Jointly Prepared by the
Department of the Interior U. S. Geological Survey;
JOIDES; and the
Deep Sea Drilling Project, Scripps Institution of Oceanography

Volume 64: Chart 1. Hydraulic piston core photographs, Hole 480, plus underway profiles, Leg 64 (collected by Deep Sea Drilling Project).

HYDRAULIC PISTON CORE PHOTOGRAPHS—SITE 480— PLUS UNDERWAY PROFILES, LEG 64

COLLECTED BY DEEP SEA DRILLING PROJECT

by
T. E. Chase[1], B. J. Long[2], J. D. Young[1], K. R. Kelts[3], and B. A. Seekins[1]

LOCATION MAP

INTRODUCTION

JOIDES and the Deep Sea Drilling Project – International Phase of Ocean Drilling (DSDP–IPOD), funded by the National Science Foundation and operated by the University of California at San Diego, conducted DSDP Leg 64 in the Gulf of California during December, 1978, and January, 1979. During this cruise, the newly developed Hydraulic Piston Corer was used for the first time to recover undisturbed sequences up to 150 meters long of the unconsolidated hemipelagic sediments.

At almost the same time, the Pacific–Arctic Branch of Marine Geology of the U. S. Geological Survey was building a continuous flow camera for photographing marine cores onto a 35 mm frameless, positive-color, microfilm strip. In addition, a microfilm enlargement and retrieval unit project the images from microfilm onto reproducible stable base material (mylar). This joint packet illustrates the quality of the hydraulic profiles of Leg 64, as they are recorded on the microfilm system. More detailed investigations can be made from the microfilm copy.

The HPC operates on the principle of a 4.5-meter core barrel which is lowered inside the drill string, hydraulically ejected into the sediment and retrieved. The pipe is then lowered 4.5 meters to the next interval and the procedure repeated. The cores are cut into 1.5 meter long sections, split into halves and stored. See Figure 1.

At Site 480, the laminated sediments of the oxygen minimum zone of the Guaymas Slope, 31 cores were cut with 80% of the 152-meter stratigraphy recovered intact. At Site 481 in the Guaymas Basin turbidites, 11 cores were recovered with 64% of the sequence undisturbed.

The core photography was done by placing one-half of the core into a modified "D"-Tube tray with a centimeter scale along the side. A conveyer system synchronously moves the tray under the core camera while continuous 35 mm color positive microfilm strips are exposed. The underway seismic profiles were also filmed onto continuous 35 mm microfilm but not in color. The color photographs for this report are from contact duplicates of the original microfilm. The underway seismic profile strip mounts were made from the 35 mm microfilm by CONTRAPTION set to a three-inch enlargement.

The lithologic descriptions are reprinted from Curray, J. R., Moore, D. G., et al., 1982, *Initial Repts. DSDP*, 64: Washington (U. S. Govt. Printing Office).

See also:
Schrader, H., Kelts, K., et al., 1980. Laminated diatomaceous sediments from the Guaymas Basin (central Gulf of California): 250,000-year climate record. *Science*, 207:1207–1209.

PARTICIPATING SCIENTISTS
J. Eduardo Aguayo, Marie-Pierre Aubry, Gerhard Einsele
Daniel J. Fornari, Joris Gieskes, Jose C. Guerrero-Garcia,
Miriam Kastner, Kerry R. Kelts, Mitchell Lyle,
Yasumochi Matoba, Adolfo Molina-Cruz, Jeffrey Niemitz,
Jaime Rueda-Gaxiola, Andrew D. Saunders, Hans Schrader,
Bernd R. T. Simoneit, and Victor Vacquier

Authors' affiliations:

1 U. S. GEOLOGICAL SURVEY
MENLO PARK, CALIFORNIA

2 DEEP SEA DRILLING PROJECT
SCRIPPS INSTITUTION OF OCEANOGRAPHY
LA JOLLA, CALIFORNIA

3 EIDGENOSSISCHE TECHNISCHE HOCHSCHULE
GEOLOGISCHES INSTITUT
CH8092 ZURICH, SWITZERLAND

Authors were assisted by:
C. P. Miller and R. L. Ching
U. S. Geological Survey

L. Garifal and W. G. Mills
Deep Sea Drilling Project

S. M. Smith, D. A. Newhouse, U. G. Albright, and V. W. Psaropulos
Geologic Data Center, Scripps Institution of Oceanography

Leg 64 Chief Scientists
JOSEPH R. CURRAY and DAVID G. MOORE

Generalized topographic map of the Gulf of California, showing major basins and locations of Sites 480 and 481. Contours from: Bischoff, J. L., and Niemitz, J. W., 1980. Bathymetric Maps of the Gulf of California. USGS Misc. Invest. Ser. 1–1244.

