PROTOCOL DREDGE 31

Cruise No. SO 37	Stat. No. Equipm. 36 DK 05	Location IV	Area E
Date 29.5.1985	Protocol written by : Weber/Commeau		

Pinger on wire 300. m from dredge

	Time GMT	Latit. N	Longit. W	Water depth	Wire length	Tension (t)	Remarks
begin operation	04,51	15°35.26	169°14.52	1558	—	—	
begin lowering	04.55	15°35.24	169°14.55	1559	—	0.2	
+1. bottom contact	05.42	15°35.28	169°14.49	1630	1655	1.5	
	0613	15°35.20	169°14.21	1641	1994	2.8	
	0614	15°35,22	169°14.21	1608	1994	3.2	
	0642	15°35.78	169°14.54	1464	2035	3.2	
	0648	15°35.82	169°14.64	1440	2034	4.0	
	0649	15°35.83	169°14.66	1437	2034	3.6	
	0651	15°35.83	169°14.69	1427	2034	3.4	
	0652	15°35.88	169°14.71	1434	2034	4.2	
	0654	15°35.91	169°14.73	1457	2034	3.9	
	0655	15°35.93	169°14.74	1461	2034	4.2	
	0657	15°35.95	169°14.74	1487	2034	5.0	
	0657	-11-	-11-	1479	2034	7.8	
	0659	15°36.00	169°14.77	1532	2034	3.2	
	0701	15°36.01	169°14.77	1528	2034	4.1	
	0704	15°36.04	169°14.80	1503	2034	3,9	
	0707	15°36.08	169°14.81	1490	2034	4.4	
	0709	15°36.10	169°14.80	1588	2034	4.3	
begin heaving	0713	15°36.14	169°14.76	1588	1984	4.3	
	0715	15°36.15	169°14.74	1589	1928	5.4	
End Bottom Contact	0727	15°36.23	169°14.67	1575	1665	2.3	
begin heaving	0710	15°36.12	169°14.78	1592	2034	2.9	
end heaving	0759	15°36.46	169°14.41	1529	—	.2	
end operation	0813	15°36.56	169°14.28	1529	—	—	

+Corrected data 15°35.80' N 169°13.91' W

ship course ..100°-280°-330-10° calcul. mean water depth.....m

total time of bottom contact 105.min ship velocity..8.kts

bottom topography ..... length of dredge section .....m

Result

200.kg Total

10.kg Nodules

160.kg Substrate

...kg Sediment

S03736DS Station Data 5-29-85

Pinger on wire 300m from dredge

	Time (GMT)	Lat. N	Long W	Water Depth	Wire length	Tension
Begin Operation:	04:51	15°35'26"	169°14'52"	1558	–	–
Begin Lowering:	04:55	15°35'24"	169°14'55"	1559	–	0.2
± Bottom contact:	05:42	15°35'28"	169°14'49"	1630	1655	1.5
Begin heaving:	07:10	15°36'12"	169°14'78"	1592	2034	2.9
End heaving:	07:59	15°36'46"	169°14'41"	1529	–	0.2

ship Course 100° – 0° – 330° – 70°
total time on bottom 105 min
Ship veloc 0.8 kts.

Total dredge recovery – 200 kg.
Total nodules " " – 10 kg.
Total crusts " " – 30 kg.
Total substrats " " – 160 kg.

100% crust coverage
100% talus
no nodules

Thickest crust – 9 cm
Thinnest crust – 1 cm } avge: 3 cm

botryoidal surface topography

2-3 generations of crust, lowest laminar, dense, upper ones dendritic, usually not marked by distinct hiatus (usu. more porous, Fe oxide enriched; some pieces showing a phosphorite layer between generations (dendrite penetrated, 1-2 mm thick) rare, encrusting forams

Photos: 2(?) Biology: corals, bryozoans, sponges

Substrates: AOB(?) hyaloclasite
AOB
AOB/phosphorite/chalk Breccia

ock Type: Alkali Olivine Basalt → do, Hyaloclastite → -do-, -do-

olor: Medium gray (N6) to medium light gray (N7) → Light brown (5YR 6/6) (matrix) to Brownish-gray (5YR 4/1) (cement) → Grayish-orange (10YR 7/4) (overall color)

exture: Intergranular → pyroclastic / clastic

henocrysts: Olivine, ±5%, ±1mm dia → (Framework Grains): AOB hyaloclasts, ±90% (±3 mm dia); AOB volcaniclasts, ±2% (±1 mm dia) → -do-, ±85%, ±2mm avg dia

single, iddingsitized, skeletonized

(Cement) dark, dense Phosphorite, ±8% → ±15%, vastly mixed (nontronite, Mn(O,OH)(?), light & dark phosphorite, zeolites(?) patches throughout the rock)

Average grain size: ±3 mm (range: ±0.5mm — ±7mm) → ±2mm avg dia (range: ±0.5mm — 4mm

roundmass: Plagioclase? Olivine? Pyroxene? Opaques? (not determined)

Average grain shape: angular → -do-

Sorting: moderately poor → -do-

Porosity: high → -do-

Permeability moderately low → -do-

sicles: % ±30% (Varies) (~2 — ~30%)
size: ≤1mm — ±5mm (avge: ~1mm)
shape: round to oval
filling: usually lined w/ zeolites/calcite(?) and/or yellowish-brown smectite

Alteration: complete (smectitization of hyaloclasts, AOB volcaniclasts, oxidation, zeolitization, phosphorization of original coccolith(?) ooze cement, peripheral bleaching of hyaloclasts) → -do-

Remarks: Appears to be the main lithology on Keli Ridge in the 1000-2000m range, certainly in this dredge;

teration: moderate-(oxidation, to extensive smectitization, iddingsitization of olivines, zeolitization(?))

marks: angular cobble-size clasts derived from volcanogenic breccia; most are coated w/ a patina of Fe(OH)(?) w/ superimposed Mn(O,OH)(?); cemented by phosphorized chalk; served as substrate (volcanogenic breccia) for dendritic textured, at least 3-mm-thick ferromanganese crust (heavy on Fe-component) w/ botryoidal surface topography and supertopography; appears to have been possibly erupted as pillow lava.

6DS14

apparently deposited as thin (several centimeters) beds of unstratified-to-crudely-stratified material; characteristic of material from Keli Ridge; this material displays hyaloclasts which are oxidized & smectitized to a golden brown internally and "bleached" (±1mm) peripherally by some iron-stripping alterative activity; the sample in our possession displays essentially flat beds with small irregularities in topography, is floored apparently by AOB phosphorite-cemented volcanogenic breccia and roofed with dense phosphorite, it is a talus clast not outcrop, and is encrusted (nodular) with dendritic, botryoidal

-do-, but finer grained, somewhat better-sorted; curious is the wide variety of cements in this sample: the hyaloclastites are often found in the condition in which they were erupted, i.e. with much open space between hyaloclasts; these are filled in later, by hydrothermal deposits, smectite from low-temperature devitrification of glass, calcareous ooze, ferromanganese deposits; curious that this deposit has all of these and within the space of often only a few mm; our sample is an encrusted talus

Rock Type:	AOB Hyaloclastite	→ -do-	→ -do- (Composite Samples)
Color:	Pale Brown (5YR 6/6)	≠ Dominant Light brownish-gray (5YR 7/1) (Cement) Light Brown (5YR 6/6) (Lenses) Light greenish-gray (5GY 8/1) (matrix)	≠ Pale dusky yellow (5Y 7/4)
Texture:	Pyroclastic	→ -do-	→ -do-
Framework Grains:	AOB Hyaloclasts ±60% ±5mm Open Space, ±15% ±2mm dia	→ do, ±0.75 mm dia. range (no open space)	→ -do-, ±85%; ±3 mm dia. range
Cement:	Smectite (Montmorillonite?) / Zeolites (undiff.) / Manganese oxide?! / Unidentified oxide(s)? } ±20% ±5%	≠ Phosphorite (crystalline apatite?) Smectite Zeolites(?) ±40%	-do-, but separate: Phosphorite; ±5% & w/o zeolites Smectite, ±10%
Large grain size:	±5 mm	≠ ±0.75 mm	≠ ±3 mm
(range:	≤1mm — ±15mm)	≠ (range: ≤0.25mm — ±7mm)	≠ (range: ≤1mm — 10mm)
Large grain shape:	angular	≠ Subangular	≠ angular
Sorting:	poor	→ -do-	→ -do-
Porosity:	extremely high	≠ high	≠ very high
Permeability:	high	≠ low	≠ high
Alteration:	Total (Smectitization, Zeolitization, oxidation)	-do-, oxidation, phosphorization	-do-
Remarks:	Very similar to 36DS2 and 36DS3 (may all be same lithology or at least same eruptive event) much less dense, much more open space between hyaloclasts often lined w/ ±1mm dia euhedra of phillipsite and bodies of Mn(O,OH)?! and unidentified talcose, reddish-brown mineral w/ splendent luster and greenish-brown streak (hard, does not easily powder beyond separating into minute folia); our sample is a rounded clast (talus) encrusted w/ intergrown dendritic and laminar ferromanganese oxide (several thin generations w/ various hiatal) botryoidal	≠ Similar in color to other hyaloclastites thus far described from 36DS, but richer brown (more $Fe(OH)_3$?) in cement); other differences are more striking: the hyaloclasts appear to be "bleached" but apparently not so altered to smectite(?); phillipsite crystals, if present, are very much smaller; matrix: cement ratio varies widely (±90:10 — ±50:50) and ranges from light brown smectite/zeolite mixture to light brownish-gray crystalline apatite?!; much hyalo clast material in the ash range; our sample is a talus clast(?) encrusted with dense dendritic ferromanganese crust (lower cm or so) to porous, lighter dendritic material	≠ Our sample is a talus clast displaying a faint bedding contact and two distinct units: 36DS2 is the most abundant in the clast unbedded and with only a small amount of smectite cement between the hyaloclasts with occasional, variably oriented, millimeter-scale veinlets(?) of crystalline phosphorite (See 36DS7 for description of this adjacent lithology) — the hyaloclasts are "bleached" as in other samples from this site; encrusted w/ ±1 cm thick layer of 1 generation, dendritic (internally), botryoidal (exterior) ferromanganese oxide.

Rock Type: (composite sample) AOB Hyaloclastite	≠ →	AOB Hyaloclastite Breccia	≠ → AOB Hyaloclastite
Color: Pale dusky yellow (5Y7/4)		grayish & yellow (5Y8/4) (matrix)	
		dark yellowish-brown (10YR4/2) (cement)	≠ → pale grayish yellow (5Y9/4)
Fe, e: Pyroclastic	≠ →	clastic	≠ → pyroclastic
Framework Grains: AOB Hyaloclasts, ± 50%, ± 1mm dia	→	-do-, ± 45%, ± 2 mm dia.	≠ Grains & cement altered complete to nontronite? & zeolites?, virtually indistinguishable
Cement: Smectite, ± 50%	→	-do-, , ± 55%	
Average grain size: ± 1mm	≠ →	± 2 mm dia	≠ undetermined
(range: ≤ 0.10 mm — 4mm)	≠ →	(range: ≤ 0.25mm — ± 5mm)	
Average grain shape: angular	≠ →	subangular	
Sorting: poor	→	-do-	
Porosity: high	≠ →	moderately low	≠ → moderately high(?)
Permeability: moderately high	≠ →	low	→ -do-
Alteration: Total (Smectitization, zeolitization, oxidation)	→	-do-	→ -do-, excepting oxidation

Remarks: a lot like 36DS5 but color of cement is darker brown, contrast of grains to cement is sharper and matrix grains are not so much in the ash range. displays marked stratification, almost like graded bedding, in units ± 1cm thick each separated by ≤ 1mm thick deposits of phosphorite. the grain size varies widely both within the respective beds and without.

very similar to 36DS7, but is not bedded, but massive, grain size larger and smectite cement more consistently abundant; our sample is a subrounded talus clast encrusted with dendritic (internal) botryoidal (external) ferromanganese oxide, thickness not determined

Appears to be a sample of hyaloclastite which has been completely converted to smectite (nontronite?) & zeolites(?); "ghosts" of former hyaloclasts only faintly apparent now and then in the rock; perhaps a sample of one of the hyaloclasts from this dredge (i.e. 36DS10) which been either locally or regionally altered by hydrothermal activity.

			36 DS2)
Rock Type:	AOB Hyaloclastite Volcanogenic Breccia	AOB hyaloclastite Volcanogenic breccia	Phosphorized Chalk
Color:	Grayish-orange (10YR 7/4)	very pale orange (10YR 8/2)	very pale orange (10YR 8/2) (fresh break) (weathered and stained dark yellowish orange by Fe(OH)(?) (10YR 6/6))
Texture:	Clastic	-do-	granular
Framework Grains:	AOB Hyaloclasts ± 70% Augite(?) crystals, ± 3% Iddingsite crystals, ± 2%	AOB hyaloclasts, ± 50%, ± 2 cm dia phosphorite clasts, ± 10%, ± 2 mm dia	phosphorized foraminiferal tests (extensively recrystallized)
Cement:	Smectite/Zeolites(?), ± 25%	phosphorite, ± 40%	phosphorite (apatite)
Average grain size:	± 3 mm (range: ≤ 0.10 mm – ± 15 mm)	± 0.5 cm (range ± 1 mm – 3 cm)	≤ 0.10 mm (range < 0.01 mm(?) → 0.25 mm)
Average grain shape:	angular	subangular	round
Sorting:	extremely poor	very poorly-sorted	well-sorted
Porosity:	low	moderately high	moderately low
Permeability:	low	moderately low	very low
Alteration:	Total (Smectitization, zeolitization(?), oxidation)	penultimate (smectitization, zeolitization(?) of hyaloclasts, phosphorization of cement)	extensive (phosphorization of original $CaCO_3$ foraminiferal test component, in filling of much pore spaces w/ apatite)
Remarks:	Has the appearance of being reworked (vastly-different grain sizes, with ash-size component dominating as if hyaloclastite were disaggregated and mixed with ash(?) also, differently-altered components)	forms a ± 2-cm-thick bed, floored by zeolite(?)-veined hyaloclastite + breccia (36 DS 10), with which our sample forms a composite; the volcaniclasts apparently have two different origins: the volcanogenic component volcaniclasts have patinate dendritic ferromanganese oxide coatings; the phosphorite intraclasts are typically dark yellowish-brown (10YR 4/2), extremely dense, crystalline, and angular, without any encrusting deposits, suggesting two separate events mixing two genera of clastic material into foraminiferal chalk. Is floored by thin, patinate, dendritic ferromanganese oxide, which diffuses dendritically down into 36 DS 10, and is roofed by ± 15 mm-thick deposit of dendr[illegible]	recrystallization: Massive phosphorized, recrystallized foraminiferal chalk deposit ≥ 3 m thick capping AOB hyaloclastite 36 DS 2; > 50% replacement by apatite, extensively recrystallized (crystals [apatite?] equant, ≤ 0.01 mm dia); floored and roofed by ferromanganese oxide deposits (lower, which separates 36 DS 12 from 36 DS 2 in our only sample of this material, is a veneer or sooting of dendritic Mn(OOH)(?) [illegible] immobilized, down-diffused in thin dense phosphorite layers which caps 36 DS 2; upper-probably dendritic, Fe-rich, botryoidal manganese crust of unknown [probably several cm] thickness; our sample appears to be manganese-encrusted talus (nodular) and [illegible]

Rock Type: AOB Hyalodastite Breccia

Color: Light greenish-gray (5GY 7/1) to Grayish-orange 10YR 7/4

Texture: Pyroclastic

Framework Grains: AOB Hyaloclasts, ± 75 %, extremely variable grain size

Cement: Smectite / Phosphorite, ± 25%, extremely variable in concentration from place-to-place

Average grain size: not determined

(Range: ± 1mm — 6cm)

Average grain Shape: angular

Sorting: extremely poor

Porosity: Very high

Permeability: Moderate

Alteration: Total (Smectitization, zeolitization(?), Oxidation, phosphorization)

Remarks: Similar in many ways to 36DS6, but appears to be possibly gradational between the parent AOB pillow lava and the more typical hyaloclastite: the interior of the talus clast which composes our sample is nearly solid, glassy (amygdaloidal) palagonite, fractured and veined with smectite and phosphorite and becoming progressively more fragmented and disaggregated (and "bleached") upward toward the encrusting ferromanganese oxide rind: the ferromanganese oxide on our sample is dendritic (internal structure), botryoidal (external structure) with an also botryoidal microtopography, and displays only one generation of growth.

Sample No: S0736DS14

Rock Type: Volcanogenic Breccia

Color: Brown (5YR 4/2) (matrix)
White (N9) cement

Texture: Clastic

Framework Grains: AOB Volcaniclasts (36DS1), ±40%, ±5mm avg dia.

Cement: partially phosphorized(?) foraminiferal chalk, ±60%.

Average grain size: ±5mm

Range: ± 2 mm(?) — 1 cm(?) (perhaps much larger)

Average grain Shape: angular

Sorting: Poor

Porosity: extremely high

Permeability: Very high

Location: Partial (Smectitization, oxidation, zeolitization(?) of matrix; phosphorization(?) of cement)

Remarks: material found adhering to angular clast of AOB (36DS1) which probably represents a volcanogenic sedimentary unit. We obtained no sample of this material save what we found adhering to the AOB clast