m

AGE	ZONE	FOSSIL CHARACTER: FOSSIL	ABUND.	PRES.	SECTION	METERS	DEFORMATION	LITHO.SAMPLE
EARLY MID EOCENE	Chiphragmalithus cristatus (middle)	N	A	P	1	0.5 1.0	1	
		N	A	P	2		1	
	Chiphragmalithus cristatus (lower)	N	A	P	3		1	CC XM
		N	A	P	4		1	
	Discoaster elegans	F N R	- A R	- P P	Core Catcher			

LITHOLOGY



LITHOLOGIC DESCRIPTION

FORAM BEARING NANNO RICH CALCIC CLAY

5G8/1

and

5G6/1

Very light greenish gray to greenish gray, with some darker bands and patches. Semilithified, moderately mottled, burrows indistinct. Semilithified, fractures and minor faults dipping 45-70°. ?bedding dips 0-10°. Pale purple mineral on slickensides Section 3 20-22 cm. (5P6/2) Forams sparsely distributed throughout, rare bluish purple specks (?pyrite).

5G8/1 Average of about 60% carbonate in core.

and

5G9/1

5G9/1

to
5G7/1

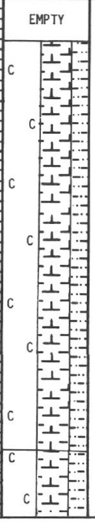
Chondrites

5G8/1
and
5G6/1

pale green 10G6/2

Site 210 Hole Core 38 Cored Interval: 569-578 m

AGE	ZONE	FOSSIL	ABUND.	PRES.	SECTION	METERS	LITHOLOGY	DEFORMATION	LITHO. SAMPLE	LITHOLOGIC DESCRIPTION
EARLY MID EOCENE	Discoaster elegans	N	A	P	1 2 3	0.5 1.0	EMPTY	1 1	CC XM	5G5/1 N4 5BG8/2 5BG7/2 to 5GY8/2 5BG7/2 to 5GY8/1
		F N R	C A R	M P P	Core Catcher					



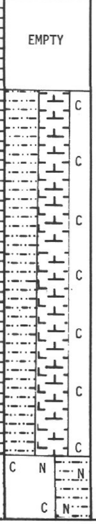
CLAY RICH CALCIC NANNO OOZE
Greenish gray, semilithified, moderately mottled, very fine forams, layering dips about 10°.

At 105 color changes to very pale blue green, pale blue green and light greenish gray with pale purple (5P6/2) patches around black cores (pyritic) in burrows. Few fractures.

Average of about 65% carbonate in core.

Site 210 Hole Core 39 Cored Interval: 578-587 m

AGE	ZONE	FOSSIL	ABUND.	PRES.	SECTION	METERS	LITHOLOGY	DEFORMATION	LITHO. SAMPLE	LITHOLOGIC DESCRIPTION
EARLY MID EOCENE	Discoaster elegans				1 2 3	0.5 1.0	EMPTY	1 1 1	XM CC	5BG8/2 to 5GY8/1 5G5/1 greenish gray
		F N R	C C R	M P P	Core Catcher					



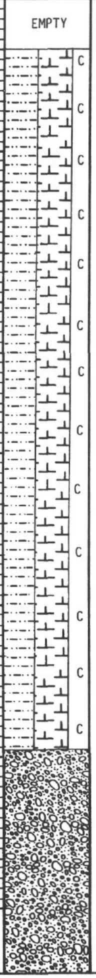
CALCIC RICH CLAY NANNO OOZE
Very pale blue green to light greenish gray. Semilithified, moderately mottled, pale purple patches (5P6/2) around black cores (pyritic?) in burrows, few fractures inclined at about 45°, a few darker bands (purple tint), sparsely scattered forams.

Average of about 65% carbonate in core.

NANNO BEARING CLAY CALCIC OOZE

Site 210 Hole Core 40 Cored Interval: 587-596 m

AGE	ZONE	FOSSIL	ABUND.	PRES.	SECTION	METERS	LITHOLOGY	DEFORMATION	LITHO. SAMPLE	LITHOLOGIC DESCRIPTION
EARLY MID EOCENE	Discoaster elegans	N	C	P	1 2 3 4 5 6	0.5 1.0	EMPTY	1 1 1 1 1	CC XM	5BG8/2 to 5GY8/1
		F R	C VR	M P	Core Catcher					



CALCIC RICH NANNO CLAY
Lithology similar to Cores 38 and 39.

Layering more distinct in Section 2, dips 5 to 10°.

Layering less distinct a few fractures (slickensided) inclined at 30-45°.

Broad banding.

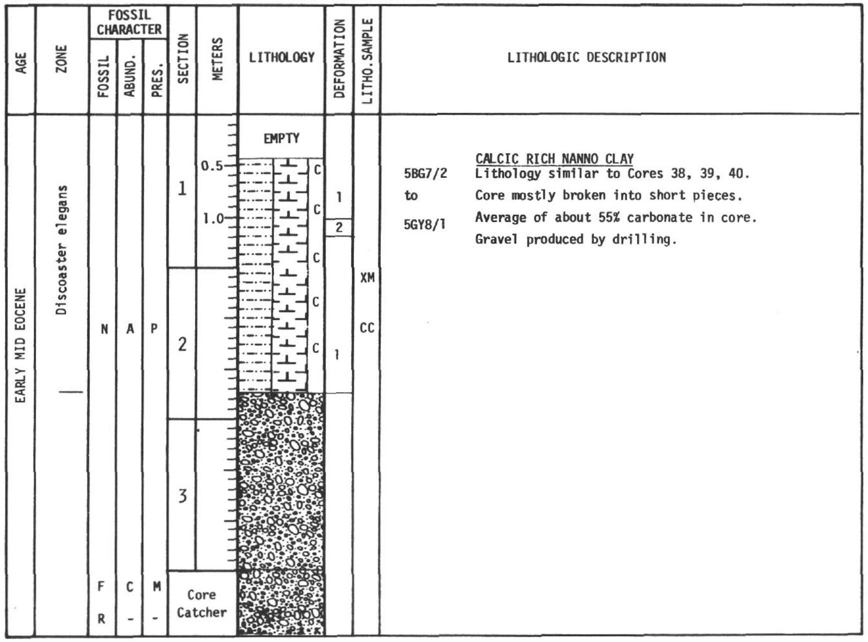
Fractures subhorizontal.

Greenish gray (5G6/1) patches (concretionary) at 60, 87, 104.

Average of about 55% carbonate in core.

Gravel produced by drilling variety of lithologies present back to those in Core 32.

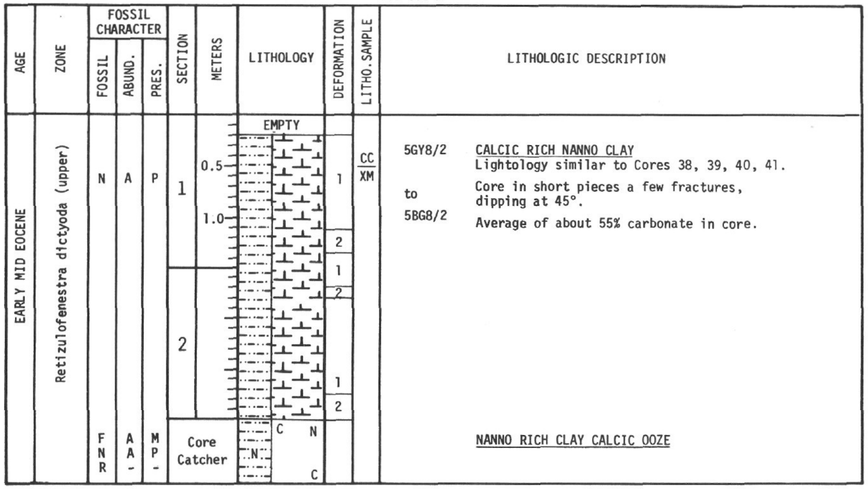
Site 210 Hole Core 41 Cored Interval: 596-605 m



5BG7/2 to 5GY8/1

CALCIC RICH NANNO CLAY
Lithology similar to Cores 38, 39, 40.
Core mostly broken into short pieces.
Average of about 55% carbonate in core.
Gravel produced by drilling.

Site 210 Hole Core 42 Cored Interval: 605-614 m

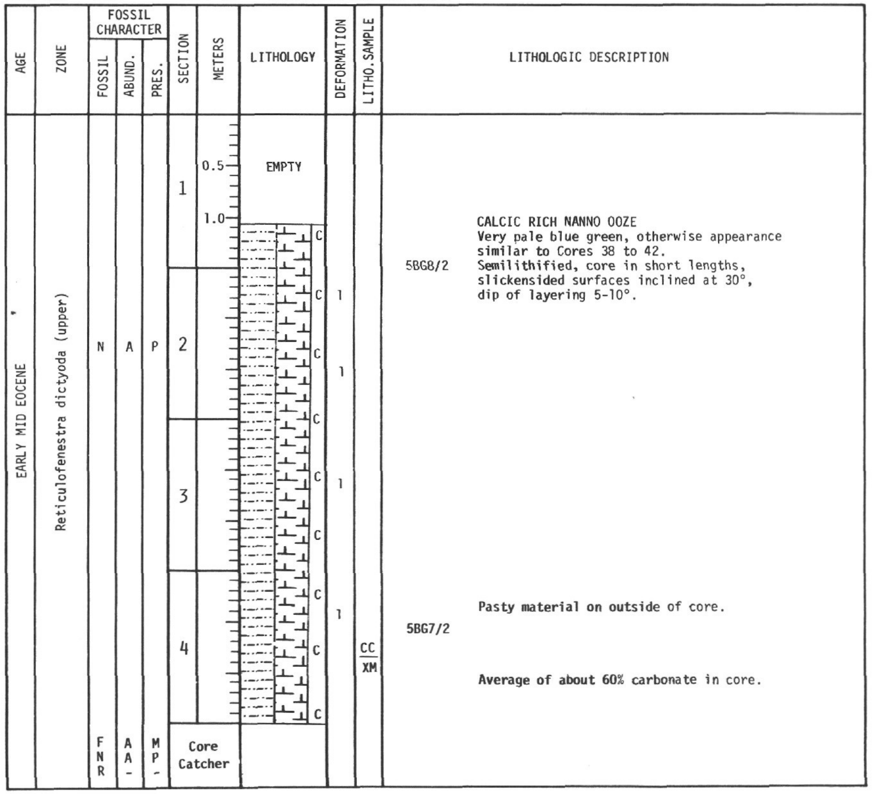


5GY8/2 to 5BG8/2

CALCIC RICH NANNO CLAY
Lightology similar to Cores 38, 39, 40, 41.
Core in short pieces a few fractures, dipping at 45°.
Average of about 55% carbonate in core.

NANNO RICH CLAY CALCIC OOZE

Site 210 Hole Core 43 Cored Interval: 614-623 m



CALCIC RICH NANNO OOZE
Very pale blue green, otherwise appearance similar to Cores 38 to 42.
5BG8/2 Semilithified, core in short lengths, slickensided surfaces inclined at 30°, dip of layering 5-10°.

Pasty material on outside of core.

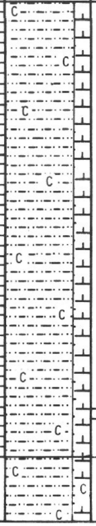
5BG7/2

Average of about 60% carbonate in core.

Site 210 Hole Core 44 Cored Interval: 623-632 m

AGE	ZONE	FOSSIL	ABUND.	PRES.	SECTION	METERS	DEFORMATION	LITHO. SAMPLE	LITHOLOGIC DESCRIPTION
EARLY MID EOCENE	Reticulofenestra dictyoda (upper)				1	0.5 1.0	1		5BG7/2
					2		1	CC XM	
					3		2 1		5BG8/2
		F N R	A A -	M P -	Core Catcher				

LITHOLOGY



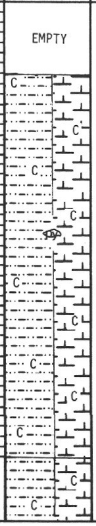
CALCIC RICH NANNO CLAY
Very pale blue green, lithology similar to Cores 38 to 43 in appearance. Semilithified, dip of layering 5-10°.

Average of about 55% carbonate in core.

Site 210 Hole Core 45 Cored Interval: 632-641 m

AGE	ZONE	FOSSIL	ABUND.	PRES.	SECTION	METERS	DEFORMATION	LITHO. SAMPLE	LITHOLOGIC DESCRIPTION
EARLY MID EOCENE	Reticulofenestra dictyoda (upper)				1	0.5 1.0	1		5BG8/2
					2		1	CC XM	5BG7/2
					3		1		
		F N R	A C -	M P -	Core Catcher				

LITHOLOGY



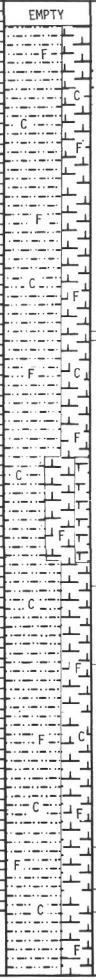
CALCIC AND NANNO RICH CLAY WITH FORAM RICH BANDS
Very pale blue green to pale blue green.
Semilithified, appearance similar to Cores 38 to 44. Foraminifera rich bands in Section 3 at 58-61, 70-72, 88-90 and 147-149 cm.
Dip about 5°.
Pyrite nodule flattened in bedding in Section 2, 1 cm x 2 cm.

Average of about 40% carbonate in core.

Site 210 Hole Core 46 Cored Interval: 648-657 m

AGE	ZONE	FOSSIL	ABUND.	PRES.	SECTION	METERS	DEFORMATION	LITHO. SAMPLE	LITHOLOGIC DESCRIPTION
EARLY MID EOCENE	Reticulofenestra dictyoda (upper)				1	0.5 1.0	1		5BG7/2
					2				5BG7/2 with 20% of bands of N6
		N	A	P	3		2		5BG7/2 with 30% bands of N6
		N	C	P	4		1	CC XM	5BG7/2 with a few bands of N5
EARLY EOCENE	Reticulofenestra dictyoda (lower)	N	C	P	5		2 1		5BG8/1 with a few bands of N6
					6		2 1		5BG8/2
		F N R	A C -	P P -	Core Catcher				

LITHOLOGY



FORAM BEARING CALCIC AND NANNO RICH CLAY WITH FORAM RICH BANDS
Lithologically similar to Cores 38-45, semilithified, softer sections indicated by deformation.
Section 1: foram rich at 37 and 125 cm.
Dip 5 to 10°, weak flat fossility.

Section 2: 1 to 5 cm bands rich in foram make up 50% of rock to 100 cm. Darker bands with more fine pyrite.

Section 3: forams rare to 90 cm, more common below. Darker bands with fine pyrite.

Section 4: forams rich 24-25 cm, 27-29, 34-36, 47-48, 49-54, 60-61, 70-72, 87-88, 92-93, 105-107, 103-104.

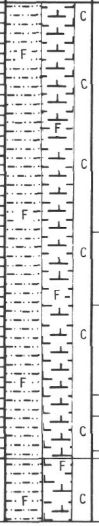
Fragments in paste.

Section 5: 3 foram bands between 90 and 150 cm. Fractures inclined at 45-30°.

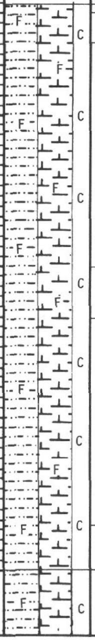
Section 6: scattered forams throughout.

Average of about 50% carbonate in core.

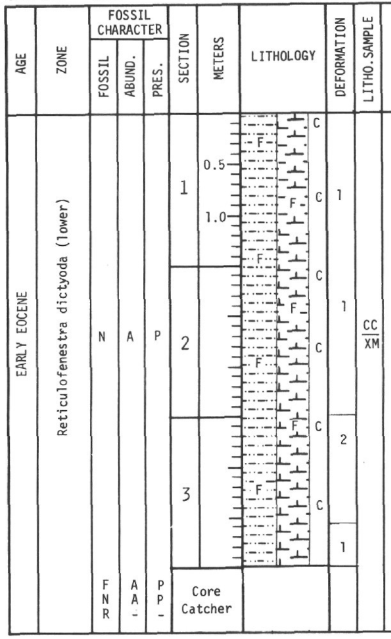
Site 210 Hole Core 47 Cored Interval: 665-674 m

AGE	ZONE	FOSSIL CHARACTER FOSSIL	ABUND.	PRES.	SECTION	METERS	LITHOLOGY	DEFORMATION	LITHO. SAMPLE	LITHOLOGIC DESCRIPTION	
EARLY EOCENE	Reticulofenestra dictyoda (lower)				1	0.5 1.0		1		5BG7/2 to 5BG8/2 bands of N6	FORAM BEARING CALCIC RICH NANNO CLAY Lithology like 46*, forams scattered throughout pale blue green. Pyrite crystal clusters at 50, 64, 76 (1 to 3 mm) in diameter, dip near 10°.
					2			2 to 3		5BG7/2 with some bands of medium gray N5	Section 2: softer rock fragments in paste.
					3			2 2	CC XM	5BG7/2	Section 3: fewer forams. Average of about 50% carbonate in core. *Burrows mostly filled with light olive gray sediment (5Y6/1) only infrequently with pyrite otherwise sediments very much like previous cores.
		F N R	A A -	P P -	Core Catcher						

Site 210 Hole Core 48 Cored Interval: 678-687 m

AGE	ZONE	FOSSIL CHARACTER FOSSIL	ABUND.	PRES.	SECTION	METERS	LITHOLOGY	DEFORMATION	LITHO. SAMPLE	LITHOLOGIC DESCRIPTION	
EARLY EOCENE	Reticulofenestra dictyoda (lower)				1	0.5 1.0	EMPTY 	1 2 1		N7 to 5B6/1	FORAM BEARING CALCIC RICH NANNO CLAY Lithology similar to Core 47, light gray to very light bluish gray. Forams scattered throughout, burrows mostly filled with light olive gray sediment (5Y6/1) only infrequently pyritic.
		N	A	P	2				CC XM	5B7/1	Section 2: trace of bedding dips about 5°. Fractures inclined at 45° at top of section (and base of Section 1).
					3			2			Section 3: Sediment stiff clay at top of section grades down into semilithified sediment below.
					4			2			Section 4: Semilithified to 102 cm. Stiff paste below. Average of about 55% carbonate in core.
		F N R	- A -	- P -	Core Catcher						

Site 210 Hole Core 49 Cored Interval: 692-701 m



LITHOLOGIC DESCRIPTION

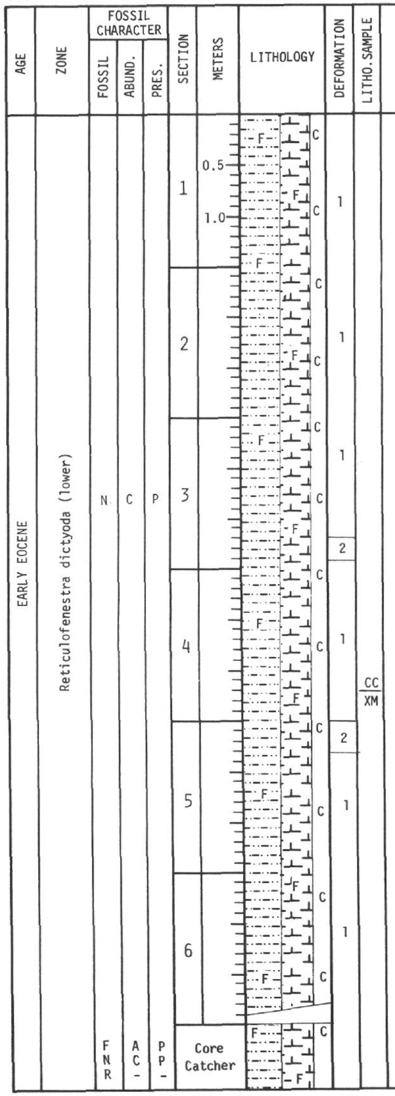
5B7/1

FORAM BEARING CALCIC RICH NANNO CLAY
Light bluish gray, lithology same as Core 48.
Semilithified.
Section 1: clusters of pyrite crystals at 18 and 36 cm.