NAVIGATION LISTING-LEG 64

(Sheet 1 of 4)

TRACKLINE MAP LEG 64

EQUIPMENT USED

Hydraulic Piston Corer: Developed by
S. T. Serocki, M. A. Storms, D. H. Cameron

Continuous Flow Core Camera: Developed by
T. E. Chase, J. D. Young

Film Enlargement and Retrieval Unit ("Contraption"):
Developed by T. E. Chase, J. D. Young

For information about these data, contact the Information Handling Group, Deep Sea Drilling Project, A-031, Scripps Institution of Oceanography, La Jolla, California, 92093

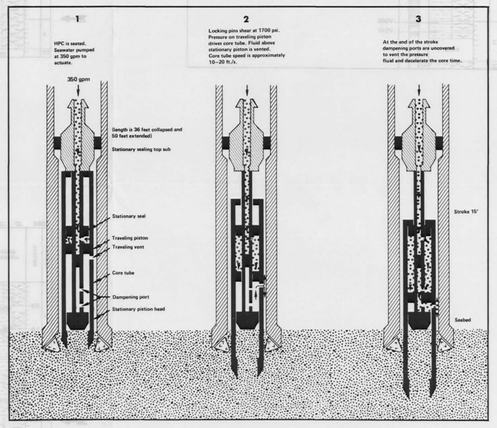

Fig. 1. Operational sequences of the hydraulic piston corer.

LITHOLOGIC DESCRIPTIONS - SITE 480

SECTIONS BETWEEN ARROWS SHOWN ON PLATE 1 IN COLOR

CORE 1

CORE 1 CORED INTERVAL 0.00–4.75 m

Dark muddy diatomaceous ooze
Light diatomaceous ooze

Undisturbed hydraulic piston core. Rhythmically laminated mm-couplets of alternating moderate olive brown (5Y 4/4) **MUDDY DIATOM OOZE** and pale olive (10Y 6/2) **DIATOM OOZE**. Pale laminae commonly matted texture from fibrous frustules. Core has gelatinous consistency due to high water content. Strong H_2S component.

SMEAR SLIDE SUMMARY

	1-110.5 (D)	1-111 (M)
TEXTURE:		
Sand	–	–
Silt	40	70
Clay	60	30
COMPOSITION:		
Quartz	1	–
Feldspar	2	1
Mica	–	1
Clay	50	20
Pyrite	TR	–
Diatoms	45	75
Sponge spicules	1	1
Silicoflagellates	3	2
Plant debris	1	–
Pollen	–	2

CORE 2

CORE 2 CORED INTERVAL 4.75–9.50 m

Unconformity

Rhythmic laminations of alternating moderate olive brown (5Y 4/4) **MUDDY DIATOM OOZE** and pale olive (10Y 6/2) **DIATOM OOZE**. Some diatom ooze layers as thick as 0.75 cm with "paper"-like mats of diatoms (e.g. Section 1, 71 cm). Some deviation from horizontal bedding of laminae (coring effect?). Strong H_2S. Gelatinous consistency near the top of the core, but firms toward the bottom. Laminated couplets sub-mm- to sub-cm-scale in thickness, parallel with discordant layering Section 2, 130–150 cm.

CORE 3

CORE 3 CORED INTERVAL 9.50–14.25 m

VOID

Nannofossil diatomaceous mud

Rhythmically laminated couplets of alternating moderate olive brown (5Y 4/4) muddy diatom ooze and pale olive (10Y 6/2) diatom ooze. Strong H_2S odor.

At Section 1, 90 cm to Section 2, 16 cm and Section 3, 55–125 cm: zones of homogeneous **DIATOMACEOUS MUD** with nannofossils. Silty bioturbated, upper unit contact gradational.

Section 2, 75 cm: crenulation.

