Dredge 6

L5-83-HW — Submitted as (Job BW07)

D18-B3-

D18-B3-5AB	I	0-6 mm	6.6 gm	from REE samples combined D18-B3-5A & D18-B3-5
D18-B3-5CD	II	6-12 mm	2.6 gm	(combined " " 5C & " " -5
D18-B3-5EF	III	12-18 mm	2.1 gm	(combined " " 5E & " " 5F
D18-B3-5GH	IV	18-24 mm	5.6 gm	" " " 5G & " " 5H
D18-B3-5IJ	V	24-30 mm	2.2 gm	" " " 5I & " " 5J
D18-B3-5KL	VI	30-36 mm	3.4 gm	" " " 5K & " " 5L
D18-B3-5MN	VII	36-42 mm	2.4 gm	" " " 5M & " " 5N
D18-B-3-50		42-45 mm	1.1 gm	not submitted, as far as I can tell JEG.

D6-A1-

D6-A1-AB	I	0-6 Mm	2.1 gm	From REE Samples combined D6-A1-A & D6-A1-B
D6-A1-CD	II	6-12 mm	2.3	" " " -C & D6-A1-D
D6-A1-EF	III	12-18 mm	3.1 gm	" " " E & " " F
D6-A1-GH	IV	18-24 mm	6.12 gm	" " " G & " " H
D6-A1-IJ	V	24-30 mm	6.31 gm	" " " I & " " J
D6-A1-KL	VI	30-36 mm	8.61 gm	" " " K & " " L
D6-A1-MN	VII	36-42 mm	3.60	" " " M & " " N
D6-A1-O	VIII	42-45 mm	3.80	

Sample Description

Cruise I.D: L5-83-HW

Sample I.D: Sta: D6-A1

Location: Norfolk Ridge

Size: 21x17x7cm Weight: 2.3Kg

Mn crust thickness:

Total: min: 4.1cm max: 5cm ave:

Inner crust: min: 8mm max: 11mm ave: 9mm

Outer crust: min: 3.2 max: 3.8 ave: 3.5cm

Surface texture: Very smooth

Internal structure:

layered: ✓ 2

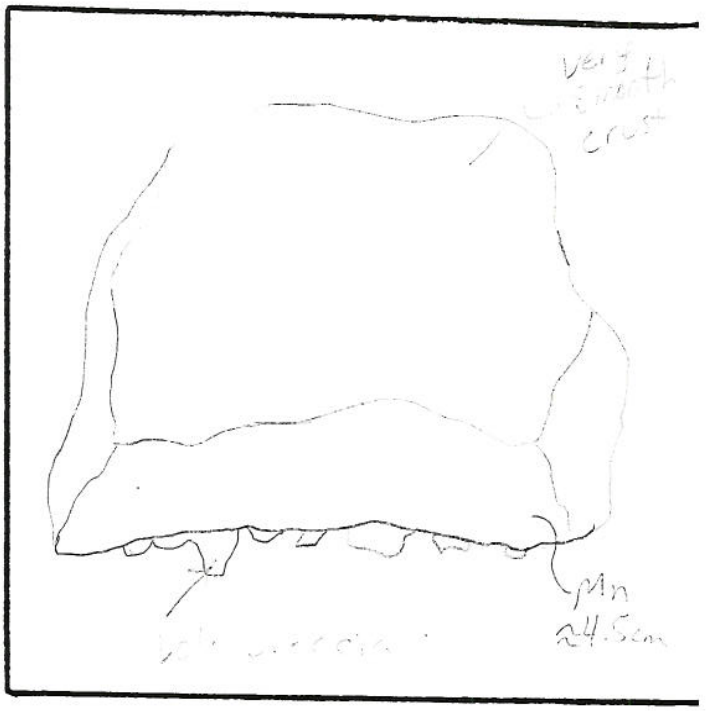
laminated: ✓

massive:

porous:

dendritic:

other:



Mineralogy (XRD):

Associated alteration, phosphorite, or hydrothermal deposits:

heavy Fe oxide staining inside crust & phosphorite infilling in inner crust just above breccia

Substratum: not much, only 1-3cm thick

Rock type: Vole. breccia

Description: Mn crust covers 3 sides & part of bottom. Crust is porous on bottom; Poorly sorted (1mm-2cm), sub-angular, altered, vole clasts

Mineralogy (XRD):

Analyses and subsamples:

analysis:	Mn crust: Min	Max	analyst:
Slabbed for paleoceanography study			REE, sampled on a 3mm interval
1)	4.3	5.0 cm	
2)	4.0	4.8cm	D6-A1 A 0-3mm
3)	3.9	4.8 cm	D6-A1 B 3-6mm
4)	3.8	4.6cm	D6-A1 C 6-9mm
5)	4.1	5.2cm	" " D 9-12mm
6)	4.0	4.8cm	" " E 12-15mm
7)	3.8	4.8cm	" " F 15-18mm
XRD			" " G 18-21mm
Chemistry			" " H 21-24mm
δ p.t.s.			" " I 24-27mm
Os isotopes			" " J 27-30mm
δ¹³C extraction			" " K 30-33mm
			" " L 33-36mm
			" " M 36-39mm
			" " N 39-42mm
			" " O 42-45mm