Section 3: 0-102 cm stiff clay, 102-146. Semilithified fragments in stiff paste.

Average of about 50% carbonate in core.

Site 210 Hole Core 50 Cored Interval: 702-711 m



LITHOLOGIC DESCRIPTION

5B7/1

FORAM BEARING CALCIC AND NANNO RICH CLAY WITH FORAM RICH BANDS
Lithology similar to core 49 - light bluish gray.

Section 1: slightly banded, bedding indistinct dip about 10°, forams sparsely scattered throughout. Pyrite crystals at 126.

Section 2: forams more abundant 80 cm to 150 cm. Soarsely scattered elsewhere.

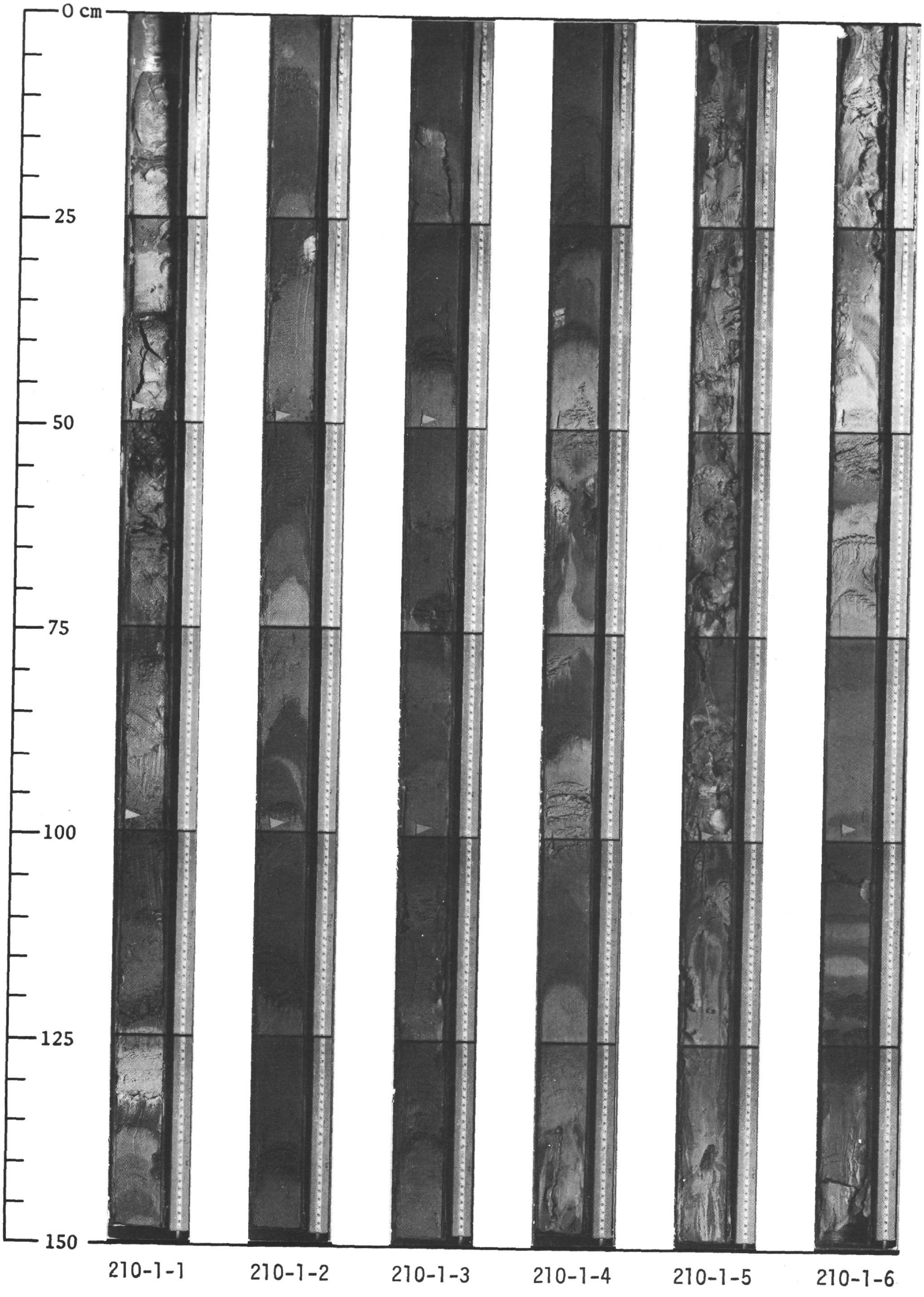
Section 3: semilithified except 117-137 which is stiff and pasty. Forams abundant 15-23, 81-84, 107-117, sparsely scattered elsewhere.

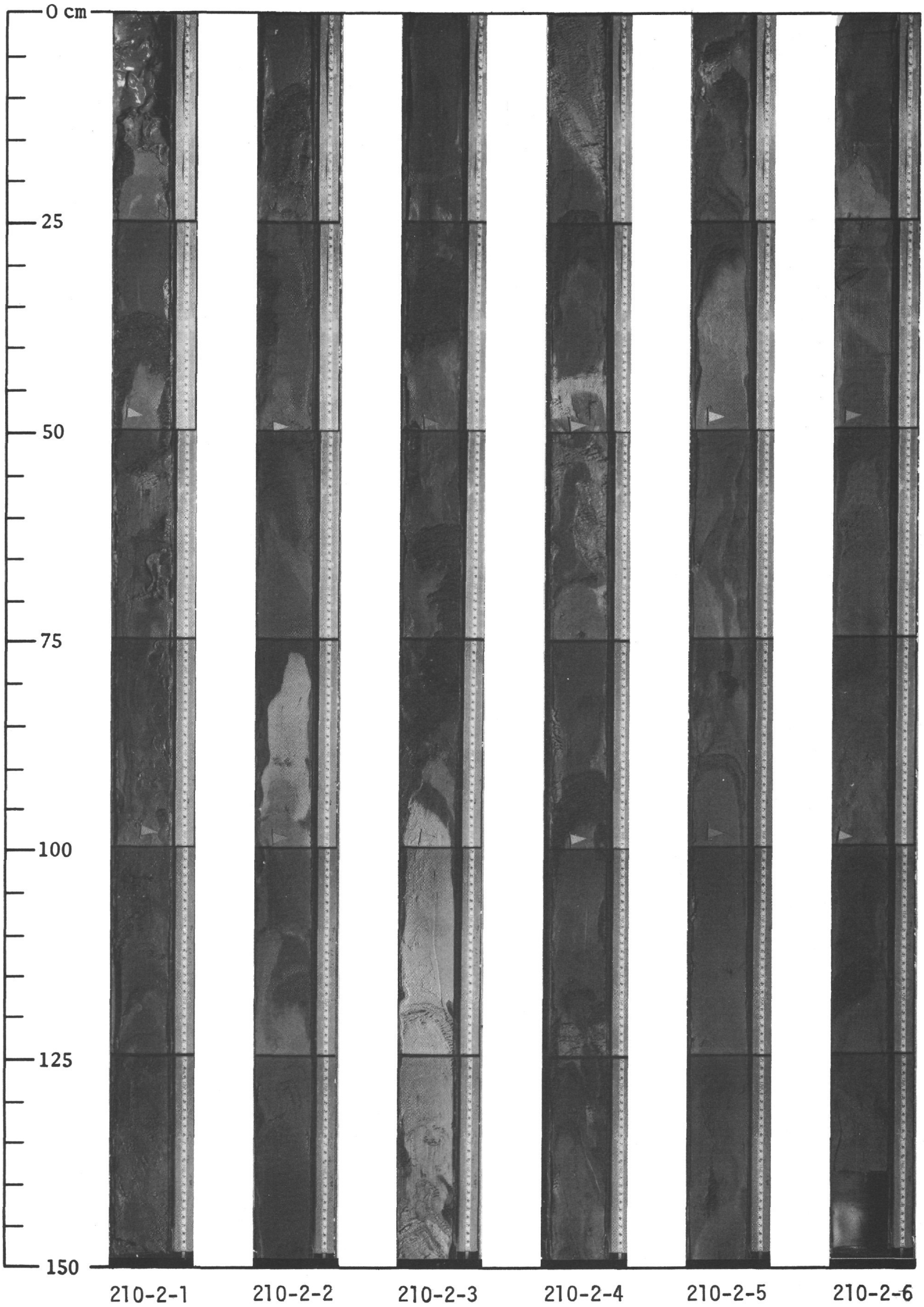
Section 4: bedding dips at about 10°, forams abundant in bands in upper half, bands make up 20% of 0-75 cm. Fine grained pyrite band at 106, common pyrite cluster at 115.

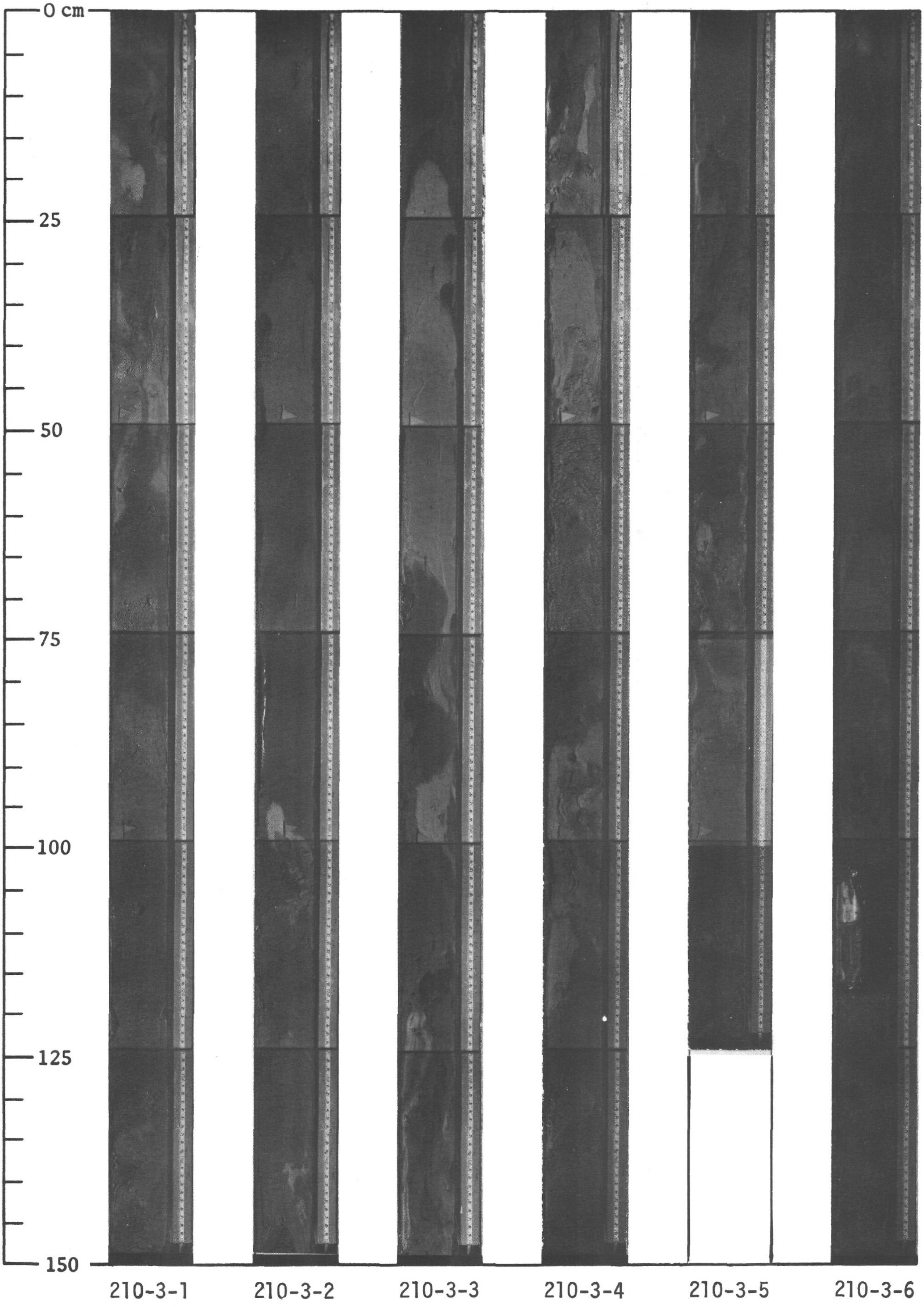
Section 5: soft and pasty 0-30 cm, otherwise semilithified, foram moderately common throughout, lenses (2mm x 1-2 cm) of fine pyrite at 47, 52, 54, 67, 68, 77 and 83 cm.

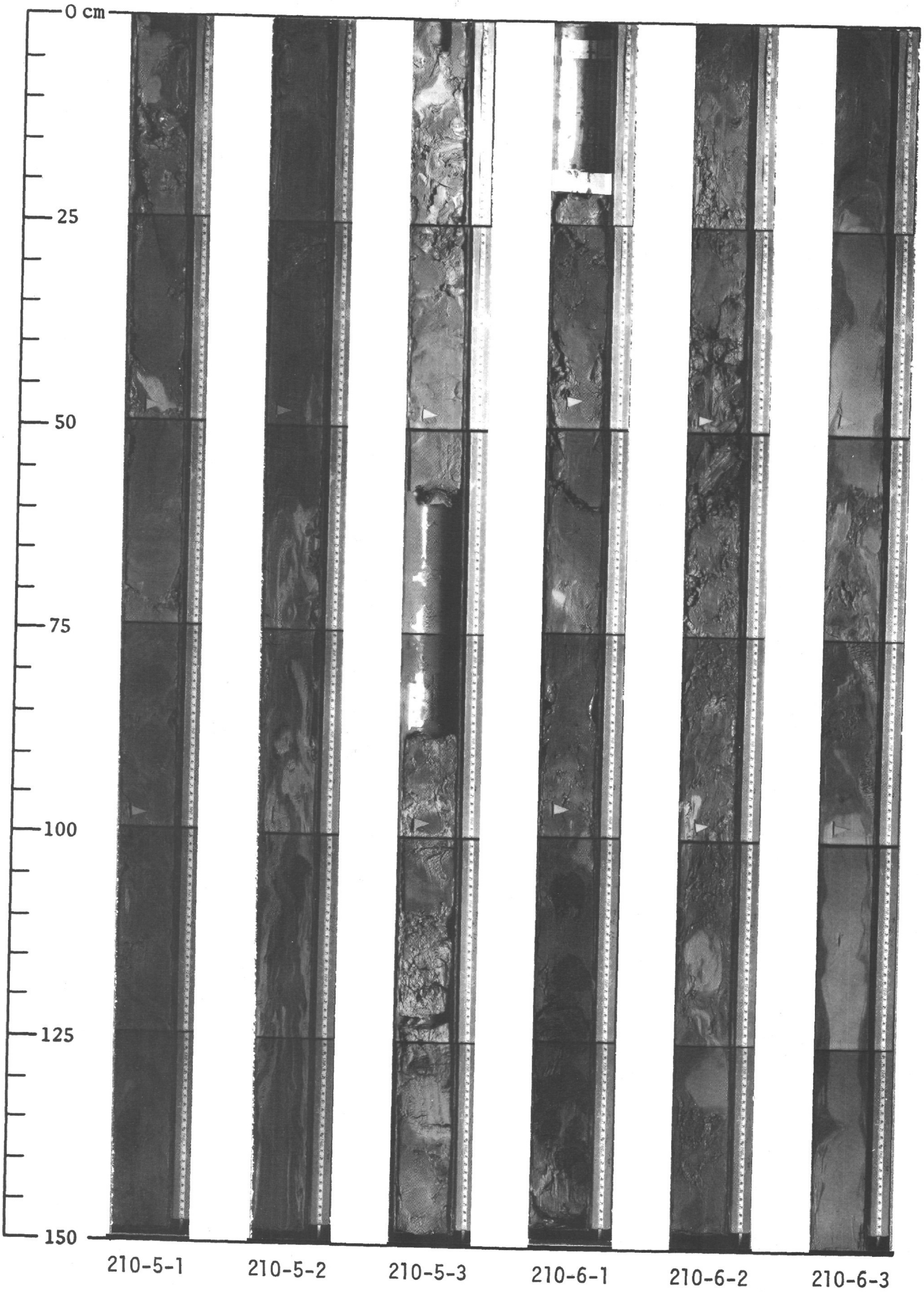
Section 6: forams common between 10 and 60 cm, fine pyrite lens at 56. Dip 5-10°, 2 fractures inclined at 45° at 35 and 55 cm.

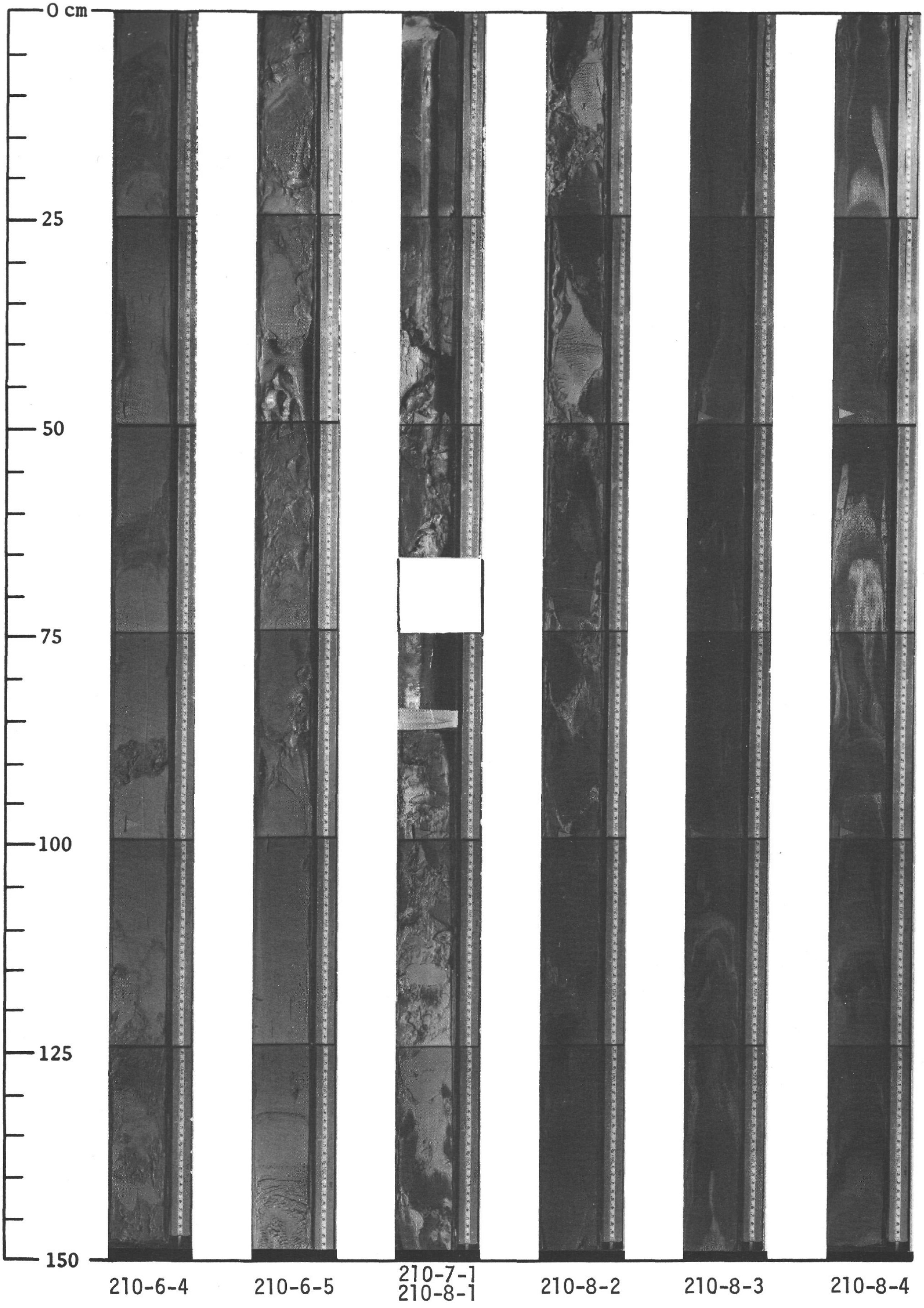
Average of about 40% carbonate in core.

