6. SITE 490[1]

Shipboard Scientific Party[2]

HOLE 490

Date occupied: 8 April 1979

Date departed: 13 April 1979

Time on hole: 115 hours

Position: 16°09.56′N; 99°03.39′W

Water depth (sea level; corrected m, echo-sounding): 1761

Water depth (rig floor; corrected m, echo-sounding): 1771

Bottom felt (m, drill pipe): 1777

Penetration (m): 588.5

Number of cores: 64

Total length of cored section (m): 586.5

Total core recovered (m): 341.4

Core recovery (%): 58

Oldest sediment cored:
Depth sub-bottom (m): 588.5
Nature: Muddy siltstone
Age: Late Miocene

Principal results: Drilling at Site 490 penetrated 588.5 meters of mud, silt, and muddy siltstone ranging in age from Quaternary to late Miocene (Table 1). Figure 1 shows properties of these sediments. Fractures and slickensides indicate normal faulting during the early Pliocene. The strike of these faults was roughly perpendicular to the trend axis. We found no evidence of compression stress.

Pre-middle Pliocene sediments were deposited below the CCD (carbonate compensation depth). Subsequent rates of uplift are difficult to establish in detail because of poor microfossil assemblages but are roughly 200 m/m.y. Similarly, sedimentation rates are poorly known in detail but irregularly average about 150 m/m.y.

Methane is common and ethane ranges from below limits of detectability to 0.18% near the bottom of the hole. Gas-releasing ice inclusions and frozen sediments may indicate the presence of gas hydrates, but solution in seawater could also account for amounts of gases released.

Oldest sediments sampled in this hole could have been deposited on top of accretionary zone sediments as part of the slope apron or, alternatively, deposited off the edge of continental crust between continental schists of Site 489 and the accretionary zone.

BACKGROUND AND OBJECTIVES

A major objective of the Leg 66 program was the sampling of sediments deposited during late presubduction and early synsubduction times in order to obtain information about the onset and beginnings of subduction. As noted in the Site 489 site chapter, the Leg 66 transit is unique in that upper parts of the presubduction and synsubduction sequences, relatively simple structurally and accessible beneath a relatively thin slope apron, are evident in seismic data. At Site 489 and 490 (Figs. 2 and 3) we focused on late presubduction and early synsubduction, 489 sampling sediments deposited on the seaward edge of the continental crustal block and 490 sampling those deposited in an area thought to lie immediately seaward of the continental crust edge.

Several geological models of Site 490 are consistent with the seismic reflection data. First, the principal strong reflector, at about 0.35 s sub-bottom, could be gneissic basement, as in Hole 489. The irregular surface of the reflector resembles that of gneissic basement farther shoreward. Deeper reflectors may have the same origin as those within the gneissic basement. Fault breccia along landward-dipping shear zones could account for the landward-dipping reflectors beneath the principal reflector. The seismic refraction velocity below the principal reflector is about 3.0 km/s, the same as the velocity of uppermost basement at Site 489. Although the lack of higher refraction velocities at greater depth argues against a basement interpretation, fractured gneissic basement would be then consistent with the observed velocities.

A second possibility is that rocks below the principal reflector consist of slope sediments deposited in the time interval between separation and removal of continental crust to the southwest and the beginning of active subduction—that is, late presubduction-facies. Seismic reflection data show these rocks to be somewhat deformed today, but deformation could have occurred during early stages of subduction.

The third possibility, and the one most consistent with seismic reflection data, is that rocks beneath the principal sub-bottom reflector belong to the early accretionary zone suite—that is, early synsubduction facies.

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[1] *Initial Reports of the Deep Sea Drilling Project*, Volume 66.

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Table 1. Coring summary, Hole 490.

Core	Cored Interval below Bottom (m)	Cored (m)	Recovered	
			(m)	(%)
1	0.0–7.0	7.0	6.06	64
2	9.0–18.5	9.5	8.83	93
3	18.5–28.0	9.5	9.63	101
4	28.0–37.5	9.5	7.22	76
5	37.5–47.0	9.5	9.35	98
6	47.0–56.5	9.5	7.70	81
7	56.5–66.0	9.5	4.39	46
8	66.0–75.5	9.5	6.05	64
9	75.5–85.0	9.5	3.20	34
10	85.0–94.5	9.5	6.98	73
11	94.5–104.0	9.5	1.20	13
12	104.0–113.5	9.5	2.63	28
13	113.5–123.0	9.5	0.30	3
14	123.0–132.5	9.5	0.00	0
15	132.5–142.0	9.5	6.47	68
16	142.0–151.5	9.5	5.35	56
17	151.5–161.0	9.5	2.92	31
18	161.0–170.5	9.5	8.49	89
19	170.5–180.0	9.5	0.90	9
20	180.0–189.5	9.5	9.43	99
21	189.5–199.0	9.5	8.27	87
22	199.0–208.5	9.5	8.60	91
23	208.5–218.0	9.5	7.10	75
24	218.0–227.5	9.5	7.52	79
25	227.5–237.0	9.5	9.17	97
26	237.0–246.5	9.5	6.20	65
27	246.5–256.0	9.5	4.92	52
28	256.0–265.5	9.5	9.73	102
29	265.5–275.0	9.5	6.04	64
30	275.0–284.5	9.5	3.46	36
31	284.5–294.0	9.5	2.08	22
32	294.0–299.0	5.0	7.91	83
33	299.0–303.5	4.5	1.28	13
34	303.5–313.0	9.5	4.68	49
35	313.0–322.5	9.5	7.20	76
36	322.5–332.0	9.5	9.21	97
37	332.0–341.5	9.5	9.43	99
38	341.5–351.0	9.5	8.70	92
39	351.0–360.5	9.5	9.15	96
40	360.5–370.0	9.5	8.73	92
41	370.0–379.5	9.5	2.19	23
42	379.5–389.0	9.5	7.30	77
43	389.0–398.5	9.5	4.27	45
44	398.5–408.0	9.5	3.70	39
45	408.0–417.5	9.5	1.60	17
46	417.5–422.5	5.0	0.72	8
47	422.5–427.0	4.5	1.98	21
48	427.0–436.5	9.5	1.61	17
49	436.5–446.0	9.5	2.58	27
50	446.0–455.5	9.5	1.22	13
51	455.5–465.0	9.5	1.65	17
52	465.0–474.5	9.5	1.17	12
53	474.5–484.0	9.5	1.30	14
54	484.0–493.5	9.5	6.03	63
55	493.5–503.0	9.5	6.05	64
56	503.0–512.5	9.5	8.14	86
57	512.5–522.0	9.5	9.16	96
58	522.0–531.5	9.5	9.02	95
59	531.5–541.0	9.5	7.25	76
60	541.0–550.5	9.5	5.35	56
61	550.5–560.0	9.5	5.21	55
62	560.0–569.5	9.5	5.97	63
63	569.5–579.0	9.5	3.01	32
64	579.0–588.5	9.5	1.88	20

Velocities are consistent with those expected in moderately indurated sediment, and weak landward-dipping reflectors resemble those downslope in younger parts of the accretionary zone.

Discrimination among the three models is fundamental to an understanding of the evolution of the subduction system. Samples from Site 490, together with samples from adjacent holes, were expected to contribute to the understanding of the early evolution of the subduction mechanism in this region.

OPERATIONS

Site 490 is located 13 km south-southwest of Site 489. Transit time between Site 489 and beacon launch at 490 was one hour.

Operations proceeded routinely, and the seafloor was found with a punch core at 1777 meters, 22 meters deeper than the PDR reading. A mudline core test of the pressure core barrel was conducted before continuous coring resumed. Good hole conditions and generally good core recovery persisted throughout the hole with the exception of an interval of fractured siltstones and loose sand strata from about 405 to 475 meters below seafloor (BSF). Unstable hole conditions were again encountered beginning at about 570 meters. Despite mud flushes to clean the hole, excessive fill caused the drill string to stick temporarily following the retrieval of Core 490-64 from 588.5 meters BSF. The hole was cleaned out, with some difficulty, to total depth.

A "wiper trip" was made to prepare the hole for logging. Considerable fill was again encountered at the bottom of the hole. Torquing and plugging of the drill string prevented cleaning the hole below 580 meters. A go-devil was then pumped down the pipe to actuate the hydraulic bit release. The release failed to shift after repeated pressuring up with the mud-pump. The go-devil was retrieved with the sandline and a second go-devil was pumped down. Again the bit failed to release and the overshot was lowered to retrieve the go-devil. The go-devil stuck at the bit and a second wireline was required to work it free after the safety release pin in the overshot was sheared.

Plans for logging were abandoned, and the hole was filled to about 280 meters BSF with weighted drilling mud. The bit was then pulled to the top of the mud fill, and cement slurry was emplaced up to about 120 meters BSF before the drill string was recovered. The *Challenger* departed for Site 491 at 1400 hours, April 13.

LITHOLOGIC SUMMARY

Drilling at Site 490 penetrated 588.5 meters into argillaceous sediments of upper Miocene to Quaternary age. Sedimentary and structural attributes suggest division of sediments into three units (Fig. 4, back pocket).

Unit 1, Quaternary (0– ~ 142 m sub-bottom), consists of muddy silt to mud, for the most part olive gray in color, becoming olive green in the uppermost 20 meters and olive black between 94.5 and 114 meters. Although predominantly homogeneous, subtle color changes sug-

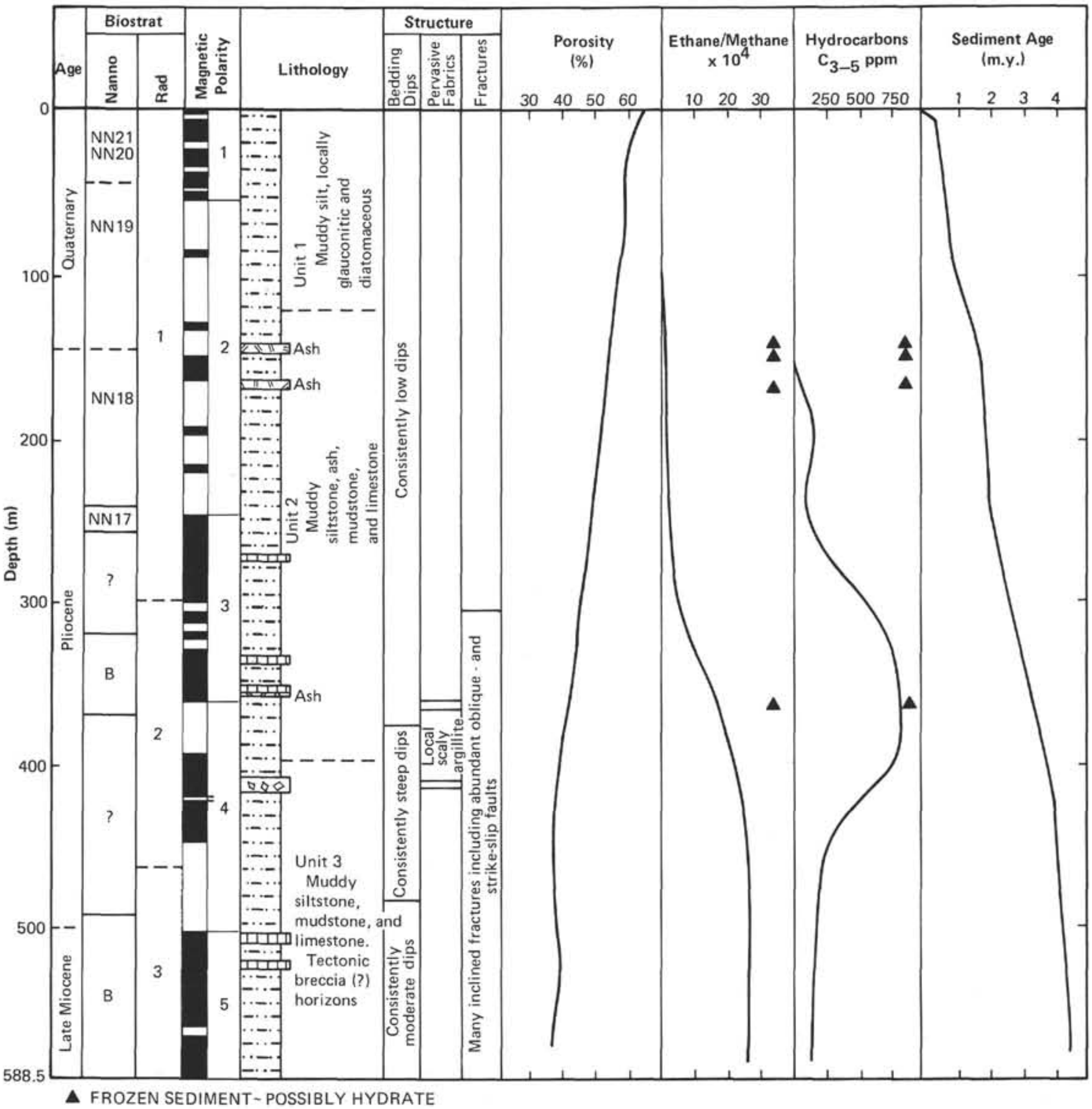

Figure 1. Summary of age, nannofossil and radiolarian zones (1 = *Pterocanium prismatium*, 2 = *Spongaster pentas*, and 3 = *Stichocorys peregrina*, B = barren), magnetic polarity zones (black = normal, white = reversed), lithology, structures, porosity, organic geochemistry (C_2/C_1 and C_{3-5}), age-depth relationships for recovered sediments. Radiolarian and nannofossil boundaries based on Berggren and Van Couvering [1974] and paleomagnetic ages based on Ryan et al. [1974].)

gest bedding in several places. Bioturbation is only discernible in a small area of Core 12. From about the 85 to 107 meter levels the mud is diatomaceous. Occasional minute white spots of sponge remains occur throughout the unit, and scattered blebs of fine sand (2–8 mm in diameter) occur below the 56-meter level.

Two bored limestone nodules, each measuring 8 × 2 cm, occur in the topmost 10 meters (Sample 490-1-4, 80–90 cm and 490-1-1, 20–30 cm). In the shallower sample, the borings are concentrated in the upper half of the nodule. Carbonate elsewhere in the unit is limited to occasional diffuse olive brown spots and indurated concretions, never more than a few centimeters in diameter.

Glauconite is locally important in this unit, occurring both in scattered concentrations and as a common trace component in the upper 60 meters of mud. A 10-cm graded bed of glauconitic muddy sand at the 47-meter level has a sharp, irregular (possibly scoured) base and is probably redeposited.

Unit 2, Pliocene and lowermost Quaternary (~ 142–~ 399 m), comprises some 250 meters of olive gray muddy siltstone, for the most part bioturbated. Only small variations in composition and grain size are evident; these include one mudstone horizon (Core 21), one siltstone horizon (Core 35), and a siliceous component in the muddy siltstone in Core 23.

The essential uniformity of this unit is broken in places by minor thin interbeds and lenses of ash and limestone. Millimeter-scale laminations and thin beds of silt and fine sand, in some cases graded, are relatively abundant in several horizons. The small calcareous areas (both diffuse and relatively well indurated) and

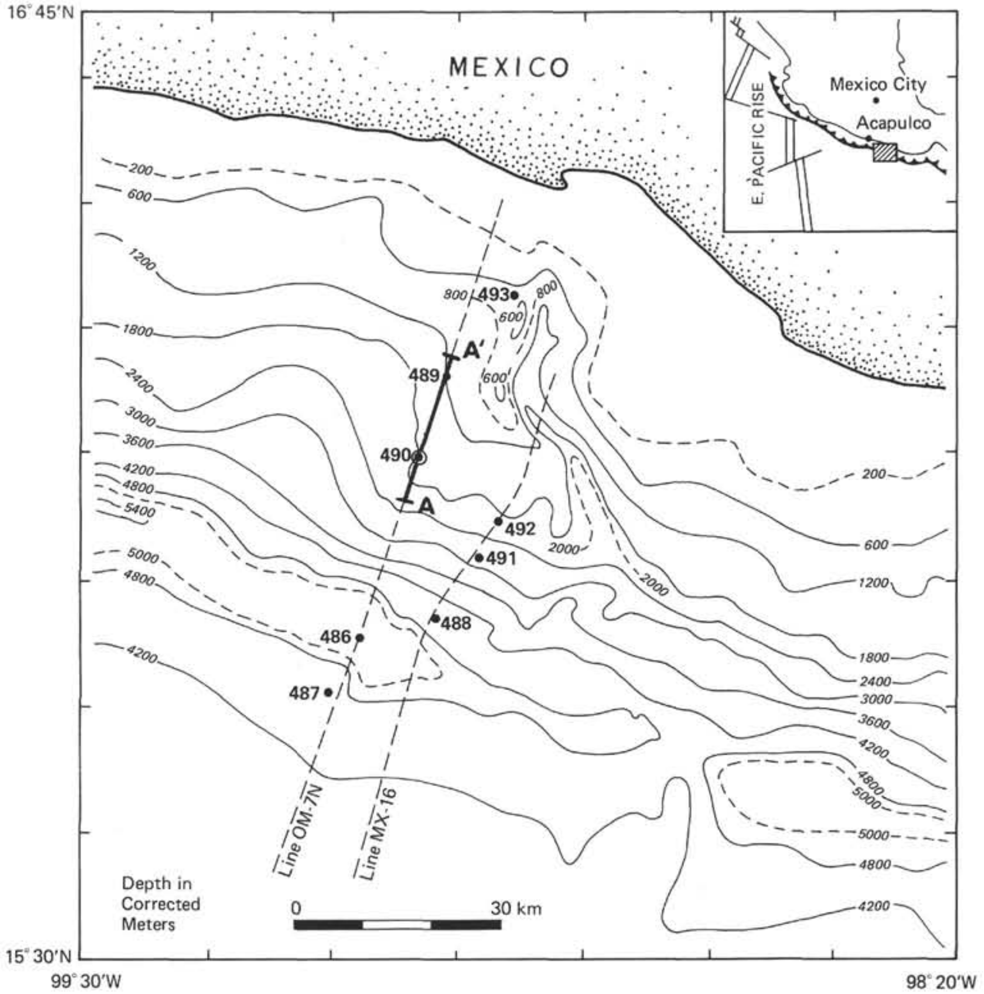

Figure 2. Site location and index. A-A′ shows location of Figure 3.

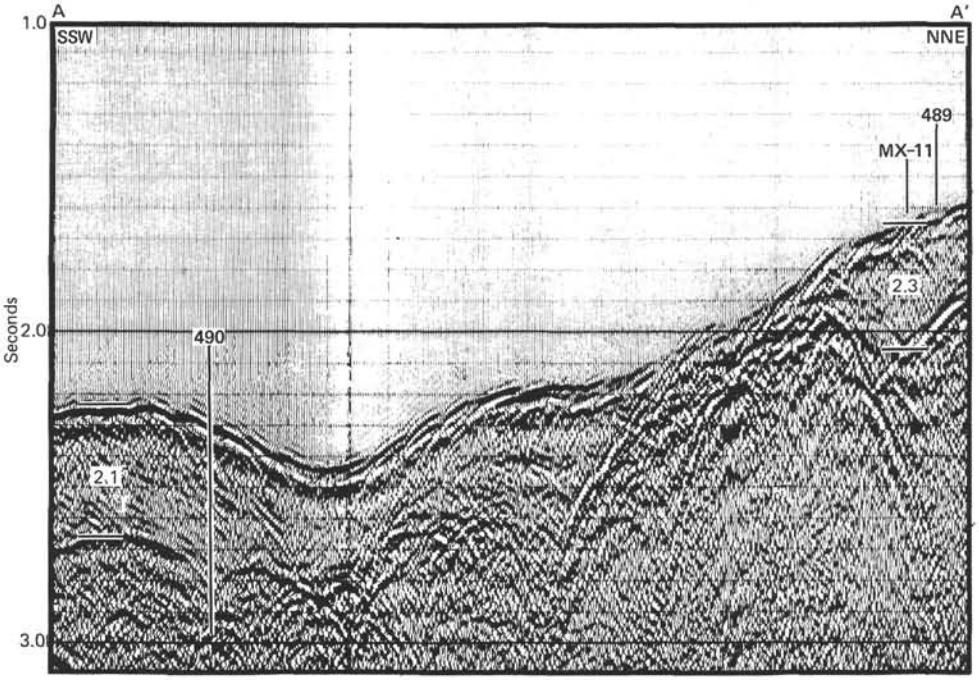

Figure 3. Portion of multichannel seismic Line OM-7N with hole locations 489 and 490.

occasional millimeter-scale fine sand blebs observed in Unit 1 also occur in Unit 2. Glauconite is a common trace of the sediment, with one major concentration occurring between ~260 and 280 meters. Pyrite nodules up to several millimeters across are common through much of the unit. A 30-cm mud chip breccia occurs at 231 meters (Sample 490-25-4, 0–32 cm); plant material is concentrated in the muddy silt immediately underlying and overlying this unit.

Ash and vitric beds occur in several places. At 145.5 meters (Sample 490-16-3, 50 cm) horizontal lamination is pinpointed in a 25-cm vitric silt by light to dark gray color changes. At 166.5 meters (Sample 490-18-4, 50–85 cm) a 35-cm ash bed, with similar horizontal lamination, is coarser grained in the basal 4 cm. These ash beds were very cold when first removed form the core liner. In Core 18, thermister probe readings varied between −0.8° and −2°C. Furthermore, an irregular 3-cm fragment of bubbling ice was recovered in Core 15. The implications of these observations are discussed in the Organic Geochemistry section. Several thinner ash and vitric silt beds occur in the lower half of Unit 2.

Limestone and chalk occur in thin lenses and discrete beds, between 6 and 40 cm thick. The sediment varies in color from pale greenish gray to light olive gray to dusky yellow green and contains no clear biogenic component. Several beds contain irregular microveins, and the thickest bed (Sections 490-29-4, and 490-29-5) is internally brecciated.

Bedding, which in most places is easily discernible in Unit 2, infrequently deviates from the horizontal. Oblique open fractures become increasingly common toward the base of the unit; many of these are thought to be of tectonic origin, especially where slickensiding is observed. In Unit 3, bedding is inclined throughout, and slickensided fractures are more or less ubiquitous. For convenience, the boundary between Units 2 and 3 has been placed above the first of two breccia horizons (Core 44). It might equally well be placed above the first appearance of pervasive slickensided fracture planes (Core 42).

Unit 3 (~399–588.5 m) differs little from Unit 2 in overall sedimentary characteristics (Fig. 4). Thin chalk and ash beds are present, although glauconite is largely missing. However, the muddy siltstone of Unit 3 is well indurated throughout and characterized by abundant fracture planes varying in orientation from zero to near vertical. Slickensides, often showing dip-slip movements, are common on the fracture surfaces. Bedding, often demarcated by concentrations of flattened burrows, dips at shallow to moderately steep angles.

Breccia units at the top of the unit consist of a mixture of loose, muddy siltstone chips and some medium sand. The granule- and pebble-sized clasts of muddy siltstone are highly indurated, angular, and up to 5 cm across. The thicker breccia indicated in the generalized column was observed in a zone of poor recovery (Cores 45 and 46) and may or may not occupy the entire zone.

Interpretation

The central question arising from Site 490 data is whether to interpret the deformed sediments of Unit 3 as accreted trench or ocean floor deposits below a relatively undeformed lower slope sequence (Units 1 and 2) or to consider the whole section a slope sequence progressively more deformed at the base. Given that trench deposits are not invariably sandy, especially during periods not associated with lower stands of sea level, the fine-grained sediments of Unit 3 give little clue to their paleogeographic setting, other than that they were probably deposited below the CCD (see Biostratigraphy section). They could be terrigenous ocean floor sediments, fine-grained trench fill, or deposits of the lower portion of the lower slope.

The somewhat abrupt appearance of intense fracturing might indicate a structural break around 380 meters sub-bottom (around Core 42), arguing for an accretionary origin for Unit 3. On the other hand, dip–slip motions indicated by slickensides are not what would be expected in a compressional (i.e., underthrusting and offscraping) regime. Dip–slip motions have been recorded on fractures and microfaults in lower slope sediments from the Japan (Leg 57, Hole 440B, e.g., Core 45) and Marianas (Leg 60, Site 459) forearcs. The origin of this deformation is further discussed in the Paleomagnetism and Summary and Conclusions sections.

On balance, the whole section recovered from Hole 490 is best interpreted as a lower slope sequence of upper Miocene through Quaternary age.

Drilling Artifacts

Horizontal laminations, 2 to 4 mm thick on average, are common in the better-lithified cores retrieved so far during Leg 66. Their extreme regularity (2–4 cm spacing) engendered debate among the shipboard sedimentologists as to their origin: sedimentary or mechanical.

BIOSTRATIGRAPHY

At Site 490 we penetrated a Quaternary to upper Miocene section of hemipelagic middle-slope sediments. Carbonate dissolution in the lower half of the hole, reworking of upslope Miocene to Quaternary microfossils, and microfossil dilution by terrigenous sediments hamper biostratigraphic dating.

Figure 1 presents the biostratigraphic summary of Site 490. The miscorrelation between the nannofossil NN11 Zone and the radiolarian *Stichocorys peregrina* Zone represents coccolith reworking. In view of the fact that calcareous nannoplankton preservation is very poor in the lower part of Hole 490 and that nannoplankton are absent at the base of the hole, it is possible that all preserved nannoplankton below Core 34 (310 m) were redeposited and buried before dissolving. Pliocene nannofossils, which accumulated under ordinary pelagic conditions, are mostly dissolved as well. Reworked Miocene and Pliocene radiolarians occur throughout the Pliocene and Quaternary sections of Hole 490.

Calcareous Nannoplankton

The assemblages of coccoliths and other nannofossils found in the sediments of Hole 490 are assigned to Quaternary, Pliocene, and upper Miocene. No nannofossils older than Miocene were found, not even reworked ones.

Quaternary Nannoplankton (Sections 490-1,CC–490-15,CC)

With the exception of Section 490-1,CC only moderately preserved coccoliths are present. In 7,CC there is the lowest occurrence of *Gephyrocapsa oceanica* with the central bridge preserved. The last occurrence of *Emiliania annula* (*Pseudoemiliania lacunosa*) was found in 10,CC. The last discoasters (*Discoaster brouweri*) occur in 16,CC, marking the Pliocene/Pleistocene boundary at about the top of the Olduvai (1.6 m.y. ago). The following datum levels were observed: Core 7: NN20 Zone bottom–0.6 m.y.; Core 15: NN19 Zone bottom–1.6 m.y.

Pliocene Nannoplankton (Sections 490-16,CC–490-27,CC)

The *Discoaster brouweri* Zone NN18 extends from Sections 490-16 to 490-25,CC. The *D. pentaradiatus* Zone NN17, a comparatively narrow nannoplankton zone, is found in 26,CC and 27,CC. The following datum levels occur: Section 490-16,CC: NN18 top–1.6 m.y.; Sections 490-25 to 26,CC: NN17 top–2.5 m.y.; Section 490-27,CC: NN17 bottom–2.7 m.y. Core catchers 28,CC and 29,CC are barren.

Upper Miocene Nannoplankton

From Sections 490-30,CC down to 490-59,CC the nannoplankton assemblages have few coccoliths. The dominant species are *Discoasters quinqueramus*, which are five-rayed discoasters with distinct knobs on either sides of their central areas, and common sphenoliths (*Sphenolithus abies* and *S. neoabies*). There are also rare *D. calcaris* and *D. variabilis* in 30 to 32,CC and *D. brouweri* and *D. surculus*. No ceratoliths were recorded. Whether these assemblages are reworked or not is an open question. From 30,CC to 32,CC one might still consider reworking of NN11 nannoflora to a poor NN17 nannoflora. Deeper down, however, *D. quinqueramus* and the sphenoliths are the main constituents of the poor assemblages. Nannoplankton zones NN16 to NN12 are lacking and should be recognizable by common *D. surculus* and *Ceratolithus tricorniculatus*. The NN11 *D. quinqueramus* range zone comprises a long interval of 4.5 m.y. in the upper Miocene—that is, from 5 to 9.5 m.y. ago.

Siliceous Microfossils

Silicoflagellates were found only sporadically except in Sections 490-5,CC and 490-30,CC, where the following species occur: Section 490-5,CC: *Dictyocha stapedia, D. fibula*, and *Mesocena elliptica*. This places Section 490-5,CC in the *M. elliptica* Zone (Bukry and Foster, 1973) or the *M. quadrangula* Zone (Martini, 1976), in the lower to middle Quaternary (top NN19). In Section 490-30,CC we found *D. fibula, D. perlaevis, D. rhombica, D. speculum*, and *D. crux*. This places 30,CC in the *D. fibula* zone (Martini, 1976) in the upper Miocene (NN11) to middle Pliocene (top NN15). *Actiniscus tetraterias*, which has an upper Pliocene to lower Pleistocene range (Dumitrica, 1973), was found in 16,CC.

Foraminifers

Hole 490 penetrates Miocene to Quaternary glauconitic muds, muddy silts, and siltstones. The sediment in the lower part of the section is indurated and could not be fully disintegrated for foraminiferal study.

Cores 1 to 12 contain abundant well-preserved upper Quaternary foraminifers. Cores 13 to 28 contain poorly preserved lower Quaternary and Pliocene foraminifers. Cores 29 to 64 are nearly barren of foraminifers except for reworked upper slope species.

Scarcity of the foraminifers in the sedimentary section precludes application of standard foraminiferal zonation. Nevertheless, abundance and preservation of foraminifers are useful in distinguishing the depth of deposition of inner slope sediments.

Cores 1 through 16 contain the following Quaternary foraminifers: *Globorotalia flexuosa, G. tumida, G. menardii, Globigerinoides ruber, G. triloba, G. sacculifer, G. quadrilobatus, Neogloboquadrina dutertrei, Pulleniatina obliquiloculata*, and *Orbulina universa*.

The planktonic foraminiferal assemblage in the section indicates tropical to subtropical watermasses. Benthic foraminifers in the upper Quaternary sediments are abundant and diverse and correspond well to the modern water depth (lower bathyal). Some of the typical forms include *Melonis pompilioides, Planulina wuellerstorfi, Gyroidina soldanii, Hoeglundina elegans, Oridosalis umbonatus, Pullenia bulloides, Cassidulina subglobosa, Uvigerina proboscidea, U. aculeata, U. hispida, Lagena, Stilostomella*, and, occasionally, *Pyrgo*.

The Pliocene section, in Cores 17 through 30, contains the following species: *Globigerinoides fistulosus*?, *G. ruber, Hastigerina aequilateralis, Pulleniatina obliquiloculata*, and *Neogloboquadrina humerosa*. The Pliocene–lower Quaternary assemblage also contains shelf or upper slope reworked forms that include *Cancris, Hanzawaia*, and *Bolivina*. Certain sandy layers in the section—for example, Sample 490-24-1, 18–20 cm shows a high concentration of upper slope foraminifers that were transported down by turbidity currents.

Depositional Environment

The absence of foraminifers in the Miocene sediment at Site 490 indicates dissolution below the CCD. Relatively abundant partially preserved foraminifers in the Pliocene and lower Quaternary sections reveal an upward shallowing trend through the CCD, whereas the abundant and diverse well-preserved upper Quaternary foraminiferal assemblage indicates deposition above the CCD.

Radiolarians

Two factors affect the radiolarian record at Site 490: dilution by a fairly high sedimentation rate and contamination by upper Miocene through Quaternary radiolarians reworked from upslope outcrops. Contamination is the more serious problem, because extinction levels are difficult to recognize and many seem to be in error.

Approximately the upper one-third of Site 490 is Quaternary. The Quaternary/Pliocene boundary is difficult to locate because *Pterocanium prismatium* (Riedel and Sanfilippo, 1971) is absent in this area. Within the Quaternary, the extinction level of *Axoprunum angelinum* (0.4 m.y. ago, Hays, 1970) occurs within Core 2 at 15 meters, and the extinction level of *Anthocyrtidium angulare* occurs within Core 18. Pliocene radiolarians are moderately to poorly preserved, and a largely barren interval occurs between Cores 33 and 50 (305–445 m). The only recognizable datum plane is the evolution level of *A. angulare* (280 m), which occurs midway through the *P. prismatium* Zone (Dinkelman, 1973).

An upper Miocene/lower Pliocene fauna consisting of *Ommatartus antepenultimus, O. penultimus, Stichocorys peregrina*, and *A. angelium* defines the *S. peregrina* Zone (Dinkelman, 1973) below Core 61. The paleomagnetic data suggest that Hole 490 bottoms in the uppermost Miocene, which is consistent with this faunal zone interpretation. Poor preservation above Core 61 precludes accurate location of the Miocene/Pliocene boundary, but extrapolation suggests location near 560 meters in Core 62.

Deposition of reworked radiolarians began at Site 490 in the mid-Pliocene and continues actively today. The mid-Pliocene initiation of Miocene contaminant microfossils may mark the onset of erosion of middle and upper Miocene sediments upslope.

SEDIMENT ACCUMULATION RATES

The age versus depth curve is based on biostratigraphic datum levels and some paleomagnetic reversal boundaries (Fig. 5). The presence of the *Axoprunum angelinum* extinction level within Core 1 suggests a slow accumulation rate of 10 m/m.y. for the uppermost portion of Site 490. The carbonate nodule with animal borings found in Core 1, Section 4, suggests an erosional and/or nondepositional episode within Core 1. Rates for the rest of Site 490 show no consistent trend but vary between 90 and 405 m/m.y.

PALEOBATHYMETRY AND VERTICAL TECTONICS

Paleobathymetric determinations based on assemblages of benthonic foraminifers is impossible at Site 490 because of the poor foraminiferal preservation below 90 meters and total absence of large foraminifers below 280 meters. As a result, the paleobathymetry is estimated by relating the carbonate preservation at Site 490 to the level of the CCD. This trend suggests that late Miocene deposition at Site 490 began below the CCD, then passed through it in the early Pliocene time (4 m.y. ago) (Fig. 5) (McMillen and Bachman, this volume). Uplift rates calculated by removal of sediment accumulation of 580 meters at Site 490 are roughly 200 m/m.y. since the late Miocene.

PALEOMAGNETISM

Paleomagnetic analyses at Site 490 established magnetostratigraphy and determined dips of certain beds and faults. Sediments in Hole 490 can be correlated with polarity epochs to Epoch 5. Dip direction and stress field are concordant with submarine topography around the site.

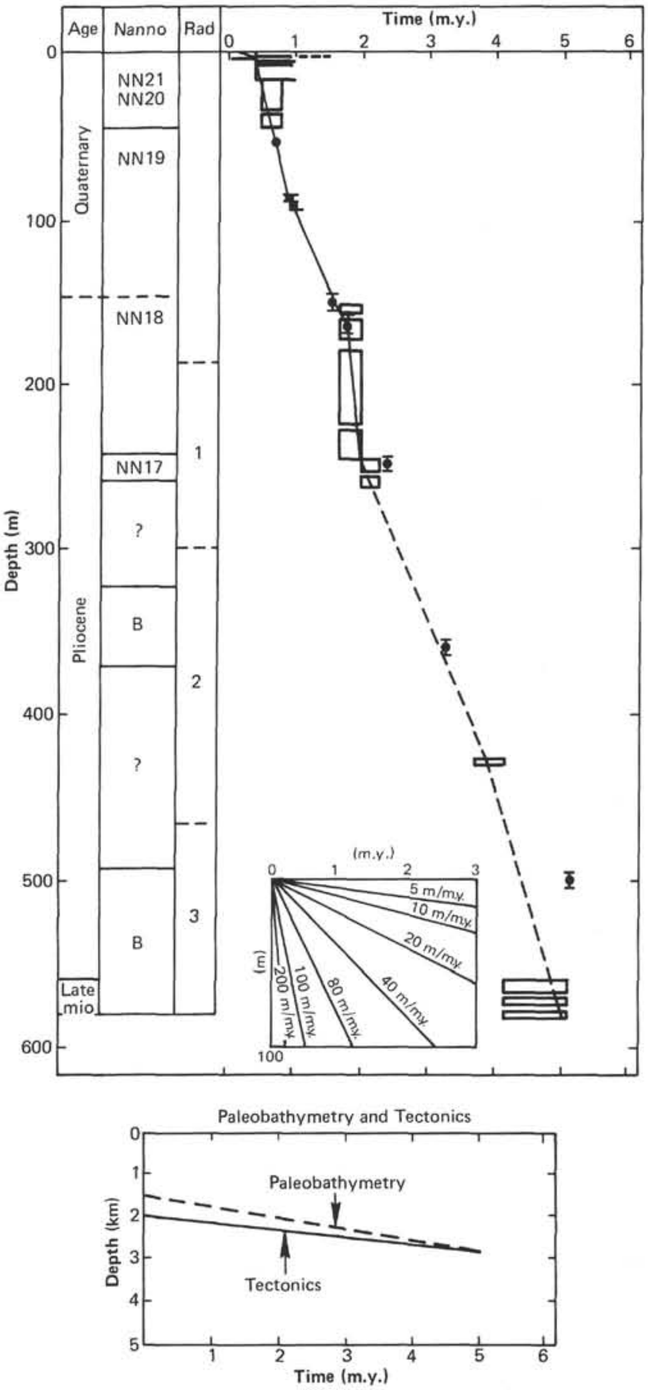

Figure 5. Age vs. depth and inferred paleobathymetry at Site 490.

We collected 105 oriented samples from the sedimentary sequence of Hole 490. Stability of remanent magnetization of selected samples was checked with stepwise AF demagnetization (Niitsuma, this volume).

Average intensity of the samples is $10^{-6.6 \pm 0.9}$ emu/cc after 15 mT AF demagnetization. Intensities in sandstones are one or two orders of magnitude less, suggesting that sandy material originated in a different source area than sediments. Changes in inclination suggest seven magnetozones.

The magnetozones can be correlated with the Brunhes normal polarity epoch (1), the Matuyama reversed polarity epoch (2), the Gauss normal polarity epoch (3), the Gilbert reversed polarity epoch (4), the normal events of a and C_2 in the Gilbert Epoch, early part of Gilbert Epoch (4), and Epoch 5, as shown in Figure 1. This correlation is consistent with nannoplankton fossil data.