All of the above crust [illegible] combined to 6mm [illegible]

Samples were

Sampled again for Neodymium isotopes at Scripps [illegible] 0-45mm 13 samples

Sample Description

Cruise I.D: L5-83-HW

Sample I.D: Sta: D6-A1

Location: NeckerRidge

Size: 28x16x7cm Weight: 3.49 Kg

Mn crust thickness:

Total: min: 2.5 max: 5.0 ave: 3.5cm

Inner crust: min: max: ave: 2.5cm

Outer crust: min: max: ave: 2 cm

Surface texture: smooth

Internal structure:

layered: ✓ (in some areas)

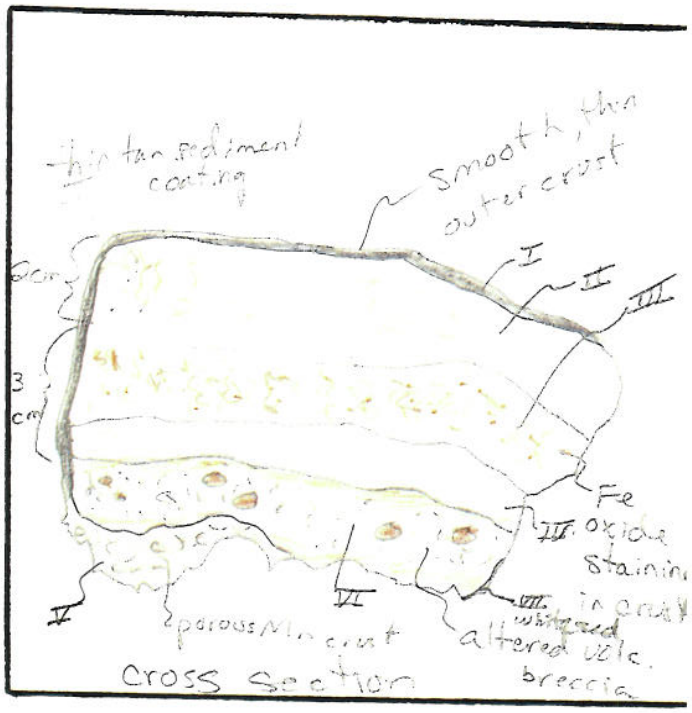
laminated:

massive: ✓

porous:

dendritic:

other:



Mineralogy (XRD):

Associated alteration, phosphorite, or hydrothermal deposits:

Brown phosphorite coating

Fe oxide staining in crust & substratum

Substratum:

Rock type: Volcaniclastic sandstone or breccia

Description: Thick smooth massive crust on top, porous thin crust on part of bottom; Highly altered orange & green pebbles (1mm-1cm), dotted w/ Mn pebbles, a little white & tan soft sediment. Mn around a lot of the clasts & in the crevices

Mineralogy (XRD):

Analyses and subsamples:

analysis:	analyst:
XRD	C. Daniel
I outer crust (0-2mm)	
II inner layer (2-20mm)	
III 3rd " (20-25mm)	
IV 3rd layer (25-30mm)	
V porous Mn bottom	
VI breccia	
VII white sed	

Sample Description

Cruise I.D: L5-83-HW

Sample I.D: Sta: D6-A1

Location: Decker Ridge

Size: ~6x8x4 cm Weight: _____

Mn crust thickness:

Total: min: _____ max: _____ ave: _____

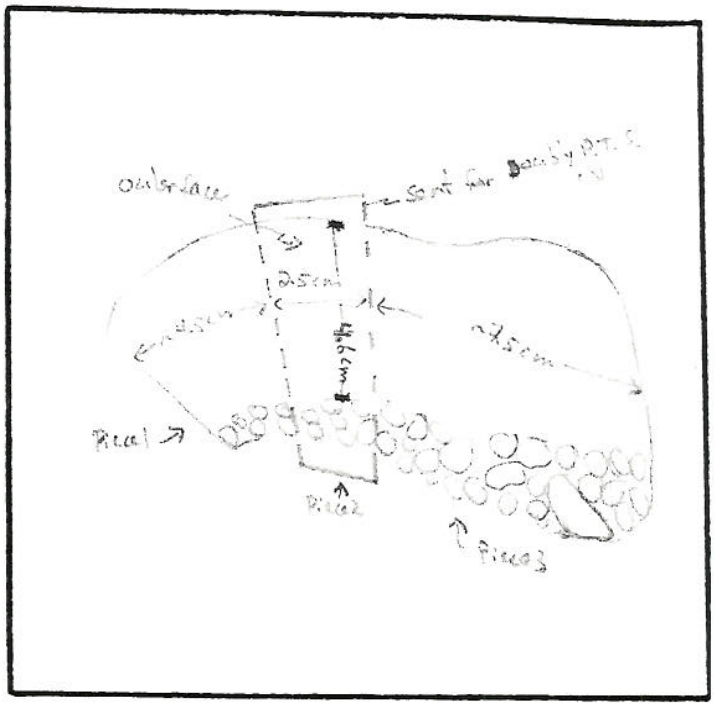
Inner crust: min: _____ max: _____ ave: _____