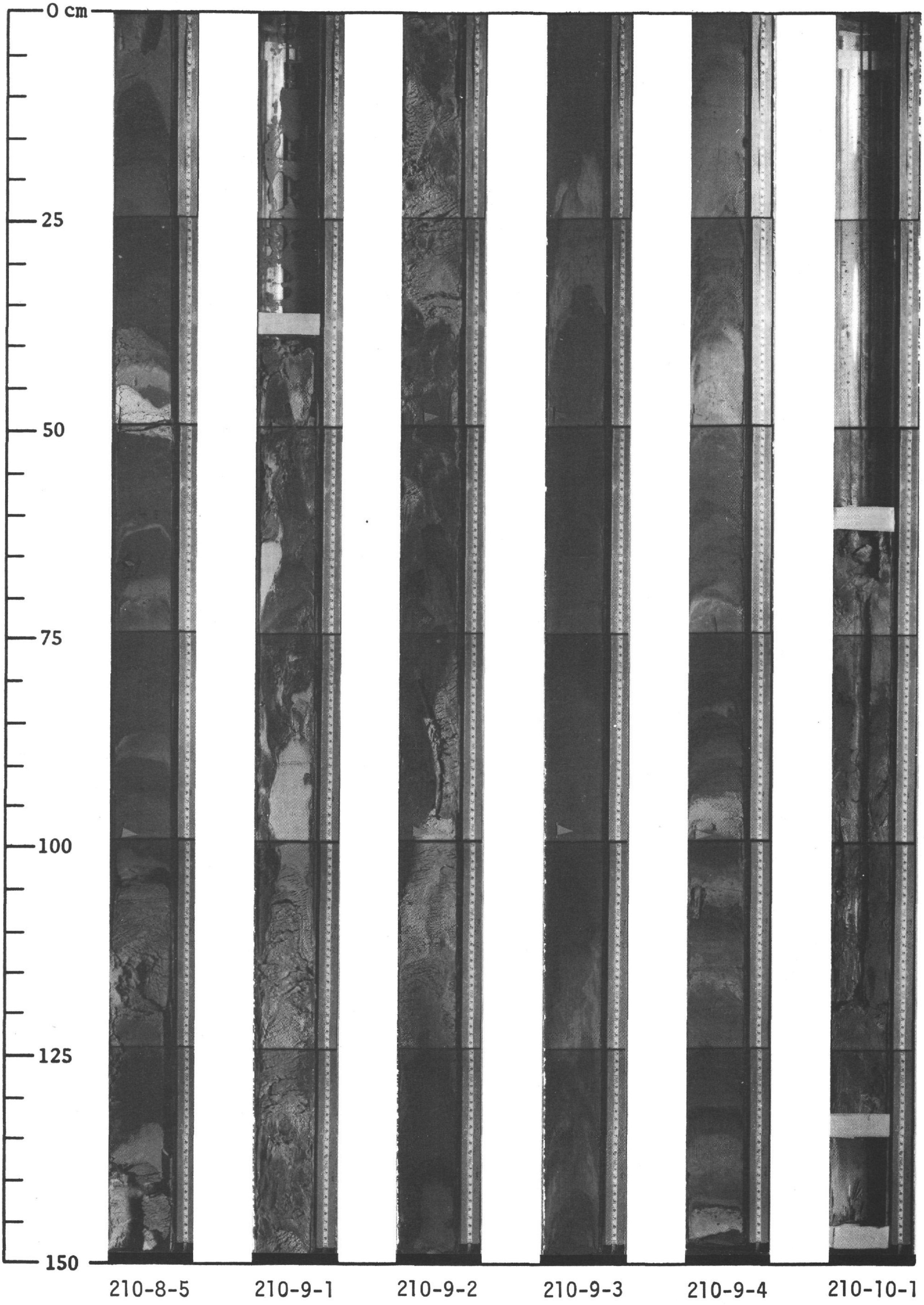

0 cm
25
50
75
100
125
150
210-1-1
210-1-2
210-1-3
210-1-4
210-1-5
210-1-6

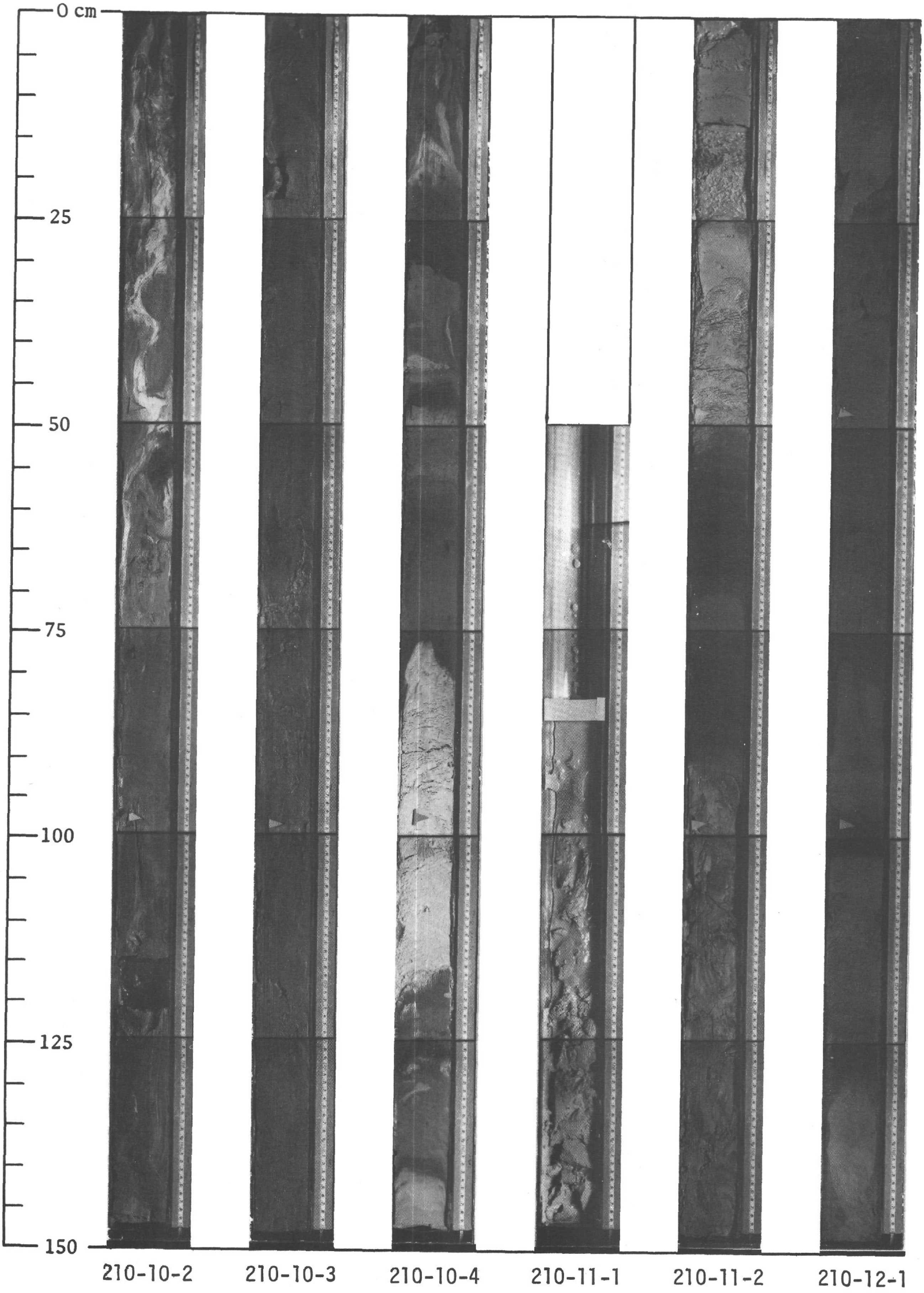

0 cm
25
50
75
100
125
150
210-2-1
210-2-2
210-2-3
210-2-4
210-2-5
210-2-6

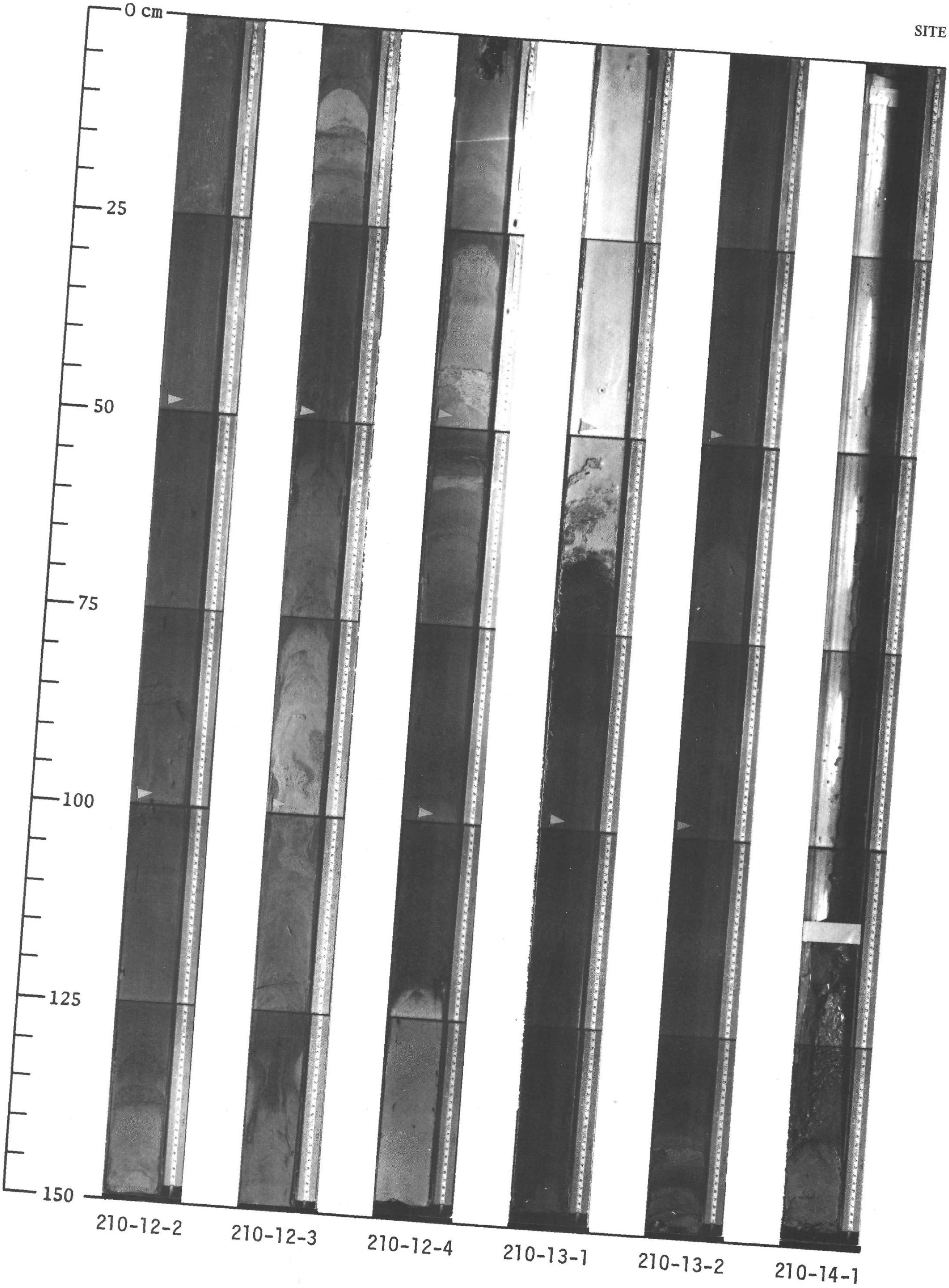

0 cm
25
50
75
100
125
150
210-3-1
210-3-2
210-3-3
210-3-4
210-3-5
210-3-6

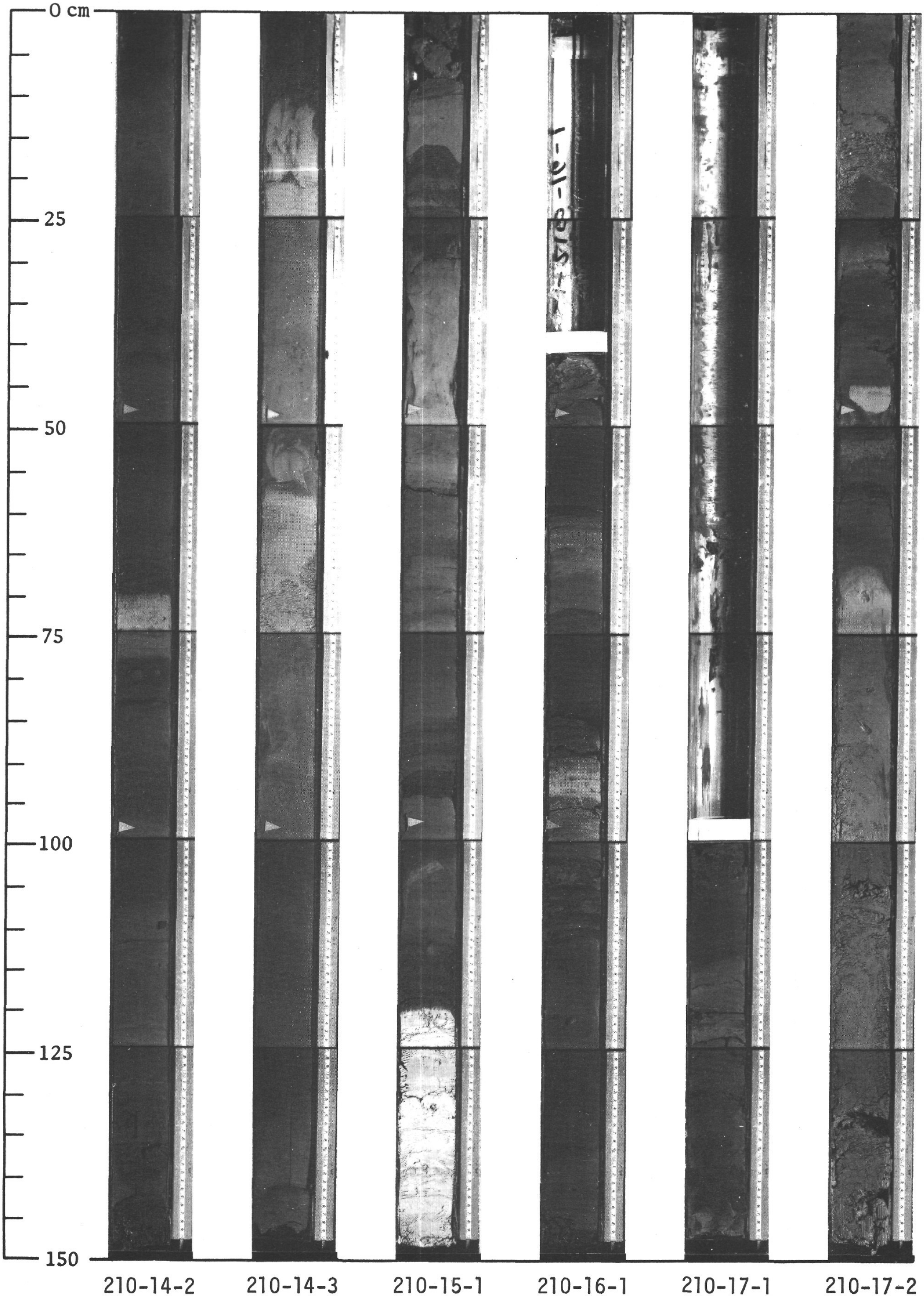

0 cm
25
50
75
100
125
150
210-5-1
210-5-2
210-5-3
210-6-1
210-6-2
210-6-3

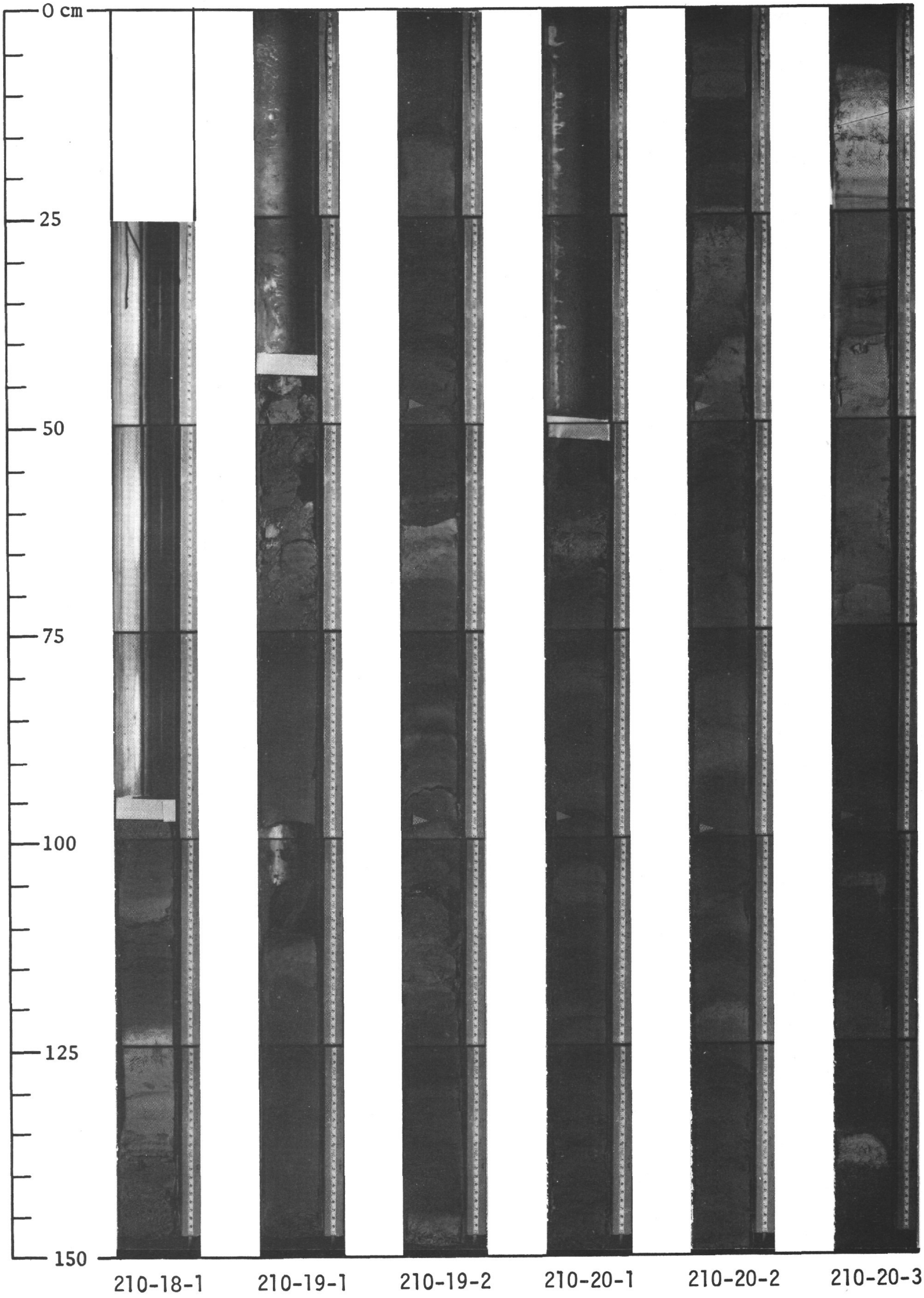

0 cm
25
50
75
100
125
150
210-6-4
210-6-5
210-7-1
210-8-1
210-8-2
210-8-3
210-8-4