SMEAR SLIDE SUMMARY

	1-120 (M)
TEXTURE:	
Sand	–
Silt	40
Clay	60
COMPOSITION:	
Quartz	2
Feldspar	4
Mica	2
Heavy minerals	1
Clay	55
Pyrite	1
Zeolite	1
Carbonate unspec.	2
Foraminifers	2
Calc. nannofossils	15
Diatoms	15
Sponge spicules	1
Fe-Mn opaques	1

CARBONATE BOMB: CC: 5%

CORE 5

CORE 5 CORED INTERVAL 19.00–23.75 m

Unconformity (?)

Zones of rhymically laminated couplets of moderate olive brown (5Y 4/4) **MUDDY DIATOM OOZE** and pale olive (10Y 6/2) **DIATOM OOZE** alternating with zones of homogeneous, moderate olive brown (5Y 5/4) **DIATOM MUD**. Contacts partly diffuse to gradational. Homogeneous mottles common in laminated zones may be burrows. Strong H_2S odor. Scattered benthic foraminifer-rich zones.

CARBONATE BOMB: CC: 0%

CORE 6

CORE 6 CORED INTERVAL 23.75–28.50 m

Slump unconformity

Rhythmically laminated mm-scale couplets of moderate olive brown (5Y 4/4) muddy diatom ooze and pale olive (10Y 6/2) diatom ooze. Varves alternating with zones of homogeneous moderate olive brown (5Y 4/4) diatom mud. Strong H_2S odor. Commonly laminated zones show disturbance in the form of clayey lumps which intersect the core liner.

CARBONATE BOMB: CC: 0%

CORE 7

CORE 7 CORED INTERVAL 28.50–33.25 m

Unconformity
Diatomaceous ooze
Varve

Rhythmically laminated couplets of moderate olive brown (5Y 4/4) **MUDDY DIATOM OOZE** and pale olive (10Y 6/2) **DIATOM OOZE** alternate with zones of olive brown (5Y 4/4) **DIATOM MUD** in homogeneous sections. Strong H_2S odor. Laminated sections have some clayey homogeneous mottles indicative of disturbance. Sediment structures include a recumbent fold at Section 1, 0–12 cm.

Section 3, 93–98 cm: large fish bone.

SMEAR SLIDE SUMMARY

	3-54 (M)
TEXTURE:	
Sand	–
Silt	80
Clay	20
COMPOSITION:	
Quartz	1
Feldspar	
Opaques	TR
Clay	15
Pyrite	1
Carbonate unspec.	TR
Calc. nannofossils	TR
Diatoms	80
Radiolarians	TR
Silicoflagellates	2

CARBONATE BOMB: CC: 4%

CORE 10

CORE 10 CORED INTERVAL 42.75–47.50 m

Unconformity

Unconformity

Section 1, 0–60 cm: homogeneous, moderate olive brown (5Y 4/4) to light olive gray (5Y 3/2) **DIATOM MUD** with some darker mottles which have organic (black) spots.

Below Section 1, 60 cm: Rhythmically laminated moderate olive brown (5Y 4/4) **MUDDY DIATOM OOZE** and pale olive (10Y 6/2) **DIATOM OOZE** couplets. Unconformities in the laminae are observed. Laminations are faint near the top of the section, becoming more distinctive with depth.

Strong H_2S odor.

CORE 13

CORE 13 CORED INTERVAL 61.75–66.50 m

VOID

CF

N6-N7
Diatomaceous clay

Section 1 to Section 2, 50 cm: light olive gray (5Y 5/2) diatom mud with medium light gray (N6) sand blebs and stringers grades into grayish olive (10Y 4/2) to moderate olive brown (5Y 4/4) diatom mud with possible evidence of bioturbation seen as pale olive (10Y 6/2) burrows. Medium sands, sorted, may be small turbidites but grading is subtle.

At Section 2, 50 cm: begin rhythmic couplets of moderate olive brown (5Y 4/4) **MUDDY DIATOM OOZE** and pale olive (10Y 6/2) **DIATOM OOZES.** Contact: burrowed transitional. Some light to medium light gray (N6–N7) silt layers are observed in the top of the laminated zone with mm-scale basal sands associated with each. These may be small turbidites or current deposits. Occasional clay lump disturbance. Rhythmites grade back to homogeneous (bioturbated) gray olive (10Y 4/2) diatom mud at the bottom of core (Section 3, 45 cm).

Strong H_2S odor.

SMEAR SLIDE SUMMARY

	2-66 (M)
TEXTURE:	
Sand	–
Silt	40
Clay	60
COMPOSITION:	
Quartz	15
Feldspar	3
Opaques	2-3
Clay	60
Volcanic glass	TR
Pyrite	2
Carbonate unspec.	3
Calc. nannofossils	TR
Diatoms	15
Radiolarians	TR
Silicoflagellates	TR

CARBONATE BOMB: CC: 1%

CORE 14

CORE 14 CORED INTERVAL 66.50–71.25 m

VOID
FD
VOID

Muddy diatomaceous ooze with volcanic glass

Diatomaceous mud

Section 1 to Section 2, 10 cm: laminated couplets of moderate olive brown (5Y 4/4) **MUDDY DIATOM OOZE** and pale olive (10Y 6/2) **DIATOM OOZE** with some clayey homogeneous mottles (disturbance). *Wood chips common.* Some diatom ooze couplets are mm-scale, most sub-mm.

At Section 2, 10 cm: grades to grayish olive (10Y 4/2) homogeneous (bioturbated?) **DIATOM MUD**, nannofossil-bearing.

At Section 1, 110 cm: dark fine-grained fragmental layer with some minor vitric ash. R. I. >1.52 and grains containing tiny opaques.

Strong H_2S odor.

SMEAR SLIDE SUMMARY

	1-100 (D)	1-110 (M)	2-70 (D)
TEXTURE:			
Sand	–	2-3	–
Silt	40	62	50
Clay	60	35	50
COMPOSITION:			
Quartz	2-3	3	4
Feldspar		1	1
Opaques	1	3	1
Clay	50	28	45
Volcanic glass	–	20	–
Pyrite	1-2	TR	2
Carbonate unspec.	3	2	4-5
Foraminifers	TR	1	TR
Calc. nannofossils	10	7-8	12
Diatoms	35	35	35
Silicoflagellates	–	TR	–
Plant debris	–	–	TR

CORE 16

CORE 16 CORED INTERVAL 76.00–80.75 m

VOID
VOID

Rhythmically laminated, moderate olive brown (5Y 4/4) **MUDDY DIATOMACEOUS OOZE** with pale olive (10Y 6/2) **DIATOMACEOUS OOZE** couplets. Some laminations folded. Strong H_2S odor.

Several large irregular patches of mottled homogeneous muds (e.g., Section 1, 30 cm and Section 2, 30 cm). Cross-cut laminations (burrows?).

At Section 3, 50 cm: some very thick pale olive diatom ooze laminae.

In Section 3: fish scales prominent, scattered on surface and along partings. Scattered phosphate (e. g., Section 3, 35 cm).

At Section 3, 85 cm: on thin, pure nannofossil lamina.

CORE 18

CORE 18 CORED INTERVAL 85.50–90.25 m

VOID
VOID
VOID

Rhythmically laminated moderate olive brown (5Y 4/4) **MUDDY DIATOMACEOUS OOZE** and pale olive (10Y 6/2) **DIATOMACEOUS OOZE** couplets with well-defined laminae. Several zones of thick diatom ooze layers suggest high productivity (Section 1, 90, 110, and 130 cm and Section 2, 7, 12, 27, 33, and 45 cm). These laminae have a more yellowish color (5Y 7/6). Strong H_2S odor.

CORE 20

CORE 20 CORED INTERVAL 45.00–99.75 m

CF

Unconformity
En echelon laminae (cross-bedding?)

OG

Rhythmically laminated moderate olive brown (5Y 4/4) **MUDDY DIATOM OOZE** and pale olive (10Y 6/2) **DIATOM OOZE** couplets.

At Section 1, 9–11 cm and 90–99 cm; and Section 2, 38–40 cm and 143 cm: medium gray (N5) well-sorted sand beds ungraded with sharp contacts. Laminations unconformably to the sand layers.

At Section 1, 90–100 cm **SAND** has scattered wood chips.

At Section 2, 120–130 cm: unconformities and apparent cross-bedding are observed within laminated zones.