Outer crust: min: _____ max: _____ ave: _____

Surface texture: _____

Internal structure: _____

layered: _____
laminated: _____
massive: _____
porous: _____
dendritic: _____
other: _____



Mineralogy (XRD): _____

Associated alteration, phosphorite, or hydrothermal deposits: _____

Substratum:

Rock type: _____

Description: _____

Mineralogy (XRD): _____

Analyses and subsamples:

analysis:	analyst:
Doubly P.T.S.: The face of Piece 2 was sent to Rudolf Von Huene to make the D.P.T.S. suitable for microprobe on a 1"x3" slide. T.S. was made of the outer face, see diagram. Do microprobe analysis across 4.6cm transect between outer surface & substrate.	

Sample Description

Cruise I.D: L5-83-HW

Sample I.D: Sta: D6-A-2

Location: Necker

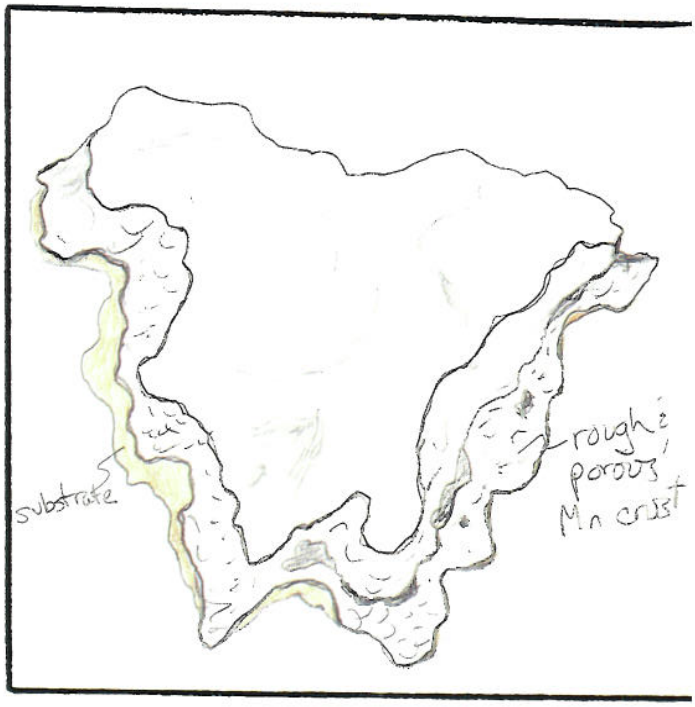
Size: 30x25x10cm Weight: 4.92 kg broken & cut

Mn crust thickness:

Total: min: 1mm max: 12mm ave: 4mm

Inner crust: min: max: ave:

Outer crust: min: max: ave:



Surface texture: porous & rough

Internal structure:

layered:
laminated:
massive: ✓
porous:
dendritic:
other:

Mineralogy (XRD):

Associated alteration, phosphorite, or hydrothermal deposits:

Fe oxide staining

Substratum:

Rock type: volc. breccia

Description: thin Mn crust on top volc. clasts which are altered &/or phosphatized white to tan phosphate matrix. Clasts range from 0.5 to 9cm

Mineralogy (XRD):

Analyses and subsamples:

analysis:	analyst:
XRD:	C. Daniel
I substrate composite	
II crust bulk (0-12mm)	
chemistry substrate	U.S.G.S.
density	C. Daniel

LS-83-HW

D6-A-2

Sample Description

Cruise I.D: L5-83-HW

Sample I.D: Sta: D6-A3

Location: Necker Ridge

Size: 20x12x10cm Weight: ~2.42kg

Mn crust thickness:

Total: min: 2cm max: 3.5cm ave: 3cm

Inner crust: min: 1.5 max: 2.5 ave: 2cm

Outer crust: min: 1cm max: 2cm ave: 1cm

Surface texture: Smooth to flakey

Internal structure:

layered: ✓ 2

laminated:

massive: ✓

porous:

dendritic:

other:

Mineralogy (XRD):

Associated alteration, phosphorite, or hydrothermal deposits:

Substratum:

Rock type: Basalt

Description: Gray to brown angular, highly fractured basalt coated in glazes with a white slightly calcareous silty sediment. Minor Fe oxide staining. Also slightly mottled w/ Mn

Mineralogy (XRD):