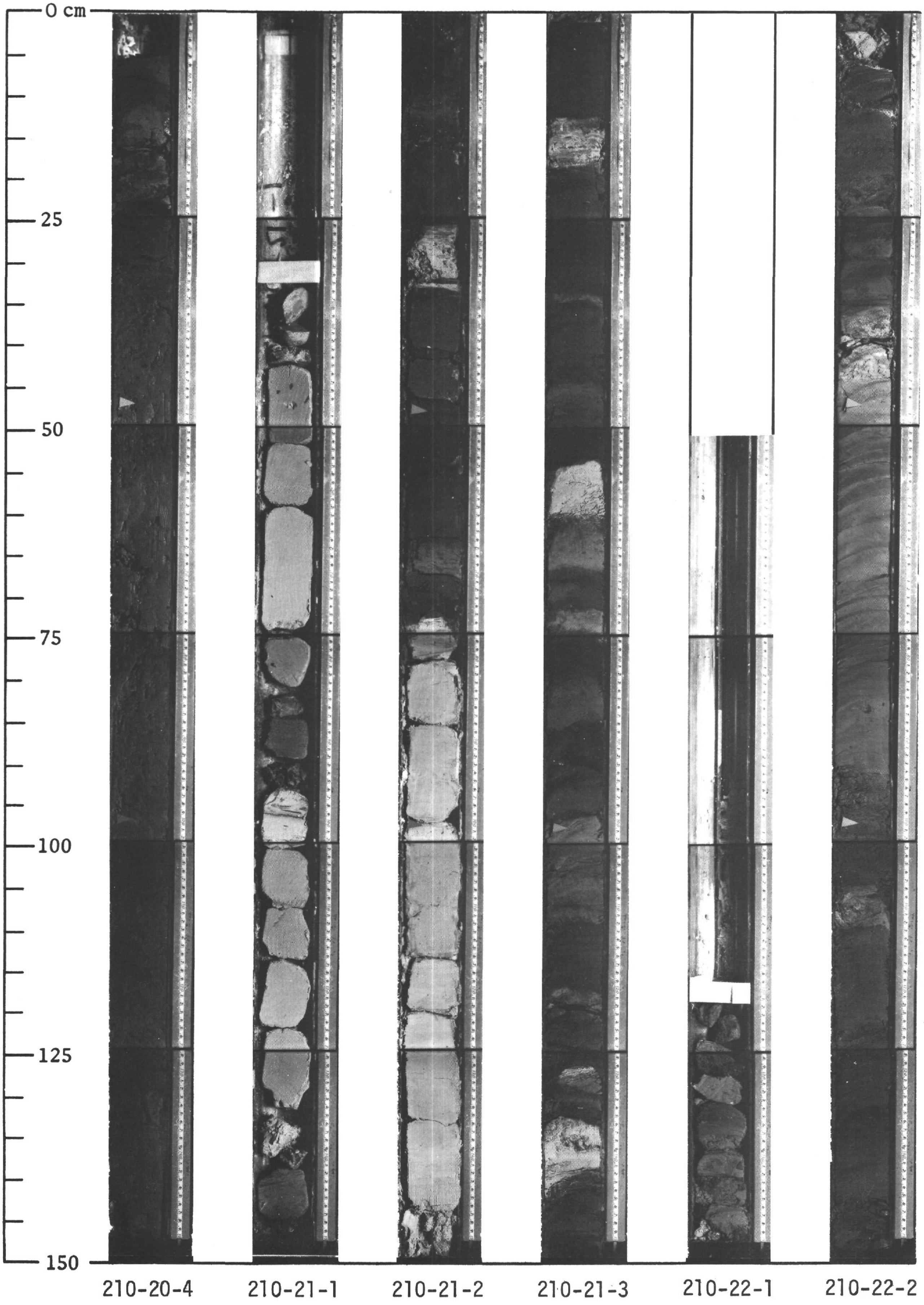

0 cm
25
50
75
100
125
150
210-8-5
210-9-1
210-9-2
210-9-3
210-9-4
210-10-1

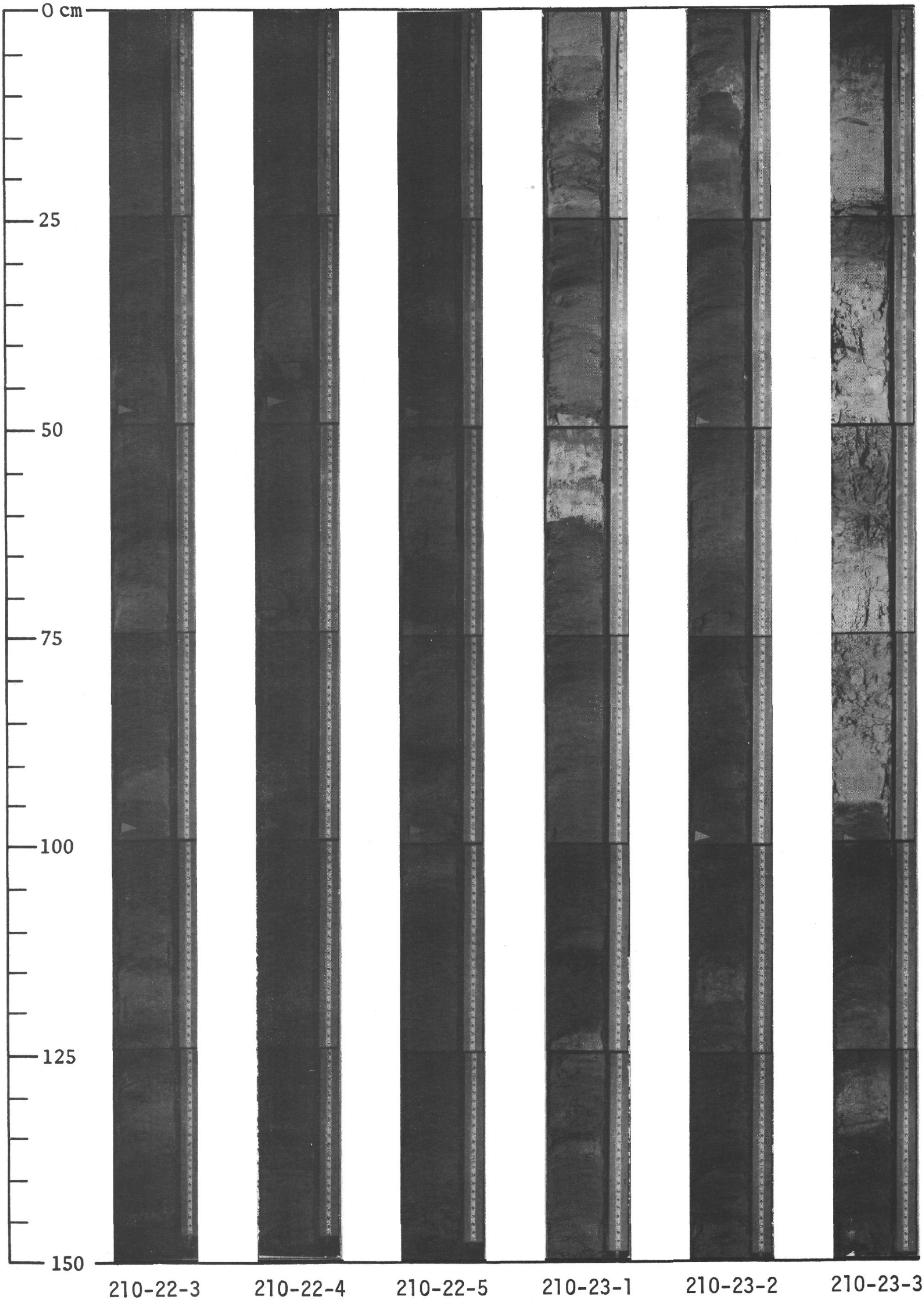

0 cm
25
50
75
100
125
150
210-10-2
210-10-3
210-10-4
210-11-1
210-11-2
210-12-1

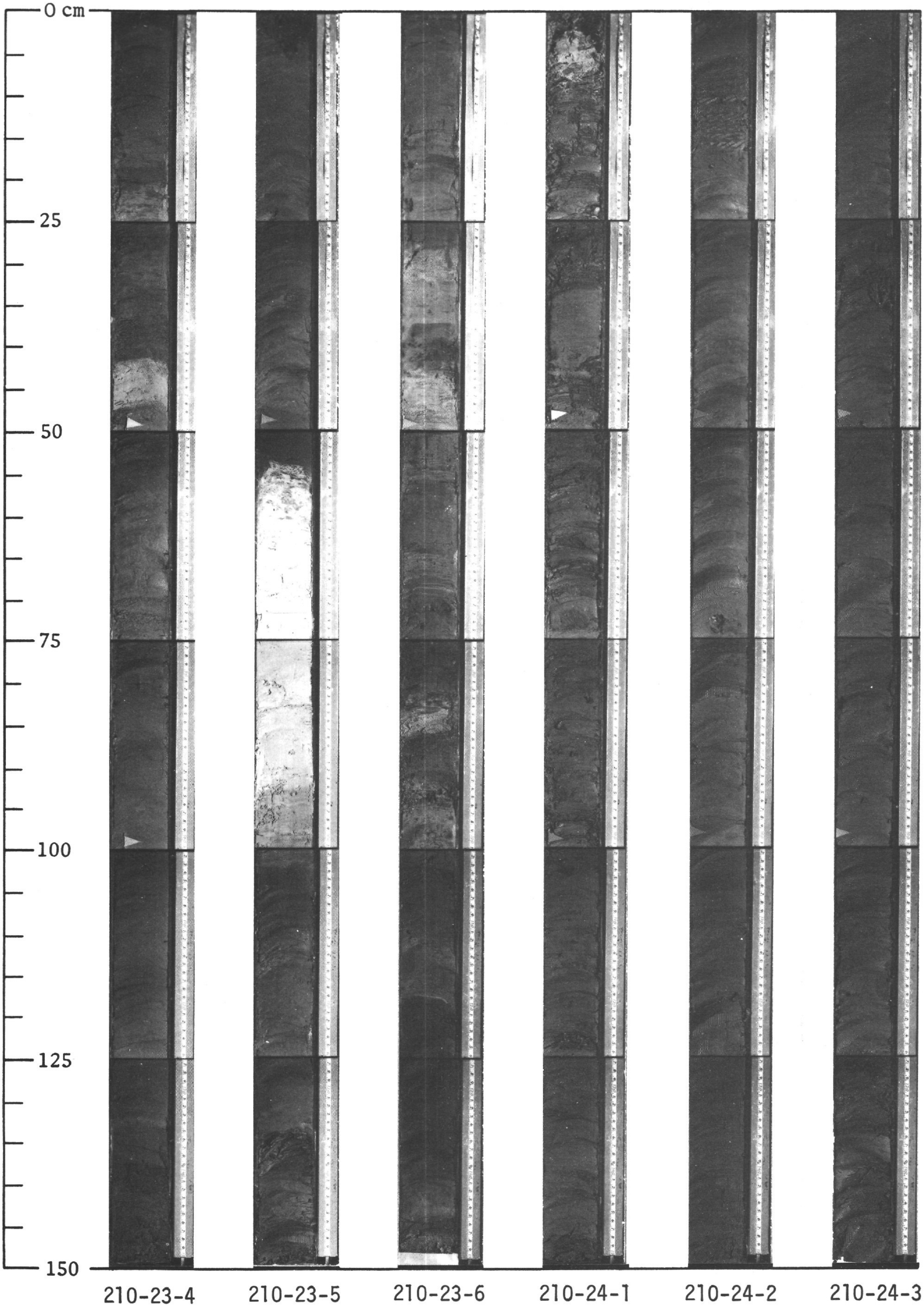

0 cm
25
50
75
100
125
150
210-12-2
210-12-3
210-12-4
210-13-1
210-13-2
210-14-1

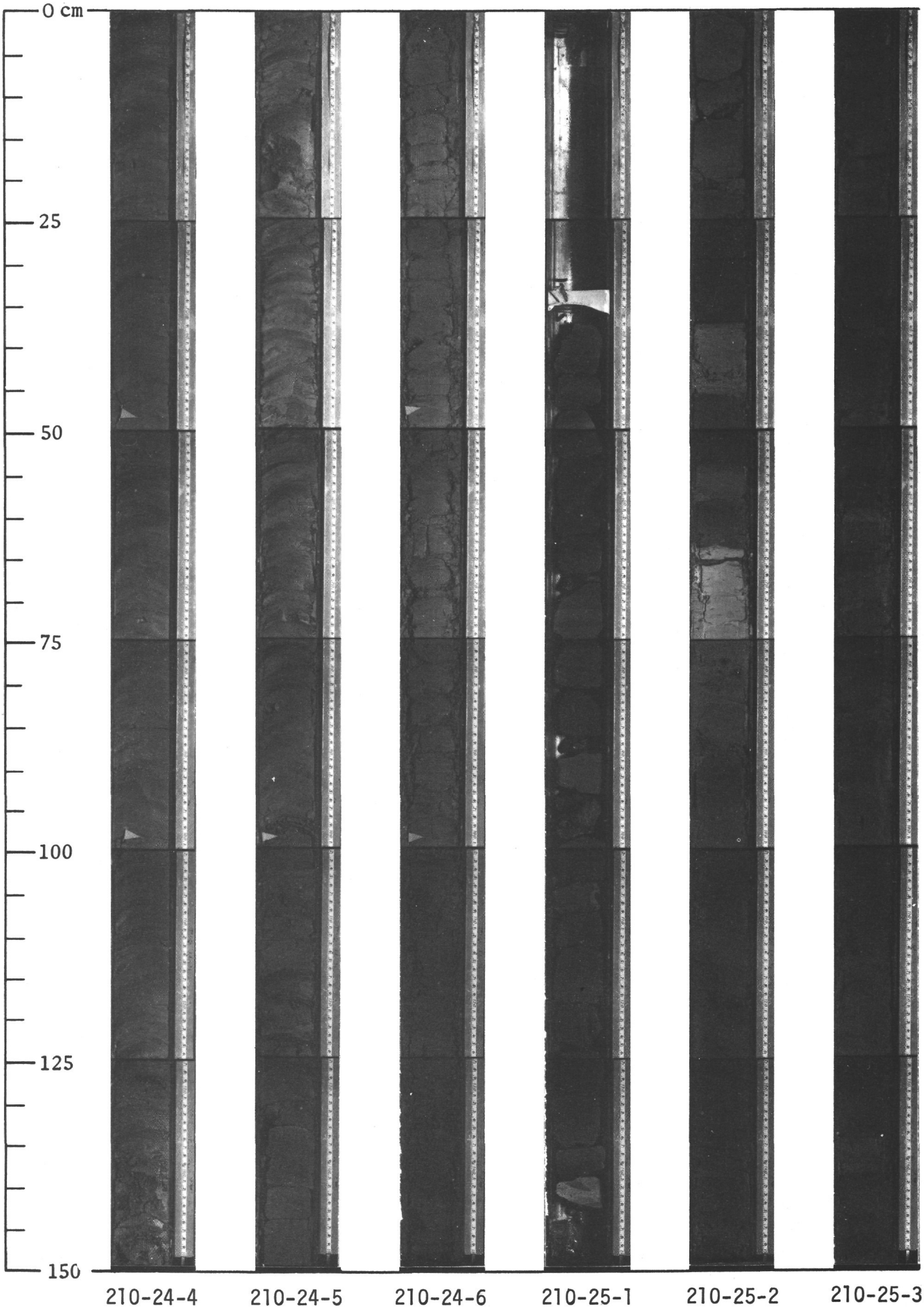

0 cm
25
50
75
100
125
150
210-14-2
210-14-3
210-15-1
210-16-1
210-17-1
210-17-2

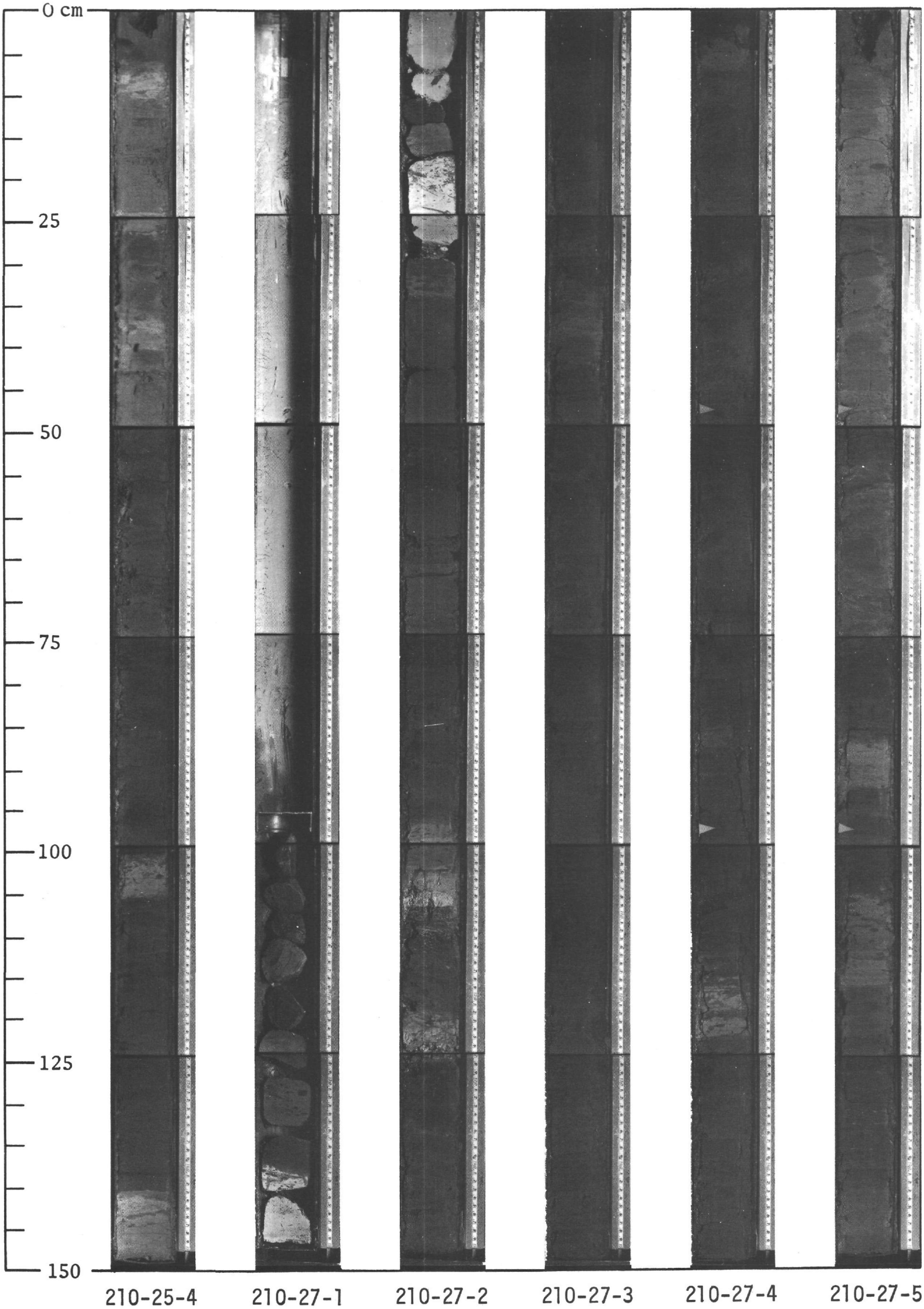

0 cm
25
50
75
100
125
150
210-18-1
210-19-1
210-19-2
210-20-1
210-20-2
210-20-3

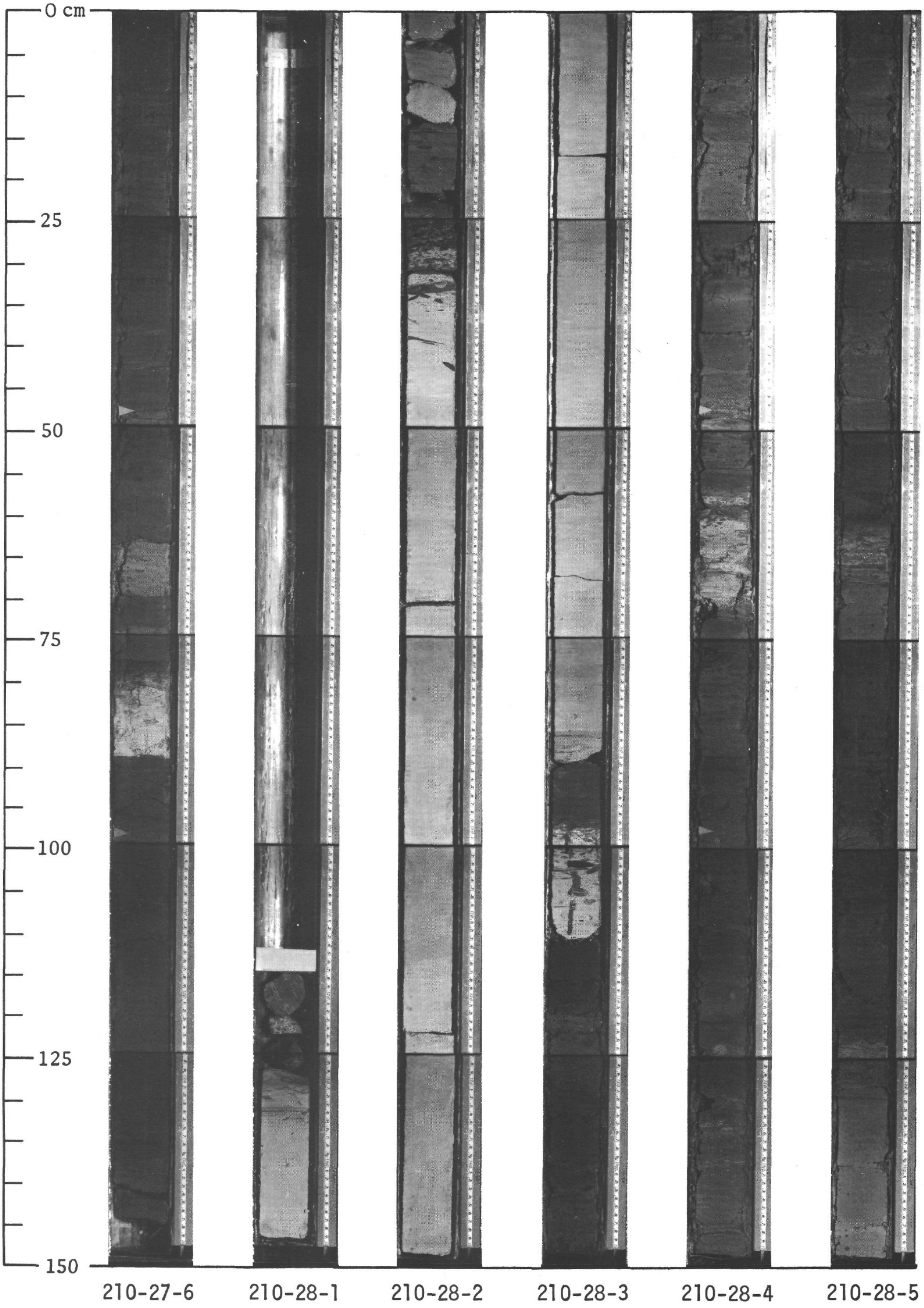

0 cm
25
50
75
100
125
150
210-20-4
210-21-1
210-21-2
210-21-3
210-22-1
210-22-2

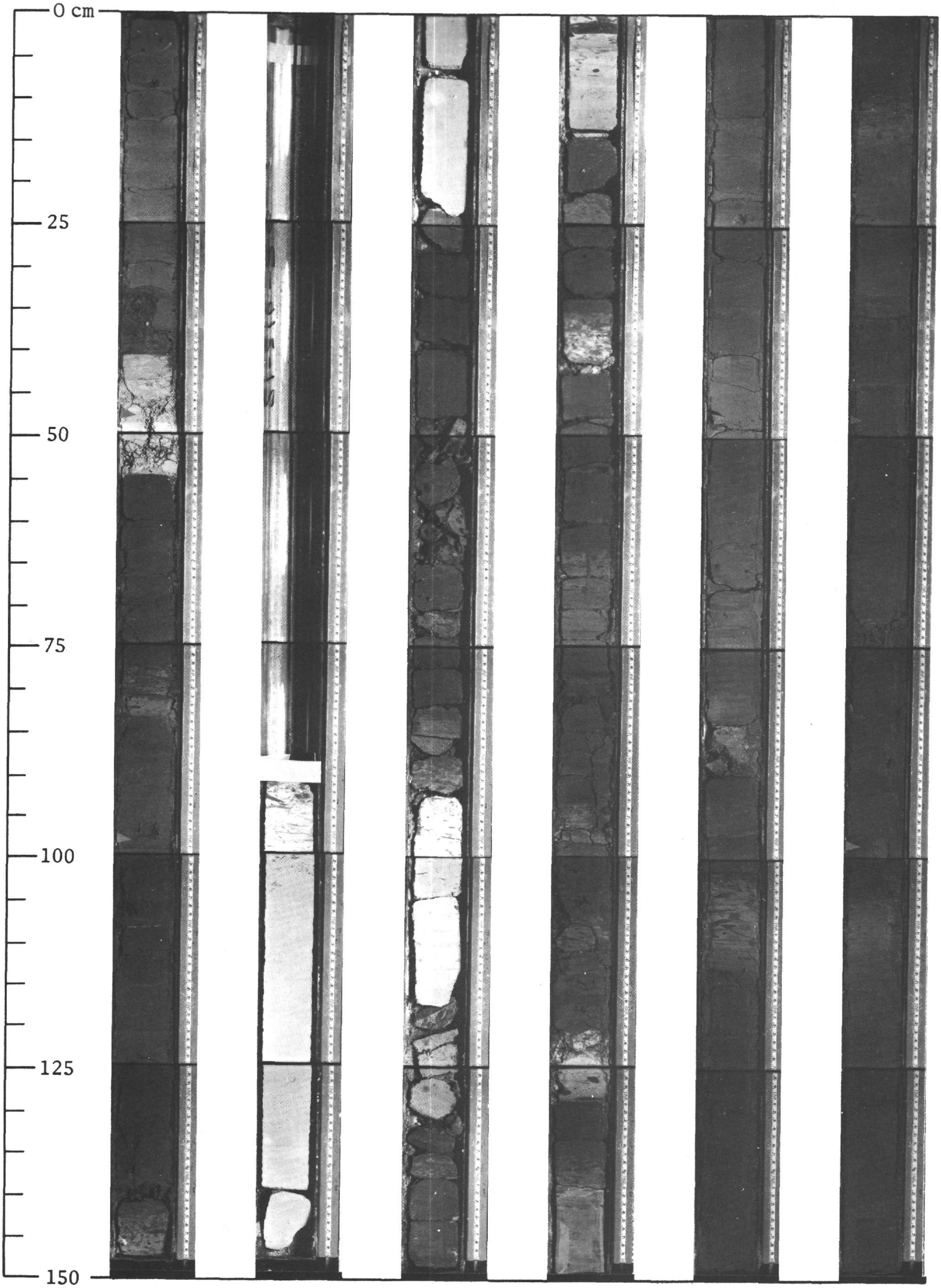

0 cm
25
50
75
100
125
150
210-22-3
210-22-4
210-22-5
210-23-1
210-23-2
210-23-3

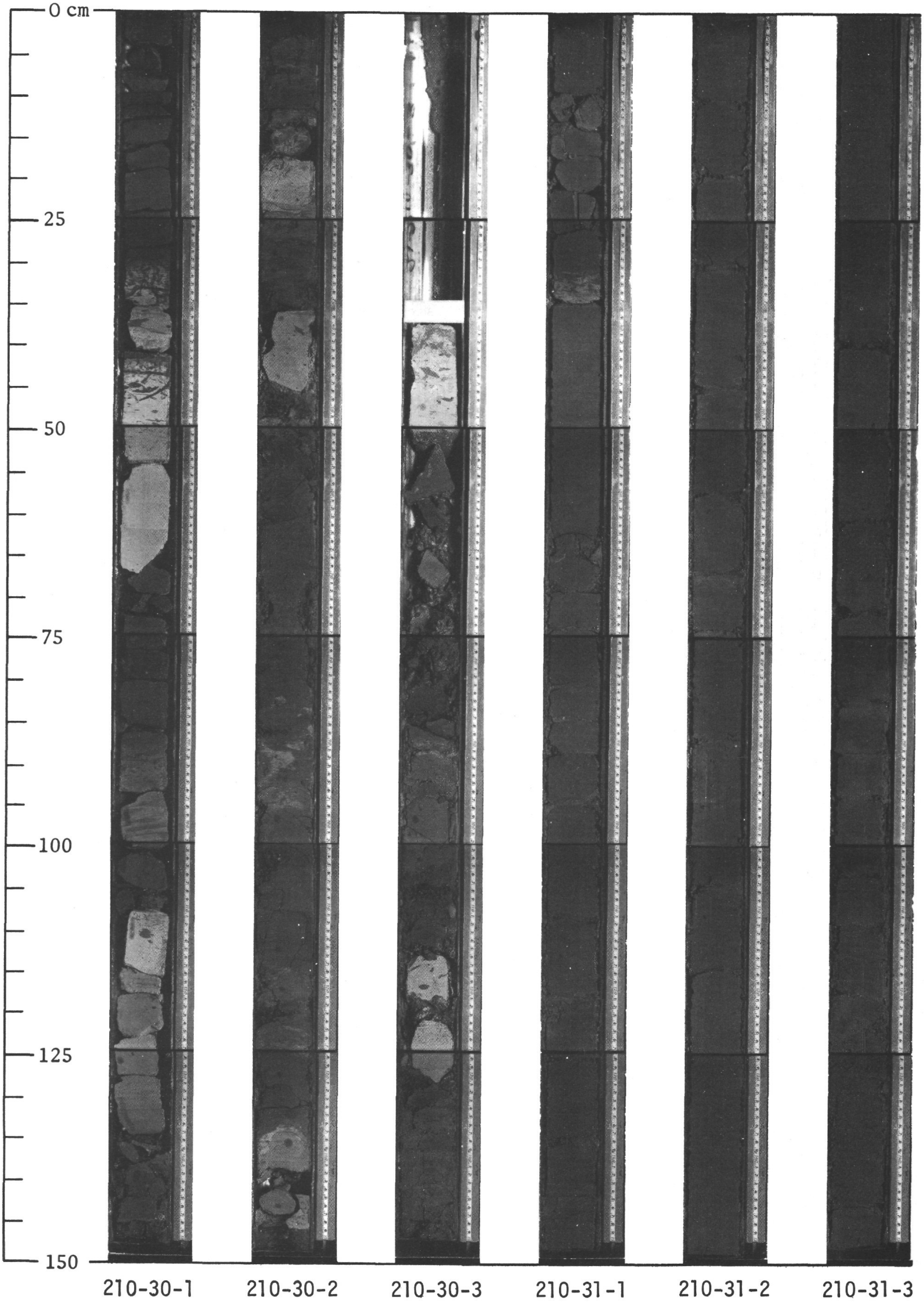

0 cm
25
50
75
100
125
150
210-23-4
210-23-5
210-23-6
210-24-1
210-24-2
210-24-3

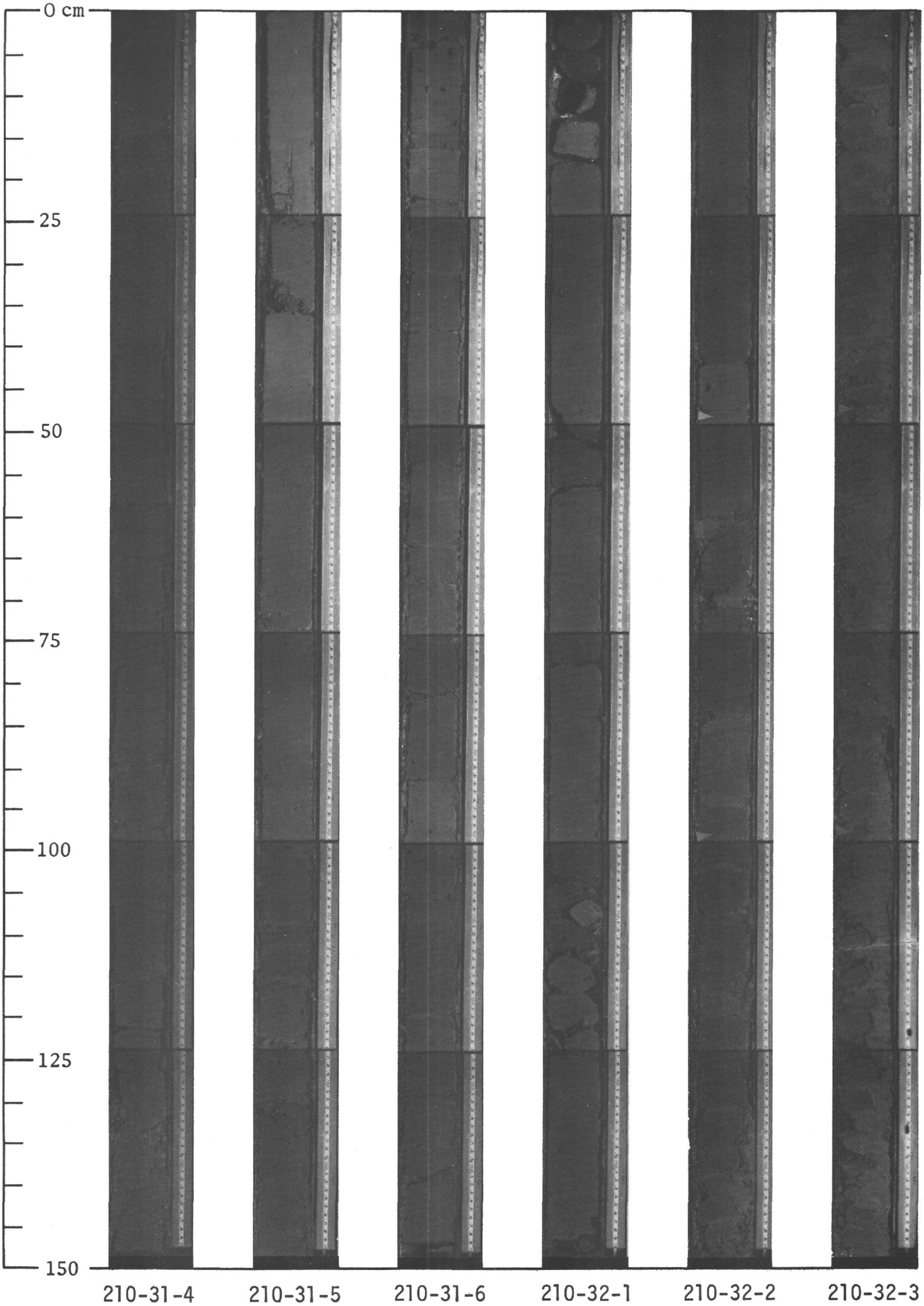

0 cm
25
50
75
100
125
150
210-24-4
210-24-5
210-24-6
210-25-1
210-25-2
210-25-3

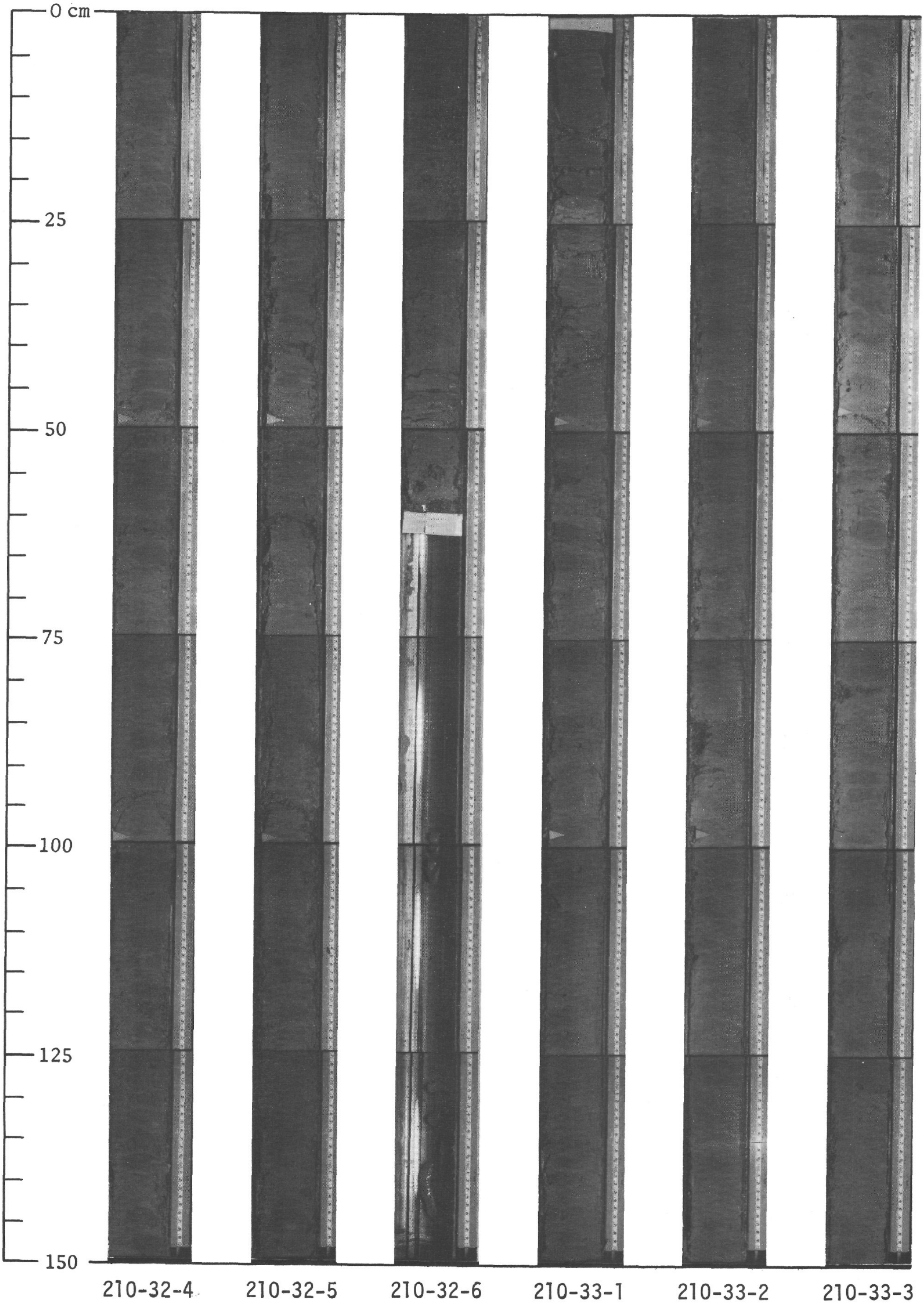

0 cm
25
50
75
100
125
150
210-25-4
210-27-1
210-27-2
210-27-3
210-27-4
210-27-5

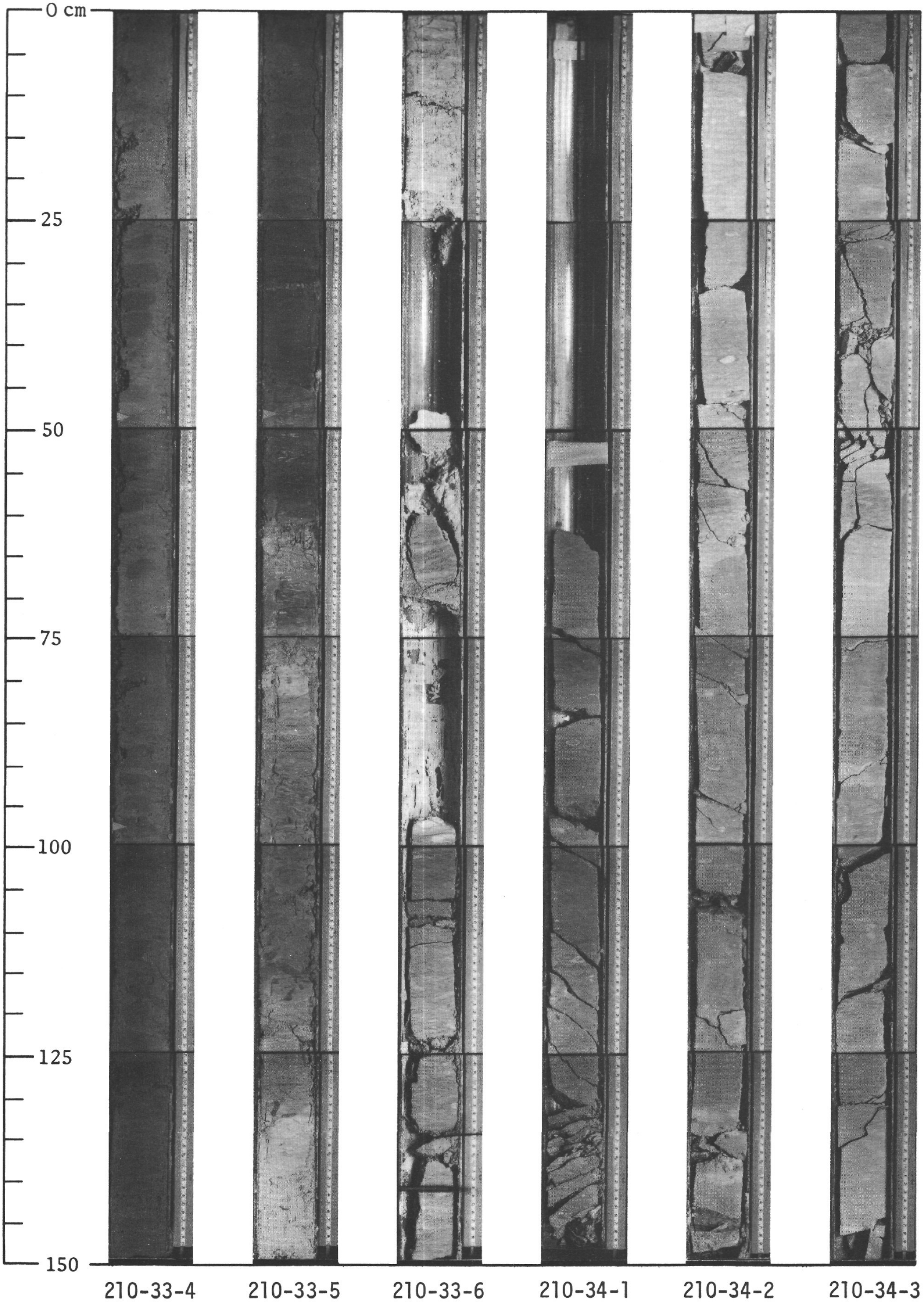

0 cm
25
50
75
100
125
150
210-27-6
210-28-1
210-28-2
210-28-3
210-28-4
210-28-5

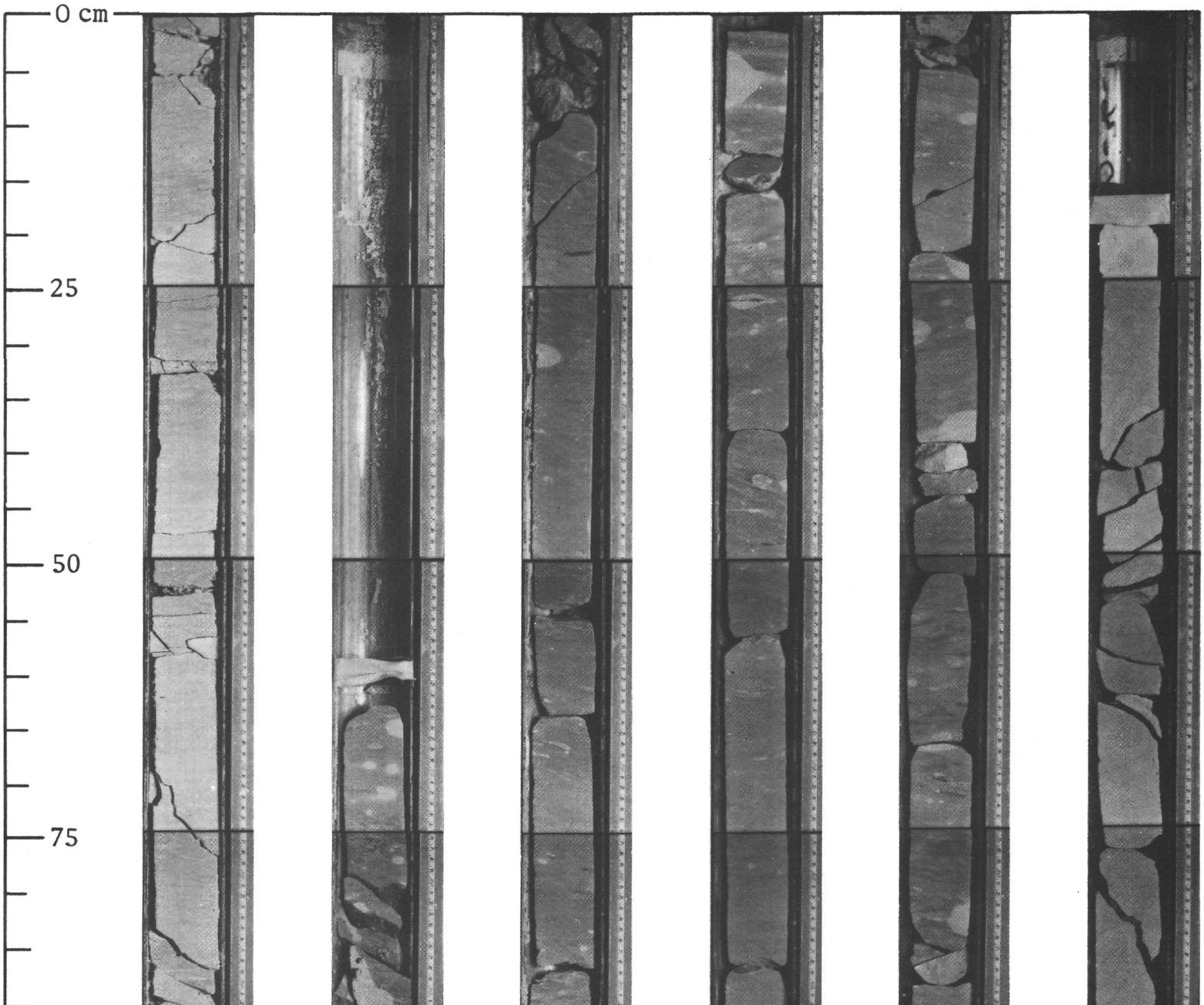

0 cm
25
50
75
100
125
150
210-28-6
210-29-1
210-29-2
210-29-3
210-29-4
210-29-5

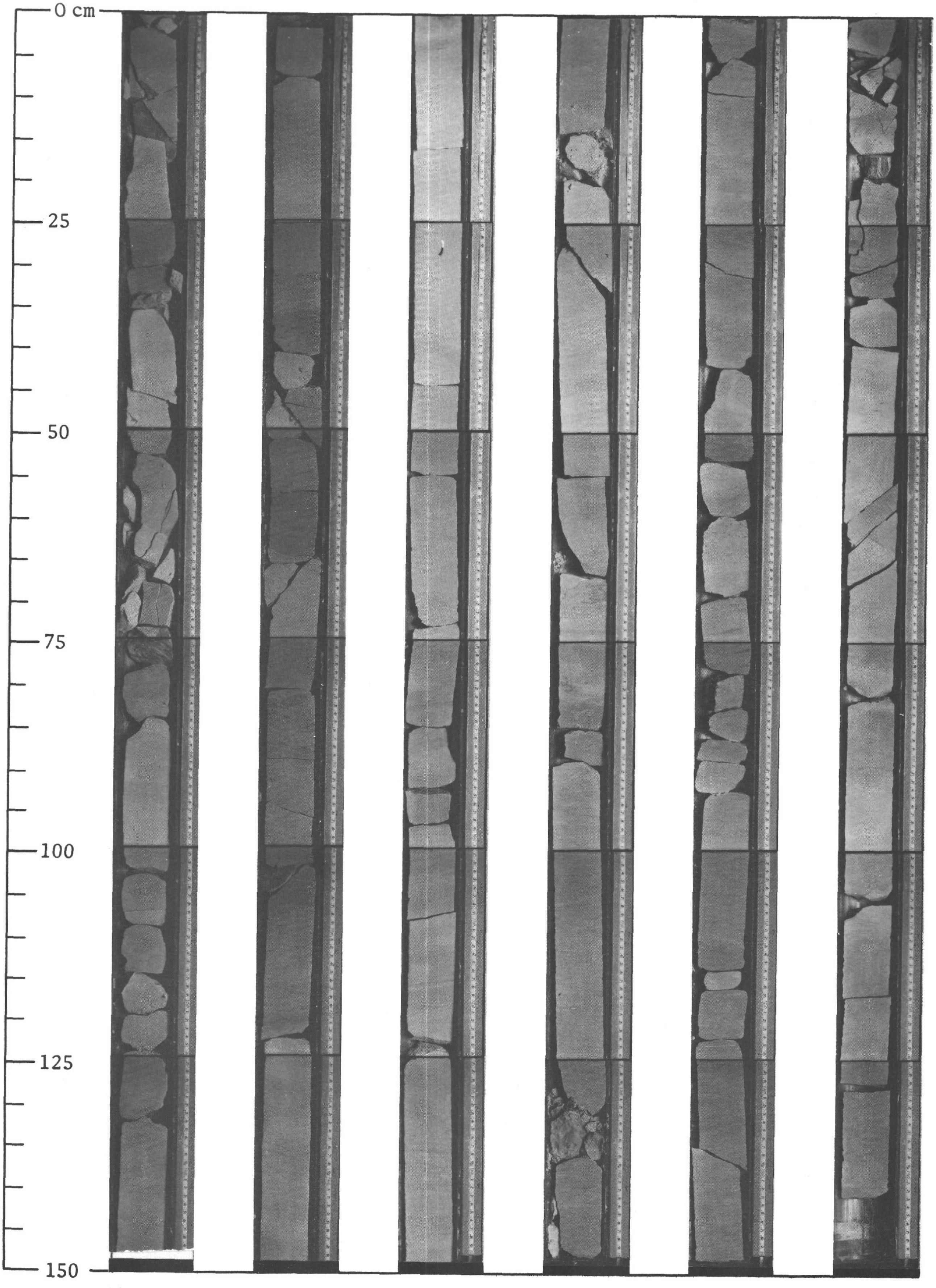

0 cm
25
50
75
100
125
150
210-30-1
210-30-2
210-30-3
210-31-1
210-31-2
210-31-3

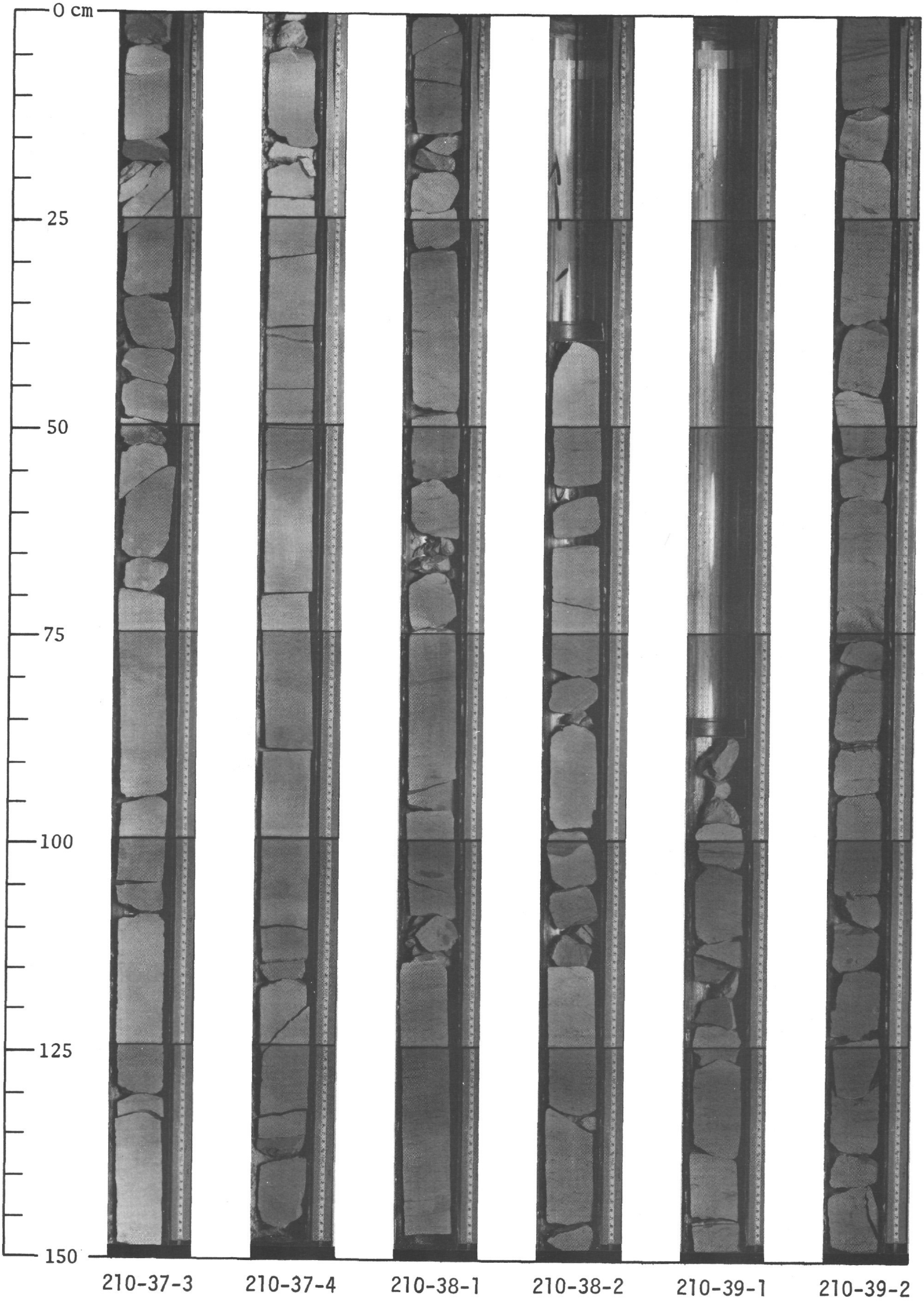

0 cm
25
50
75
100
125
150
210-31-4
210-31-5
210-31-6
210-32-1
210-32-2
210-32-3


0 cm
25
50
75
100
125
150
210-32-4
210-32-5
210-32-6
210-33-1
210-33-2
210-33-3

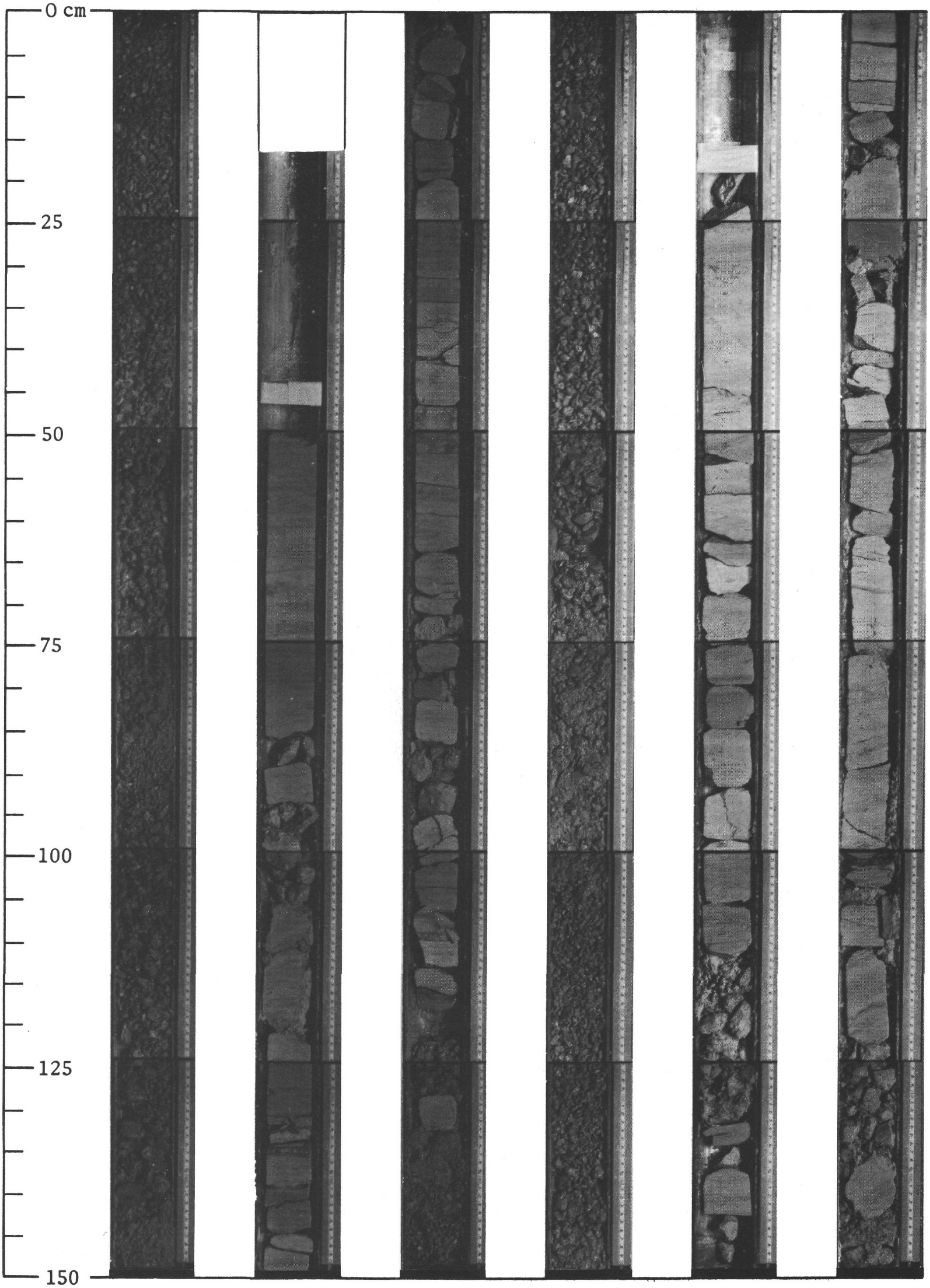

0 cm
25
50
75
100
125
150
210-33-4
210-33-5
210-33-6
210-34-1
210-34-2
210-34-3

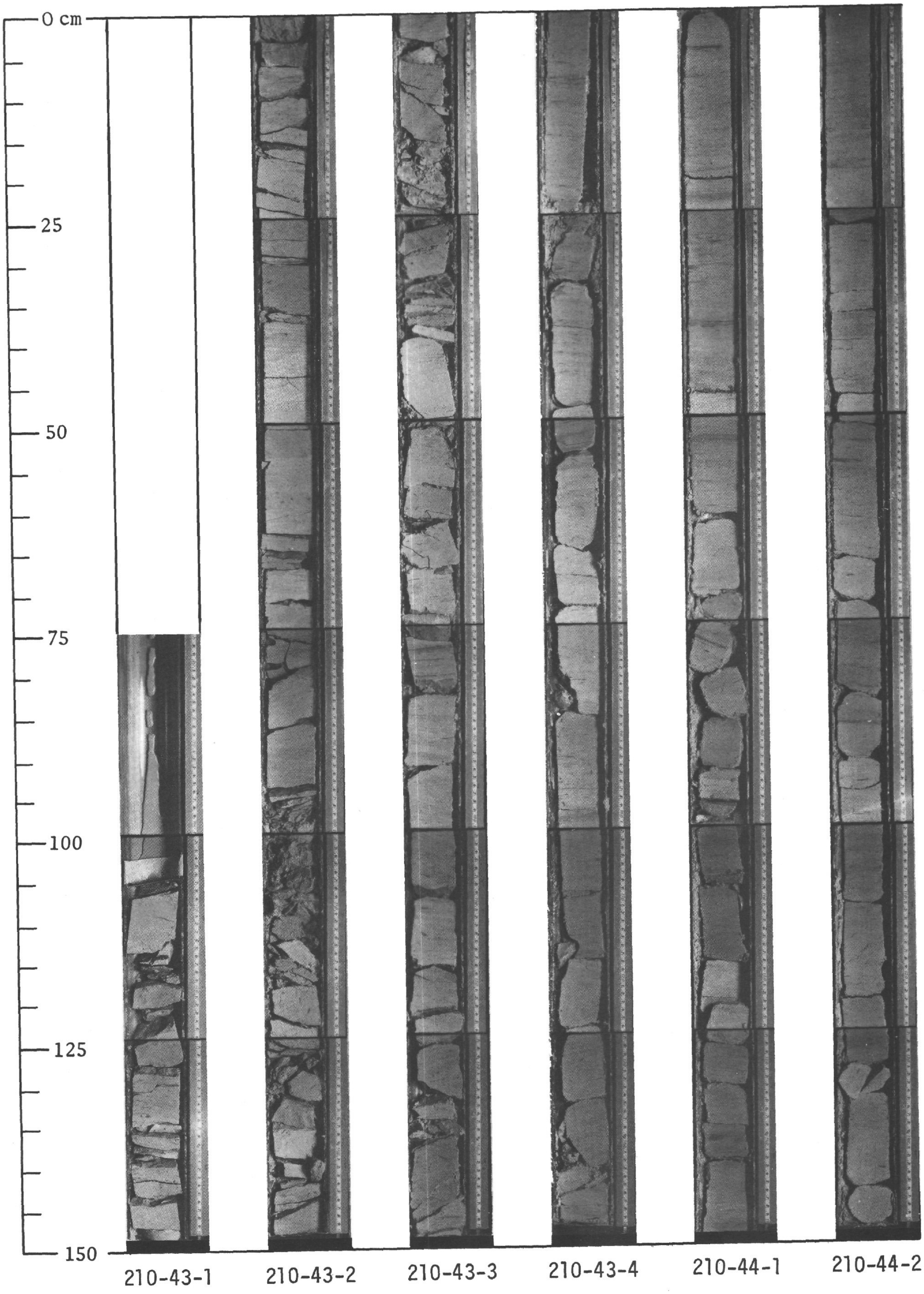

0 cm
25
50
75
100
125
150
210-34-4
210-35-1
210-35-2
210-35-3