Strong H_2S odor.

CF 1-95: gray sand; angular to subangular components. Very feldspathic. Well-sorted, grains slightly weathered. Feldspars, mostly plagioclase (60%), angular quartz (25%), gray siltstone rock fragments (15%), fine-grained white (3%), biotite (2%), green hornblende (3%). No calcareous or fossil debris.

CORE 21

CORE 21 CORED INTERVAL 99.75–104.50 m

VOID
VOID
VOID
VOID

Dolomitic claystone
5B 5/1
Quartz silt
10Y 6/2
Diatomaceous mud

Interlayering of several lithologies:

1. Zones of rhythmically laminated couplets of moderate olive brown (5Y 4/4) **MUDDY DIATOMACEOUS OOZE** and pale olive (10Y 6/2) diatom ooze, mm- to sub-mm-scale. Strong H_2S odor.

2. Several thicker laminae to cm-beds of greenish gray (5G 6/4) to medium bluish gray (5B 5/1) **SILTY CLAYS TO SANDY SILT**, in Section 1, at 41, 90, and 145–150 cm. In Section 2, they occur as a sequence of 17 rhythmic cm-thick beds from Section 2, 5–50 cm with 3 more from Section 2, 117–124 cm: these are clearly graded **TURBIDITES** with a well-sorted, thin sandy base. Some are separated by a few thin diatomaceous laminae. Upper and lower contacts are sharp. Immediately below the turbidite sequence is a gradational change downward (Section 2, 65–104 cm) from homogeneous to laminated oozes. Laminations below turbidite unit are fainter than above.

3. At Section 1, 130–142 cm: a grayish-yellow (5Y 8/4) lithified, **DOLOMITIC MUDSTONE** is intercalated into homogeneous diatomaceous muds, with some faint layering. This dolomitic bed is homogeneous with some faint burrow mottling. Along the lower contact is a 3–4 cm layer of bluish gray (5B 5/4) silty sand.

SMEAR SLIDE SUMMARY

	1-136 (M)	2-15 (M)	2-18 (M)
TEXTURE:			
Sand	–	–	–
Silt	50	50	55
Clay	50	50	45
COMPOSITION:			
Quartz	–	4	5-6
Feldspar	–	15	1
Opaques	–	3	1
Clay	40	70	40
Pyrite	1	2-3	2
Carbonate unspec.	45	–	–
Calc. nannofossils	TR	–	–
Diatoms	5	8-10	50
Silicoflagellates	–	–	2-3
Plant debris	–	4	TR

CARBONATE BOMB: CC: 10%

CORE 22

CORE 22 CORED INTERVAL 104.50–109.25 m

VOID

VOID

En echelon laminae (cross-bedding)

Interlayering of:

1. Two zones of homogeneous moderate olive brown (5Y 4/4) **DIATOM MUD** Section 1, 2–89 cm and Section 1, 120 cm to Section 2, 100 cm. Top 30 cm may be drill disturbed.

2. Two zones of rhythmically laminated couplets of sub-mm-scale moderate olive brown (5Y 4/4) **MUDDY DIATOM OOZE** and pale olive (10Y 6/2) **DIATOM OOZE.** Contacts are transitional. The lower zone shows a downward increase in the frequency and number of thick pale olive laminae. There is a secondary cyclic development on a 5–10 cm scale. At Section 3, 50 cm laminated oozes are discordant, cutting off about 10 couplets. At Section 3, 78 cm: disrupted lamination, partially folded. At Section 3, 116 cm a minor 3-laminae recumbent sharp fold. Strong H_2S odor.

CORE 26

CORE 26 CORED INTERVAL 123.50–128.25 m

VOID
VOID
Light diatomaceous ooze
Dark

Ph
10YR 6/6
Grayish orange clay

VOID

Muddy diatomaceous ooze (redeposition, shallow benthic diatoms)

Sections 1 and 2: uniform, undisturbed sequence of rhymically laminated couplets of pale olive (10Y 6/2) and moderate olive brown (5Y 4/4) **DIATOM OOZE, AND MUDDY DIATOM OOZE.** Couplets very fine ranging from 0.2 mm/pair to 0.5 mm/pair. Thicker mattered "paper"-like diatom layers common; second order cycles on decimeter-scale. Diatom-rich layers are distinctive and relatively thick indications. Higher productivity and/or low terrigenous input. Light layers commonly fragile frustules. Section 3 and Core-Catcher: contact from laminated down to homogeneous sharp. Transitional zone Section 3, 50–60 cm to burrowed homogeneous with zones showing concentrations of phosphatic material and with fish scales.