Sediments from lower part of Site 490 dip from 10° to 81°. If the drilling core axis is vertical, orientation of bedding plane can be calculated from magnetic data (Niitsuma, this volume).

Most bedding planes dip westward; a few dip northward. Mean and standard deviation of westward dips are toward N80° ±25°W. This direction corresponds to the topographic slope direction in the area of Site 490.

The change in dip angle with subsurface depth is represented as follows: dips of sediments below 350 meters gradually increase with depth until they are cut by normal faults, with slickensides dipping from 10° to 75° toward N84° ±17°W between 400 and 430 meters. Dips gradually decrease with depth below this fault zone. The change suggests that the steep dips are related to the normal faults.

Many faults with slickensides were observed in the lower part of sediments in Hole 490. The stress field associated with the conjugate set can be calculated using the fault plan orientations and fault displacements. We find that the compressional axis is almost vertical and the tensional axis horizontal with east–west direction. Direction of the tension axis is concordant with the dip direction of bedding plane. Thus the steep dip of bedding plane may have been caused by drag folds associated with westward-dipping normal fault. The westward slope of submarine topography can also be explained by this tectonic movement.

ORGANIC GEOCHEMISTRY

The shipboard organic geochemistry monitoring program consisted of analysis of gases released in core liners, degasification of selected sediment samples, and visual inspection for fluorescence in split core.

Gases

Moderate amounts of gas were released in core liners from depths of 30 meters and below. The gas initially contained methane, CO_2, and small amounts of H_2S. The last, detectable by its distinctive odor, was present down to depths of about 60 meters. Methane content remained fairly constant with depth (Fig. 6) except for a minimum in the 420 to 470 meter interval. This interval was associated with a high sand content in the sediments that resulted in substantial gas and sediment loss from washout and dilution of core liner gas with air gases.

Ethane content was below the detection limit of the Carle gas chromatograph at depths shallower than 155 meters but increased gradually with depth to reach a maximum of 0.18% by volume. The methane to ethane ratio also increased with depth, reaching a maximum of 26.3×10^{-4} near the base of the cored section (Fig. 6).

CO_2 content in core liner gases varied from 6.5% to 0.24%, being higher in the upper portions of the cored sequence and decreasing with depth.

Hydrocarbons in the C_3–C_5 range were monitored on the Hewlett-Packard 5710-A gas chromatograph from a depth of 165 meters to T.D. Their abundance was found to vary with depth and showed a maximum in the 300 to 400 meter interval (max. 879 ppm, Fig. 6).

Upon splitting Core 15 (Sample 490-15-5, 110 cm at a sub-bottom depth of 139.6 m), gas-releasing ice inclusions were observed near a gas expansion void of some 8 to 10 cm in length (Fig. 7). These ice fragments released gas in the ratio of 0.91 volume of gas per volume of ice. The evolved gases consisted of methane (76, 77%) and CO_2 (23, 23%) with no ethane detectable on the Carle gas chromatograph. Degasification of a sample at a sub-bottom depth of 155 meters by high-speed blending showed a gas-generating ratio of 4.2×10^{-2} volume of gas per volume of sediment and with a similar composition (methane, 74.65%, and CO_2, 25.34%).

An *in situ* interstitial water sample was retrieved from near this depth (189.5 m) and released gas in the ratio of 0.47 volume of gas per volume of water (GGR = 47×10^{-2}); the composition of the gas was 87.10% methane and 12.90% CO_2.

Gas released from samples involving pore fluids and sediments showed a CO_2 content considerably higher than did the core liner gas. This indicates that core liner gas composition is significantly affected by the water solubilities of the different gases at the pressures and temperatures prevailing during sampling and result in CO_2 depletion of the gas released in core liners. Core temperatures of $-2°C$ to $8°C$ have been observed, and the gas pressure depends on the degree of induration of the core material and on the presence or absence of closure of the core against the liner. There is no control of these parameters.

We were unable to establish the origin of the ice in Core 15; it could have originated in the freezing of a mixture of interstitial and seawater trapped between the core and core liner. The decrease in core temperature necessary for ice generation may not be adequately accounted for by gas release and expansion; possibly a phase change would be required as well. Degasification of *in situ* interstitial water indicates that the amount of dissolved gas is of the order of 1 ml gas/ml of interstitial water.

Fluorescence

Split cores showed no evidence of fluorescence due to crude oil or bitumen impregnation.

Organic Carbon, Hydrogen, Nitrogen, and Carbonate

Samples for CHN and carbonate analysis were taken from selected cores and analyzed as indicated in the Site 487 Site Chapter. The results of these analyses are shown in Figure 6. Throughout the cored sequence, the organic carbon content varied from 0.80% to 3.0% and the total nitrogen content from 0.06% to 0.27%. The

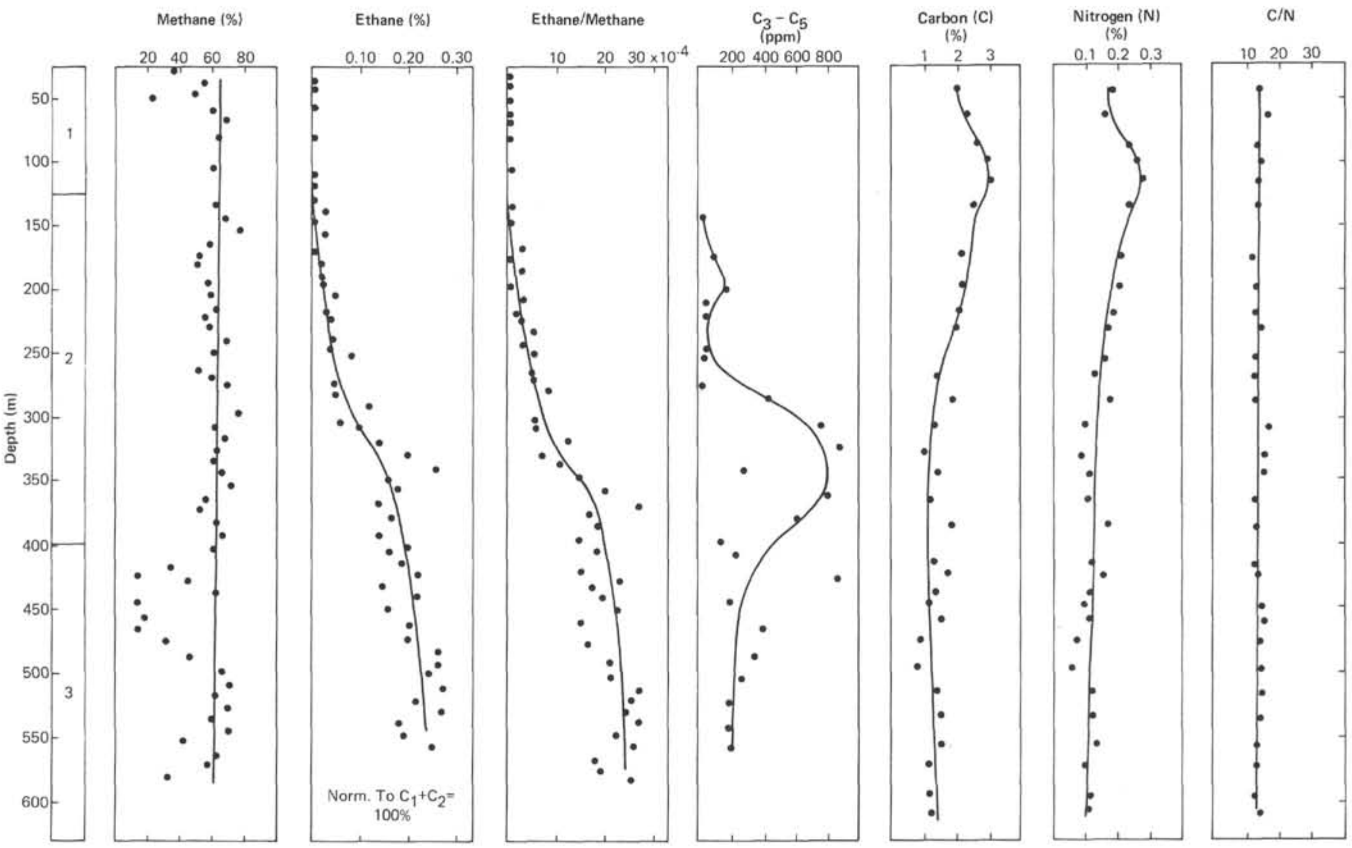

Figure 6. Methane and methane/ethane ratios, ethane and higher hydrocarbon abundance, and carbon and nitrogen abundances.

organic potential of the sediments ranged from good for the upper 200 meters to intermediate for the lower section. The carbon content decreases with depth, being higher in upper sediments and decreasing in the lower part of the sequence. The nitrogen content also decreases with depth and parallels the decrease in organic carbon.

C/N varied from 11.9 to 16.8, remaining approximately constant throughout the hole (Fig. 6). This is in the range for organic matter associated with recent sediments (Fairbridge, 1972) and suggests that the organic matter present in these sediments has a low degree of thermal maturation. Low amounts of carbonates (up to 4%) were detected in the upper 250 meters of the hole, decreasing below the detection limit of the carbonate bomb analysis.

Conclusions

Gases, mainly of biogenic origin, were detected throughout this hole, causing a low to moderate degassing of the cores. The organic potential of the sediments varied from intermediate to good, but the C/N suggests a low degree of geothermal maturation. No evidence of petroleum or bitumen impregnation was detected. Further, suspected hydrates consisting of gas-releasing ice inclusions and frozen sediments were detected in the 145.4 to 145.7, 166.5 to 166.8, and 364.0 to 364.5 meter intervals. Heavier hydrocarbons, C_3–C_5, increased with depth without evidence of an increase in geothermal maturation. The origin of these gases is not known. They could have originated in more geothermally matured sediments and been emplaced in shallower depths by migration, but a biogenic origin cannot be excluded.

PHYSICAL PROPERTIES

Site 490 physical property analyses included porosity, water content, wet bulk density, compressional sound velocity, and undrained shear strength determined by standard DSDP techniques (Boyce, 1976). Significant changes in Site 490 physical properties with depth correspond directly with changes in lithology. From 0 to 140 meters (Unit 1, see lithologic column) these properties change very slowly (Figs. 8 and 9), typical of sediments deposited in a lower slope environment at moderate sediment accumulation rates. Between 140 meters and 400 meters (Unit 2) the change in physical properties corresponds to the transformation from soft sediment to mudstone. Below 400 meters (Unit 3) a small but significant change in these properties may reflect an increase in deformation. A general summary of these individual properties is presented in the following sections.

Porosity, Water Content, and Bulk Density

Porosity decreases from 68% at 2.3 meters to 35% at 540 meters (Fig. 8). This fairly uniform decrease suggests gravitational rather than tectonic forces as the primary dewatering mechanism. Water content decreases regularly from 48% at 2.3 meters to 16% at 540 meters.

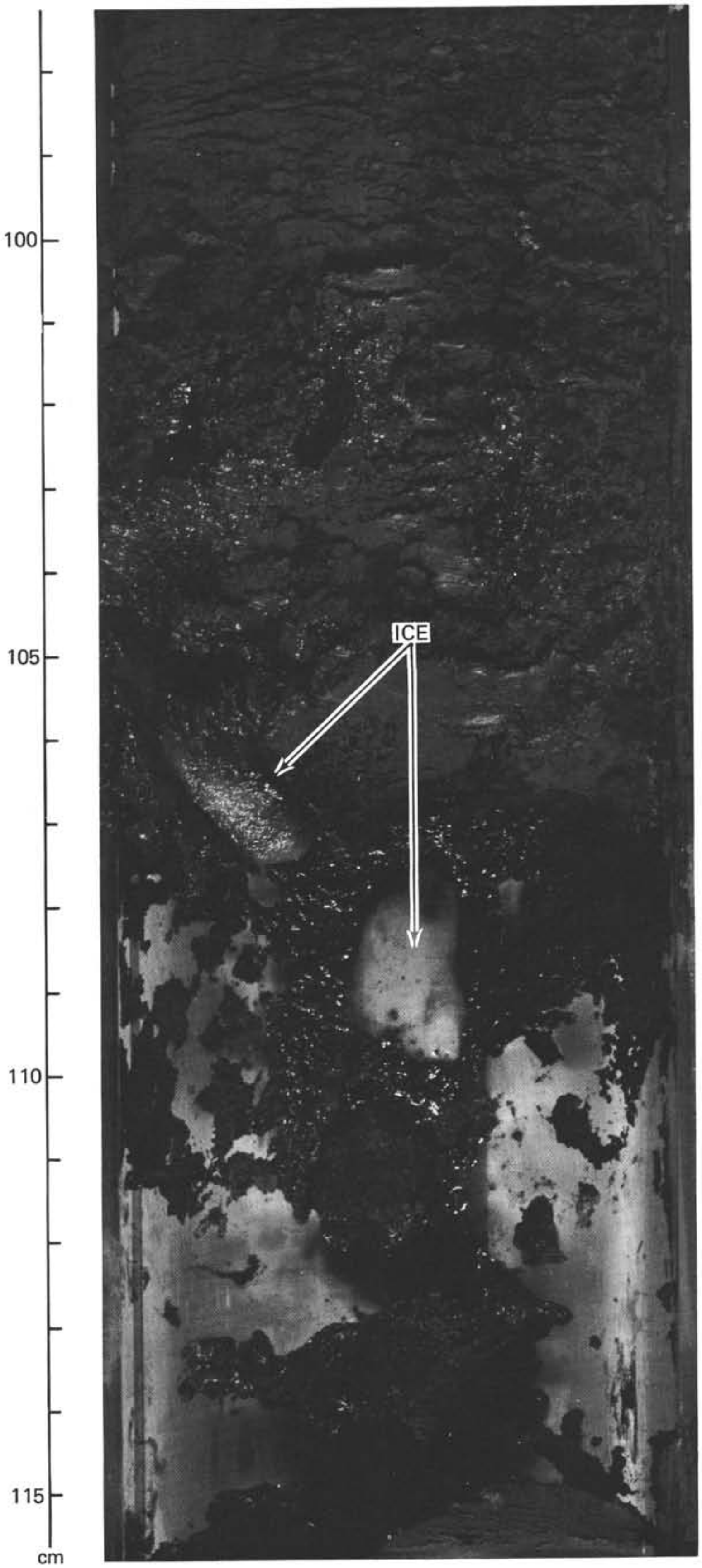

Figure 7. Gas-releasing ice inclusions (C15 SS-110).

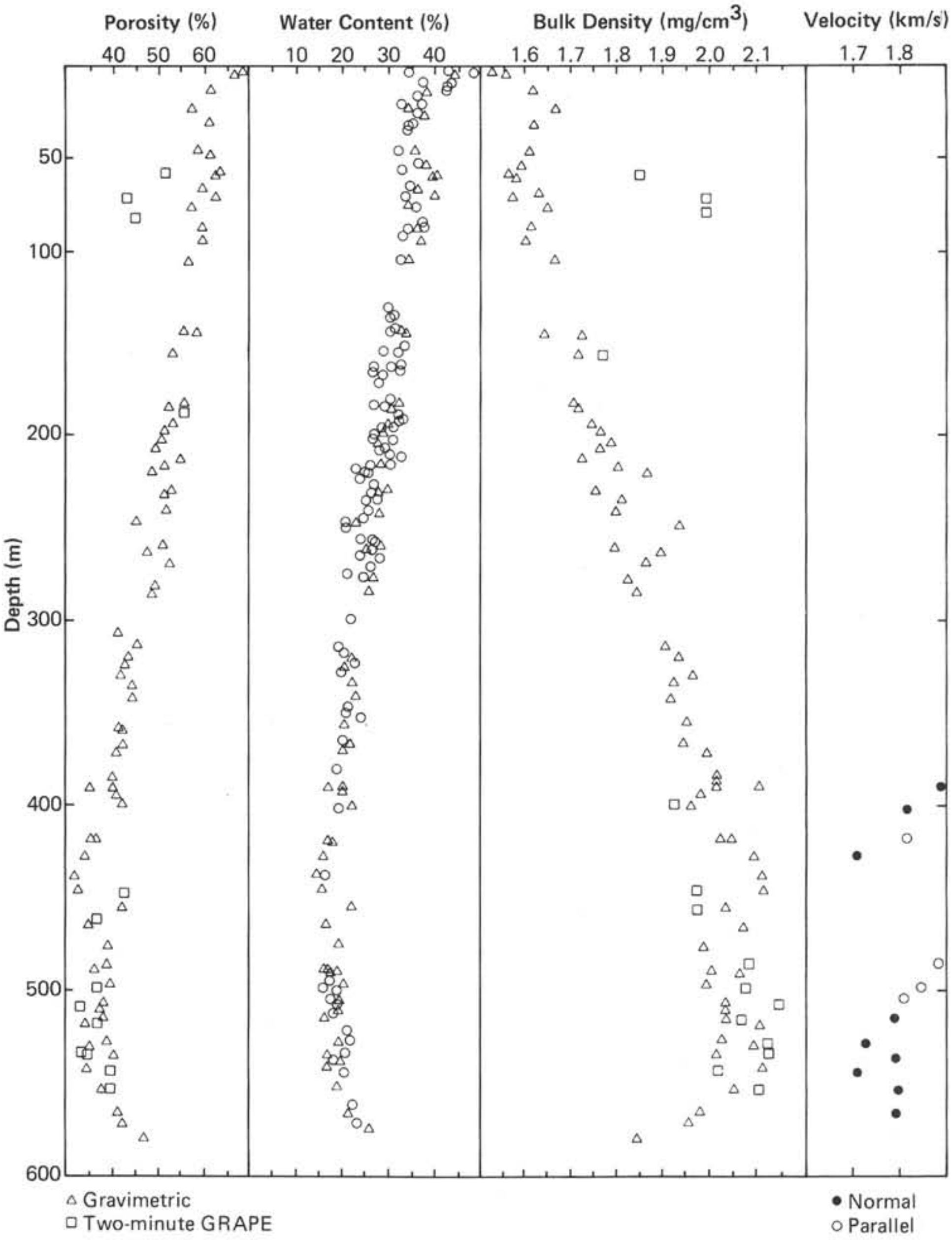

Figure 8. Physical properties summary profiles.

Bulk density decreases from 1.53 Mg/m^3 at 2.3 meters to 2.11 Mg/m^3 at 540 meters.

Compressional Sound Velocity

Only two velocity measurements were performed above 350 meters sub-bottom because of gas attenuation. Below 350 meters velocity varies, ranging from 1.71 km/s at 427 meters to 1.88 km/s at 485 meters.

INHOLE TEMPERATURE MEASUREMENTS

Three inhole temperature measurements yielded usable data only at 227.5 meters. The typical curve, with a slow increase in temperature as the probe and sediments equilibrate, is observed for this run at 227.5 meters, giving a gradient of 2.5°C/100 m, which agrees well with the minimum gradient of 2.1°C/100 m predicted on the basis of reflection depths and hydrates phase relationships (Shipley et al., 1979).

Thermal conductivity measurements using sediment slabs yielded values of 2.3 to 2.8 μcal/cm s°C. These values result in heat flow values of about 6 or 7 μcal/cm^2 s, much higher than predicted. We suspect conductivity measurements are in error, probably owing to the lack of needle probes normally used to measure conductivities of soft sediment. Shipley and Shephard (this volume) discuss thermal measurements made during Leg 66.

CORRELATION OF SEISMIC REFLECTION DATA AND DRILLING RESULTS

Site 490, 13 km seaward of Site 489, is interpreted to be seaward of the continental basement. A migrated

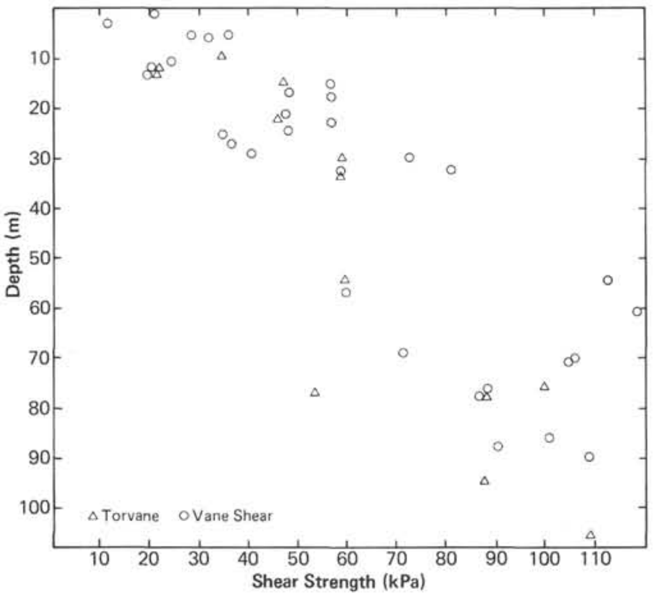

Figure 9. Shear strength vs. depth.

seismic reflection line crosses the drilling site at the position indicated in Figure 10.

Seaward of the site several landward-dipping reflections in the deeper part of the section are interpreted as part of the accretionary zone. In detail, Site 490 lies within an anomalous zone along the seismic line where the normally strong sub-bottom reflection at 0.38 s (340 m) is discontinuous (Fig. 3). Above 0.38 s several reflections in the slope apron dip gently northeast and appear to be truncated at or near the seafloor. The lack of an unconformity suggests that the seafloor "truncation" results from a depositional process and that dipping reflections are part of a prograded slope facies.

The drilled section has a velocity of 1.8 km/s, as derived from analysis of multichannel seismic data. No refractors were detected from the several sonobuoy experiments within the upper slope area. A velocity of 1.8 km/s and a penetration of 585.5 meters is equivalent to 0.65 s (Fig. 10).

Correlation of reflectors to the cored section is difficult, because the number of reflections exceeds observed lithologic and physical property changes. However, one reflection (0.30 s, 270 m), may correspond to thin limestone beds and/or to the beginning of fractures.

SUMMARY AND CONCLUSIONS

Site 490 penetrated 588.5 meters of mud, silt and muddy siltstone ranging in age from latest Miocene to Quaternary. Locations of age boundaries are vague because of carbonate dissolution in the lower cores and reworking evident in upper cores.

Fracturing with slickensides, first observed between 300 and 400 meters, became pervasive below 400 meters. A significant increase in induration accompanied the development of pervasive fracturing. Paleomagnetic data and slickenside orientations suggest northwest-dipping normal faults with minor reverse faults between 400 and 430 meters. We found no evidence of the compressive stress that would be expected to accompany accretion.

Paleontologic data show that the pre-middle Pliocene part of the section was deposited below the CCD. Subsequent uplift raised the section through the CCD and thence to its present position. We estimate uplift rates to be 200 m/m.y. Sedimentation rates show no zonation except for the extreme top of the hole, where 10 m/m.y. is observed. Rates in the lower part of the hole are irregular, averaging about 150 m/m.y.

Reworked Miocene and later fauna evident in middle Pliocene and younger parts of the section probably derive from upslope erosion, as evidenced by a pronounced unconformity at Site 489.

Methane was evident throughout the section. Ethane ranged from lower limits of detectability to a maximum of 0.18% near the bottom of the hole. Smaller amounts of C_3–C_5 were also detected. A gas-releasing ice inclusion at 137 meters produced a 0.91 ml CH_4/ml H_2O. The gas could be either an *in situ* hydrate or incorporated in seawater frozen because of cooling from gas expansion during core recovery. Organic carbon content ranged from 0.8 to 3.0%, with highest percentages occurring in the upper 200 meters. All organic carbon showed a low degree of thermal maturity. Traces of more mature hydrocarbons (C_2–C_5) probably migrated from rocks below the hole.

We conclude the following:

1) Oldest sediments observed in Hole 490 were deposited in a lower slope environment. Younger rocks were deposited in progressively shallower environments as the section was uplifted, probably owing to underplating during accretion.

2) The section was normally faulted in middle(?) Pliocene, resulting in uplift of rocks to the east and formation of a small basin to the west. The coincidence of uplift and the upslope hiatus at Site 489 suggests a cause and effect relationship. Redeposition of microfossils after the early Pliocene probably correlates with the middle Miocene–Quaternary unconformity observed in Hole 489A.

3) There is no firm evidence relating Hole 490 sediments to the accretionary zone. We find no sands suggestive of deposition in a trench environment, no steeply landward-dipping bedding indicative of rotation during ing underplating, no fracture orientations indicative of north–south compression, and no landward-dipping reflectors in the immediate vicinity of 490. Thus these sediments were probably deposited on the lower slope, either as part of a slope apron or as a slope deposit in the gap between the accretionary zone and the seaward lip of continental crust. The magnitude of compressional stresses transmitted to Hole 490 sediments during underplating was evidently inadequate to completely deform the sediments, probably because underplating occurred relatively deep beneath the bottom of the hole.

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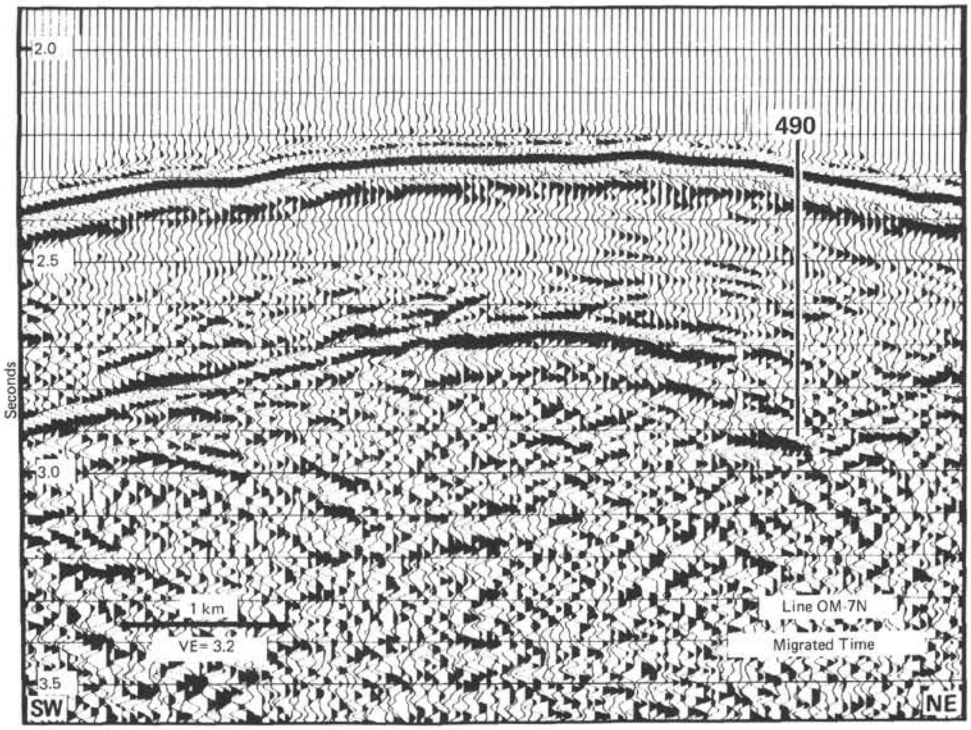
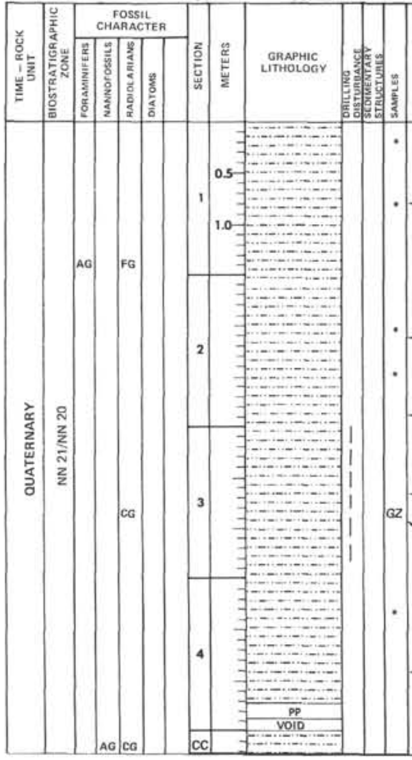


Figure 10. Seismic reflection profile near Site 490.

SITE 490 HOLE CORE 1 CORED INTERVAL 0.0–7.0 m



LITHOLOGIC DESCRIPTION

Prominent glauconite concentrations between 60 and 85 cm

2 x 1.5 cm indurated moderate olive brown calcareous claystone concretion

Diffuse concentration of glauconite

2 x 1.5 indurated moderate olive brown calcareous claystone concretion

More diffuse, soft to indurated, but crumbly, moderate olive brown, slightly calcareous areas present in lower half of section

8 x 2 cm limestone fragment, same color as mud. Nodular. Borings concentrated towards right side (?top).

MUDDY SILT, grayish olive (10Y 4/2) to grayish olive green (5GY 3/2), soft to firm, structureless with sand-sized glauconite grains, dark greenish gray (5GY 4/1) to greenish black (5GY 2/1).

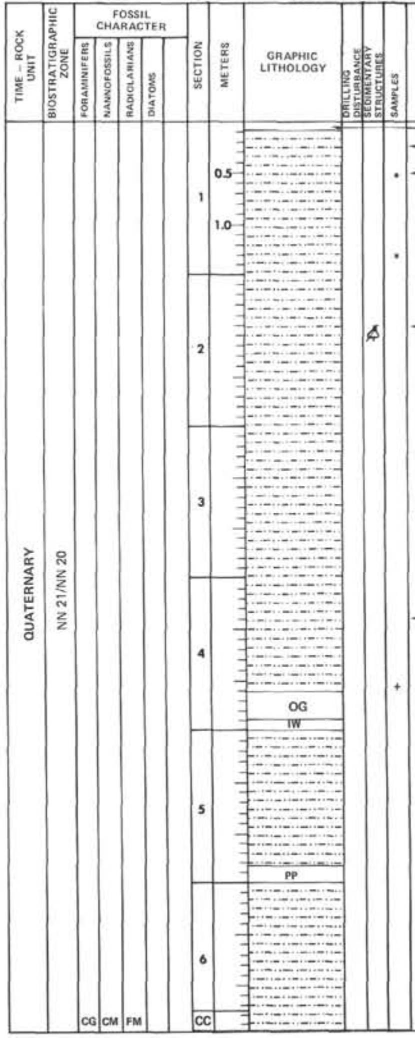
SMEAR SLIDES

	Mud (glauconitic)	Muddy silt (sandy)	Claystone (calcareous)	Muddy silt (glauconitic)	Mud
	1-20	1-73	2-55	2-100	4-30
TEXTURE:	(M)	(D)	(M)	(D)	(M)
Sand	5	12	–	8	1
Silt	40	53	–	57	44
Clay	55	35	100	35	55
COMPOSITION:					
Quartz	33	46	TR	45	42
Feldspar	15	10	–	10	7
Mica	3	2	–	2	3
Heavy minerals	–	–	–	1	1
Pyrite	1	2	–	1	–
Clay	45	30	97	30	45
Glauconite	2	8	–	3	TR
Carb. unspec.	–	3	–	–	–
Foraminifers	–	–	–	2	–
Nannofossils	TR	–	–	5	1
Radiolarians	TR	TR	–	TR	TR
Diatoms	TR	TR	–	–	TR
Silicoflagellates	–	–	–	–	TR
Plant fragments	1	1	–	1	TR

GRAIN SIZE

	3-83
Sand	2.9
Silt	57.6
Clay	39.5

SITE 490 HOLE CORE 2 CORED INTERVAL 9.0–18.5 m



LITHOLOGIC DESCRIPTION

VOID

8 x 2 cm limestone ?concretion, bored, same color as mud

50–62 cm – diffuse area of moderate olive brown (5Y 4/4) slightly calcareous mud

15 mm x 4 mm wood fragment

3 x 3 mm dark yellowish orange (10YR 6/6) clast (?zeolite)

MUDDY SILT, grayish olive green (5GY 3/2) moderately firm, apparently structureless. Occasional white sponge spicule concentrations.

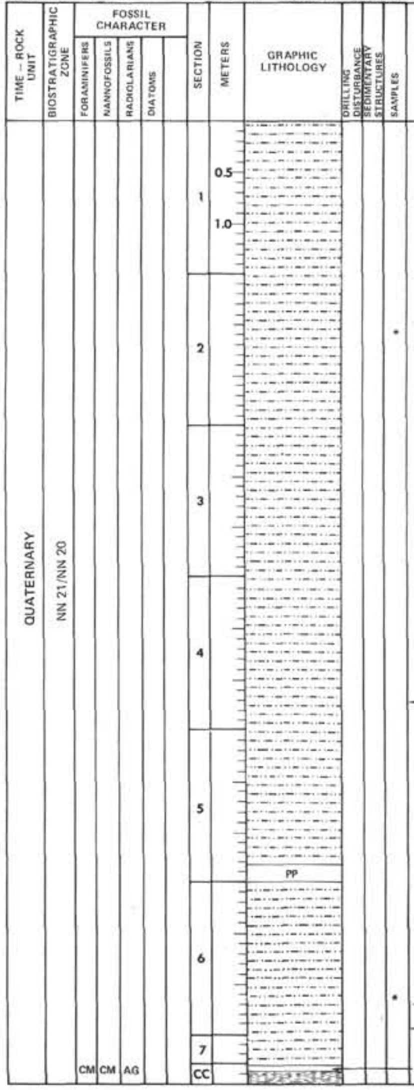
SMEAR SLIDES

	Mud	Mud
	1-54	1-130
TEXTURE:	(D)	(D)
Sand	2	3
Silt	10	42
Clay	88	55
COMPOSITION:		
Quartz	5	40
Feldspar	TR	8
Mica	2	2
Heavy minerals	TR	1
Pyrite	1	1
Clay	88	45
Glauconite	TR	TR
Carb. unspec.	2	1
Foraminifers	TR	TR
Nannofossils	–	TR
Radiolarians	–	TR
Diatoms	TR	1
Sponge spicules	TR	TR
Silicoflagellates	TR	TR

ORGANIC CARBON AND CARBONATE

	4-106
% Organic Carbon	2.0
% $CaCO_3$	0

SITE 490 HOLE CORE 3 CORED INTERVAL 18.5–28.0 m



LITHOLOGIC DESCRIPTION

MUDDY SILT, olive gray (5Y 3/2) to grayish olive (10Y 4/2), moderately firm, structureless. Occasional minute white sponge spicule concentrations in Sections 2, 3, 6, and 7.

SMEAR SLIDES

	Mud	Glauconitic sand
	2-60	6-117
TEXTURE:	(D)	(M)
Sand	1	60
Silt	39	30
Clay	60	10
COMPOSITION:		
Quartz	–	64
Feldspar	–	8
Mica	–	4
Heavy minerals	–	3
Pyrite	1	1
Clay	–	7
Glauconite	–	12
Carb. unspec.	1	1
Foraminifers	TR	TR
Nannofossils	1	–
Radiolarians	TR	–
Diatoms	3	TR
Sponge spicules	TR	–
Silicoflagellates	TR	–
Plant fragments	1	–

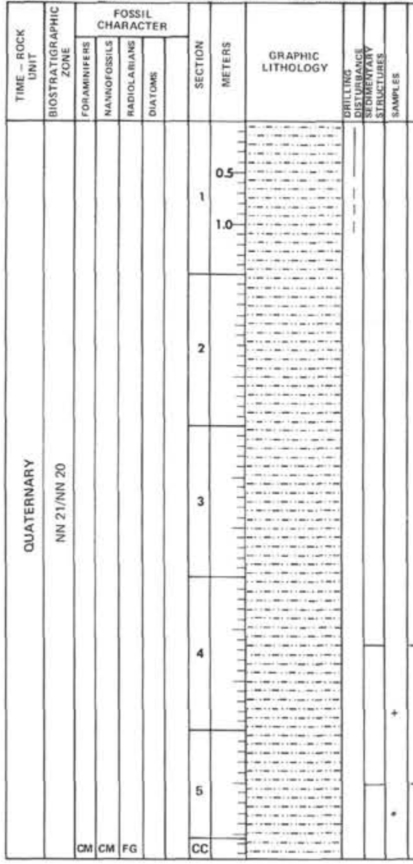
Slightly darker unit – more olive gray than grayish olive

Glauconitic sand unit, top and base diffuse, greenish black (5G 2/1)

Glauconite concentration, local

VOID

SITE 490 HOLE CORE 4 CORED INTERVAL 28.0–37.5 m



LITHOLOGIC DESCRIPTION

Moderately firm

Gas expansion cracks

10Y 4/2

Vague 2 mm thick olive gray (5Y 3/2) lamination

3–4 mm olive gray (5Y 3/2) lamination

MUDDY SILT, olive gray (5Y 3/2) to grayish olive (10Y 4/2) soft to moderately firm, apparently structureless. Occasional white sponge spicule concentrations in Sections 4 and 5.