210-35-4
210-36-1

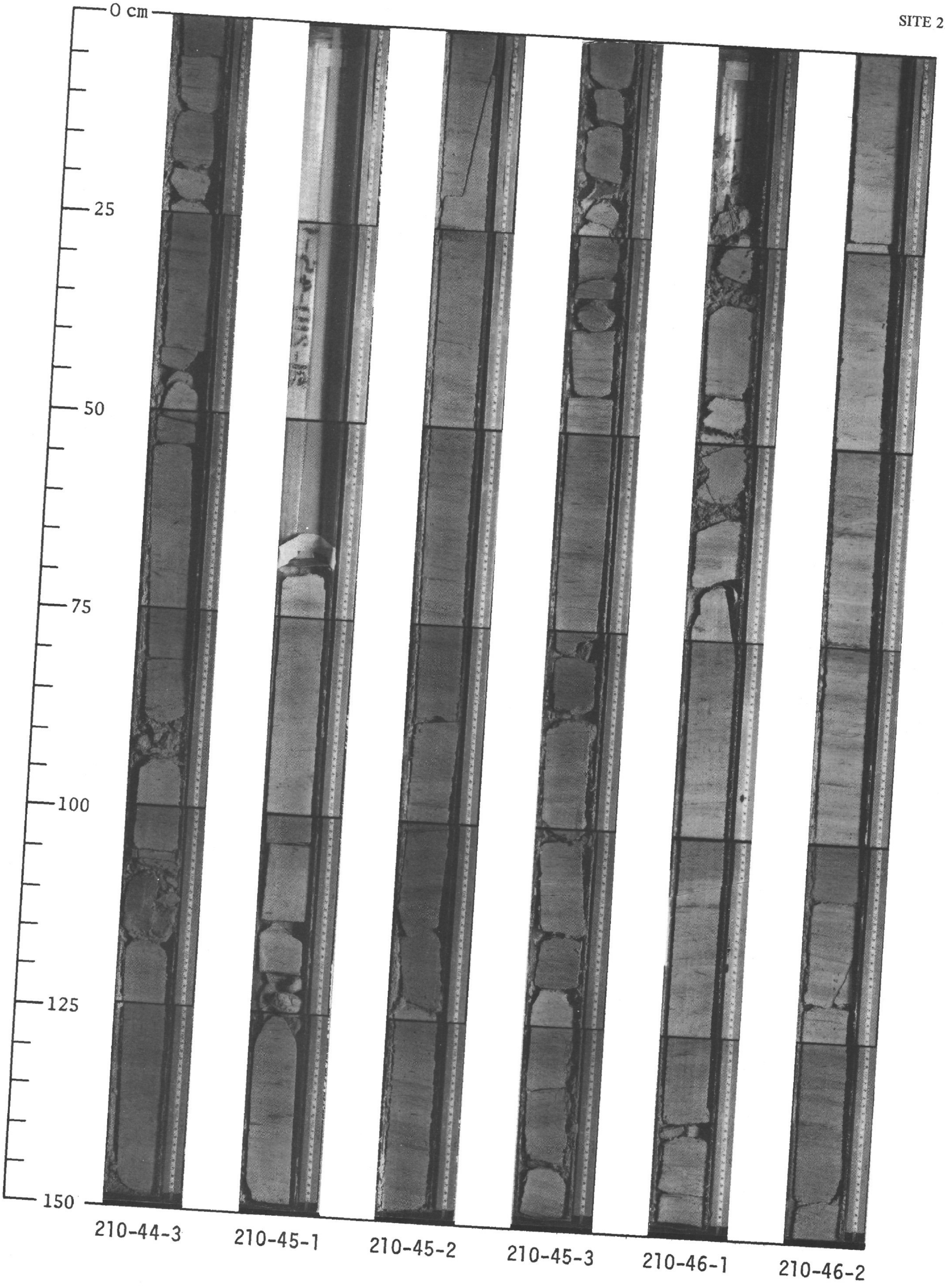

0 cm
25
50
75
100
125
150
210-36-2
210-36-3
210-36-4
210-36-5
210-37-1
210-37-2

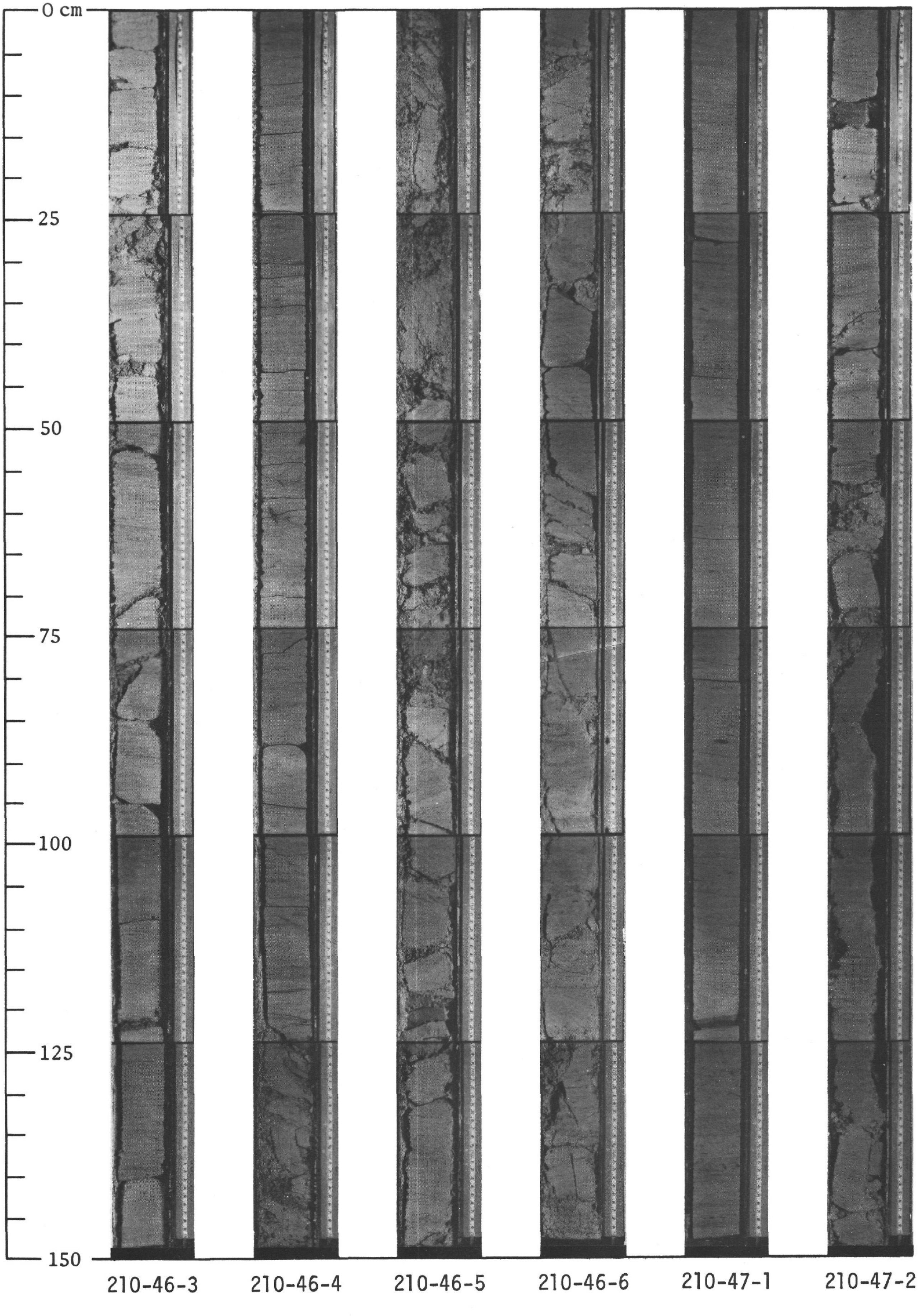

0 cm
25
50
75
100
125
150
210-37-3
210-37-4
210-38-1
210-38-2
210-39-1
210-39-2

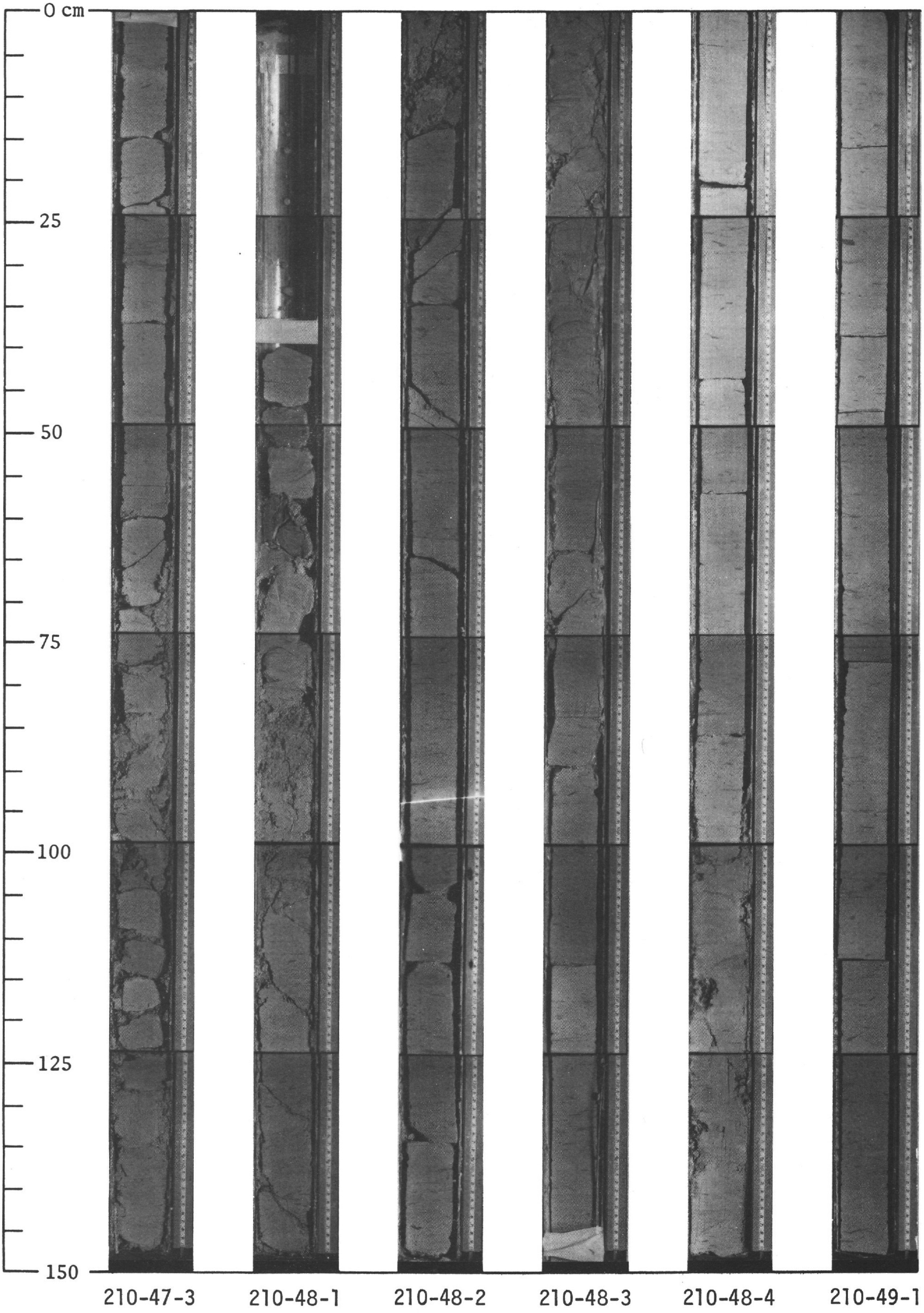

0 cm
25
50
75
100
125
150
210-39-3
210-40-1
210-40-2
210-40-3
210-40-4
210-40-5

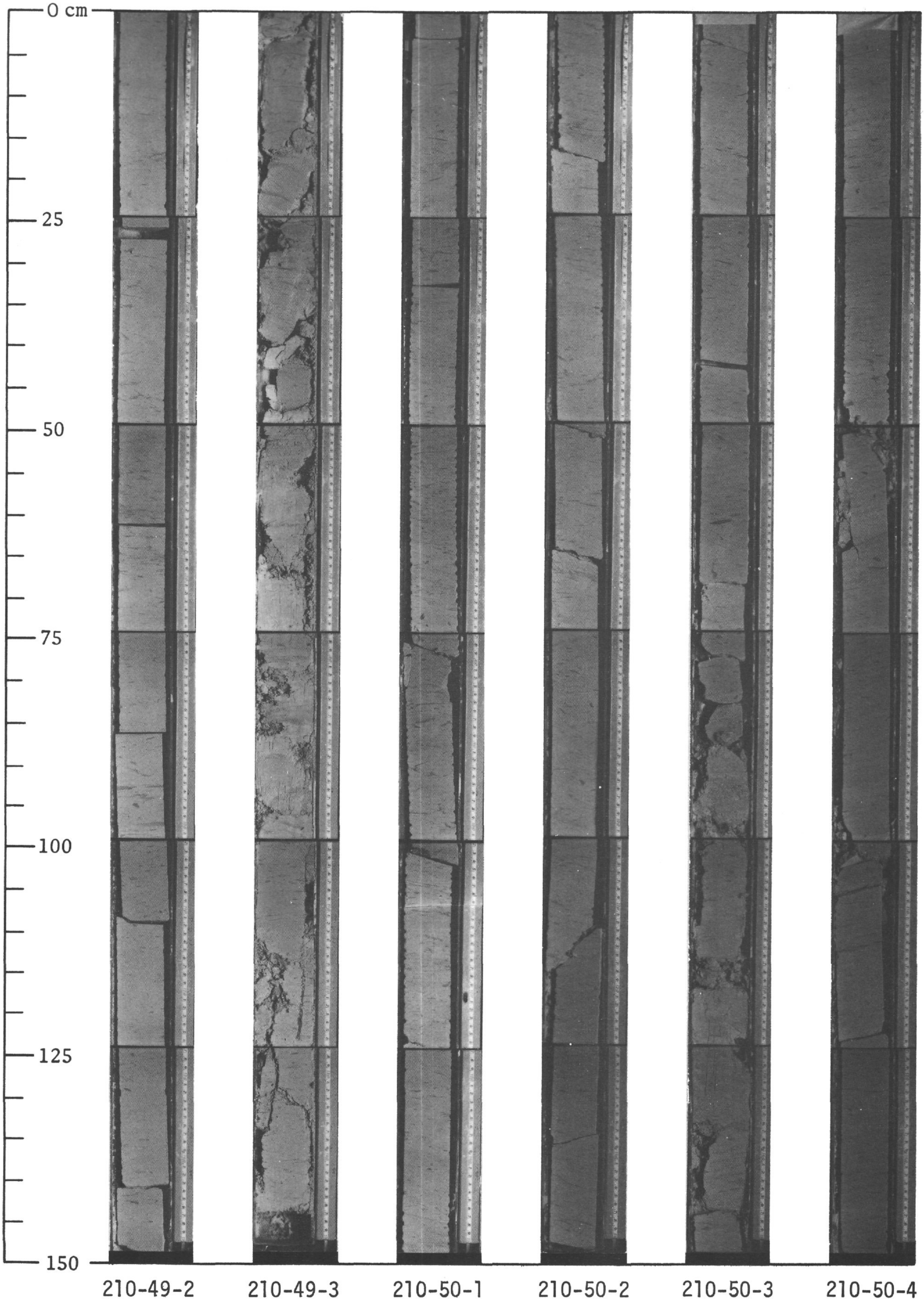

0 cm
25
50
75
100
125
150
210-40-6
210-41-1
210-41-2
210-41-3
210-42-1
210-42-2

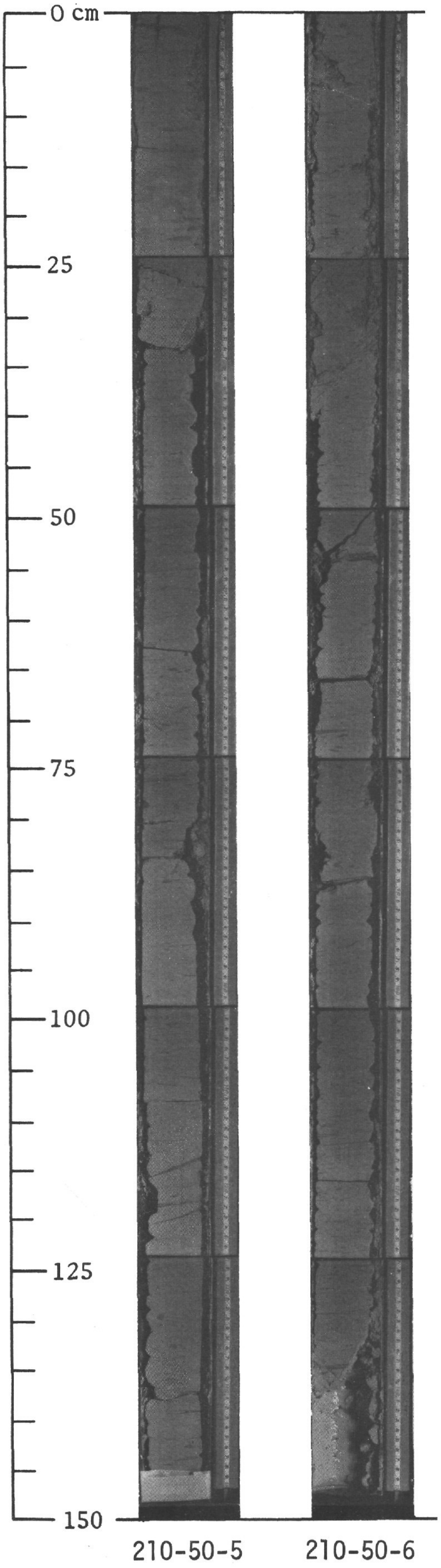

0 cm
25
50
75
100
125
150
210-43-1
210-43-2
210-43-3
210-43-4
210-44-1
210-44-2


0 cm
25
50
75
100
125
150
210-44-3
210-45-1
210-45-2
210-45-3
210-46-1
210-46-2

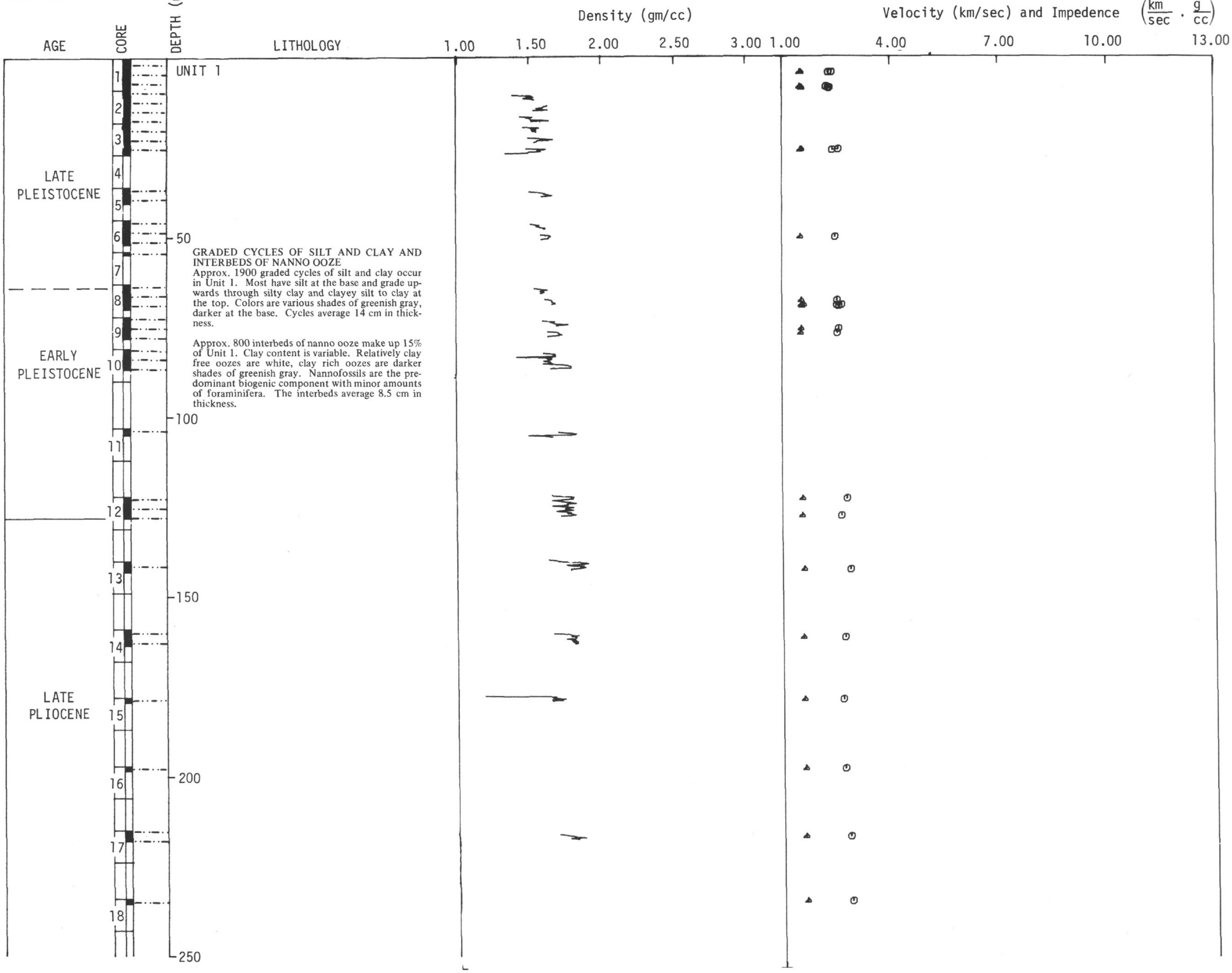

0 cm
25
50
75
100
125
150
210-46-3
210-46-4
210-46-5
210-46-6
210-47-1
210-47-2


0 cm
25
50
75
100
125
150
210-47-3
210-48-1
210-48-2
210-48-3
210-48-4
210-49-1


0 cm
25
50
75
100
125
150
210-49-2
210-49-3
210-50-1
210-50-2
210-50-3
210-50-4


0 cm
25
50
75