D6-A3

Analyses and subsamples:

analysis:	analyst:
Pt group (12/86)	Floyd Brown

Sample Description

Cruise I.D: L5-83-HW

Sample I.D: Sta: D6-A5-1

Location: Necker Ridge

Size: 30x20x9cm Weight: ~3.7 Kg

needs to be cut

Mn crust thickness:

Total: min: max: ave: 4cm

Inner crust: min: max: ave: 3cm

Outer crust: min: max: ave: 1cm

Surface texture: Smooth w/tiny botryoids (flakes off in sheets of botryoids)

Internal structure:

layered: ✓ ?

laminated:

massive:

porous:

dendritic:

other: botryoidal

D6-A5-1

Mineralogy (XRD):

Associated alteration, phosphorite, or hydrothermal deposits:

Fe oxide staining in crust

Substratum: very little

Rock type: Volc. breccia

Description: Orange to gray highly altered, vesicular, angular poorly sorted, basalt clasts in white, phosphatized matrix

Mineralogy (XRD):

Analyses and subsamples:

analysis:

analyst:

Sample Description

Cruise I.D: L5-83-HW

Sample I.D: Sta: D6-A5-2

Location: Necker Ridge

Size: 28x22x12 cm Weight: ~4.3 Kg

Mn crust thickness:

Total: min: 4mm max: 2cm ave: 1.2cm

Inner crust: min: max: ave:

Outer crust: min: max: ave:

Surface texture: Botryoidal-Smooth (w/cavities & depressions)

Internal structure:

layered:
laminated:
massive:
porous: ✓ w/ Fe oxide staining
dendritic:
other:

D6-A5-2

Mineralogy (XRD):

Associated alteration, phosphorite, or hydrothermal deposits:

Substratum:

Rock type: Volc. Breccia

Description: Highly altered angular orange, red gray basalt clasts (1-5cm size) poorly sorted & loosely packed w/ phosphorite clasts, (1-6cm size) a few have Mn dendrites in a phosphatized silty(?) sediment & Mn matrix. The gray-green basalt(?) clasts are altered to clay w/ orange phenocrysts of olivine(?) altered to addingsite.

Mineralogy (XRD):

Analyses and subsamples:

analysis:

analyst:

Sample Description

Cruise I.D: L5-83-HW Sample I.D: Sta: D6-A5-3 Location: Necker Ridge

Broken

Size: _____ Weight: 2.52 kg

Mn crust thickness:

Total: min: ____ max: ____ ave: 3cm

Inner crust: min: ____ max: ____ ave: 1.5cm

Outer crust: min: ____ max: ____ ave: 1.5cm

Surface texture: Rough & slightly botryoidal

Internal structure: _____

layered: ✓ 2
laminated:
massive:
porous:
dendritic:
other:

Mineralogy (XRD): _____

Associated alteration, phosphorite, or hydrothermal deposits:

Fe oxide staining on crust & substrate
phosphorite coating

Substratum:

Rock type: Basalt

Description: Thick Mn crust on top; gray altered basalt coated with Fe oxide/white phosphorite? sediment. Also vein of phosphorite

Mineralogy (XRD):

D6-A5-3

Phosphorite Studies

Analyses and subsamples:

analysis:	analyst
XRD:	C. Dan
I Substrate composite	
II outer crust (~1.5cm)	
III inner crust (1.5-3cm)	
Chemistry-Substrate	U.S.G.S.
Density	C. Daniel
35 mm slide 6/29/90	G. Smith

D6-A5-3

Sample Description

Cruise I.D: L5-83-HW Sample I.D: Sta: D6-AS-4 Location: Necker Ridge

2 broken pieces (in separate bags)
Size: 18x12x12cm Weight: ~2.5 kg
13x10x8cm (has been cut)

Mn crust thickness: (7cm) (6cm) (smaller)
Total: min: 1.5cm (5cm) max: 2.5cm ave: 2cm → larger rock

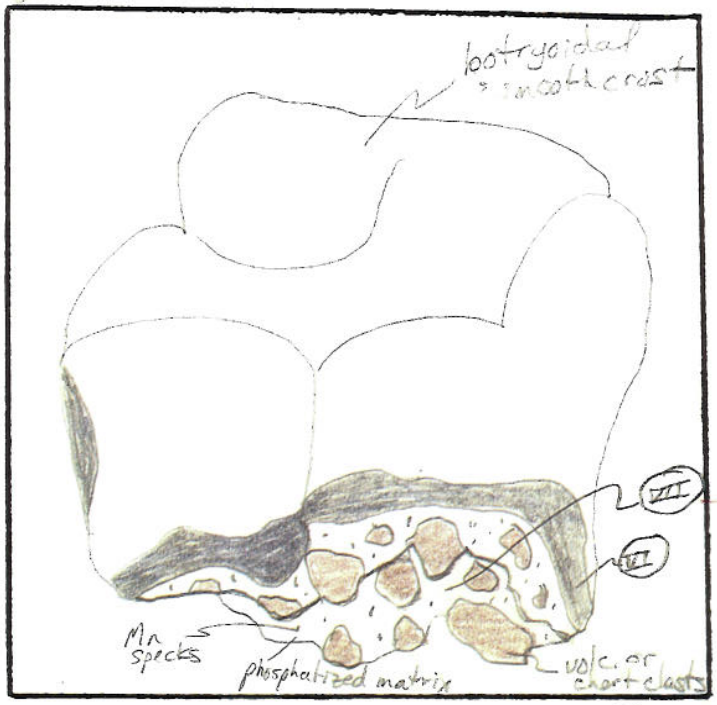
not sure if they go together. Smaller one has thick crust no substrate the other has thinner crust w/ substrate

