PROTOCOL DREDGE

Cruise No. SO 37	Stat. No. Equipm. 5 DK	Location SO-37/1	Area H Titan Seamount
Date 18.05 1985	Protocol written by : Halbach / Herzig		

Pinger on wire 300 m from dredge

siehe tension record

	Time GMT	Latit. ~~N~~ S	Longit. W	Water depth	Wire length	Tension (t)	~~Remarks~~ KURS
begin operation	22.45	23'04	176°04'09	2100	0	0	
begin lowering	22.48	23'04	176°04'09	2100	0	1	
+1. bottom contact	23.23	23'02	176°04'12	2107	2166	2	
	23.31	22'84	176°04'13	1877	2250	2	
Bemerkungen: -	23.35	22'74	176°04'14	1895	2214	2	
	23.49	22'50	176°04'00	2150	2214	5.5	320°
Dredge Boden.	23.56	22'37	176°04'09	2150	2214	6.0	280°
kontakt von	00.00	22'29	176°04'22	2120	2361	2.0	308°
	00.07	22'17	176°04'38	2100	2361	6.0	280°
2100 - 1400 m*	00.19	22'07	176°04'70	1900	2461	3.0	286°
	00.24	22'04	176°04'76	1800	2511	3.0	286°
*echte Tiefe	00.47	21'94	176°05'16	1668	2511	4.6	287°
	00.53	21'93	176°05'20	1600	2506	7.1	310°
	00.57	21.93	176°05'23	1500	2466	8.0	281°
	01.00	21.92	176°05'25	1500	2454	8.5	271°
	01.10	21.92	176°05'26	1400	2434	8.7	299°
	01.31	21.89	176°05'34	1350	2205	5.2	293°
	01.41	21.88	176°05'35	1300	2033	7.1	338°
	01.50	21.93	176°05'28	1300	1600	8.2	
begin heaving	01.45	21.92	176°05'29	1300	1780	3.5	
end heaving	02.22	21.83	176°05'50			1.8	
end operation	02.34	21.79	176°05'73				

+Corrected data 0° 23.26' S 176 4.39' W

ship course 5.0 calcul. mean water depth 1750 m

total time of bottom contact 147 min ship velocity 0.5-1.5 kts

bottom topography steiler Hang length of dredge section 1.2 m Schiffsweg

Result

250 kg Total (bis auf 400 kg geschätzt!) 150 kg Substrate

.... kg Nodules 60 kg Sediment[1] (Konsolidiert z.T.)

5-13-[illegible]

S032 5DK

	GMT	Lat S	Long W	Water Depth	Wire L	Tension
Begin operation:	22.45	0°23'04	176°04'09	2100m	0	0
Lowering:	22.48	0°23'04"	176°04'09"	2100m	0	1
# bottom contact	23.23	0°23'02"	176°04'12"	2107m	2166	2
Begin heaving:	01.45	0°21'32"	176°05'29"	1300m	1780	3.5
End heaving:	02.22	0°21'83"	176°05'50"			1.3
End operation:	02.34	0°21'79"	176°05'77"			
[illegible]	[illegible]	[illegible]	[illegible]			
[illegible]	[illegible]					

Corrected Bearings: 0°23'26" S, 176°4'39" W
Corrected Bathy: 1750m

250 kg total wt.

% talus / % outcrop in 75-30% [illegible]

% crusts in total dredge: ~ 90% 0.5 mm or more

0% nodules

{ thickest crust = 3 cm
{ thinnest crust = 5 [illegible] } 0-30 avge

Surface topography: photographed [illegible]
[illegible]

One generation crust 10% [illegible]
[illegible] Volcanogenic breccia [illegible]

	1	2	3
Rock Type:	Alkali Olivine Basalt	→ do - but w/ Pyroxene	(?) do-, Aphyric, Scoriaceous
Color:	medium dark gray (N4) to Grayish-green (5YR3/1) to medium olive gray (5Y5/1)	Dark gray (N3) to Pale yellowish brown (10YR 6/2)	→ do-
Texture:	Intergranular	→ -do-	→ -do-
Phenocrysts: (Single pcts)	Olivine, ±5 mm dia, ±3% Range: 1-15 mm dia.	→ - do- ± 3 mm dia, ± 5%	Aphyric (rare augite)
		1-5 mm dia.	
		Pyroxene (augite?) ±10%, ± 3 mm dia.	
		→ do - Range: 1-10 mm dia	
Groundmass:	Olivine, Plagioclase, opaques, Pyroxene } not determined	Olivine (much less than 5% pl.), Plagioclase, Pyroxene, opaques } not determined	} - do - ? (beyond resolution)
Vesicles:	% absent (dense) - rare irregular ±5 mm dia vugs.	→ do absent (dense)	30-50%
	filling: empty	→ 2 cm dia	round-oval, ± 1 mm dia
		phillipsite, calcite	empty, rarely calcite
Alteration:	extensive (smectitization, oxidation, hydration, carbonation)	superficial-moderate (smectitization of olivines)	extensive (smectitization, oxidation, zeolitization(?) cross-cut by numerous calcite veinlets)
Remarks:	pebble to boulder-size angular-to-subangular clasts set in several different volcanogenic breccia from this site; primary outcrop probably not exposed; Olivine pxts are generally individual and are skeletonized by smectitization and carbonation (smectite is pale yellow-green, probably saponite); rock is highly fractured, bearing stains of $Fe(OH)_3$ (?) & MnO_2 along the fracture faces; may have all been erupted subaqueously as pillow basalt (numerous pieces bear several mm-thick palagonite zones which grade directly to adhering hyaloclastite; serves as substrate for ±5 mm thick deposits of knobby, wormy single generation Mn-oxide (dendritic type)	→ -do-	→ -do-
		subangular - subrounded	angular
		→ -do-	→ -do-
		→ -do-	→ -do-
		→ -do-	
		iddingsite	
			→ -do-
		contact sharp w/ V.B.'s or presents a weathered laterized upper(?) surface	
		- freshest basalt, this dredge -	→ -do-
			most pieces appear to have been A a - type flows since the lavas are scoriaceous & include fragments of other vesicular - to scoriaceous bas

← may all be related to one volcanic edifice

	4	5	6
Rock Type: Andesite (Hawaiite?)	→ - do -	→ - do -	
Color: (Olive gray 5Y 5/1)	Medium gray (N5)	Light olive gray (5Y 6/1)	
Texture: Intergranular	→ - do - some flow orientation	highly flow-oriented	
Phenocrysts (single pxts) euhedra: Hornblende(?) ± 3 mm dia. avg. 10%	5%, ± 1 mm dia avge	→ do 10%, ± 1 mm dia.	
Augite(?) ± 1 mm dia. avg. 5%	5%, ± 1 mm dia avge	→ do 5%, ± 1 mm dia.	
Plagioclase ≤ 1 mm dia. avg. 3%	4%, ≤ 1 mm dia avge	≠	
Olivine(?) ≤ 1 mm dia. avg. 2%	1%, ≤ 1 mm dia. avge	→ - do -	
Groundmass: Hornblende, Augite, Plagioclase, Olivine, Opaques — not determined	- do -	→ - do -	
Vesicles: % absent (dense)	→ - do -	→ - do -	
Alteration: moderate (Oxidation, smectization, zeolitization)	≠ Slight (oxidation, smectization)	≠ extensive (smectization, oxidation)	
Clasts: pebble-to-boulder-size	→ - do -	→ - do -	
Cubanular clasts set in	≠ subrounded	≠ angular	
hornblende/augite hyaloclastite	→ - do -	→ - do -	
hornblende appears as abundant needles and laths with adamantine luster, angular cleavages, in quite random orientation in the groundmass; plagioclase occurs gravely as small laths or equidimensional prisms; augite occurs as short, stubby eight-sided crystals with rt.-angle cleavages; olivine is rare and then totally altered to whitish $CaCO_3$(?) and skeletonized; exposed (to seawater) surfaces coated with $Fe(OH)_3$(?) grain does not serve as substratum for deposit of MnO_2.	- do -		
	≠ some what flow oriented	≠ highly flow-oriented	
	→ - do -	≠	
	- do -	→ - do -	
	- do -	→ - do -	

← intrusive? (trap?) →

← All have adhering hyaloclastite →

(if apparently the same composition; may represent xenoliths derived from material elsewhere in the volcanic [illegible])

	7	8	9
...ck Type: Andesitic?? Hyaloclastite	→ -do-	→ -do-	
... Moderate yellowish-brown (10YR 5/4) (mean color)	> Yellowish-brown (10YR 5/2) (mean color)	≠	yellowish olive-gray to (mean color 5Y 6/2)
...dividual units quite variable: moderate brown (5YR 4/4) to light brown (5YR 5/6) to Moderate yellowish-brown (10YR 5/4) to Dark yellowish-orange (10YR 6/6)	→ -do- ranging from Olive gray (5Y 4/1) to light olive-gray (5Y 6/1) to moderate brown (5YR 4/4) to dark yellowish-brown (10YR 4/2) to light brown (5YR 5/6) to Moderate yellowish-brown (10YR 5/4) to dark yellowish-orange (10YR 6/6)	≠	grayish-orange (10YR 5/4) impression ... mentioned ... is the new ... frag... w/ Fe OH
...xture: Pyroclastic	→ -do-	→ -do-	
...mework ...rains: Cinder-size andesitic frit clasts (±90%) hornblende crystals	-do- also includes fragments (pebbles gravel) of dense andesite	≠ generally	
...ment: Calcite, zeolites?, ±20%	→ -do-	→ -do-	
...erage Grain Size: ±5 mm	→ -do-	→ -do-	
...erage Grain Shape: subangular	→ -do-	≠ subrounded	
...ting: Moderately poorly-sorted	≠ very poorly-sorted	≠ Moderately poorly sorted	
...sity: Extremely high	→ -do-	→ -do-	
...ability: Moderately low	→ -do-	≠ very high	
...on: Total (Smectitization, zeolitization, Oxidation, carbonation, hydration)	≠ nearly complete except for a few fresher included clasts → -do-	≠ incipient to moderate → -do-	
...erks: Appears to be the most abundant of several varieties recovered by dredging at this station; composed of andesitic, completely altered, glassy glass fragments. Much of the rock is open space (interstices) lined superficially with calcite and zeolites, enough to bind the matrix together. oxidation is the pronounced alteration, though the very abundant hornblende euhedra (±5%) seem unaltered. serves as substrate for patinate MnO_2 deposit & $Fe(OH)_3$?!	→ similar to 5DK7 but with fresher cinders and rock fragments; -do- probably represents the source of dense andesites (hawaiites? mugearites?) found in dredge	→ -do-, but with much fresher material	
	→ ? (not observed on my samples)	≠ Serves as substrate for smoothed, warty (external) veneer - thin ≈ 0.5 mm MnO_2 deposit	

...ample No:	SO3+5 DK 16	SO3+5 DK 11	SO3+5 DK 12/13
...ck Type:	AOB(?) Hyaloclastite	→ -do- (prob. related to 5DK2)	-do- ("Matrix Cement" for V.B. 5DK...
...slor:	Light yellow (5Y 8/6) (mean color)		
...lagonite ...asts)	to Dark reddish-brown (10R 3/4) to Moderate reddish-brown (10R 4/6) to Light brown (5YR 6/4)	→ -do- (larger clasts)	→ grayish-yellow (5Y 8/4) (cement) (mean color) to light brown (5YR 4/4) (matrix clasts)
...exture:	Pyroclastic	→ -do-	→ -do-
...amework ...rains:	ash-Cinder-size AOB frit ~40%	→ Cinder frit, 40-60% avge size, ~2mm	→ ± 25%, ~5mm avge dia.
...ment:	Nontronitic(?) Smectite, ~60%	→ 60-40%	→ -do-, ± 75%
...erage Grain Size:	± 1mm	→ ± 2mm	→ ~5mm
...erage Grain Shape:	angular	→ -do-	→ -do-
...ting:	moderately poorly-sorted	→ moderately-sorted	→ poorly-sorted
...rosity:	Moderately low	→ Low	→ Moderately low
...meability:	very low	→ very low	→ very low
...eration:	Total (smectitization, oxidation, hydation, zeolitization)	→ -do- (palagonitization)	→ -do-
...marks:	Smectitized hyaloclastic tephra developed on surfaces of AOB pillow lava — gradation from pillow lava into dark reddish-brown palagonite (glassy chilled rind on pillow) into fragmental hyaloclastite — demonstrates origin of hyaloclastites quite nicely!; MnO_2 deposit (dendritic, microbotryoidal ~0.5mm thick) observed on one of my samples.	-do-, gradation is obvious	Serves as "cement" for supriaceous basalt like 5DK3 and other volcaniclastics described here as Matrix Cement for Volcanogenic Breccia 5DK13
		serves as substrate for knobby, warty, one-generation, 5mm-thick MnO_2 deposit which displays dendritic growth both internally and as supertopography.	→ ≤0.5mm patinate MnO_2 coating (dendritic)

	13	14	15
Rock Type:	Volcanogenic Breccia	→ -do-	→ -do-
Color:	Yellowish-orange (10YR 7/6) (mean color)	≠ (Matrix) Reddish-brown (10R 3/6) (Cement) Olive-brown (5Y 3/4)	— Moderate brown (5YR ?/
Texture:	clastic / pyroclastic	→ pyroclastic / clastic	≠ → clastic
Framework Grains:	mostly subangular pebbles of 5DK3 composition, other more differentiated species, ~35%	→ basalt clasts AOB, ± related to 5DK1? (±30%, 4 mm, avge range: ±0.5 mm – 4 cm) ≠ palagonite clasts, AOB, related to 5DK1? ±20%, 4 mm avge range: ±1 mm – 1 cm ≠ crystals (euhedra) augite (?) ±5%	AOB fragments (clasts) (related to 5DK1?)
Cement:	See 5DK12	→ avge size: ±2 mm dia. Neutronite?/phillipsite	→ foraminiferal chalk, ±5% phosphorite
Average Grain Size:	±3 cm	→ ±5 mm	→ 1 cm
Average grain Shape:	subangular	→ angular	→ -do- !
Sorting:	poorly-sorted	→ very poorly-sorted	→ -do-
Porosity: / Permeability:	See 5DK12	→ Low	≠ → Moderate
		→ Very low	≠ → Moderate
Alteration:	-do-	≠ intense (oxidation, smectitization, zeolitization)	→ -do-
Remarks:	-do-	→ -None-	→ appears to be monolithologic (AOB) slope debris, (talus), very loosely-cemented, with many creviciform openings between the talus fragments. clasts of the breccia are highly stained w/ $Fe(OH)_3$? and the breccia serves as substrate for thick (2 mm – 8 cm) knobby, warty, extend to laminar-dendritic (cyclical) one generation crusts of Mn

	16	17	18
ock Type: Volcanogenic Breccia	→ -do-	→ -do-	
olor: Pale greenish-yellow mean color. (10Y 9/2)	Very pale orange (10YR 9/2)	≠ Yellowish-gray (5Y 7/2)	
exture: clastic	→ -do-	→ -do-	
ame work rains: 1.) AOB intraclasts (prob. related to 5DK 2) (pX/ol AOB) Avge size: ~5mm – 4cm (1cm avg) Abundance: ±10%. 2.) AOB hyaloclastite clasts → -do- Avge size: ~5mm Abundance: ~10%.	-do-, but ~25% AOB clasts	→ -do-	
ment: Coccolith(?) chalk, ±50%.	-do-, but ~65% chalk,	≠ ~50% chalk	
atrix: AOB sand, ±5%. AOB hyaloclastite sand, ±25% (related to 5DK14)	→ ±10% volcanic ash(?)	≠ ~25% tephra	
age Grainsize: ±2mm (range: ±0.10mm – 4cm(?))	→ -do-	→ -do-	
ge grain shape: Subangular	→ -do-	→ -do-	
t. g: Very poorly-sorted	→ -do-	→ -do-	
rosity: Moderately high	≠ ± Very high	→ -do-	
rmeability: Low	≠ ± Low	→ -do-	
teration: Superficial (phosphorization, zeolitization)	→ -do-	→ smectitization	
arks: cobble-to-boulder-size clasts dislodged from outcrop by dredge; apparently developed on Volcanogenic breccia 5DK 14 as several pieces are in contact with this breccia and have it adhering to them; both the matrix ~~intra~~clasts and fragments of the nontronitic cement of 5DK 14 are incorporated into this breccia, the nontronite tinting the coccolith(?) chalk cement of 5DK 16 green; surface of this breccia unit is, in turn, covered thinly (2-5 mm) with coccolith chalk which is, in turn covered with a patina of $Fe(OH)_3$(?) & MnO_2	-do- Similar to 5DK 16, but lacking the nontronite and AOB hyaloclastite intraclasts; appears to be developed on (& includes material from) a more tephra-rich breccia (5DK 18); serves as substrate for ±5mm-thick one generation dendritic growth (internally), knobby, warty MnO_2 crust w/ finely cuspate supertopography	≠ -None-	

Missing

	19	20	21
hock Type:	Volcanogenic Breccia	Phosphorized Chalk	Coquina Limestone
Color: (m color)	Very pale yellowish-orange (10YR 9/6)	very pale orange (10YR 9/2) to	very pale yellowish-orange (10YR 9/6)
e, ure:	Clastic	granular	Clastic
Framework Grains:	Andesite clasts 20–40% (extremely variable) Shell debris, 40–60%. Interstices, ± 15%	foraminiferal tests, ≤100%	-do- ±25% ≤1mm dia Shell fragments, ±20%, ±3mm dia avg pellets, ±45%, ±2mm dia avg algal mat fragments(?) ±10%, ±5mm dia andesite fragments, <1%, ±2mm dia avg
ment:	Calcite, recrystallized, ±5%	-do- & inhomogeneous apatite	calcite (matrix material apparently held together by CaCO3 dissolved from itself and then recrystallized
verage Grain Size:	~0.5 cm (range: ±1mm–3cm)	≤0.20 mm	± 2 mm
verage Grain Shape:	subangular	round	
orting:	Very poorly-sorted	Very well-sorted	moderately poorly-sorted
Porosity:	Extremely high	varies between dense and porous varieties (~40–95%)	Extremely high
rmeability:	Very high	-do- (~10–100%)	Extremely high
teration:	superficial (solution, recrystallization of calcite; deposition of $Fe(OH)_3$? by downward diffusion from overlying ferromanganese crust.	Superficial (phosphorization of calcite, penetration by remobilized $Fe(OH)_3$(?) & $Mn(OOH)$)	superficial (solution, redeposition, recrystallization of calcite in matrix components
emarks:	Cobble-to-boulder-size clasts broken from outcrop by dredge, composed largely of lagoonal-type shallow water carbonate debris (shells, pellets(?), oolites(?), corals, bryozoans, sponges, algal mats(?), etc. and volcaniclastics. serves as substrate for ±5mm-thick one generation, dendritic (internal morphology), knobby warty (external morphology) ferromanganese crust with coarsely nodose supertopography; ~30% of the knobs display effects of current scouring and are polished. Calcareous material is stratified, and one piece (5DK19b) displays a ± 2cm thick bed of much denser, volcaniclastics-poorer description (Only ~7%)	Very angular pebble-to cobble-size clasts broken, apparently, at some time before being collected by dredging (few surfaces are without Fe, Mn deposits) Most pieces are intensely penetrated with tubular bore-holes (worms, clams?); these serve as conduits for passage of seawater and most are lined with apatite, either as a shiny varnish-like deposit, and subsequently, $Fe(OH)_3$(?) and $Mn(OOH)$(?); in section, phosphorization may be seen as an aureolic development peripheral to the walls of the conduits and on surfaces once exposed to seawater; two types of this deposit are recognized: (a) porous, friable, light-weight, and highly penetrated with tubes; (b) denser, less porous, recrystallized, more replaced by apatite, less penetrated by tubes; surfaces exposed to seawater as outcrop	Cobble-size subangular clasts, perhaps dislodged from unexposed outcrop by dredge (no Fe or Mn deposits anywhere); faint stratification apparent — probably deposited in a lagoonal environment or on a submarine shallow terrace related to 5DK19, but cleaner, w/o the volcaniclastic material.

	22	23	24
		Biotite Monzonite ?	Biotite Diorite ?
Rock Type:	Foraminiferal Chalk		
Color:	White (N9)	Dark greenish-gray (5GY 3/1)	→ -do-
Texture: Framework:	granular foraminiferal tests ± 99% ± 0.10 mm dia.	granitic equigranular (Phenocrysts) - Absent -	Gabbroic granular Hornblende? (Totally altered to biotite ± 50%, 3 mm avge dia.
Matrix:	foro Manganese micronodules ≤ 1% ≤ 0.10 mm dia.	(Groundmass) Plagioclase ± 30% Biotite ? ± 30% Hornblende ? ± 10% Augite (?) ± 10% K-feldspar ± 20%	Plagioclase, ± 50%, ± 2 mm dia.
Cement:	Probably lacking (rock is very soft and friable)		
Average grainsize:	≤ 0.10 mm	± 2 mm	
Average grainshape:	round		
Sorting:	Very well-sorted		
Porosity:	Extremely high		
Permeability:	Extremely high		
Alteration:	lacking (phosphorization?) negligible	Slight (oxidation, smectitization (?))	Intense (Biotitization of amph.; kaolinization of feldspar?)
Remarks:	Pebble-to-cobble-size fragments dislodged by dredge from outcrop, very similar in aspect to the phosphorized chalks (5DK20) but much less indurated, much more permeable and porous; penetrated by boring, burrowing animals (worms? clams?) making the rock cavernous, like 5DK20 (generally to a smaller and less diversified extent) The tube walls which penetrate the rock are stained slightly w/ $Fe(OH)_3$ (?), coloring them brownish-orange.	Single large cobble, 14 cm x 11 cm x 8 cm, subangular, loosened from hyaloclastite 5DK8, probably; possibly represents a loosened fragment of wall-rock from within the volcano or a fragment (xenolith) derived from a differentiated magma chamber below the volcano. the evenness of the grainsize indicates formation in a stable environment, free from influxes of fresh magma from other sources probably erupted subaqueously along with the hyaloclastite as a xenolith.	2, large pebble-size xenoliths from. → -do-, except this one appears to have been affected by entry of K-rich fluids (biotite coronas on amphibole)