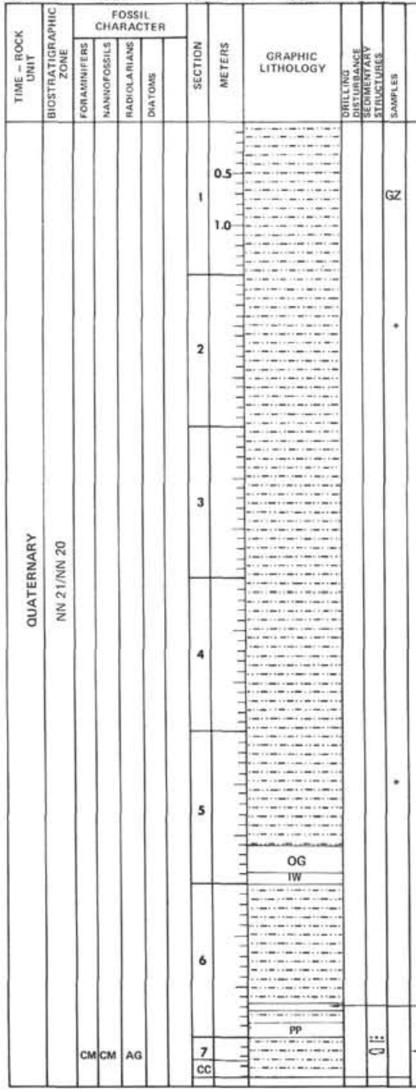
SMEAR SLIDES

	Muddy silt
	5-80
TEXTURE:	(D)
Sand	1
Silt	54
Clay	45
COMPOSITION:	
Quartz	41
Feldspar	15
Mica	3
Heavy minerals	1
Pyrite	1
Clay	35
Carb. unspec.	1
Diatoms	1
Sponge spicules	1
Silicoflagellates	TR
Plant fragments	1

ORGANIC CARBON AND CARBONATE

	4-130
% Organic Carbon	2.2
% $CaCO_3$	4

SITE 490 HOLE CORE 5 CORED INTERVAL 37.5–47.0 m



LITHOLOGIC DESCRIPTION

MUDDY SILT, olive gray (5Y 3/2) to grayish olive (10Y 4/2), soft to moderately firm, structureless with minor glauconite SAND, greenish black (5G 2/1). Gas expansion cracks common.

SMEAR SLIDES

	Muddy silt	Mud
	2-50 (D)	5-50 (M)
TEXTURE:		
Sand	1	1
Silt	54	44
Clay	45	55
COMPOSITION:		
Quartz	43	34
Feldspar	5	2
Mica	2	2
Heavy minerals	TR	–
Pyrite	2	TR
Clay	45	55
Glauconite	–	TR
Carb. unspec.	TR	2
Foraminifers	TR	TR
Nannofossils	TR	TR
Radiolarians	TR	TR
Diatoms	1	1
Sponge spicules	2	2
Silicoflagellates	TR	–
Plant fragments	–	2

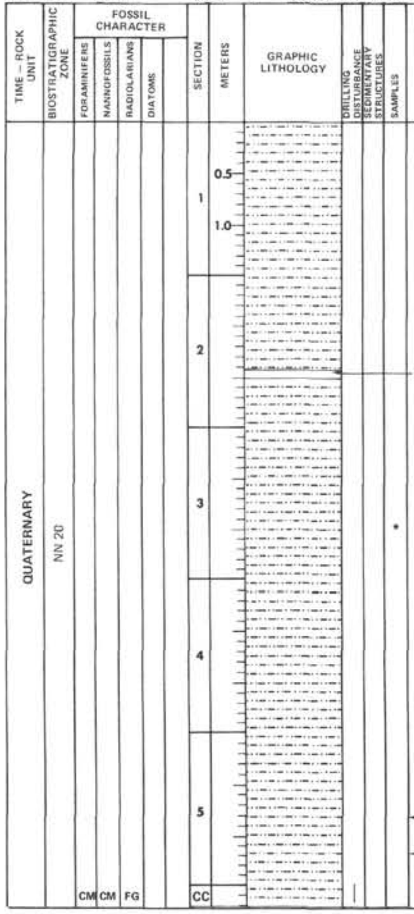
GRAIN SIZE

	1-70
Sand	1.8
Silt	55.0
Clay	43.2

VOID

Graded bed of medium- to fine-grained glauconitic sand, irregular (loaded?) scoured base.

SITE 490 HOLE CORE 6 CORED INTERVAL 47.0–56.5 m



VOID

LITHOLOGIC DESCRIPTION

MUDDY SILT, olive gray (5Y 3/2) homogeneous. Gas expansion cracks common. Scattered sponge remains. Core-Catcher artificially compacted (extruded from Core-Catcher originally).

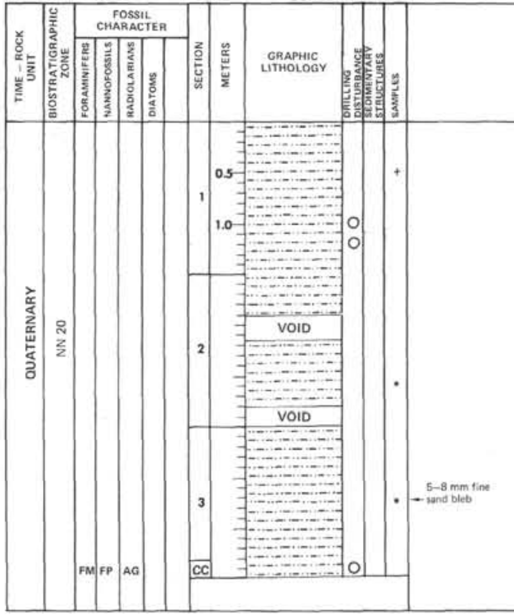
SMEAR SLIDES

	Mud
	3-100 (D)
TEXTURE:	
Sand	1
Silt	44
Clay	55
COMPOSITION:	
Quartz	33
Feldspar	2
Mica	2
Heavy minerals	TR
Pyrite	TR
Clay	55
Glauconite	TR
Carb. unspec.	1
Foraminifers	TR
Nannofossils	TR
Radiolarians	TR
Diatoms	3
Sponge spicules	2
Plant fragments	2

80–90 cm – concentration of sponge remains

110–150 cm – scattered sponge remains

SITE 490 HOLE CORE 7 CORED INTERVAL 56.5–66.0 m



LITHOLOGIC DESCRIPTION

MUDDY SILT, olive gray (5Y 3/2) soft to moderate firm, homogeneous, scattered sponge remains, scattered very small (2–5 mm) diffuse sand blebs. Gas expansion cracks common.

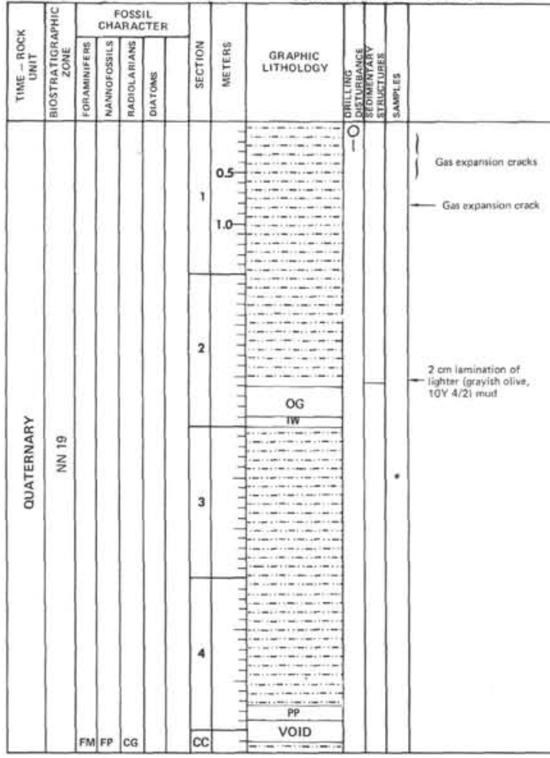
SMEAR SLIDES

	Mud	Very fine sand
	2-110	3-71
TEXTURE:	(D)	(M)
Sand	–	100
Silt	30	–
Clay	70	–
COMPOSITION:		
Quartz	17	80
Feldspar	2	20
Mica	3	–
Pyrite	1	–
Clay	70	–
Zeolite	TR	–
Carb. unspec.	TR	–
Foraminifers	TR	–
Nannofossils	TR	–
Diatoms	3	–
Sponge spicules	2	–
Plant fragments	2	–

ORGANIC CARBON AND CARBONATE

	1-50
% Organic Carbon	2.5
% $CaCO_3$	0

SITE 490 HOLE CORE 8 CORED INTERVAL 66.0–75.5 m



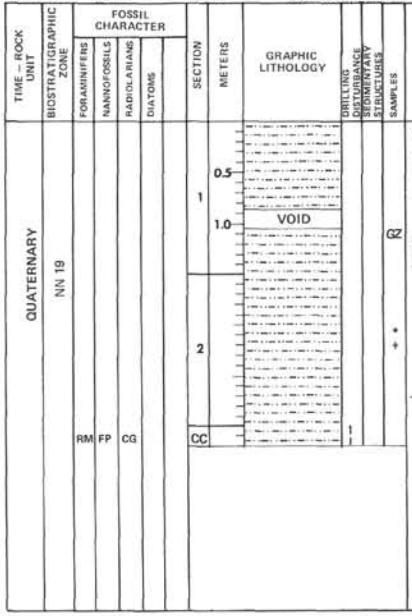
LITHOLOGIC DESCRIPTION

MUDDY SILT, olive gray (5Y 3/2) soft to firm, homogeneous, infrequent sponge remains. Firmer towards base of core.

SMEAR SLIDES

	Mud
	3-50
TEXTURE:	(D)
Sand	1
Silt	29
Clay	70
COMPOSITION:	
Quartz	21
Feldspar	1
Mica	1
Pyrite	1
Clay	70
Carb. unspec.	TR
Nannofossils	TR
Radiolarians	TR
Diatoms	2
Sponge spicules	2
Plant fragments	2

SITE 490 HOLE CORE 9 CORED INTERVAL 75.5–85.0 m



LITHOLOGIC DESCRIPTION

Dispersed gas expansion cracks

Very firm

Gas expansion crack

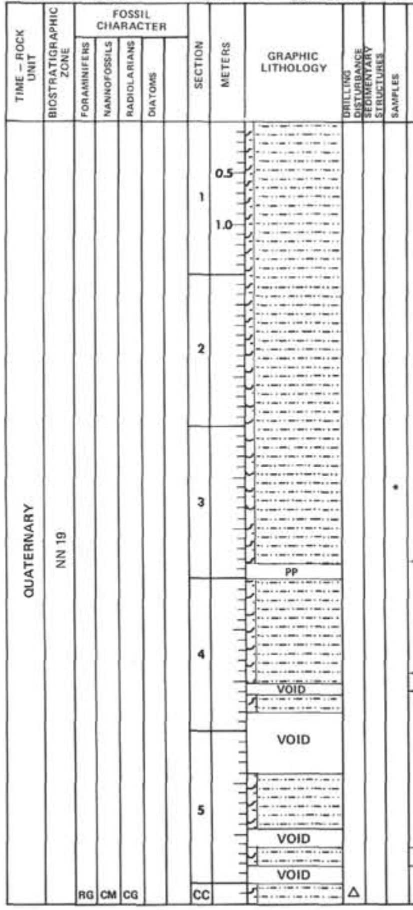
MUDDY SILT, olive gray (5Y 3/2), soft, homogeneous, very small (2–3 mm) blebs of fine sand and sponge spicules. Firmer towards base.

SMEAR SLIDES	Mud
	2-60
TEXTURE:	(D)
Sand	2
Silt	40
Clay	60
COMPOSITION:	
Quartz	26
Feldspar	2
Mica	2
Pyrite	TR
Clay	60
Diatoms	6
Sponge spicules	2
Plant fragments	1

GRAIN SIZE	
	1-110
Sand	3.1
Silt	64.8
Clay	32.0

ORGANIC CARBON AND CARBONATE	
	2-70
% Organic Carbon	2.9
% $CaCO_3$	0

SITE 490 HOLE CORE 10 CORED INTERVAL 85.0–94.5 m



LITHOLOGIC DESCRIPTION

Gas expansion crack

5Y 2/1

Gas expansion crack

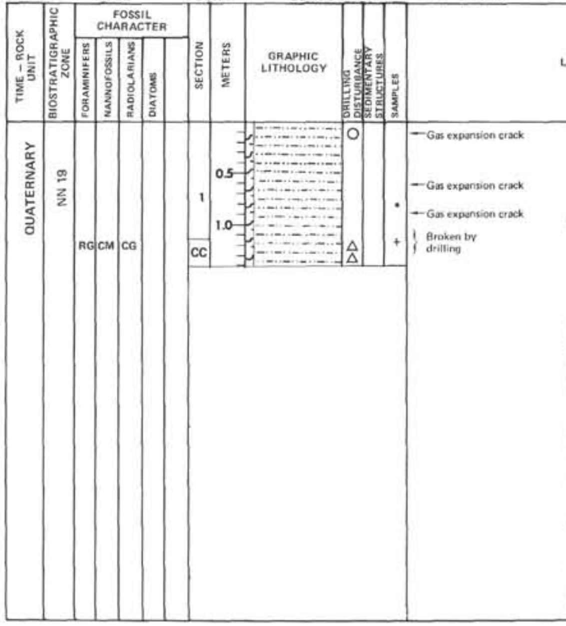
Gas expansion crack

Several gas expansion cracks

DIATOMACEOUS MUDDY SILT, olive gray (5Y 3/2) to olive black (5Y 2/1), firm, homogeneous, scattered minute (1–2 mm) blebs of fine-grained sand.

SMEAR SLIDES	Diatomaceous mud
	3-60
TEXTURE:	(D)
Sand	2
Silt	43
Clay	55
COMPOSITION:	
Quartz	26
Feldspar	2
Mica	2
Pyrite	2
Clay	55
Nannofossils	TR
Radiolarians	TR
Diatoms	9
Sponge spicules	3
Plant fragments	1

SITE 490 HOLE CORE 11 CORED INTERVAL 94.5–104.0 m



LITHOLOGIC DESCRIPTION

DIATOMACEOUS MUDDY SILT, olive black (5Y 2/1) firm, homogeneous, scattered minute (1–3 mm) blebs of fine SAND, and sporadic sponge remains.

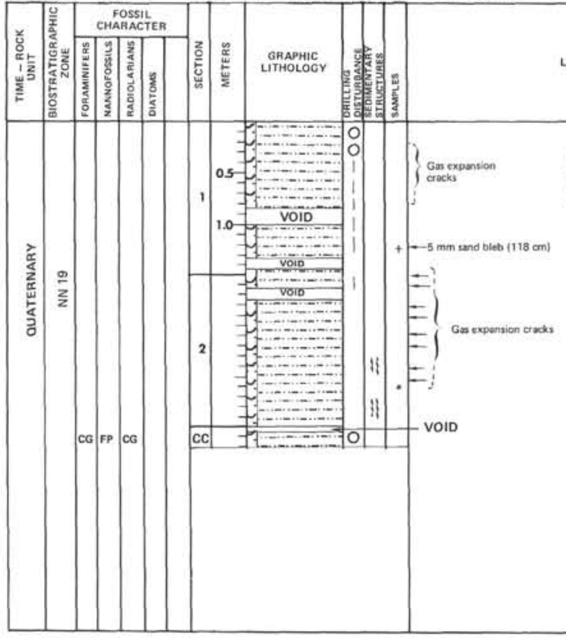
SMEAR SLIDES

	Diatomaceous mud
	1-80
TEXTURE:	(D)
Sand	2
Silt	43
Clay	55
COMPOSITION:	
Quartz	25
Feldspar	4
Mica	2
Pyrite	2
Clay	55
Foraminifers	TR
Nannofossils	TR
Radiolarians	TR
Diatoms	9
Sponge spicules	2
Plant fragments	1

ORGANIC CARBON AND CARBONATE

	1-113
% Organic Carbon	3.0
% $CaCO_3$	3

SITE 490 HOLE CORE 12 CORED INTERVAL 104.0–113.5 m



LITHOLOGIC DESCRIPTION

DIATOMACEOUS, MUDDY SILT, olive black (5Y 2/1) and minor grayish black (N2), soft to very firm, homogeneous. Below 75 cm in Section 2, moderately mottled, with olive gray and minor grayish black areas. Bioturbated.

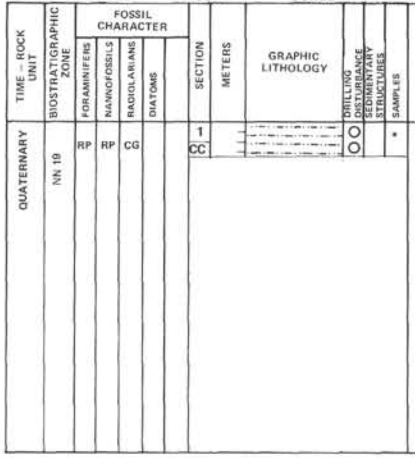
SMEAR SLIDES

	Diatomaceous mud
	2-119
TEXTURE:	(D)
Sand	1
Silt	44
Clay	55
COMPOSITION:	
Quartz	26
Feldspar	3
Mica	2
Heavy minerals	TR
Pyrite	2
Clay	55
Foraminifers	TR
Nannofossils	TR
Radiolarians	1
Diatoms	8
Sponge spicules	3

ORGANIC CARBON AND CARBONATE

	1-124
% Organic Carbon	2.4
% $CaCO_3$	1

SITE 490 HOLE CORE 13 CORED INTERVAL 113.5–123.0 m



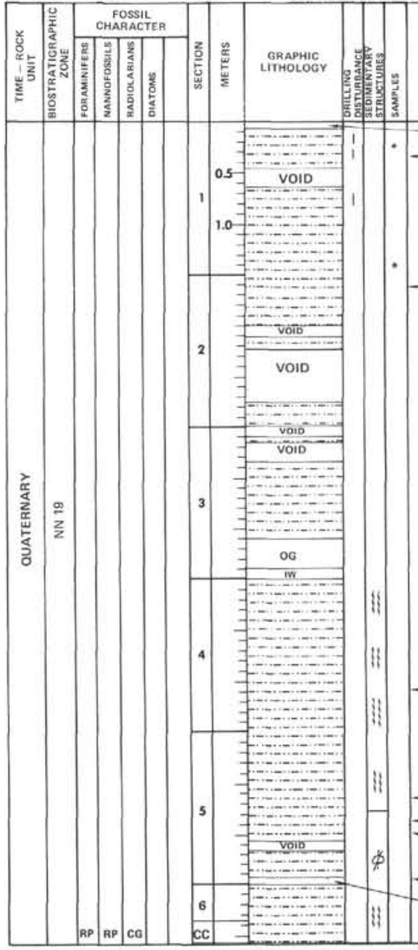
LITHOLOGIC DESCRIPTION

MUDDY SILT, olive black (5Y 2/1), soft.

SMEAR SLIDES

	Mud
	1-16
TEXTURE:	(D)
Sand	1
Silt	29
Clay	70
COMPOSITION:	
Quartz	17
Feldspar	4
Mica	3
Pyrite	1
Clay	70
Nannofossils	TR
Radiolarians	TR
Diatoms	3
Sponge spicules	1
Plant fragments	1

SITE 490 HOLE CORE 15 CORED INTERVAL 132.5–142.0 m



LITHOLOGIC DESCRIPTION

—VOID

— Gas expansion cracks

— Gas expansion cracks

— 2 cm indurated calcareous concretion, without sharp margins

— Gas expansion cracks

— mm lamination of very fine sand

Gas expansion cracks

— Gas expansion cracks

VOID

Site 490, Core 14, 123.0–132.5 m: NO RECOVERY.

MUDDY SILT, olive gray (5Y 3/2) soft, structureless to MUDDY SILTSTONE, olive gray (5Y 3/2) structureless (below 85 cm in Section 1).

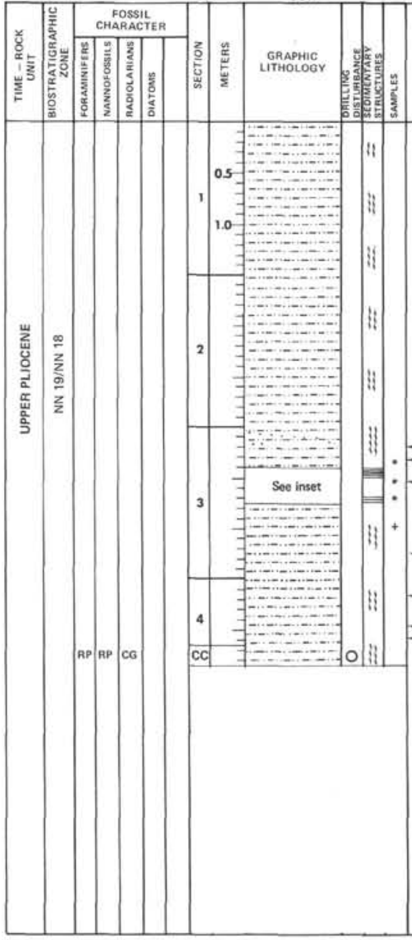
Section 4: Slightly darker mottling effect in this section due to bioturbation. Several diffuse areas, up to several cm across, light olive brown (5Y 5/6) to grayish olive (10Y 4/2), calcareous – ?incipient concretions (40, 70, 84, and 100 cm). Millimeter-scale fine sand blebs between 100 and 115 cm. Very occasional minute white sponge specks.

Section 5: 118 cm: Pale calcareous area, as in Section 4. 120 cm: 5 x 3 x 1 cm wood fragment. 123–125 cm: 3 cm irregular ICE fragment (canned).

SMEAR SLIDES

	Muddy silt	Muddy silt (sandy)
	1-25	1-145
TEXTURE:	(D)	(M)
Sand	7	20
Silt	53	60
Clay	40	20
COMPOSITION:		
Quartz	57	73
Feldspar	7	7
Mica	2	2
Heavy minerals	1	TR
Pyrite	1	1
Clay	30	15
Glauconite	–	TR
Carb. unspec.	TR	–
Radiolarians	TR	0.5
Diatoms	TR	0.5
Sponge spicules	1	1
Silicoflagellates	–	TR
Plant fragments	1	TR

SITE 490 HOLE CORE 16 CORED INTERVAL 142.0–151.5 m



LITHOLOGIC DESCRIPTION

0–28 cm soft, muddy silt

MUDDY SILTSTONE, grayish olive (10Y 4/2) to olive gray (5Y 3/2), fine SAND beds and VITRIC SILT.

Inset (Section 3)

mm fine sand bed, 10–30° accurate dip (5 cm)
(accurate dip apparently caused by drilling)

— Minute fine sand bleb (15 cm)

— Diffuse calcareous discoloration, approaching light olive brown in color (5Y 5/6) (30–35 cm)

— Apparent dip ~10° (40–75 cm)

— Diffuse calcareous discoloration approaching light brown (5Y 5/6) in color (125–127 cm)

— Minute fine sand bleb (15 cm)

Gas expansion cracks

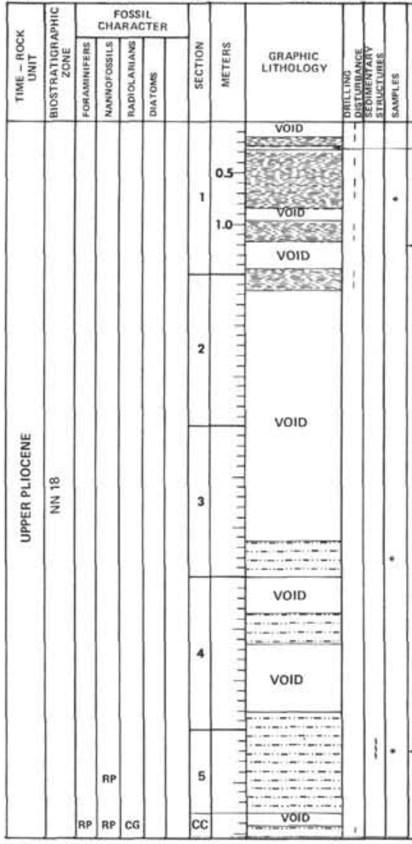
SMEAR SLIDES

	Vitric (muddy) silt	Vitric silt	Muddy silt
	3-32	3-58	3-73
TEXTURE:	(M)	(M)	(D)
Sand	1	3	2
Silt	69	88	82
Clay	30	15	10
COMPOSITION:			
Quartz	61	68	64
Feldspar	7	7	5
Mica	3	2	3
Heavy minerals	1	1	1
Pyrite	1	1	7
Clay	20	10	5
Glass	5	10	15
Carb. unspec.	TR	–	–
Radiolarians	0.5	TR	TR
Diatoms	0.5	TR	TR
Sponge spicules	1	TR	–
Plant fragments	–	1	TR

ORGANIC CARBON AND CARBONATE

	3-100
% Organic Carbon	2.0
% $CaCO_3$	2

SITE 490 HOLE CORE 17 CORED INTERVAL 151.5–161.0 m



LITHOLOGIC DESCRIPTION

VOID

5G 2/1

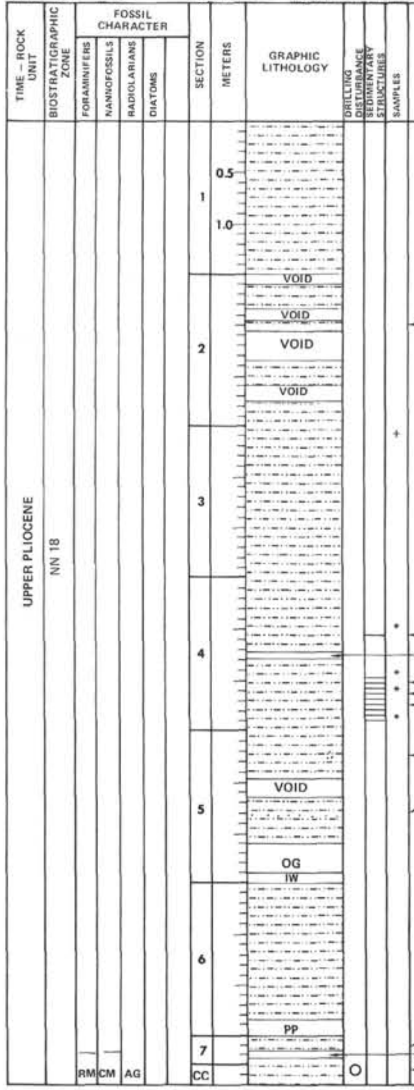
Vague mottling in upper portion of section – probably bioturbation

MUD, grayish olive green (5GY 3/2) to greenish black (5G 2/1) and MUDDY SILTSTONE, greenish black (5G 2/1), soft, structureless.

SMEAR SLIDES

	Muddy siltstone (siliceous)	Muddy siltstone (diatomaceous)	Siliceous mud
	1-79	3-133	5-20
TEXTURE:	(D)	(D)	(D)
Sand	1	2	4
Silt	39	53	56
Clay	60	45	40
COMPOSITION:			
Quartz	30	34	43
Feldspar	5	7	7
Mica	2	3	2
Heavy minerals	1	TR	TR
Pyrite	1	2	2
Clay	56	45	40
Glass	–	–	TR
Glauconite	TR	–	–
Carb. unspec.	–	TR	–
Silic. unspec.	–	1	–
Radiolarians	TR	TR	TR
Diatoms	2	5	3
Sponge spicules	3	1	3
Silicoflagellates	–	–	TR

SITE 490 HOLE CORE 18 CORED INTERVAL 161.0–170.5 m



LITHOLOGIC DESCRIPTION

Gas expansion crack

mm fine sand lamination (55 cm)

VOID

Thermister probe readings:
Minus 2.0°C – 110 cm
Minus 1.8°C – 120 cm
Minus 0.8°C – 127 cm

mm-scale diffuse fine sand blebs (25–30 cm)

Fine sand bed (mm scale), apparent dip 12° (75 cm)

Fine sand blebs

VOID

Ash areas in Core-Catcher rubble

MUDDY SILTSTONE, grayish olive green (5GY 3/2). Occasional minute white spong specks. Splitting of this indurated sediment with wire cutter (instead of saw, to avoid losing possible clathrates) means that internal structures are difficult to see. Occasional drilling biscuit laminations are evident in places. Fine SAND laminations and ASH are rare.

In Section 4, 100–135 cm parallel laminated ash unit, predominantly greenish gray (5GY 6/1) with laminations of medium gray (N5), medium light gray (N6) and light gray (N7) to very light gray (N8). When first opened, frozen. Fine sand-size in basal 4 cm, very fine sand-size over remainder.

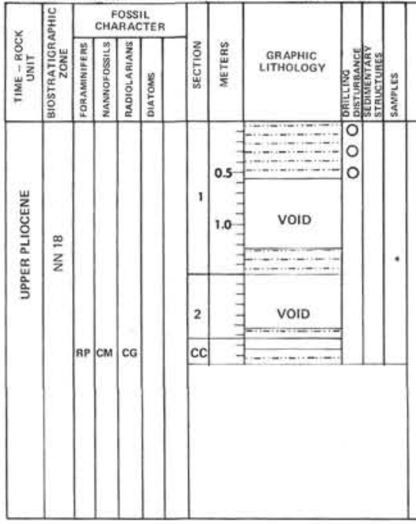
SMEAR SLIDES

	Muddy siltstone	Muddy siltstone (diatomaceous)	Ash	Ash
	4-43	4-93	4-108	4-134
TEXTURE:	(D)	(M)	(M)	(M)
Sand	10	3	35	85
Silt	70	67	65	10
Clay	20	30	5	5
COMPOSITION:				
Quartz	70	48	10	10
Feldspar	7	10	2	2
Mica	3	4	TR	TR
Heavy minerals	1	1	TR	TR
Pyrite	1	2	1	2
Clay	15	25	2	5
Glass	–	–	85	80
Undeterm. silic.	1	–	–	–
Foraminifers	–	–	–	TR
Nannofossils	–	2	TR	–
Radiolarians	TR	TR	–	TR
Diatoms	1	4	TR	1
Sponge spicules	1	4	TR	TR
Silicoflagellates	–	TR	1	–
Plant fragments	TR	–	–	–

ORGANIC CARBON AND CARBONATE

	3-10
% Organic Carbon	2.1
% $CaCO_3$	3

SITE 490 HOLE CORE 19 CORED INTERVAL 170.5–180.0 m



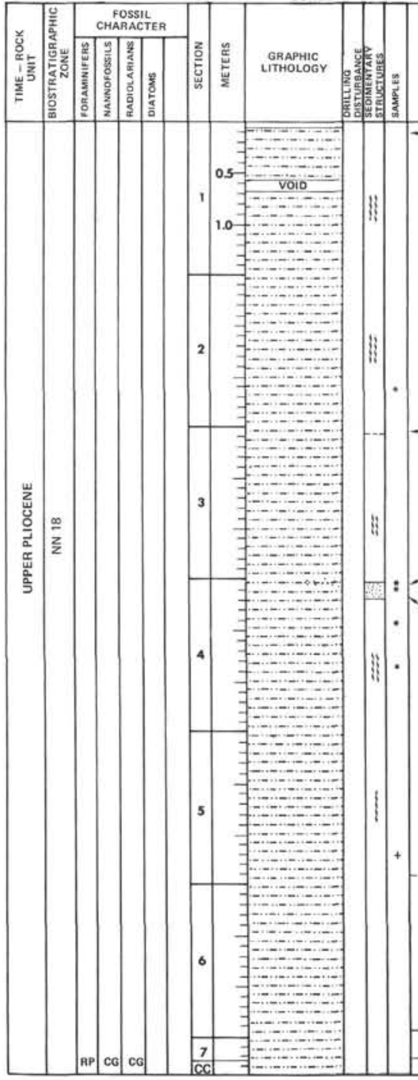
LITHOLOGIC DESCRIPTION

MUDDY SILT to MUDDY SILTSTONE, greenish black (5G 2/1), structureless.

SMEAR SLIDES

	Muddy siltstone (siliceous)
	1-134
TEXTURE:	(D)
Sand	4
Silt	56
Clay	40
COMPOSITION:	
Quartz	44
Feldspar	10
Mica	3
Heavy minerals	1
Pyrite	2
Clay	35
Nannofossils	TR
Radiolarians	2
Diatoms	1
Sponge spicules	2

SITE 490 HOLE CORE 20 CORED INTERVAL 180.0–189.5 m



LITHOLOGIC DESCRIPTION

Muddy siltstone, grayish olive green contact with underlying unit sharp, apparent dip 2°

MUDDY SILTSTONE, olive black (5Y 2/1) with grayish olive green (5GY 3/2). Mottling due to intense bioturbation. Color varies downcore from olive gray (5Y 3/2) to greenish black (5GY 2/1). Drilling laminations at regular (3 cm) intervals. Pyrite concentrations common as hard nodules up to 3 or 4 mm diameter.

In Section 4 at 19 and 30 cm two thin dark clay laminations occur – the lower one displaces a bioturbated zone. The dark laminations are soft and pass into a marginal smeary layer of similar dark clay – evidnece that these laminations are produced in the drilling process.

Grayish olive (10Y 4/2) lamination, 4 mm thick, with indistinct contacts

Dark greenish gray color band, more silty than normal

One bed of glauconite sand with pyrite (15 cm)

5Y 3/2

5GY 2/1

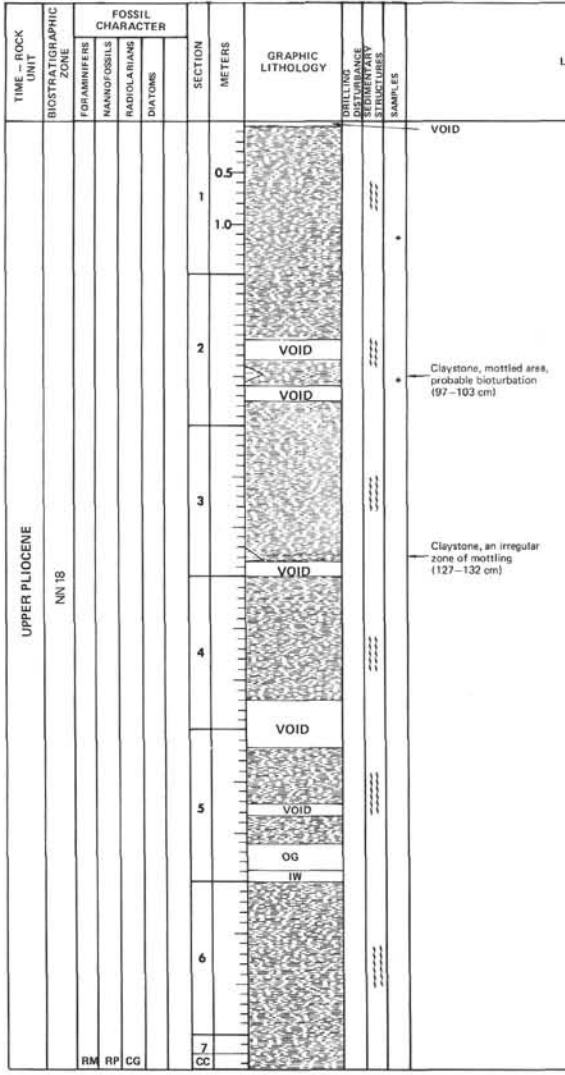
SMEAR SLIDES

	Muddy silt (diatomaceous)	Glauconitic muddy silt (sandy)	Zeolitite	Pyrite nodule	Muddy silt (diatomaceous)
	2-114	4-7	4-10	4-35	4-89
TEXTURE:	(D)	(M)	(M)	(M)	(D)
Sand	2	30	–	–	1
Silt	63	55	–	–	74
Clay	35	15	–	–	25
COMPOSITION:					
Quartz	49	47	–	–	53
Feldspar	10	10	–	–	10
Mica	2	1	–	–	3
Heavy minerals	TR	15	–	–	TR
Pyrite	2	6	–	100	1
Clay	30	–	–	–	25
Glauconite	–	20	–	–	–
Zeolite	–	–	100	–	–
Carb. unspec.	TR	–	–	–	–
Nannofossils	TR	–	–	–	–
Radiolarians	TR	TR	–	–	TR
Diatoms	5	TR	–	–	6
Sponge spicules	2	TR	–	–	2
Silicoflagellates	–	–	–	–	TR

ORGANIC CARBON AND CARBONATE

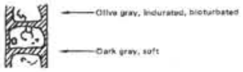
	5-120
% Organic Carbon	2.0
% $CaCO_3$	1

SITE 490 HOLE CORE 21 CORED INTERVAL 189.5–199.0 m



LITHOLOGIC DESCRIPTION

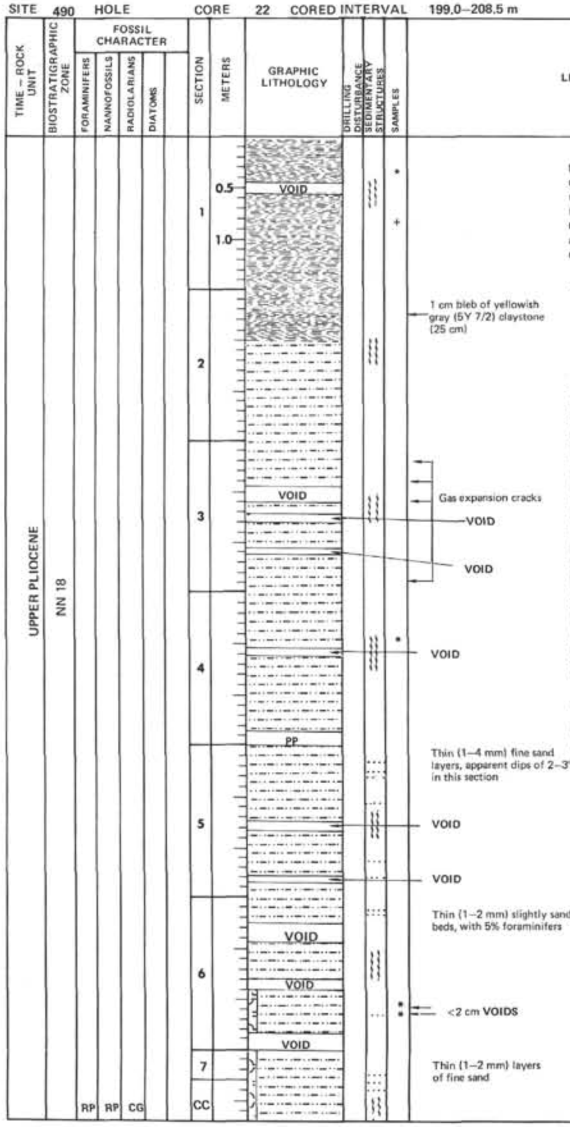
SILICEOUS MUDSTONE, olive gray (5Y 3/2) with CLAYSTONE grayish olive (10Y 4/2). Slight mottling, moderate biotrubation, pyrite nodules common in Sections 1 through 4. Drilling biscuits and laminations – spaced every few cms to tens of cms.