Inner crust: min: (2cm) max: (4cm) ave: (3cm)

Outer crust: min: (2.5cm) max: (3.5cm) ave: 3cm

Surface texture: Smooth (smaller rx)
Botryoidal & smooth (larger rx)

Internal structure:
- layered: ✓ ~2–3 } smaller rock
- laminated: ✓
- massive: ✓ larger
- porous: ✓ more larger of smaller rx
- dendritic:
- other:



larger rock
Smaller rock pic. on back

Mineralogy (XRD):

Associated alteration, phosphorite, or hydrothermal deposits:

Substratum:

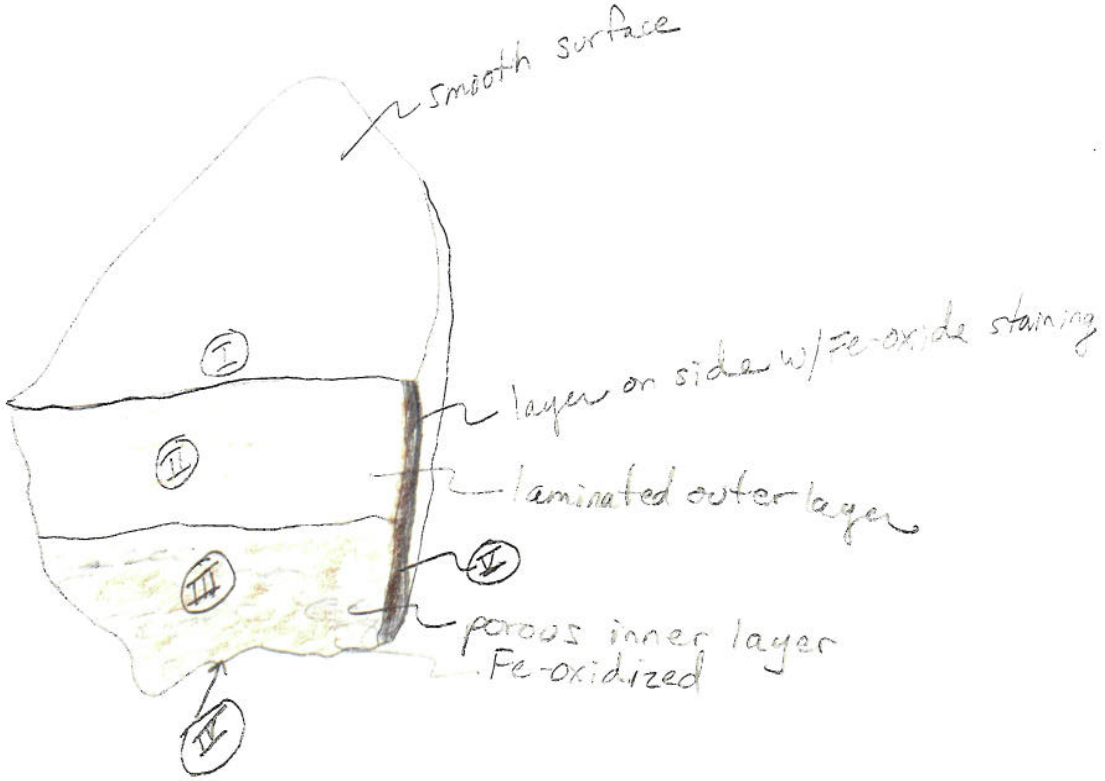
Rock type: Phosphatized Volc. Breccia ?

Description: Altered angular large (1-3cm) cherty (?) or volcanic (?) clasts loosely packed in a silt to gravel sized phosphatized white matrix speckled w/ Mn.