100
125
150
210-50-5
210-50-6

SITE 210

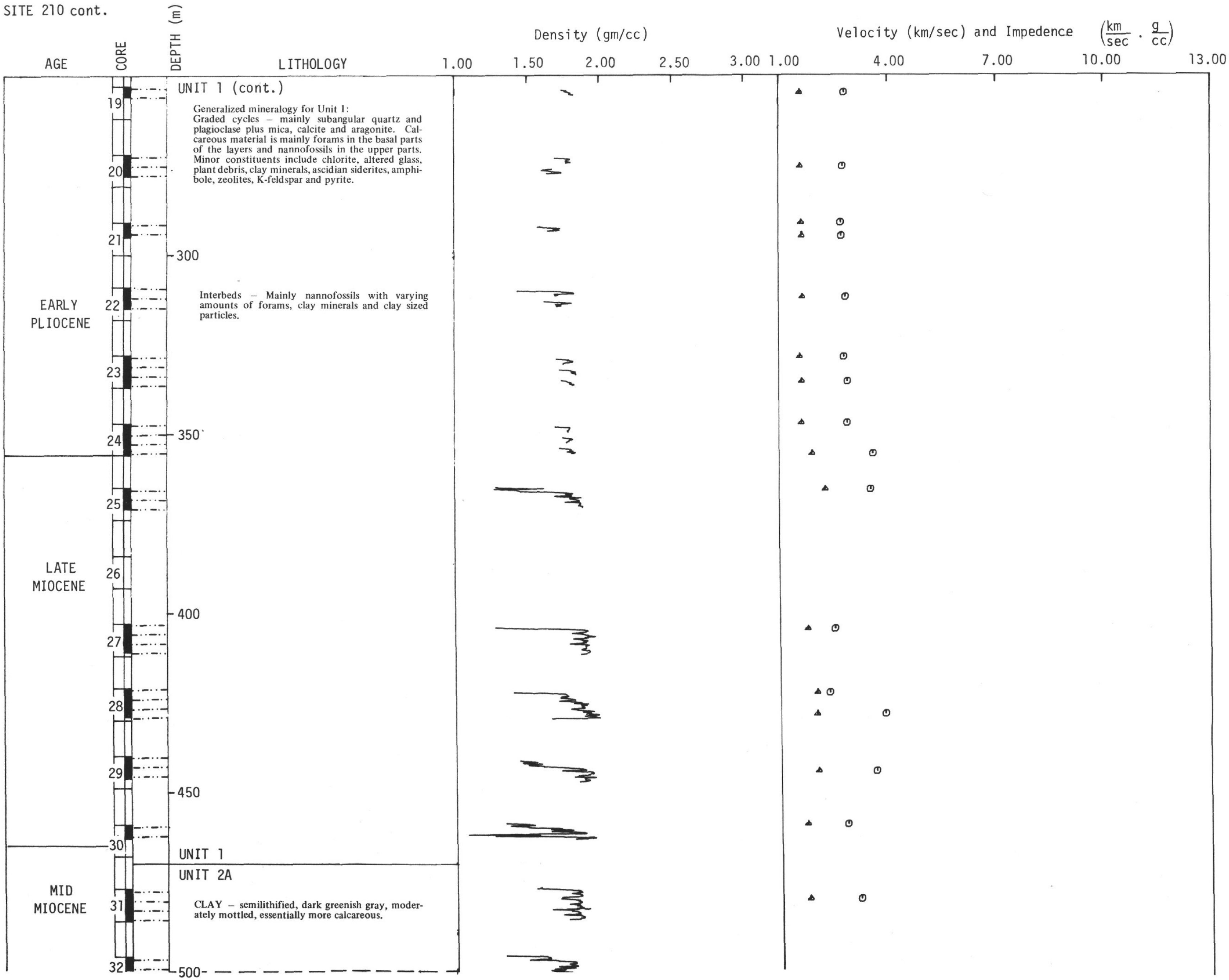


GRADED CYCLES OF SILT AND CLAY AND INTERBEDS OF NANNO OOZE

Approx. 1900 graded cycles of silt and clay occur in Unit 1. Most have silt at the base and grade upwards through silty clay and clayey silt to clay at the top. Colors are various shades of greenish gray, darker at the base. Cycles average 14 cm in thickness.

Approx. 800 interbeds of nanno ooze make up 15% of Unit 1. Clay content is variable. Relatively clay free oozes are white, clay rich oozes are darker shades of greenish gray. Nannofossils are the predominant biogenic component with minor amounts of foraminifera. The interbeds average 8.5 cm in thickness.

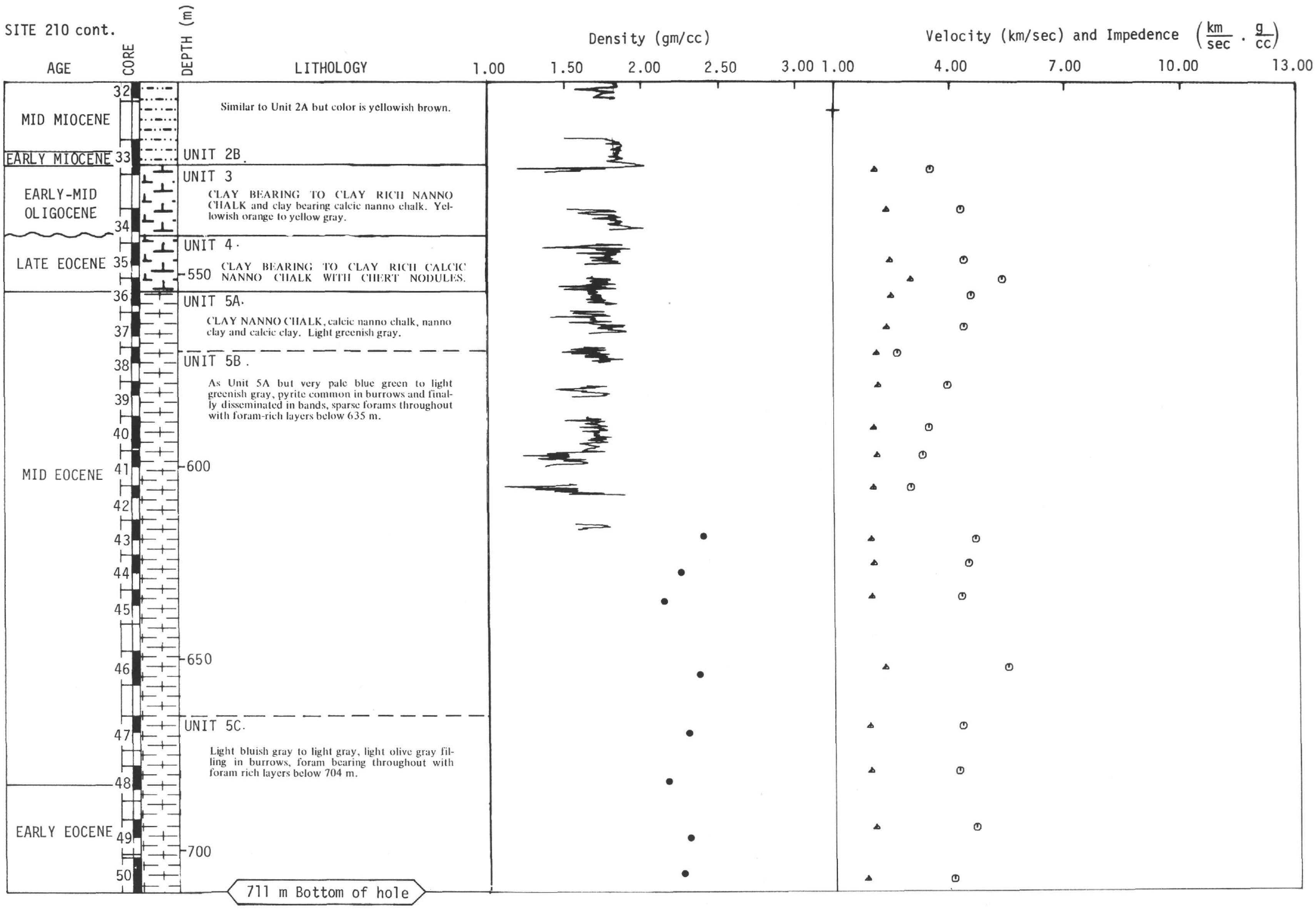
SITE 210 cont.



Generalized mineralogy for Unit 1: Graded cycles – mainly subangular quartz and plagioclase plus mica, calcite and aragonite. Calcareous material is mainly forams in the basal parts of the layers and nannofossils in the upper parts. Minor constituents include chlorite, altered glass, plant debris, clay minerals, ascidian siderites, amphibole, zeolites, K-feldspar and pyrite.

Interbeds – Mainly nannofossils with varying amounts of forams, clay minerals and clay sized particles.

CLAY – semilithified, dark greenish gray, moderately mottled, essentially more calcareous.



Similar to Unit 2A but color is yellowish brown.

UNIT 2B.

UNIT 3

CLAY BEARING TO CLAY RICH NANNO CHALK and clay bearing calcic nanno chalk. Yellowish orange to yellow gray.

UNIT 4.

CLAY BEARING TO CLAY RICH CALCIC NANNO CHALK WITH CHERT NODULES.

UNIT 5A.

CLAY NANNO CHALK, calcic nanno chalk, nanno clay and calcic clay. Light greenish gray.

UNIT 5B.

As Unit 5A but very pale blue green to light greenish gray, pyrite common in burrows and finally disseminated in bands, sparse forams throughout with foram-rich layers below 635 m.

UNIT 5C.

Light bluish gray to light gray, light olive gray filling in burrows, foram bearing throughout with foram rich layers below 704 m.