SMEAR SLIDES

	Siliceous mudstone	Claystone
	1-113	2-101
TEXTURE:	(D)	(M)
Sand	2	–
Silt	43	2
Clay	55	98
COMPOSITION:		
Quartz	35	2
Feldspar	7	TR
Mica	2	TR
Heavy minerals	TR	95
Pyrite	1	–
Carb. unspec.	–	3
Foraminifers	–	TR
Nannofossils	TR	–
Radiolarians	1	–
Diatoms	6	TR
Sponge spicules	3	TR

SITE 490 HOLE CORE 22 CORED INTERVAL 199.0–208.5 m



LITHOLOGIC DESCRIPTION

MUDSTONE, olive gray (5Y 3/2) moderately bioturbated. Gradational change to muddy siltstone in Section 2 and to a SILICEOUS MUDDY SILTSTONE in Section 6. Thin fine SAND lamination common in Sections 5 and 6. Common to abundant drilling biscuits and laminations, at regular (2–3 cm) intervals. Small (up to 2 mm) pyrite nodules common to abundant.

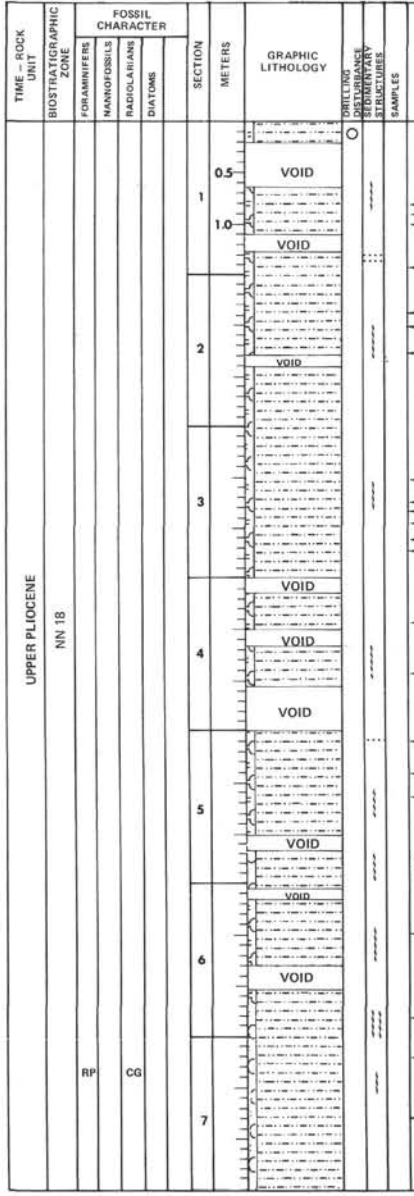
SMEAR SLIDES

	Mudstone	Muddy siltstone	Siliceous muddy siltstone	Foraminiferal muddy siltstone (sandy)
	1-36	4-41	6-103	6-112
TEXTURE:	(D)	(D)	(M)	(M)
Sand	3	5	5	40
Silt	42	60	60	45
Clay	55	35	35	15
COMPOSITION:				
Quartz	35	47	55	63
Feldspar	7	10	15	10
Mica	2	2	4	1
Heavy minerals	–	TR	2	1
Pyrite	1	1	–	1
Clay	50	35	11	15
Glass	–	–	TR	–
Carb. unspec.	–	TR	–	–
Glauconite	–	–	–	1
Foraminifers	–	–	–	5
Nannofossils	–	–	1	–
Radiolarians	TR	TR	4	TR
Diatoms	4	3	6	2
Sponge spicules	1	2	2	1
Silicoflagellates	TR	TR	–	–
Plant fragments	–	–	TR	–

ORGANIC CARBON AND CARBONATE

	1-80
% Organic Carbon	1.9
% $CaCO_3$	0

SITE 490 HOLE CORE 23 CORED INTERVAL 208.5–218.0 m



LITHOLOGIC DESCRIPTION

Gas expansion cracks

Fine-medium sand beds, 1–2 mm, 6° apparent dip (138–143 cm)

Gas expansion cracks

3.5 cm foraminifer muddy sand

Gas expansion crack

Gas expansion cracks

Small black flecks – organic matter?

Gas expansion crack

Fine sand lamination

Gas expanion crack

Layer of small (1–2 mm) black flecks (?organic matter)

Several gas expansion cracks

2 cm **VOID**

Gas expansion crack

Numerous horizontal breaks in the siltstone, due to extrusion from core barrel. No drilling deformation within individual pieces.

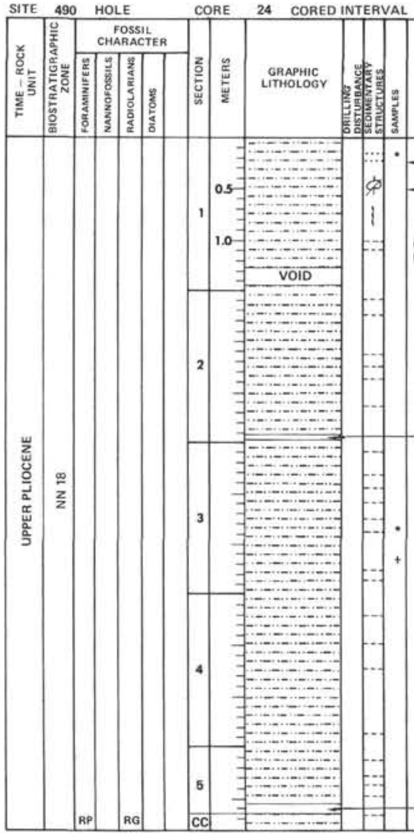
1.5 x 1.5 x 0.5 cm white ash fragment

SILICEOUS MUDDY SILTSTONE, olive gray (5Y 3/2) slight bioturbation, infrequent drilling biscuits, and infrequent pyrite nodules (1–2 mm). Drilling biscuits abundant in Section 6.

SMEAR SLIDES

	Foraminiferal muddy sand	Siliceous muddy siltstone
	2-73	3-44
TEXTURE:	(M)	(D)
Sand	40	1
Silt	35	55
Clay	25	44
COMPOSITION:		
Quartz	35	54
Feldspar	10	15
Mica	5	3
Heavy minerals	2	2
Pyrite	2	1
Clay	7	10
Glass	2	–
Carb. unspec.	2	1
Foraminifers	25	–
Nannofossils	1	1
Radiolarians	1	3
Diatoms	6	7
Sponge spicules	1	2
Silicoflagellates	–	TR
Plant fragments	1	1

SITE 490 HOLE CORE 24 CORED INTERVAL 218.0–227.5 m



LITHOLOGIC DESCRIPTION

6 cm foraminiferal muddy silt (13–22 cm)

Several plant fragments up to 3 cm

Thin (1–3 mm) silt intervals

VOID

Pale blue green (5BG 7/2) ?reduction spots/?clasts – slightly more indurated than matrix, 5 mm + 1 cm diameters (5 and 20 cm)

VOID

MUDDY SILTSTONE, olive gray (5Y 3/2), slightly bioturbated. Thin silt layer and lamination occur throughout core but most common in Sections 1, 2, and 3. Very few pyrite nodules (up to 1 mm) common to abundant drilling biscuits.

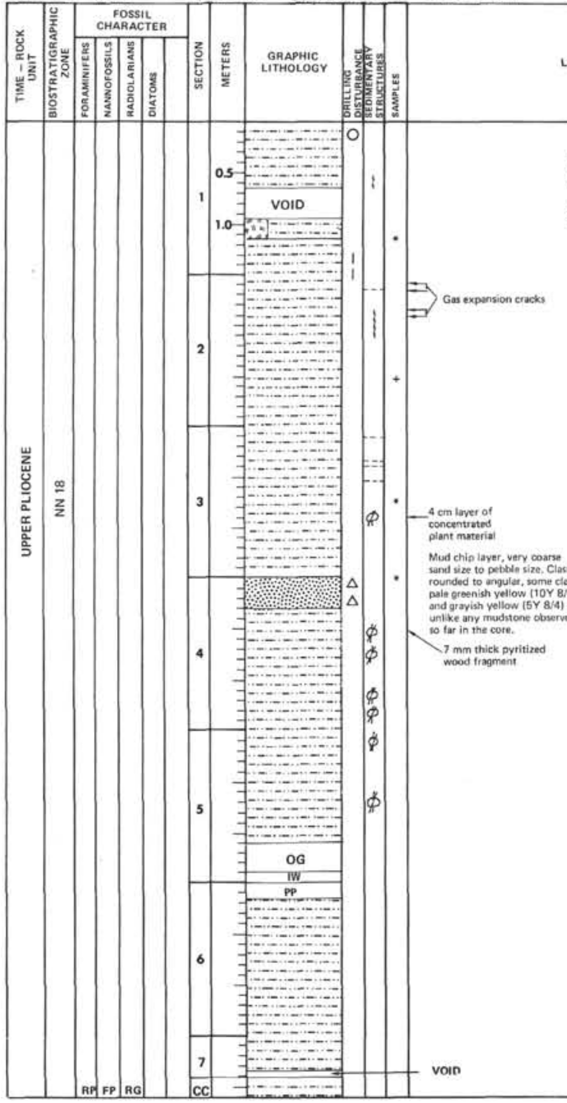
SMEAR SLIDES

	Foraminiferal muddy siltstone (sandy)	Muddy siltstone
	1-18	3-86
TEXTURE:	(M)	(D)
Sand	25	10
Silt	35	50
Clay	40	40
COMPOSITION:		
Quartz	50	54
Feldspar	8	15
Mica	5	5
Heavy minerals	1	2
Pyrite	1	2
Clay	13	15
Glass	2	2
Carb. unspec.	3	–
Foraminifers	15	–
Nannofossils	1	1
Radiolarians	TR	–
Diatoms	TR	2
Sponge spicules	1	1
Silicoflagellates	TR	–
Plant fragments	TR	1

ORGANIC CARBON AND CARBONATE

	3-112
% Organic Carbon	1.6
% $CaCO_3$	0

SITE 490 HOLE CORE 25 CORED INTERVAL 227.5–237.0 m



Gas expansion cracks

4 cm layer of concentrated plant material

Mud chip layer, very coarse sand size to pebble size. Clasts rounded to angular, some clasts pale greenish yellow (10Y 8/2) and grayish yellow (5Y 8/4) – unlike any mudstone observed so far in the core.

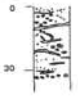
7 mm thick pyritized wood fragment

LITHOLOGIC DESCRIPTION

MUDDY SILTSTONE, olive gray (5Y 3/2) locally vitric. Slightly bioturbated, with occasional thin 1–2 mm silt interbeds. Rare to common drilling biscuit.

Section 1, 95–150 cm: interval less indurated, firm muddy silt, otherwise as above.

Irregular organization



Vague internal structure suggests a number of discrete depositional events

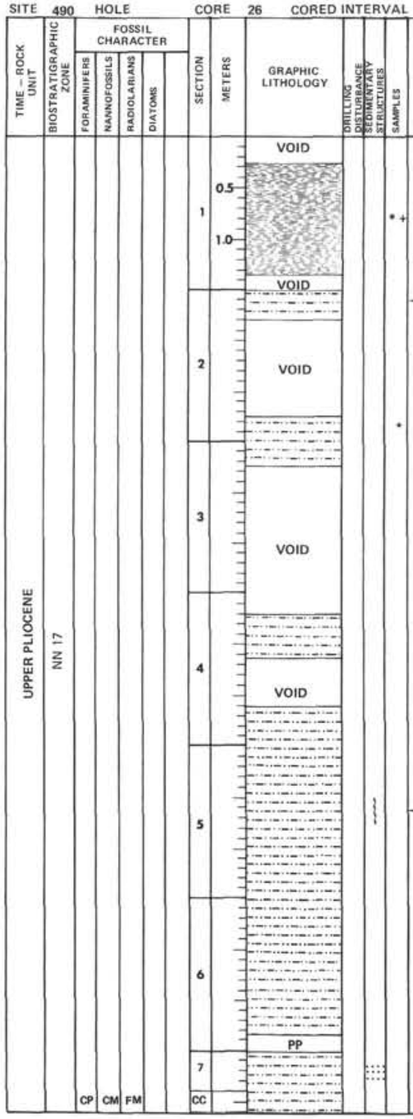
SMEAR SLIDES

	Vitric muddy siltstone	Muddy siltstone	Muddy sand
	1-114 (M)	3-75 (D)	4-1 (M)
TEXTURE:			
Sand	30	TR	35
Silt	45	55	25
Clay	25	45	40
COMPOSITION:			
Quartz	50	60	58
Feldspar	10	5	10
Mica	5	4	5
Heavy minerals	3	2	5
Pyrite	1	1	1
Clay	–	20	10
Glass	25	1	2
Glauconite	–	–	3
Foraminifers	TR	1	1
Nannofossils	2	–	1
Radiolarians	TR	TR	–
Diatoms	2	4	1
Sponge spicules	2	2	3
Silicoflagellates	–	TR	–
Plant fragments	–	TR	TR

GRAIN SIZE

	2-100
Sand	12.4
Silt	51.5
Clay	36.2

SITE 490 HOLE CORE 26 CORED INTERVAL 237.0–246.5 m



0–10 cm: firm

Slightly bioturbated

Thin layers of silt and fine sand (14–24 cm)

LITHOLOGIC DESCRIPTION

MUD, olive gray (5Y 3/2) soft and MUDDY SILTSTONE, olive gray (5Y 3/2), abundant drilling biscuits. Common small pyrite nodules (1 mm). Gas expansion cracks common in Section 4, Minor SILT and SAND at base of core.

SMEAR SLIDES

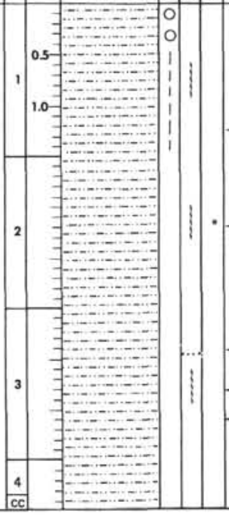
	Mud	Muddy siltstone
	1-80 (D)	2-132 (D)
TEXTURE:		
Sand	8	15
Silt	40	50
Clay	52	35
COMPOSITION:		
Quartz	56	56
Feldspar	10	10
Mica	5	10
Heavy minerals	2	1
Pyrite	2	1
Clay	20	8
Glass	TR	8
Carb. unspec.	2	2
Foraminifers	TR	TR
Nannofossils	1	1
Radiolarians	TR	TR
Diatoms	TR	1
Sponge spicules	2	1
Plant fragments	TR	1

ORGANIC CARBON AND CARBONATE

	1-80
% Organic Carbon	1.4
% $CaCO_3$	1

SITE 490 HOLE CORE 27 CORED INTERVAL 246.5–256.0 m

TIME – ROCK UNIT	BIOSTRATIGRAPHIC ZONE	FOSSIL CHARACTER: FORAMINIFERS	NANNOFOSSILS	RADIOLARIANS	DIATOMS
PLIOCENE	NN 17	RP	RP	FG	



LITHOLOGIC DESCRIPTION

? Reducing spot – 7 cm maximum dimersion, angular, well indurated

Pyrite common 60–85 cm

1 mm fine sand

Gas expansion cracks

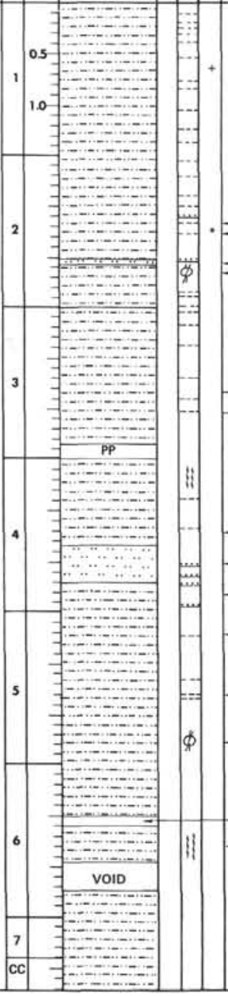
MUDDY SILTSTONE, olive gray (5Y 3/2) drilling biscuit near base, small amount of pyrite. Section 2 slightly mottled.

SMEAR SLIDES

	Muddy siltstone
	2-66
TEXTURE:	(D)
Sand	5
Silt	70
Clay	25
COMPOSITION:	
Quartz	53
Feldspar	8
Mica	3
Heavy minerals	TR
Pyrite	2
Clay	25
Glauconite	2
Radiolarians	TR
Diatoms	TR
Sponge spicules	1
Plant fragments	1

SITE 490 HOLE CORE 28 CORED INTERVAL 256.0–265.5 m

TIME – ROCK UNIT	BIOSTRATIGRAPHIC ZONE	FOSSIL CHARACTER: FORAMINIFERS	NANNOFOSSILS	RADIOLARIANS	DIATOMS
PLIOCENE				FG	



LITHOLOGIC DESCRIPTION

MUDDY SILTSTONE, olive gray (5Y 3/2) thin (up to 5 mm) silt layers, mostly graded, with apparent dips 0–9°. Drilling biscuits present.

2 cm graded calcareous muddy silt (65 cm)

Diffuse area of calcareous muddy silt 5 x 3 cm (75 cm)

5 cm slightly grade silt bed

Plant fragments bed (112–116 cm)

2–3 cm silt beds

SMEAR SLIDES

	Siltstone (sandy)
	2-75
TEXTURE:	(D)
Sand	30
Silt	50
Clay	20
COMPOSITION:	
Quartz	48
Feldspar	8
Mica	4
Heavy minerals	TR
Pyrite	1
Clay	20
Glass	TR
Glauconite	1
Foraminifers	15
Nannofossils	1
Radiolarians	TR
Diatoms	TR
Sponge spicules	1
Plant fragments	1

ORGANIC CARBON AND CARBONATE

	1-60
% Organic Carbon	1.9
% $CaCO_3$	1

4 cm silt bed

4 silt beds, lower three graded

Very fine sand lamination, 11° apperent dip

3 mm silt, 11° apparent dip

12° apparent dip

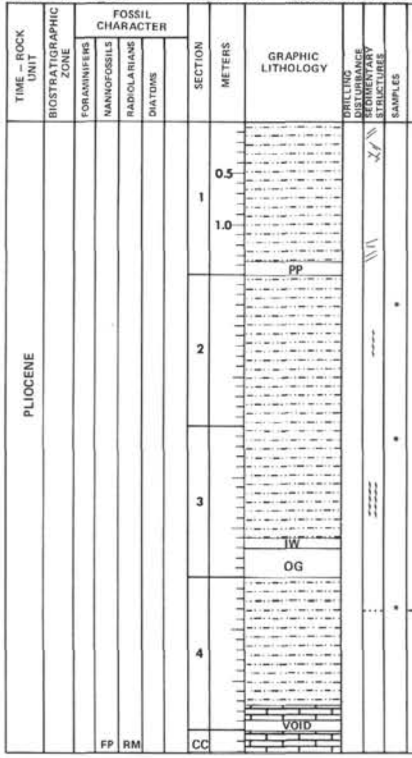
Carbonaceous matter

VOID

Calcareous pods (fine silt size calcite)

Irregularly concentrated glauconite, local calcareous pods (one at 70 cm is 2 x 1 cm)

SITE 490 HOLE CORE 29 CORED INTERVAL 265.5–275.0 m



LITHOLOGIC DESCRIPTION

Apparent dips
of fractures
20°
40°
37°
27°

Apparent dips
of fractures
35°
0°
10°
35°

30 cm: diffuse fine sand lamination, ~1 cm thick, slightly inclined

MUDDY SILT, grayish olive (10Y 4/2) with minor dusky yellow green (5GY 5/2) LIMESTONE. Fractures common in Section 1 and drilling biscuits occur in all sections. Bioturbation confined to discrete areas. Glauconite grains abundant in Sections 1 and 2.

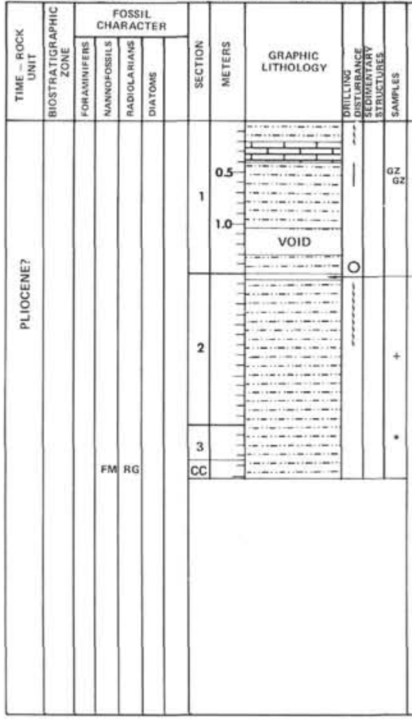
Section 2,60 cm: Vague mottling – probably bioturbation. 80 cm: Concentration of diffuse pale olive areas.

Section 4: Fragments limestone, with internal brecciated texture and common, variously-oriented pale microveins.

SMEAR SLIDES

	Glauconitic siltstone (sandy)	Muddy siltstone	Muddy sand
	2-32	3-17	4-30
TEXTURE:	(M)	(D)	(M)
Sand	40	1	60
Silt	50	79	30
Clay	10	20	10
COMPOSITION:			
Quartz	56	67	70
Feldspar	10	10	10
Mica	3	3	3
Heavy minerals	2	1	2
Pyrite	3	2	2
Clay	10	20	10
Glauconite	15	–	1
Radiolarians	–	TR	TR
Diatoms	–	TR	TR
Sponge spicules	1	1	2

SITE 490 HOLE CORE 30 CORED INTERVAL 275.0–284.5 m



LITHOLOGIC DESCRIPTION

VOID

MUDDY SILT and MUDDY SILTSTONE grayish olive (10Y 4/2) structureless with LIMESTONE, greenish gray (5GY 6/1 wet) with irregular paler carbonate veins, light bluish gray (5B 7/1). Drilling biscuits visible in Section 3.

SMEAR SLIDES

	Muddy siltstone (sandy)
	3-16
TEXTURE:	(D)
Sand	20
Silt	60
Clay	20
COMPOSITION:	
Quartz	65
Feldspar	10
Mica	2
Heavy minerals	2
Pyrite	2
Clay	15
Glauconite	TR
Foraminifers	TR
Radiolarians	TR
Diatoms	2
Sponge spicules	2
Silicoflagellates	TR

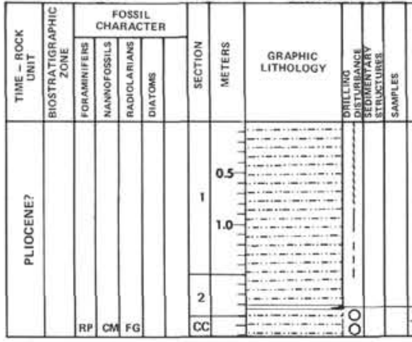
GRAIN SIZE

	1-50	1-50
Sand	46.2	40.9
Silt	38.7	40.3
Clay	15.1	18.8

ORGANIC CARBON AND CARBONATE

	2-80
% Organic Carbon	1.2
% $CaCO_3$	0

SITE 490 HOLE CORE 31 CORED INTERVAL 284.5–294.0 m



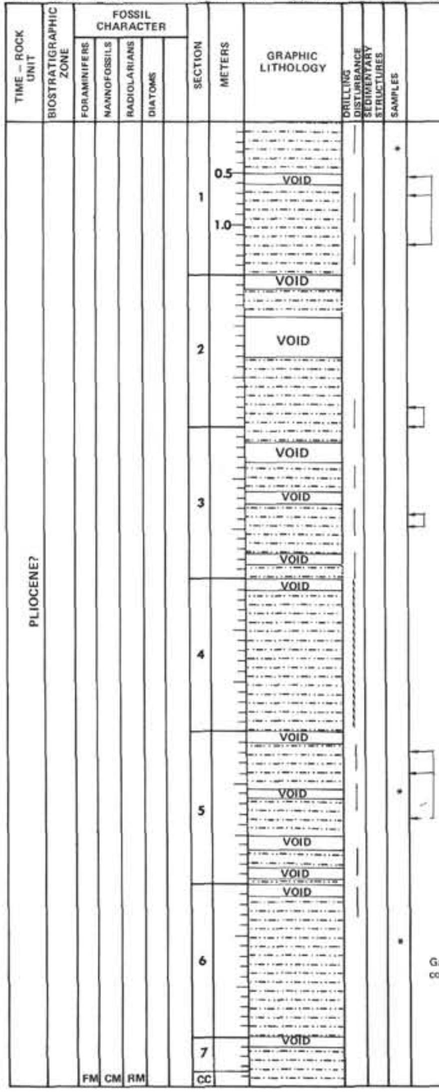
LITHOLOGIC DESCRIPTION

MUDDY SILTSTONE (silt where intensely deformed by drilling), grayish olive (10Y 4/2) structureless.

VOID

Fractured siltstone

SITE 490 HOLE CORE 32 CORED INTERVAL 294.0–299.0 m



Gas expansion cracks

Gas expansion cracks

Gas expansion cracks

Gas expansion cracks

Gas expansion are common in Section 6

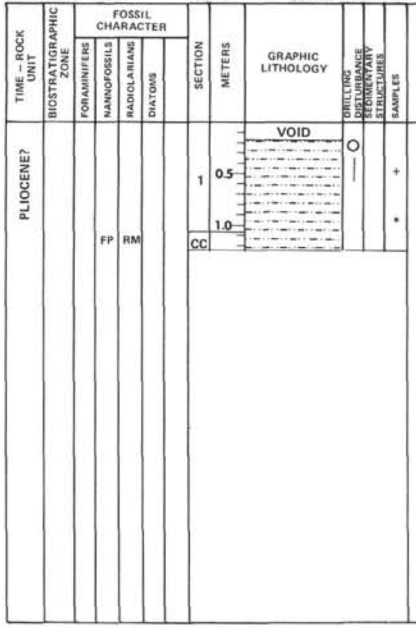
LITHOLOGIC DESCRIPTION

MUDDY SILT, grayish olive (10Y 4/2), moderately hard, structureless.

SMEAR SLIDES

	Muddy siltstone (sandy)	Muddy siltstone (sandy)	Mudstone (sandy)
	1-25	5-55	6-55
TEXTURE:	(D)	(D)	(M)
Sand	15	10	30
Silt	65	70	30
Clay	20	20	50
COMPOSITION:			
Quartz	59	67	40
Feldspar	10	8	8
Mica	2	2	2
Heavy minerals	2	1	2
Pyrite	1	2	2
Glauconite	–	TR	–
Carb. unspec.	2	2	2
Foraminifers	–	TR	–
Nannofossils	TR	TR	1
Radiolarians	TR	TR	TR
Diatoms	2	1	1
Sponge spicules	2	2	2
Silicoflagellates	–	TR	–

SITE 490 HOLE CORE 33 CORED INTERVAL 299.0–303.5 m



Soft silt down to 55 cm

LITHOLOGIC DESCRIPTION

MUDDY SILT (to 55 cm) and MUDDY SILTSTONE, grayish olive (10Y 4/2) to olive gray (5Y 3/2), structureless.

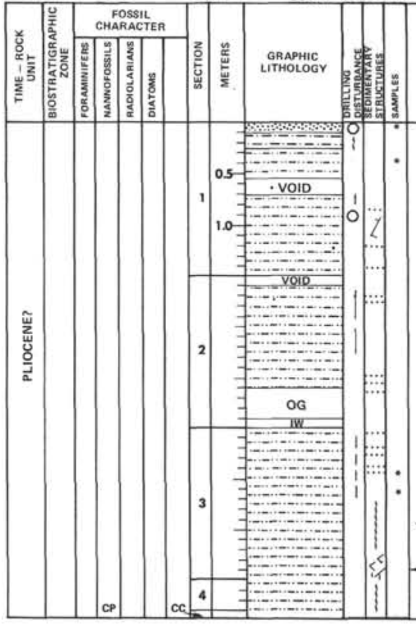
SMEAR SLIDES

	Muddy siltstone (sandy)
	1-91
TEXTURE:	(D)
Sand	25
Silt	60
Clay	15
COMPOSITION:	
Quartz	65
Feldspar	10
Mica	3
Heavy minerals	2
Pyrite	2
Clay	15
Carb. unspec.	2
Foraminifers	TR
Nannofossils	TR
Radiolarians	TR
Diatoms	TR
Sponge spicules	1

ORGANIC CARBON AND CARBONATE

	1-40
% Organic Carbon	1.0
% $CaCO_3$	0

SITE 490 HOLE CORE 34 CORED INTERVAL 303.5–313.0 m



1 cm sandy laminations
Open fractures
(? drilling disturbance)

Sandy laminations

Sandy laminations

Fracturing (probably drilling disturbance)

LITHOLOGIC DESCRIPTION

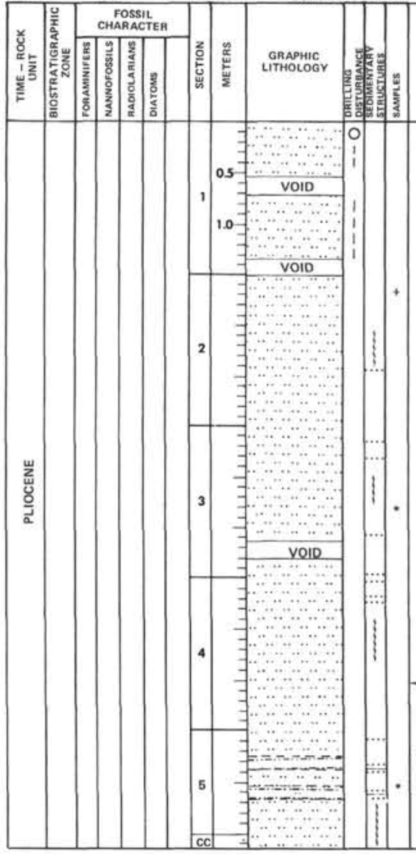
MUDDY SILTSTONE, olive gray (5Y 3/2), with drilling lamination and minor fine- to medium-SAND, medium dark gray (N4), soupy and SANDY MUD (drilling breccia?), olive black (5Y 2/1).

Section 2: more mottled (olive gray and darker olive gray).

SMEAR SLIDES

	Fine-medium sand	Muddy siltstone	Fine sand	Muddy siltstone (sandy)
	1-6	1-39	3-48	3-64
TEXTURE:	(M)	(D)	(M)	(D)
Sand	75	4	60	35
Silt	20	66	30	45
Clay	5	30	10	20
COMPOSITION:				
Quartz	80	54	68	70
Feldspar	8	8	8	7
Mica	2	2	3	2
Heavy minerals	1	1	2	1
Pyrite	2	2	3	1
Clay	5	25	10	15
Glauconite	–	TR	–	–
Carb. unspec.	1	2	1	2
Foraminifers	–	TR	–	–
Nannofossils	–	1	TR	TR
Radiolarians	TR	TR	TR	TR
Diatoms	TR	2	1	1
Sponge spicules	1	3	4	1

SITE 490 HOLE CORE 35 CORED INTERVAL 313.0–322.5 m



LITHOLOGIC DESCRIPTION

SILTSTONE, olive gray (5Y 3/2), moderate bioturbation. Section 1: fractured throughout, with soupy material between the blocks. Rare drilling biscuits in Sections 3, 4, and 5.

Fine sand-filled burrows

Fine sand laminations

4 cm fine sand beds at 0–4 and 16–20 cm

← Fine sand blebs

Two sand-silt-silty mud graded units, 38–30 and 63–50 cm

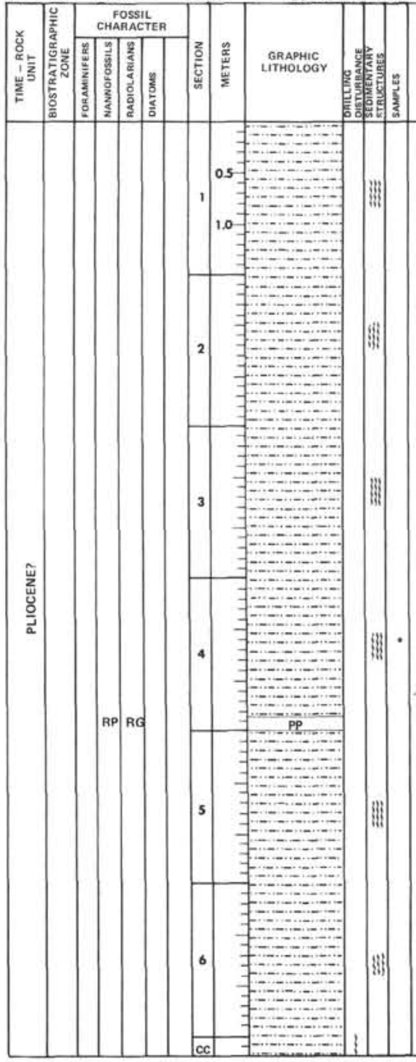
SMEAR SLIDES

	Muddy siltstone	Siltstone (sandy)
	3-82	5-51
TEXTURE:	(D)	(M)
Sand	20	3
Silt	70	62
Clay	10	35
COMPOSITION:		
Quartz	74	54
Feldspar	8	7
Mica	3	2
Heavy minerals	1	1
Pyrite	2	2
Clay	10	30
Carb. unspec.	TR	1
Foraminifers	–	TR
Nannofossils	–	TR
Radiolarians	TR	TR
Diatoms	TR	1
Sponge spicules	2	2

ORGANIC CARBON AND CARBONATE

	2-17
% Organic Carbon	1.4
% $CaCO_3$	0

SITE 490 HOLE CORE 36 CORED INTERVAL 322.5–332.0 m



LITHOLOGIC DESCRIPTION

MUDDY SILTSTONE, greenish black (5G 2/1). Open fractures variously oriented in Sections 1 and 2. Fractures generally observed in Section 3. Drilling biscuits become common.

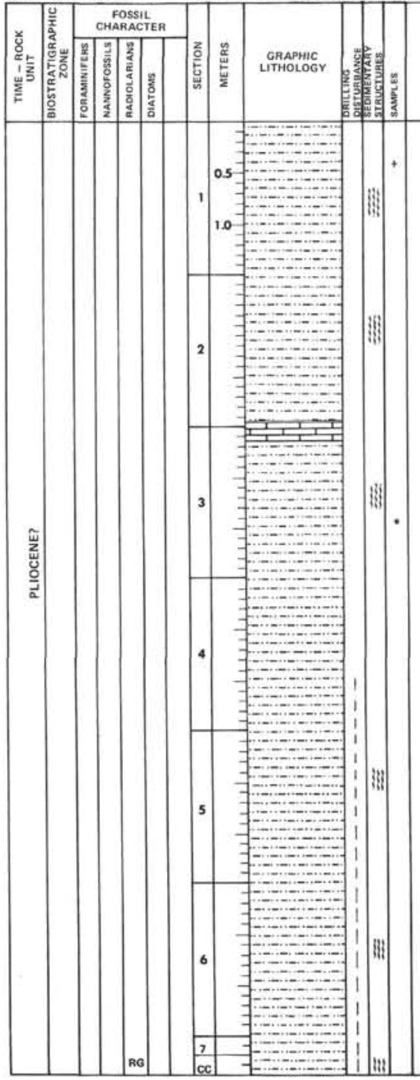
Some burrow fillings more silty than matrix

← Olive black (5Y 2/1) clay lump

SMEAR SLIDES

	Muddy siltstone (sandy)
	4-61
TEXTURE:	(D)
Sand	15
Silt	65
Clay	20
COMPOSITION:	
Quartz	71
Feldspar	8
Mica	3
Heavy minerals	1
Pyrite	1
Clay	15
Foraminifers	TR
Nannofossils	TR
Radiolarians	TR
Diatoms	TR
Sponge spicules	1

SITE 490 HOLE CORE 37 CORED INTERVAL 332.0–341.5 m



LITHOLOGIC DESCRIPTION

MUDDY SILTSTONE, grayish olive green (5GY 3/2), slightly mottled, highly bioturbated, drilling biscuits common with minor limestone, light olive gray (5Y 5/2) to grayish olive (10Y 4/2), structureless.

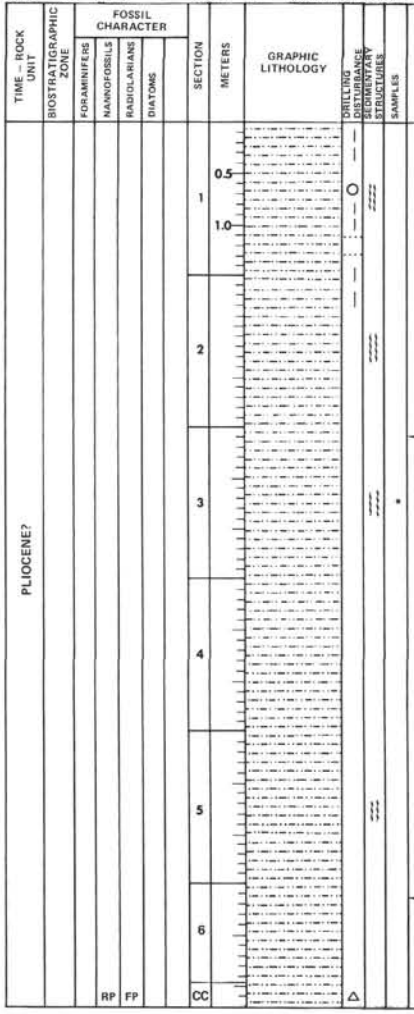
SMEAR SLIDES

	Muddy siltstone 3-97 (D)
TEXTURE:	
Sand	15
Silt	65
Clay	20
COMPOSITION:	
Quartz	68
Feldspar	8
Mica	3
Heavy minerals	2
Pyrite	2
Clay	15
Glauconite	TR
Nannofossils	TR
Radiolarians	TR
Diatoms	TR
Sponge spicules	2
Silicoflagellates	TR

ORGANIC CARBON AND CARBONATE

	1-40
% Organic Carbon	1.1
% $CaCO_3$	0

SITE 490 HOLE CORE 38 CORED INTERVAL 341.5–351.0 m



LITHOLOGIC DESCRIPTION

Small area of light olive gray (5Y 5/2) calcareous clay

Rare to common pyrite micronodules in this section.