Mineralogy (XRD):

Analyses and subsamples:

analysis:	analyst:
XRD (smaller rx)	C Daniel
I sfc: 0-.5cm Mn	
II outer layer ~3cm	
III inner " 3-5cm	
IV porous bottom or substrate?	
V side layer Mn	
VI bulk Mn (larger rx)	
VII bulk substrate	
Pt group (12/86)	Floyd Bowser


smooth surface
I
II
III
IV
V
layer or sides w/ Fe-oxide staining
laminated outer layer
porous inner layer
Fe-oxidized

L5-83-HW
D6-A5-4

L5-83-HW
CM
D6-A5-4

Sample Description

Cruise I.D: L5-83-HW

Sample I.D: Sta: D6-A5-5

Location: Necker Ridge

Size: Broken 2 pieces

Weight: 28 kg

Mn crust thickness:

Total: min: max: ave: 2 cm

Inner crust: min: max: ave:

Outer crust: min: max: ave:

Surface texture: Botryoidal - rough & porous

Internal structure:

layered:
laminated:
massive: ✓
porous:
dendritic:
other:

Mineralogy (XRD):

Associated alteration, phosphorite, or hydrothermal deposits:

[illegible]

Substratum:

Rock type: Vole Breccia
not much substratum ~ 2cm thick

Description: Highly altered orange sub-angular to sub-rounded poorly sorted (1mm - 1.5cm) closely packed clasts in a tan silty sand matrix. Some white, silty calcareous sediment packed in bottom of rock

Mineralogy (XRD):

L5-83-HW
D6-A5-5

Analyses and subsamples:

analysis:	analyst:

Sample Description

Cruise I.D: L5-83-HW

Sample I.D: Sta: D6-15-5

Location: Necker Ridge

Size: 20x20x12cm Weight: 2.8 Kg

Mn crust thickness:

Total: min: 0.5cm max: 3.4cm ave: [illegible]

Inner crust: min: 3mm max: 1.8cm ave: 1cm

Outer crust: min: 3mm max: 1.8cm ave: 1cm

Surface texture: Botryoidal-rough & porous

Internal structure:

layered: ✓ 2

laminated:

massive: ✓ inner

porous: ✓ outer

dendritic:

other:

L5-83-HW

D6-~~A5-6~~ A5-6

Mineralogy (XRD):

Associated alteration, phosphorite, or hydrothermal deposits:

Peroxide staining

Substratum:

Rock type: Volc Breccia

Description: Extremely altered orange sub-rounded poorly sorted clasts (1-12mm) in a yellow well indurated sandy matrix (of altered glass?)

Mineralogy (XRD):

Analyses and subsamples:

analysis:	analyst:

Sample Description

Cruise I.D: L5-83-HW Sample I.D: Sta: D6-A5-7 Location: Necker Ridge

Size: _____ Weight: 2.15 kg

Mn crust thickness:

Total: min: 0.6cm max: 3.5cm ave: 3cm

Inner crust: min: .4cm max: 2cm ave: 1.5cm

Outer crust: min: .2cm max: 1.5cm ave: 1cm

Surface texture: Porous to Abraded smooth

Internal structure:

layered: ✓ ✓
laminated:
massive: ✓
porous: ✓
dendritic:
other:

Mineralogy (XRD):

Associated alteration, phosphorite, or hydrothermal deposits:

Fe oxide staining

Substratum:

Rock type: Volcaniclastic Breccia
1 Basalt w/thin (1-2mm) coating of Mn

Description: Highly altered orange sub-rounded volc clasts (.3-3cm) in yellow to tan silty-sand matrix w/some phosphate & a little white calcareous sediment.
Basalt is altered grey-brown & vesicular

Mineralogy (XRD):

L5-83-HW
D6-A5-7

Analyses and subsamples:

analysis:		analyst:
Mn crust chem. (Reston) and REE (Denver)		Jung-Keuk Kang 6/88 Job# BZ88
I 0-5 mm	5 gm (CC)	
II 5-8 "	2 " "	
III 8-14 "	7 " "	
IV 15-28 mm	6 " "	

hard substrate sluice

Sample Description

Cruise I.D: L5-83-HW Sample I.D: Sta: D6-AS-8 Location: Necker Ridge

Size: Broken Weight: 3.26 kg

Mn crust thickness:

Total: min: 1cm max: 3cm ave: 2.5cm

Inner crust: min: max: ave:

Outer crust: min: max: ave:

Surface texture: Botryoidal rough porous

Internal structure:

layered: ✓ ?
laminated:
massive: x
porous: x
dendritic:
other:

Mineralogy (XRD):

Associated alteration, phosphorite, or hydrothermal deposits:

Substratum:

Rock type: Volc. Breccia

Description: Same as D6-AS-5 except part of rock is phosphatized.