At Section 2, 52 cm: grayish orange (10YR 6/6) phosphate, nodule, 2 cm, flattened lozenge. Isotropic fine anhedral phosphate.

Strong H_2S odor.

SMEAR SLIDE SUMMARY

	1-83.4 (D) (light)	1-83.6 (D) (dark)	1-137 (M)	2-53 (M)	3-63 (D)
TEXTURE:					
Sand	–	–	–	–	–
Silt	70	45	35	15	55
Clay	30	55	65	85	45
COMPOSITION:					
Quartz	1	4	1-2	2	2
Feldspar	1	1			1
Mica	1	–	–	–	TR
Opaques	TR	1	–	TR	TR
Clay	25	50	–	–	40
Pyrite	< 1	TR	1	1	1
Carbonate unspec.	–	1-2	–	–	3
Foraminifers	–	TR	–	–	2
Calc. nannofossils	–	TR	–	–	8-9
Diatoms	70	40	45	10	40
Radiolarians	–	TR	–	–	TR
Sponge spicules	–	1	–	–	–
Silicoflagellates	1	–	TR	TR	–
Plant debris	–	TR	–	–	–
Rock fragments	–	–	–	–	1
Isotropic phosphate	–	–	53	85	1

CORE 27

CORE 27 CORED INTERVAL 128.25–123.00 m

VOID
VOID
VOID
N5
VOID

1. Rhythmically laminated moderate olive brown (5Y 4/4) **MUDDY DIATOM OOZE** and pale olive (10Y 6/2) **DIATOM OOZE.** Sharp and gradational contacts between laminated zones.

2. Moderate olive brown (5Y 4/4) homogeneous **DIATOM MUD.** In transitional zones, downward from homogeneous to laminated, evidence of burrowing by large animals as dark, homogeneous mottles or splotches which cut laminations or with relic laminated patches.

At Section 2, 50–70 cm: 12 couplets/cm.

13 couplets/cm in Section 3. General downward increasing frequency of thick pale olive laminae.

At Section 2, 105 cm: sub-cm lenses of gray sand and at Section 2, 145 cm scattered bits of wood.

Strong H_2S odor.

CARBONATE BOMB: CC: 0%

CORE 29

CORE 29 CORED INTERVAL 137.75–142.50 m

VOID
VOID
VOID
VOID

Complete core comprises undisturbed regular rhythmic laminations of moderate olive brown **MUDDY DIATOMACEOUS OOZE** and pale olive (10Y 6/2) to dusky yellow brown (5Y 6/4) **DIATOM OOZE** couplets. Some sections extremely finely laminated. Near base of Section 3, numerous very prominent thick diatom ooze-rich pale layers. Several secondary cycles of light to dark on a 10-cm-scale. Strong H_2S odor.

At Section 3, 57 cm: 3 disturbed laminae.

CARBONATE BOMB: CC: 1%

CORE 31

CORE 31 CORED INTERVAL 147.25–152.00 m

FD
FD
FD

Rhythmically laminated moderate olive brown (5Y 4/4) to gray olive (10Y 4/2) **MUDDY DIATOM OOZE** and pale olive (10Y 6/2) to moderate yellow (5Y 7/6) **DIATOM OOZE** couplets. Fade in intensity in some zones parallel with decrease in diatom abundance.

At Section 2, 65–90 cm: small section of grayish olive (10Y 4/2) homogeneous (bioturbated?) **DIATOM MUD** with gradational contact to laminated zones. Strong H_2S odor.

Section 1, 86–101 cm: finger-like, oblique homogeneous sandy intrusion in rhythmites. Upper part homogeneous mud. May be drill disturbance or burrow track.

Section 3: several scattered occurrences of fish/crab debris. One large crunchy pod at Section 3, 84.5 cm.

Section 3, 62 cm: angular discordance in rhythmites. General 10–20 cm secondary cycle of lighter to darker zones.

CARBONATE BOMB: CC: 0%