Healed fracture, smooth, apparently mud-filled, apparent dip 69°

MUDDLY SILTSTONE, olive gray (5Y 3/2). Drilling laminations common to abundant. Moderately bioturbated.

Section 4: minor fractures, with 21–72° apparent dip.

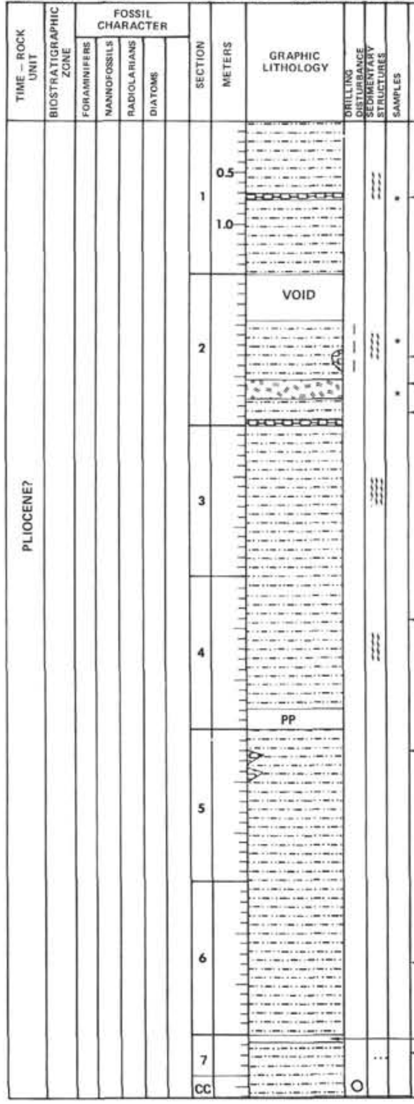
Section 5: minor fractures, with 17–69° apparent dip. Apparent conjugate set.

Section 6: minor fractures, 15–75° apparent dip.

SMEAR SLIDES

	Muddy siltstone 3-74 (D)
TEXTURE:	
Sand	10
Silt	60
Clay	30
COMPOSITION:	
Quartz	65
Feldspar	10
Mica	10
Heavy minerals	2
Pyrite	1
Clay	10
Glass	TR
Glauconite	TR
Carb. unspec.	1
Foraminifers	TR
Nannofossils	TR
Diatoms	TR
Sponge spicules	1
Plant fragments	TR

SITE 490 HOLE CORE 39 CORED INTERVAL 351.0–360.5 m



LITHOLOGIC DESCRIPTION

MUDDY SILTSTONE, olive gray (5Y 3/2). Moderately bioturbated, drilling biscuits common to abundant.

Section 3: Minor fractures, 12° to vertical.
Section 5: Minor fractures, 15–65° apparent dips.
Section 6: Small pyrite nodules (1–2 mm) rare to common.

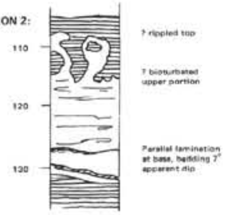
6 cm bed, no clear biogenic component, irregular basal contact with minor tuff, white to light gray (N7) and light olive gray (5Y 5/2) chalk.

4 cm lens

Bioturbated (108–114) and parallel laminated (126–132)

Small (2–3 mm) angular fragments of chalk underlain by tuff

SECTION 2:



2 x 3 cm limestone clast

Small diffuse areas of chalk (CB8)

1 cm VOID

VOID

Slightly sandier lens, 1 cm thick

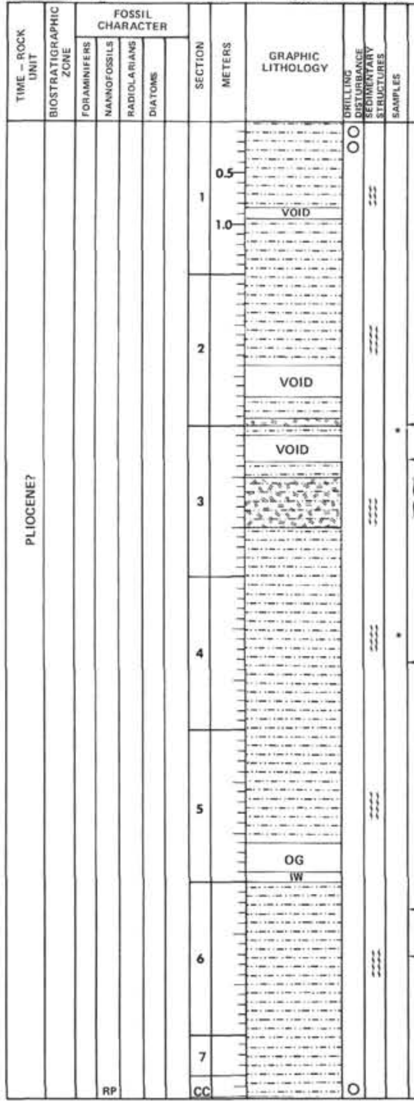
SMEAR SLIDES

	Chalk	Muddy siltstone	Ash
	1-74 (M)	2-64 (D)	2-120 (M)
TEXTURE:			
Sand	–	20	–
Silt	5	50	–
Clay	95	30	–
COMPOSITION:			
Quartz	4	42	–
Feldspar	1	20	–
Mica	–	15	–
Heavy minerals	–	2	–
Clay	–	15	–
Glass	–	3	100
Carb. unspec.	95	1	–
Foraminifers	–	TR	–
Nannofossils	–	TR	–
Radiolarians	–	TR	–
Diatoms	–	1	–
Sponge spicules	–	1	–

ORGANIC CARBON AND CARBONATE

	3-6
% Organic Carbon	1.8
% $CaCO_3$	0

SITE 490 HOLE CORE 40 CORED INTERVAL 360.5–370.0 m



LITHOLOGIC DESCRIPTION

MUDDY SILTSTONE, olive gray (5Y 3/2). Moderately bioturbated. Drilling biscuits common to abundant pyrite micronodules (1–2 mm) rare to common. Minor, very light gray (N8) ASH and TUFF and light olive gray (5Y 5/2) CHALK.

Section 4: Minor fractures in this section, 0–90°.

Ash, soft

Ash lens

Mixed zone of tuff and muddy siltstone...mixed by bioturbation. Frozen. Thermister reading at 75 cm level (2 hrs after core came up) + 1.7°C.

Chalk lens

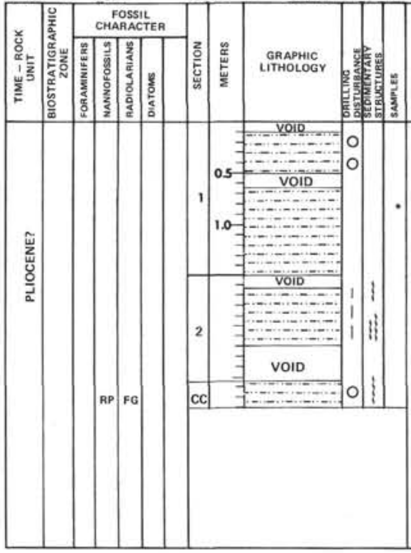
Chalk, diffuse, moderately bioturbated

3 mm pyrite nodule (84 cm)

SMEAR SLIDES

	Muddy siltstone	Ash
	3-1 (M)	4-56 (D)
TEXTURE:		
Sand	–	1
Silt	2	60
Clay	98	39
COMPOSITION:		
Quartz	3	49
Feldspar	2	15
Mica	–	10
Heavy minerals	–	10
Pyrite	–	1
Glass	95	8
Glauconite	–	1
Carb. unspec.	–	5
Nannofossils	–	TR
Diatoms	–	TR
Sponge spicules	–	1
Plant fragments	–	TR

SITE 490 HOLE CORE 41 CORED INTERVAL 370.0–379.5 m



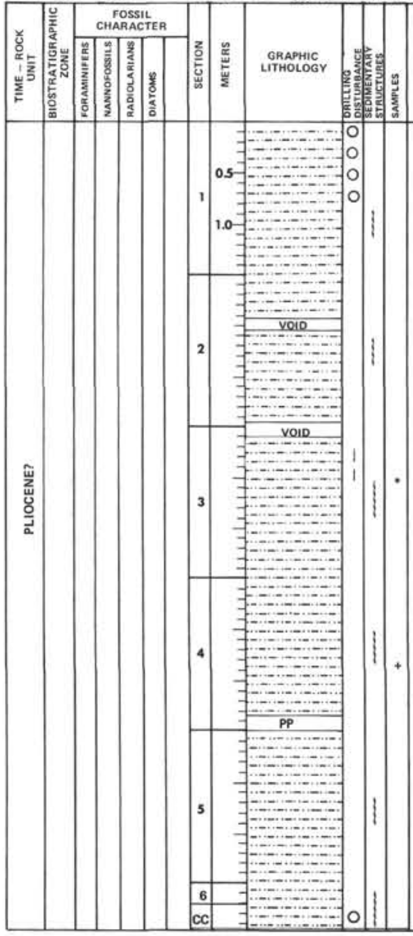
LITHOLOGIC DESCRIPTION

MUDDY SILTSTONE, olive gray (5Y 3/2). Moderately bioturbated, drilling biscuits throughout, in places separated.

SMEAR SLIDES

	Muddy siltstone
	1-88
TEXTURE:	(D)
Sand	8
Silt	50
Clay	42
COMPOSITION:	
Quartz	49
Feldspar	15
Mica	10
Heavy minerals	2
Pyrite	2
Clay	10
Glass	7
Glauconite	1
Carb. unspec.	1
Nannofossils	TR
Radiolarians	TR
Diatoms	1
Sponge spicules	2

SITE 490 HOLE CORE 42 CORED INTERVAL 379.5–389.0 m



LITHOLOGIC DESCRIPTION

MUDDY SILTSTONE, olive gray (5Y 3/2), slightly bioturbated, common to abundant drilling biscuits. Many oblique fractures with slickensides.

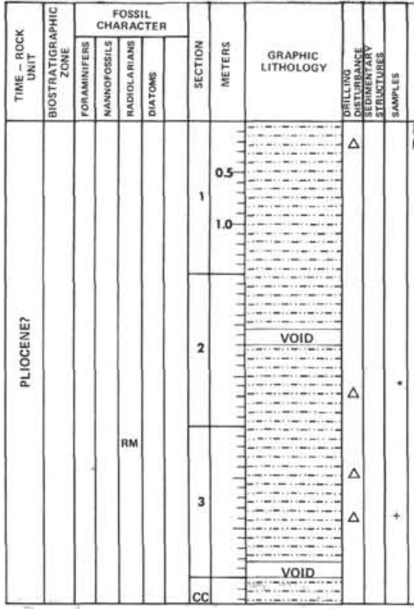
SMEAR SLIDES

	Muddy siltstone
	3-52
TEXTURE:	(D)
Sand	10
Silt	60
Clay	30
COMPOSITION:	
Quartz	55
Feldspar	15
Mica	15
Heavy minerals	1
Pyrite	2
Clay	5
Glauconite	5
Carb. unspec.	1
Nannofossils	TR
Diatoms	TR
Sponge spicules	1

ORGANIC CARBON AND CARBONATE

	4-87
% Organic Carbon	1.3
% $CaCO_3$	0

SITE 490 HOLE CORE 43 CORED INTERVAL 389.0–398.5 m



LITHOLOGIC DESCRIPTION

Soft (muddy silt)

MUDDY SILTSTONE, olive gray (5Y 3/2), slightly bioturbated. Drilling biscuits common to abundant. Intense fracturing in Section 2 with 2 main sets apparent dips ~10° and 80°.

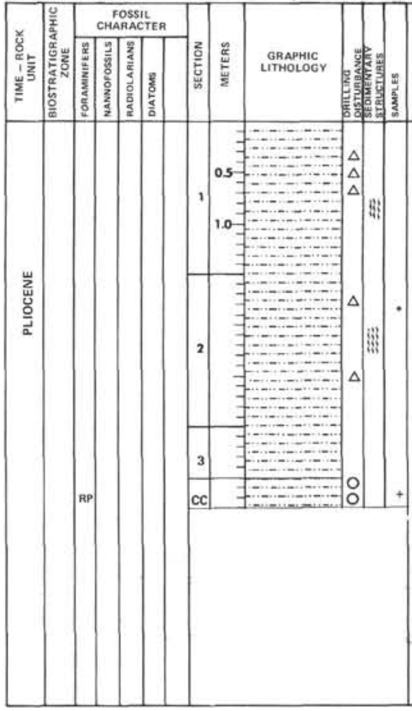
SMEAR SLIDES

	Muddy siltstone 2-103 (D)
TEXTURE:	
Sand	7
Silt	73
Clay	20
COMPOSITION:	
Quartz	66
Feldspar	8
Mica	2
Heavy minerals	1
Pyrite	2
Clay	20
Carb. unspec.	TR
Radiolarians	TR
Diatoms	TR
Sponge spicules	1

ORGANIC CARBON AND CARBONATE

	3-86
% Organic Carbon	1.8
% $CaCO_3$	0

SITE 490 HOLE CORE 44 CORED INTERVAL 398.5–408.0 m



LITHOLOGIC DESCRIPTION

MUDDY SILTSTONE, olive gray (5Y 3/2) intensely bioturbated. Very highly fractured. Most planes sub-horizontal in Section 1. Section 1, 30–60 cm: Brecciated unit, posibly primary breccia, but not cemented. In Section 2 the fractures are steeply dipping faults as well as sub-horizontal planes occur. Bedding is defined by concentrations of aligned burrows, 52–58° apparent dips. Numerous slickensides on faults, in two cases showing dip-slip (normal) motion.

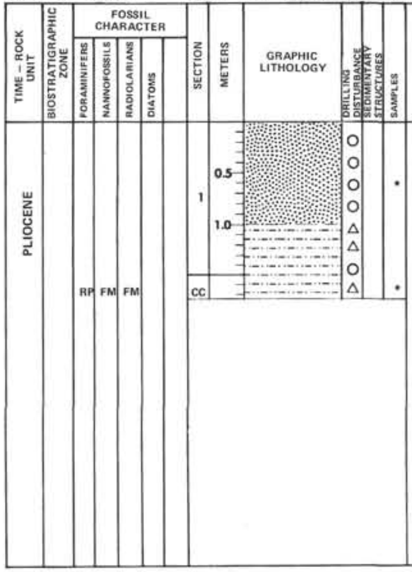
SMEAR SLIDES

	Muddy siltstone 2-38 (D)
TEXTURE:	
Sand	8
Silt	62
Clay	30
COMPOSITION:	
Quartz	61
Feldspar	10
Mica	2
Heavy minerals	1
Pyrite	2
Clay	20
Zeolite	TR
Carb. unspec.	TR
Nannofossils	TR
Radiolarians	TR
Diatoms	1
Sponge spicules	3

ORGANIC CARBON AND CARBONATE

	CC-16
% Organic Carbon	1.3
% $CaCO_3$	0

SITE 490 HOLE CORE 45 CORED INTERVAL 408.0–417.5 m



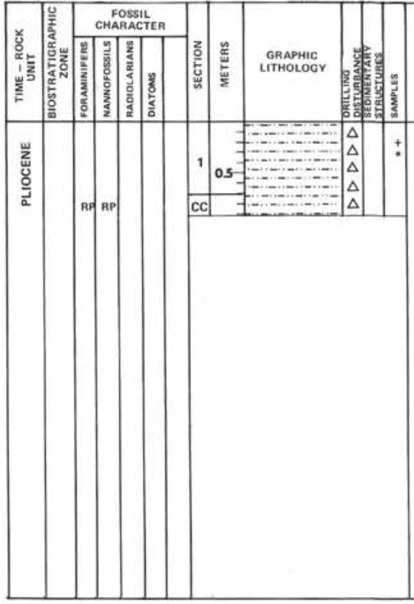
LITHOLOGIC DESCRIPTION

Loose sediment cuttings of pebble-sized muddy siltstone at the base, medium SAND above. Pebbles of muddy siltstone up to 3 cm in Core-Catcher.

SMEAR SLIDES

	Muddy siltstone (sandy)	Medium sand
	1-60	CC
TEXTURE:	(D)	(D)
Sand	85	30
Silt	10	50
Clay	5	20
COMPOSITION:		
Quartz	80	67
Feldspar	10	10
Mica	1	3
Heavy minerals	3	1
Pyrite	1	2
Clay	5	15
Zeolite	–	TR
Foraminifers	TR	TR
Nannofossils	–	TR
Radiolarians	–	TR
Diatoms	TR	TR
Sponge spicules	TR	2

SITE 490 HOLE CORE 46 CORED INTERVAL 417.5–422.5 m



LITHOLOGIC DESCRIPTION

MUDDY SILTSTONE clasts, olive gray (5Y 3/2), up to 5 cm across in a soft matrix of similar materials – possibly pulverized by drilling.

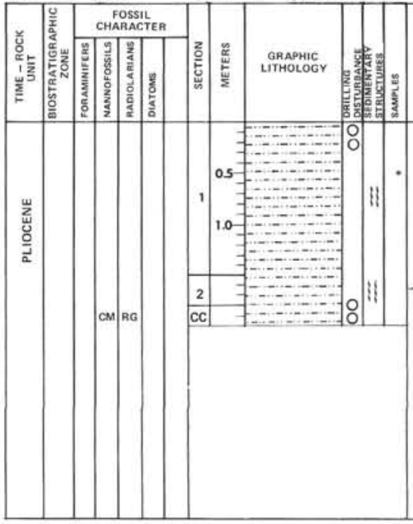
SMEAR SLIDES

	Muddy siltstone (sandy)
	1-30
TEXTURE:	(D)
Sand	35
Silt	40
Clay	25
COMPOSITION:	
Quartz	60
Feldspar	8
Mica	4
Heavy minerals	2
Pyrite	2
Clay	20
Nannofossils	1
Diatoms	1
Sponge spicules	2

ORGANIC CARBON AND CARBONATE

	1-20
% Organic Carbon	1.1
% $CaCO_3$	0

SITE 490 HOLE CORE 47 CORED INTERVAL 422.5–427.0 m



Fractures dip 5–50° (true) here

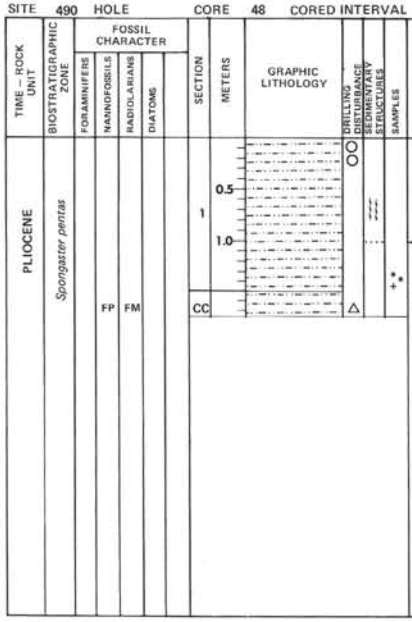
LITHOLOGIC DESCRIPTION

MUDDY SILTSTONE, olive gray (5Y 3/2), very well indurated, slightly to moderately bioturbated, very fractured (5–78° true dips), slickensides predominantly indicate dip slip motion.

SMEAR SLIDES

	Muddy siltstone (sandy)
	1-50
TEXTURE:	(D)
Sand	20
Silt	60
Clay	20
COMPOSITION:	
Quartz	70
Feldspar	7
Mica	2
Heavy minerals	3
Pyrite	1
Clay	15
Nannofossils	TR
Radiolarians	TR
Diatoms	TR
Sponge spicules	2

SITE 490 HOLE CORE 48 CORED INTERVAL 427.0–436.5 m



Fine sand

Drilling breccia internal details not visible

LITHOLOGIC DESCRIPTION

MUDDY SILTSTONE, olive gray (5Y 3/2) moderately bioturbated, very fractured. Below 30 cm the rock is broken into discrete blocks, ~10 cm long possibly along pre-existing fracture surfaces.

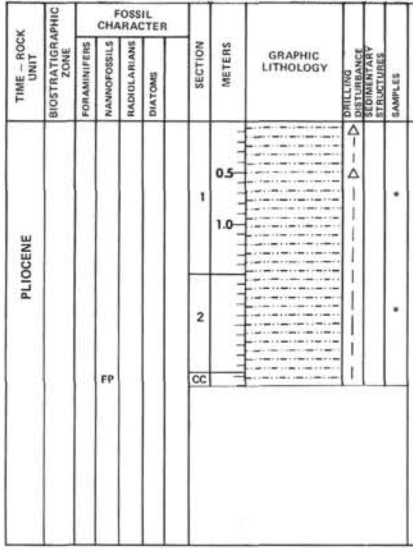
SMEAR SLIDES

	Muddy siltstone	Muddy sand
	1-93	1-95
TEXTURE:	(D)	(M)
Sand	10	60
Silt	75	30
Clay	15	10
COMPOSITION:		
Quartz	73	74
Feldspar	10	9
Mica	3	2
Heavy minerals	2	3
Pyrite	2	1
Clay	10	10
Carb. unspec.	TR	–
Nannofossils	TR	TR
Radiolarians	TR	–
Diatoms	TR	TR
Sponge spicules	–	1

ORGANIC CARBON AND CARBONATE

	1-148
% Organic Carbon	1.5
% $CaCO_3$	0

SITE 490 HOLE CORE 49 CORED INTERVAL 436.5–446.0 m



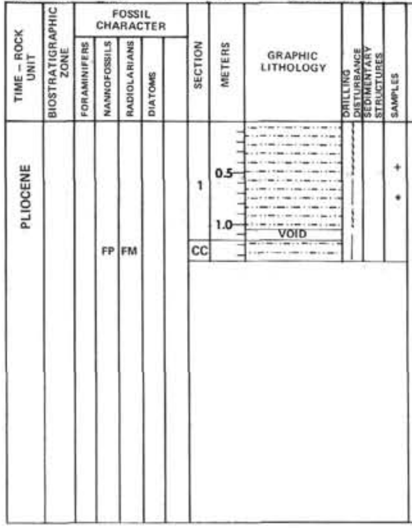
LITHOLOGIC DESCRIPTION

MUDDY SILTSTONE, olive gray (5Y 3/2) moderate bioturbation, with silt to fine sand burrow fillings. Combination of breccia and soupy sediment. Also drilling breccia infilling between larger clasts. Fractures, variously oriented, some with slickensides.

SMEAR SLIDES

	Muddy siltstone (sandy)	Muddy siltstone (sandy)
	1-70	2-35
TEXTURE:	(D)	(D)
Sand	40	30
Silt	45	50
Clay	15	20
COMPOSITION:		
Quartz	68	69
Feldspar	8	8
Mica	2	2
Heavy minerals	2	2
Pyrite	2	2
Clay	15	15
Glass	1	–
Zeolite	TR	–
Carb. unspec.	1	1
Foraminifers	–	TR
Nannofossils	–	TR
Radiolarians	TR	TR
Diatoms	TR	TR
Sponge spicules	1	1

SITE 490 HOLE CORE 50 CORED INTERVAL 446.0–455.5 m



LITHOLOGIC DESCRIPTION

MUDDY SILTSTONE, olive gray (5Y 3/2), moderately bioturbated. No obvious bedding or slickensides. Mostly drilling breccia, some detached blocks.

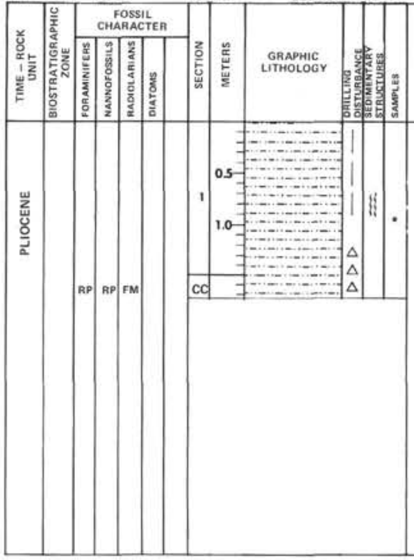
SMEAR SLIDES

	Muddy siltstone (sandy)
	1-73
TEXTURE:	(D)
Sand	40
Silt	45
Clay	15
COMPOSITION:	
Quartz	68
Feldspar	10
Mica	2
Heavy minerals	2
Pyrite	2
Clay	15
Diatoms	TR
Sponge spicules	1

ORGANIC CARBON AND CARBONATE

	1-48
% Organic Carbon	0.9
% $CaCO_3$	0

SITE 490 HOLE CORE 51 CORED INTERVAL 455.5–465.0 m



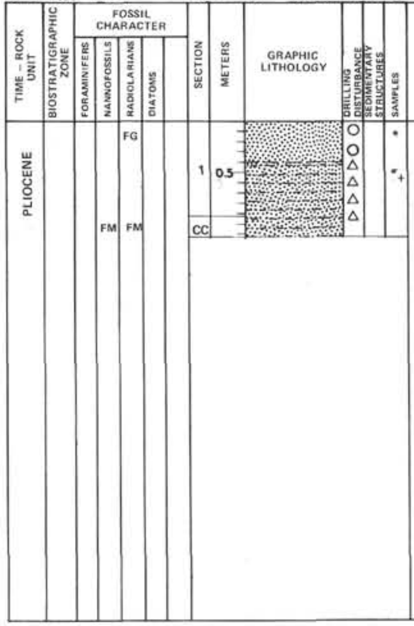
LITHOLOGIC DESCRIPTION

MUDDY SILTSTONE, olive gray (5Y 3/2) mixture of drilling breccia and parted blocks. Bedding indicated at 50, 75, and 95 cm levels by burrow alignments (apparent dips 40 to 43°).

SMEAR SLIDES

	Muddy siltstone (sandy)
	1-95
TEXTURE:	(D)
Sand	35
Silt	55
Clay	10
COMPOSITION:	
Quartz	72
Feldspar	10
Mica	3
Heavy minerals	2
Pyrite	2
Clay	10
Carb. unspec.	TR
Foraminifers	TR
Nannofossils	TR
Radiolarians	TR
Diatoms	TR
Sponge spicules	1

SITE 490 HOLE CORE 52 CORED INTERVAL 465.0–474.5 m



LITHOLOGIC DESCRIPTION

Loose fine to medium SAND, olive gray (5Y 3/2) and sub-angular clasts of bioturbated, indurated MUDDY SILTSTONE, olive gray (5Y 3/2) set in loose sand (as above).

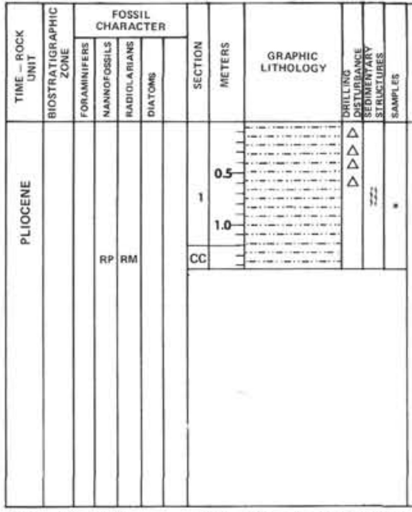
SMEAR SLIDES

	Fine to medium sand	Muddy siltstone
	1-10	1-54
TEXTURE:	(D)	(D)
Sand	99	3
Silt	1	80
Clay	–	17
COMPOSITION:		
Quartz	86	58
Feldspar	5	15
Mica	–	1
Heavy minerals	7	1
Pyrite	–	3
Clay	–	17
Glauconite	2	–
Carb. unspec.	–	1
Nannofossils	–	TR
Radiolarians	–	TR
Diatoms	TR	2
Sponge spicules	–	2

ORGANIC CARBON AND CARBONATE

	1-56
% Organic Carbon	0.8
% $CaCO_3$	0

SITE 490 HOLE CORE 53 CORED INTERVAL 474.5–484.0 m



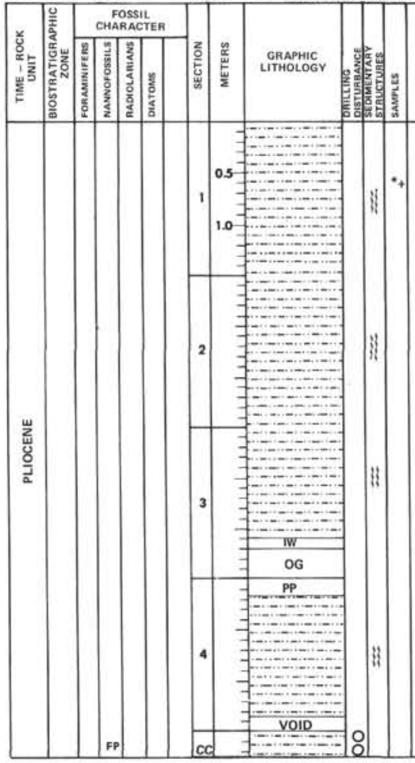
LITHOLOGIC DESCRIPTION

MUDDY SILTSTONE, olive gray (5Y 3/2) moderately bioturbated. Discrete indurated blocks are separated by soft matrix of the same material. Drilling biscuits.

SMEAR SLIDES

	Muddy siltstone
	1-80
TEXTURE:	(D)
Sand	2
Silt	73
Clay	25
COMPOSITION:	
Quartz	50
Feldspar	15
Mica	2
Pyrite	3
Clay	25
Carb. unspec.	2
Nannofossils	TR
Radiolarians	TR
Diatoms	TR
Sponge spicules	3

SITE 490 HOLE CORE 54 CORED INTERVAL 484.0–493.5 m



LITHOLOGIC DESCRIPTION

MUDDY SILTSTONE, olive gray (5Y 3/2) highly fractured, fractures dipping up to 68° (true dip). Bedding with true dips to 39° , Moderate bioturbation.

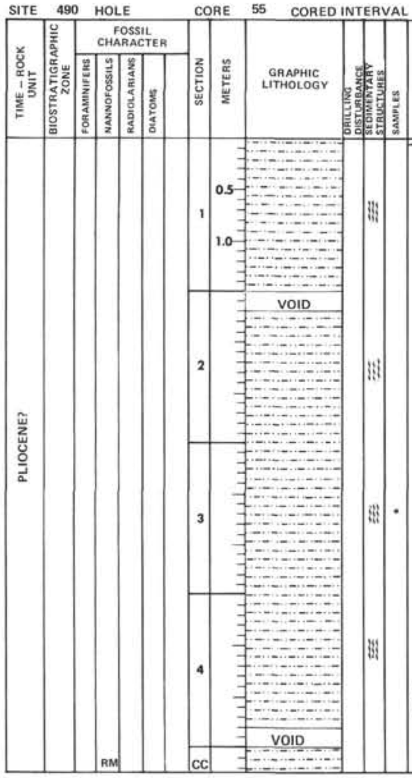
SMEAR SLIDES

	Muddy siltstone
	1-52
TEXTURE:	(D)
Sand	20
Silt	45
Clay	35
COMPOSITION:	
Quartz	50
Feldspar	15
Mica	12
Heavy minerals	2
Pyrite	2
Clay	10
Glass	2
Carb. unspec.	3
Nannofossils	TR
Radiolarians	TR
Diatoms	1
Sponge spicules	2
Plant fragments	1

ORGANIC CARBON AND CARBONATE

	1-56
% Organic Carbon	1.5
% $CaCO_3$	0

SITE 490 HOLE CORE 55 CORED INTERVAL 493.5–503.0 m



LITHOLOGIC DESCRIPTION

0–4 cm: **VOID**

MUDDY SILTSTONE, olive gray (5Y 3/2) intensely bioturbated. Fractured into discrete 10–25 cm blocks.

Section 1 fractures dip 9–31° (true dip).

Section 2 fractures dip 5–55° (true).

Section 3 fractures 5–59° (true).

Section 4 fractures 12–30° (true).

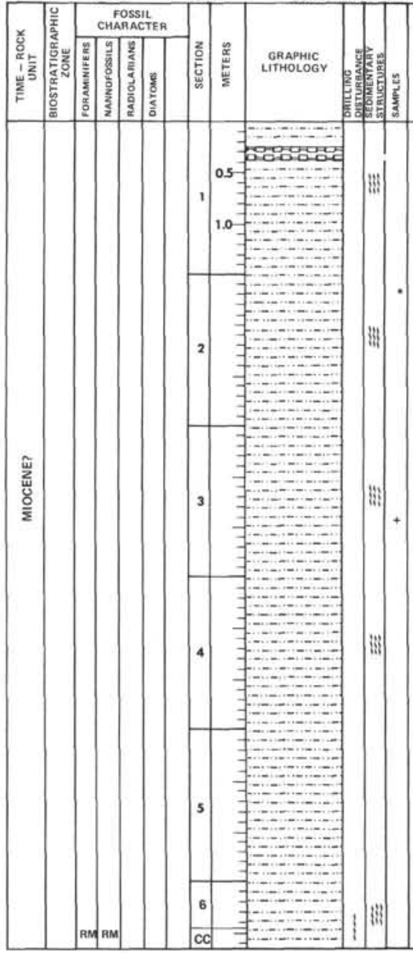
Core-Catcher fractures 10–18° (true).

SMEAR SLIDES

	Muddy siltstone
	3-68
TEXTURE:	(D)
Sand	5
Silt	70
Clay	25
COMPOSITION:	
Quartz	67
Feldspar	8
Mica	6
Heavy minerals	2
Pyrite	2
Clay	10
Glass	1
Glauconite	TR
Carb. unspec.	1
Nannofossils	TR
Diatoms	TR
Sponge spicules	3

80–120 cm: intensely fractured, with healed fracture zones – ?primary tectonic breccia

SITE 490 HOLE CORE 56 CORED INTERVAL 503.0–512.5 m



LITHOLOGIC DESCRIPTION

Bioturbated chalk

MUDDY SILTSTONE, olive gray (5Y 3/2), intensely bioturbated with one light olive gray (5Y 5/2) CHALK layer. Well indurated.

Section 1: 9 fractures in this section (8–32° true dips), some with slickensides, mostly indicating bedding, dip-slip motion,. Flattened and concentrated burrows, 25° true dip.

Nine fractures in 150 cm, 18–51° true dip some with slickensides, some not

Drilling biscuits common below

Two fractures in 150 cm

Five fractures in 150 cm all apparently with slickensides

No fractures in Sections 5 and 6

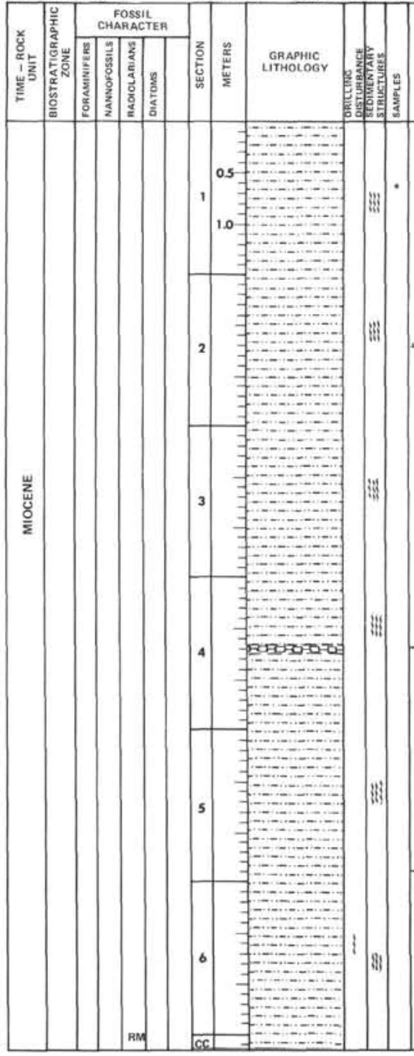
SMEAR SLIDES

	Muddy siltstone
	2-15
TEXTURE:	(D)
Sand	12
Silt	68
Clay	20
COMPOSITION:	
Quartz	63
Feldspar	10
Mica	2
Heavy minerals	2
Pyrite	1
Clay	20
Glass	TR
Zeolite	1
Radiolarians	TR
Diatoms	TR
Sponge spicules	1

ORGANIC CARBON AND CARBONATE

	3-93
% Organic Carbon	1.6
% $CaCO_3$	0

SITE 490 HOLE CORE 57 CORED INTERVAL 512.5–522.0 m



LITHOLOGIC DESCRIPTION

MUDDY SILTSTONE, olive gray (5Y 3/2), well indurated, sporadic drilling biscuit developments, intensely bioturbated, Minor light olive gray (5Y 3/2) chalk.

Six laminations in 150 cm

Eight non-drilling fractures in 150 cm (3 with slickensides)

Bedding, 26° true dip

One fracture in 150 cm (with dip-slip slickensides)

Chalk intensely bioturbated

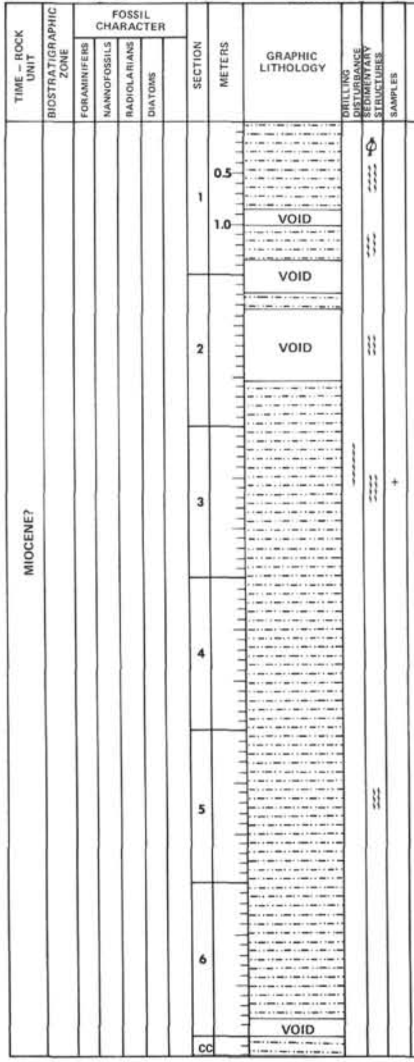
Six fractures in 150 cm (no slickensides)

Bedding, apparent dip 40°

SMEAR SLIDES

	Muddy siltstone (sandy)
	1-63
TEXTURE:	(D)
Sand	30
Silt	55
Clay	15
COMPOSITION:	
Quartz	78
Feldspar	8
Mica	2
Heavy minerals	1
Pyrite	1
Clay	15
Zeolite	1
Diatoms	TR
Sponge spicules	1

SITE 490 HOLE CORE 58 CORED INTERVAL 522.0–531.5 m



LITHOLOGIC DESCRIPTION

10 cm: bedding 42°, azimuth 270°
12 cm: fault 53°, azimuth 234°
24 cm: (in working half) 3 cm x 3 mm^2
woody fragment

MUDDY SILTSTONE, olive gray (5Y 3/2), moderate bioturbation, drilling biscuits common.

ORGANIC CARBON AND CARBONATE

	3-57
% Organic Carbon	1.5
% $CaCO_3$	0

Seven fractures (2 along bedding planes), 1 (44 cm level) with slickensides

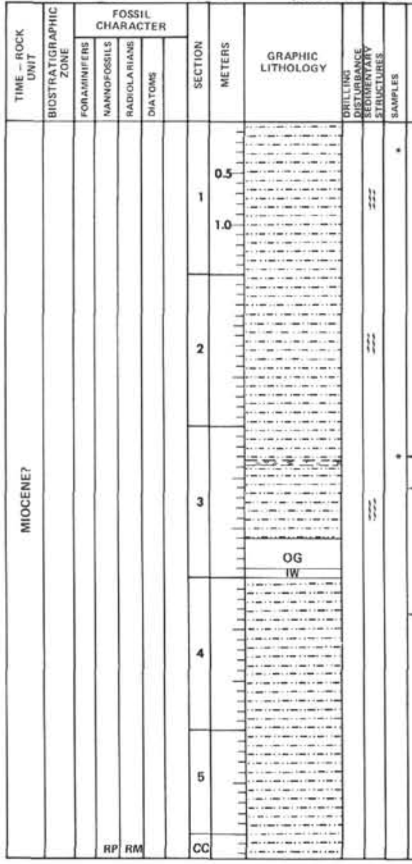
44 cm: fault, 38° dip, azimuth 158°, slickensides azimuth 215°

Four or five fractures with slickensides
27 cm: fault, 59° dip
51 cm: fault, 27° dip, 173 azimuth 214°
55 cm: fault, 46° dip, 180 azimuth 208°

2 cm: fault, 85° dip, 240 azimuth, slickensides pitch 15–90° azimuth
25 cm: bedding, 40° dip
fault, 45° dip, 203 azimuth, with slickensides at 190° azimuth (large) and 178° azimuth (small)

About 10 fractures (section cut at low angle to slickensides)

SITE 490 HOLE CORE 59 CORED INTERVAL 531.5–541.0 m



LITHOLOGIC DESCRIPTION

38 cm: bedding, 37° dip

MUDDY SILTSTONE, olive gray (5Y 3/2), moderate bioturbation, drilling biscuits common. Four fractures, all apparently along bedding defined by burrow concentrations.

110 cm: bedding, 36° dip

SMEAR SLIDES

	Muddy siltstone	Ash
	1-30 (D)	3-37 (M)
TEXTURE:		
Sand	5	–
Silt	75	100
Clay	20	–
COMPOSITION:		
Quartz	64	–
Feldspar	10	–
Mica	2	–
Heavy minerals	TR	–
Pyrite	3	–
Clay	20	–
Glass	–	100
Carb. unspec.	1	–
Nannofossils	TR	–
Sponge spicules	TR	–

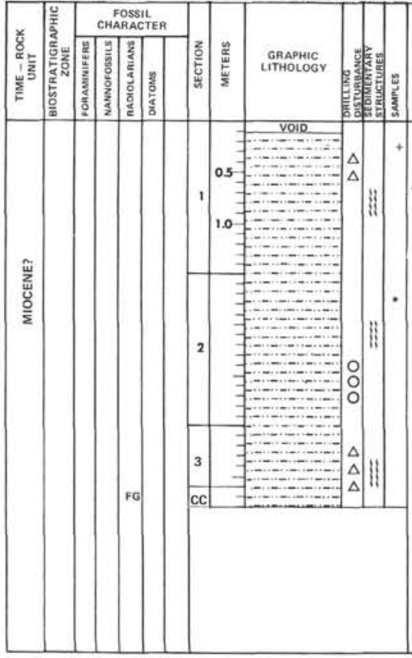
Ash bed

52 cm: fault, 62° dip, 10° azimuth, slickensides, pitch 62° to 90° to east, footwall facing 270°, pitch 34° to 27°.

64 cm: fault, 63° dip, 348° azimuth, slickensides pitch 34–90° (from notches in footwall facing 270°, pitch 48° to E...suggesting normal movement with right lateral components

33 cm: fault, 56° dip, 58–74° azimuth, slickensides pitch 68° NE

SITE 490 HOLE CORE 60 CORED INTERVAL 541.0–550.5 m



LITHOLOGIC DESCRIPTION

50 cm: fault, 45–59° dip slickensides, pitch 50° to NE

65 cm: bedding 18° dip

Eight fractures in section, either bedding and/or faults

MUDDY SILTSTONE, olive gray (5Y 3/2), moderate bioturbation. Fracturing now appears sub-parallel to fault surfaces, drilling biscuits common.

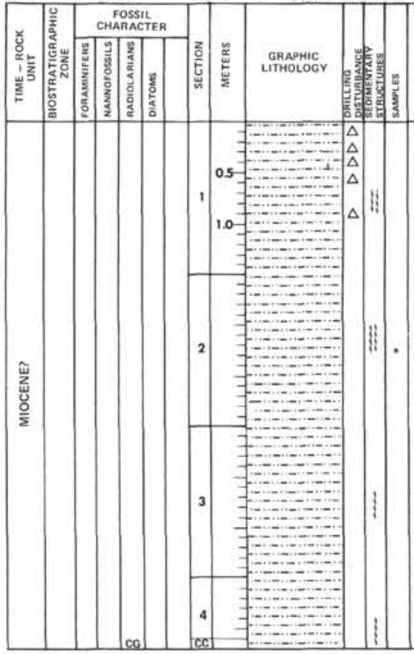
SMEAR SLIDES

	Muddy siltstone
	2-25
TEXTURE:	(D)
Sand	5
Silt	75
Clay	20
COMPOSITION:	
Quartz	47
Feldspar	15
Mica	5
Heavy minerals	TR
Pyrite	3
Clay	20
Carb. unspec.	TR
Nannofossils	TR
Sponge spicules	TR

ORGANIC CARBON AND CARBONATE

	1-29
% Organic Carbon	1.2
% $CaCO_3$	0

SITE 490 HOLE CORE 61 CORED INTERVAL 550.5–560.0 m



LITHOLOGIC DESCRIPTION

MUDDY SILTSTONE, olive gray (5Y 3/2), fractured, slickensides, moderate bioturbation. Common drilling biscuits.

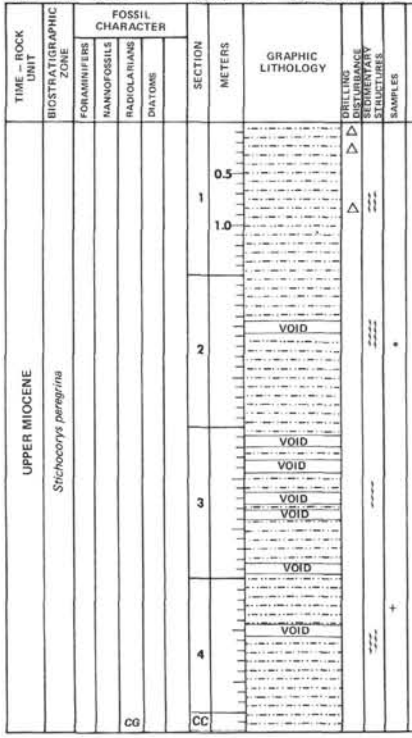
SMEAR SLIDES

	Muddy siltstone
	2-73
TEXTURE:	(D)
Sand	5
Silt	55
Clay	40
COMPOSITION:	
Quartz	69
Feldspar	5
Mica	5
Heavy minerals	3
Pyrite	1
Clay	15
Glass	2
Carb. unspec.	TR
Sponge spicules	TR

Only minor fracturing in Sections 2 and 3

20° true dip picked out by ?flattened burrows – aligned mud chips

SITE 490 HOLE CORE 62 CORED INTERVAL 560.0–569.5 m



LITHOLOGIC DESCRIPTION

MUDDY SILTSTONE, olive gray (5Y 3/2), moderate bioturbation. Common drilling biscuits. Fractured.

SMEAR SLIDES

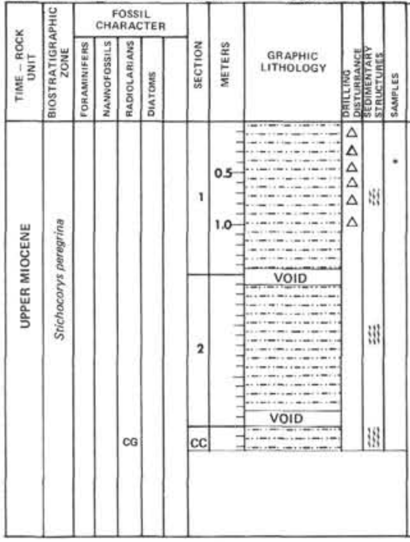
	Muddy siltstone
	2-72
TEXTURE:	(D)
Sand	5
Silt	50
Clay	45
COMPOSITION:	
Quartz	69
Feldspar	17
Mica	3
Heavy minerals	2
Pyrite	1
Clay	10
Glass	1
Carb. unspec.	TR
Radiolarians	TR
Diatoms	1
Sponge spicules	1
Silicoflagellates	TR

ORGANIC CARBON AND CARBONATE

	4-29
% Organic Carbon	1.2
% $CaCO_3$	0

110–120 cm: bedding 10° apparent dip

SITE 490 HOLE CORE 63 CORED INTERVAL 569.5–579.0 m



LITHOLOGIC DESCRIPTION

Three fractures with slickensides in 150 cm

18 major slickensided fractures in 132 cm

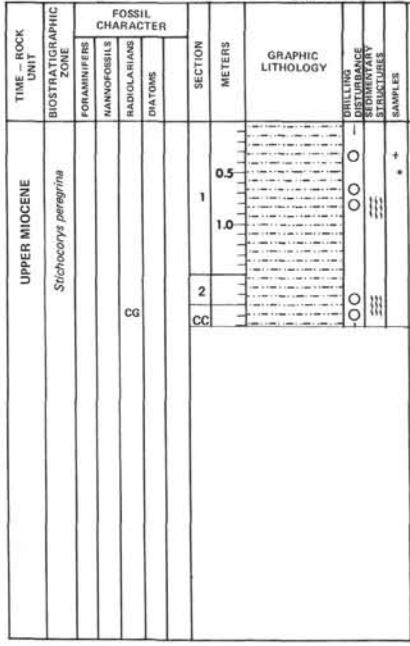
One slickensided fracture in 22 cm

MUDDY SILTSTONE, olive gray (5Y 3/2), intensely bioturbated. Common drilling biscuits.

SMEAR SLIDES

	Muddy siltstone
	1-40
TEXTURE:	(D)
Sand	5
Silt	65
Clay	30
COMPOSITION:	
Quartz	72
Feldspar	5
Mica	5
Heavy minerals	1
Pyrite	3
Clay	10
Glass	1
Carb. unspec.	TR
Radiolarians	1
Diatoms	2
Sponge spicules	1
Silicoflagellates	TR

SITE 490 HOLE CORE 64 CORED INTERVAL 579.0–588.5 m



LITHOLOGIC DESCRIPTION

Ten major slickensided fractures in 150 cm

Two slickensided fractures in 52 cm

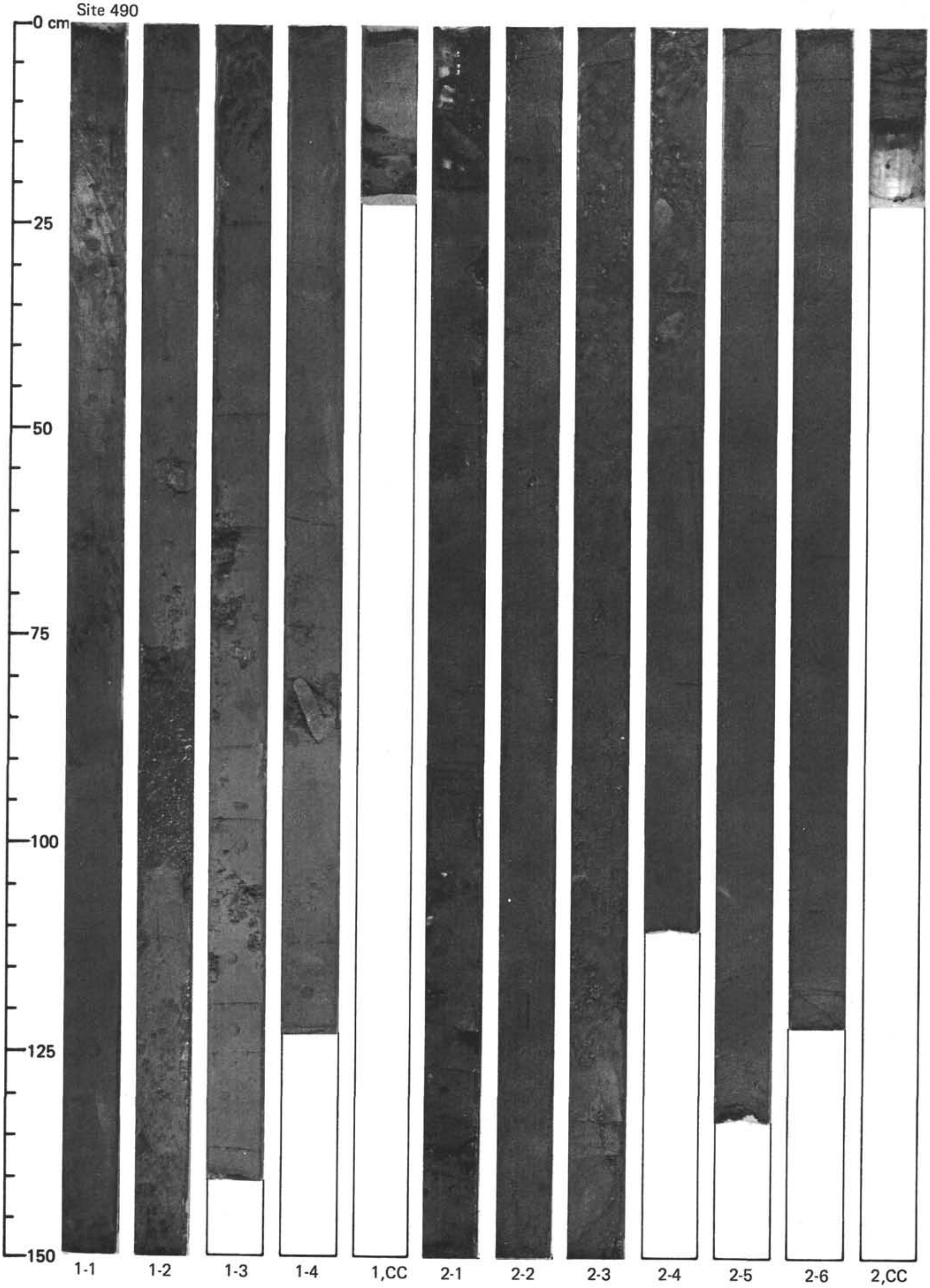
MUDDY SILTSTONE, olive gray (5Y 3/2), intensely bioturbated. Broken up with fractures with slickensides and by drilling deformation. Fine-grained soft muddy silt between biscuits and fragments.

SMEAR SLIDES

	Muddy siltstone
	1-50
TEXTURE:	(D)
Sand	TR
Silt	55
Clay	45
COMPOSITION:	
Quartz	64
Feldspar	6
Mica	4
Heavy minerals	2
Pyrite	5
Clay	15
Glass	1
Radiolarians	TR
Diatoms	1
Sponge spicules	2
Silicoflagellates	TR
Plant fragments	TR