Mineralogy (XRD):

L5-83-HW
D6-AS-8

Analyses and subsamples:

analysis:	analyst:
XRD:	C. Daniel
I Substrate composite	
II outer crust	
III inner crust	
Chemistry substrate	

Sample Description

Cruise I.D: L5-83-HW

Sample I.D: Sta: D6-A5-9

Location: Vicker Ridge

Size: Bag of small broken pieces

Weight: 800g

Mn crust thickness:

Total: min: max: ave: 5cm

Inner crust: min: max: ave: 1cm

Outer crust: min: max: ave: 1cm

Surface texture: Botryoidal - rough & porous

Internal structure:

layered: ✓

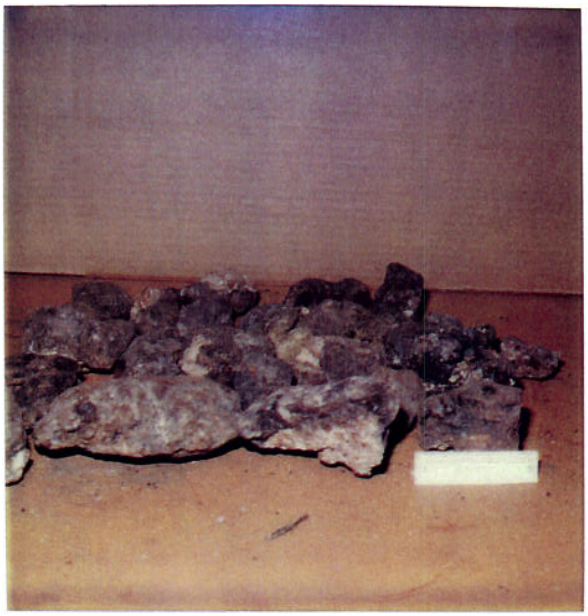
laminated:

massive: ✓

porous: ✓

dendritic:

other:



~~L5-83-HW~~ L5-83-HW

D6-A5-9

Mineralogy (XRD):

Associated alteration, phosphorite, or hydrothermal deposits:

Substratum:

Rock type: Volc. Breccia

Hardly any substratum ≈ 1cm thick

Description: Same as D6-A5-5

Some pieces are all Mn crust upon substratum

Mineralogy (XRD):

Analyses and subsamples:

analysis:	analyst:

Sample Description

Cruise I.D: L5-83-HW Sample I.D: Sta: D6-A5-10 Location: [illegible]

4) "different" rocks: [illegible]

Size: 1) 11x8x5cm 2) 10x8x8cm 4) 17x[illegible]x9cm Weight: 350g

Mn crust thickness:

Total: min: [illegible] max: [illegible] ave:

Inner crust: min: max: ave:

Outer crust: min: max: ave:

Surface texture: Botryoidal to abraided smooth

Internal structure:

layered:
laminated:
massive:
porous: ✓
dendritic:
other:

Mineralogy (XRD):

Associated alteration, phosphorite, or hydrothermal deposits:

Substratum:

Rock type: Volcaniclastic Breccia #1, 3, 4
Basalt #2

Description: Basalt - green-brown, vesicular, phosphatized? w/ tan silty sediment coating; Breccia - altered orange, sub-rounded large (up to 10cm) clasts cemented together w/ smaller (.5-2cm) clasts & phosphate? Mn

Mineralogy (XRD):

L5-83-HW
D6-A5-10

Analyses and subsamples:

analysis:	analyst:

Sample I.D: Sta: D6-B1

Size: _____ Weight: 6.7 Kg

Location: Necker

Mn crust thickness:

Total: min: 2mm max: 2cm ave: 1.5cm

Inner crust: min: 5mm max: 1cm ave: .8cm

Outer crust: min: .5cm max: 1.2cm ave: 1cm

Surface texture: porous to abrasion smooth

Internal structure:

layered: ✓ 2

laminated:

massive: ✓

porous:

dendritic:

other:

Mineralogy (XRD):

Associated alteration, phosphorite, or hydrothermal deposits:

Fe oxide stains of clasts & worm tubes (?) in crust

phosphate veins in crust

Substratum:

Rock type: volc breccia

Description: Mn crust on [illegible]

Altered red orange brown yellow & gray sub-rounded volc. clasts (1-2.5cm) several rimmed w/Mn & 1 clast of breccia in white & gray phosphate & Mn matrix

Mineralogy (XRD):

L5-83-HW

D6-B1

Analyses and subsamples:

analysis:	analyst:
XRD inner & outer	Rosemary ?

Sample Description

Cruise I.D: L5-83-HW

Sample I.D: Sta: D6-B2

Location: Nodes

Size: 32x17x12cm Weight: 4.257 Kg

Mn crust thickness:

Total: min: 2 max: 1.5 ave: .3cm

Inner crust: min: max: ave:

Outer crust: min: max: ave:

Surface texture: Botryoidal - rough & porous

Internal structure:

layered:
laminated:
massive: ✓
porous:
dendritic:
other:

Mineralogy (XRD):

Associated alteration, phosphorite, or hydrothermal deposits:

Fe-oxide staining in crust

Substratum:

Rock type: Volcaniclastic Breccia

Description: Altered orange-tan Sub-rounded poorly sorted (2mm-4.5cm) vole. clasts in white phosphate & Mn matrix. Large (.5-1cm wide) fracture thru center of rock.