ORGANIC CARBON AND CARBONATE

	1-33
% Organic Carbon	1.3
% $CaCO_3$	0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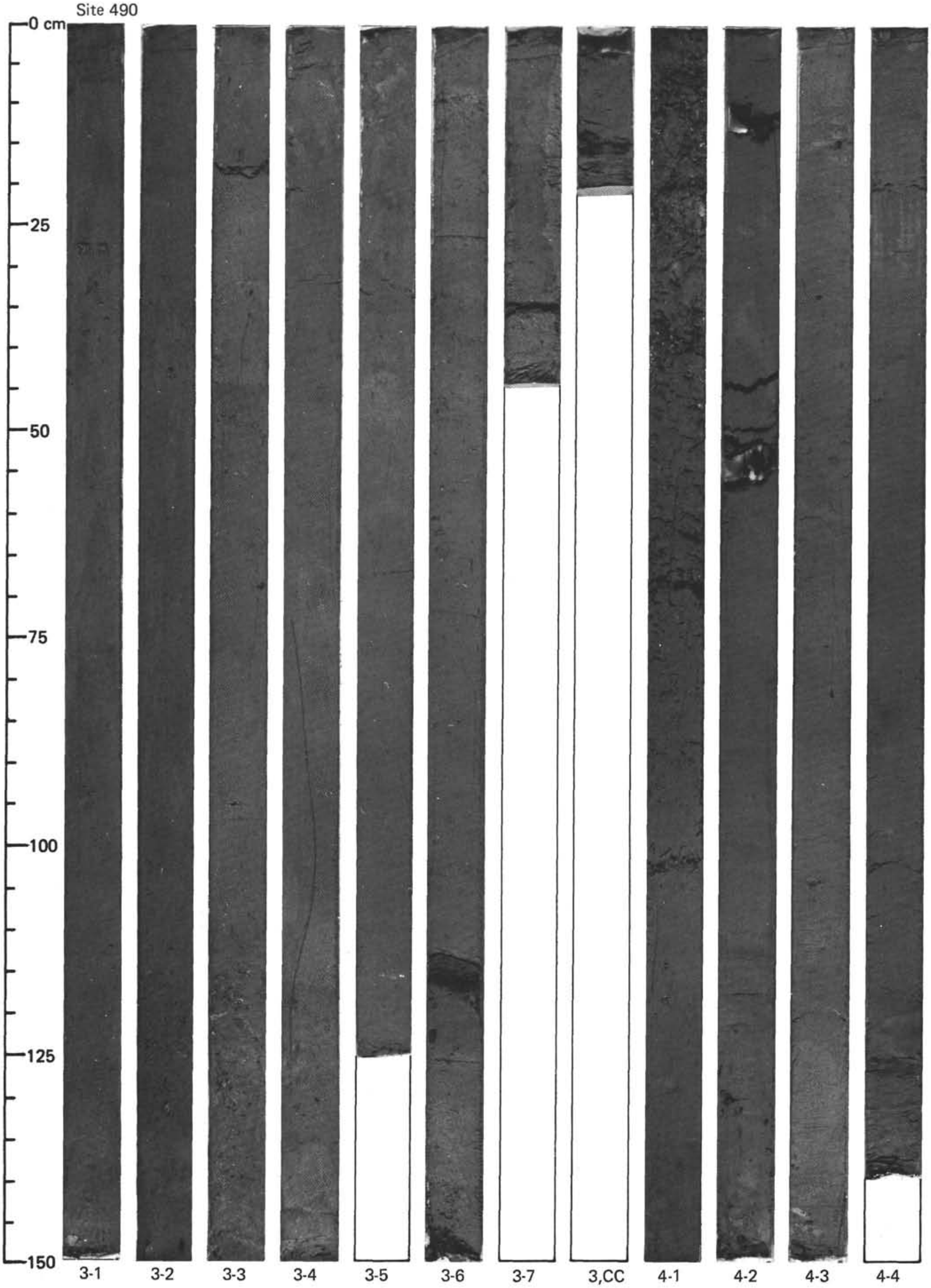
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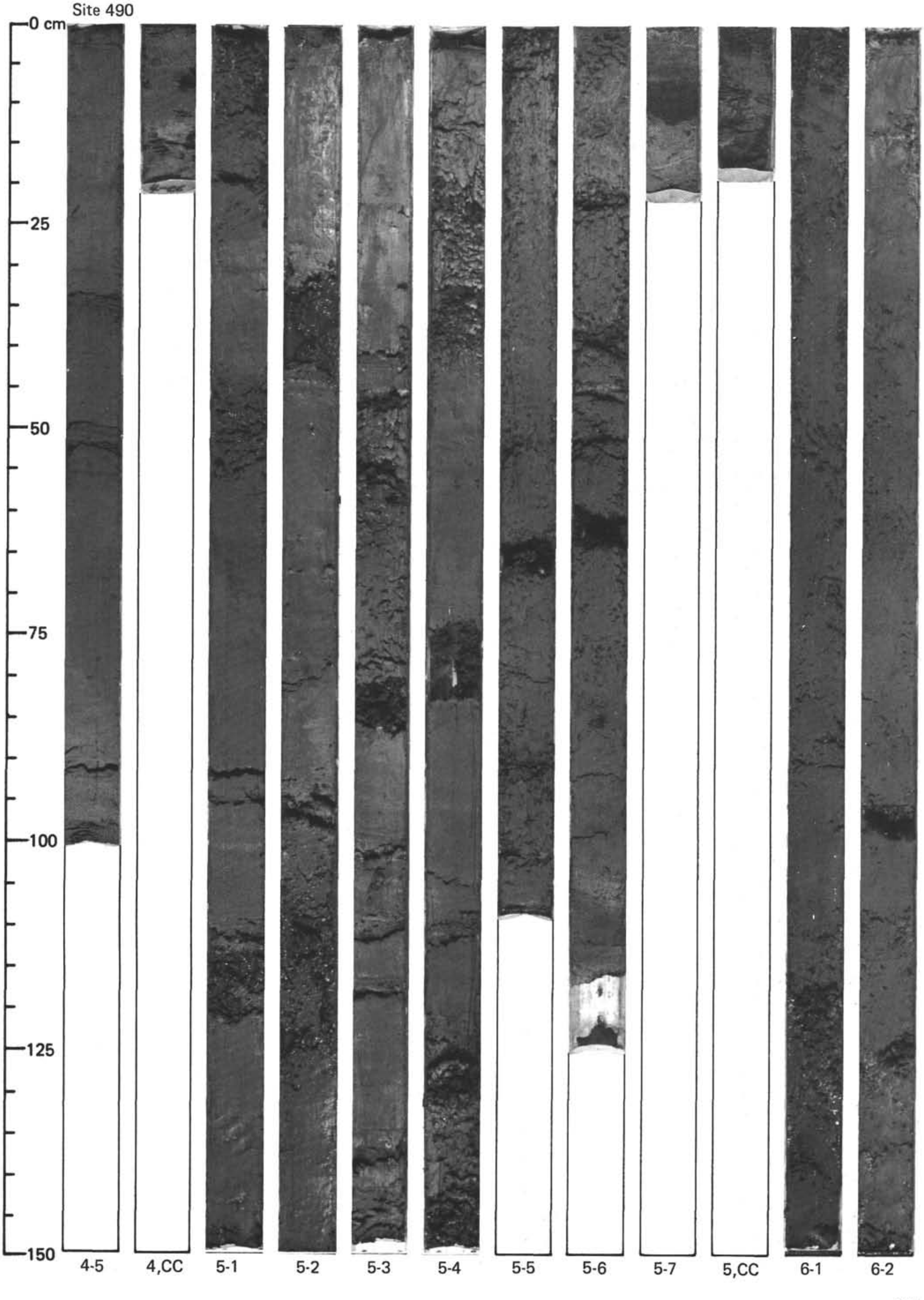
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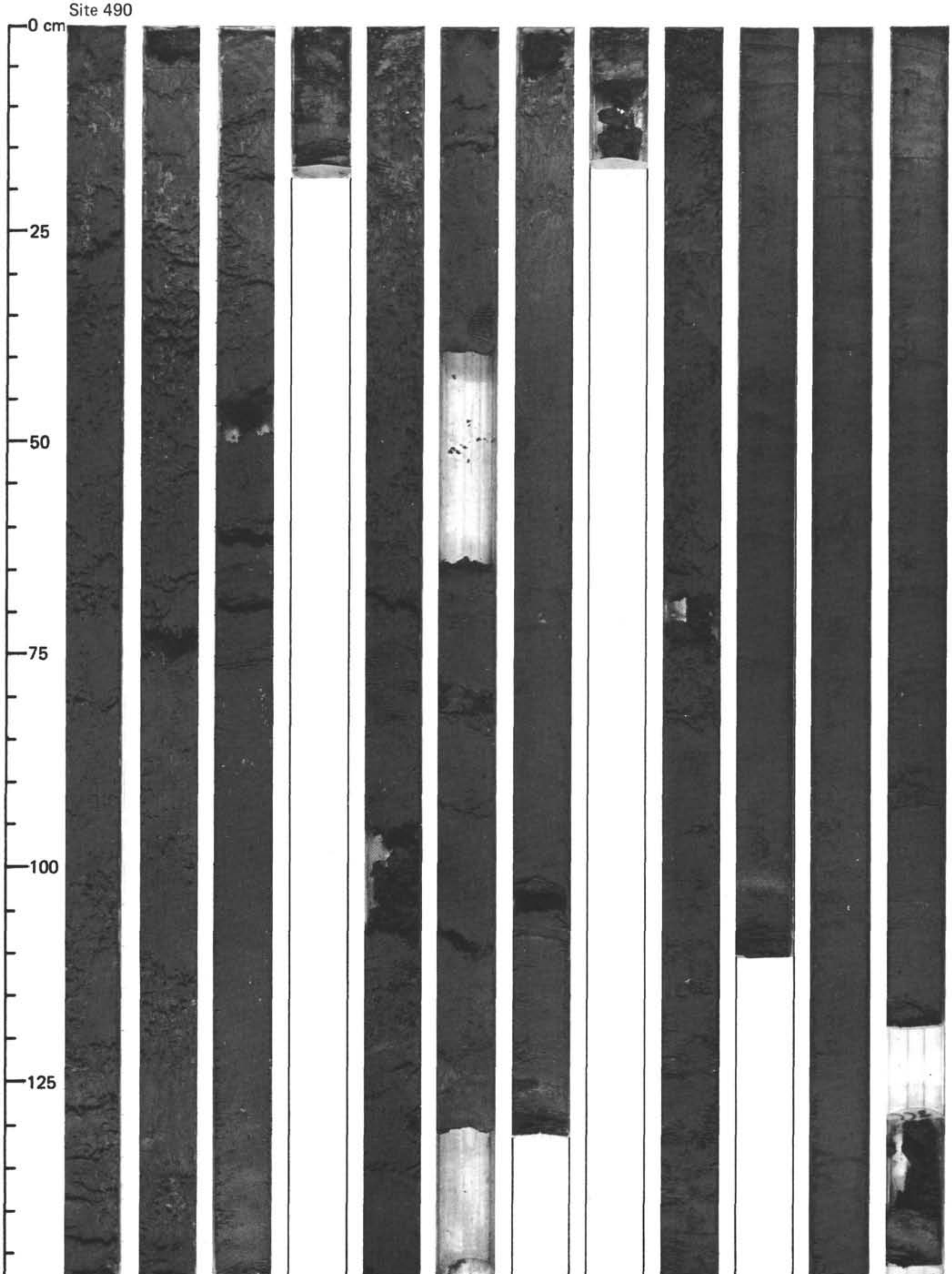
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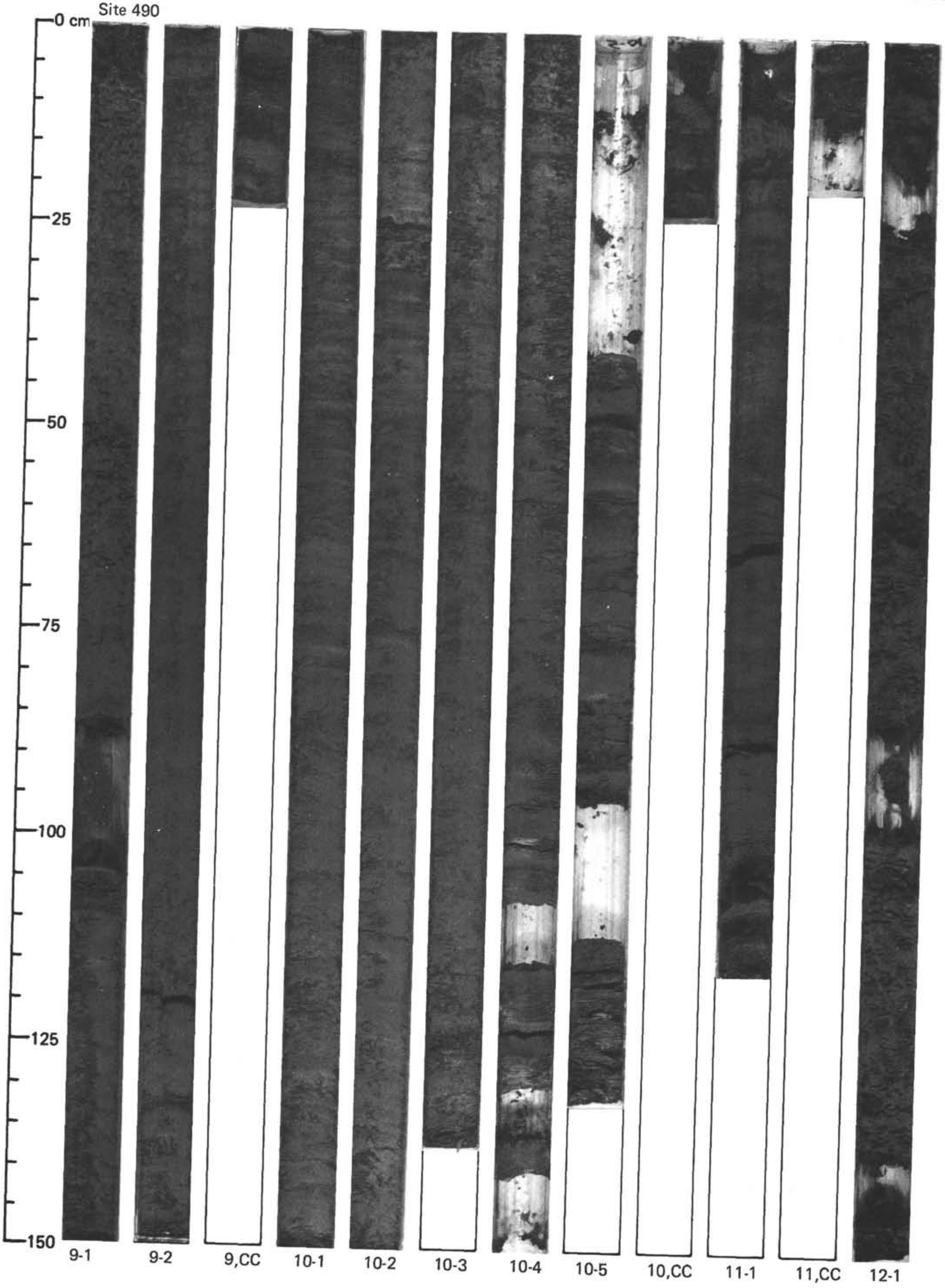
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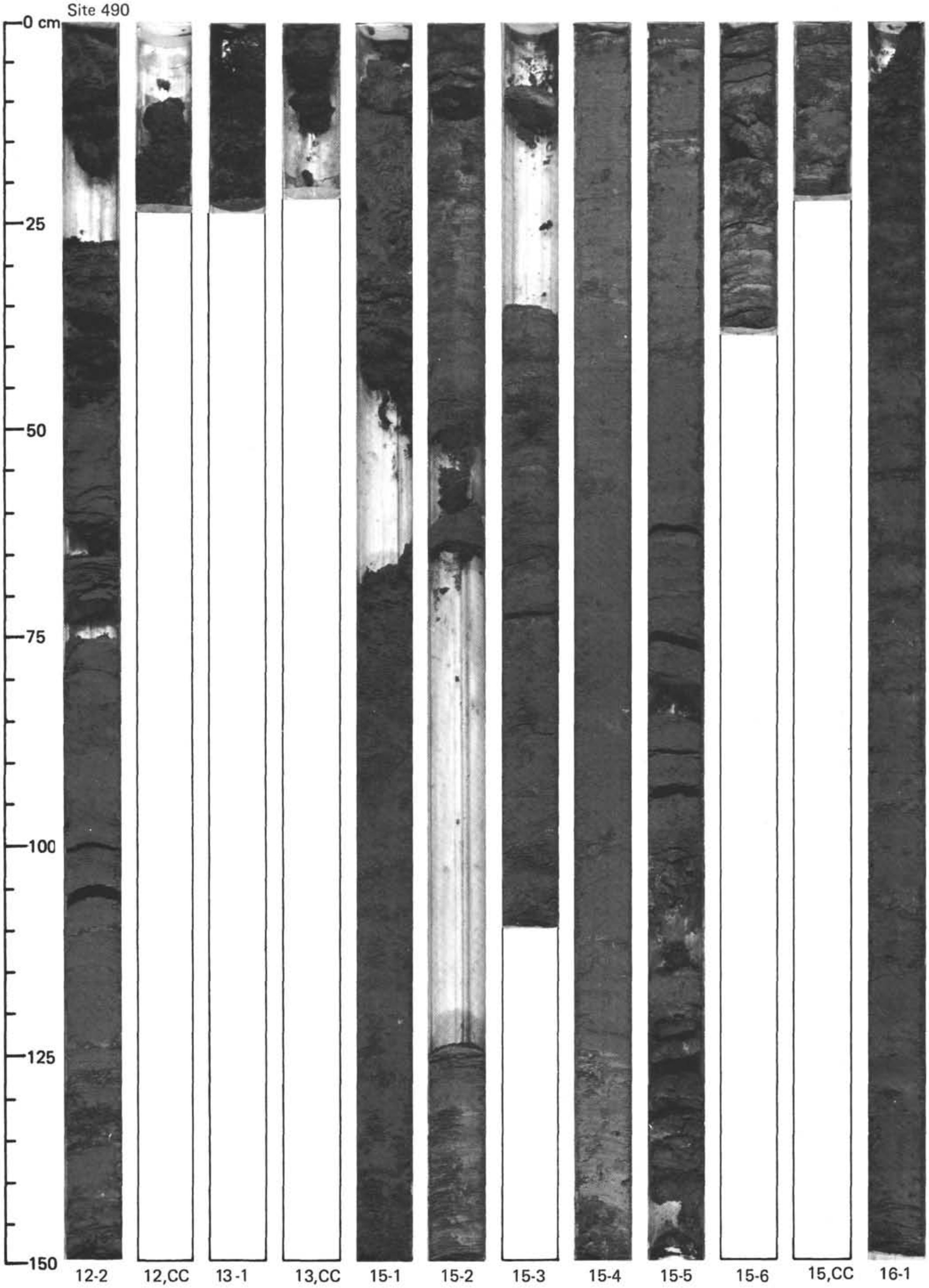
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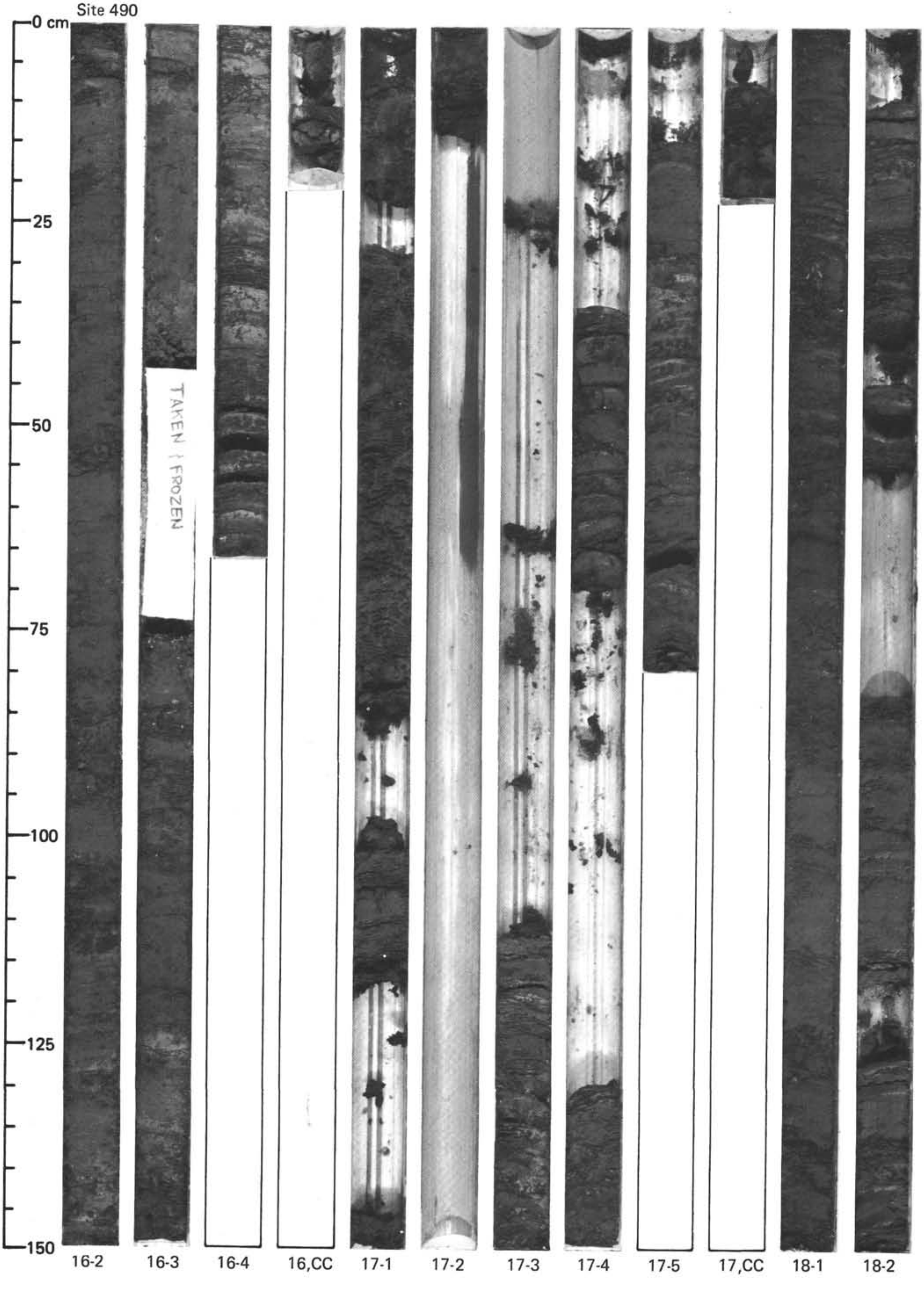
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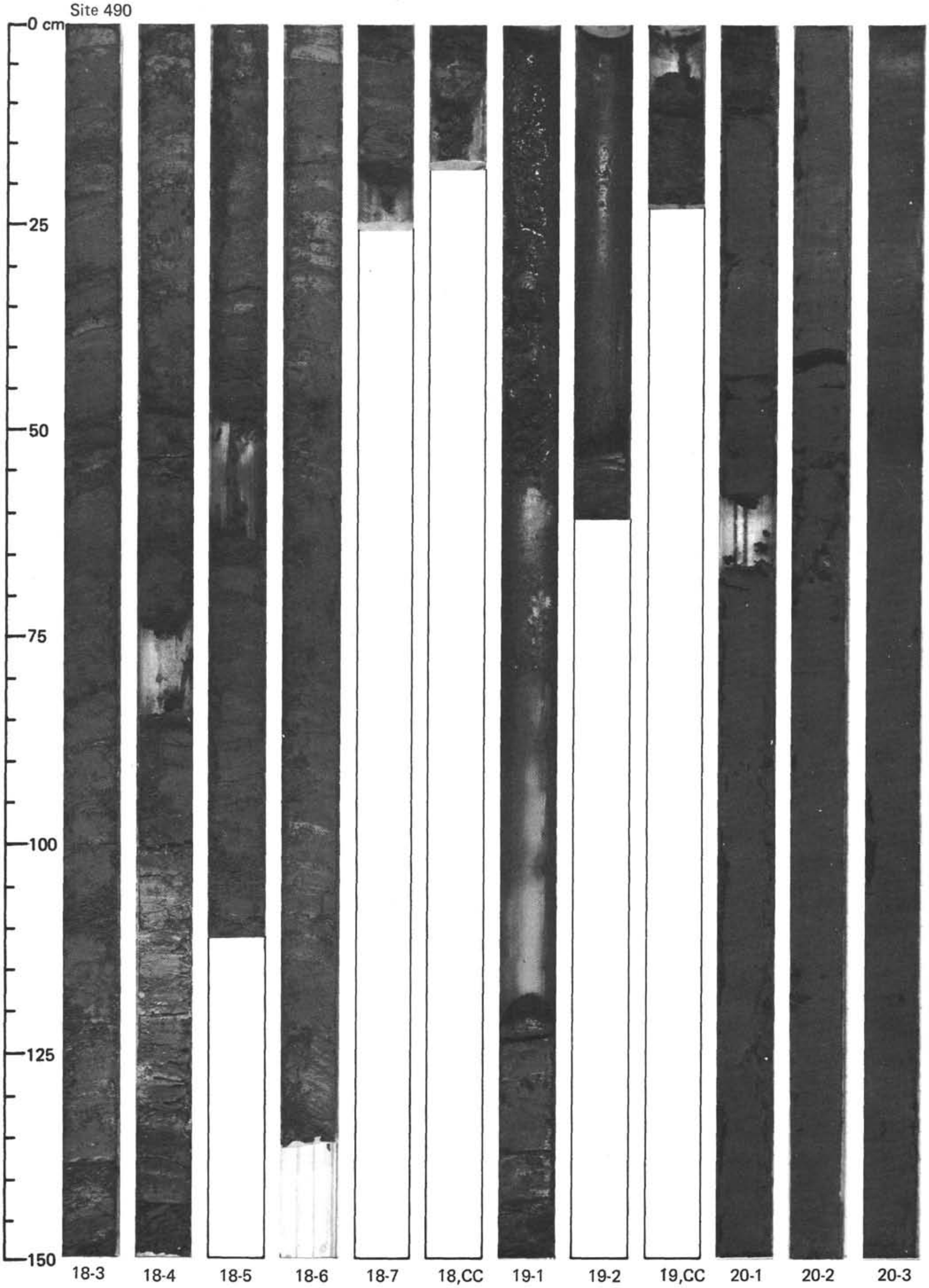
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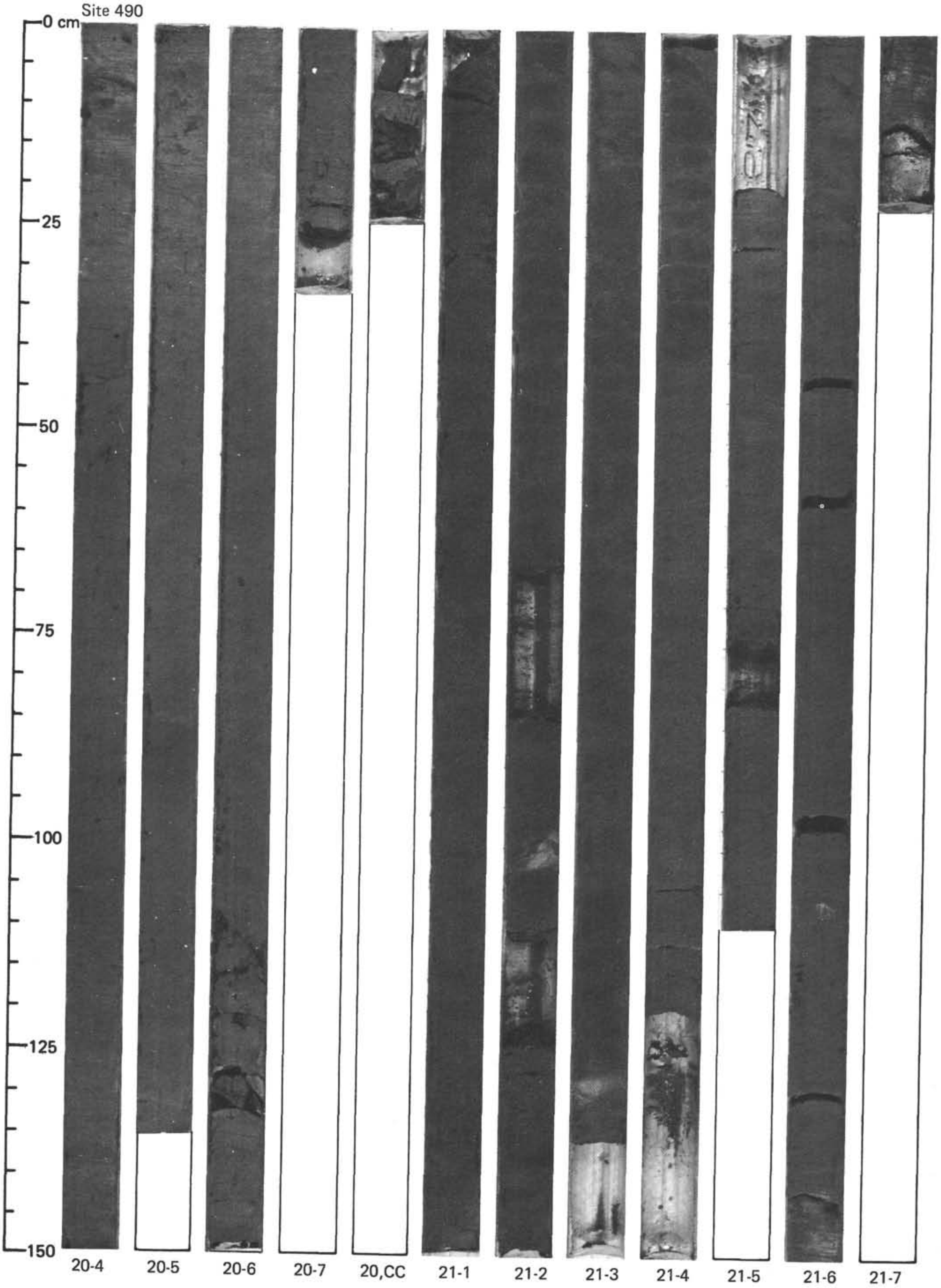
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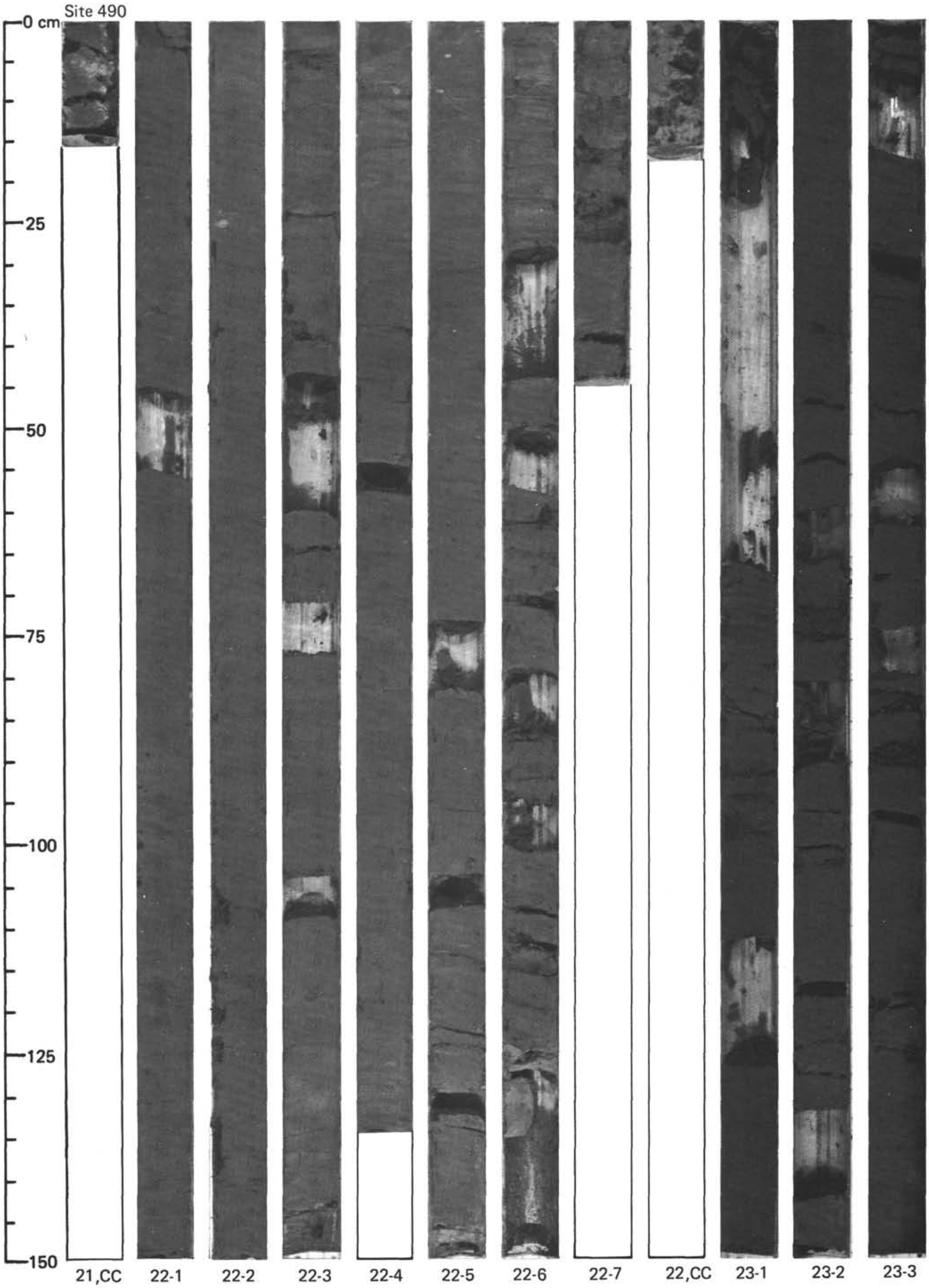
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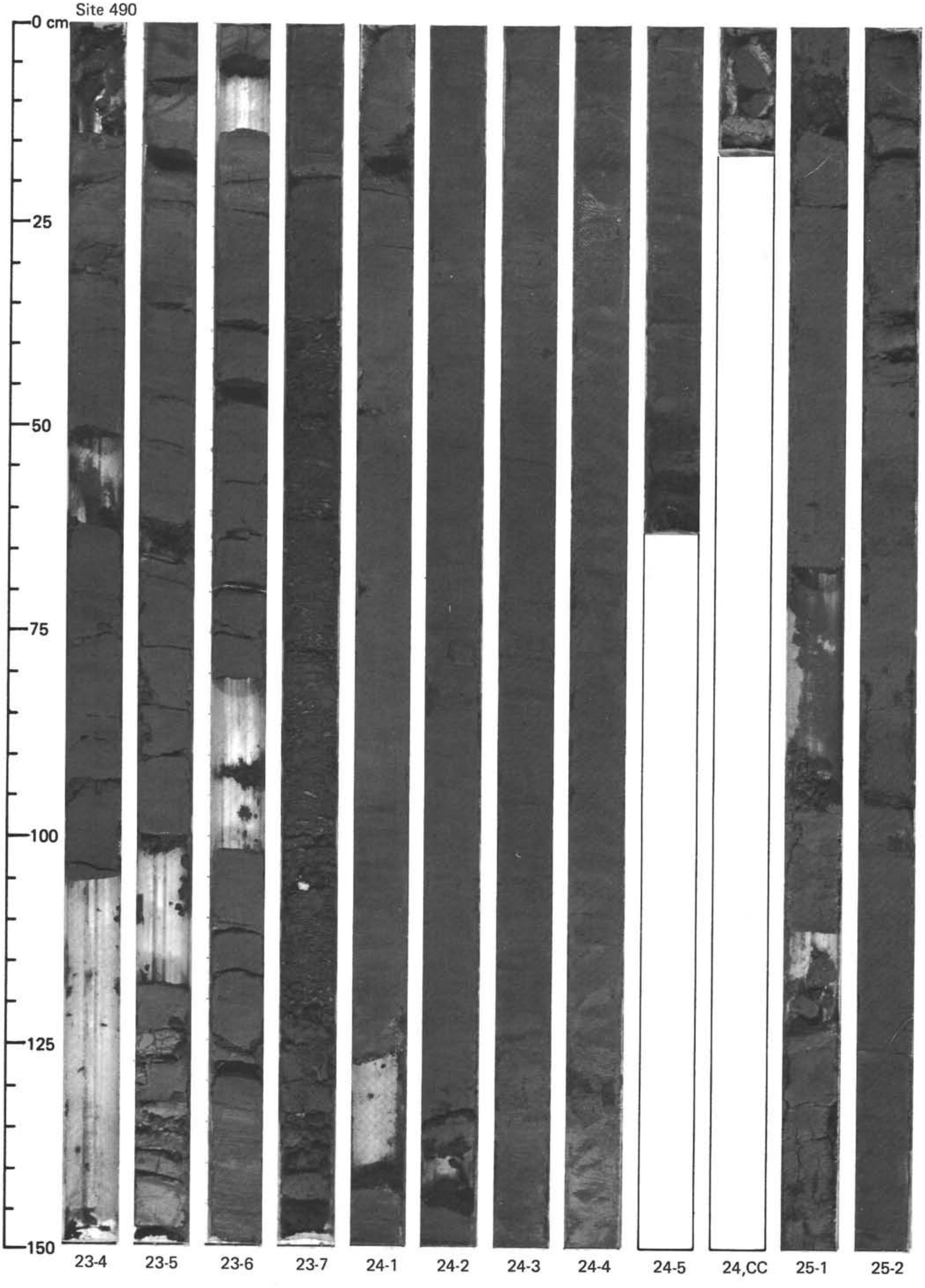
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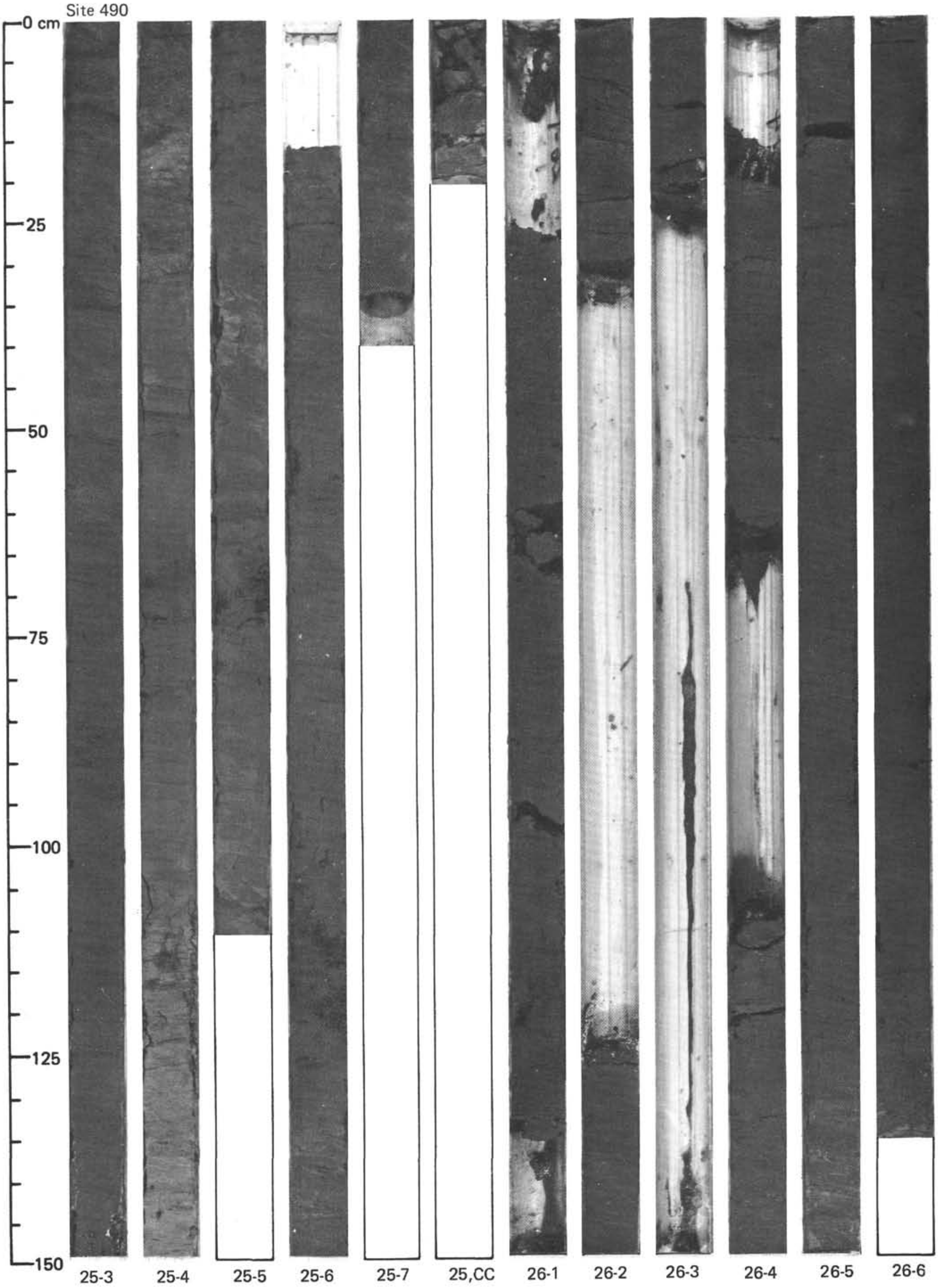
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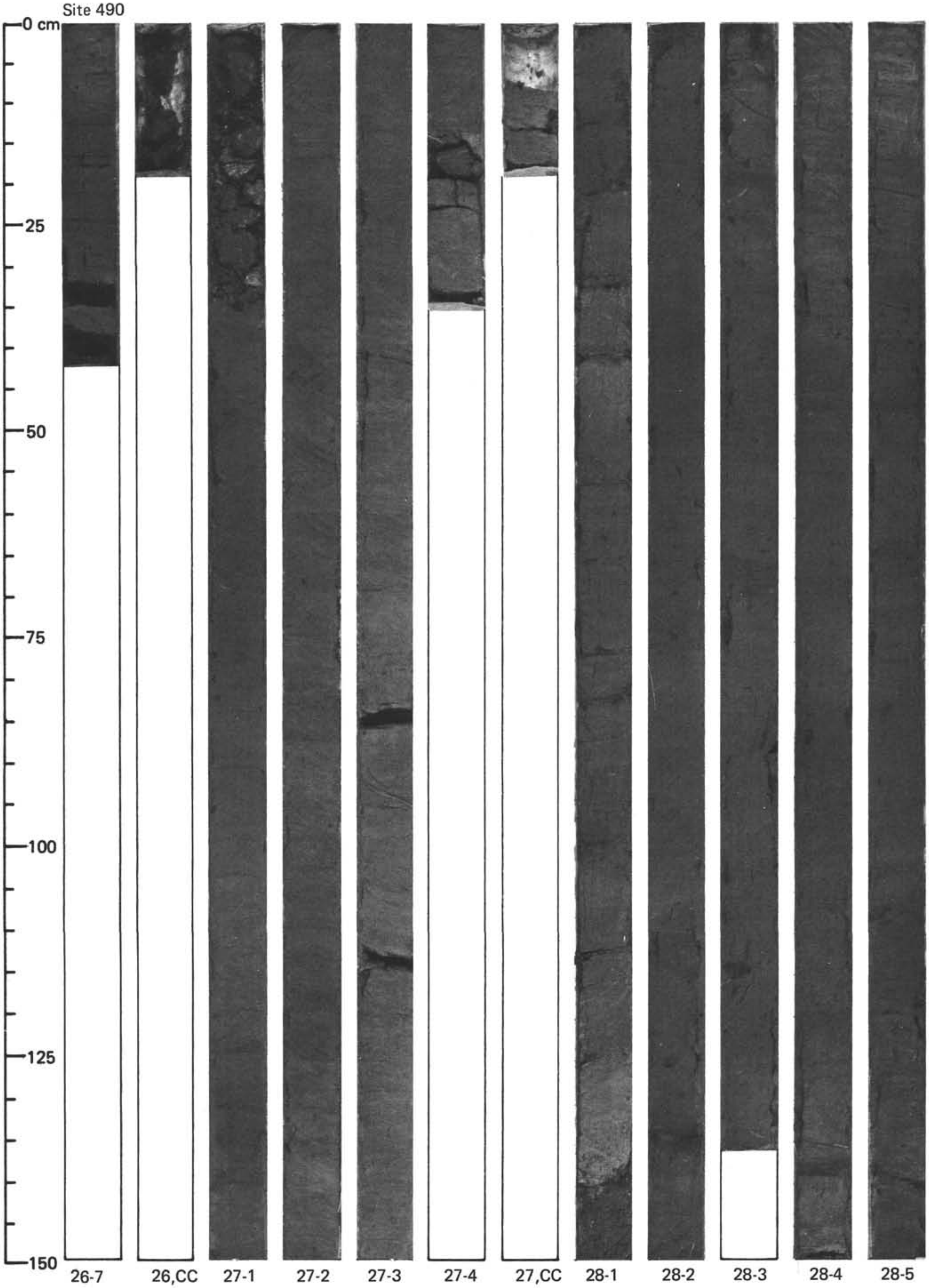
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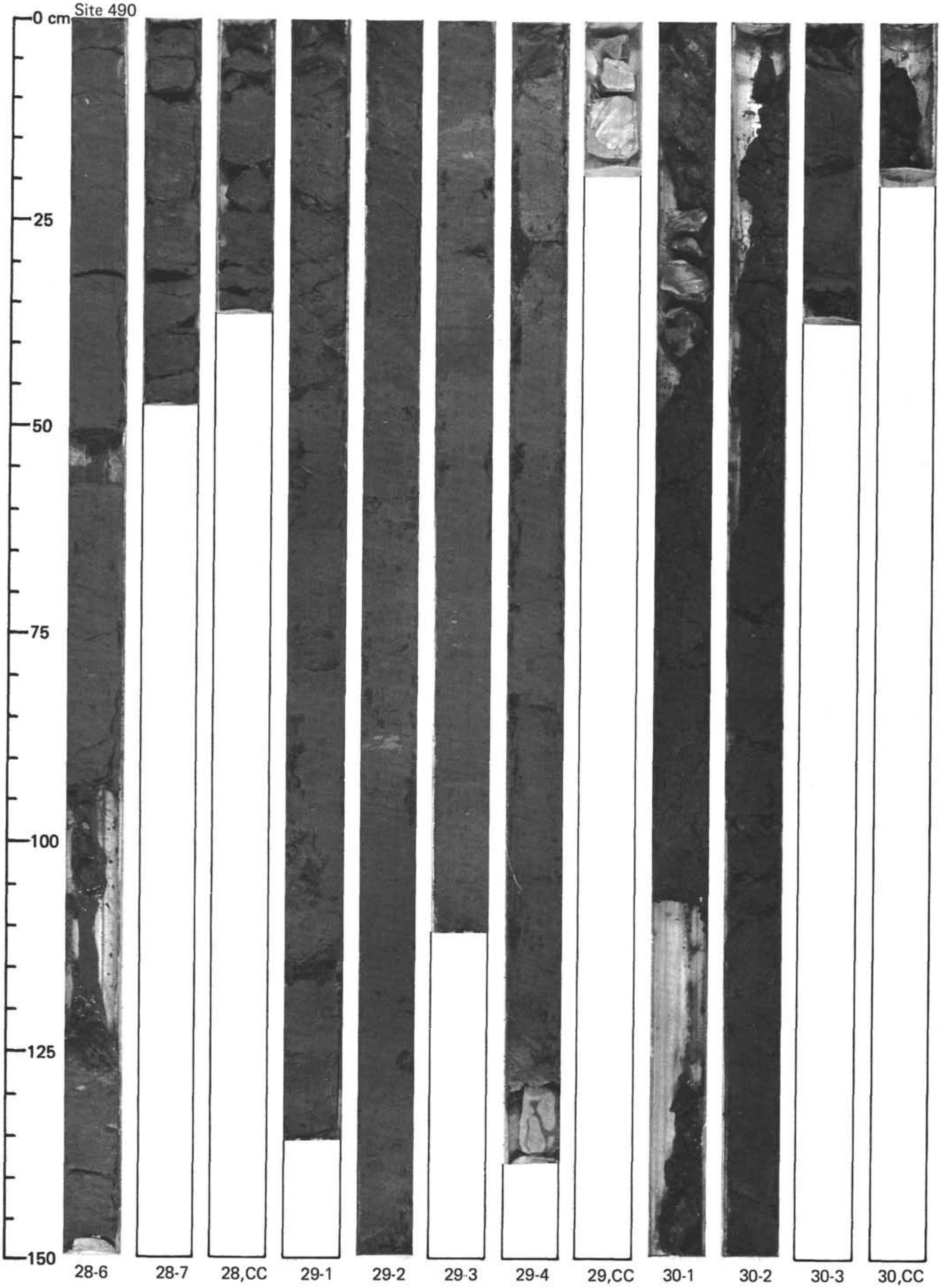
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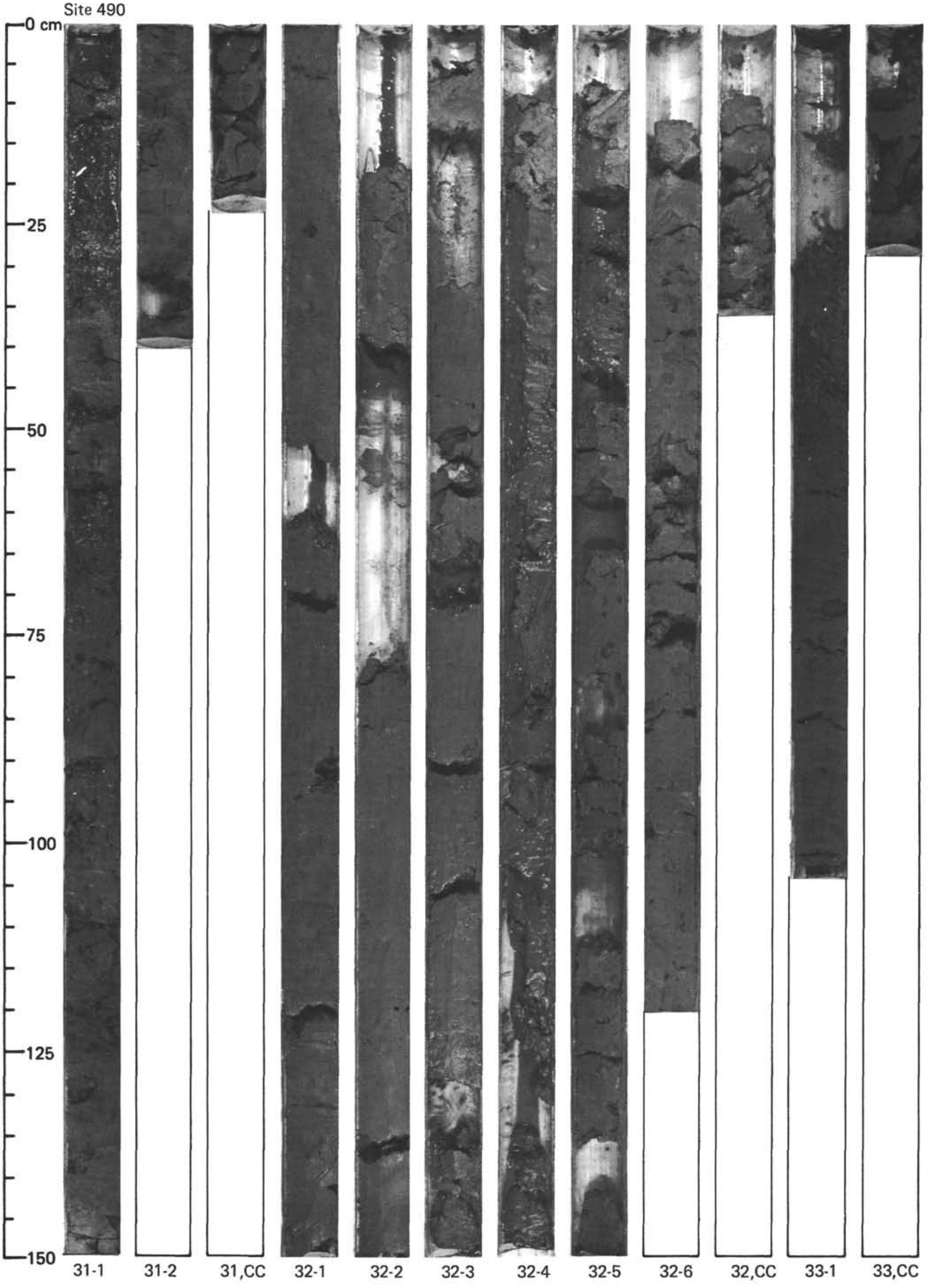
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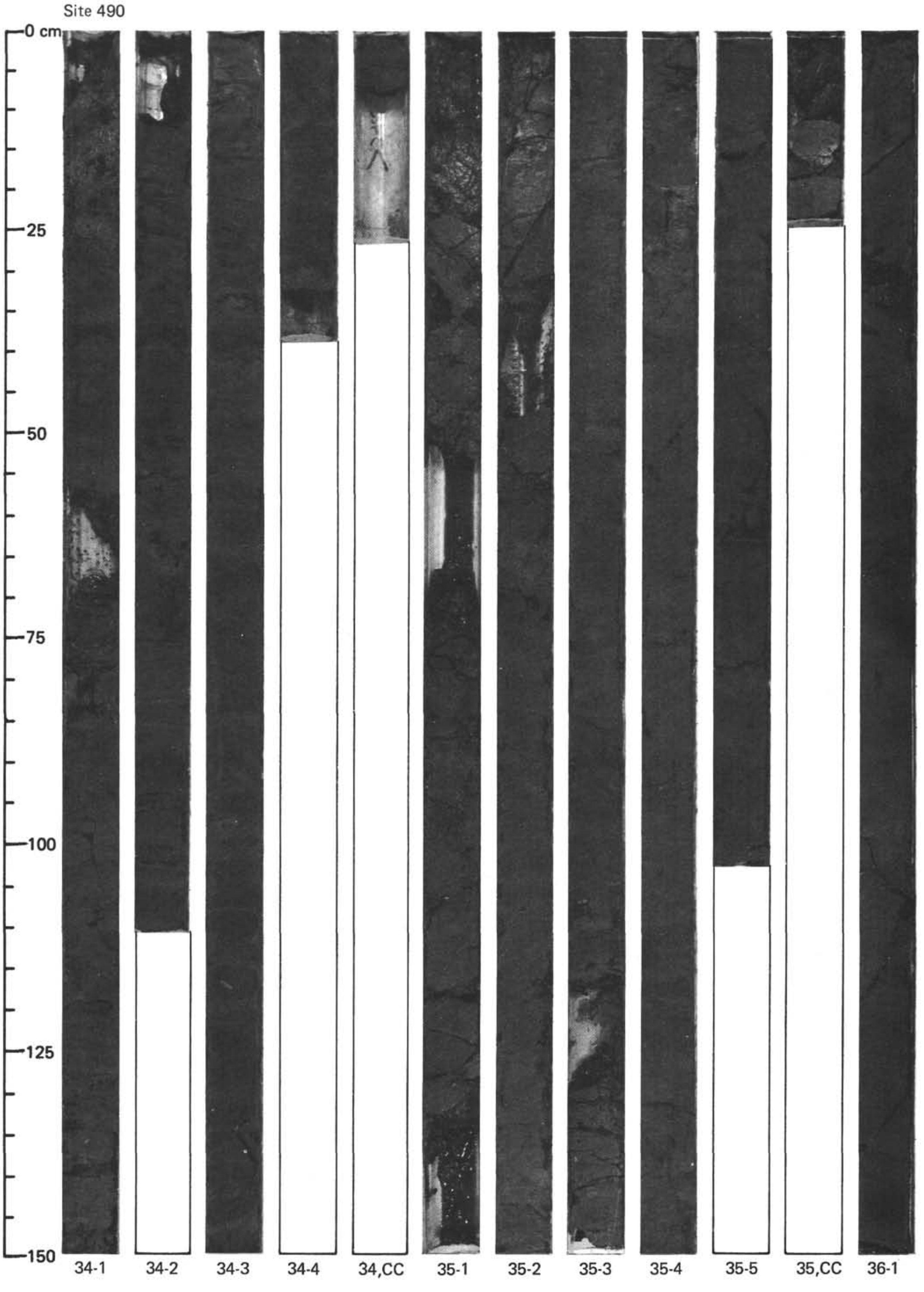
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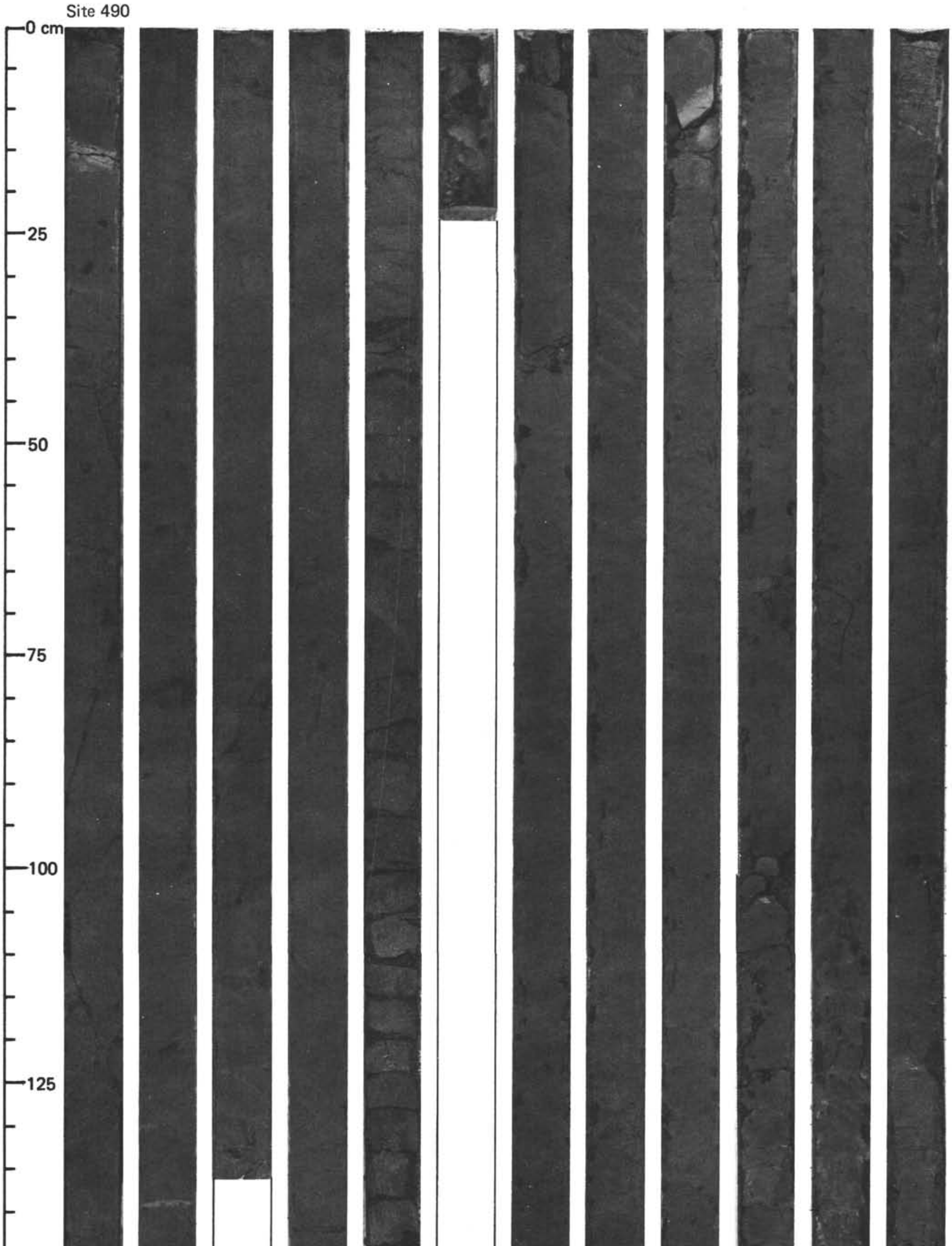
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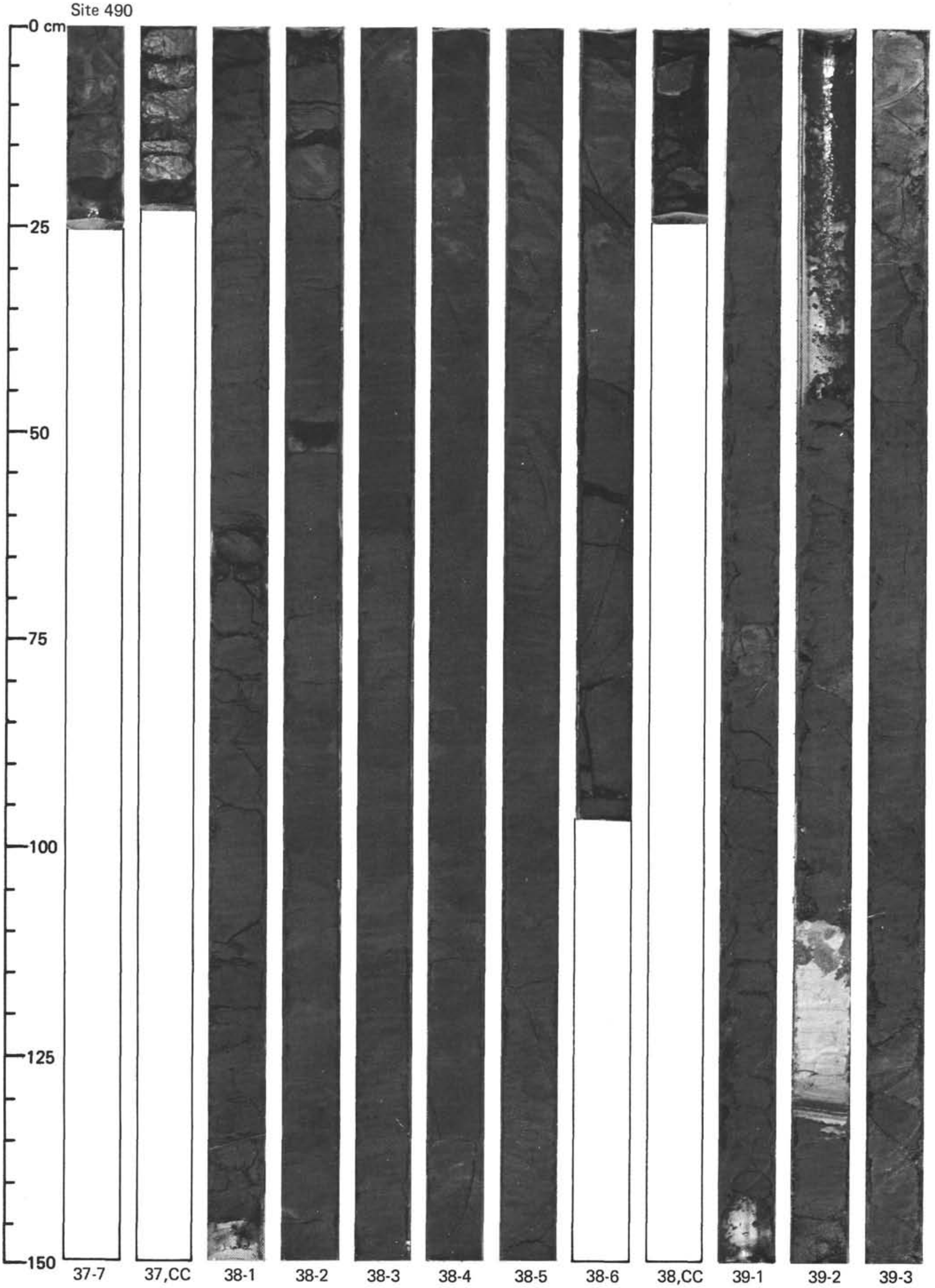
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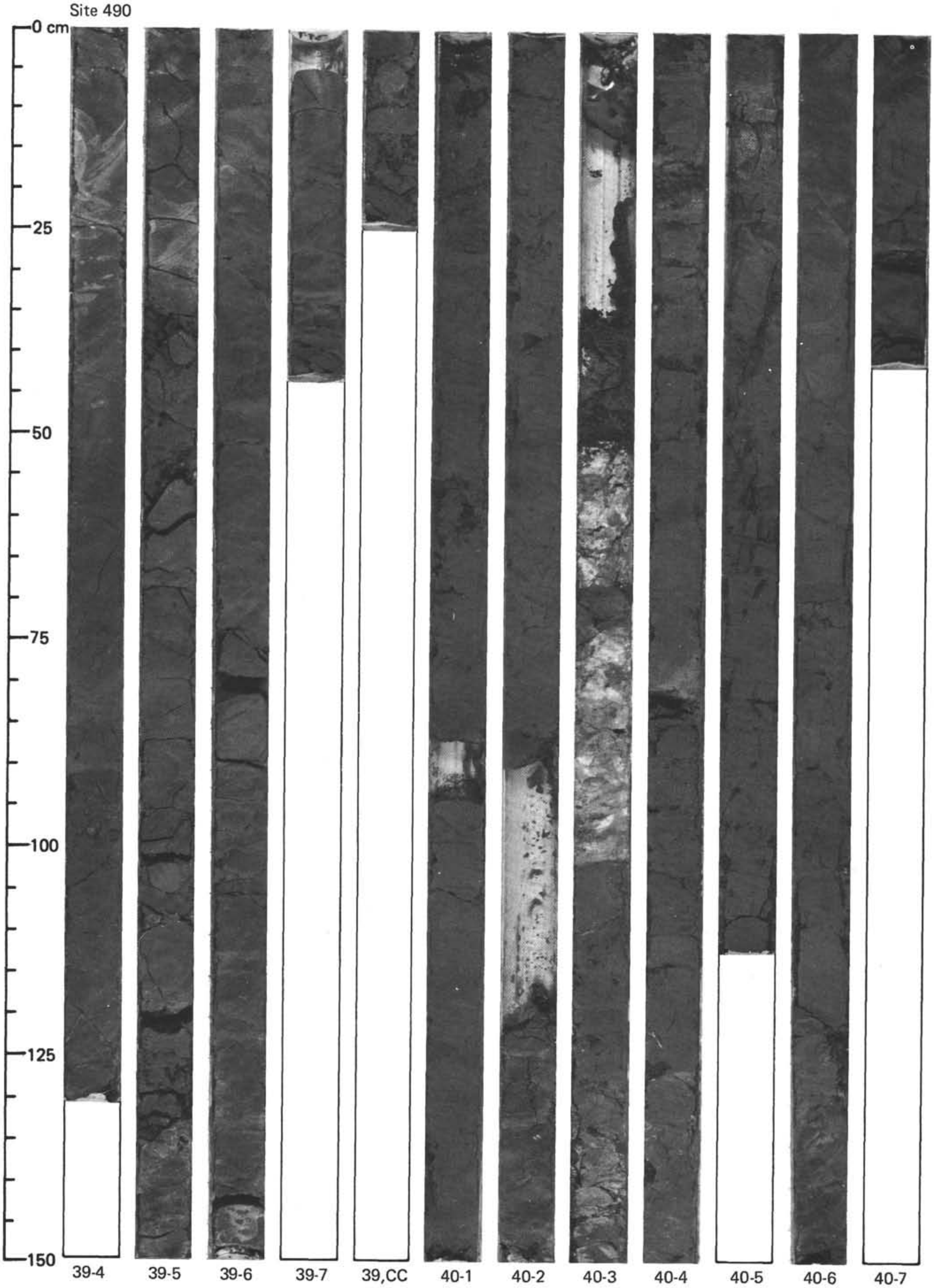
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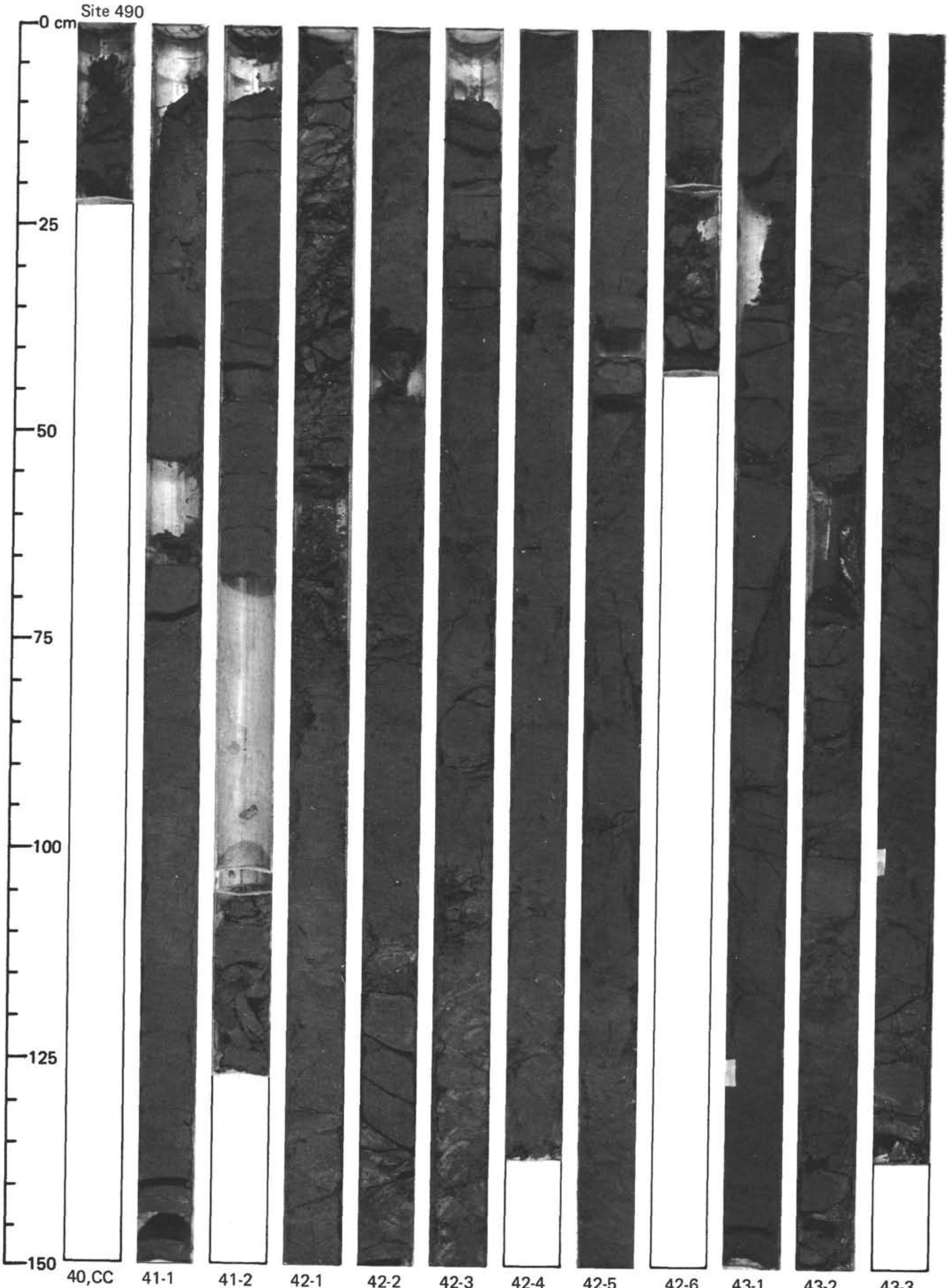
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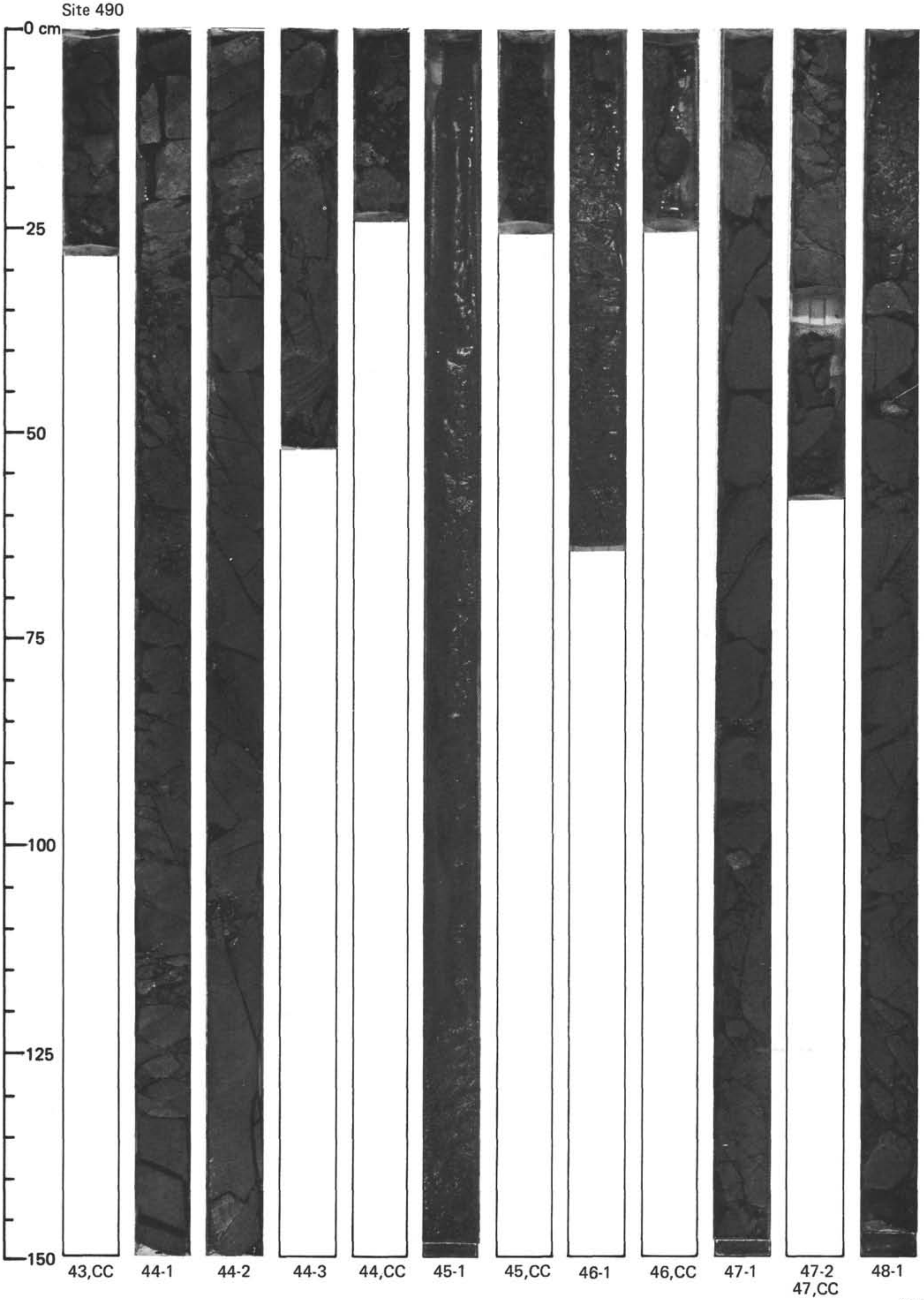
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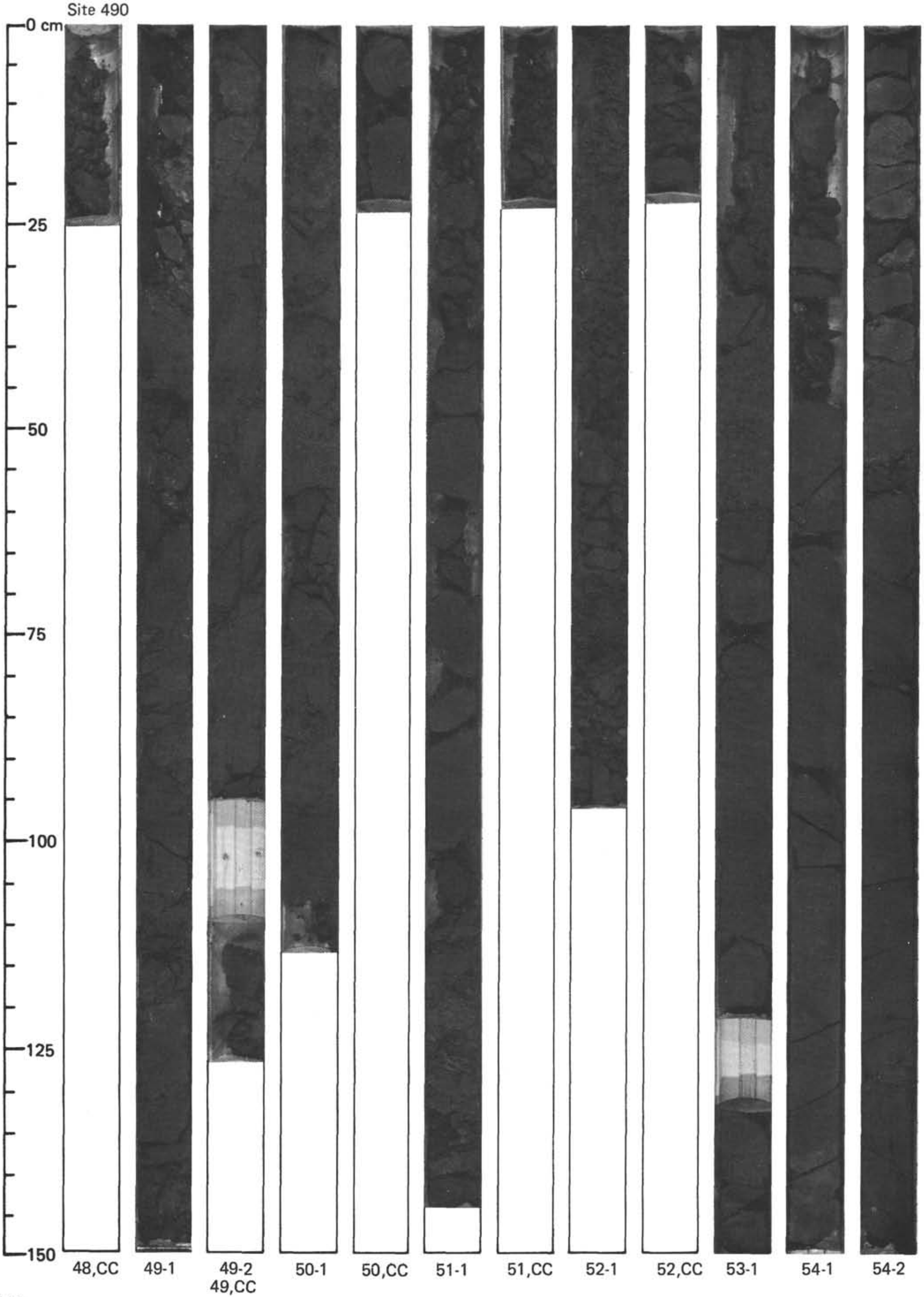

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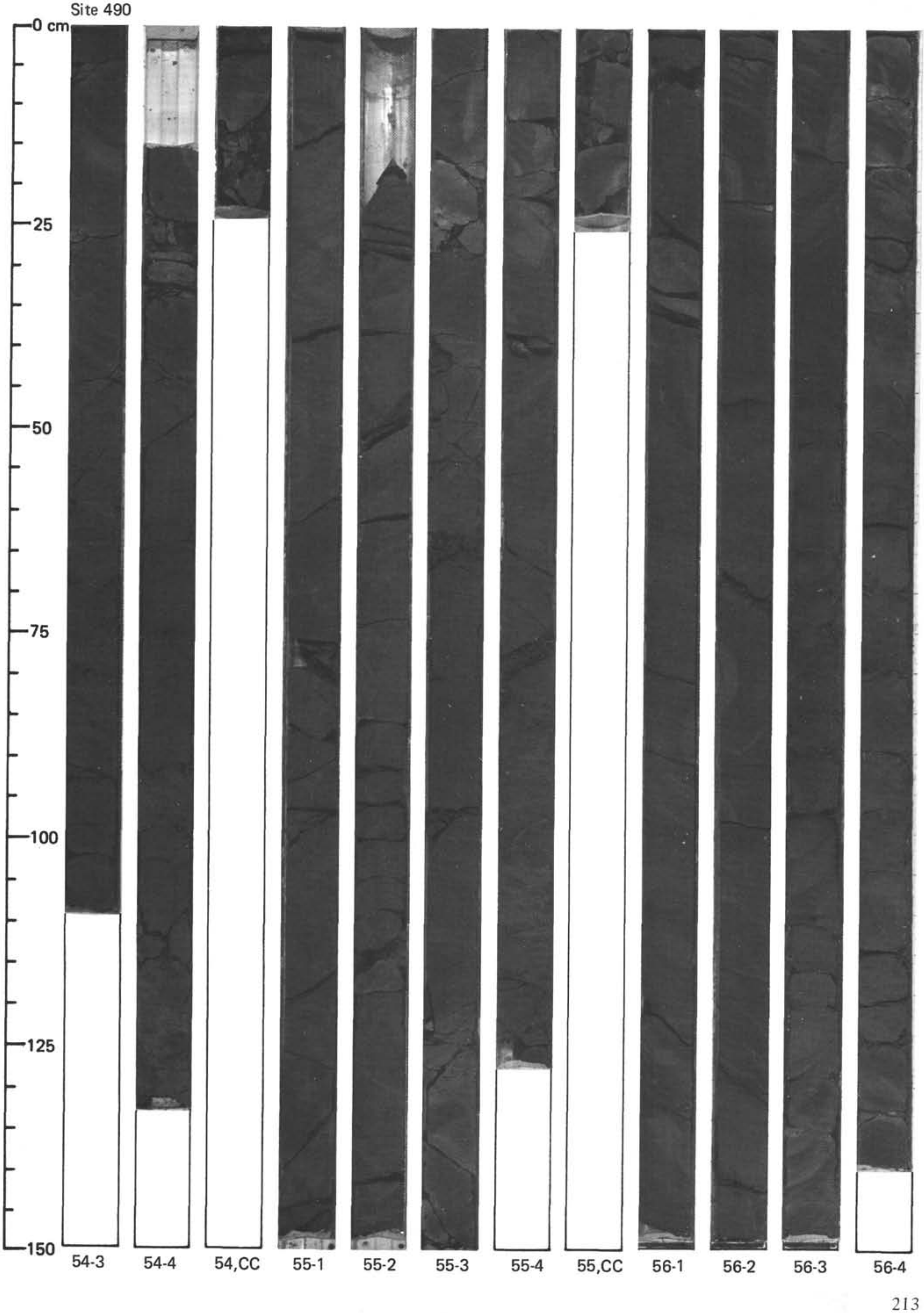
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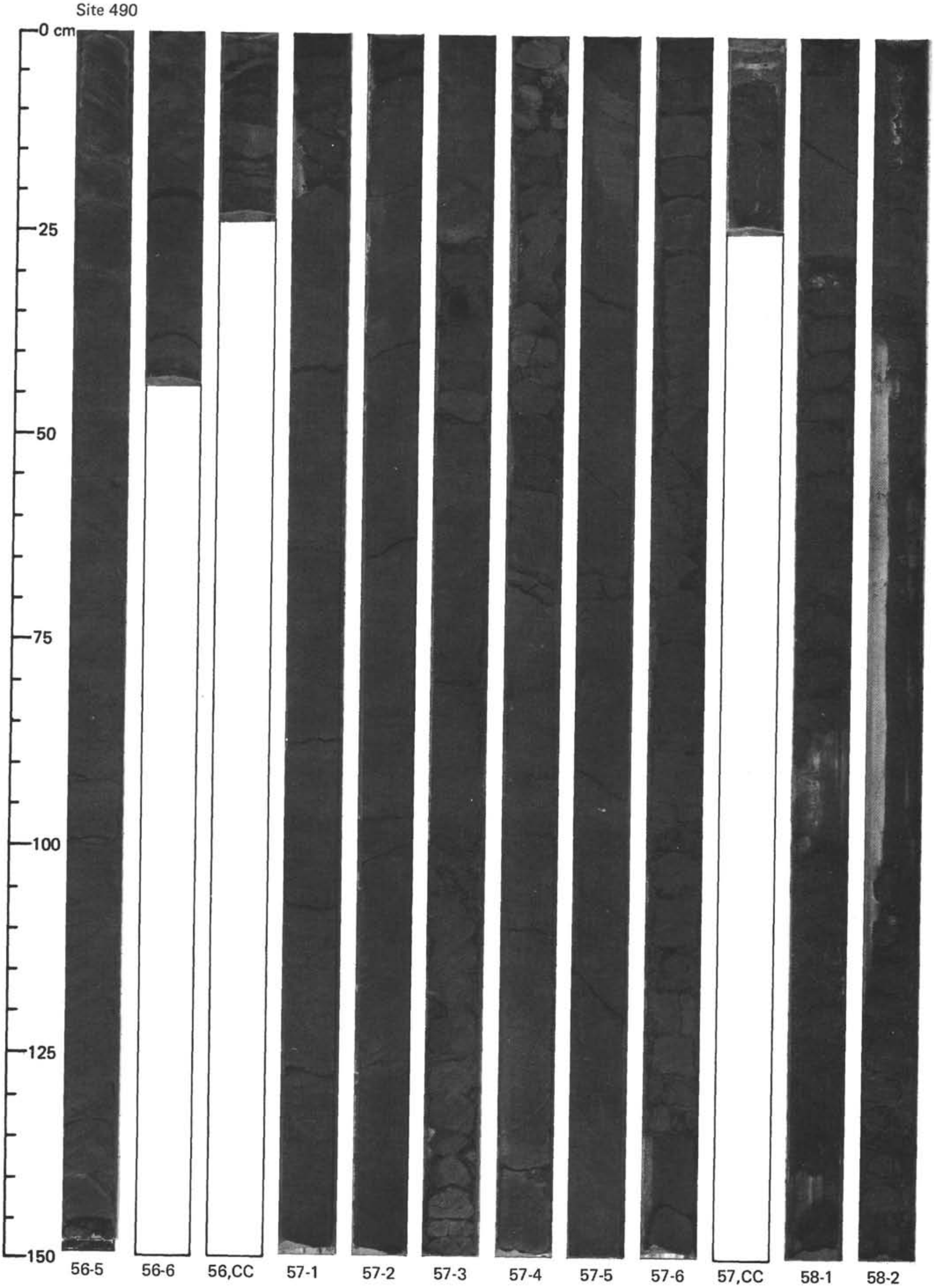
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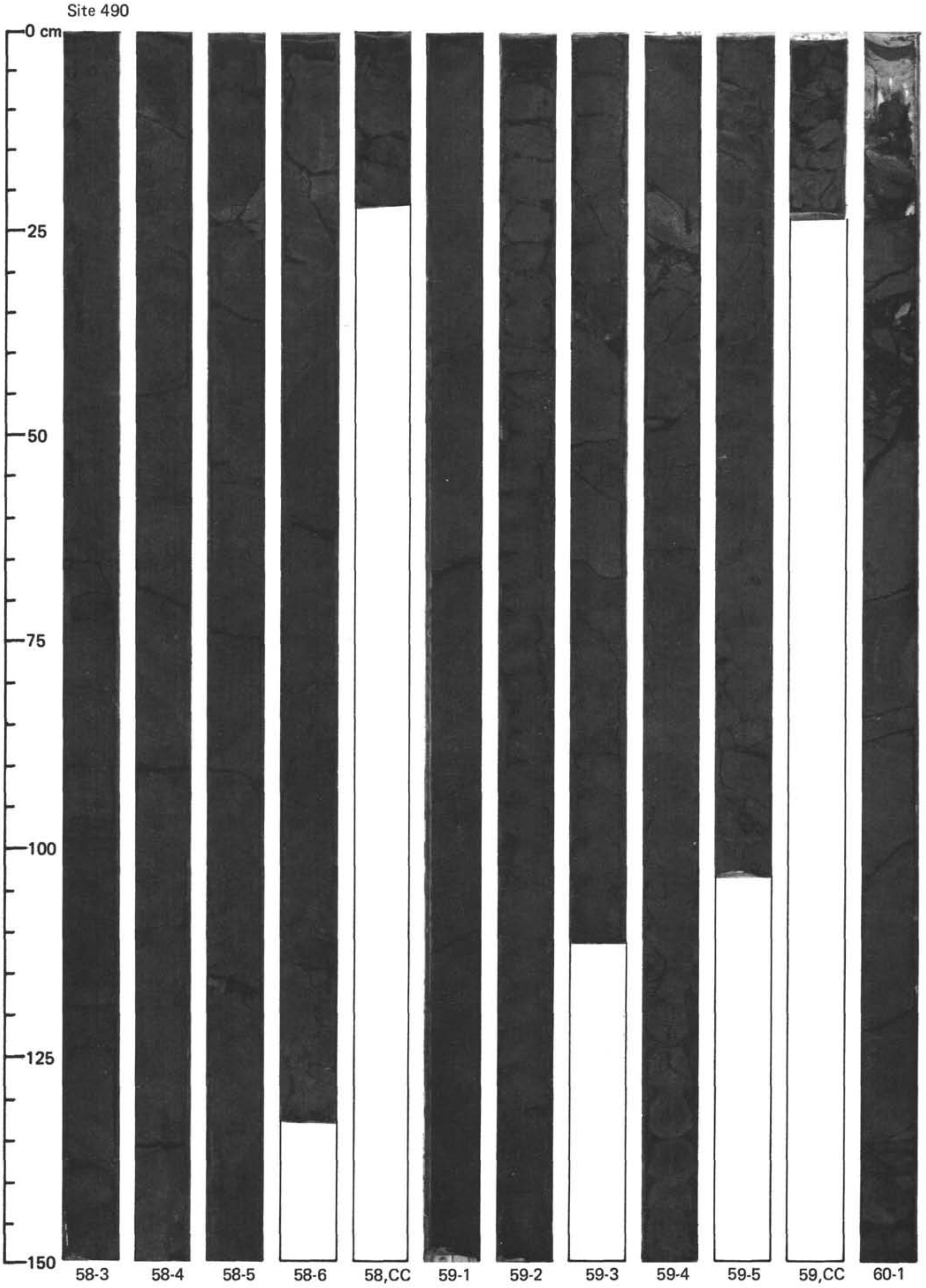
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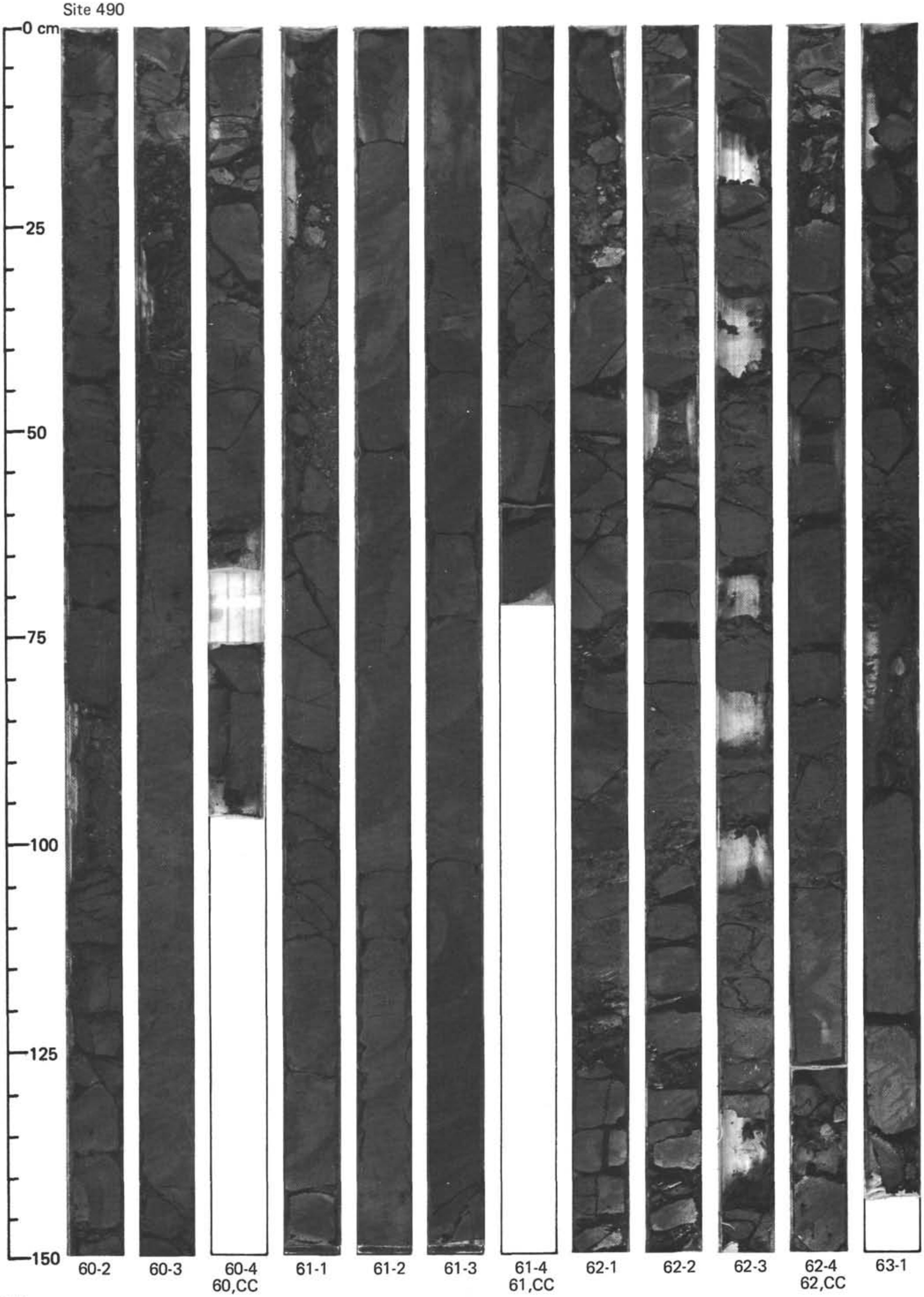
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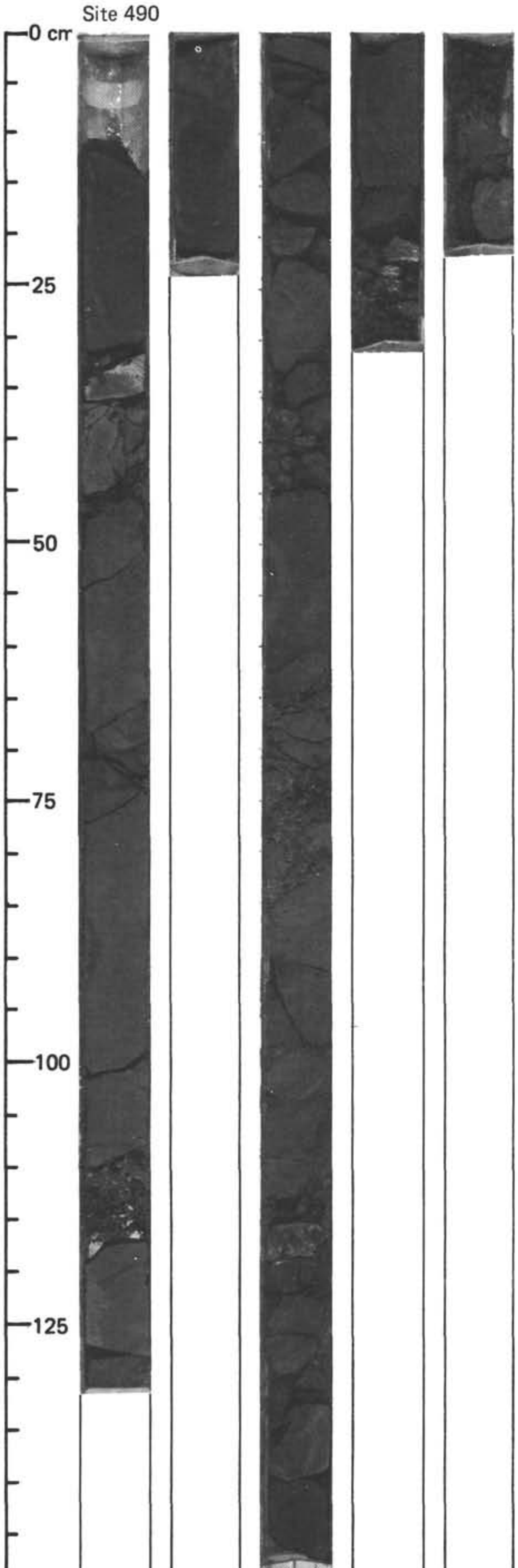
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