Mineralogy (XRD):

L5-83-HW
D6-B2

Analyses and subsamples:

analysis:	analyst:

Sample Description

Cruise I.D: L5-83-HW Sample I.D: Sta: D6-B3-1 Location: Necker Ridge

Size: ≈ 13x10x4cm Weight: <100g

Bag of broken pieces + one 9x7x7cm piece of botryoidal Mn

Mn crust thickness:

Total: min: ____ max: ____ ave: 2mm

Inner crust: min: ____ max: ____ ave: ____

Outer crust: min: ____ max: ____ ave: ____

Surface texture: Rough & porous

Internal structure:

layered:
laminated:
massive: ✓
porous:
dendritic:
other:

Mineralogy (XRD):

Associated alteration, phosphorite, or hydrothermal deposits:

Fe oxide staining

Substratum:

Rock type: Altered basalt?

Description: Altered brown hard basalt? w/layer of red orange material above it & a layer of white calcareous sediment above the red-orange layer. A few forams in crust

Mineralogy (XRD):

L5-83-HW
D6-B3-1

Analyses and subsamples:

analysis:	analyst:

Sample Description

Cruise I.D: L5-83-HW

Sample I.D: Sta: D6-B3-2

Location: Necker Ridge

Size: _____ Weight: <100g

4 small pieces all <10cm³; one is all Mn crust

Mn crust thickness:

Total: min: 2mm max: 1.5cm ave: _____

Inner crust: min: _____ max: _____ ave: _____

Outer crust: min: _____ max: _____ ave: _____

Surface texture: rough + porous to abraded smooth

Internal structure: _____

layered: ✓ ✓

laminated: _____

massive: ✓

porous: ✓

dendritic: _____

other: _____

L5.83-HW

D6-B3-2

Mineralogy (XRD): _____

Associated alteration, phosphorite, or hydrothermal deposits: _____

Substratum:

Rock type: Vole Breccia

one is basalt - like D6-B3-1

Description: Altered red orange to gray subrounded vole clasts in altered yellow silty sand matrix w/some phosphate

Mineralogy (XRD): _____

Analyses and subsamples:

analysis:	analyst:

Sample Description

Cruise I.D: L5-83-HW

Sample I.D: Sta: D6E Item 6 - D6-E2 Location: Mercer Ridge

Size: _____ Weight: _____

Mn crust thickness:

Total: min: _____ max: _____ ave: _____

Inner crust: min: _____ max: _____ ave: _____

Outer crust: min: _____ max: _____ ave: _____

Surface texture: _____

Internal structure: _____

layered: _____
laminated: _____
massive: _____
porous: _____
dendritic: _____
other: _____

Mineralogy (XRD): _____

Associated alteration, phosphorite, or hydrothermal deposits:

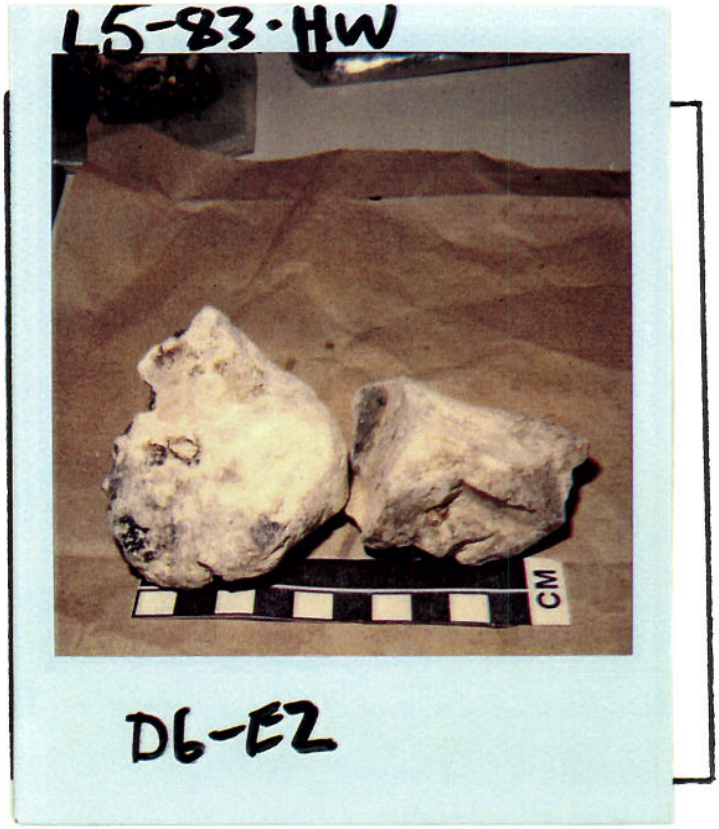
Substratum:

Rock type: _____

Description:

D6-E-1: bar calcareous sandy sediment rock dredge
D6-E-2: two calcareous well-rounded mudstone
D6-E-3: white calcareous worm-burrowed mudstone
E-4:
E-5: same as E2
D6-E6: same as E3 & E4; piece to J Haggerty
D6-E6: Chert & phosphorite

Mineralogy (XRD):



Analyses and subsamples:

analysis:	analyst: