U. S. DEPARTMENT OF THE INTERIOR
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PRELIMINARY RESULTS OF THE 1986 *Sea Cliff* DIVE PROGRAM, Escanaba Trough

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INTRODUCTION

Preliminary results of a series of dives aboard the U.S. Navy submersible *Sea Cliff* during the summer and fall of 1986 are presented. A series of research cruises, mostly using the USGS research ship S.P. Lee, established the basic geologic setting of the Escanaba Trough and provided detailed information on the SESCA and NESCA areas (Fig. 1), which is summarized by Morton et al. (1987, 1990) and Holmes and Zierenberg (1990). Bathymetric maps of the NESCA and SESCA area are presented in Fig. 2 and Fig. 3, respectively. Several large massive sulfide deposits were located and sampled. The *Sea Cliff* dive program provided important new information, not available from surface ship, which has refined our understanding of the geology of these areas. The highlights of the new information gained during the dive program are presented in this manuscript. The dive narrative in Appendix 1 presents an overview of each dive, and more a detailed account of the observations from each dive are given in Appendix 2, which contains transcribed voice tapes from the dives, and descriptions of geology based on external camera photos. Appendix 3 contains the logs of observations recorded on the hand held color video recorder used in the submersible on dives 658 through 663; appendix 4 contains descriptions of the sulfide and sulfate samples collected on these dives. Descriptions of doubly polished thin sections prepared from selected samples are presented in Appendix 5. The dives were transponder navigated, but the positioning accuracy was often poor due to either equipment problems or lack of experienced navigation personnel at sea. Extensive reprocessing of the transponder data by Janet Morton has allowed detailed reconstruction of the tracks for most of the dives. The dive tracks are presented in Figs. 4-11. These figures also show Robert Zierenberg's interpretation of the geology based on the observers' dive transcripts and examination of available photographs and video tape.

ACKNOWLEDGEMENTS

The Escanaba Trough dive program was coordinated by the Gorda Ridge Technical Task Force. We gratefully acknowledge the cooperation of the U.S. Navy, especially the dedicated and professional crew of the *Sea Cliff* submersible group who went beyond the call of duty in an effort to see that the scientific goals of this mission were accomplished, despite difficult weather conditions.

GEOLOGY

The SESCA and NESCA sites are two of several areas in the Escanaba Trough where volcanic edifices along the spreading axis have built up through approximately 500 m of hemipelagic and turbiditic sediment that buries the southern portion of the slow spreading (~2.3 cm/yr) Gorda Ridge. Prior to the dive expedition it was established that both areas have high heat flow and are largely covered by sediment of highly variable thickness, with volcanic rocks exposed in limited areas (Morton et al., 1990). Massive sulfide deposits had been discovered and sampled by dredging at each site (Morton et al., 1987). Both sites have generally similar geology, but we will emphasize the minor details which differ between the areas.

NESCA Site

The NESCA volcanic edifice is centered at approximately 41°00' N Lat., 127°29' W Long (Fig 1). Pillow basalt is exposed over a large area of the volcanic edifice at the NESCA site, and was observed on dive 660 (Fig. 2). The fresh glassy pillow rims decorated with small buds attest to recent volcanism at this site. Although these flows are very recent, they are dusted with sediment and sediment has accumulated in pockets between pillows. The pillows tend to be large (1-2 m) and bulbous rather than elongate. Striations and expansion cracks are common. No signs of rifting, hydrothermal deposits or alteration were observed in the volcanic rocks.

The area west of the exposed pillow basalt was explored on dive 658 (Fig 2). Seismic profiles show that the north flank of the volcanic hill is covered by sediment, and that the sediment is disrupted by normal faults that are down-dropped to the north (Morton et al., 1990). Numerous north-block-down fault scarps were observed in the sediment on this dive, and some scarps bound back-tilted sediment terraces. An extensive area of sulfide mineralization was discovered on this dive. The sulfides occur in a sediment covered area and may be localized by the normal faults.

The traverse on dive 659 (Fig. 2) started in the flat plain northwest of the volcanic hill, near the start of dive 658. This plain was completely sediment covered and generally smooth, and is interpreted as an area underlain by flat sheet flow basalt. Dive 659 investigated an area of very irregular bottom topography and complex geology to the northwest of the exposed volcanic rocks of the central hill. Numerous channels cut across the area. The channels vary from a few meters to several tens of meters wide and are generally about half as deep as they are wide. They are often asymmetric with one near vertical wall and a less steep wall sloping from 45° to 70°. Mass wasting of the channel walls is evident, but no indications of down-channel sediment transport were observed. The area is sediment covered, including even the steepest channel walls, which only locally expose truncated layers of mudstone and siltstone. A possible sediment-covered basalt sheet flow was observed in one vertical channel wall. In this case it appeared that the roof of a drained lava channel had collapsed after burial by sediment. It is likely that some of the channels represent drained or collapsed lava channels, however, these features may actually be small grabens related to ridge extension or erosional channels cut by turbidity currents. Small outcrops of massive sulfide chimneys and crust were observed throughout this area, especially near the channel margins. One larger area of sulfide talus was observed on a steep scarp but no extensive sulfide deposits were located during this dive.

SESCA Site

The volcanic edifice at the SESCA site is exposed at the surface in only a few areas. The most prominent topographic features are the three flat-topped, sediment covered hills that sit atop the volcanic edifice (Fig. 3). Massive sulfide deposits occur around the base of these hills.

The dives at the SESCA area concentrated on the northern most hill, referred to as North Hill, and the central hill, referred to as the 3170 Hill (Fig. 3) . Observations from the submersible show that the hills have a similar morphology which suggests that both hills formed by similar processes. The tops of the hills are very flat and smooth, and are completely covered by bioturbated sediment. The hills are bounded

on all sides by near vertical scarps that parabolically flatten with depth. In places the scarps are stepped such that the base of one scarp flattens to a smooth plain that is truncated by the next lower scarp. The sides of the hills are also generally sediment covered, even on near vertical slopes. Locally, the steeper scarps expose truncated beds of mudstone and siltstone. The hills are clearly retreating by mass wasting, and sediment transport grooves and channels were observed on the flanks. Mudstone talus is commonly observed on the flatter slopes, but there are no large talus or sediment aprons surrounding the hills.

The sediment hills are uplifted approximately 100 m above the surrounding area, and occur near the apparent trace of the spreading axis. . The mechanism of uplift is not certain. The hills might be basement cored horst blocks. A more likely cause of uplift is intrusion of basalt into the sediments. Basaltic magma extruded at a sediment covered ridge crest can form sills, unless the restriction to lateral flow exceeds the force necessary to lift the roof rocks. At this point the magma body inflates and acts like a piston to lift the overlying sediment (Lonsdale and Lawver, 1980), producing a small bysmalithic intrusion. This type of intrusion would form a series of faults around the base of the uplifted sediment hill. The heat from the intrusion could both drive and focus hydrothermal circulation. Hydrothermal deposits would tend to form over the faults due to the higher hydrologic continuity of the fracture system compared to the relatively impermeable hemipelagic sediments.

An alternative explanation is that the hills are simply erosional remnants of sediment from a larger scale uplift of sediment over the entire volcanic edifice. This explanation does not account for the presence of sulfide deposits, constructed in part above the sediment-water interface at the base of the hills, or the submersible observations and seismic evidence for faulting at the base of the hills. There also does not appear to be a sufficient volume of redeposited sediment around the hills to accommodate the large amount of mass wasting implied by this alternate hypothesis.

No volcanic rocks have been observed or recovered from the slopes of the hills, however, volcanic rocks are exposed in the flat area southwest of the North Hill. These flows occur at the depth of the first normal fault that uplifts the hill and are not seen above this level. Inflation of a bysmalithic intrusion could have uplifted the sediment hill until the magma reached the sea floor and then flowed laterally away from the base of the hill.

The volcanic rocks are older than those observed at the NESCA site. They are partially sediment covered, and no fresh volcanic glass was observed. The most commonly observed lava forms are large (1-2 m), nearly spherical pillows. The pillows are expanded and often show trap-door break-outs. In some areas the pillows either sit on or were extruded up from sheet-flow basalt. The low relief on the sheet flows makes them difficult to observe in sediment covered areas, and the proportion of surface volcanic rocks exposed as pillows is greater than their volumetric percent. Near the base of the North Hill, the volcanic rocks are cut by numerous north-south trending open fissures a few centimeters to about one meter wide. The fissure walls generally expose sheet flow basalt. No hydrothermal activity or rock alteration is associated with the fissures. The presence of filter feeding organisms in the fissures suggests that the fissures may localize down-flow in zones of hydrothermal recharge.

Sulfide Deposits

Large deposits of massive sulfide were explored on dives 658, 662 and 663. The sulfide deposit observed at the end of dive 661 may be continuous with the deposits explored on dive 662. Dive 659 encountered extensive sulfide mineralization, but no large deposits were observed. None of the dives detected any evidence for active discharge of hydrothermal fluid. One interesting result from the dive program was the establishment of the relative ages of the sulfide deposits. Some of the deposits showed evidence of very recent activity, while others had been inactive for a sufficient time period to be modified by chemical and mechanical weathering.

The sulfide deposits explored on dive 658 were the youngest and most extensive deposits observed during the dive program. Massive sulfide and sulfide talus were observed to crop out discontinuously along a north-south traverse approximately 500 m long between the depths of 3216 m and 3270 m. Problems with the navigational system preclude detailed reconstruction of the dive track, and therefore the true outcrop pattern of the sulfide deposits could not be mapped. However, reconciliation of the depths of the sulfide occurrences with the bathymetry requires at least 250 m of semicontinuous outcrop of sulfide and sulfide talus. Although much of the hydrothermal material observed was talus, constructional mounds and chimneys of sulfide that formed in place were observed near both the shallowest, and deepest, occurrence of sulfide.

Most of the sulfide observed occurs as coarse talus blocks that range in size from 20 cm to a few meters. Platy slabs of massive sulfide 10 to 20 cm thick and 0.5 to 1 m on a side are common. The fresh appearance and coarse grain size of the sulfide is striking; reflections from individual crystals could be seen at a distance of a few meters when the submersible was on the bottom in a field of sulfide. The sulfide talus occurs in mounds and ridges several meters high and tens of meters long. Areas between mounds are sediment covered, but disturbance of the sediment by the submarine during sampling attempts revealed that fine grained black sulfide is present at a depth of a few centimeters below the surface. Some small chimney-like projections of sulfide occur within the sediment covered areas and one 30 cm high chimney composed of hydrothermal barite was recovered within a field of sulfide.

Several constructional mounds of massive sulfide were also observed. The mounds are tens of meters in diameter and are a few meters high. They are typically surrounded by sulfide talus and are topped by sulfide chimneys about 1 meter high. The preservation of the thin chimneys, and the fresh appearance of the pyrrhotite grains, indicate that the deposits formed very recently. The observation of dead tube worms and the shells of vent specific clams is further evidence that the deposits were active in the recent past. Bacterial mat was observed covering sulfide in one area, suggesting that some of the deposits may have been leaking hydrothermal fluid. However, the extensive occurrence of sulfide talus and the coarse grain size of some sulfide suggest that the deeper portions of the deposits have already been disrupted and exposed by faulting.

Dive 659 encountered sulfide mineralization over a wide area on the north side of the Central Hill. The sulfide occurrences are mostly small chimney-like projections a few tens of centimeters high extending above the sediment covered bottom. The amount of exposed sulfide is generally small. In many cases sulfide crusts were seen exposed below the sediment, often as thin plates which appear to have buckled upward by displacive growth of sulfide below the sediment-water interface. Sulfide

and hydrothermal barite were often observed near the edges of collapse channels and are occasionally exposed at the tops of the scarps that form the channel walls. The largest exposure of sulfide observed was a 3 m high, 60° scarp of massive sulfide talus. The talus blocks are equant, angular, and 10 to 50 cm on a side. Both the top and bottom of the scarp are flat and sediment covered. The lateral extent of the outcrop was not determined. This exposure is interpreted as a fault exposure of massive sulfide, but is not clear whether the sulfide formed on the sea floor and was buried by sediment, or formed below the sediment-water interface and was later exposed by faulting.

Dive 660 had a short bottom time and observed only pillow basalts with no indications of hydrothermal deposition or alteration.

A transponder was recovered at the start of dive 661. The submersible then traversed west to a site at the base of the North Hill where massive sulfide had been photographed from the *S.P. Lee* on and earlier cruise. *Sea Cliff* encountered massive sulfide at a depth of 3230 m. The deposits were small mounds of sulfide talus with some chimney-like projections. Mechanical problems prevented sampling of the sulfides and forced termination of the dive before the extent of the deposits could be determined.

Dive 662 also encountered massive sulfide deposits at the base of the North Hill. An extensive field of massive sulfide was explored on this dive. The Mesotech sonar display indicated that the hydrothermal deposit is 20-30 m wide and more than 100 m long, extending parallel to the slope of the hill in the direction of the deposit observed on dive 661. The volume of sulfide exposed on the sea floor was impressive. The sulfide occurs as elongate mounds and ridges several meters high. Rounded slabs of sulfide talus are common, and at least one fallen sulfide tower several meters long was observed. The submersible traversed through valleys bounded on both sides by steep-sided massive sulfide that extended above the view of either observer. The mounds are generally rounded and partially oxidized. Locally, the mounds are topped by 1-2 m high stubby chimney-like projections. The morphology of the deposits showed they were older than those observed on dive 658, but they were not as old as the deposits seen on dive 663.

The sulfide deposits at the base of the 3170 Hill explored on dive 663 are similar to those at the base of the North Hill. The deposits of the North Hill occur on a flat or slightly back-tilted sediment bench at the base of the North Hill, whereas the deposits on the 3170 Hill occur near the base of the slope at a depth of about 3250 m. The deposits are closer to the base of the hill than they appear on Fig. 11, because the hill is actually steeper than shown by the contours. A flat sediment covered area occurs uphill from the deposit on the 3170 Hill. This could be an uplifted or back-tilted block, or it could be ponded sediment that filled in, and eventually overflowed, a sediment dam created by growth of the sulfide deposits.

The highly weathered sulfide exposures are rough textured, steep sided cliffs (up to 6 meters thick) of porous barite and secondary Fe-oxide left behind because of preferential dissolution of sulfide. Degradation of the deposit has removed any original constructional projections, and the top of the deposit is sediment buried. In places, the deposit is cut by large mass-wasting canyons that expose several meters of massive sulfide on the walls; sediment and mudstone talus is prevalent on the canyon floors.

Sulfide Samples

A total of 32 kg of sulfide samples were collected by the *Sea Cliff* during the dive program. These samples are generally similar to pyrrhotite-rich massive sulfide samples dredged from the Escanaba Trough (Koski et al., 1988; Benninger and Koski, 1988). A general description of the samples is presented in Appendix 4; the chemical composition of selected samples, determined by emission spectroscopy, is presented in Table 1.

Pyrrhotite is the predominant mineral in the sulfide samples, and generally constitutes more than 90% of the mineralogy. Pyrrhotite grain size ranges from very fine to several mm, and grains tend to form hexagonal platelets. An interlocking network of pyrrhotite plates leaves a large volume of pore space that is void or partly filled by other sulfide minerals. The coarsest grained pyrrhotite forms in internal cavities and fluid channelways in the samples. Pyrrhotite in some samples is unaltered; in others it is partly to totally altered or replaced. Unaltered pyrrhotite is predominantly, if not exclusively, hexagonal. Monoclinic pyrrhotite occurs in altered samples. Alteration of pyrrhotite takes several forms. Sea floor weathering of the samples often leads to formation of goethite and lepidocrosite rims on the pyrrhotite grains. Commonly the pyrrhotite is altered to fine grained aggregates of marcasite, which may include Fe-oxide and monoclinic pyrrhotite. Some of this type of alteration may be associated with the circulation of late stage, lower temperature fluids through the sulfide deposits. A common alteration of pyrrhotite, especially in samples formed below the sediment-water interface, is replacement of pyrrhotite by monoclinic native sulfur. The replacement is often pseudomorphic and Fe- and CuFe-sulfate minerals often occur interstitial to the former pyrrhotite grains.

Isocubanite is the next most abundant primary sulfide mineral and can form up to 5% of the rock. Isocubanite grains are generally subhedral and occur interstitial to pyrrhotite, but nearly monomineralic bands of isocubanite occur in a few samples. Many of the interstitial grains of isocubanite have exsolution-like fiamme and replacement rims of chalcopyrite, however the volume of chalcopyrite in the majority of samples is small relative to isocubanite.

Sphalerite is nearly as abundant as isocubanite, and generally occurs interstitial to pyrrhotite. Sphalerite tends to be dark red to opaque in transmitted light. Sphalerite often shows partial replacement by isocubanite similar to the texture referred to as chalcopyrite disease by Barton and Bethke (1987)

Marcasite is common in altered samples and is the major mineral present in some samples, but pyrite is generally absent. Most of the marcasite forms from alteration and pseudomorphic replacement of pyrrhotite, but colloform banded marcasite is common in some samples. Colloform banded marcasite occurs as an outer rim overgrowing pyrrhotite, and is often itself overgrown by banded Fe-oxide. Botryoidal aggregates of marcasite also occur interstitial to pyrrhotite.

Other sulfide phases occur in trace amounts. Arsenopyrite and galena are the most common of the minor phases. Alabandite (MnS) occurs in one sample of mineralized sediment. Native bismuth has been observed as inclusions in arsenopyrite examined by S.E.M.

The predominant nonsulfide phase is barite, which occurs as crust of bladed crystals on the exterior surfaces of some massive sulfide samples. A chimney of nearly monomineralic barite was also recovered from a sediment covered area next to a massive sulfide outcrop (Appendix 4; 659-R2). Iron oxide is common in weathered

samples and both goethite and lepidocrosite are present. Some samples contain traces of late-stage amorphous silica. One sample of iron stained rubble recovered from the surface of weathered massive sulfide consisted predominantly of talc (Appendix 4; 663-R2). A few of the sulfide samples contain hemipelagic sediment incorporated during sulfide growth, and a small number of these samples also contained yellow colored hydrocarbon.

The chemical composition of the sulfide samples is consistent with the observed mineralogy, and is similar to analyses reported by Koski et al. (1989). The samples are Fe-rich with up to 2 wt percent Cu and Zn. A sample from the base of a small pyrrhotite-rich chimney contains 7.7% Cu, 1.3% Zn, 0.3% Pb, 150 ppm Ag and 2.2 ppm Au (Table 1; 659-R1). This portion of the sample formed at, and just below, the sediment-water interface and contains a small amount of incorporated sediment as well as some hydrocarbon. Subsurface sulfide deposition may be an important process in sediment covered hydrothermal systems, however this portion of the system can only be sampled effectively by drilling.

Biology

The dive program was designed to include both a geologist and a biologist on each dive whenever possible, however because of schedule changes forced by bad weather, there were no divers with biological expertise available for dives 658 through 663. The scientist on each dive attempted to collect as much biological information as possible. Most of the biological observations, especially those pertaining to unrecognized fauna, were tied to photos taken by the port-side observer. Unfortunately, the shutter of the port-side camera was not synchronized with the strobe flash, and the lack of usable photos precludes specific identification of fauna. The following generalities about the biology of this area are thus the inexpert observations of geologists and should be interpreted with caution. Review of external camera photos by qualified biologist will hopefully correct some of the deficiencies in the biological observations.

A majority of the area of sea floor observed on the dives was sediment covered. The most commonly observed animals were several varieties of holothurians, brittle stars, basket stars, anemones and fish. The sediment was generally bioturbated and roughly circular arrays of cm size burrows surrounding a central sediment dome a few cm high, referred to as fairy rings, were common. The creature responsible for creating these structures was not observed. Pyramid urchins were fairly common and were a major source of observed feeding traces. Galatheid crabs were often identified, but only a few shrimp were seen. Free swimming animals other than fish were not common, but included an octopus, a few types of jellyfish and some unidentified animals, each of which were generally only observed once.

Stalked animals in sediment covered areas were less abundant, but were commonly observed. They include stalked and fan shaped sea pens, cork screw-like sea pens, stalked wine goblet shaped glass sponges and a few crinoids. In areas where volcanic rock provided a hard substrate, stalked animals, including fan shaped sea pens and straight and branch stalked sea pens, were more abundant. Several types of sponges are common in the areas with exposed basalt. A crescent shaped, bilobate creature, referred to here as the "venus fly trap" anemone, was observed on several dives. This creature is often found on small sulfide or mudstone outcrops exposed to bottom currents. In this form, it attaches itself by means of a stubby, fleshy

stalk a few centimeters high and wide that is similar to most anemones. It was also observed to colonize other stalked organisms, in which case it surrounds the stalk of its host with its own stalk. Many stalked animals were host to other animals, including brittle stars and gelatinous membrane-like creatures.

Hydrothermal deposits were generally more heavily colonized than surrounding areas. This may in part be due to the fact that the deposits present a stable, hard substrate in an area of soft sediment. In addition to stalked animals, the deposits were often heavily colonized by anemones and starfish, with less abundant brittle stars and galatheid crabs. Close-up views of the sulfide deposits often revealed a diffuse, fuzzy coating of filamentous material interpreted to be sulfur oxidizing bacteria. This was especially prevalent on the young deposits seen on dive 658. The abundance of starfish and anemones on the deposits may be partly related to availability of sulfur oxidizing bacteria as a food source. No vent specific fauna were observed, except for one cluster of dead tube worms and a small patch of disarticulated vent clam shells observed on dive 658.

Table 1. Chemical composition of selected *Sea Cliff* dive samples.

	Pyrrhotite-rich massive sulfide			Base of pyrrhotite-rich chimney	Barite chimney
	658-R3	658-R4	662-R1	659-R1	658-R2
wt. %					
Fe	48.1	52.5	48.2	17.9	1.3
Cu	0.55	2.06	2.22	7.70	0.02
Zn	0.61	0.12	2.05	1.38	0.02
ppm					
Ag	15	15	150	150	1.5
As	nd	nd	500	2,000	nd
Au	<0.1	<0.1	<0.1	2.2	<0.1
Ba	57	53	22	1,500	>20,000
Bi	57	53	22	68	5.8
Cd	15.6	6.5	67	47	0.8
Hg	<2	<2	51	<2	106
Ni	5	5	10	30	15
Pb	700	800	3,500	2,600	<100
Sb	7.8	17	140	44	8.8
Sn	nd	nd	20	30	nd

nd - not determined

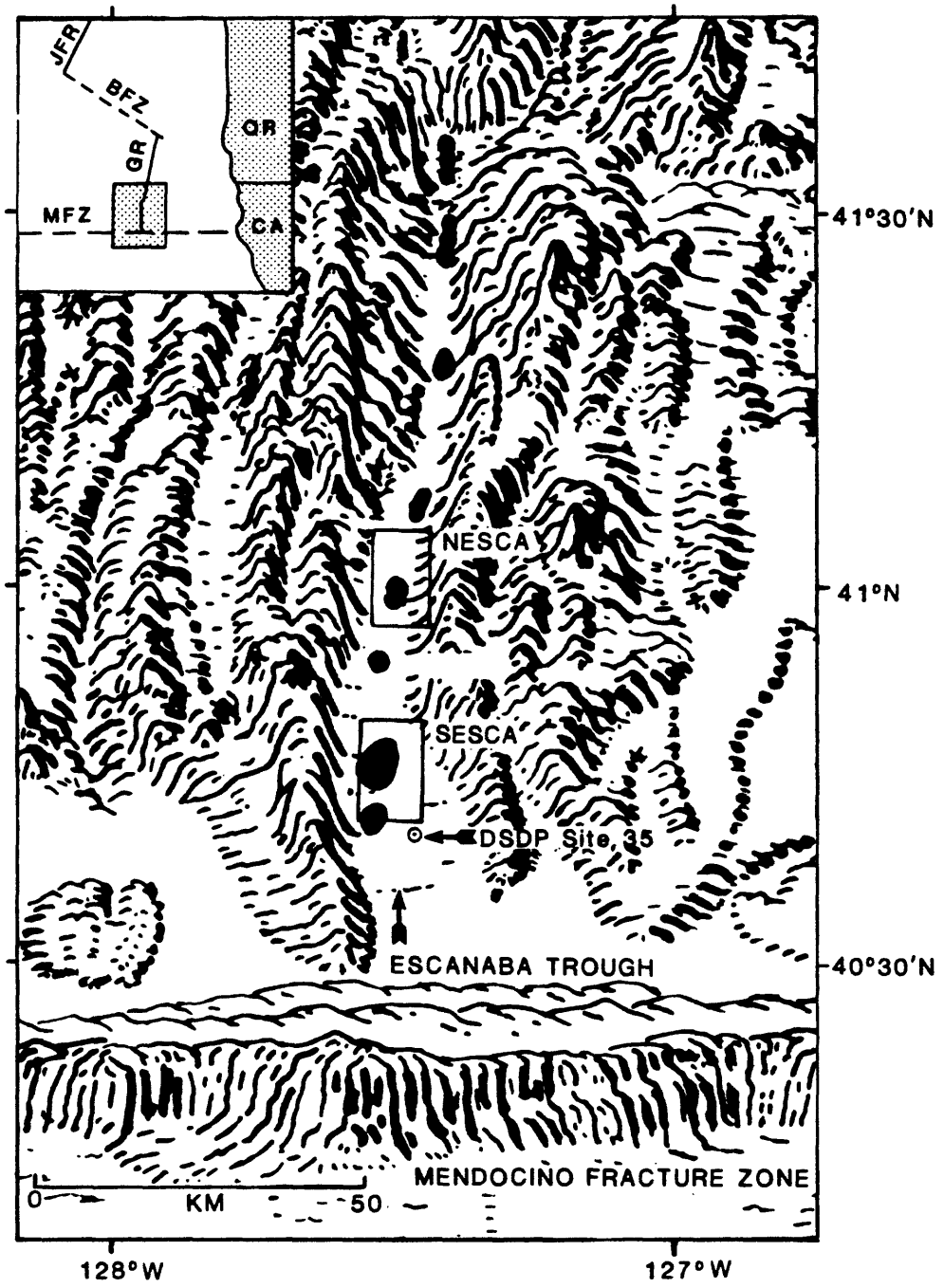

Fig. 1. Physiographic map of the Escanaba Trough showing the volcanic edifices (black spots), the location of DSDP site 35 and the SESCA and NESCA areas. Geographic references on the inset index map are Juan de Fuca Ridge (JFR), Blanco Fracture Zone (BFZ), Gorda Ridge (GR), and Mendocino Fracture Zone (MFZ). After Morton and others, 1990.

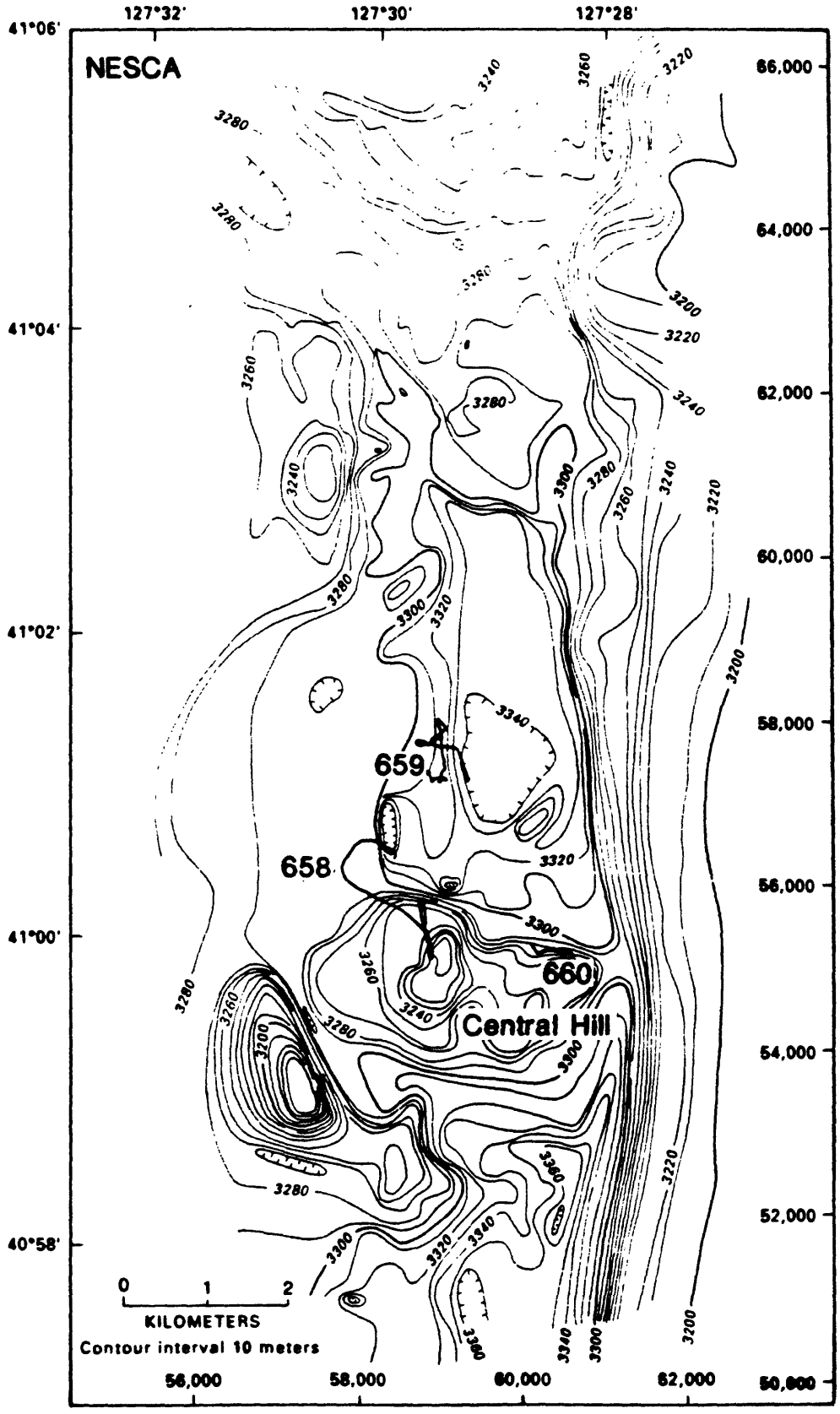

Fig. 2. Bathymetric map of the NESCA area showing the Central Hill, and dive tracks for 658, 659, and 660.

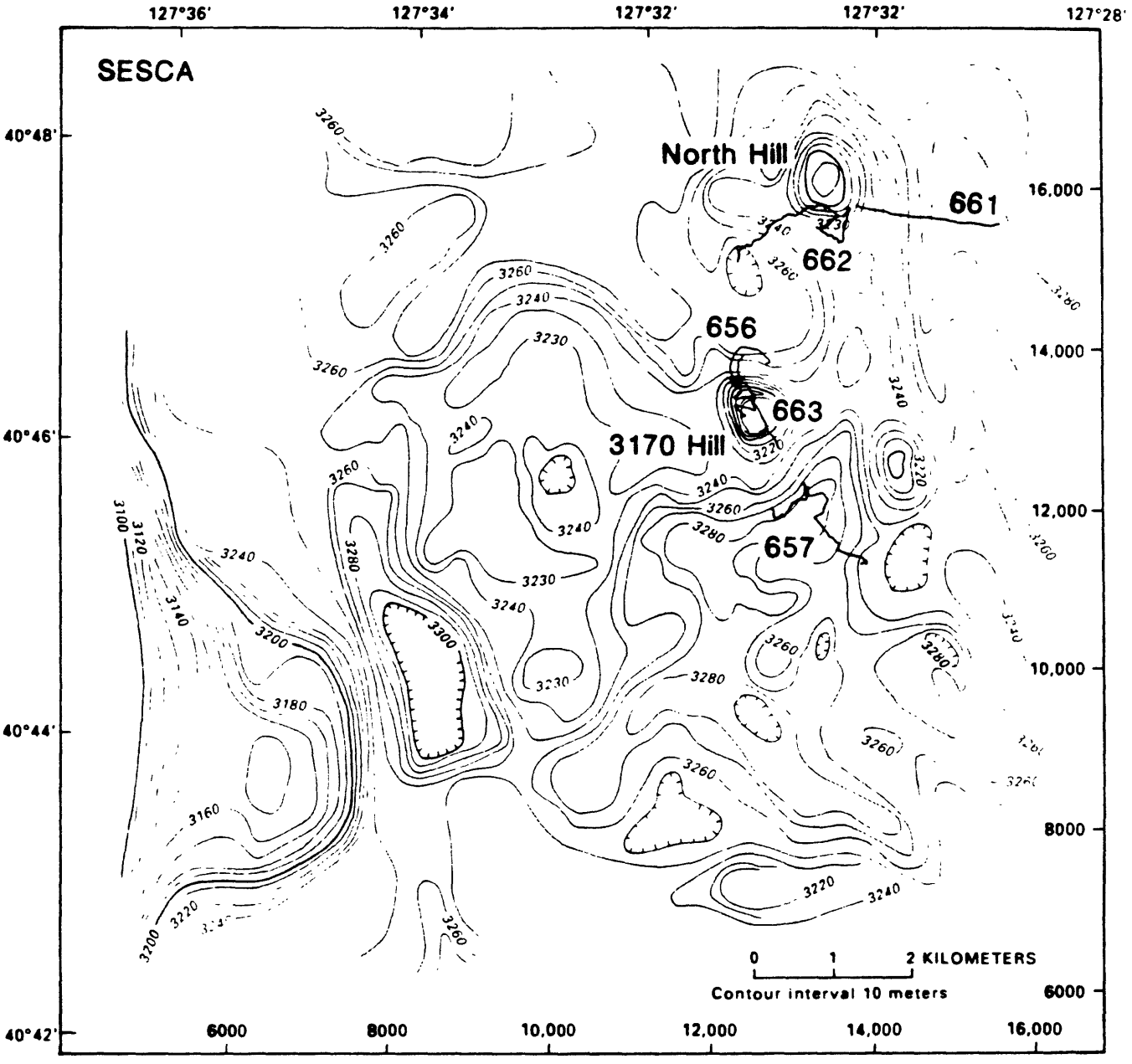

Fig. 3 Bathymetric map of the SESCA area showing, the location of the North Hill, the 3170 Hill, and dive tracks for 656, 657, 661, 662, and 663.

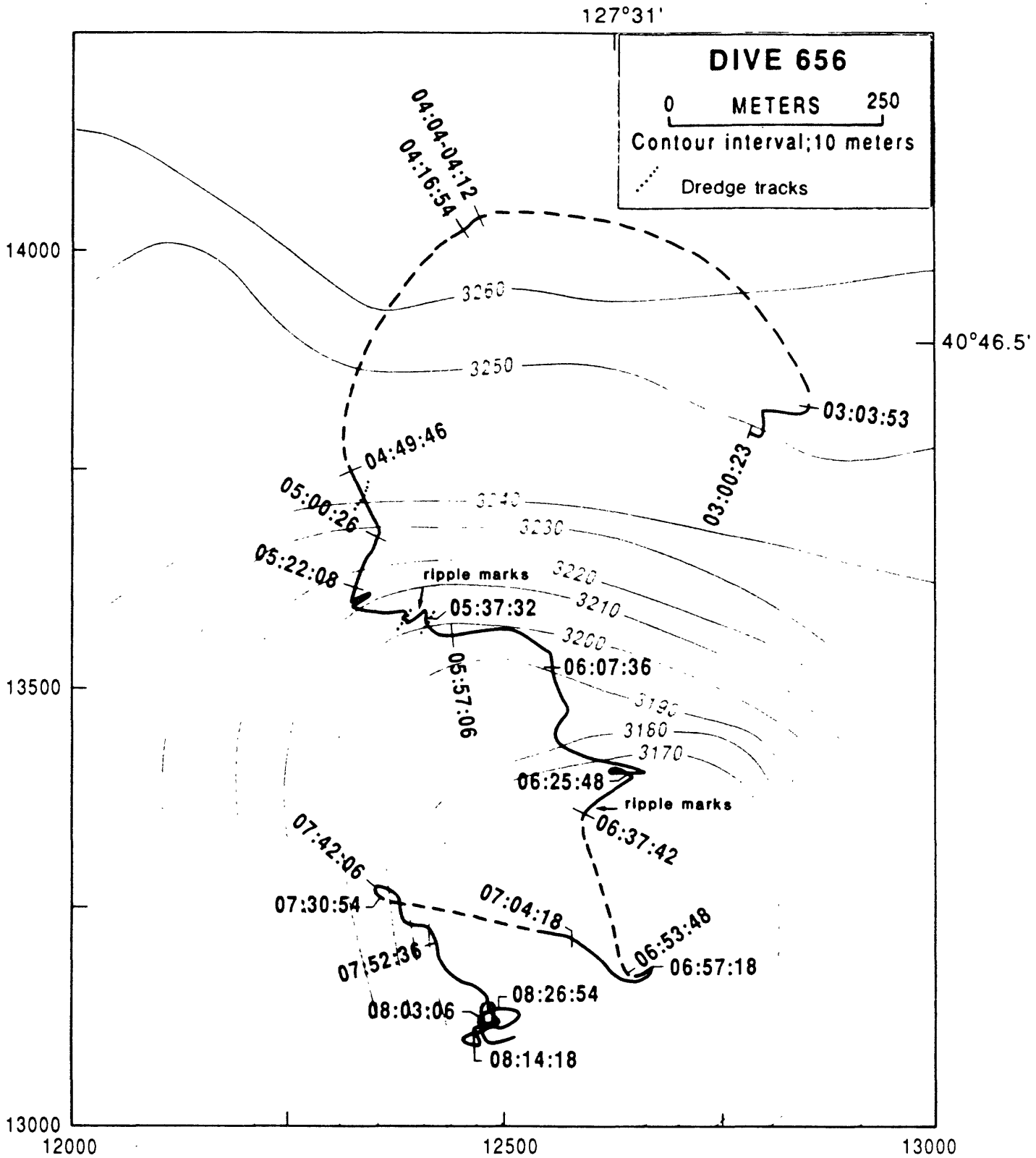

Fig. 4. Dive track and interpreted geology for dive 656, dashed where highly uncertain or where submersible was off the bottom for an extended traverse. The bathymetric contours of the hill are only approximate and do not match in detail the depth recorded by the submersible.

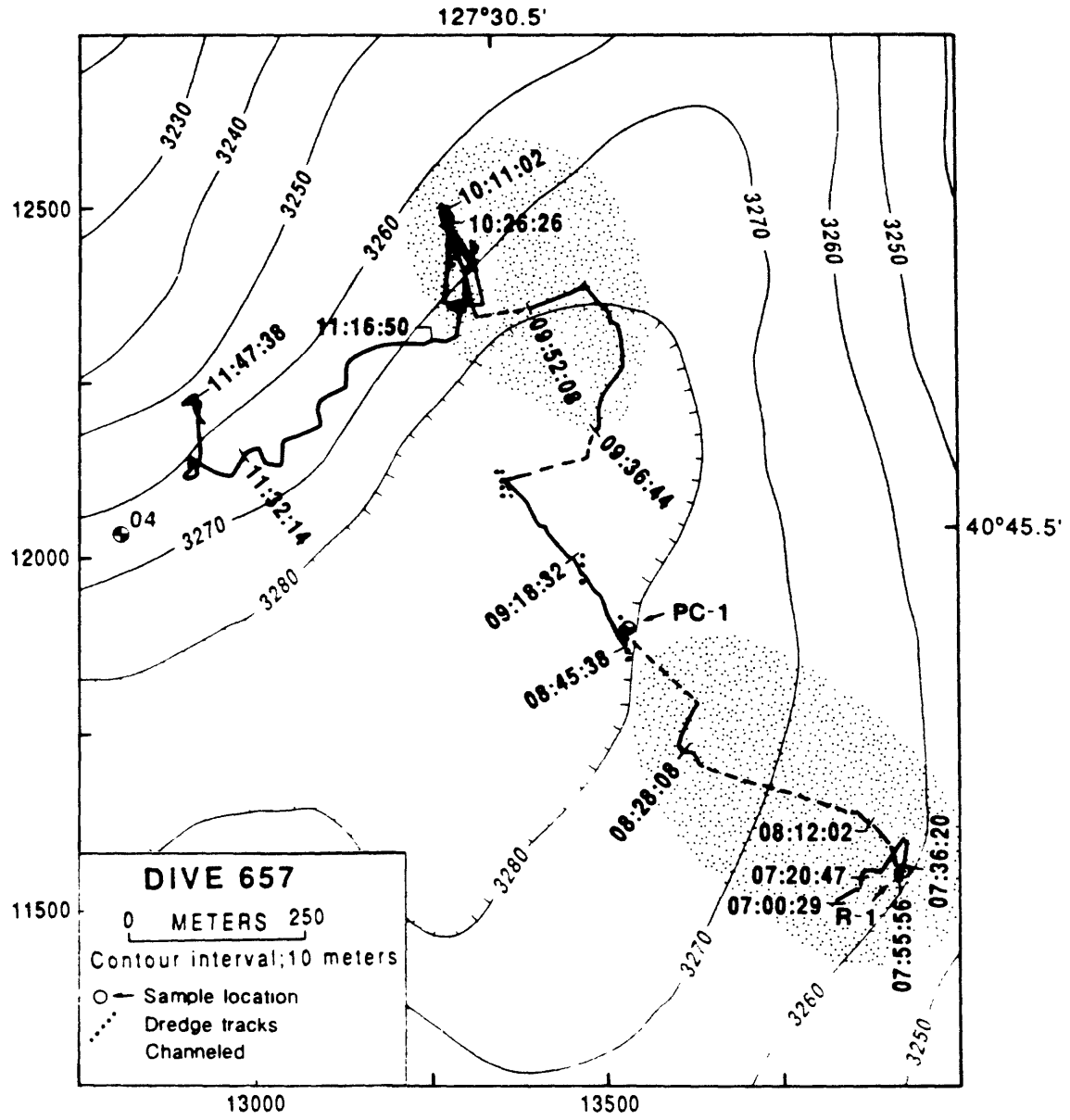

Fig. 5. Dive track and interpreted geology for dive 657, dashed where highly uncertain or where submersible was off the bottom for an extended traverse. The bathymetric contours of the hill are only approximate and do not match in detail the depth recorded by the submersible..Circle marked 04 is the location of one of the bottom moored acoustic transponders.

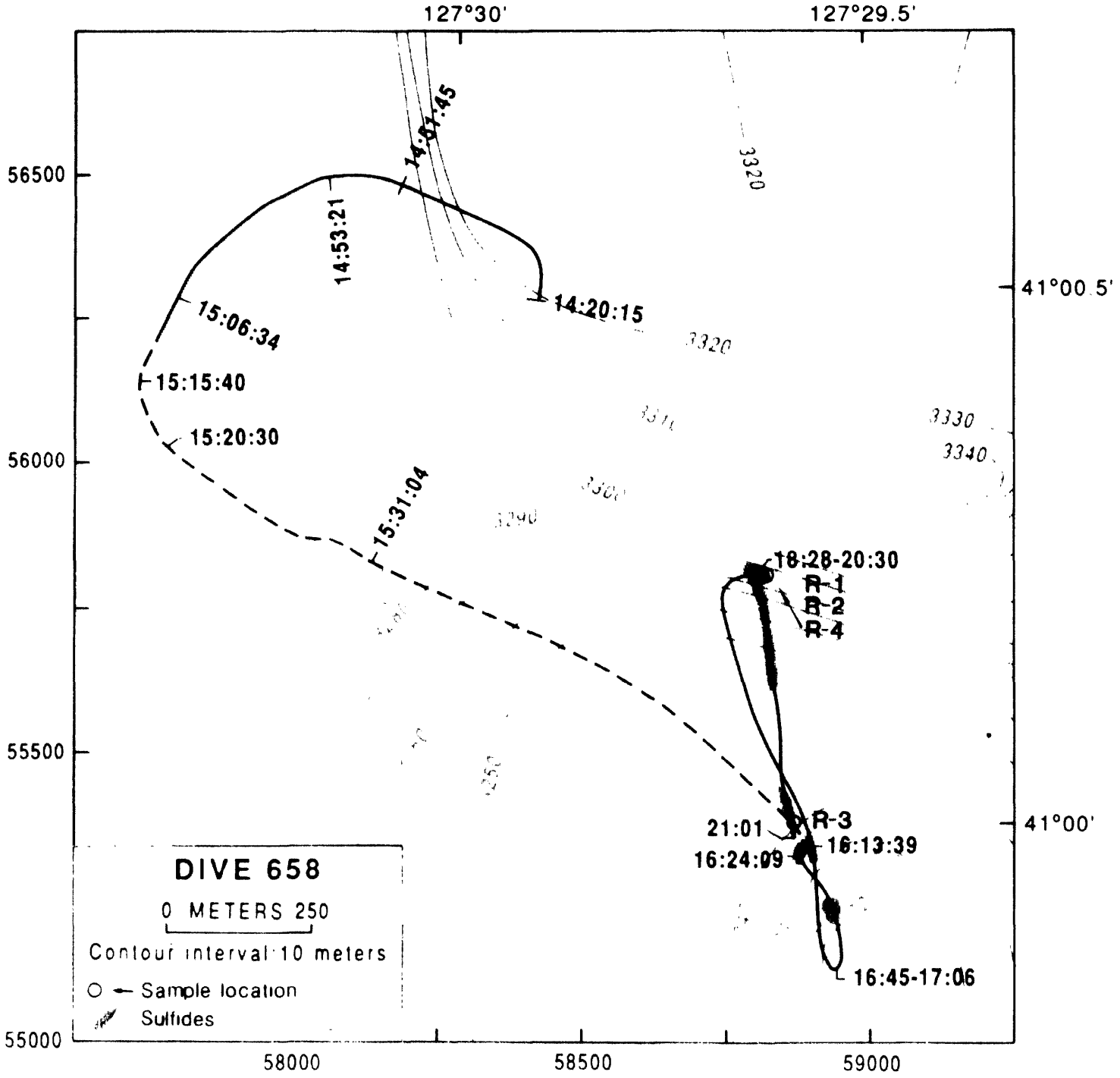

Fig. 6. Dive track and interpreted geology for dive 658, dashed where highly uncertain or where submersible was off the bottom for an extended traverse. The bathymetric contours of the hill are only approximate and do not match in detail the depth recorded by the submersible.

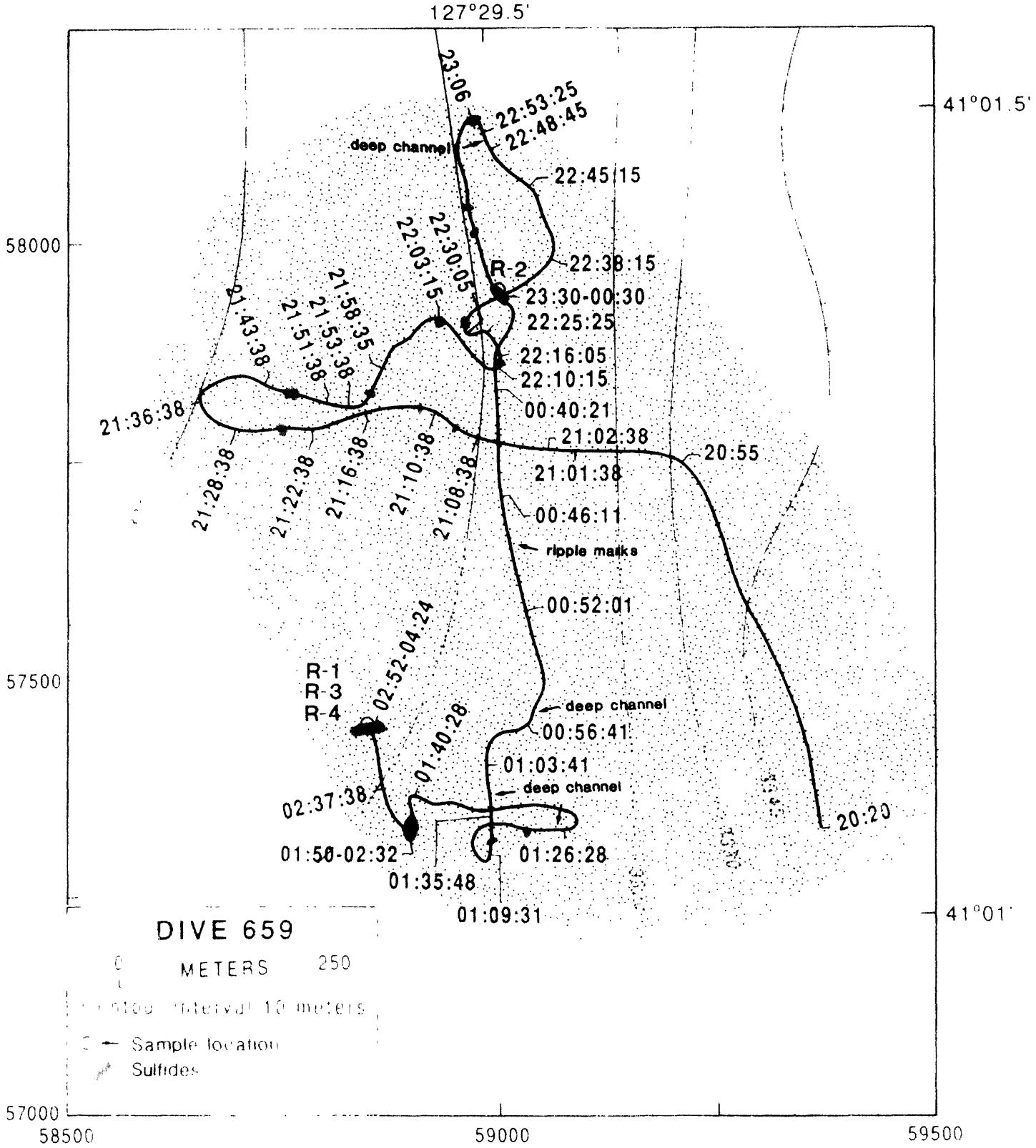

Fig. 7. Dive track and interpreted geology for dive 659, dashed where highly uncertain or where submersible was off the bottom for an extended traverse. The bathymetric contours of the hill are only approximate and do not match in detail the depth recorded by the submersible. The entire area covered by the dive had complex channeled bottom morphology as indicated by the stippled pattern.

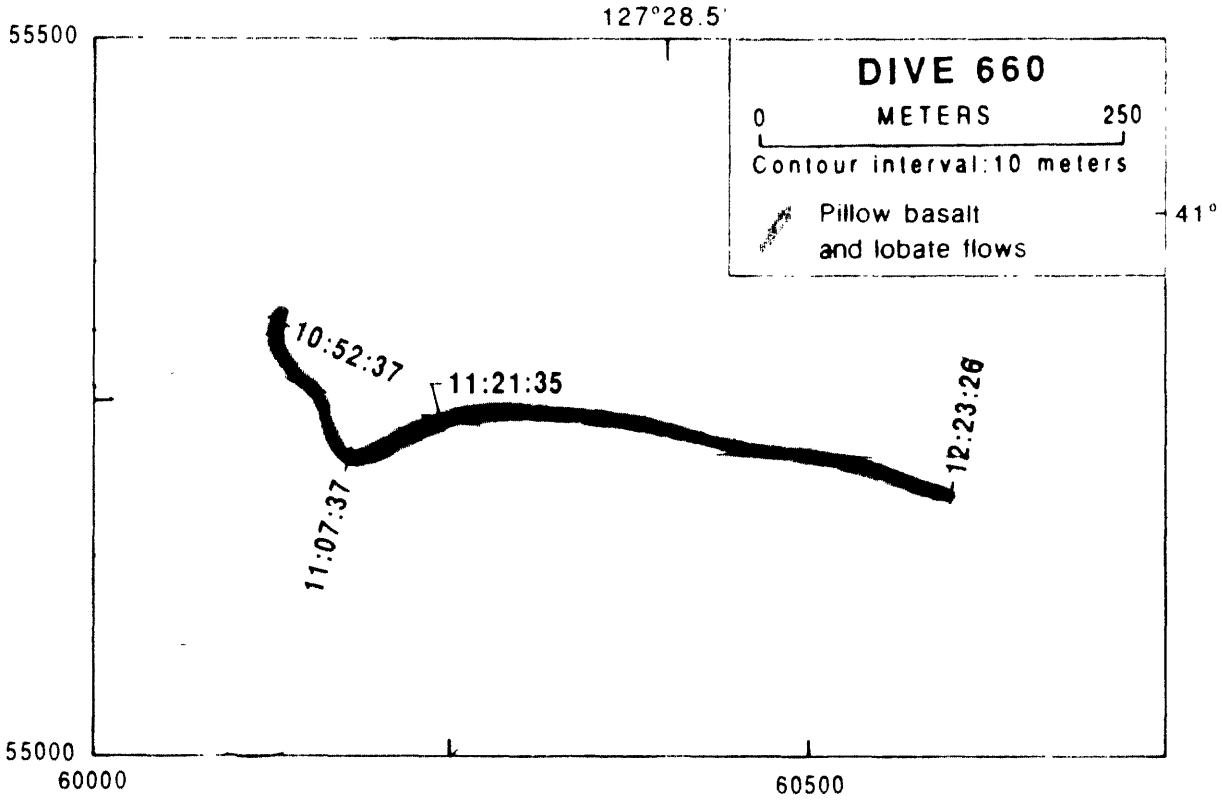

Fig. 8. Dive track and interpreted geology for dive 660. The bathymetric contours of the hill are only approximate and do not match in detail the depth recorded by the submersible..

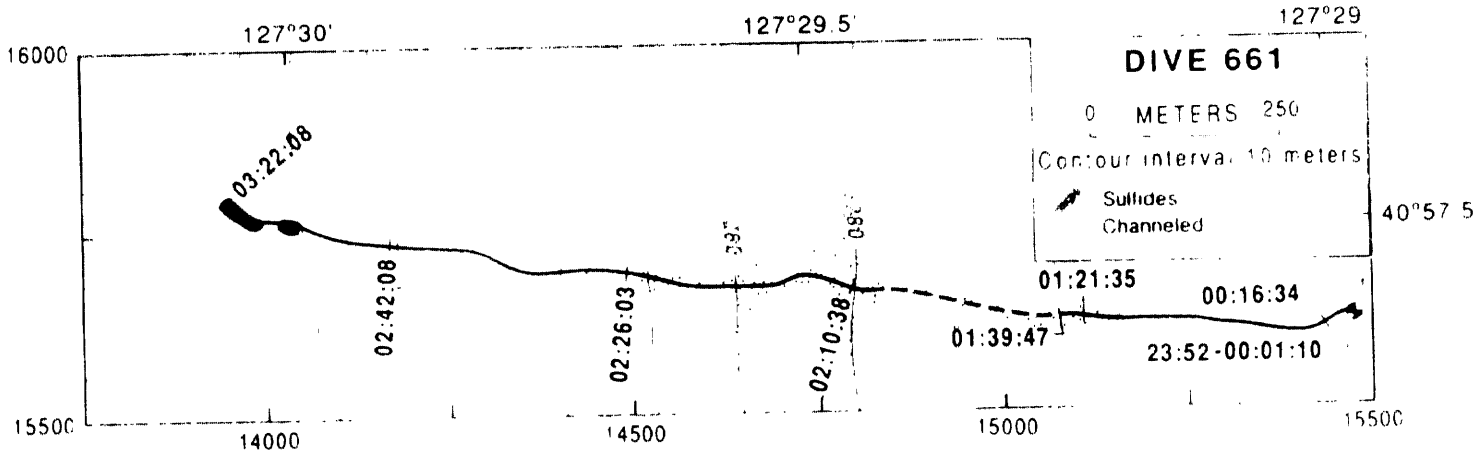

Fig. 9. Dive track and interpreted geology for dive 661, dashed where highly uncertain or where submersible was off the bottom for an extended traverse. The bathymetric contours of the hill are only approximate and do not match in detail the depth recorded by the submersible.

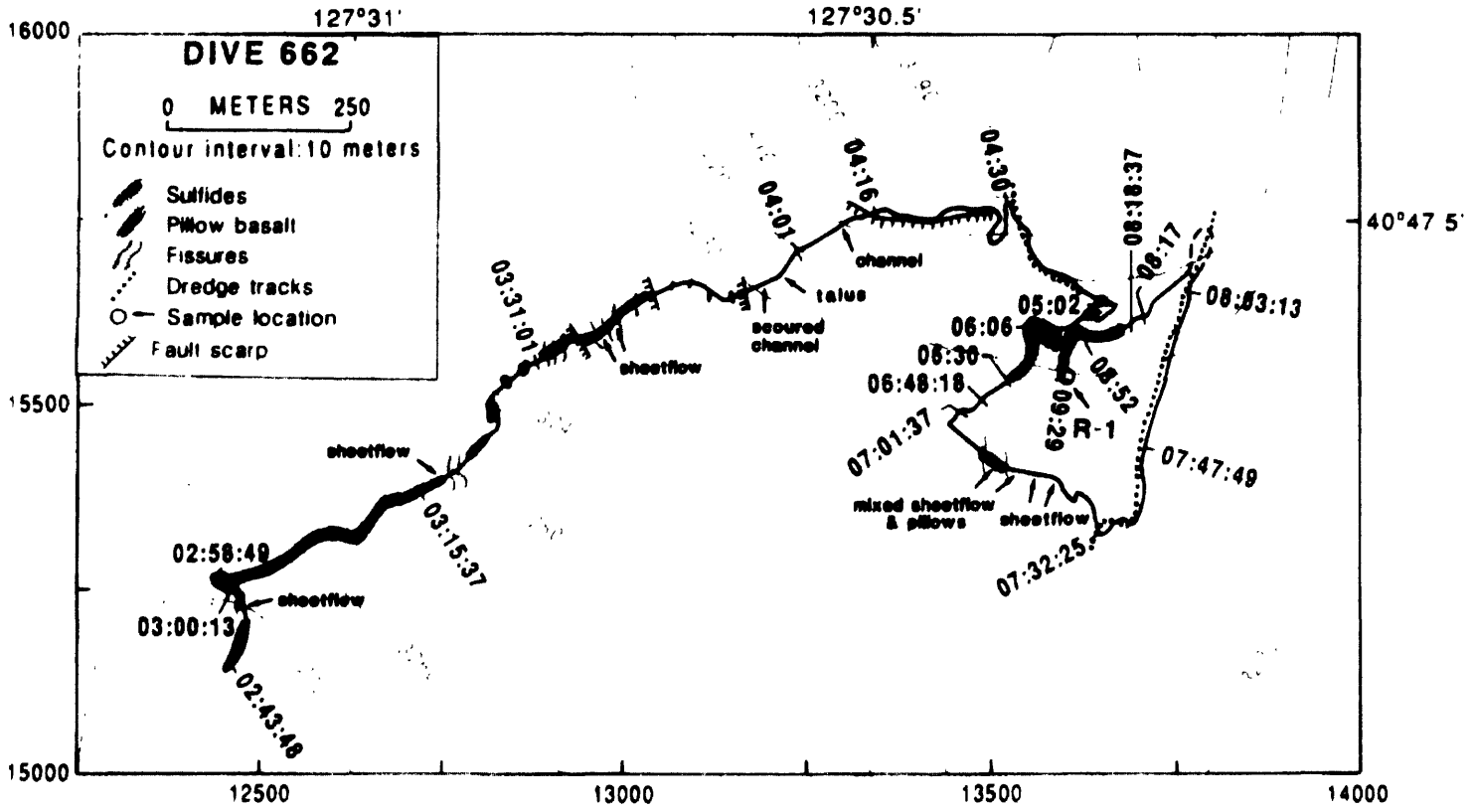

Fig. 10. Dive track and interpreted geology for dive 662, dashed where highly uncertain or where submersible was off the bottom for an extended traverse. The bathymetric contours of the hill are only approximate and do not match in detail the depth recorded by the submersible. In particular, the edge of the flat topped hill is marked by the hatchered scarp symbol, not by the 3190 m contour.

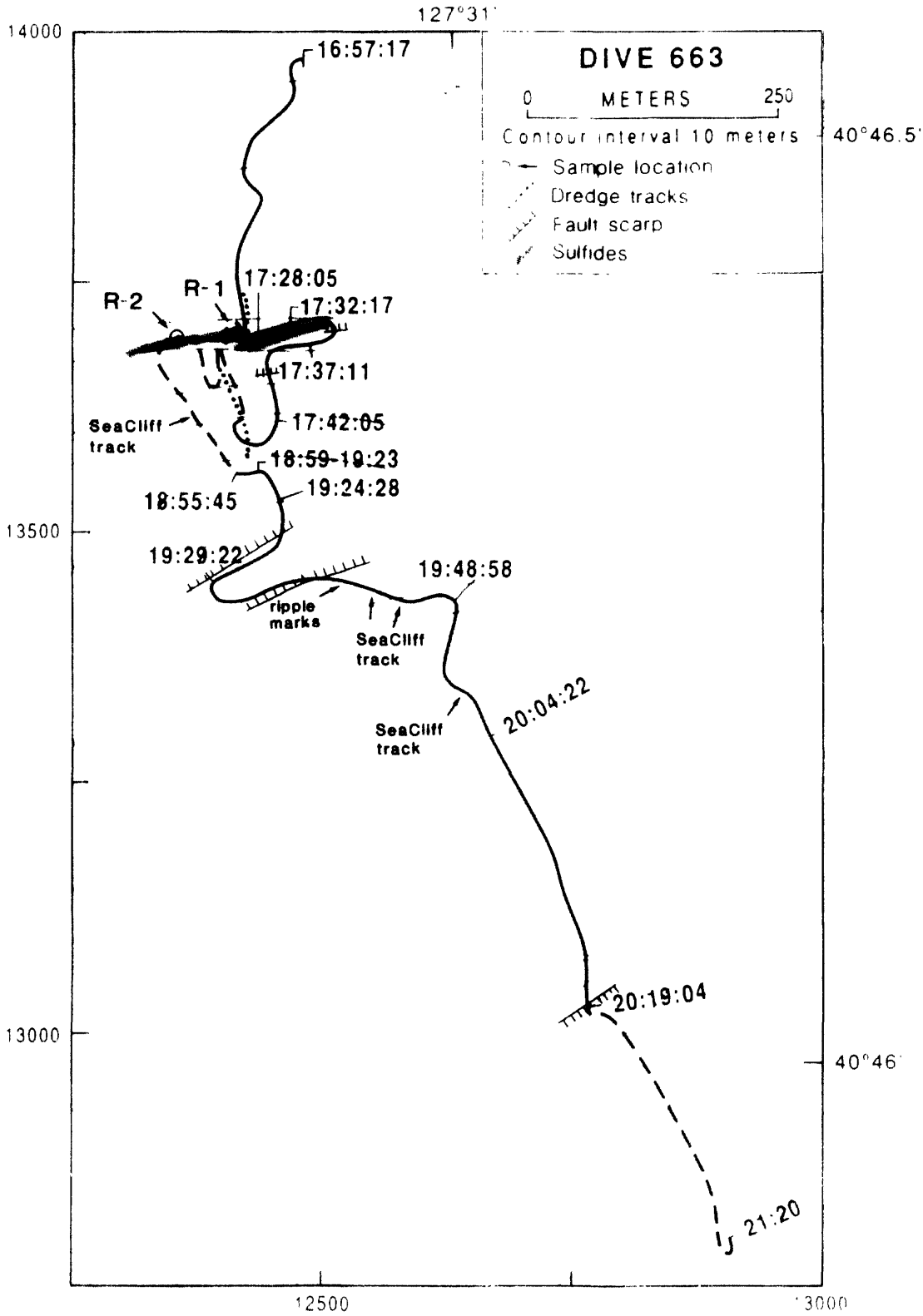

Fig. 11. Dive track and interpreted geology for dive 663, dashed where highly uncertain or where submersible was off the bottom for an extended traverse. The bathymetric contours of the hill are only approximate and do not match in detail the depth recorded by the submersible. The points labeled SeaCliff track refer to marks in the sediment made by the submersible on dive 656.

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APPENDICES

APPENDIX I.
NARRATIVE DIVE OVERVIEW

Dive 656

The first dive of the series was launched at 02:00, 19 July 1986 (all times are GMT). The planned dive track was a north to south traverse across the summit of the 3170 Hill at the SESCA site (Fig. 4), an area where sulfide deposits had been photographed during work aboard the USGS research vessel S.P. Lee. Sea Cliff reached bottom at 04:00, after experiencing some difficulty with the seawater variable ballast system (SWVB). Poor telephonic communication between S.P. Lee and Sea Cliff made it difficult to follow the initial dive plan. The summit of the 3170 hill was reached at 06:45. Several traverses were made across the flat sediment-covered summit before the continuing problems with the SWVB forced a decision to terminate the dive. Sea Cliff departed the bottom at 08:30, 19 July, and reached the surface at 12:30.

Observations during this dive revealed the complex nature of the sediment hills which sit atop the SESCA volcanic edifice. The sides of the hill are very steep, although there are some narrow plateaus or terraces. The flatter shelves are cut by gullies that expose laminated mudstone. Piles of whitish mudstone observed around the dome flanks are interpreted as talus from the erosion of the steep slopes. The dome was mostly covered by greyish-green silt and showed signs of bioturbation. Circular patterns of 1 cm wide burrows spaced about 10 cm apart were commonly observed. Sea cucumbers and several types of anemones were encountered during the dive. No hydrothermal deposits were observed on this dive.

Dive 657

The second dive at the SESCA site began at 04:30 on 20 July 1986 under freshening winds and seas. The dive objective was to transit along the northern margin of the 3280 m basin to the south of the 3170 Hill (Fig. 3 and 5), in an area where hydrothermal deposits had been photographed and recovered by dredging. *Sea Cliff* reached the bottom at 06:45, and proceeded on a zig-zag track along the northern flank of the basin. *Sea Cliff* left the bottom at 11:30 and was on the surface shortly after 13:30, 20 July. Sea conditions had continued to deteriorate throughout the dive, and by the time recovery operations commenced, conditions were estimated at sea state 5. A difficult recovery was completed at 14:30, with only minimal damage sustained when *Sea Cliff* contacted the starboard propeller guard of *Transquest* and one of the bow-mounted strobe lights was torn from the fiberglass shroud of *Sea Cliff.*

During this dive the sediment covered sea floor was was observed to be broken by low ridges and valleys trending west and southwest. Piles of whitish mudstone were observed along the margins of the tracks that were cut through the sediment by previous dredging attempts from the *S.P. Lee.* Evidence of burrowing organisms, holothurians, varieties of sea anemones, and rattail fish were observed. Two samples of mudstone and one push sediment core were collected during this dive, but one of the rock samples was washed out of the sample basket during recovery of the submersible. No hydrothermal deposits or volcanic rocks were encountered.

Dive Interlude

At the conclusion of dive 657, sea conditions were too rough to permit continuation of the dive program. *S.P. Lee* continued to conduct limited scientific operations; *Sea Cliff* was secured and Transquest maintained station waiting for conditions to ameliorate. The seas built steadily for the next 24 hours, and weather reports showed no change in the long-term predictions. At 23:30 on 21 July, a decision was made to sail *Transquest* back to Eureka and wait for better weather.

Transquest arrived in Eureka to begin what was hoped would be a short interlude. What followed was a month-long period of high winds and rough seas that prevented *Transquest* from returning to the work area, despite several attempts. On 21 Aug, *S.P. Lee* departed Eureka to fulfill other commitments, and the U.S. Navy assigned *USS Point Loma* to act as surface support vessel for further dive operations.

With the weather showing a marked improvement, *Transquest* sortied from Eureka at 17:00, 21 August (day 32 of the Eureka hostage crisis). Conditions remained marginal throughout the transit to Escanaba Trough, but the seas dropped after *Transquest* and *Point Loma* rendezvoused in the NESCA area. Because of the unanticipated and lengthy interruption caused by the bad weather, and the limited remaining time that *Transquest* and *Point Loma* were available, only eight days remained to complete the 1986 dive program. Dives commenced again on 23 August. The dive time was split between the NESCA and SESCA sites in Escanaba Trough in order to further delineate the extent of the sulfide deposits mapped during the 1985 and 1986 work aboard *S.P. Lee*.

Dive 658

Dive 658 commenced at 12:00, 23 July at the NESCA site (Fig. 6). The dive was planned to begin in the flat plain to the north of the Central Hill, then traverse south to the edge of the exposed volcanic rocks, where it was to follow a northward traverse along the trajectory of dredge 14D (L2 86 NC), which had recovered high-grade massive sulfide. If time permitted at the end of the dive, an attempt would be made to recover malfunctioning transponder 4.

Sea Cliff reached bottom (3310 m) at 14:00 in the plain north of the Central Hill. This area is sediment covered and has low topographic relief. Bottom organisms such as holothurians, anemones, brisingids and brittle stars are fairly abundant, as are fish. Pyramid urchins appear to be the major contributor to feeding traces in the sediment. Stalked organism were occasionally observed.

Sea Cliff next transited south, up in the water column, to intersect the north facing slope of the Central Hill. We intersected a steep sediment-covered slope at 3238 m, and observed extensive areas of sulfide talus with some chimney-like projections. Some ridges of massive sulfide have near vertical edges which may be fault scarps. The sulfide here is often coated with white material interpreted to be sulfur oxidizing bacteria, and is heavily colonized by anemones with some crinoid. Galatheid crabs and asteroids are abundant. There are no indications of hydrothermal activity, and no live vent-specific fauna were seen. One cluster of dead tube worms was observed however, and some partly sediment buried disarticulated vent clam shells were tentatively identified.

The sediment covered north slope of the Central Hill is characterized by a series of stepped normal faults, which are down-dropped to the north. The fault scarps have 30° to 90° slopes and are 20 cm to at least 5 m high. Some of the terraces between scarps have reverse dips, possibly due to rotation on listric normal faults.

Scarps are generally sediment covered and only rarely expose layered sediment. Some areas of siltstone and mudstone talus were observed. Biologic activity is much more abundant on the terraces between scarps than on the steeper slopes, but is not as abundant as on the plain north of the Central Hill.

An extensive area of hydrothermal deposits was encountered at 3265 m. This area includes large areas of sulfide talus, with blocks and slabs of sulfide up to several meters in maximum dimension, and large constructional sulfide mounds flanked and capped by sulfide chimneys. Basalt talus and pillows were tentatively identified in a few areas, but these may have actually been sulfide deposits. The sulfide outcrops are separated by sediment covered areas. Some sediment covered areas near outcropping sulfide deposits disturbed by the submersible were observed to be underlain by fine-grained black sulfide sand. The extent of hydrothermal material is very impressive. Much of the material is very coarse-grained; reflections from individual crystals could be seen at a distance of a few meters from the submersible. The morphology of these deposits shows them to be the youngest of any observed during the dive program, although no hydrothermal venting or living vent specific fauna were observed. Several samples of massive sulfide and one sample of massive barite were collected. *Sea Cliff* departed the bottom at 21:00 and reached the surface at 23:00.

Dive 659

A battery charger malfunction delayed the next dive until 18:00 on 24 August. This dive was planned to complete some of the objectives originally scheduled for dive 658. *Sea Cliff* was launched over the flat plain north of the Central Hill (Fig. 7) and was to proceed eastward across the margin of the depression and then northward along the trajectory of dredge 14D (L2 86 NC). If time was available at the end of the dive, an attempt would be made to recover transponder 4. The primary dive objective was to locate and sample the high-grade polymetallic sulfide deposit sampled by dredge 14D, and it was hoped that the scour track left by the dredge would provide a landmark that could be used as a guide to the deposits.

The sea floor topography at the landing site was much rougher than anticipated. The hummocky bottom is cut by numerous channels that range from a few meters to about 50 meters wide, and are generally about half as deep as they are wide. The bottom of the deeper channels could not be seen without stopping to descend into the channel, and was in some cases measured with the fathometer. Some channels have rounded edges and slopes of 30° to 40°; others have vertical scarps. The channels were often asymmetric with one limb much steeper than the other, but both channel edges are generally at the same depth. These observations are consistent with channel formation by erosion. The walls and the floors of the channels are generally sediment covered, but discontinuous outcrops of mudstone occur on some of the steepest slopes. There is abundant evidence of mass wasting along the sides of the channels, but no evidence was seen for transport of material along the channel axes.

Some of the channels may have formed by collapse of lava tubes. Basalt was tentatively identified in one channel where a thin bed of dark rock was exposed along a vertical channel wall, and is overlain by semi-indurated, laminated sediment. The presence of horizontally bedded mudstone exposed along the steeper channel walls requires that the channeled areas were covered by sediment before they formed by either collapse or erosion. An alternative interpretation is that the dark layer is

massive sulfide which formed below the sea floor by lateral movement of fluid through sediment.

Some channels may actually be small grabens formed during extension of the sea floor. Many of the channel edges had the appearance of fault scarps, and open fissures were observed in the sediment in a few places. In particular, a 3 m high scarp, which exposed the largest deposit of sulfide encountered on this dive, was probably formed by faulting.

Hydrothermal deposits were encountered throughout the dive. Most of the hydrothermal material is sulfide breccia exposed by, or eroded from, the channel walls. Hydrothermal barite and altered sediment are also associated with some sulfide occurrences. The flatter areas between channels are also sites of hydrothermal deposits, especially near the channel edges. Sulfide in these areas occurs as partly sediment buried-talus, thin sediment covered sulfide crusts that were exposed by either slumping or buckling of the crust by upward displacive growth near the sediment-water interface, and small chimney-like projections of sulfide. Most of the chimneys are less then 1/2 m high and were partly covered by sediment. Some of these structures may may be sediment-buried chimneys with only their tops exposed, but others have clearly grown after deposition of the sediment. A few still had open central fluid conduits.

Although hydrothermal material was observed throughout the dive, no large constructional deposits were encountered. The largest deposit of hydrothermal material is exposed along a 3 m high scarp of undetermined lateral extent. The entire face of the scarp is covered by 10 to 30 cm angular blocks of massive sulfide. The flat terrace at the top of the scarp is covered by sediment, but small isolated sulfide chimneys and sulfide crust are present.

Biologic diversity is similar to that seen on dive 658. Sediment covered areas are bioturbated and the circular arrays of burrows referred to as fairy rings are common. Fish, holothurians, anemones, asteroids and urchins are all fairly abundant. Stalked animals such as branched, fan, and cork screw shaped sea pens and "wine goblet" glass sponges are less common. A commonly observed animal in areas of sulfide mineralization is the venus fly trap anemone. This anemone is not specific to sulfide outcrops, but does preferentially colonize hard substrates. Observations on this and later dives indicate that this animal also colonizes other stalked animals. When these anemones were disturbed during sampling attempts, they would retract and curl into a tight ball. Venus fly trap anemones and other filter feeders showed a marked preference for colonizing the crests of the channel walls. Less commonly observed animals included a large octopus, shrimp, galatheid crabs, small jelly fish, and a free swimming, spider-shaped animal (pycnogonid?) that was seen harvesting flocculant matter from the water column with its long legs. Some unidentified animals were observed. The effort to photo document the biology was not rewarded because of problems with the port side interior camera.

Dive 660

Concern regarding the condition of one of the batteries aboard *Sea Cliff* caused a 24-hour delay while the electrical systems were thoroughly checked. This situation also resulted in a change in dive procedures whereby a Naval officer replaced the civilian equipment operator. The objective of this dive was to transit across the north-trending faults marking the eastern margin of the Escanaba Trough valley floor (Fig. 8). Observations made during dive 658 suggested that the steep northern margin of the

central volcanic hill is at least partially fault-controlled, and that faulting might extend to the east and intersect the boundary faults which are marked by uplifted turbidite benches. One objective of the dive was to investigate the hypothesis that massive sulfide deposits formed along the trace of the proposed east-trending fault.

Sea Cliff was launched at 09:30, 26 August, and reached bottom at about 11:00 slightly west of the intended starting point. Communication conditions had improved, but the location of *Sea Cliff* with respect to the transponders resulted in poor tracking. *Sea Cliff* moved eastward over a field of huge pillow and lobate lava flows at a depth of 3280 m. The pillows are up to 3 m in diameter, lightly sedimented, and many have bread crust texture. The pillows appear to be young, with glassy rinds and little or no sediment cover. The bottom was colonized by white sponges and starfish, and a few rattail fish were seen swimming slowly in and out of the field of illumination. Strong easterly currents up to 2 knots were encountered in places.

After transiting eastward over the volcanic terrain for approximately one hour, the failure of a side pod propulsion unit and one manipulator arm forced premature termination of the dive. *Sea Cliff* surfaced at 14:30, and repair operations commenced immediately.

Dive 661

Transquest transited to the SESCA site while the side pod propulsion unit was being repaired. Continuing concern over the battery condition again limited civilian participation to one observer. The initial objective of this dive was to cut the mooring line on transponder 1 so that it could be retrieved by *Transquest*, and then proceed on a westerly course across the margin of the SESCA uplift and onto the base of the North Hill.

The dive commenced at 21:30, and surface controllers vectored *Sea Cliff* to the vicinity of the transponder mooring. The glass floats above the transponder were located using the CTFM sonar, and *Sea Cliff* descended along the mooring line to the bottom. The cable cutter installed in the starboard manipulator was used to cut the mooring line just above the anchor, and *Sea Cliff* then commenced the westward traverse.(Fig. 9)

The gray-green muddy bottom in the vicinity of transponder 1 is colonized by urchins, holothurians, and sea pens. Accumulations of brownish organic debris, possibly fecal pellets, were seen near some of the rings of small burrows (fairy rings). The sea floor slopes gently down to the west, steepening to about 30° over the eastern flank of the south-trending valley bordering the SESCA area (Fig. 3). On the western side of the valley, the sea floor has a N-S trending ridge and swale topography, similar to the terrain observed north of the Central Hill at NESCA on dive 659 . Amplitudes of the ridges range from 2-5 m, with wave lengths on the order of 10-20 m. Scattered outcrops of mudstone occur near the crests of the ridges. Sulfides were encountered at a depth of 3230 m at the base of the North Hill. The deposits consist of broken mounds and stubby chimney-like protuberances spaced 1-3 m apart along the upper part of a ridge. The sulfide deposits observed on this dive appear to be continuous with the large deposit observed on dive 662. No evidence of hydrothermal discharge was observed.

Several hydraulic leaks developed in the port manipulator at the commencement of sampling operations in the sulfide field. Sampling attempts were aborted, and abnormal electrical leakage and ground readings forced the dive to be

terminated at 04:30, after approximately 3.5 hours of observations. *Sea Cliff* was recovered shortly after 06:30, 27 August.

Dive 662

Battery conditions had improved enough after a lengthy charging and maintenance period to once again allow two scientists on the dives. However, the manipulator arms could not be serviced at sea, which limited sampling operations for the remaining dives. The plan for this dive was to traverse up the southwestern flank of the northern sediment hill at SESCA (Fig. 3 and 10) in order to investigate sulfide deposits that had been observed at the base of the North Hill on several camera runs, and recovered by dredge 22D (L1 86 NC).

Sea Cliff was launched at 01:00, 28 August 1986, and reached bottom at 02:30, in 3277 m water depth in an area of heavily sediment-covered pillow basalt. *Sea Cliff* traversed northeastward toward the northern sediment hill crossing areas of total sediment cover and areas with some exposed pillow basalt. The pillows are typically 1-2 m across, bulbous, and generally show inflationary features such as trap door break-outs and bread crust texture. Some areas of sheet flow were observed, including areas with large sheets of foundered lava crusts and areas where bulbous pillows 1-3 m across had been extruded from break-outs in the top of the sheet flow. Truncated sheet flows are also exposed in several fault scarps. One fault scarp was active at the time of lava extrusion as lava that had cascaded over the scarp was subsequently faulted. Another scarp bounds a reverse-slope sediment-covered bench at approximately 3260 m. Beyond this is an area of sheet flow cut by open fissures 10 to 100 cm wide.

No volcanic rock is exposed above the base of the North Hill at a depth of about 3250 m. The slope of the hill continually steepens upward giving the slope an exponential curve shape. Even near vertical portions of the slope are sediment covered with only rare outcrops of mudstone and siltstone. The slope is clearly a mass-wasting scarp and the edge of the hill is retreating by erosion. The slope is cut by sediment transport grooves and mudstone talus occurs at the base. However, the volume of talus at the base of the slope is minor compared to the amount of material eroded, and has not completely buried volcanic rocks that crop out near the base of the hill. Slope failure may be catastrophic and the unlithified mudstone and siltstone that forms the hillside may disaggregate and be removed from the immediate depositional area as density driven mass flows.

The top of the scarp was reached at 3186 m after which *Sea Cliff* contoured along the scolloped edge of the scarp to the south side of the hill. The scarp is so steep that the port side observer could see nothing but the flat, hummocky, bioturbated hill-top less then 1 m below, while the starboard observer could not see bottom. The south side of the hill was descended and the track from a previous dredge attempt was encountered, then followed toward the south.

Sulfides were first encountered at a depth of 3235 m on a flat sediment-covered area near the base of the hill. The area of sulfide outcrop is only a few meters square, and consists of a few 10-20 cm high chimney-like projections and minor sulfide crusts a few cm thick. This isolated occurrence is very similar to deposits observed on dive 659. Attempts to sample this material were unsuccessful due to problems with the hydraulic manipulator arms.

A traverse towards a strong Mesotech sonar reflector was taken across a flat sedimented covered bottom, then up a slight slope that tilts back toward the North Hill,

and into an extensive area of massive sulfide mineralization that occurs between depths of 3228 to 3242 m. The Mesotech sonar display indicated that deposits were 20-30 m wide and at least 100 m long, and extend eastward parallel to the hill slope toward the deposit observed on dive 661. The deposits observed are mostly large mounds of sulfide which are generally massive, but occasionally brecciated. The submersible occasionally drove through valleys between mounds such that observers on both sides of could see only walls of massive sulfide extending above their field of view. The outcrops are rounded and somewhat weathered and chimney-like projections are not common. One 2 m high vertical projection about did present a sampling opportunity. Several kg of sulfide were collected without the use of the non-operative manipulator arms by ramming the outcrop with the sample basket.

The sulfide outcrops are heavily colonized by starfish, sponges, anemones, basket stars and a variety of stalked animals. The biology observed on the rest of the dive is similar to that described for the preceding dives except that stalked animals are much more abundant due to the presence of the basaltic substrate. Stalked animals include simple sea pen-like animals, "wine goblet" glass sponges, crinoids, fan shaped seapens and tall, straight and branched seapens with a shape similar to ocotillas. A large percentage of the stalked animals are colonized by other animals. Of particular interest was the recognition that the "stalked venus fly traps" are the same animal as the "venus fly trap anemones" commonly seen attached to rocks on dive 659. The fly traps were seen attached to the stalks of several different animals, and occasionally more than one generation of fly trap colonized the same stalk.

A portion of this dive traversed along and filmed the track from an earlier dredging attempt from the *S.P Lee*. The observations showed that the behavior of a dredge on the bottom can be complex. In many areas only the chain bag of the dredge was dragging on the bottom, in other places the dredge dug as much as a meter deep into the sediment. Where the dredge dug into the sediment it always exposed white mudstone beneath the grey-green to brownish surface sediment. Blocks of whitish mudstone are strewn for a few meters to either side of the track and it appears as though the dredge was "bulldozing" its way through the sediment. Large gaps were observed in the track where the dredge left bottom. In one area the dredge track made a near right angle turn around a small sediment mound. In other areas, marks were seen that show that slack cable was laying on the bottom. One conclusion from these observations is that a dredge which is dragged through unconsolidated sediment can fill with sediment and prevent the recovery of hard rocks. The sediment would be washed from the bag during recovery resulting in an empty dredge haul. This was a common occurrence on Leg 2 of the 1986 *S.P. Lee* cruise.

The dive was terminated at 09:30, 28 August 1986, and reached the surface approximately two hours later.

Dive 663

The Navy *Sea Cliff* crew preformed rapid post- and pre-dive checks allowing the *Sea Cliff* to be back on the bottom 7 hours after it left bottom on dive 662. *Sea Cliff* landed on a flat mud covered bottom at 17:00, 28 August 1986, in 3270 m of water just north of the base of the 3170 Hill at SESCA (Fig 11). The dive track was planned to traverse up the north face of the hill just east of the track of dive 656, then cross the top of the hill and descend along the south slope. Sulfide deposits had been observed on both flanks of the hill during work on the *S.P. Lee*.

The track of dredge 15D (L1 86 NC) was encountered and we followed the track to a ledge of massive sulfide exposed between 3246-3256 m. The outcrop was generally exposed over a 5 m depth interval, and was followed for nearly 100 m. Two locations were sampled (without the use of the manipulators). The massive sulfide is exposed along steep to vertical faces, and in places is cut by erosional mass wasting channels. The top of the sulfide exposure is sediment covered and the flat sediment bench uphill from the deposit may have formed by ponding of sediment behind the deposit. These are the oldest deposits encountered during the dive program. All of the exposures are highly weathered and the outcrop surface is commonly made up of a jagged, porous mass of iron oxide and barite left after dissolution of the sulfide. The outcrops are colonized by starfish, anemones, sponges and stalked animals.

After investigating the sulfide deposits a traverse was made up the side of the hill. The geology of the 3170 Hill is identical to that of the North Hill observed on dive 662. The hillside is a series of sediment-covered mass wasting scarps that are near vertical at the top of the hill and flatten downward. Mudstone talus occurs on the lower, flatter slopes, and layered mudstone crops out on the upper, steep slopes. Some of the outcropping mudstone has been exposed long enough to be coated by discontinuous manganese oxide crusts. At least three separate scarp steps were encountered before the top of the hill was reached.

Tracks form *Sea Cliff* dive 656 were encountered both on a flat sediment bench at the top of one scarp and at top of the hill. A dredge track was encountered that indicated that the dredge had alternately scoured the sediment and rolled down the slope.

Evidence for strong bottom currents was observed near the edge of the hill top, including mudstone talus lag deposits and sediment ripples with wave lengths of 20-30 cm and amplitudes of 3-6 cm. The top of the hill is totally sediment covered and very flat, with a very slight slope down to the north. The sediment is heavily bioturbated, but there appear to be fewer animals than typically seen on flat sediment covered-areas. A scarp that bounds the south side of the hill was reached at approximately 3170 m depth. From this point the *Sea Cliff* transited southwest through the water column and descended to the base of the hill at 3224 m and landed on a sediment covered bioturbated bottom. Low battery levels forced termination of the dive before the sulfide deposits discovered by *S.P. Lee* could be located. The submersible left the bottom at 21:20 and surfaced approximately two hours later. *Sea Cliff* was secured on deck and after recovering another transponder using conventional surface interrogation techniques, and *Transquest* proceeded to Eureka, arriving at 21:00, 29 August 1986.

APPENDIX II.
TRANSCRIPTS OF DIVERS VOICE RECORDERS (Hdg-Gyrocompass heading, Photo-Approximate handheld photo number, Obs-Observer (P-Port observer, S-Starboard observer, and E-External camera photo descriptions))

DIVE 656

Location: SESCA
Port observer: Bill Normark
Starboard observer: Mark Holmes

Julian day: 200
Date: July 18-19 1986
Pilot: Bruce Bosshard

Time (GMT)	Depth (m)	Hdg	Photo	Obs	Comments
03:18				P	Voice check during descent. First time I can just make out the bottom.
				P	At 20-25 ft elevation, can barely make out the bottom. Some rock outcrops, mostly mud cover, and a fair bit of suspended sediments--perhaps (stirred up) by the number of selective weights that have been dropped.
03:25:30				P	Sediment kicked up makes observation impossible. Have been having trouble adjusting trim--it appears that a descent weight did not drop.
03:30				P	Moving forward--down to just above the bottom. The sea floor is sediment covered. (I) see many different piles of excrement, several large holothurians, mostly buried in the mud.
03:31	3270			P	Light off while we have kicked up a huge cloud of mud, still attempting to come to trim. Bottom in sight again and descending.
03:52				P	Moving, slowing just above sediment covered sea floor.
03:53:40	3273			P	on bottom.
03:56				P	First hand held photo--as a continuation of roll that Mark started at surface (Sea Cliff/TQ deck shots. Shot at *f*5.6--will try second shot, same alt. at *f*4 (don't think I got second shot off)
03:58				P	Pilot reports a significant current from out port quarter (astern); it means we have to keep moving to avoid sediment cloud kicked up--2nd photo has not been taken because of sediment cloud
04:20:30				P	Looking at range and bearing to target (received from LEE); decide to proceed on course 180°, which should carry us up the north flank of the dome.
04:25				P	Have external camera on at 16 sec. rep. rate-begin traverse to south to dome.

04:26				P	Have fired 3 shots with hand held (tape says external) camera--strobe has not fired. Strobe check by shorting cable connectors shows strobe itself is functioning.
04:29:30				P	Still moving over sediment covered bottom--moving upslope, many signs of burrowing and fecal piles on sediment. External camera only working.
04:34:45	3273			P	
04:47			1	P	Underway again for little over a minute-have fired hand held camera again, new roll of film using Jan's camera; this time strobe has fired, so I think we're set to go again on this side (for handheld (hh)). External camera is on, 16 sec. interval
04:49:20	3222			P	
04:50:50			2	P	Taking 2nd hand held--very close to typical, mud covered sea floor. This is just before we hit the bottom and stirred up a great deal of mud. External camera is turned off while mud is kicked up.
04:50:55	3368	187		E	Sulfide?
04:55				P	We are now moving across the bottom again; external camera back on. We're still over a mud covered bottom (with) extreme evidence of bioturbation.
04:56:10	3265		3	P	Hand held of a critter-3rd picture.
04:57				P	Bruce reports a steep slope, mud-covered in front of us, and we're pumping light trying to get over this (slope?) External camera off as mud is kicked up.
04:59:05	3261		4	P	Another hh photo-should be a holothurian near left side of frame.
05:00	3260	159	1	S	Bottom mostly muddy. Small dome approximately 20-25 cm across, 10 cm relief, with white stalked animal in foreground.
05:03				P	Visibility obscured again, sediment is kicked up. We're turning slightly to port (to go) upslope.
				P	Are we on the north side of the dome, do you think? (Mark asks) Yes.
05:03:05	3256			P	Moving down gentle slope several meters (Sea Cliff call to LEE in background)
05:07				P	Have been stopped for approximately one and one half minutes. An outcrop is in front of sub. Texture is very porous, could easily be hydrothermal deposit. Will attempt to sample.
05:14	3258			P	Have plotted position received from surface approx. 05:10 x=12342.1 y=13610.6. This plot

					puts us approx 50 m. SW of target J. Water has cleared and (we are) preparing to take first sample at this locality. Depth=3258/9
				P	Frame #341 on external camera is picture of sample. Bruce reports it is very fragile and we hope it will last transit back. This will be sample #1 for this dive.
05:17				P	Sample is in basket
05:22					
				P	(We are) underway again, coming to course 045° to find target area J-K.
05:25	3255	100	2-4	S	Small rock exposures near a drop-off, dropping away to the southwest.
05:27				P	Have been moving approx. 090° over mud-covered slope, heavily bioturbated and occasional (sic) animals. Hand held picture ~15 sec ago.
05:27:55	3249			P	Steep slope in front of us
				P	Steep slope. We again have problems coming to trim and pumping lighter, kicked up sediment, and external (camera) is off. Nothing to see out porthole.
05:35	3236	085	5,6	S	Continuing upslope. I've just taken a picture of white domes of what could be weathered rocky material on the slope. It was hard to say from a distance, and we appear to have crossed a dredge track here on the north side of the dome. That was the next still picture taken.
05:36	3231	080	7	S	Just took a shot that may have been obscured by a mud cloud, but there were definite bed-forms and ripples that were parallel to our course of 080 (088 true).
05:37	3230	065	8	S	Very steep drop-off, possibly 25-35°, off to the starboard side of the submarine now. Picture was taken right after that last announcement.
05:41:30			5	P	Take hand held photo of a steep slope up outside, which has a lot of small, white chunks---looks like a lot of loose pieces---in the center of the slope. Unfortunately, the sub ....Ah, what is this big thing?....from the sub it looks like.....Mark: "External's going". Normark: "can you see anything (or) is it too cloudy out there? Bruce and Mark are too faint.
			9	S	Large domes of the whitish, exposed material. Just dropped the recorder. I hope to take a picture of a large stalked animal that went by the starboard porthole. We're still transiting

					upslope. I was describing the large mounds of whitish material that appear to be deposited on or protruding through the sediment.
05:42(approx)			6	P	Took hand held photograph of a flat white surface out the window--very smooth, standing up, and it looked like--broken---now moving forward slowly again. Still have the slope up, again covered with small, light-colored irregular pieces. Almost looks like a clump or cluster--not cluster, but clumps of harder objects that have come rolling (down the) hill. Handhelds to this point have been taken to this point at f5.6--now go to f4 for a few shots
05:44:40				P	Again pumping to try and get light and have kicked up sediment and there is no clear shot at this time
05:45	3250				
05:50			7	P	Hand held photo showing a small scarp with horizontal laminations or grooving which may have been caused by (this) sub touching bottom, but it is not clear because immediately below the outcropping, the sediment looks basically undisturbed.
05:52				P	Now pumped light and trying to go up the hill. Very steep and appears to be angle-of-repose scarp.
05:53			8	P	Hand held photograph showing what appears to be groove, from material sliding down the face but with perhaps a layering in the dome itself.
05:54	3241			P	Still moving along steep slope. Bruce reports what appears to be an old dredge track.
05:54:40			9	P	2nd of set of hand held photos of larger of these whitish colored chunks on a very steep slope. Bruce is reporting a dredge track in front...Bruce says something...
05:54:44	3239	097		E	Trench in sediment, possibly mark from dredge cable.
05:55:10	3236			P	
05:56:05	3233	086		E	Parasite on top of stalked animal.
05:56:10	3232	080		P	Moving upslope
05:56:30				P	Slope is now gentler than it was. Now back to small mounds and burrows.
				P	COMMENT: Referring back to sighting of dredge track. Out the port side saw marks that formed a chevron--as would appear if you had an anticline exposed on sediments, very strange.
05:58	3226		10	P	Another hh photo of this slope.

05:58	3226	077	10	S	We're nearing the top of the dome now. That was actually a plateau. Took another still picture of one of the large stalked animals that passed just outside the viewport.
05:59	3224		11	P	hh photo of lip of a small terrace with a depression in back.
05:59:25	3221				
06:00	3214	100	11	S	Picture of one of the very large, exposed white rubble domes near the crest of the large dome across which we are transiting.
06:00:30			12	P	hh photograph of the fairly moderate slope with some of the white rubble, but still some signs of mounds and burrows.
06:01	3212				
06:02:40	3204				
				P	We have come to another break in slope, we're now rising above the bottom and I can barely see the sea floor.
06:03:50	3199			P	Still moving up slope; bottom is quite steep. I can make it out, but not quite close enough for photographs.
06:04:12	3198	116		E	Ray on sediment covered bottom.
06:05	3195		13	P	Hand held photo--in the right and distant part is a huge fish and on the left side a billowing cloud of mud that now engulfs the whole porthole.
06:06	3193			P	We've kicked up a big cloud again and are still trying to pump light.
06:07			14	P	Hand held photo of a large brittle star.
06:07:30			15	P	Photo of a stalked animal that looks something like a venus fly trap hanging upside down.
06:08:10	3190		16	P	Photo of a black, holothurian-like organism.
06:09	3188			P	Moving across sedimented bottom still moving slightly upslope. Bottom is heavily bioturbated with many mounds, and brittle stars, holothurians, sea pens.
06:12	3185			P	We've now come to another slope on course 180°. Will now move upslope.
06:13				P	Again we've hit bottom, need to pump light to get over--cloudy water precludes seeing the bottom.
06:14:00	3183			P	Moving again.
06:14			17	P	Hand held photo of one of these purple-black critters with the dimensions of a holothurian.
06:15				P	Change course to about 15°, to go more directly upslope to the left.
06:15	3181	163		S	We're still rising upslope. The dip of the slope is actually about 70° to starboard, with a sub

					heading of 165°; between 70 and 90° to starboard.
06:17	3178			P	Now it's generally flat or gently sloping upward to the port side. Bottom is still completely sediment covered. Lots of mounds, burrows and small attached organisms.
06:17	3178	148		S	Even accounting for distortion, it appears that the flanks of the hill are terraced with several false summits as you come up. Some of the slopes falling off to the starboard side of the vehicle have to be approaching 35° at least, very steep, but short, pitches down to the next terrace or platform.
06:19			18	P	Hand held photo of an attached organism, very slender and forms a curl shaped (like) a pigs tail (?) with small ornamentation.
06:22	3175			P	In a distance, I can see a dropoff on the port side, which appears to be the edge of the mound.
06:22	3175	035	12,13	S	Two shots of a large white fish hovering over the bottom. We're near the crest of this large dome and are plotting our course from this point.
				P	External camera will document top of this mound, basically just burrows, small mounds.
06:30	3176			P	Plotting position given from LEE x=12,628, y=13,412
06:30				P	Our plot agrees with the LEE's which says that to target L(Lima) (top dead center of this (3170) hill), (bearing) is 200°, range about 200 m. We have been resting on the bottom in a quiet condition to allow them to get the position.
06:35				P	We are moving, have got the external (camera) on again, and a frame count of 467.
06:35	3176	220		S	We are now moving across the crest of the dome. It seems to be fairly flat-topped. We're headed for target Lima. We will drive past target Lima to the south-southwestern edge of the plateau and then turn back around and head to the north.
06:36	3175			P	Summit is completely muddy so far and showing signs of heavy bioturbation--excrement piles, burrows, mounds are common--external photos are documenting the summit.
06:37	3176	204	14	S	Just passed over a scarp that fell sharply away from us. Just below the crest there were ripple

					marks, I couldn't see how far downslope they went, they appear to be 10-15 cm wavelength. I took a picture at that point, but it may have been too far over the slope to show anything.
06:37:50	3176			P	Now moving down a slope, which at this time (06:38), is getting appreciably steeper--whew--this is a really steep slope--yeh, I can see it ---some discussion by Bruce---turn to the port--I think you want to turn about 90° to left--Bruce reports--'I see little bit of the bottom now'.
				P	Want to go straight down this---?(Bruce) This looks too...I'd just like (off with recorder).
06:39	3185			P	Have come down to 3184 m fairly rapidly, very steep--we are now going to change course 90° to the left and move back on top of this feature.
06:41			19	P	Hand held photo at this very steep slope. A lot of this light colored material that looks like it is at angle of repose, sliding down this mound.
06:42:40	3181	180	20	P	Basically going along very steep slope from left down to the right. Another hand held photo just before this log entry showing the lot of white stuff exposed on this steep slope.
06:46	3171	150		P	We seem to be back up on top of the mound.
06:49	3170			P	Moving across the relatively flat, sediment covered mound.
06:50:50			21	P	Hand held shot showing a dropoff at the upper part of the photo and a few dark animals in foreground.
06:51	3169	156	15	S	Hand-held picture of one of the thin corkscrew-like white animals; bottom attached.
06:52				P	Moving near the edge, on the port side, of the summit--amazing number of these holothurian shaped critters that look more like elongate tunicates or something.
06:52:20				P	I lose the step on the left side and now seems to be open summit again, flat, sediment covered.
				P	One of these black, elongate (holothurian) like creatures was rolled over by our pressure wave and has two holes on the bottom side--one small, centered and one larger one near opposite end that was off to one side.
06:54	3169	135		S	Very steep drop-off to the starboard side, approximately 090° relative, at least 35°.
07:01				P	We're coming underway again after getting a position; coming to course 300° and move ~100 m for point L.
07:04	3169	280		P	Trying to move over to find spot L.

07:04:20				P	Just moving over edge of scarp.
07:05:40	3184			P	We are...just bumped into the bottom.
07:08	3190	017		P	Has been no view out the port side for last 3 min.
07:10				P	Still above bottom, can't see a thing.
07:13:30	3212	247		P	Bottom is not in view yet.
07:14:40	3221	213			
07:15:40	3227	170			
07:20	3236	297		P	Still do not have bottom in site.
07:21	3240				
07:22:45	3244			P	Still bottom not in site.
07:25	3248	303			
07:25:45	3244			P	Back on bottom---or, within view--It is still just a mud-covered bottom as we've just seen here regularly--intense bioturbation.
07:29	3251		16	S	We're sitting on the bottom while the LEE gets a fix. Just took a still picture of a sea anemone off the starboard side with a fish passing by it.
07:30				P	After receiving a position from the LEE, decided to try a transect up the west side of this hill--coming on course 104°, and make one other attempt to intersect position (target) L(ima).
	3251			P	We've been resting on the bottom since the previous information (entry).
07:42	3250	115	17	S	Still picture taken. In the right side of the still picture will be one of those white mounds poking up through the sediment.
		104		S	We're commencing a run back across the dome on course 104°, attempting to pass over target Lima.
07:43	3249	099		P	We are starting transect uphill, but have immediately gone into a large white cloud again.
07:55	3231	090		S	For the past 45 minutes we've been encountering very substantial clouds of mud in the water column, extending up 3-4 m. The areal extent of these makes it difficult to explain merely by our interference and impact on the bottom, which has been few, as a matter of fact. We're unsure whether these could be larger-scale disruptions of the bottom sediment, by hydrothermal circulation possibly.
07:58	3229	178	18,19	S	We've come to rest on the side of the hill in an area where there's lots of exposed rough debris, and I just took two bottom shots. The slope was going up to the starboard side, so

					we were against the slope on my side. Very close, so I hope they're in focus.
08:02	3231	270	22	S	We're in on the side of the hill. I took another still picture of the exposed rocks on the starboard side. I have the hand-held video now against the starboard port, and I had a few moments of very nice exposed white rock, them some clouds of debris, now it is coming back into focus.
08:10				P	There was a gap of unknown length at this point as the pause button was stuck in the on position.
08:46				S	Going up past 10,000 feet.
					End of voice log.

DIVE 657

Location: SESCA
Port observer: Mitch Lyle
Starboard observer: Drew Carey

Julian day: 206
Date: July 24, 1986
Pilot: Mike Ruppert

Time (GMT)	Depth (m)	Hdg	Photo	Obs	Comments
05:14				S	Ship heading 357°, Sea Cliff 320°.
05:31				S	Vents open, start dive. Bottom sounding 3257 m.
06:22	2160				
06:42	2960			S	Drop descent weights.
07:06	3291			S	On bottom, landed on slope near whitish mound.
07:19				P	On the bottom, making a series of meter readings, then will drive to a target 60 m away.
07:25		062		P	Driving to target spotted on CTFM. Outcrops, soft, blocky, appearance of one like someone dropped a cement block into the bottom. Large numbers of outcrops, on reasonably steep hill, goes down to port at 15°.
07:33				P	Parked on first station. Ruppert instructed to pick up a black rock. We see some outcrops, blocky, black sulfide-looking outcrops, plus smaller, perhaps vein-like material. Outcrops have animal life on them, but no obvious vent organisms.
07:39:17	3286	235		E	Coarse blocks of mudstone talus, possible pillow in distance.
07:40				S	Whitish rocky outcrops. Picture of rock sample before placement in sample basket, section D.
07:47:06				S	Basket-scraper-scoop not working when used with down thrusting motion. Should be used working from bottom up with shovelling motion.
07:53		221		P	Still at sampling site 1. Everything blocky, black coating on everything, may or may not be sulfides. They were very crumbly when we tried to pick up one. (R-1 sample). See a hard surface layer that sort of breaks up. Can see it breaking as it goes down the slope. Looks like a broken up pavement going away. We're on a ridge right here, can see another small ridge vaguely in the distance. Have no real feel for small-scale topography.
07:54:43				S	Soft sediment with gorgonians. Many Paelopatides Confundens. Many fecal castings- coils, mounds, extrusions. Air to water magnification. Much bioturbation. Starfish (Echimastes).

08:06		212		P	We are preparing to leave sample station 1. Tried a scoop sample, but didn't get anything but mud. Going to drive 300° to target D.
08:10		310		P	Driving off station. Apparently a mound, because after driving off (I) am now 2-3 m above bottom. There are a few outcrops of indurated sediments around here and a lot of talus around the main pile.
08:12:47	3288	338		E	Smooth sediment covered bottom.
08:13		322		P	We just crossed over a ridge and dropping further down into the basin. The bottom here is mud.
08:14	3293	310		P	Dropping down another ridge, and must be going into basin.
08:18	3297	286		P	Have part of R-1 sample in forward port basket as well.
08:19	3296	272	5	P	Typical bottom with benthic organisms in it.
08:23:49	3297	276		E	White "legged" holothurian and jellyfish shadow.
08:24			6-7	P	Pictures taken of various sessile benthic organisms, still driving for a target in the direction of D, but only 200 m away. Driving over mud bottom, 100 m to target and closing.
08:25	2396	284		P	Coming up on target somewhat. Bottom beginning to slope up, still mud however. Quite a lot of varied benthic organisms in background area: holothurians, crinoids, seapens. Still no sight of rocks. Coming up slope, still no outcrops.
08:29:46	3291	307		E	Brown derby jellyfish.
08:30				P	Coming on big hill. Seems to be where target was. Don't see target on CTFM, but still on mud bottom.
08:31	3283	300		P	We seem to be coming to top of hill that made the target. No outcrops, will keep driving over it. Top.
08:31:40	3283	309		E	Horizontal stalked creature. Pulled over by asteroid?
08:37	3281	309		P	Topography here is rather abrupt, even though every thing is smooth and sediment covered. Driving up a ridge, turned a little bit to the right and dropped down about a 30° slope. Bottom went down about 10 m or more, but there are no obvious faults.
08:39	3273	281		P	Top of another ridge. Drops off about a 5°-10° slope to the port side. Still no sign of outcrop.
08:40:03	3272	288		E	Exposed patch of sand?

08:41		292	P	Just coming over the edge of something fairly steep. Bottom dropped off 10-15 m, and still dropping.
08:45	3271	328	P	We have crossed one of our dredge tracks. We will follow it.
08:46:01	3271	326	E	Dredge track in distance.
08:46 to 09:11			E	Dredge track.
08:51		331	P	Stopped to take push core (PC-1) in our dredge track. It is going through some of the whitish material we've seen in photos, material does not look like sulfides. Looks like sediment, but is not normal bottom sediment. Could be indurated or could be some sulfate.
09:02:17			S	Start trip to next station (D). Hand held photos en route, sea cucumbers, "squiggle" sea pens, pyramid urchins, rattail fish. Video camera recording. (Hand held, starboard port).
09:02:21			S	Soft sediment, tracks, zooplankton (lots of small crustaceans in water) along with sediment cloud.
09:05			P	We took sediment core (PC-1), trying to put it back in holder, at sample site 2. It is a soft (anhydrite?) mound with dredge track through it.
09:16:12	3280	318	E	Dredge track with red shrimp.
09:17			P	Started driving, following dredge track.
09:19	3279	318	P	Dredge track on starboard side. (I switched sides with Drew so he could see bottom some.) Can see track in video I'm taping now. Bottom is relatively muddy and flat, coming out on top of small hill.
09:19:19	3280	322	E	Turbidite(?) block exhumed by dredge.
09:22:50	3279	313	E	White block exhumed by dredge. The block broke apart upon impact with the sea floor.
09:23			P	Flying by dredge track. Can see outcrops, a lot of indurated sediment, as you can see on video tape. Whole field of broken out pieces of white debris. As we cross dredge track, can see huge chunks of sediment sticking out. Really deep gouge.
09:25	3282	321	P	Ruppert reports second dredge track crossing first.
09:27	3280	331	P	Looking out starboard window, following dredge track. See several outcrops of white indurated sediment.
09:31	3283	055	P	Changed course at the recommendation of S.P. Lee to head for target D. Definitely indurated sediment sticking out, no obvious anhydrite or sulfide patches.

09:33	3282	054		P	Passing over another dredge track.
09:35	3275	072		P	Crossed another dredge track.
09:37				P	More outcrops of white material. These seem fairly common in area. Rising up some sort of mound, can not tell if it sticks up above typical topography.
09:42:19	3273	349		E	Purple sea snake.
09:44:25	3272	031		E	Unknown red animal.
09:43	3272	045		P	We're driving over mud bottom going slightly up hill. Not very much to report.
09:54	3278	268		P	We're driving toward F right now passing over mud bottom as usual. Some reasonably steep slopes. This one here is dropping off to port at 15°. There is no obvious shape to things, though generally rising to the north of us, similar to Mark Holmes map.
09:59	3287	308	10	P	Crossed a dredge track again, will follow that some more. (I'm back on port side.)
09:59:43	3287	322		E	Sediment disturbed by dredge track.
10:01				P	Some little white domes look really like they've been pushed out of the sediment. They're really rather odd looking, more like somebody dumped a pile of white clay on top of the brown mud. They don't really look so much like they're growing out of the bottom as much as if something dropped them on the bottom.
10:02				P	See a second dredge track that can't be more than 5-6 m from the first one. We must have been driving fairly well.
10:03	3286	341	12	P	We seem to go slowly up hill. We're following one dredge track and can see a second that's not more than 3 m from the first. Picture of a stalked benthic organism right in the center of one of the dredge tracks. Question: are these fresh or old dredge tracks?
10:03	3286	341		E	Stalked purple anemone exposed through disturbed sediment.
10:06			13	P	Picture of sea anemone with dredge track in background.
10:07	3286	339		P	Taking picture of dredge track, you can see normal damage by the dredge. I think a lot of the material was thrown up by the dredge.
10:07:36				S	Lots of Paelopatides.
10:09:44	3286	343		E	Two ages of venus fly traps on the same host..
10:11:16	3286	002		E	Bottle brush animal.
10:12:15	3286	002		E	White golf ball appears next to the bottle brush.

10:14	3286	345	P	Going to try to sample benthic organism that resembles venus fly trap, it fell apart during sampling, not sampled.
10:42	3304	270	P	Driving off to target F.
10:49		270	P	Had problem with hydraulics, are ignoring it.
11:00	3305	347	P	Driving away trying to head for F. Over mud bottom, no outcrops.
11:13			P	We're being pushed around badly by bottom currents, trying to drive 270. Trying to pick course we can drive.
11:18		172	P	Driving 10 m off bottom to get out of mud cloud. Nothing out window.
11:21	3306	272	P	Bottom in sight again.
11:43		025	P	Coming back to bottom. Still having trouble with current. Trying to drive out of mud cloud.
12:00	3262		P	Terminating dive.

DIVE 658

Location: NESCA
Port observer: Robert Zierenberg
Starboard observer: Mark Holmes

Julian day: 235
Date: August 23, 1986
Pilot: Terry Owen

Time (GMT)	Depth (m)	Hdg	Photo	Obs	Comments
				S	This is tape number 1, starboard observer, Sea Cliff dive 658. The dive program is once again underway after a one-month hiatus due to bad weather. The northern Gorda program at GR14 and GR15 never got off the ground. We'll be diving on the lava lake north of the NESCA central dome. Plan is to traverse to the SSW until we reach the dome, conduct a study of the lower margin, then head generally northward along the track of dredge 14.
11:50				S	Launch from Transquest
12:03				S	Vents were open
12:10				S	Descent began at 0510L.
13:30	3030			S	Passing 3000 m.
13:33	3110			S	Dropped descent weights.
13:33:00	3124			P	Dropping descent weights.
14:18	3309	032		S	We are on the bottom. Water depth 10,745 ft (uncorrected). Rob is making observations while I'm attending to housekeeping duties right now.
14:20	3308	015		P	On the bottom, very smooth flat sediment covered bottom. There is a purple holothurian and a few small white stalked organisms. Very high concentration of "organic plankton" in the water column. A purple urchin right below me. Very smooth sediment covered bottom, sparsely populated by a few holothurians and a few stalked organisms.
14:31	3310			P	Just above the bottom, very flat bottom with small mounds of about 5-10 cm of sediment. Fairly densely coated with small organisms, white slimy looking tentacled organisms, which seem to be driven by a strong bottom current moving about 180°. Some fecal matter, up to 2 or 3 cm. Very sparsely populated by holothurians, the small white organisms and an occasional urchin.
14:33				P	Picture one at 14:33 is a purple holothurian.
14:33:44	3311	035		P	Sediment as described. Fairly strong bottom current which is moving the small organisms and some flocculant matter in traction along the bottom.

14:35			P	A few very small white stalked organisms like sea pens, but generally not too many stalked organisms and nothing but very small organisms stuck on the bottom, very few holothurians. Much of the bottom is small sediment mounds, usually less than 5 cm high and 10-15 cm in diameter.
14:36:35			P	White brittle star, a field of them, two or three, about 10 cm from arm to arm. A purple holothurian, a few poorly developed fairy castles in amongst the other mounds which are more irregular.
14:37			P	Picture two white stalked sea pen.
14:38:19	3317	022	P	Approaching some kind of change in slope ahead, starting to drop off at about a 45° angle. (Pilot: It drops off to the right.) Slope increases to about 70° angle ahead. Just passing a large, about 50 cm across, brittle star. Slope heads off to the right, our heading is 022. Just passed over a large fairy castle surrounded by holes, only two of the holes looked to be partially open, the rest are sediment filled. Apparently only two were being actively burrowed, the two open holes were adjacent.
14:40:22			P	Passing a bluish colored large fish about 30 cm long, and coming up on a stalked, apparently a crinoid with a strange star-like creature... Picture number three is a stalked crinoid, and in the foreground, if it shows up, is starfish- like creature, but more webbed, and somewhat gelatinous looking.
14:41:07	3317	035	P	Changing heading, turning to starboard. (Actually turned to port.) Directly in front of the sub was a mound with an 80° slope dropping off to starboard.
14:42	3314	025	P	We are heading up the slope. There is now a white anemone and a purple holothurian, several purple holothurians, three of them now in the field of view, and a basket star (brisingid), but a fairly sparsely populated bottom other than that. Another basket star.
14:44:27	3311	008	P	Over a 30 cm fish and a purple buried anemone with waving tentacles, a few small white stalked sea pen-like animals again, and some of the white basket stars.
14:46	3310		P	Small, semitransparent purple shrimp, or shrimp- like creature resting on the bottom. It is

				approximately 5 cm long. Coming down now on a white-armed basket star.
14:48	3309		P	Hanging just above the bottom waiting for a range and bearing to target Echo.
14:51	3315		P	
14:53	3315		P	Changing heading to 190°. Still over sediment covered bottom with sparse fairy rings, rare stalked sea pen-like animals, some holothurians.
14:54	3284		P	Have lost sight of bottom, ascending to receive range and bearing to target. Flocculant and live matter in the water column is very abundant making visibility poor.
14:55	3314	151	P	Have sight of bottom again. Bottom slopes away to the port. There's a stalked purple anemone which has built up a tube about 2 cm high off the bottom. The tube looks like it is made up of sediment; it is sediment colored.
14:56	3314	180	P	Heading up slope now. Slope estimated to be 25°, and faces approximately north.
14:57:18	3312	200	P	Moving up slope. Very strong current also moving up slope blowing anemones and other creatures in the same direction that we are traveling. A small burrowing red sea urchin, about 2 cm across, only one like it seen so far. A very large white fish in the distance, approximately 30-40 cm long, heading down slope and into the current, with its head pointing down to the bottom. It has a very long tail, but does not appear to be a rattail fish.
14:58	3310	187	S	I'm commencing shooting some video footage. Camera is pointed out the starboard port. There are anemones going by, I believe, or some sea pens lying on their sides. Just wanted to get some footage of the normal sediment-covered bottom as we're attempting to proceed to target Echo down to the south-southwest. This target is on the flank of the central lava dome (Central Hill) at NESCA. We're going to attempt to examine the sediment-rock contact at that point and then head back to the north along dredge track 14. We'll go on here shooting some TV (video) footage over the sediment-covered bottom. Can see many small hummocks, burrows, in some cases the circular pits, and some of the animals that are inhabiting the sediment-covered floor. There are some of the pit fields and a large holothurian. The small hummocks

				may be caused by some sort of burrowing animal that's just beneath the sediment cover. Some of the more semi-circular and circular pits are very evident in the TV footage that I'm shooting now. Time is 1500 - mark.
15:01	3307	118	P	
15:02	3306	190	S	As you can see in the TV footage at this time, the water is filled with particulate matter - much more so than we encountered at the SESCA site on Dive 656.
15:03	3305	186	P	As we move up the slope there is less mounding and apparently less sediment burrowing than what we saw at the initial descent site, which was somewhat flatter. This slope is estimated to be only 15°-20° and is otherwise little different than our landing site.
15:04	3304		P	Picture three is of a white anemone-like creature on a short stalk, facing up-slope, more web-like between the tentacles than the typical anemone, the dark anemone, and maybe some other type of creature.
15:05			P	Have just passed several pyramid urchins, some of them leaving trails. They range from about 5-7 cm in diameter up to almost 15 cm in diameter.
15:05			S	I've stopped the video at this point. We'll keep an eye on the monitor to see what shows up.
15:06			P	There is a small trench about 1 m long and about 15 cm deep, another one ahead of it about 5 m away, similar, they look fairly old and partially sediment filled, but something fairly large has burrowed or dug into the bottom. They were both about 20 cm across, 15 cm deep and about 1 m long.
15:07:30	3303	188	P	Heading down a slight slope. Just passed another fairy ring. Fairy rings are fairly abundant now as we're on a fairly level slope.
15:08			P	Picture four was of a basket star. Picture five, immediately there after, was of a stalked anemone.
15:08:38			P	Just passed a fish, approximately 30 cm long, with a very thick body and thick tail, swimming into a current, which is apparently from the north. Several purple holothurians in this area, and a few of the basket stars, but very few stalked animals. Relatively little burrowing at this immediate site. Picture number six was a pyramid urchin standing up on its feet (spines), it's about 20 cm across.

15:09	3306		P	Slope increasing down to the starboard bow.
15:11	3311		P	The bottom has sloped away very steeply off to the starboard, and I have lost sight of the bottom. Ascending to altitude 30 m to try to get range and bearing to target Echo.
15:15	3300		P	We're going up to an altitude of 100 ft to try to get better communications between Sea Cliff and Transquest.
15:19	3278	110	P	We are flying above the bottom heading to point Echo.
16:15	3208		P	Approaching the bottom.
16:18	3230		P	Bottom can be seen from forward port hole, very steep slope, 70°-80°, can not see bottom from port porthole.
16:19:04	3230		P	I can just see bottom, very steep slope. Now we're backing away from the slope, trying to get to the base of the slope, cannot see bottom.
16:20	3238	157	S	We're on the bottom in the vicinity of Target Echo. We have an exposed, very steep, rocky slope ahead of us. I've turned the Benthos camera on for the first time. That first partial traverse we made from Delta to Echo, we didn't take any pictures with the bow camera. It is operating at the present time.
16:20:20	3234		P	I can just see bottom, it is sediment covered, some blocky talus blocks of unknown composition, slope dips steeply to aft and slightly to starboard. I'd say we're about 2 m off on my side.
16:21	3236		P	We've got a blocky bottom with what appears to be basaltic rubble (probably all sulfide), some of it somewhat glassy, blocks from 5 cm to 1 m, sediment covered, sediment cover is approximately 70%, sediment lies on top of talus blocks, some of them are colonized by crinoids.
16:22:45	3239	087	P	Still basalt (sulfide) talus, I can see a galatheid crab and a small starfish, a fish swimming up slope. Sparsely colonized by some stalked animals including crinoids. Can you see a white...
16:24	3239		P	(Mark: Altitude 13 ft). Just passed very blocky talus with several protrusions. (To pilot) You're clear of the bottom, your about 2 m up on my side. The protrusion is to the stern. Going back to try to sample several protrusions sticking up off the top of a blocky talus block. They are either basaltic pillars or hydrothermal

				chimneys. They are colonized with crinoids and other animals. (Pilot: I've lost the bottom.) I can see bottom, you're going to back into the slope, you'd better move forward. (Mark: Altitude 12 feet on the sonar.) The slope is up to the stern, it is sloping away (deeper) to the bow. We've got blocks that are covered with some whitish material that almost looks like bacterial mat, several asteroids. We've got some urchins, a lot of slabby outcrop which could be basalt or could be hydrothermal material, all sediment covered, several small asteroids about 5 cm, some galatheid crabs, one or two.
	3240		P	I've got bottom now about 8 ft deep, fairly sediment covered and flat. I can see a few pieces of talus on it, a slope going to the stern at about 30°-40°.
16:29	3239	047	P	
16:30			P	Can see bottom again, pretty much mud covered with pieces of talus sticking out, mostly sediment buried talus, most fragments 10-20 cm, sparsely colonized, a few fish seen. Now we're coming over a block of material which is very irregular and slabby. I can see some very shiny surfaces which may be coarse grained pyrite. It looks like mudstone, probably with pyrite. We've got some possible buried clam shells in the sediment, whitish material that looks like buried clam shells, we're going over a galatheid crab now.
	3240		P	Last picture was of a sediment covered bottom with shale(?) chips 1 or 2 cm across littering the surface, slightly lighter colored than the mud. I've got a slope moving up away from me to the port side.
16:32:19	3240	140	E	Smooth sediment covered bottom.
16:33	3238	142	P	Fairly steep slope to the port but almost totally sediment covered at this point. We are going to traverse up the slope and try to find what may have been hydrothermal material exposed in talus on the slope. Now I've got some whitish material, it looks like bacterial mat which is sediment covered, most likely hydrothermal. Very slabby outcrop taking a picture. (To pilot) If you can turn to my side there are some chimneys sticking up out of the sediment. Turn to the left. No, the other way. There are what looks like hydrothermal

chimneys, inactive hydrothermal chimneys sticking out of the sediment. I can see some very shiny material underneath some of them, some ledges that stick out. We are in a hydrothermal field now, no sign of active venting. (To pilot) I don't see any sign of active venting, but we would like to sample any one of those protrusions sticking up. We have a fairly extensive hydrothermal field, but definitely sediment buried. Below some of the protrusions are slabby outcrops and underneath some of the slabby outcrops are some shiny reflective minerals, probably sulfide. Last picture is of some kind of swimming creature, it looks like a swimming holothurian. We're still over a rather steep slope, mostly sediment covered, but with slabby outcrop showing up. Nice large chimneys about 2 m high sticking out of the slope towards the stern, clearly hydrothermal, but again inactive. There is a colony of dead tube worms. Heavily colonized by galatheid crabs as well. There is a very large talus block, almost a ridge-like structure running off to the stern. It's about a meter across and probably 4 m long. It's got a couple of galatheid crabs on it. It may be a very large fallen chimney. It has some ribbed structure. I can just see out in the distance a very large field of chimneys sticking up about 2 m high. I'm not sure if that shows in the video (being taken out port side). This is a fairly massive outcrop, it goes up above my field of view, it seems to be all hydrothermal material. Right now I'm filming a small chimney which seems to be breached somehow. It's all sediment covered on the outside, but I can see sparkling sulfide minerals. The video camera is pointed right at it. You might be able to see some sparkling sulfides. Now we've moving in on a field which is very white and covered with bacterial mat. Essentially, entirely massive sulfide. It's about 3 meters away from me and goes up above my field of view, it is essentially coalesced chimneys. Some of it has a brecciated texture, but it looks like it's caused by patchy development of bacterial mat. We have a massive mound structure, it's very complex, it's definitely inactive at this level,

				heavily colonized with anemones. I can see some very shiny hydrothermal material at the base of it. The front of the sub should be coming around... There is a large galatheid crab underneath the overhang, more sulfide showing. Out to our left is another field of hydrothermal deposits. (Pilot: I think we hit something). Yeah, we're going to back in to this. You better go up, we're going to back into a hydrothermal mound. There's a very large outcrop, we're moving up and away from it, we seem to be clear now to the port. I can still see the top of a pinnacle structure, it's essentially a massive wall, you're clear of it right now, it's about 3 m away. I can barely see it. Very steep on one side, may be a fault scarp, again colonized by galatheid crabs, very massive, no apparent chimneys left on this. The slope is dropping away to port, essentially vertical. I've got it (sulfide ridge) directly below me on port and about 2 m under us. We're going right over the top of it now and over a scarp and out into the water column. I've lost sight of bottom. (Mark: Altitude 20 ft) If you turn to starboard you should be able to see it. You should be able to see the bottom, it's a steep pinnacle, it drops directly vertically off below us. (Mark: I can barely see the bottom. There's nothing sticking up below us. Our altitude is 15 feet.)
16:35	3229		S	Lot's of action on Rob's side. Appears to be an extinct hydrothermal field with some chimneys. It's very difficult country to put the sub down on and sample. We're going to continue up slope. The sub is flying over the bottom in such a way that I can't see the bottom out the starboard side.
			S	O.K. We're commencing video footage right now - the camera is pointed out the port side. This will have to go with Rob's commentary; maybe the TV camera is picking it up.
16:35:01	3232	075	E	Slabby 1-2 cm thick subcropping crust.
16:40:42	3218	116	E	Possible sulfide outcrop.
16:42:37	3215		P	
16:44	3214	156	S	I've got the TV camera pointed out the starboard side now, although we're at a little too high an altitude. In fact, our altitude has now increased to about 30 ft, so I'm not getting any pictures at the present time. Stop it.

16:44:10	3216	173	P	The bottom on my side is sediment covered and flat with some talus, can just barely make it out. On Mark's side is a hydrothermal pinnacle, to the starboard.
16:45	3213		P	Cannot see bottom. We are maneuvering to try to sample the hydrothermal materials. Several massive cliffs of hydrothermal material have been seen, including what could be large composite chimney structures several meters across. Much more massive than anything observed at the plume site on my dive at Juan de Fuca. All apparently inactive, but underneath some of the ledges of sulfide are shiny sulfide pinnacles. Can now see bottom, it is sediment covered, no protrusions, sloping steeply off to the port and to the stern. In the distance, perhaps a fault scarp of 1 or 2 m dropping off. Cannot see bottom as we are turning to approach the cliff with the forward looking camera. We're coming up a mud covered bottom, about a 30°-40° slope, there are no hydrothermal protrusions or talus here. Only very sparsely colonized by any animals. There are some grooves trending down slope suggesting buried talus or possibly debris flow channels. Essentially uncolonized by animals, much lower abundance of life than anywhere else seen. Very little burrowing, some old fairy castles completely sedimented over, barely recognizable now, and a couple of urchins, but other than that, completely sediment covered. Crossing over a small buried scarp, a sudden break in slope about 30 cm high.
16:47:12 to 16:50:19			E	Smooth sediment covered bottom.
16:49:40	3212		P	We are sitting on the bottom on a flat sediment covered bottom, sparsely colonized by any animals, except for very small stalked creatures less than 1-2 cm high. I can see one galatheid crab alive out in the distance. Fairly steep slope, but no talus observed here.
16:55:21	3212		P	We are just sitting on the bottom, sediment covered bottom, very sparsely colonized by anything right here except small 1 cm high stalked animals. There's a nice eight legged asteroid right below me about 15 cm across. I will take picture number 17 of the asteroid as soon as we drift into position.
16:55:43 to 16:59:46			E	Smooth sediment covered outcrop.

16:57			P	We're still sitting in the same place. Off to the port I can see a ridge, sediment covered, that goes up about 4 m above me and then rounds out and drops down to the other side. We're sitting in a little swale. We could be in a little sediment filled half graben with that ridge representing the sediment dam, and we're in a little swale filled in with sediment here. Picture 18 of a strange hooded anemone-like creature. (To pilot) You're coming right up on the slope and are probably going to drift into it on the port side. It's sediment covered and fairly shallowly dipping, about 20°. Picture 19 was a stalked creature about 5 cm high. Picture number 20 was of a white, legged, holothurian. Up in front of us is a scarp dropping off away from us, I can't see how steeply yet as we're still coming up to it. A 70° or 80° scarp, all sediment covered, dropping off in front of us.
16:59:46	3212		E	Resedimented surface?
17:00:51 to 17:06:16			E	Slightly conical sediment mound 50 cm high with steep slope dropping off away from sub.
17:01	3210	146	P	Picture 21 was of the fault scarp. Pictures 22 and 23 are of a stalked creature with a flower-like bulb (Wine goblet glass sponge), with an asteroid on top of it. We have a very steep scarp, essentially vertical, but sediment covered, dipping off directly to the port, our heading is 222.
	3211	222	P	We are still sitting at 3180 m on top of a sediment covered knoll. It drops off vertically on the side that I can see, and apparently vertically in front of us, very smooth, sediment covered, no talus.
17:05	3210	240	P	We are now going to turn around and fly north off of the scarp. Turn around, sink down, try to find the base of the scarp, move up it again and try to relocate the hydrothermal deposits and hopefully sample them if we can find an appropriate sampling position. Picture 23 is an other picture of the top of the knoll showing the very steep drop off into a little swale, which looks very similar in being sediment covered and then drops off again vertically.
		220	P	We're moving at 220. I can see another fault drop-off, still sediment covered, no outcrop, no talus blocks, and then another step, it's very terraced and stepped here. There is a flat

				sediment covered terrace, a drop off of 4 or 5 m and that repeats at least 4 times that I can see. It probably continues at depth, but I can't see, we're dropping right off on the last scarp, the bottom has just dropped away out of sight.
17:07:40	3210	000	P	Flying out into the water column. Picture taken up in the water column of a brown jellyfish about 4-5 cm across with very short tentacles.
17:14	3230	000	P	We're coming down on a very flat bottom, sloping away in front of us. It drops vertically (off to the port side) off a fault scarp. There's another stepped scarp about a meter high.
17:16	3232		P	We're sitting just off bottom. Very smooth sediment covered slope, very little bioturbation, very few creatures on it, a few small little sediment mounds but not much, some fecal pellets. A steep slope off in front of us and I can see well out in the distance a fault scarp out to the port side.
17:17:35	3234		P	Moving down a sediment covered slope which slopes away to the starboard bow. Off to the port and running approximately east-west is a steep scarp down-dropped to the north. I can now see a basket star and a purple holothurian, a couple of basket stars, but fairly sparse biota. I see a fish about a 2 m long well out in front of us in the distance, there's a slope that drops off. We may have some hydrothermal material right at the edge, there's some blocky material.
17:21	3239	262	P	We're coming around towards that, it is colonized, some outcrops in the sediment colonized by a fan-like tentacled creature. There's another outcrop down below me, completely sediment covered with a protrusion which looks like it may be an extinct hydrothermal chimney. It appears to be mostly talus blocks, some of them up to a meter across. One of them has a protrusion sticking out that looks like a chimney. We're going to try to turn and come back to that.
17:26	3249	080	P	Flat sediment covered bottom sloping up to the bow. I can again see a sediment covered bottom which is step faulted down with sediment covered fault scarps of one or two meters. Each drops off to a little flat sediment covered plateau. The fault scarps are completely sediment covered, not fresh. Poorly colonized; very few creatures. We're

				turning now to head back towards the major hydrothermal field.
17:33	3250	060	P	I've got a sediment covered bottom, there are a couple of steps going off to the port. A very large 2 m rattail fish on it. We're now on a flat plateau at the top of one of the scarps, sediment covered, all the fault scarp I could see was sediment covered. It has a nice flat plateau poorly colonized by any creatures. Again, we're coming up another little scarp. There's a galatheid crab sitting on it. A very rounded scarp, if it is a scarp at all, actually there's just a swale after coming over that last scarp. The ridge is running approximately east-west.
17:33:52 to 17:37:06			E	Smooth sediment covered bottom.
17:35:47	3253	060	P	Picture 26, galatheid crab and asteroid sitting on a sediment covered bottom. We're on a plateau at the top of a very steep set of stepped scarps. The bottom is rolling away from us now to the bow. There are some more basket stars with their arms pointing up. I can see some urchins in the distance, but a fairly uncolonized nondescript bottom. A couple of white urchins, as opposed to the more common purple urchins.
17:37	3254		P	We're starting to go down a very steep sediment covered slope, about 40°-60°, probably a buried fault scarp, uncertain. I see a small galatheid crab, several holothurians, but not too densely populated.
17:39:42	3254	175	P	We're right at the edge of a rounded, very steep drop off, just on the edge of this sediment covered plateau again, which drops off steeply to the port and to the bow. Directly 270 from our heading I see a vertically outcropping mass. It is providing talus to the slope below us. Very large talus blocks. However, as we approach it looks like siltstone or mudstone that's being exposed and moving down the slope. We've got definite down slope movement here. A huge galatheid crab sitting on it. I don't see any hydrothermal material. It would be worth turning the sub around to take a picture of it if you could though. Maybe some video. It's definitely mudstone and siltstone. The stern is moving in towards it, your going to want to...you've got a big sediment cloud, you might

					have hit it. I'm sedimented out here. You might want to pull up vertically away from it, it is pretty soft. We're flying parallel to a ridge that's out the port window. It's got essentially a vertical drop off about 20-30 cm high and then goes to a 60° slope. On the slope are talus blocks of mudstone derived from the scarp itself. Now we're coming over sediment mounds 20-30 cm high, sparsely colonized by anemones and so forth. We've got sort of a rolling topography now in front of us without evidence for mass wasting that we saw as we came over that last cliff.
17:40	3254	163	1-2	S	Two still pictures in quick succession, one of a crinoid-like animal bent over in the current, followed by (a shot of) a small fish. At 17:40 we have passed over a scarp falling steeply away beneath us that may be the border of the sediment and sulfides.
17:43	3252	116	3-4	S	Off the starboard side now, exposed blocks of mudstones. Some of the textures were pretty rough. It looked like it may have sulfide. It's being obscured by a mud cloud now. I attempted to get a picture or two as we passed over it.
17:43	3252	090		P	Now we're over a fairly flat bottom to the port, but with a step down from starboard to port. We're riding right along the top of a ridge. Off the port side there is a 1 m fish looking at some whitish blocks that are somewhat talcy looking. I can't take a picture because we're kicking up a sediment cloud. Was able to take a picture of the afore mentioned fish and the white talcy blocks, there were only a couple of them, about 10 to 20 cm. They could have been siltstone, they were isolated blocks sitting on an otherwise mundane sediment covered terrace. I can see that the terrace drops off rather steeply in front of me again; clearly step faulted.
				P	(Start of side 2 of tape) Three pictures of a slabby outcrop, including one that shows underneath the slab what was probably basalt, thin sheet flow, sediment covered, with a scarp dropping off to the port side. Our depth there was approximately 3270 m, the time was approximately 18:00.
18:03	3267	088	5	S	Picture of a transparent animal on the bottom, actually two of them together. One was

					transparent - looked like an octopus, although I'm sure it was some type of sea anemone.
				S	Turned bow camera on again. We are at the foot of a slope that rises up to the south. Appears to be exposed pillows or some exposed basalt on it. It's out the forward porthole and I can't see it very well.
18:05	3265	195	6-9	S	We just passed over some outcrops of massive sulfide. I've taken three or four bottom shots of it. We're going to attempt to stop and sample it. Rob has it out his side too. The stuff appears to be all over.
18:08:29	3269	174		E	Subcropping sulfide crust.
18:10:06	3270	176		E	Sediment buried outcrop of crusty orange iron oxide gossan.
18:11:11	3269	192		E	Bluish white material at the base of orange iron oxide gossan.
18:11:44	3268	192		E	Dark subcropping sulfide.
18:12	3266	213		P	Can just see bottom, I've got talus, mostly sediment covered with a few blocks of talus, very few blocks, could be basalt, I can't tell.
18:13	3264			P	We've got outcropping massive sulfide. I can't believe it! Slabby very coarse grained massive sulfide. Mostly talus blocks. There's beautiful coarse grained material sparkling in the lights. Meter long slabs 20 cm thick.
18:14:10 to 18:32				E	Sulfide crusts barely subcropping through sediment on a 30° slope.
18:15	3265	200		P	We're dusted out right now. The last I saw was extremely coarse grained sulfide exposed in talus slabs. Mostly slabby talus 50 cm to 2 m long, irregular blocks, usually 10-20 cm thick; very coarse grained sparkley material. It actually appeared to be sphalerite, but it probably isn't, it had that sheen to it. A lot of sediment in amongst the talus. Right now we're sitting on the bottom in a sediment cloud.
18:15	3265	181		S	We're sitting on the bottom in 3265 m. Getting our bearing and preparing to go back and attempt to sample sulfides.
18:28	3265	226		P	We are sitting on the bottom in amongst the previously described sulfide talus, some of which has a brecciated texture to it; much of which is slabby. I see a lot of shiny surfaces including one band that is light grey colored and looks like galena, possibly cutting more pyrrhotite-rich material. There are some anemones on the blocks which are sediment

					covered. The talus is slightly colonized by worms and anemones. Apparently off to the starboard there is a large pinnacle of sulfide. We will try to sample some of this material before leaving the site. Start of roll two of film. The last several pictures were shot at very close range while sitting on the bottom. They are pictures of the slabby and blocky massive sulfide showing some of the creatures on them at very close range. I can see what looks like pyrrhotite crystals on one, lots of shiny surfaces reflecting back in the lights.
18:31:11	3265			P	We are now trying to sample some of the slabby material while we are sitting on the bottom. I will describe the sample when it is collected.
18:32:46	3265	218		E	Sampling attempt.
18:36				P	Picture one of second role is a picture of a white stalked anemone about 2 cm high. In the center of the frame is a clear worm with curly white intestines, and towards the bottom of the frame is a large turd, probably holothurian, all sitting on basalt (probably sulfide). Picture 2 is of a white bag-like animal with an anemone growing on it, colonizing the sulfide with a grey streak through it that looks like galena. Underneath that outcrop there is a little puffball of some kind of critter. This area is generally sediment talus that has been colonized by small stalked animals.
18:38	3266			P	Sample taken. We will try to take a picture of the sample before it is put into the basket. Picture three is very similar to 1 and 2 taken slightly more towards the bow of the sub, showing the blocky nature of some of the outcrop.
18:38:43	3265	215		E	Small sample in manipulators.
18:40	3265	229	10	S	We're resting on the bottom. Just took a shot, frame 12 I believe it was, of a block of sulfide on a sediment bottom out the starboard port. We're in the final stages of collecting a sample with the manipulator from some of the sulfide blocks.
18:43:20	3265	230		E	Aluminum foil on bottom.
18:44:38	3265			P	Piece of massive sulfide collected, and placed in the critter basket.
18:45	3265			P	We're shooting some of the first part of video tape number 2 from the port observer's position. This is the area where we just took a

					sample. You'll be able to see the blocks of sulfide, and in some cases there's glitter in the sulfide minerals. There's opinion aboard the submarine now that there may be galena in some of the samples from the appearance in the light.
18:49	3265		11	S	Another shot, frame 13. The same sulfide block filed off the starboard side. We've been sitting on the bottom taking samples.
18:50:17	3266			P	Looking out on the sediment covered bottom where the submarine sat down. We've moved slightly (to starboard and aft) you can see that underneath the yellowish brown colored surface sediment is a very dark fine grained black sediment which is probably all sulfide derived from weathering of the blocks. In front of us is a chunk of aluminium foil garbage laying in the vent fields, it probably shows up in the forward looking camera. Picture 4 shows the disturbed spot where the sediment has been removed by the submarine sitting on the bottom, with the darker material showing underneath the yellow material, which was removed by the submarine. Next picture shows some stalked creatures colonizing the sulfides. Next to the white stalked creatures, below them in the field of view of that last picture is a white puffball type creature, and then below that are one, or maybe two gelatinous masses attached to the rock, one of which is attached by a very small stalked anemone like the ones in the picture, but much smaller. The white anemone-like creatures in the last picture are just about 2 cm across. There are several creatures like the ones described colonizing all of the sulfides, and underneath one of the sulfides I can see the arms of a starfish just sticking out. Out the starboard window some of the talus is definite orange red brown as opposed to more fresh looking material out the port.
18:52	3266	244	12	S	Another picture of the sulfide blocks.
18:54:41	3266	230		E	Sulfide slab broken by manipulator.
19:02:23	3266	220		E	Baritic material, aluminum foil in the distance.
19:12	3266	238	13	S	We're turning around slowly from the area in which we took the sample. I just took a still picture of some slabs and blocks, what appears to be weathered blocks. They're reddish in color, sulfides. There's one in the

				foreground, the lower right hand tip of which has been broken off. I don't know whether it was from the impact of the submarine or not.
19:13:57	3266	241	E	Attempting to sample sulfide.
19:14:25	3266	047	P	We are turning slightly from the sampling site giving me a slightly new view of the sulfides. What appeared to be a slab of basalt probably isn't. It is a very dark rock, it could be zinc sulfide. I can't really tell. It is about 15 cm thick, it looks different than the shiny sulfide we've been looking at. Most places where the submarine has disturbed the sediment, you see a darker grey to black sediment underneath the yellowish brown sediment caused by oxidation of the underlying sulfide.
19:16:05			P	Picture of the darker slab, which could be either basalt or zinc sulfide and also showing some of the disturbance caused by the submarine itself. Off in a field which is almost totally sediment covered, is a 15 cm high conical, what appears to be an asparagus shaped chimney top sticking out of the sediment. It is perfectly upright and looks like it could be in place, but buried by sediment.
19:17	3260		S	We're attempting to collect another sample. The bow camera is turned on.
19:17:40	3266	217	E	Sampling barite chimney.
19:25	3266		P	Second sample R-2 taken at the same site as the first sample, and placed in basket just aft of the core sampler.
19:25			P	Picture 6 is the top of the previously described possible chimney, sediment covered on top, conical shaped and about 15 cm high. The second sample dropped in behind the core sampler is very white material. I can just barely see some white material out my side which looks like talc. The second sample R-2 of white hydrothermal material was about the size of a football. I can see a slabby sample in the distance with a protrusion off the top, freshly broken, probably by the submarine. The interior of the sample is a dark grey metallic color, the outer coating is all white and might be talc. At the same sampling sight. I got a very close look at the undisturbed sediment bottom, it is very densely populated by either mm length worms, or by aggregate filaments of some kind of bacteria. I can just see organic material, which covers almost all

					of the bottom, waving in the current, which is very strong here. It is probably mostly bacterial, but there may be a lot of very fine filamentous worms as well. Sample was collected at the same site, but the soft material fragmented during sampling. Some of it fell into the basket, but it may not make it to the surface.
19:27	3267	242	14	S	We're in the general sulfide field that we've been sampling. Maneuvering to collect another sample. Just took a still picture of a small white starfish among the sulfide blocks. It would have been frame number 17 (To Rob: Got something you like? To Terry: Can you knock the pinnacle into the basket?).
19:27:25	3267	245		E	Sampling sediment buried sulfide.
19:29				S	We're shooting some TV footage out the front. You can see the manipulators clearly. We're going to take another sample in this general area, which is a little bit off to the right of where we have collected the first two samples.
19:34:27	3267			E	Sample in manipulators.
19:35	3267	224	15	S	Collected another sample in the same general area. It's going to go into the after starboard basket. Frame 17 shot while sample 4 was being collected. Off the starboard side is a large outcrop of sulfides. White starfish in several places on them, as well as some other translucent animals. I think the wide-angle picture will show those up.
19:37				P	Sample four was a rounded piece about the size of a softball, and went in behind the critter basket.
19:38:14	3267			E	Sample dropped?
19:40:56				E	Sulfide exposed beneath sediment by sub tracks.
19:43	3260			S	Taking some TV footage out the starboard porthole of sulfide blocks. Generally muddy bottom. We're very near a large outcrop of the sulfides just beyond the field of view. We will attempt to collect samples. Now we're looking at a mud bottom, some sediment stirred up by the submarine maneuvering, and an object rolling along the bottom there for awhile.
19:44	3269			P	Backing out of sulfide site, as we backed out I could see it was mostly sediment covered. In the distance I could see a very large, approximately 2-3 m high outcrop of massive

				sulfide, colonized by sea pens and anemones, with some galatheid crabs around.
19:52:34	3269	213	E	Push core of white sediment (core was later dropped).
19:55:16	3270	213	E	Attempted push core sample near white hydrothermal outcrop.
20:08	3270	213	P	About to leave sampling site to traverse up the cliff and look at the massive sulfides.
20:08:52	3269	214	E	White baritic rubbly outcrop, some iron oxide.
20:09	3268	217	P	Traversing across sediment covered bottom.
	3267		P	I can't see the bottom now, sedimented out, but it looked like I could see a track, it was possibly a dredge track, but now I can't see the bottom, we're too high up and sedimented.
20:12	3266		P	I can see bottom at about 4 m below me. I can definitely see a track again. A very straight track, could be our submarine tracks. The bottom is sediment covered with a little bit of talus. It is a little too far away to see the talus clearly and identify it.
20:13	3263		P	Over sediment covered bottom with half meter or so talus, large stalked animal seen. A very large sulfide pinnacle is being described by the pilot out the front view port. It can not be seen from either side. Just passed a very large sulfide pinnacle approximately 3-4 m high with some 1-2 m chimneys on the side of it. There is about a 75 cm long white fish swimming in the current lee of the pinnacle. On the other side was a very long white rope-like thing laying on the bottom. It was approximately 2 m long, about a cm or less wide. It looked like a piece of rope, it could have been an animal, but it was laying flat on the bottom. It was not like anything else I've seen.
20:13:12	3263	214	E	Faintly visible chimney shaped projection.
20:16	3257		P	Swinging back around to the south to try to intercept the sulfide pinnacle. We are going to try to set down at the base of it and sample a small side chimney while we're sitting on the sediment covered bottom.
20:20	3250		P	In the water column. Swinging around in the vicinity of a large sulfide pinnacle.
20:20	3254	187	S	We're 65 ft above the bottom. Hopefully the Transquest will be getting fixes on us. We should be above the sulfide field that we've been sampling.

20:24	3272		P	We're about 3 m off the bottom, flat, sediment covered, a few holothurians, one galatheid crab, no talus blocks, a very flat bottom, poorly inhabited.
20:24:28	3275	236	P	On bottom.
20:29:30	3273		P	Traversing up a slope of about 15°-20°, sediment covered, somewhat hummocky. No outcrop or talus blocks, sparsely populated by animals, only rare holothurians.
20:30:36	3271	194	E	One cm thick slab of lithified sulfide(?) subcropping beneath sediment, broken into 50 cm slabs.
20:30:46	3270		P	We've got a few blocks of white talcy material, and I can see that the submarine has been sitting here and that is what has exposed the white talcy material. There are two parallel tracks right beneath us where the sub sat. Talus blocks of hydrothermal material out in the foreground. I can see a small mound out in the distance of whitish material and what could be a sediment push core at the end of a track. Yes, I do believe it is a sediment push core (broken and dropped at first sampling site). The sediment push core is right at the edge of a talcy outcrop. I can see a bunch of blocky slabby talus now, some of it is definitely sulfide, some of it is very thick, half a meter thick talus slabs with a lot of sparkley sulfide material. We just passed our sampling site. We're back to blocky talus outcrop, some very large thin slabs, 3-4 m on a side; some white material. Off to the starboard is a large massive sulfide mound. On my side is a steep slope with sub tracks on it where we just sampled hydrothermal sulfides,. Everything is debris and talus in my field of view, but there is a large constructional feature in Mark's field of view to the starboard.
20:32	3266	208	S	We've turned around; are making our approach on the area of the sulfide target again. Had the bow camera firing at an 8 second interval.
20:35	3262	193	S	We just made a very close pass out the starboard viewport of a very large sulfide spire in the general area in which we took the samples. I took TV footage of that at the time we passed.
20:36	3258.	163	S	We're passing by more exposures of sulfide off the starboard side. I'm photographing it

				with the TV camera. Water is pretty cloudy; picture is indistinct.
20:36	3262	190	P	Off to the port is a ridge, mostly of blocky talus of hydrothermal material, mostly sulfide. You can see it sparkling even from a distance of about 4 m. There's a very large, 75 cm, white fish in the sulfide field. You can see some very coarse grained sulfides even from this distance which is about 3-4 m. A fish is now swimming with its head directly up, taking a picture of him, he's almost a meter long. There are a few stalked animals. We're moving up the ridge. The ridge is directly underneath us now about 3-4 m down, at least 4 m down.
20:37:33	3257		P	We have a very large chimney structure coming in to view off the starboard side.
20:38:50	3259		P	I see a sediment covered bottom; a very steep slope, a very slabby outcrop, there are some hydrothermal chimneys sticking up from some of the slabs and coming up out of the sediment. The chimneys are about 30 cm high. Taking a picture now of these hydrothermal sediments and a picture of a very slabby outcrop, possibly all sulfide, although there is no real indication as it is heavily sedimented. Changing heading slightly, there is a large sea fan, out of the field of view of the picture, unfortunately. A large canyon directly off to the port filled with talus and debris, mostly dark and slabby, we've got dark slabby material over here directly off to the port. Taking a picture, a couple of starfish in the picture. There's a step down off this sulfide.
20:40:40	3252	184	P	Still moving up a slope with talus, some slabby looking outcrop. A ridge of what looks to be sulfide in the distance. A large galatheid crab on the ridge. Most of the sulfide except for the ridge itself is sediment buried. I can see in the distance the slope is steepening and can see more blocky talus, relative to the flatter bottom which is pretty much sediment covered. Picture of a hydrothermal outcrop, possibly some basalt here, with a large galatheid crab, no, I can see some definite sulfide on that last picture with a crab. There's a very large mound-like structure colonized by several starfish some very bright shiny sulfide

					on it, the mound itself is about 3-4 m across, several meters high, 10 m high perhaps, very blocky and massive. (To pilot) We're moving right in on this, can you see that Terry, the ridge right below us to the port side. You'd better come up a little. We're going to clear it. OK, we're going to move right towards an other big target, you'd better swing around to the port and you'll be headed right at it.
20:41	3250	163	16	S	Frame 18 was of some massive sulfide exposures pretty far away off the starboard side. I'm not sure they're going to show up in the picture very well. We're continuing up slope. I'll try to get other pictures of the sulfides off the starboard side. They're quite far away.
20:42	3247	189		S	O.K., the TV camera is being used off the port side. Picture is indistinct now; the vehicle is a little high off the bottom.
		17-18		S	Two shots in succession of a sedimented ridge of sulfide quite far below the ship. Some white starfish on it. Those were frames 20 and 21 on the counter.
20:42:13	3250	189		E	Rounded outcropping sulfide
20:44	3243	176		P	I've got a hydrothermal mound about 3 m below me, very rubbly and broken, some starfish on it, it's all sediment covered, no outcrop. Now I see some more outcrop. Apparently some pillows on the starboard side. Partially buried outcrop; I can see some sulfide sparkling on the bottom. Now over a completely sediment covered bottom.
20:44:17	3272	185		E	Sulfide talus.
20:45 to 21:00				E	Massive sulfide outcrop, some rubble and talus, minor sediment cover, some remnants of chimney-like projections, locally stained by iron oxide.
20:45	3242			P	There's an octopus, or something of that nature down on the bottom, just floating off in the water column. Just barely see a few outcrops, it's too deep. Now out to the distance I can see a low ridge of partially outcropping material. I can't tell what it is because it is too far away. Mostly sediment covered still with just rubbly outcrop sticking up. Some chimneys, now that I can see that ridge, some small chimney-like features sticking up out of the sediment, probably hydrothermal material.

20:46	3238			P	Moving up towards the top of the hill, we've got a strong (Mesotech) target, and apparently a large chimney in front of us. Down to the port, I can just see talus blocks, pretty much sediment covered, but a lot of rubbly talus, most of it 50 cm to maybe a meter, very coarse talus. Some whitish material covering the talus blocks on this side, very definite sulfide. I can see sparkling out the window, fairly coarse grained. Picture of the talus. Picture back aft a little bit of some of the whitish material. There's a white fish and some anemones on the talus right in front of us.
20:47	3235	223	19-21	S	We're coming to rest on the bottom in an area of many small blocks of sulfide. Small white galatheid crab. Just took two pictures of that. I'll get another picture with the crab very plainly in the background.
20:48:54	3238	239		E	Sulfide sample 658-R3 in manipulator.
20:49	3238			P	Sitting on the bottom on sulfide talus, attempting to sample some of the talus. Out in the distance is some very large talus, 1-2 m blocks, not all of it is necessarily sulfide, some of it looks like it could be basalt, it looks like some of it could be sitting on pillow basalt, but on the other hand I see a lot of sparkling crystal faces suggesting that it could be mostly sulfide.
20:53:22	3238			P	Sitting on the bottom attempting to sample massive, blocky, rubble outcrop of sulfides. Everything that I can see out the port has the appearance of the pyrrhotite-rich massive sulfide samples. In the distance are very large 1-3 m blocks of material, which appeared to be basalt just from their massive size, but I can see crystal faces all through there and they may all be massive sulfide. There is nothing to indicate that any of them are not massive sulfide except for the sheer volume of material that is exposed. Sparsely colonized, a few asteroids, one white fish, pictured earlier, and one unknown white pectin shaped animal attached to the rock. It could be some kind of anemone, there are some anemones right down below me. Everything is dusted with sediment, and there is a lot of sediment between blocks of sulfide.
	3238			P	Picture 25 taken of massive rubbly outcrop of sulfide where we are attempting to sample. At

					the same site I can now see two blocks sitting on top of what appeared to be massive sulfide, the two blocks are very black and shiny looking and look like volcanic glass. Both blocks are about 10 cm in diameter, sort of rounded with a somewhat shiny reflection, and may or may not be volcanic glass, it is hard to tell. They are distinct from the weathered and sediment covered sulfide.
20:58	3238	234		S	We've just collected a fifth sample. We're leaving it in the manipulator jaws. We're going to proceed uphill, course approximately 230-235, and terminate the dive at the crest of the hill after taking some additional photographs and then lift off.
20:59	3238	220	22	S	Just took a picture of the blocky sulfides with a white starfish among the blocks. That would have been frame 23 on the camera counter. I believe that would have been frame 24.
20:59:12	3238			P	Proceeding uphill from the site where we have just sampled sulfide talus. R-3 Sample is still in the manipulators, and will stay there until we get to the surface. We are transiting up this talus hill, I can see we are over large blocks of talus, several meters in any dimension. There is a large pinnacle sticking up well out in the distance to the port. It sticks up about 5 or 6 m, capped by sulfide. I can see a lot of sparkley crystal faces, there is a galatheid crab sitting on top of the talus. We are moving up a very steep constructional feature, it drops off very steeply, I can barely see bottom on the port side although it is right in front of us dead ahead. We've got a very steep pile of sulfide rubble.
21:00	3236		23-24	S	Another picture of the blocks with a large purple holothurian in the foreground. Pictures of scattered blocks of sulfide - quite a bit of sediment covering this area. A purple sea anemone in the middle of the field. That would have been frame 26.
21:01	3235	189	25	S	That was a picture of the crest of the ridge, with some, I believe, brittle stars. Mostly deep black water in the left part of the picture on that one.
21:01	3235			P	At the base of a slope I can just see some very large robust round chimney structures; fat Christmas-tree shaped, very pointed on the top, growing off the side of a sulfide mound.

		Out in the distance I can now see another very steep-sided edifice, tabular, with another chimney up about 2 m sticking up out of that, in the distance is sediment cover between that and another slabby outcrop up hill from that, barely sticking out, again probably all massive sulfide. Too high up now, lost the bottom.
21:03	P	Ascending. Preparing to drop ascent weights. The last sulfide sample, which is in the manipulator was picked up about 10 m from the base of a large sulfide edifice, which will be the last sulfide edifice that shows up in the external photos.
		END OF TAPE
		Recovery at 1630 (local), 23 Aug., 1986

Dive 659

Location: NESCA
Port observer: Robert Zierenberg
Starboard Observer: John Wiltshire

Julian day: 236-237
Date: August 24, 1986
Pilot: Bruce Bosshard

Time (GMT)	Depth (m)	Hdg	Photo	Obs	Comments
19:54:00	3151			P	Dropping descent weights.
20:17	3300	034		P	Making bottom approach.
20:19:17	3309			P	We're approaching... (6 sec. gap) ...very sparse biota at this time. Our altitude is approximately 3 m
20:20	3312			P	About 1 m off the bottom. Very flat sediment covered bottom. There's a big mound right in front of us, apparently a dredge track right in front of us (both according to pilot, not substantiated by observers). The bottom is not well colonized, there is one purple urchin and one asteroid.
20:21:06	3313			P	Right now we're on bottom. Very thin, millimeter thin, armed asteroid in the sediment, some small stalked creatures 1-2 cm high, sort of fuzzy-looking, they look like they are possibly coated with bacteria. Well out to the port I can see a holothurian, there is also what appears to be some talus of siltstone coming off of a slight ridge going up to port. I'll have to wait until we come up off the bottom to see it, but apparently some down slope movement from this ridge.
20:23	3310			P	We've come off the bottom slightly, we've got a rather irregular bottom with some very steep steps in it, some ridges, they all seem to be trending... (To pilot) Yes, head 320° , head for the target.
20:24	3308	035		P	Changing heading to 340°, heading for target. The bottom is ridged, almost like mega ripples. The lee (steep) side is pointing away to port. They could be small stepped scarps. We've got mounds of white siltstone poking up through the sediment cover.
20:24:59	3309	315		E	Sediment covered bottom.
20:25:23				P	Picture 1 was a stalked animal. There are some talus blocks of siltstone, definitely some sediment transport. Some very irregular ridges through here. The ridges are about 1 m high. They are continuous for 10's of meters, separated by about 5-6 m. This is much rougher than what I expected to see. The bottom is completely sediment covered and

				only sparsely populated. Some very large mounds several meters high, we're climbing up one now. On top of the ridge I'm looking at now, there are some more talus blocks. There has been some redistribution of material. Most of the material seems to be siltstone. It is lighter colored than the brown sediment. There is a minor amount of pebble sized fragments, most of the siltstone fragments are 10-20 cm in diameter and rather equant, but flattened.
20:26:19	3309	315	E	Steep slope, reworked sediment.
20:26:36	3308	324	E	Drop off away from sub to port.
20:26:52	3307	317	E	Bioturbation brings up lighter sediment.
20:27	3307	214	P	Picture 2 is of an octopus on the bottom, quite a ways out in the distance. Just beyond the octopus is a very large stalked creature with a huge gelatinous... (To pilot) It should just be coming in to your field of view right now. We are turning the sub to take a picture of the octopus and the stalked creature with the forward looking camera. Out my window I can see a couple of brisingid starfish. A rather rough and rolling sedimented terrain. It's dropping off in front of us, our heading is 214° right now as we move up to take a picture of these two creatures.
20:27:24	3307	298	E	Sediment mound 1.5 m high with exposed mudstone.
20:27:57	3307	229	E	Octopus in the distance.
20:28:29	3307	211	E	Octopus with a large sponge in the background.
20:31:37	3303	345	P	We've got a sediment covered bottom, dropping away steeply to the port, it's stepped and ridged. Ridge heights are about 1-2 m, ridge lengths are at least 3-4 meters. Not much in the way of transported sediment, mostly just buried by sediment. Not very heavily colonized. Coming down now on irregular ridges trending more or less parallel to our track at 320°. Still moving over a ridged, sediment covered bottom. Now the ridges are trending perpendicular to our path. The ridge direction is some what irregular, some relief up to about 2 m on some of the ridges. Not very well populated, a few fish, not too many stalked animals, very few stalked animals, very few holothurians. Some suggestion that there might be mudstone

				outcropping on the lee side of some of the sediment mounds. Many of them are asymmetric with a very steep face, but there is no consistent direction to the steep face of the ridges.
20:34	3321		P	Seeing more outcrop at the top of these ridges, they are very steep faced, faces up to 60°, outcropping siltstone. Apparently we've got some subsidiary faulting going on, these are 1-2 m features, going all over the place, not in a coherent direction, but they are bringing up outcropping rock in places, very soft outcropping semi-lithified mud, that generally is dipping to the starboard, with our direction at 035° right now. Going over a stalked animal with a branching top. Now coming up over a very steep drop off. It drops down at 70°-80°, a drop of about 2 m, maybe slightly more. A few blocks of mudstone outcropping, and as talus at the bottom of the ridge.
20:36:10	3318	272	P	Continuing traverse towards the dredge tracks, bottom as described before, somewhat smoother here, fewer outcrops, fewer steps. Still very sparsely populated, a few stalked animals, including a few sea pens, rare holothurians, a few echinoids, a few brisingids, but the density of animals is fairly low.
20:37:35	3322	024	P	Continuing traverse, sediment covered bottom as before.
20:38	3324		P	Still sediment covered bottom, rolling irregular hills. Pseudo-outcrops of mudstone on the steepest parts of some of them, but generally smoothly sediment covered. A few anemones, a few holothurians, but not too much in the way of large creatures. Off in the distance is a large brisingid, a little more than 50 cm across.
20:40	3326	340	P	Bottom as before. Not much bioturbation here, a few mounds, rare fairy circles, fairly limited bioturbation. Passing a very strange, what looks like fecal material, although it could have been an animal with sediment covering itself, it looked very straw-like, it either had lots of little legs, or was composed of very coarse fish bones or something, not photographed. Minor amounts of subcropping mudstone still, but pretty much a sediment covered bottom.

20:41	3324		P	Picture number 3 was of a large purple holothurian, approximately 50 cm long.
20:42	3326		P	There is a small purplish shrimp about 10 cm long on the bottom. Still making a traverse towards the site. We're climbing up a little bit now, some irregular mounds and ridges, some showing outcropping siltstone around the steepest parts, but generally sediment covered.
20:43	3325		P	Picture 4 was of a very large white anemone. Coming up now on a large mound with exposed outcropping siltstone. It's peak shaped. Picture 5 is of a creature that I can't identify. It almost looks like a legged holothurian laying on its back, sort of purplish colored, with its feet up in the air. There are several siltstone blocks on this mound, which we're just barely sitting on here. Outcropping siltstone on the top, and some minor movement of material down the slope.
20:43:55	3326	287	E	Steep slope with outcropping siltstone dipping down slope face.
20:44	3326		P	In a sediment cloud at the moment.
20:46	3322	093	P	We've just come over a large sediment mound, it was actually a pinnacle, dipping away in all directions, outcropping siltstone on the top.
20:48	3322		P	Current Zulu time 20:48. The last time recorded was incorrect (Equipment operator reset data frame). Depth 3322, still over sediment covered hilly bottom. Still transiting towards dredge track.

NOTE: The clock was reset, all transcript and photo times have been corrected by adding two hours.

20:47	3320		P	We've got several mounds on the port and also ahead. Lots of subcropping to outcropping siltstone. Very choppy, blocky outcrops in front of us, predominantly sediment covered to port, but with some very steep ridges. Off to the port now I can see a very steep slope with...
20:49:08	3320	305	E	Outcropping mudstone at top of small scarp.
20:49:40	3320	031	P	We've got very steep ridges now, a lot of... Lots of the siltstone of the afore mentioned ridges has slumped down the steeper side and is exposed as talus blocks from 10 cm to somewhat less than 1 m, somewhat rounded blocks, all very locally derived, none of them very far traveled, just off these ridges, which

				are apparently subsidiary to a larger scale structure, but it's a fairly incoherent structure as these ridges trend in several directions.
20:51:19	3319	033	P	(To pilot) I don't see any dredge tracks. We've got outcropping siltstone. That's a pretty good scarp off to the left. Siltstone exposed on the scarp. We've got some more small scarps, one cork screw-like animal. We've got some three dimensional outcrop now, siltstone around some of the ridges. I can see that it's still pretty flat lying, it has not been tilted significantly.
20:52	3320		P	Topography is becoming a little more irregular. We're seeing more outcropping siltstone, but still predominantly sediment covered. All of the siltstone seems to be unconsolidated, none of it looks like very lithified stuff. It's lighter in color than the normal brown sediment lying on top of it, still fairly sparsely colonized by animals. Fairly irregular bottom, with local scale relief of tens of cm and distant scale relief of 10 m or so.
20:55	3323		P	Changing heading to 270°, heading off to the port to try to intersect the dredge track from dredge 14.
20:56	3323		P	Last picture was picture 6 of a purple stalked anemone with a small sediment covered stalked tube about 4-5 cm high.
20:57	3323		P	Very irregular bottom. I see a slope moving up to the port fairly steeply, a few tens of meters high, very hummocky. Just passed a very long legged creature in the water column, daddy long legs-type proportions to it. With its legs it had collected a lot of the abundant flocculant matter which is clouding up the bottom view here most of the time. It seemed to be harvesting that flocculant matter out of the current. It had a body length of about 1 cm and leg span of 4-5 cm, perhaps a little more.
20:58:30	3322		P	Still over sediment covered bottom. Much flatter here, and while we're in flatter terrain there is a lot more mounding and bioturbation. None of the mounds are obviously active right now, but the bottom has been worked over by some creatures. As we move up now we see a little slope with some outcropping siltstone. The slopes are much less bioturbated.
20:59	3322	284	P	Picture 7 was a very close up shot of a 50-60 cm long fish. Still traversing over a very

				irregular bottom. We've got almost a gullied terrain, as seen in camera run 19C. Along the sides of the gully is outcropping white siltstone with some movement down perpendicular to the trend of the gully, straight down the slope into it. Fairly rounded sediment covered gully bottom.
20:59:13	3322	281	E	Outcropping mudstone on scarp, stepped down to the forward starboard.
21:00:18	3323	272	E	One m high ridge with subcropping mudstone.
21:01	3323		P	We are coming up to a rather steep scarp which I can't see at present. It's dropping away towards the front. I can see it now dropping off very steeply, 60°-70°, fairly smooth slope, not too many talus blocks on it, toward the bottom a few talus blocks and an irregular topography at the bottom, again perhaps a large channel. We'll see if we pick up the other side as we continue along. Yes, coming up on the other side, it does seem to be some kind of a large channel-like feature. The other side is not nearly as steep as the side we just went over.
21:02	3326		P	Picture 7 was of a brown, gelatinous, balloon-shaped animal in the water column, 7-8 cm in diameter, it may not have made it into the field of view of the picture.
21:02:36			P	Picture 8 was of a stalked animal, probably a sea pen, which was also inhabited by some kind of animal clinging to it. (To pilot) I've got a couple of anemones and a stalked animal, yes, there are the rocks.
21:03			P	Picture 8 and 9 taken together, at 21:03, of some anemones and stalked animals on an outcrop of siltstone. We've got a pretty steep hill or scarp coming up in front of us with slump blocks of siltstone, somewhat disaggregated. I see pretty irregular topography here, a lot of sediment movement. Picture 10 is of a purple holothurian next to one of these sediment mounds. We've got some very large and irregular blocks now of slumped siltstone out in the distance. Very hummocky terrain, relief of several meters. A lot of mass sediment movement. Fairly sparsely populated by animals. All but the very steep slopes are sediment covered.
21:03:33	3326	268	E	Small channel.

21:04	3324		P	Picture 10 is of some outcropping siltstone. Coming up on a pretty good scarp, lots of outcropping rock now on the edge of the scarp, lots of big blocks, meters long laying at the bottom of the scarp.
21:04	3325	260	S	Recording mound structures on video (off at 21:05)..
21:04:54	3325	257	E	Steep slope with mudstone talus and venus fly trap anemones.
21:05	3323		P	Picture 12 and 13 are of a beautiful venus fly trap right next to a big anemone. We've got a lot of talus here, some half meter size talus. Another picture of a venus fly trap in the talus itself. We're rising vertically now. Coming up a steep slope. The top of the slope is colonized by quite a few stalked animals and anemones. Last picture was a general picture of the creatures colonizing the last slope with the big blocks on it and the nice pictures of the venus fly trap. A picture to show the topography and the colonization at the top of this slope.
21:05:10	3325	259	E	Outcropping blocks of mudstone at the top of a steep slope.
21:06	3323		P	Moving along an irregular sediment covered bottom. A white fish just swam by and sort of dug its nose in to the sediment, but did not try to burrow in, it just sort of headed in and kicked up a little sediment and then stopped. Picture 17 and 18 are of a small scarp. Picture 18 included a purple shrimp about 1 cm long. Picture 20 is of a venus fly trap on a slump block of siltstone. Coming over another slope with some outcropping siltstone.
21:07	3322	270	P	Going over very irregular terrain; going up and down scarps with exposed siltstone. Looks like they're probably channelized features with fairly flat sediment covered bottoms and some rock outcropping or siltstone outcropping on the edges. Colonization is higher at the tops of them than at the bottom. Only local areas are heavily colonized by anemones and other animals. Two successive pictures of venus fly traps, including in the field of view anemones and a galatheid crab. Vertical shot of a venus fly trap. The fly traps have a very thick yellow stalk about 4-5 cm in diameter, thick gelatinous, leathery stalks, and then they open up into bilaterally symmetric half moon shaped partitions about 20 cm across and tentacled all

				the way around. They fold themselves over like a tortilla.
21:07:04	3323	243	E	Blocky mudstone on scarp.
21:07:20	3322	259	E	Subcropping sulfide(?) crust.
21:08:19 to 21:09:30			E	Isolated small sulfide chimneys and exposed mudstone.
21:07	3322	270	S	Video on, off at 21:07.
21:09	3320		P	Coming down again over another scarp. It is dropping down about 15 ft. Some burrowing here, but not a lot, a few fairy castles, not overly abundant. The venus fly traps show a definite preference for the tops of the ridges or talus slopes which expose rock, apparently looking for a place with good current flow, and not too much sediment deposition.
21:09:30	3321	255	E	Subcropping sulfide.
21:10	3323	088	P	Sitting on sediment covered bottom. Still traversing towards the dredge track.
21:11	3321		P	Picture of a stalked creature, a sea fan type thing with lots of arms sticking out, a palm frond shaped animal.
21:12	3322		P	Last picture was of a stalked corkscrew-like animal. Corkscrew animal was picture 24 on the camera counter.
21:12:12	3321	251	E	Minor subcropping sulfide.
21:13	3319		P	We're on an fairly steep slope now with about 4-5 m of relief.
21:14	3317	250	P	Still over sediment covered bottom, irregular topography, rounded, a few meters of relief, right here it is fairly sparsely populated with animals.
21:15	3322		P	Stalked animal, sea pen-like animal, with a straight stalk and short, 1 cm or so, arms coming off of that stalk. The entire animal was about 60-70 cm high.
21:16	3318		P	Just traversed over a large channel again. This channel is about 4-5 m deep and fairly smooth and sediment covered. Very large white animal in the water column, well off in the distance to the port, beyond where I could photograph it or even see it clearly. It could be a large fish or it might be a large octopus-like animal. It's too far away to see. It is a fish.
21:16	3318	282	S	Video on, off at 21:18, recording fine, light brown bioturbated sediment.
21:18			P	Picture 26 is of a very large white fish 60-70 cm long.
21:19	3322		P	Another picture of a venus fly trap sitting next to an anemone.

21:21	3321		P	Still heading towards the dredge track. A very channelized bottom here, still very irregular, there seems to be channels coming off of this slope. Highs and lows of a few meters to 10 m or so high. More animals at the top of the slopes than down in the basins, some outcropping siltstone, some mass flow blocks of siltstone along the steeper edges at the base of the channels, everything else is pretty much sediment covered.
21:22	3316	270	S	Heading up slope in direction of point G.
21:22:32	3320	276	E	Pyramid urchin.
21:23	3318	270	P	Last picture was of a white stalked anemone with only a few legs, 8 or 10 legs maybe, sort of a clear gelatinous white, about 10-15 cm high.
21:23:49	3319		P	We've got a lot of talus blocks, we're coming up a very steep slope now with a lot of talus blocks on it. Some of the talus block are up to a meter. All appear to be siltstone blocks. No indication of anything else. You can see bedding in the siltstone blocks, it's tilted at very irregular angles, obviously a mass flow-type deposit. Now coming over this ridge and a very steep slope dropping off on the other side, essentially an 80°-90° slope. Cannot see the bottom.
21:23:52	3319	252	E	Subcropping sulfide(?).
21:23:58	3318	254	E	Subcropping sulfide(?).
21:24	3318		P	Came off of that last fault scarp and lost the bottom. It drops off more than our amount of vision. We're still in the water column. We're trying to turn on the fathometer to get the depth to the bottom to estimate how high this scarp was.
21:24:08	3318	262	E	Outcropping mudstone and sulfide(?)
21:24:13	3318	262	E	Outcropping mudstone and sulfide(?)
21:24:20	3318	269	E	Outcropping sulfide(?).
21:26	3318		P	The fathometer now on; says we are about 30 ft off the bottom after going over that scarp. The scarp was essentially vertical to maybe 80°, but was entirely sediment covered with no outcropping siltstone or anything else on it. Just a vertical sediment covered scarp.
21:27	3323		P	We're back on bottom again, smooth sediment covered bottom. The bottom is sloping away behind us back towards the last scarp we went across. In other words this is a definite channel feature with one very steep side and

					another more rounded and gently sloping side. It could be a block faulted half graben with a sediment smoothed face on one side.
21:29	3326			P	Coming up another very steep scarp. The pilot says it's about 10 ft high all sediment covered. I can see a break in slope about 8-9 ft up it. The slope at the top and bottom is about 60° and there's a bench about 8-9 ft up that is about 40° and sediment covered, smoother than the other two, it looks like it is just a bench in a fault scarp perhaps. The top of the scarp we're just coming over now is very rounded, sediment covered. More colonization of organisms on the opposite side from us. The slope on that side is about 30°, a few blocky sediment covered pieces of siltstone talus, almost completely buried in sediment, but enough of an outcrop to get some anemones to colonize them. Just a rather irregular rolling topography here with channels and hills and knobs. A few meters to maybe 10's of m of relief for most of it.
21:30:30	3325			P	We've come over the top of another rise and I see some siltstone talus, a few cm to maybe 10 cm in diameter. Again, the slope on the west side of that channel as in the last one is more heavily colonized by animals. Now moving up the east slope of another channel, pretty much sediment covered, a few knobs of siltstone outcropping towards the top and those are somewhat colonized.
21:31	3327			P	The first of the last two pictures was a corkscrew animal. The second was a general shot showing a large 1 m or so talus block sitting in a sediment covered field.
21:32:22	3326	286		E	Exposed mudstone and mudstone talus.
21:34:58	3328	309		E	Mudstone blocks on top of hill.
21:37	3328			P	Sitting on sediment covered bottom, some blocky siltstone outcrop. Apparently we have gone west of the target and we will have to turn around and go back to it. We missed the dredge track in the irregular terrain.
21:40	3329	020	1-3	S	Sediment mounds and sediment casts.
21:41:40	3329			P	On bottom. Still an irregular, ridgey, sediment covered topography, with the steepest area having some mudstone outcrops and talus blocks.
21:43	3325	113		P	Apparently in front of us is a steep scarp. I'm sedimented out and can't see at the moment.

				I've got bottom now. A fairly steep slope, sloping away to the starboard. We've got almost a conical ridge here, it's sloping away on both sides, sediment covered. Sloping up to the port in the distance with some stalked animals sitting on some dark looking outcrop. Off in the distance were a couple of talus blocks which were dark colored, possibly real rocks. They are heavily colonized. They looked different than the siltstone we've seen so far.
21:44	3319		P	(Pilot: Do you want me to pick one of these up?) I want to take a look at some of these rocks. If you just keep on with what you're doing I'll be able to get a good look at them. We've now got outcrop with some blocky talus which is very dark. Moving up on it is pretty heavily colonized. The blocks are about 1 m or so at the largest. It looks like hydrothermal material. We've just landed near one of the venus fly traps and it has closed itself up, pulled in its tentacles like an anemone, closed its two halves together forming a rounded blob on the bottom.
21:46:04	3321	086	E	Sulfide talus.
21:47	3320		P	On the bottom. We've got some dark blocky talus. It's fairly slabby looking, could be hydrothermal material, it's very old, it's all out of place, none of it is in situ. It's more heavily colonized by animals than the sediment covered bottom. Getting a better look at some of it here. It is apparently fine grained if it is sulfide minerals. Could be slabby chunks of basalt, not definitive at this point. We are not going to sample here as this material is all old and out of place; we are going to try to find the source for these talus blocks.
21:48:10	3320	065	E	Sulfide crust pushed up and broken by growth of sulfide from below.
21:50	3319	113	P	Still on a sediment covered bottom with blocky flow blocks of siltstone now. I no longer see the darker material which could have been hydrothermal. The talus blocks are colonized by venus fly traps and anemones. There is a galatheid crab, no I believe it's a shrimp. A few other stalked animals and some holothurians now. Our heading is 113, we're turning to 060 to traverse across the slope to

				try to intersect the dredge track higher up the slope.
21:50:23	3318	113	E	Mudstone (plus sulfide?) talus.
21:51	3317		P	We've now got some blocky talus on the top of one of these mounds, 50 cm sized talus blocks, very irregular, highly sedimented, I can't tell if it is siltstone or not. Yes, it looks like siltstone. It's dropping off very steeply again on the other side of this. I see some animal colonies, and back to another sediment covered bottom, the bottom of the channel between the escarpments.
21:52:46	3320	070	P	Just passed one of our skid marks. We made a circle and are coming back again. We are going to traverse up the slope and to the east to try to intersect the dredge track. Rounded sediment covered hills here with occasional blocks of mudstone showing up on some of the steeper slopes. Just came across another very steep fault scarp with vertically outcropping mudstone on it. The top is again sediment covered and smooth. Just passed a very strange animal which I was not able to take a picture of. (To pilot) We're going to hit on this side now on a flat sediment covered bottom. The animal was stalked, but the stalk was laying down more or less on the ground and coming up from the stalk was a whole sequence of other stalks, it almost looked like a rib cage or something, only everything was sticking straight up. It wasn't actually a fish rib cage, but it had that kind of feature to it with a central spine and everything coming up off it.
21:55	3316		P	Lifted off the bottom to clear ourselves from a sediment cloud, going to traverse a little to the north and then head back to the east to intersect the dredge track.
21:56:38	3318	041	P	Sediment covered bottom dipping steeply away to the port side. Rounded sediment covered slope at about 60° or so. A little bit of blocky siltstone talus at the top of it. A few stalked animals.
21:56:54	3319	344	E	Subcropping sulfide.
21:57:30	3318		P	Picture of a large white fish.
21:58:49	3318	040	P	Still over a rounded sediment covered bottom with not too many organisms.
21:59	3319	051	S	
22:00	3319		P	On the top of a rounded sediment covered mound heading toward another steep slope. I

					can see also a slope off to the port side, a few stalked animals. Now we're coming down a slope of about 30°, sediment covered, smooth. Just passed a large talus block coming down that last scarp, about a meter in diameter, fairly dark looking on the bottom side. It could have been basalt, but everything else here is siltstone, it may have just been manganese oxide coating on siltstone.
22:02			1-3	S	Video on, off at 22:05, gullies and sediment.
22:03	3320			P	Just took a picture of a stalked animal, a very thin stalk with almost a venus fly trap type head, it is different from the venus fly trap though with its long thin stalk about 20-30 cm high.
22:03:39	3321	070		E	Outcropping barite, iron oxide and sulfide at the top of a slope with venus fly trap anemones.
22:13:33	3324			P	Just left a vertical fault scarp with exposed black rocks, slabby rocks. It could have been either hydrothermal material or basalt. We're going to go back in that direction and consider sampling.
22:14	3325			P	We're on a steep slope, sediment covered with blocky...
22:14:45	3324	325		E	Mudstone talus.
22:15	3320			P	We've got some blocky outcrop, could be talus below us, pretty much sediment covered, somewhat colonized. Where the slopes are flat, it's completely sediment covered. Some of the blocks are siltstone, others are darker looking and cannot be identified yet. We're coming over some blocks now which look to be basalt, they could be hydrothermal. We've got some hydrothermal material here for sure. We've got blocks of black hydrothermal material just barely outcropping from the sediment. If you can find a good place to sample, just keep driving around here until you find a nice place to sample. We've got white talcy looking mudstone with some slabs of hydrothermal material sticking up. If you can get a core sample through that white stuff, that would be excellent. I think we are probably sitting on some barite here at the top of the hill. It looks like it has manganese oxide coating on it. It is colonized by anemones. I've got a slope dipping towards the front of the boat.

22:17	3324			P	Just crossed a highly sedimented ridge somewhat covered with talus. The blocks I got the best look at were somewhat whitish, probably barite. Most of them had a black cover which was probably manganese oxide. Blocks are 50 cm or so in general, very angular, a few are slabby, some pieces are very dark, could be either sulfide or basalt, but those were further in the distance and could not be seen as well.
22:21	3323	323	4-6	S	Taking core sample.
22:30:09	3319			P	On bottom in front of talusy outcrop of siltstone. I've just changed to roll 2 in port hand held camera, and now turning tape over to side 2.
22:30:47	3319			P	Start of side 2 of tape 1, port side.
22:31	3321			P	Did not sample at the last site. When the sediment cloud cleared, we had moved. All I could see was siltstone. We decided to move up the slope looking for hydrothermal material.
22:33	3321			P	Going over some rubbly outcrop now possibly hydrothermal. Very heavily sedimented. Covered with whiter material, it could be barite. Most of it is talus blocks, some of it may have moved down hill. Some of it was very dark, some of the fragments, generally about 30 cm or so, possibly basalt, probably hydrothermal. We're going to continue up slope and try to find better outcropping material to sample. Now we've got some siltstone which is outcropping here, still highly sediment covered.
22:33:19	3323			P	Still going over a hummocky bottom, fairly well colonized by organisms compared to before, but still fairly sparse. On the ridge tops and steeper slopes we do have some talus, predominantly siltstone. Right now we have no outcrop just mud covered bottom.
22:38:59	3326			P	Picture 1 on roll 2 is a gelatinous, slightly purple, winged bottom dwelling creature 20 cm in diameter or so with a couple of wings, rather intricate looking creature. The bottom just beyond where that last picture was taken is mud covered with a little bit of whitish outcropping siltstone.
22:40	3324			P	Picture 2 was of a venus fly trap. He was open when we came up. I waited until he closed and then took the picture. It is a picture of a venus fly trap that had just closed up.

22:40	3324		P	Picture 3 is of a large purplish fish, almost 1 m long.
22:41	3324		P	We've got some outcropping mudstone sticking out of a sediment covered bottom. I could see that there was some boring going on. There were some holes in the outcrop showing that it had been bored by some organisms.
22:45	3322		P	Over rolling sediment covered bottom, very sparsely populated. There is a galatheid crab, a few stalked animals, but not too populated, fairly well bioturbated here.
22:46:18	3322		P	Just went over a 1-2 m vertical drop off, could be another edge of a channel. There was nothing exposed on the side of it, it was all sediment covered. Off in the distance it looks like we are going along ridges, channeled ridges go up and down, valley and ridge type topography on a small scale.
22:47	3321		P	We're going over a series of these channels that seem to be cut into the sediment surface. They are usually 2-3 m deep, they are running parallel to one another, may be cut by mass flow processes, but there is nothing exposed on the walls of them except occasional siltstone, generally they are sediment covered.
22:47:50	3321	047	P	Last picture was of a white animal with tube-like stalks sticking up in the air, looked like tubed feet only they were all sticking up in the air. The ends of the tubes were whitish. It was about 10 cm across or so. Next picture is of a stalked corkscrew animal.
22:49	3322		P	Just going over steep scarp, very steep scarp. Dropping off well below sight.
22:51	3325		P	Just went over a very large channel. It must be 10 maybe 20 m deep, very steep sides. We've just come to the other side, one side was vertical, the side to the south. The side to the north is near vertical, but completely sediment covered. There was some outcropping on the south side, probably all siltstone. Running down the side of that channel were some ridges going perpendicular to the edge of the channel itself. The ridges are maybe outcropping siltstone, I'm not sure, but they have about 1 m of relief and are running straight down perpendicular to the axis of the channel.
22:51:34	3326	347	E	Mudstone scarp.

22:52	3327			P	Taking video of mudstone outcropping on side of channel. On the bottom of the channel I can just barely see in the distance, at least 20 ft down, lots of white holothurians. They're being covered by our sediment cloud now but there was maybe 20 of them in the field of view. A much higher density of animals than seen anywhere else. They all seem to be congregating in the bottom of this very deep and wide channel. Channel must have been approximately 30-40 m across, and a good 10 m plus deep. The side to the south was very steep, the side to the north was a little more rounded, but was fairly steep as well.
22:52:07	3327	347		E	Mudstone scarp.
22:52:25	3327	347		E	Mudstone scarp with grooves cut by down slope sediment transport.
22:53				S	Video on, looking at steep slope.
22:54:33	3330	275		E	Near vertical sediment covered scarp.
22:54:54	3331	274		E	Near vertical sediment covered scarp.
23:02:01	3325	214		E	Subcropping sulfide crust.
23:02:28	3325	216		E	Subcropping sulfide crust with venus fly trap anemone.
23:06	3320			P	Sitting in the middle of one of these large channels. On the Mesotech display we can see a series of parallel trending channels and ridges, we can see the ridges as reflections. Trying to take some video of the Mesotech display.
23:10			6-10	S	Given position by surface at X=58988, Y=58330
23:13	3316	115		P	Going to head south and try to intersect the dredge track. The bottom here is hilly, hummocky, sediment covered, a few meters of relief on most of the hummocks.
23:15	3319			P	Hummocky sediment covered bottom.
23:15	3319	156		S	
23:15:32	3319	136		E	Subcropping sulfide crust with venus fly trap anemone.
23:16	2319	158		P	Two pictures successively of the colonized top of a ridge with venus fly traps and anemones.
23:18	3320	119		P	We've got some outcropping barite. That's hydrothermal I'm sure. Let's try to grab a sample of some of that. Just taken a picture of some barite sticking up out of the sediment. It is fairly colonized. We've got a good outcrop in front of us. We've got also some basalt outcropping apparently, some slabby basalt. It is a talusy outcrop. It looked like some

				hydrothermal barite coming up out of the sediment. Now we've got a little scarp with what looks like maybe some slabby basalt. It has been faulted up. Two pictures, maybe three, taken of that. Next picture was of a corkscrew animal at close range. And then a picture of, in the distance, before the sediment cloud comes, of a slab of basalt in a fissure. It looks like we've got a fissure running parallel to us with a slab of what looks like sheet flow basalt in it, old sheet flow basalt. Camera reading on the next picture will be picture...
23:18	3320	131	S	Video on; sediment and mudstone outcrops.
23:28	3320		P	Looking at a rubbly bottom. We just passed a piece of hydrothermal material, I just saw some sulfides. If you can get a good sample up in front of you, let's go for that. Picture 12 is of a venus fly trap colonizing some of this rubble. One piece did show sulfide sparkling back at me. Most of it is highly sediment covered. There is very little of it that can be seen. We are going to sample some that is in front of us. Picture 13 was of an anemone. Picture 14 was what appears to be hydrothermal material, colonized by some anemones. There is a small piece with what looks like small chimneys, 1 cm or so in diameter, growing up from it. We've got several small little chimney structures poking out of the sediment here, picture 16, and 17 is the same thing, colonized by anemones.
23:30	3321		P	Just shot several photos. Taking another photo of a venus fly trap at the base of what looks like a small chimney-like structure. We've got some sediment in the water, I did not take that last picture. This site is very highly sedimented. The few things that do stick up and look chimney-like are very small, a few cm high, maybe 10 cm at the most. Some of them look like they might be chimneys that have grown up through the sediment from very slow, diffuse, leaking hydrothermal fluid. Or, they may be the tops of chimneys that are sediment buried. Can't see at the moment due to a sediment cloud. We're going to try to sample.
23:31:25	3321	333	E	Subcropping sulfide with venus fly trap anemones.
23:31:41	3322	356	E	Outcropping sulfide.

23:33	3322			S	Sampling in progress at sulfide site.
23:34:23	3322	007		E	Attempting to sample.
23:35	3321		10-13	S	
23:39	3322		14-17	S	Sampling in progress at sulfide mound. Possible small chimneys at top of a gully. No active venting, three frames taken of sampling site.
23:43	3321			P	Attempting to take a push core sample through what looks like hydrothermal material, probably sulfide, dark sulfide, laying on sediment. Too friable to sample with claw. First push core dropped.
00:03	3321		17-20	S	Took three frames of side view of sulfide piles and small chimneys.
00:08:23	3322	069		E	Sulfide with venus fly trap anemones, manipulator arm.
00:09	3321			P	Picture 17 and 18 are of small protrusions from the sediment, probably hydrothermal. In the distance you can see a broken push core. It looks pretty whitish, like it could have been talcy. The push core was broken while attempting to recover it. In the distance you can see some more white material and some shale chips sticking out.
00:09:51	3322	055		E	Sample in manipulator.
00:10	3322		20-28	S	Recovered core and small chimney. Sampling in hydrothermal area with many small (1-2 feet high) inactive chimneys. Samples placed in starboard aft basket, one core in critter basket.
00:12	3322			P	Picture 20. Small protrusion of black sulfide sticking up vertically off the sea floor about 10 cm. Seems more to be a weathered remnant rather than an actual constructional feature, it does not look like it ever was a chimney. There are just blocks of slabby sulfide sticking up in several places, but I don't see anything that can truly be called constructional.
00:16	3322			P	Picture of a small what looks like pyrrhotite protrusion sticking up out of the sediment, fairly close up shot. In the field of view, probably a couple of anemones on the side.
00:17:17	3322	062		E	Chimney before sampling.
00:18	3321			P	Still at the sampling site. Last picture of a partially closed venus fly trap.
00:19	3321		28	S	Photo of variety of mounds in sample site.
00:25	3321			P	Taking video out the port side as we are leaving the sampling site for sample one. A very crumbly sample put behind the critter

				basket. The video is showing a brown jelly fish like object floating in the water column.
00:25:13	3322	106	E	2-3 cm high post-sediment chimneys.
00:27	3321	125	P	Just moving away from an attempted sampling site. We could see some very small sulfide protrusions. Now we are over sediment covered bottom again with rounded slopes. Not much in the way of outcrop right now. The slope is dipping away steeply to port. Some resedimented siltstone blocks down the slope. Slope drops away in steps, very steep in places, almost vertical, but mostly sort of a rolling gentle slope away from us.
00:29			P	Just touched down on bottom and kicked up a sediment cloud. Just before we touched down there was some outcropping siltstone, mostly mud covered. In the distance I can see our attempted sampling site with rare pieces of sulfide sticking up through the sediment and some whitish material, probably talcy material.
00:31	3321	053	P	Moving along a rubbly type bottom, all sediment covered, but sort of an irregular bottom. Some small structures on the bottom, which may be buried hydrothermal talus again. Unsuccessful at most sampling attempts at the last site because of the crumbly nature of the samples. We've got pieces behind the critter basket. One push core is in the basket, but not in its quiver. Another push core was broken at the sampling site and left.
00:31	3321	062	S	Video on.
00:34	3323	165	P	We are transiting back trying to intercept the dredge target. Over a sediment covered bottom.
00:35			P	I've got a very steep slope, it could be a scarp, on my side, with some layered outcropping. I can't see any rocks to tell what they are. This slope is trending down away from me on the port, so we are probably going to turn right into a very steep slope on the starboard. The slope is covered with a lot of talus blocks which are probably siltstone, but I can't really tell, it's pretty heavily sedimented.
00:36	3323		P	Turning to come up the slope that is off to the starboard. I can see some outcropping, it looks like mostly siltstone, but we just passed a little area that had what looked like some more sulfide sticking up out of the sediment, very small block a few cm long.

00:38	3321	174		P	Still climbing up a fairly steep, 30° plus, sediment covered slope. At this point no further outcrop, mostly just sediment covered.
00:41:29	3323	149		E	Sediment covered bottom.
00:44	3323	170		P	Still over irregular rolling sediment covered bottom. Some very steep slopes on the lee of some of the sediment slopes, dipping off at about 90°, but others are gentle slopes. Very sparsely populated by animals. In the distance to the port it is still dropping off.
00:41	3324			P	Picture showing a smooth sediment covered bottom dipping away. Next picture shows the same with some outcropping mudstone.
00:43	3327			P	Last picture was a purple holothurian with a small shrimp sitting next to it.
00:46	3326	178		P	Still transiting over smooth sediment covered bottom.
00:48	3322	160		P	Very irregular terrain dropping off to the port side, rolling downward, fairly steep rolling slopes, sediment covered bottom, no obvious talus, very few creatures colonizing the bottom.
00:48	3322	174		S	Ripple marks on bottom, abundant organisms.
00:51	3320	136		P	Transiting irregular sediment covered bottom.
00:53	3316	150		P	Still coming up hill. Traversing irregular sediment covered bottom. Somewhat bioturbated, no outcrop, few animals. Still trying to intersect dredge track.
00:53	3317	145	28-30	S	General bottom topography sediment, shot of a brittle star.
00:55	3317			P	Picture of a small white fish. Still over hummocky sediment covered bottom. Bottom now is dropping away very steeply to the fore. We're in an other definite channel here. The channel is about 2 m deep and about 4-5 m wide with a rounded bottom. A little bit of outcropping siltstone on the sides.
00:55	3316			P	Coming over a very deep channel, there are several small channels, I've got a scarp well off to the left below us. The bottom is dropping off. Another definite channel. This one is about 20 m deep, 40 m wide with mudstone exposed in some of the walls.
00:58	3320			P	Crossing very heavily channeled area, lots of relief. Ten m deep channels cutting across the slope. Rather hummocky terrain elsewhere.
01:01	3316			P	Last picture was a general shot of hummocky terrain, dipping off away from the field of view.

01:02	3318	173		P	Back into more channeled terrain. Another 1-2 m deep channel cutting across slope. Coming over the edge of another channel now.
01:04	3314			P	Still on sediment covered bottom with occasional channels some 1 m deep, some as much as several m deep. In between channels a rather hummocky terrain.
01:05				P	Just came over an other large channel way, this one about 4 m deep, maybe. Side slope coming in at about 45°, all sediment covered on both sides, no outcrop.
01:06	3309			P	Very steep gully we've just crossed over, very deep, I cannot see the bottom, the bottom probably 10 m or less deep.
01:06	3309			P	Picture taken of the side of the sediment covered gully, looking down into it. The distance was too far a way to see the bottom of it.
01:06:55	3308	128		E	Edge of mudstone debris flow.
01:07	3307	152		P	Picture of a purple fish which was pointing head down and looking directly at a galatheid crab. Still transiting, attempting to intersect the dredge track.
01:08	3110	186	30-36	S	Transit to point F.
01:08	3309			P	We've just found some sulfides, little vent like structures off to the side. I see mostly talus, I did see one fissure with no water coming out of it. The sulfides I can see below me are colonized by anemones. Right below me is a fairly steep slope with a lot of sulfide talus on it. One basket shaped thing that looks sort of like a vent. There's a large galatheid crab out in the distance. There are some blocks at the bottom of the slope that are almost 1 m. Some slabby outcrops of sulfide at the bottom. It looks like they have been exposed in a sediment channel perhaps, I see a channel going away from me now with some siltstone exposed on the other side.
01:08:00	3308	173		E	Subcropping sulfide.
01:08:32	3309	181		E	Mudstone talus.
01:10:26	3311	106		E	Mud covered bottom.
01:12	3309			P	Heading back to where we saw the sulfides, and we are going to attempt to sample there. Most of what I saw seemed to be darkish colored metallic sulfides, a lot of slabby outcrop. Some of it definitely had moved, it was talus, but as we went over the sulfide we

					also went over a channel, and some of it had slid into that channel, may have been exposed by that channel.
01:16	3312	000		S	At point F.
01:17	3311	020		S	Sediment covered, highly bioturbated, very fine grained.
01:17:00	3311	348		E	Fine pebble debris flow lag deposit.
01:18	3310		1-8	S	Load roll 2, pictures taken on side of an escarpment. Many gullies 15 to 30 feet deep. No visible sulfides. Consolidated sediment.
01:18	3311			P	Last picture of a stalked animal, going to take a second picture of it now that it is closer, a stalked animal with a tulip-like head.
01:18:37	3310	033		E	Subcropping layered mudstone.
01:20	3310			P	Picture of the side of a channel with some outcropping mudstone.
01:21	3312			P	Dropping into a sediment covered channel with some whitish mudstone outcropping at the top, and just slide debris toward the bottom and mud.
01:22	3313			P	Last picture was outcropping mudstone with some talus derived from the mudstone, small cm size pebbles of mudstone laying on the mud bottom. Last picture and the one before were taken in a deep channel way looking at one side of the channel.
01:23:45	3311	098		E	Isolated sulfide talus on debris flow deposit.
01:24	3309			P	Last picture was a picture of ridge along the top of a sediment channel separating one channel way from another.
01:24	3310	100	1-8	S	
01:26	3305	580		P	Just crossed over a vertical channel wall. The bottom dropped away out of sight.
01:26:28	3305	052		E	Mass wasting at top of channel bank.
01:29	3305	270		S	Changed coarse to 270. traversing deeply gullied area. Gullies all appear to follow the same linear trend.
01:29	3304			P	Changing course to 270 to try to intersect dredge track. We're in an area that is deeply channeled, some channels more than 10 m deep. A few tens of meters wide for some of them. Near vertical walls on some of them, like the last one which was just called a fault scarp. It had another side and was therefore a channel. Nothing but mudstone or sediment covered walls on these channels.
01:31	3306			P	Transiting irregular sediment covered bottom, still rather channeled looking, hummocky,

					occasional subcrop or talus blocks of mudstone.
01:32	3309			P	We're going right down a sediment channel at the moment, we've got steep walls on both sides. On the port side I can see some blocks of mudstone derived from the walls. Total channel depth is 2-3 m.
01:34	3308			P	Just crossed over either another steep slope, almost vertical, or the edge of a channel. (To pilot) I've got the bottom over here, sediment covered, we're 5 m or so off of it.
01:35	3310			P	Picture taken showing a hummocky bottom and in the distance dropping off vertically, probably into another channel way. We are still flying along in a channel with a little bit of outcropping mudstone, but mostly sediment covered.
01:39	3316			P	Last picture was of a fish. Picture of a white starfish.
01:54:14	3321	063		E	Sulfide fault talus.
01:58	3321			S	Given position by surface as X=58771 Y=57589
02:22	3321			S	Sampling on a rock face at a sulfide deposit.
02:26	3321			P	We're on the bottom in front of a very steep scarp covered with talus which I haven't been able to see yet. Last picture on roll 2, which may not have advanced, was of a galatheid crab on the talus.
02:30	3320	115		P	Still sitting at the base of the fault scarp with talus which I haven't gotten a good look at yet. I've just changed to roll three in the camera.
02:32			10-11	S	Sampling a small cliff face, following sulfides along scarp.
02:33	3319			P	At the top of the scarp, all sediment covered here. I could not see the talus on the scarp.
02:33:22	3319	271		E	Sediment covered bottom with a few mudstone(?) talus blocks.
02:36	3319			P	Picture 1 on roll 3 is of a purple anemone, which is indicating a very strong bottom current. You can see the tentacles pushed out by the current.
02:37	3321	060		P	Over slightly irregular sediment covered bottom.
02:37	3321	050		S	
02:39	3326			P	Descending down a steep slope. Nothing but mudstone talus outcropping that I can see. The bottom is pretty flat and sediment covered.
02:40	3332			P	At the bottom of a channel. Flat sediment covered bottom. The wall had a slope of

				about 60° and some outcrop and talus of mudstone, but otherwise sediment covered.
02:43	3332		P	Can now see the other side of the channel. Can just barely see some outcrop here. The outcrop is mostly talus blocks. What I see at the moment is mudstone, some of it colonized by venus fly traps, some of it by anemones. Off to the port side is some very blocky basalt exposed underneath the mudstone. Very possibly basaltic sills that may have lithified the mudstone. The mudstone talus is very blocky and coherent. The black basalts look like they may have intruded it. Probably not possible to sample any of this. Alternatively, this looks like what we've got is a collapsed lava channel. The mudstone was sitting on top of what looks like slabby sheet flow basalt, which has collapsed. We see some of the basalt exposed in the wall, and this channel way probably is a collapsed lava tube. Very little basalt is actually exposed, most of the exposure is mudstone. Picture 3 is of mudstone talus. Picture 4 is of some black material. We're going to swing around, taking pictures of slabby rock with dark faces, it looks like probably the top of a sheet flow terrain; a lava tube which has collapsed. Taking several pictures. There is a stalked crinoid in this picture. (To pilot) You're probably going to hit the stern on the port side. We'll have to wait to see the front looking camera pictures. There is a piece of layered mudstone outcropping, dipping away from us, whitish material. There is a possibility that all the dark material was...there is a piece of either sulfide or glassy rock. Just saw some good sparkles on one fragment sitting at top of that scarp, it could have been either glass or sulfide.
02:44:12	3331	308	E	Large mudstone talus block.
02:44:23	3331	306	E	Outcropping mudstone and mudstone talus on steep slope.
02:45:39	3328	309	E	Outcropping mudstone on steep slope dipping ~45° to port.
02:46:36	3326	342	E	Fine grained black sulfide or basalt exposed in sediment covered slope.
02:47:41	3324	002	E	Exposed sulfide.
02:47:49	3324	355	E	Barite and sulfide exposed at the head of a slump scarp.

02:48	3324			P	Picture of a stalked animal with a small white head next to a stalked white anemone. It was very close up and probably out of focus, at the top of the afore mentioned scarp.
02:48	3322			P	Just taken a picture of some small projections sticking out of the sediment. There are sea pens or sea fans sitting on them. It could possibly be sulfides, it is not possible to tell. Another picture of a stalked creature.
02:49:59	3324	029		E	Flat smooth sediment covered bottom.
02:50	3322			P	Almost entirely on sediment covered bottom, but we get talus or slabby rocks which are just barely sticking out, some of which show very shiny surfaces. Could be basalt glass, more than likely it seems to be sulfide. Dark colored, fairly shiny, probably looking at big crystal faces reflecting at us, attempting to sample.
02:50	3322		12-16	S	Sampling sulfide bearing rocks in mounded area.
02:50:15	3324	021		E	Barely exposed sulfide(?) crust with anemones.
02:51	3322		17-19	S	Given position by surface as X=58853 Y=57407.
02:51:12	3323	024		E	Stalked animals on sulfide crust.
02:52	3322			P	We've got sulfide here. Just landed on the bottom. I'm looking directly out on some very small projections coming up out of the sediment. They're 5-10 cm high. Definitely sulfide, colonized by several creatures. Taking a picture. They trend along a small ridge, taking second picture of the same area. The exposure is at the high point of the ridge and trends away. On either side where it drops off lower it is sediment covered.
02:52:09	3323	043		E	Hydrocarbon(?) lump on sea floor.
02:53	3322	049		P	Last picture was a picture of a purplish fish. Can now see some of the sulfide projections coming up out of the sediment. A few definitely have hollow tops. They are only 1 cm to 5-6 cm high, but one or two had definite hollow tops and were constructional chimneys, very small, which have grown out of the sediment. Taking a picture now straight down on some. These are very small features, darkish colored where they are not sediment covered. Very poorly exposed, only a few of them actually stick up through the sediment.
02:53:06	3323	037		E	Sulfide crusts, hydrocarbon(?) and sea fan.

02:55	3323	116		P	Picture of an anemone. In the same site where the very small chimneys are. Trying to maneuver around where we can sample some of this material.
02:56				P	Two pictures taken of outcropping sulfide. Picture reading 18. Picture 19 of another block of sulfide sitting on the surface, picture 20 of a stalked animal on barely exposed ...
02:59	3322			P	Picture of a block of sulfide talus with a galatheid crab on it.
03:00:52	3324	340		E	Sea fan and sulfide with barite.
03:01:08	3323	335		E	Same view as 03:00:52 after exposing sulfide and sulfate crust which was cracked by the manipulator arm.
03:03:51	3323	033		E	1-5 cm high, young black waxy chimneys.
03:06	3324	050	20-26	S	Sampling site. Rounded area on edge of ridge, extensive mineralization, glistening fragments when broken in water column.
03:08	3323			P	At the same site trying to sample. Last picture was of a block of sulfide. In the picture it looks like it has a hollow central structure to it, but it does not appear to be a chimney, it just appears to be talus. Now we've got some sulfide and talc breccia. Three pictures taken, the last picture shows an asteroid on the bottom side of one which is attached to some thing slimy. There are some anemones which should be showing up in the picture. Some definite pyrrhotite with white looking talcy stuff in amongst it just like the brecciated samples recovered from the SESCA site, centimeter sized fragments of white talc in a sulfide matrix. The fresh looking sulfide in that last blocky sample was probably broken by the submarine, I don't see anything else that looks that fresh. We just came over that area and tried to sample. I think those were fresh exposures due to the submarine creating the fresh surface.
03:12	3323			P	Two more pictures of sulfide talus. A block about half a meter long, some shiny surfaces on that block, it was about 50 cm square in every direction.
03:09:32	3323	035		E	Sulfide crust.
03:22:17	3322	329		E	Fish over sulfide crust.
03:31	3322			P	Have been sitting at sampling site attempting to sample. The material is to friable, we are unable to sample the sulfides. We are going to cruise up to a place with some apparent

					chimneys, I can't see them, I'm sedimented out, and try to sample.
03:32	3322			S	Extensive iron staining on many fragments.
03:33	3322		1-6	S	Change rolls. First six shots at sampling site.
03:37:32	3322	002		E	Small sulfide chimneys.
03:39	3322			P	We've just taken a sample. Sample taken resembles a chimney. It's about 1 ft long and about 3 in diameter, black. Sample placed in left front basket.
03:41:53	3322	010		E	Iron oxide crust over buried sulfide with some chimneys.
03:46	3322			P	Same sampling site as before. Two more small rock samples placed in front right basket.
03:53	3322			E	Sulfide and barite chimneys over sulfide crust.
03:57	3321		6-12	S	Taken sample at sulfide mineralization site, photos of assorted rock formations around mound.
03:58 to 04:20				E	Sampling attempt.
03:58	3321			E	Sample in manipulator.
04:05	3322			P	Same sampling site. Sample taken, location in basket unknown.
04:05	3321			E	Sample in manipulator.
04:08	3322			P	Picture at the sampling site of a sea pen and a sea fan, a lot of sediment in the water, it won't be a very clear picture.
04:08	3321		12-18	S	Two samples taken. Rocks show evidence of exfoliation around central cores.
04:14	3321			E	Sample in manipulator.
04:20	3321			P	Moving away from sampling site slowly. I can still see some sulfide blocks, I don't see any chimneys at the moment. We sampled a chimney. There were what looked like extinct chimneys sticking up from the sediment. The area is largely sediment covered and outcrop is very sparse. Taking a picture of some sulfide out in the distance. We've got a lot of sediment in the water, that picture may not be too clear.
04:23	3322			P	Still at the sampling site. We will now terminate the dive at this site.
04:23				S	Terminating dive at sampling site.
04:24				P	Released assent weights. Terminated the dive at the last sampling site. Recovery at 0100 (local) 25 Aug, 1986

Dive 660

Location: NESCA
Port observer: John Wiltshire
Starboard observer: Grocki

Julian day: 238
Date: August, 26, 1986
Pilot: Mike Ruppert

Time (GMT)	Depth (m)	Hdg	Photo	Obs	Comments
09:05				P	Hatch closed. Dove at 9:30.
10:45	3230	030		P	Ten meters off bottom.
11:00	3265		1-5	P	Bottom contact. Six frames of bottom area showing basaltic pillows and sponges. Thin sediment cover (~1 cm). No evidence of mineralization.
11:08:23	3275	075		E	Sediment covered pillows.
11:13	3275	064		P	Bottom covered in large pillow basalts and lobate flows.
11:15:16	3278	044		E	Fault(?) truncation of lobate flow.
11:15:29	3277	051		E	Near vertical sheet flow crust.
11:15:41	3277	044		E	Sediment dusted inflationary pillows.
11:15:53	3278	049		E	Large pillows with striations and buds.
11:17:06	3278	062		E	Pillows.
11:17:18	3279	078		E	Pillows.
11:18	3278	092	6-10	P	Lobate flows, some toothpaste-like structures.
11:18:56	3278	093		E	Glassy breadcrust pillows.
11:19:08	3279	098		E	Close-up view of glassy breadcrust pillows.
11:21	3279	080		P	Stirred up cloud of very fine sediment, light brown ooze.
11:23	3278	148	10-16	P	Photos of structures in pillow flows.
11:26	3273	076		P	Problems with submersible side pod. Little bottom life evident. Continuing in rough pillow terrain.
11:27	3276		17	P	Picture of rattail fish
11:28			18-19	P	Pillows large, up to ten feet on long axis, five feet high. Sitting on bottom in gully, lava surfaces appear quite fresh, little sediment cover.
11:32	3278	074	20-22	P	Pillows and lobate basaltic flows with small (2 to 10 feet) sediment pockets separating them.
11:39	3274	090		P	Fresh surfaces, video recording.
11:42	3281	165	23-25	P	Fresh surfaces on basalt outcrops, no evident mineralization, bottom is a series of ridges and gullies up to 30 feet high.
11:46	3277	024	25-30	P	Trim problems, leak on starboard manipulator, lost starboard side pod. Basaltic flows. Transit toward eastern wall slightly up slope. Some broken basaltic material between pillows.
11:53	3278	113	30-36	P	More abundant organisms, largely sponges, white, 4 to 12 inches high. Pictures of sponge and substrate.

11:57:04	3286	080		E	Sediment covered pillows.
11:58 to 12:14				E	Sediment covered pillows.
11:59	3284	090		P	Blocky bottom material.
12:06:24	3286	103		E	Sediment covered pillows.
12:08	3289	090		P	Strong current running due west at 2.5 knots down east wall, kicks up sediment.
12:11	3290			E	Collapsed flow lobe.
12:14	3289			E	Sediment covered pillows.
12:23	3281	083		P	Basaltic material irregular, appears fresh, very reminiscent of bottom off historic Hawaiian lava flows.
12:26	3246	060	1	P	Terminating dive. Frame finishes at 306 on forward camera, frame one on roll 2 of hand held.

Dive 661

Location: SESCA
Port observer: Mark Holmes
Starboard observer: James

Julian day: 238-239
Date: August 26, 1986
Pilot: Terry Owen

Time (GMT)	Depth (m)	Hdg	Photo	Obs	Comments
				P	This is Sea Cliff dive 661, 8/26/86, tape 1, port observer. Objective of this dive is to recover a malfunctioning deep ocean transponder (DOT) 2 km east of the northern dome at SESCA, and then proceed on a westerly traverse across the broad valley east of the SESCA area and over the suspected sediment-rock boundary along the eastern margin of the SESCA area.
23:52	3267	110		P	We're on the bottom. We've been following the mooring from the DOT down. Just impacted; there's a great cloud of mud coming up now.
00:01:05	3267	153		E	Bad picture of interesting animal.
00:05	3282	173	1	P	We're maneuvering around the anchor clump. First frame was one of the large white fish off the port side.
00:06	3278	183	2,3	P	Two shots in succession of what appeared to be some sort of mollusk or gastropod that was leaving a trail on the bottom. We'll just snap some pictures here at the mooring site of any interesting animals I see.
00:07	3281	210	4	P	Still maneuvering around the DOT anchor. The bottom in the vicinity of the DOT is a flat muddy bottom. Very fine material on top; doesn't take much to stir it up. Many small hummocks, fecal casts, burrows, holothurians, and, in the case of one picture I just took, one of the large white fish.
00:09:18	3277	220		E	Transponder anchor line.
00:10				P	DOT cable has been cut
00:11	3277	246	5,6	P	Picture of a small shrimp-like creature on the bottom. And another one right after that of what appeared to be an open lattice work siliceous sponge.
00:13	3278	285	7	P	Another frame, this one of one of the tall corkscrew-like stalked animals. We're only about 3 ft off the bottom.
00:16	3267	273		P	We're about 3 ft, maybe 4 ft off the bottom. Proceeding under a combination of current and our own power in the general direction of one of the Unmanned Vehicles Group

					transponders and this will take us across the sediment-rock boundary to the west of us.
00:18	3267	268		P	Bow camera was activated some time ago, and we'll just continue taking shots as we go along here.
00:19	3267	269	8	P	Hand-held shot of a large anemone.
00:19	3267	270	9	P	Shot of an anemone-like animal that looked almost like an octopus - a moored octopus.
00:21		270	10	P	Just tried to get another shot of one of those gastropod-like shelled animals that appears to be leaving tracks on the bottom. I might have missed it.
00:25	3262	285	11	P	Just took a picture of something - I have no idea what it was. It looked like a large shark's tail sticking up out of the sediment.
00:39	3265	285		P	We stopped for awhile there, in an attempt to capture one of the venus fly trap critters, but the soft organic debris covering the bottom clouded everything up for quite a while and we lost the bottom, regained contact, and now we're proceeding down the road again on this heading.
00:40			12	P	Picture of a purplish sea anemone.
00:42	3267	270		P	We're starting down the eastern slope of the valley. It's much steeper than I expected. We're loosing the bottom now. It's dipping away beneath us very steeply. Still sediment covered. We'll attempt to go down and reacquire the bottom.
00:43	3273	270		P	We've reacquired the bottom. Altitude approximately 8 ft. The floor here appears to have flattened out. We went over that steep pitch. The floor of the valley now has become quite flat.
00:45	3275	265		P	We're going to start shooting some video footage around here. The time of the start will be 00:45. Terry will put a mark on the camera record when I start it.
00:45	3275	268	13	P	Picture of a venus fly trap.
00:45	3275	290	14	P	Another picture of a venus fly trap.
00:46	3275				We're slowing and turning in an effort to capture one of the venus fly traps. Depth is 3263 here in the bottom of the valley. We have several hard CTFM contacts that suggest that the bottom becomes more rocky ahead of us and to the right.
00:48	3275	093		P	We're maneuvering on the bottom in an attempt to capture one of the fly trap animals.

00:56				P	The video tape was turned off at 00:47. We've changed batteries now.
00:58	3276	050		P	There's a CTFM contact that shows a straight hard line, possibly a rocky rampart. The trend of it is about 145 across the entire CTFM field. We're at 3264 at the bottom of the valley off to the east of the SESCA site. Heading approximately 050 toward the strong contact. Contact is about 30 m away.
00:59					Bow camera turned back on.
01:00	3275	057	15	P	Picture of a venus fly trap in the distance. This one appeared to have virtually no stalk at all. It was right on the sediment.
01:01	3275	055		P	We're on the bottom. I can see that the bottom is rising up steeply ahead of us. There's mud right now out the porthole. We're going to lift up off the bottom in an attempt to get out of the mud and get a clearer view of what's ahead of us.
01:04	3270	107		P	We've approached the wall. It's rising steeply off the starboard side. I have no view out the port side. We're still maneuvering to get a better view.
01:07	3268	202		P	We're up off the bottom. Turned the bow camera off until we acquire the bottom in the vicinity of this large ridge or valley wall.
01:08	3271	214	17	P	We're still up off the bottom. Fired off a quick shot of what appeared to be a rattail fish outside the porthole.
01:10	3274			P	We're probably over the wall. Just asked Transquest to mark our position at this time.
01:40	3251	110		P	We are above the bottom, 70 ft above the bottom. We're going back to the east to start another transect across this valley. The strong CTFM sonar contact was evidently the east wall; we'd gotten turned around when we were on the valley floor and attempting to get that venus fly trap. We're going to go back and start the transect over to get a better feeling for what the valley is shaped like.
01:47	3252	090		P	We're about 40 ft off the bottom. We've crossed back to the east across the valley. We're going to turn, descend to the bottom, and follow the valley across to attempt to get a better picture of what it's like.
01:53	3266	277		P	We're back on the bottom to the east of the valley. The bow camera has just been activated again.

01:53	3266	020		P	We're back on the bottom to the east of the valley. The bow camera has just been activated again.
01:53				P	We're on the eastern edge of the valley. Very steep wall.
01:57	3276	020		P	We're on the floor of the valley, transiting along. We just turned briefly to the north and are now getting back over to the west.
01:58	3276	270	18-21	P	Four pictures in quick succession, one of the sub's skeg marks from our previous landing in the valley, two of an octopus, and another of a venus fly trap in the distance.
02:00	3275	275	22	P	Picture of two fish hovering over the mud bottom.
02:03	3273	283		P	
02:04	3273	275	23	P	Picture of an anemone and a holothurian.
02:04	3272	271	24,25	P	Two pictures, the last one of a fish.
02:04	3273	290		P	We're going down another slope, this one not nearly so steep. Appears to be a small swale in the center of the valley.
02:05:44	3273	272		E	"Frost boil" mound of mudstone.
02:07	3272	283		P	
02:09	3274	276		P	We have a very strong CTFM contact, running parallel to our course off the starboard side, about 70 yards away. Very strong CTFM contact.
02:09	3273	285	26	P	Snapshot of an open venus fly trap pointed right toward the sub.
02:10	3274	276	27	P	Another venus fly trap photograph. It closed up very quickly as soon as the strobe went off.
02:12	3275	287	28	P	Another venus fly trap picture.
02:12	3274	264	29	P	Picture of a crab on the soft bottom.
02:14	3275	279	30,31	P	Two shots in quick succession of what appears to be either some soft corals or hydra-like animals.
02:15	3275	301	32	P	Just snapped a picture of a mud cloud enveloping a small lobster-like animal.
02:15:27	3274	282		E	Mouth-on view of a venus fly trap anemone.
02:16	3272	268		P	Starting up a gentle slope, up to the
02:17					west. Just found that my camera aperture had somehow been twisted over to *f*16. Don't know how long that's been that way.
02:18	3269	271	33	P	We're into a field of venus fly traps. The picture I just took shows one that appeared to have a secondary bud of some kind coming out the top of it.
02:20	3264	286	34	P	We're still going up a small rise. Just took a picture of a translucent siphonophore-type animal.

02:21	3263	263	35	P	Another venus fly trap-like animal.
02:22	3261	326		P	We're sitting on the bottom, checking voltages. Momentarily turned off the bow camera.
02:24	3245	274	36	P	Picture of a twinned translucent anemone-like animal.
02:25	3255	279		P	Just activated the hand-held TV camera out the starboard port. We're starting uphill at an increasing angle.
02:26	3252	278		P	Slope has increased considerably, probably 15°, maybe 20°. We're going up steadily.
02:27:57	3249	268		E	Sulfide(?) crust in sediment.
02:28	3249	269	37	P	A large white crab photograph.
02:30	3243	275	38	P	Last picture on the roll was of a small rattail fish.
02:32:33	3242			E	Dead tube worm(?) on sediment.
02:33	3242	316		P	Stopped the hand held video.
02:34	3251	317	1	P	Picture of a large sea slug-like animal, with tentacles fore and aft and on top.
02:35	3240	333	2	P	Picture of a small rattail fish.
02:38	3237	278		P	Still going gradually up slope to the west.
02:39	3237	287		P	We've come to the lip of a drop-off, down to the west. Actually quite shallow, a little tiny steep pitch. The bottom is still sediment-covered. It's a broad swale I guess we're dipping down into.
02:40	3237	299		P	The bottom is dropping away gently off the port bow.
02:41	3238	287		P	We're at the lip of another drop-off, going down to the southwest. Once again it was sort of a step, a gradual up slope to the west and then a short pitch down. It was parallel to the ridge we passed previously.
02:41	3238	278	3	P	Picture of a very large mount out the port side, much larger than the small mounds that we've been seeing for the last couple of hours. This one must have been a couple of feet across and a foot high.
02:43	3239	287	4	P	A large siliceous sponge off the port side. Just took a picture.
02:45	3239	291		P	We're continuing very gradually up slope now. What I've got off the port side are some white mounds, very reminiscent of the talc-like material that we observed on one of the large domes here at the SESCA site. The bottom is steepening up, rising to the west. Very strong CTFM targets, about a couple of hundred feet ahead of us. May be the beginnings of the outcropping of volcanic material.

02:46	3236	302		P	Coming to the crest of another rise. We've stopped on the bottom.
02:47	3236			P	Sitting on the bottom. Turned off the 35 mm bow camera while we're sitting here in the mud.
02:48	3236	307		P	Started hand-held TV out the starboard port. Bottom still increasing, up to the west. We're starting to get the outcrops of rocks. OK, into some very steep slopes now, for the most part sediment-covered, but outcrops of rock are occurring. Small, rough irregular patches several feet in diameter, sedimented but much rougher texture than the surrounding bottom. We're getting into the area of very strong CTFM targets.
02:49	3234	308	5	P	Another picture of a siliceous sponge on this steep slope.
02:50	3231	355		P	We're stopped on the bottom actually. Just took a picture of the small irregular outcroppings, again heavily sedimented but quite rough texture. It looks like basalt. The sub is grounded against it; we're going to attempt to get a sample of it now.
02:52	3231	343		P	On the bottom. Just stopped the hand-held TV recorder.
02:55:15	3240	320		E	Sulfide(?) crust in sediment.
03:00	3231	345		P	We're maneuvering on the bottom. I just turned on the hand-held video out the starboard side, even though we're mudded up at the present time. We're in the area of outcropping rocks. Attempts to collect a sample have failed because the rocks are extremely friable; very, very weathered. They do have the appearance of old chimneys rather than fresh basalt, or old basalt for that matter.
02:02				P	Turned hand-held video off.
03:05	3231	334	6	P	On the bottom, attempting to get a sample. I just took another picture of one of the outcrops off to the port.
03:06:05	3230	320		E	Massive sulfide.
03:07:25	3230	356		E	Massive sulfide.
03:08	3228	331		P	Hand-held video is started again. We're going to make a photo-recon. of this area. We've been unable to collect a sample.
03:09	3227	337	7	P	Steaming very slowly ahead. Just took a picture of a rocky outcropping rampart out the port side. We're passing up along it. Another picture taken now.

03:09	3228	335	8-10	P	Three pictures in quick succession of that rock outcrop.
03:10	3226	267	11	P	We're turning to the left to come back over that rock outcropping. I just took a picture of some large stalked animals on the northwest side of it.
03:11	3226	267		P	Stop the video.
03:12	3228	340		P	We're still headed up slope gradually to the northwest, looking for additional outcrops.
03:12	3228			E	Sediment covered bottom.
03:13	3228			E	Isolated sulfide in sediment.
03:14 to 03:20				E	Sediment covered bottom.
03:17	3225			E	Interesting animals.
03:21				P	Terminated the dive (due to serious hydraulic leaks in the manipulators).
03:23	3154			P	We're at 3142 and heading up.

Dive 662

Location: SESCA
Port observer: Zierenberg
Starboard observer: Holmes

Julian day: 240
Date: August 27, 1986
Pilot: Bosshard

Time (GMT)	Depth (m)	Hdg	Photo	Obs	Comments
				S	This dive is on the northern dome at the SESCA site. We'll be launching southwest of the dome and then transiting up to the dome. The plan is then to make traverses of the southern and eastern flank of the dome where sulfides were dredged and seen on camera tows.
02:40:52	3276	043		P	We have just made bottom contact. We are over a pillow basalt, very large lobate pillows. Pillows about 1 m, heavily sedimented, about 60-70% sediment cover, with the larger pillow sticking up through the sediment. Some very large, maybe 2 m high stalked animals, simple unbranched stalks and sponges. (To pilot: I've got the same thing over here, it is a creature of some kind. A thin white stalk sticking well up in the water column. A venus flytrap sitting on top of one of the pillows, that pillow is about 2 m.
02:43	3277			P	We're about 2 m off the bottom, very heavily sedimented bottom with large pillows. Fairly robust looking pillows with some flatter flows. Several stalked animals, a few galatheid crabs. Pillow diameters are generally at least 1 m; some of them 2 m. Very bulbous, at least 60-70% sediment cover. The top of the pillows are covered, there is no apparent fresh glass. Some very large thin stalked animals up to 2 m high, to far away to see them clearly. They do branch, somewhat like a saguaro cactus, but they seem to have some very small polyp-like projections coming from them, they're too far away to see very clearly.
02:44	3276	056		P	Picture 1 and 2 of a white stalked animal. Coming up on another pillow. In the foreground is a smaller version of the white stalked animal, about 50 cm high. In the background is "stalked venus flytrap" for lack of a better term, not to be confused with the anemone type seen at NESCA. Now we've got something that looks like coral and an anemone, a white fish and a brittle star, a plumose sea fan of some sort, with a stubby

				white coral-like animal to the right of the stalked animal. The bottom is more or less flat, sloping away a little bit to port, but with large basalt pillows sticking up. Some of them show expansion features, trap door type features. They have popped up the tops of the pillows as more lava flowed in to the pillow and expanded it. Another picture of an animal with a short stalk sticking out of the side of a pillow. It is sort of a ball, like a spiral galaxy, with several arms coming out of it. Somewhat star shaped. We are going to set down on the bottom.
02:44:42	3277	022	E	Large bulbous pillow on sediment covered bottom.
02:46	3276		P	
02:47	3275		P	Last picture was of a stalked animal, in the background an anemone-like animal sticking out from the sediment. It was burrowed in, almost looked like a buried octopus. Going by a stalked venus flytrap on a pillow. That venus flytrap was next to a ...I can't remember since I dropped the recorder just as I was about to describe the scene. I see some purple anemones with sediment covered tubes, some white anemones without sediment covering their tubes. We're now over completely sediment covered bottom, no longer have any pillows in the immediate field of view. A few holothurians including purple ones and white ones. Not overly bioturbated bottom.
02:48:13	3276	023	E	Bad pictures of interesting creatures and sediment covered sheet flow.
02:48:45	3276	031	E	Smooth sediment covered bottom.
02:49	3275		P	We're just off the bottom. It's completely sediment covered. A picture taken of a white fish about 15 cm long. In the background I can see outcropping of almost vertical slabs of basalt coming up through the sediment, basaltic septa. A large sea fan in the distance. I now see some collapsed pillows, empty tubes, tubular shaped pillows that have collapsed. Picture of an outcrop with a stalked animal sticking up with two starfish clinging to its stalk. We've got some, what looks like broken ropy sheet flow beneath us exposed through the sediment.
02:50:52	3273	338	E	Folded sheet flow buried by sediment.

02:51	3274		P	The next picture is of a white sponge colony on a small outcropping rock, similar to the one picture by the camera sled and referred to as tube worms. Last picture was of a spiral cork screw stalked animal. I now see a little bit of outcrop of ropy sheet flow again. About 80-90% sediment cover with just the higher ropy folds showing through the sediment cover. Beginning to see some material sloping away. I'm going to take another picture of ropy sheet flow with a sponge colony and some anemones in the background.
02:52	3275		P	We are now back in very robust pillows with an expanded bread crust like texture, taking a picture of them now. Nice expansion features breaking the crusts of the pillows.
02:52	3275		P	Over predominantly sediment covered bottom, we still have large pillow forms sticking up. Taking another picture of a slightly expanded pillow with a trap door-like top. I can clearly see the top of the flow from which most of the pillows leaked out and flowed over. About to take a picture of a sea fan on a pillow, may be a little close to be in focus.
02:52:48	3275	341	E	Sediment buried volcanics.
02:53	3273		P	Next picture will be picture 19. Still over sediment covered bottom with some pillow lavas sticking through. Pillows here are about 50 cm.
02:53:04	3275	345	E	Isolated hemispheric pillows in sediment.
02:53:21	3275	349	E	Trap door pillow.
02:55	3273		P	
02:56			P	We just lost our depth reading in meters.
02:57	3275	033	P	We're hanging about 2 m off the bottom. Totally sediment covered except for about 10% outcropping large pillows, most of which are heavily colonized by stalked animals and some anemones.
03:00	3273		P	Last picture was of an anemone-like animal. At the ends of the tentacles were five point stars of shorter tentacles arranged perpendicular to the main tentacles. Somewhat like some plant flowers where the stalks come out and then branch again into different flowers. There is a white fish about 30 cm long. 80-90% or more sediment covered with some large robust, 1-2 m high pillows sticking up through the sediment.
03:00:22	3273	092	E	Pillows in sediment.

03:01	3274		P	Last picture was a close-up of a thin white stalked animal. That stalked animal was on a slabby crust. Now I see a very expanded pillow that shows much breakage and expansion during formation. It sat there and oozed out slowly, popped it's crust several times, very well ribbed. Typically most of the pillows here do show this type of expansionary feature, of course all we see are the largest pillows that are sticking up through the sediment, the big bulbous ones, everything else is sediment covered.
03:02			S	This is tape number one, starboard side, dive 662, 27 August 1986. We're on the bottom, have been for several minutes. We're in an area of exposure of pillow basalts, flying at an altitude of about 10 to 12 ft. The hard substrate has quite a few bottom-dwelling animals on it, much larger in size than I've observed on softer substrate mud bottoms or the areas of sparse sulfide and basalt outcrop that we have seen.
03:02	3273		P	Still over pillow basalt terrain as described.
03:03	3274		P	Two pictures of a stalked animal, slightly out of focus, it was too close. We have some stalked venus flytraps. The heads look very similar to the anemone type venus flytraps, but they are up on thin stalks rather than on thick anemone like stalks. We're now going by some nice expanded pillows colonized by stalked animals which are themselves colonized by other animals. There's a good picture of a stalked venus flytrap. Another picture of the same one. It seems to have almost a vine-like animal growing up around the base of that one. There are some 2-3 maybe even 4 m in diameter pillows with cracked crusts, bread crust. The plates of the crusts are very thick, 4-5 cm, and the plates themselves are half a meter to a meter, very large expanded pillows.
03:04:09	3275	090	E	Pillows in sediment.
03:04:42	3274	111	E	Sponges on sediment covered sheet flow.
03:05	3272		P	We are about 2 m off the bottom, still with large bulbous expansion pillows sticking up from a predominantly sediment covered bottom.
30:06	3273		P	Four pictures taken, last one was of a sea pen animal, all the rest were of animals colonizing expanded pillows...in my immediate field of view. Bottom sediment here is fairly smooth,

					very few mounds, not too well tracked by burrowing animals, bioturbation does not seem to be too extensive. There are some stalked animals.
03:06:03	3273	044		E	Bread crust pillow.
03:06:19	3274	042		E	Trap door pillow.
03:07:06	3272	067		E	Solitary sponge on pillow.
03:07:40	3272	071		E	Tubular pillow.
03:07:56	3272	069		E	Inflated pillow.
03:08	3272			P	Last picture looking almost down on a sea fan. Next picture is of a venus flytrap from the side, it has two heads apparently on the same stalk, a smaller one below and larger one above. I could only see one stalk, I can't guarantee that was the case. I see some white sponges growing from these, what look like corals to me, lots of anemones, some spirals, one small white fish on the next pillow outcrop that goes by. We've got about 10% low pillows showing up here but still very highly sedimented. Next picture is of a lily like animal, stalked, growing up from the bottom, very short, sticking up about 20 cm maybe.
03:08 to 03:11				E	Sediment covered bottom.
03:09	3271	048	1	S	First frame of a large pillow with a white stalked animal. We're proceeding toward Point Bravo, having landed to the west of our intended target. The area we're passing over now at 03:09 has extensive sections of sediment, with small patches of pillow basalt sometimes exposed, sometimes barely covered by a dusting of sediment.
03:09:37	3270	060		P	Heading for the base of the Northern Hill in the SESCA area...up out of the sediment and more complete sediment covered...up on a fairly large lily like stalked animal, will take a picture.
03:10	32:17	058	2`	S	Picture of a large venus flytrap.
03:11				S	I've noticed that on the last couple of pictures I've taken, which includes the one right there, the shutter speed seemed quite slow even though the camera is in the mode of operation that we've always had it, so these pictures may be blurred. We're going along at about .2 knots.
03:11	3270			P	Over a predominantly sediment covered bottom, there is a galatheid crab in the field of view almost totally covered with sediment so he's hard to see, it looks like he's been sitting

					in the same place for quite some time, he hasn't moved but he was definitely alive. Several of the large white carp-like fish. Typically 30 to 50 cm long. I've seen 5 or 6 of them now. They're more abundant than the other fish seen so far. Last picture taken shooting...looked like an octopus arm, a single arm, with sucker like openings coming up out of the sediment, out of a burrow in the sediment, I'm not sure that picture will come out, a very interesting animal, I have not seen it before.
03:11:27	3271	049		E	Pillow.
03:11:43	3270	049		E	Sediment covered bottom.
03:12	3272			P	
03:13	3268			P	Over predominantly sediment covered bottom. Very few outcrops right now, very flat, not very well bioturbated.
03:14:45	3269			P	Last picture on roll 1 is of a purple holothurian showing the sedimented nature of the areas between the pillows. We are now back on very large 3-4 m wide expanded bread crust like pillows colonized by large white stalked animals. I will stop here to try to change film.
03:14:58	3268	068		E	Pillows.
03:15	3267			P	Over pillow basalt. I see a paint can on the bottom with sediment laying on top of it between the pillow basalts. Climbing up a slope now with large 1-3 m pillows, expanded, colonized as before.
03:15	3268	062	3	S	Picture of a partially sedimented pillow, sticking up through the sediment cover, with a venus flytrap.
03:15	3267	046	4	S	Another exposed pillow with a large fan-like creature on it.
03:15:30	3268	050		E	Broken pillow.
03:16	3267	067	5	S	Very large pillow formations off the starboard side. Just took picture of one.
03:16:19	3266	063		E	Inflated lobate flow.
03:17	3264	061	6-8	S	Three pictures in quick succession of a large partially sedimented pillow structure with white galatheid crabs, possibly some small siliceous sponges and other bottom dwellers.
03:17:24	3268	065		E	Broken sheet flow crust.
03:17:56	3268	054		E	Broken sheet flow crust.
03:18	3263	053	9	S	Picture taken of a large fan-shaped animal.
03:18	3263			P	Changing camera film, still in the process. We've been going predominantly over pillowed terrain, with 50-60% pillows. I now

					see some collapsed sheet flow crust out in front of me. A very large sheet collapsed down and dipping steeply down hill. It looks like a collapsed lava lake roof perhaps, but then it goes into pillow basalts. A drain back pit perhaps. Unfortunately, no picture taken due to no film in the camera. We're now over a sediment covered bottom.
03:19	3257	059	10	S	Tried to take a picture of a large fissure leading off almost at right angles to the sub, off the starboard side. Don't know whether it was a collapsed lava tube or an actual fissure in the pillows. Going up slope now over sedimented terrain, with occasional outcrops of pillows.
03:19:39	3261			P	
03:19:50	3261	053		E	Sediment covered bottom.
03:20:30	3259			P	Fissure described by Mark Holmes on the other side was seen by me about one minute ago. I was busy loading the camera and could not photograph it or describe it at that time. I now see a steep slope off to the port with some white covered basalt. It looks like it has rolled down. Picture 1 roll 2 taken of some pillow lava forms. We've got a pretty good slope off to the port here, a lot of debris has come down this slope. We're moving in on it :we might hang the tail up on it in a minute. Just saw some whitish material coming out from underneath the sediment, we may have some hydrothermal stuff here, it looks kind of like the talcy material in the sediment. It may have come down the slope. It almost looked like bacterial mat or some kind of organism underneath the sediment.
03:22:40	3256			P	Two pictures taken of something floating in the water column, it looked somewhat like a flat segmented hat floating upside down, whitish brown, I don't know how to describe it any better than that, I'll have to look at the pictures.
03:23	3257			P	Over a very flat sediment covered bottom now, we went by a scarp which went up to the port. I couldn't see it very well, but it had talus on it. At the base in the sediment covered stuff was some whitish material that could have been hydrothermal. The bottom dropped away after that, I think we turned slightly, we're now over totally sediment covered bottom with some fairy rings and more bioturbation than we have

					been seeing. A rather strange looking purple holothurian, I'll take a picture of it, leaving a slight sediment trail, a very knobby holothurian. We've got some outcrop in the distance, it's rather light looking, it could be hydrothermal, or it could be mudstone. Probably mudstone, it's hard to tell, it is too far away.
03:23:53	3257	341		E	Sediment covered slope ~15° to starboard.
03:24	3256	329	11	S	We've turned away to the northwest to investigate some targets. Just took a picture of a typical sediment-covered bottom that we're crossing over: mounded, bioturbated, sort of a layer of fluff on top that we've encountered before.
03:25	3254	046		S	Secured the bow camera.
03:26	3253			P	I can just barely make (out) bottom about 5 m below us, sediment covered with a few stalked animals, fairly flat.
03:27	3255			P	About 3 m off the bottom. Large robust pillow showing expansion cracks and bread crust texture on a bottom which is 60-70% sediment covered. Another one of these large white stalked animals in picture 4. It shows very irregular branching, it is all one animal. Taking another picture.
03:27	3256	066		S	Bow camera reactivated. We're back into a terrain of very large fractured pillows, partially covered by sediment, with broad expanses of sediment between the pillows.
03:28	3258	064	12	S	Picture of a pillow nearby with a many-headed anemone or hydra-like animal on it. Some of the pillows have white galatheid crabs and some fairly translucent appearing animals. Venus flytraps are very widespread. One passing by on a series of pillow basalts right now.
03:28	3258			P	About 2 m off the bottom. Again flat and sediment covered here with no outcrop. Probably some subcrop here because we still have some stalked venus flytraps. Next picture is of a venus flytrap. Again with a vine-like fuzzy thing growing up the base, it may be part of the animal as the one in the distance seems to show it as well. I'll have to try to check that observation. Just passed another stalked venus flytrap this time without the vine-like thing, but this one did have a starfish wrapped around its stalk. So they don't all

					have the other vine-like thing crawling up the stalks.
03:29	3257	040		P	Picture of a large expanded pillow with an odd looking sponge-like animal on it. One of the long straight stalked creatures is also in the picture. A beautiful picture of a very large white fish, taken broad side. That fish is almost 1 m long, maybe 75 cm, but he was a big fish.
03:29:54	3257	041		E	Isolated inflated lobate pillow.
03:31	3256			P	About 2 m off the bottom. We are heading down a slight slope, although we are heading up toward the hill, locally the topography is dropping. We're over a completely sediment covered bottom here, only rare stalked animals, some hints of some subcrop, but no outcrop showing right now.
03:31		058		S	We're headed down into a swale of some kind. It's too large to really see the extent of it. It's all sediment covered. We're still on a heading of 058, which should be taking us generally uphill. This may be one of the small downhill pitches that we've encountered on the flanks of these domes.
03:32	3257	052	13	S	Picture, although it was quite a long exposure, of a fissure running at right angles to our track.
03:32:40	3257			P	Picture of the same fissure described by the starboard observer. The fissure was open, somewhat sedimented in, it certainly had moved well after the basalt flow.
03:33	3257			P	Coming up on a very large deep fissure, taking several pictures...pillows at the edge of it, very heavily colonized by sponges down in the fissure. No indication of hydrothermal material coming out of it. Several pictures taken in succession of the fissure. The next picture after that was a cork screw animal, in the distance two tulip-like stalked animals.
03:33	3257	036	14-17	S	Four pictures taken in rapid succession there. The very good picture of the exposed pillows and ropy texture to the surface of the flows passing...
03:33:13	3256	049		E	Sediment covered folded sheet flow draping slope.
03:33:29	3256	045		E	Open fissure in basalt.
03:34	3256	029	18	S	Paused there at 03:34 to take another picture of one of those small ridges, ropy ridges, sticking up with a feathered-like form on it.

03:34	3255	080		P	There is another fissure coming through and a collapse pit. One picture taken of the collapse pit, could not get a picture of the second fissure. The fissure is running approximately north-south.
03:34:18	3256	030		E	Sediment buried fissure in sheet flow.
03:34:34	3256	033		E	Flow folded sheet flow, sediment buried.
03:35	3255	070		P	After the fissures we went across an area of totally sediment covered bottom. We are now coming up on a very steep volcanic rock face. Some near vertical faces, it is just coming into view. I see some truncated flows;, this is clearly a tectonic truncation. We've got a clear fault stepped down to the north and trending about 060. It has folded sheet flow at the top where I can see it. There are several flows, taking a picture of the fault now with a stalked creature in the distance.
03:35	3255	078	19,20	S	Two pictures of a large fissure. Appears to be a meter or two wide at its widest point, cutting off at 90° to our heading now, which is 082.
03:35:55	3254	075		E	Sheet flow.
03:36	3255	067	21	S	Long exposure of a fish.
03:36	3253	055			I'm shooting video out the starboard port, have been for a few minutes. We're crossing several of these large fissures and getting very good TV footage of it. I know Rob is taking a lot of pictures. We're passing a drop-off in slope off to the starboard side now, even though we're proceeding on a course of 060 which should take us up the southwestern flank of north dome.(North Hill)
03:36:44	3254	041		E	Stalked animal on sheet flow.
03:37	3253			P	Another picture of a fissure just past that fault scarp. Very nice folded sheet flow along this fissure, colonized by crinoid like animals. Past the fissure we've got sediment cover and then you can see the sediment going down into little valleys showing that it is fissured. There is a crust that could be basalt glass sticking up. We've got another fissure here, very thin fissure. In the distance is a rubbly basalt flow...may be over a lava...right now. Over folded sheet flow which is fissured, taking a picture. Two pictures of folded sheet flow, somewhat fissured terrain, I see some lobate pillows in the distance... apparently...sediment covered as well.
03:37:00	3254	047		E	Flow folded sheet flow.

03:38	3252		P	Coming up on another fissure. I see some truncated sheet flow. Picture of the truncated sheet flow exposed by the fissure. Taking another picture down into the fissure showing an older lobate flow below the last sheet flow which was fissured. Some open cracks on the sheet flow, not major fissures, but irregular breaks, but in the distance I see more fissured terrain coming up. Some expansion pillows. Taking a picture of lobate pillows coming up from a sheet flow terrain, which definitely look expansionary. Now the bottom is almost completely sediment covered, but I see the forms of some lobes sticking up through that. In the distance I see some large pillow lobes, taking a picture of some expanded pillows again with spalled crusts. Still over expanded pillow terrain.
03:38:05	3253	068	E	Thin smooth sheet flow, sediment buried.
03:39			S	Going into another area of exposed, lobate pillows. You can see the large sessile life forms attached to these pillows, much larger than in the sediment-covered areas out to the west.
03:39:10	3252	056	E	Large sponge on large pillow.
03:39:26	3252	061	E	Sea fan.
03:40	3252		P	Coming over another fissure; picture taken. A sea fan in the background of that fissure picture. Next picture is an expanded pillow with a stalked animal on top.
03:40:38	3252	074	P	Now we are over very large pillows, the slope is dropping away to port. I see a leaky tube flow coming out of the bottom of one of the large pillows. About a 3 m high lobate pillow, with a lava tube coming out of the base of it. Taking a picture now of a cascade fold on sheet flow formed as it flowed down into a depression. They seem to be faulted towards where that depression was, in other words it seems to be a basaltic equivalent of a growth fault, it was a low when the sheet flow came over and it has continued to move since the sheet flow came over. Now taking a picture of the same flow showing some broken folds colonized by a mossy creature.
03:41			S	We're passing another fissured area. The large flat pillow surfaces have been extensively fractured here, and the slope drops away from us.

			S	O.K., just for indexing, my next frame will be frame 23 (Note: This doesn't match running total).
03:41:03	3251	067	E	Broken folded sheet flow.
03:42	3251		P	I need to change film in camera after taking the last picture. Coming up on a large scarp, we now have a large sediment covered slope. We've gone past several pillows in the interim time since the last notes. We are going to have to power up to get up this scarp.
03:42:40	3251	080	E	Sediment covered bottom.
03:43:45	3249	065	E	Strange fish.
03:45	3247	060	P	We're up in the water column, I cannot see the bottom right now. We rose up to try to traverse up a very steep scarp.
03:46	3248		P	Can see bottom again, very flat sediment covered bottom at the moment, a few holothurians, not too well bioturbated.
03:47	3248	108	P	I've got the bottom. It's flat and sediment covered, no slope, poorly colonized. There are a few basaltic outcrops here, very low, barely sticking up through the sediment, small pillow-like forms. Some sheet flow showing up now, with flat slabby crusts just barely showing through in places. Coming up now a ridge of rubbly looking basalt, predominantly sheet flow. That ridge of sheet flow was slightly folded rubbly sheet flow. We've got some steeply dipping slabs, like they've broken off and started to fall into a hole but didn't get very far. On the other side of that ridge is just flat sediment covered bottom again.
03:48	3251	100	P	Over another sparse outcrop of rubbly sheet flow, but predominantly sediment covered bottom. There's a large brisingid in the distance. Not too well colonized here, moderately bioturbated.
03:48	3247	110	S	We appear to be about 15 ft off the bottom. The bottom is falling away out of my porthole, dip direction is about 050 relative to our heading.
			P	Sediment-covered bottom, slightly hummocky, pretty sparsely populated.
03:49	3252		P	Picture 1 on roll 3 is of a colony of sponges, very similar to the sponges in the picture from the camera run on L1-86-NC that were identified as tube worms. Next picture is also a picture of white sponges, a different type of

					sponge colony, they are branched and somewhat trumpeted. We're beginning to see a little bit of outcrop now, low moundy outcrop. Can't really see what it is, it is covered by sediment.
03:49:58	3254	124		E	Sponges on sediment.
03:50:15	3254	108		E	Sponge, sea fan, coral, and starfish on volcanics.
03:50	3252	079	23`	S	There was frame 23, looking almost straight down. A large white fan-like animal. And the submarine just hit something.
03:50:30	3254			P	Over mostly sediment covered bottom with occasional outcrops of broken sheet flow. Just touched down on bottom.
03:50:31	3254	086		E	Sediment covered bottom with basalt(?)-sulfide(?) with animals.
03:51	3253	065	24,25	S	A large pillow structure, followed by a venus flytrap. Those were some isolated pillow structures that stuck up through the general sediment cover that is now rising very gently in our direction of travel.
03:51:30	3252			P	Cruising above a flat sediment covered bottom, no outcrop at the moment, about 2 m off the bottom.
03:52	3253	060		P	Picture of a stalked venus flytrap with a tulip shaped stalked animal a little further out from that. Next picture is of a stalked crinoid. Just above flat sediment covered bottom at the moment.
03:52:57	3252	056		E	Smooth sediment with starfish.
03:53	3252	056		S	We're going up a very gentle slope, sediment-covered bottom. Several of the small domal structures ringed by burrows in this area. Right now the bottom drops steeply off to the starboard side of the submarine. It's a small valley running down slope, still sediment-covered.
03:54	3251			P	Flat sediment covered bottom sloping away in front of us. There is a stalked anemone; at the bottom was a large anemone-like head and upward along the stalk it looks like several little baby anemones heads on the same stalk.
03:56	3247			P	Flat sediment covered bottom off to the port. Apparently a good slope or scarp coming up ahead.
03:56	3247	057		S	Continuing up a gentle slope. Sediment covered bottom. Mounds, some surrounded by the ring of burrows. Looks like a fluffy layer of organic matter on it, some large fecal casts,

					holothurians. The slope is about 15°, we're rising gently up it.
03:57	3244	062	24	S	Just took a picture of a white coralline-looking animal in the foreground.
03:57	3245			P	Coming up a slope of about 20°, completely sediment covered, somewhat mounded and bioturbated, a few small galatheid crabs, which are also sediment covered, and a few holothurians which are sediment covered. Very few stalked animals, a few feeding trails and some fecal traces.
03:57:49	3244	065		E	Vertical picture of wine goblet sponge.
03:58	3242			P	Last picture was of a large stalked tulip like animal. We're on a sediment covered bottom sloping up in front of us. The slope is increasing to about 20°-30°. The slope is steepening as we go up slope.
03:58 to 04:07				E	Transit up slope with scour marks from down slope sediment transport.
03:59	3239			P	Coming up the slope, almost a hyperbolic curve, as we get up the slope, the slope increases. Now I'm starting to see a little bit of talus instead of just a flat sediment covered bottom. The talus I see is white mudstone, fragments just a few cm in diameter. Sparsely populated by anything. There is a single rock laying on the sediment surface, it may well be sulfide, obviously transported. Now over a small white sponge coming up from the bottom, a single siphon sponge that leans over in the current slightly.
04:00	3236			P	Still coming up the scarp. The slope is now about 45°. Very steep, not much talus on it, not many creatures, with a rather irregular look to it.
04:01	3231			P	Still coming up this sediment covered scarp. Slope now 50°, maybe 60°. Have not been able to see up the slope yet to the top. Very steep, pretty high, completely sediment covered, very few large stalked animals. Looking now at a very large stalked tulip-like animal. The outside is very smooth, it looks like a sponge, the inside is more ornate. I'll try to get a picture of that.
04:02	3228			P	Picture taken of the large stalked sponge.
04:03	3226			P	Still coming up a sediment covered scarp. Beginning to see some whitish colored talus. All I see right now are mudstone fragments. I see some subcropping mudstone and some

					fragments of mudstone which have moved down hill; predominantly sediment covered with a small galatheid crab, not too much in the way of other organisms. About a 40° slope right here. There is sort of a spidery-looking animal on the bottom.
04:03:47	3222			P	Picture of the spidery-looking animal. Still coming up this scarp. Mostly sediment covered, only centimeter or smaller sized mudstone fragments.
04:04:15	3217			P	60°-70° slope, entirely sediment covered, only very minor mudstone fragments showing on it. Incredibly steep slope for being sediment covered. Obviously it has had some mass movement down it, but there are no large blocks or any thing else, just a very smooth sediment covered slope.
04:05	3213			P	Still coming up a 60°-70° slope, in places nearly vertical, all sediment covered, just a little bit of white mudstone talus on it. Picture taken straight out the view port to give a view of this near vertical slope with sediment cover on it. I see some trails from material which has slid down now, we're coming up almost vertical along this wall. It is incredibly smooth for a vertical face.
04:06	3208			P	Still coming up a vertical scarp. We're near the top now. The top can be seen by the pilot. Another picture of this vertical face.
04:06:18	3206			P	I can now see the top of the scarp. There is a slope continuing up from that, there is a break in slope here at 3153 meters water depth. The slope above this is about 30° where it rolls over into a little knoll and then goes down. Totally sediment covered all the way up. Sediment covered on the top. You could see that there had been mass wasting down the scarp. On the top of the hill, it is smooth, bioturbated, and mounded. It drops right off again on the other side, it just rolls right back down.
04:07	3205	053	25	S	Picture of a steep slope that we've been going up. We're actually at the top of ridge, very near the crest of a ridge that drops off down away from us.
04:07:08	3205	058		E	Top of sediment covered ridge.
04:07:20	3205			P	We have landed on the bottom right on top of the scarp. About 10 ft in front of us it drops

					away on the other side, so we are on top of a ridge.
04:08				S	This is right where that last picture was taken. The Mesotech display indicates that the steep pitch ahead of us is a valley that trends almost at right angles to our heading of 060, and then there's a wall ahead of us. The Mesotech indicates that the valley is about 20 ft wide before we hit the other side.
04:09	3205	056	26	S	A picture right at the crest of the ridge before we drop off into this next valley. A large stalked tulip-looking animal in the foreground.
04:09:15	3205			P	Just about to go over the edge of this ridge on to the other side. The ridge is only 50 cm to 1 m high, then there is a little valley. The valley is just like the top of the ridge, completely sediment covered, bioturbated and mounded, a few holothurians.
04:10	3204		27	S	The floor of the valley is considerably different than the slopes. Small rubble mounds, troughs, in fact one of those that I just took a picture of at 04:10 could have been a dredge track. Whitish gray mounds, with a rough surface texture covering the floor of that small valley.
04:10	3205	048	28	S	Going up a gentle slope now. Just took a picture of one of the mounds with the circular pits around it.
04:10	3202			P	Still got a sediment covered valley with little mounds, fairy rings.
04:10:49	3200			P	A little bit of outcropping mudstone and some mudstone blocks, I see a little more here. It is not clear why these mounds are sticking up like they are. There is a little crater here. Possibly a dredge track. Taking a picture. It certainly looks like something landed there on the bottom and then came up again. I don't know what caused those furrows to disrupt that mudstone. It didn't really look like a crater that was blown out by a gas discharge or water discharge. It looked like something had landed there but was gone.
04:12	3200			P	Again we have some outcrop of mudstone, a sort of crater-like feature. Taking a picture. The origin of these structures is completely unclear to me. I cannot see why these areas have been dug out like they are exposing mudstone, with a little bit of sediment deposited on them. As yet no explanation.

04:13	3199			P	Coming up again on a very steep sediment covered slope. It is similar to the last scarp. As we move up the slope we lose the bioturbation, we lose the animals. There are a few animals here, this is somewhat more bioturbated than the last slope, because it is not quite as steep. We have a slope of about 30° so far, it seems to be steepening somewhat up slope.
04:13	3198	080	29-31	S	Three pictures in quick succession of an outcrop of the whitish mudstone mounds, just before we went over into another valley, across it very quickly and we're headed up a slope now. On this heading, slope appears to be about 20° to 25°.
04:13:39	3197			P	Still coming up this slope which is very steep. Some suggestion of some down slope movement as grooves moving down the slope. No outcrop, completely sediment covered.
04:14	3188	055		S	The slope has gotten steeper in the last few minutes, possibly 30° to 35°. Still sediment covered, although the general appearance is one of a harder bottom without the fluff. More slightly coarser debris, appears to be mudstone fragments. Still have the mounds with the circular burrows around them, so it's not too hard to prevent the burrowing animals from taking hold there.
04:14:09	3192	050		P	Still coming up this slope. The pilot can see the top of the scarp. I still see a sediment covered slope. It is starting to level out now. Slope is decreasing to about 20°.
04:14:32	3188			P	I still can't see the very top yet.
04:15:18	3187			P	We've come to the top of that slope; we are on a slope of about 10°, flat sediment covered, mounded, burrowed, not too many creatures.
04:18	3186	092		S	We've changed course to the east to transit across the southern flank of north dome. We're slightly to the north of our intended track.
04:18:11	3186			P	Continuing on now to target C, moving around the slope. Completely sediment covered bottom, highly bioturbated, somewhat mounded; holothurians are the major animals, not too much in the way of stalked animals.
04:19	3186			P	We've got another depression, like the last one I described, a hole showing some white mudstone. We've got some mounding of mudstone out in the distance, sticking up. It is

					not clear at all what is causing these holes, they could be dredge bounces, but that does not explain the mounds or punched up sediment out in the distance. If they were from a dredge, it would mean that the dredge was bouncing along and digging very regular holes, which have been covered with sediment since they were dredged. I don't think that is the explanation because there are other areas of punched up mudstone sticking up out of the darker colored brownish sediment. Unexplained.
04:21	3187			P	Bioturbated, mounded sediment covered bottom, few animals.
04:21	3187			P	We are coming up on a scarp which can be seen out the starboard view port, can be seen by the pilot, on my side I've got a slope going up to port about 10°-15°. I cannot see the scarp yet.
04:21	3187	060		S	Passed over a near vertical drop-off on the starboard side. The sub is going right along the edge of an extremely steep pitch. Slope direction would be about 100° relative.
04:22:20	3188	050		P	I still have a very flat sediment covered bottom on the port side. We're about half a meter off the bottom on my side. On the starboard side Mark cannot see the bottom. We are directly over a very steep scarp, I can see no evidence of it on my side, and Mark cannot see the bottom on his side. We're about to set down on the port side.
04:23	3287	047		S	I can see the face of the slope. It is still sediment-covered, very similar to what we've been crossing for the past many minutes. It certainly looks over-steepened for holding sediment, but it's completely sediment covered. I can see no rock outcrops at all.
04:23:19	3187			P	I still have a very gently sloping bottom, sloping up away to port. I see a few little mounds and again a little hole similar to the last one which exposes some mudstone, picture taken. I'm not sure why these little holes are here. I still have not seen the scarp which is on the starboard although we are traveling along the top of it. There is no indication of it on my side.
04:24	3187	073	32	S	A picture off and over the top of the steep pitch.

04:24:30	3187	075		P	Still have a very smooth slope, bioturbated. I do not see the edge of the scarp.
04:25:35	3188			P	I am just now picking up the scarp. It rolls over from about a 10°-20° slope to about a 60° slope, completely smooth and sediment covered. It seems to curve around a little bit. Absolutely no outcrop on it. We are coming back across the scarp again; we are coming around a knoll of a little ridge that comes around, taking a picture of the knoll of this ridge seeing two sides of the scarp. And another picture of a vertical scarp face showing some sedimentary bedding, some nice slump features. I can see the base of the scarp. We are leaving the scarp, it is curving away from us to the port. I can still see the bottom, the scarp face is somewhat scalloped and irregular. There is a little projection, depth is 3139 m, we're moving down the scarp face. Very smooth, some indication of down slope movement, some channeling in the steepest and most concave inwards portions. In the convex outward parts the slope is less steep and there is less indication of down slope movement. All of the scarp is sediment covered. I can just barely make (out) bottom down below us. I can start to see it flattening out. I've lost bottom.
04:27:50	3192			P	Still can't quite make (out) bottom as we're descending down the scarp. I can see the animals down there; I can see the bottom. I can just barely make (out the) bottom by the white creatures that are colonizing it, I can't see any features of the bottom. I can see bottom fairly well now, it is sediment covered. There is a dredge track coming up, vertically up the slope. It has cut through mudstone. Beautiful dredge track, we should get some pictures of this.
04:28:51	3202			P	The dredge track has cut perpendicular to the slope. It made a nice furrow about 1 m deep. We're about 1 m off bottom here. It is sloping up to port and a little bit up to aft. Will now take a picture of the dredge track. Two pictures taken of the dredge track. Now going to take some video of the dredge track.
04:32	3188	048	33	S	Picture of a dredge track through the mudstone off the starboard side. We've been shooting TV footage and stills out both sides.

04:33	3209	340		P	Just took a picture of some of the white mudstone blocks which have fallen into the dredge track, probably (will) be able to see the trail of a pyramid urchin. No, the trail was caused by the creature which will show in the next picture, it looks like a sponge or something, I don't know what it is, I haven't seen one of these before. A pyramid shaped creature. There he is sitting right at the end of his trail. I'll take a second picture of him.
04:35	3215	123		P	We've come to the bottom of that 20° slope back on to about a 10° slope. Just passing a brisingid, we're on a fairly flat, 10° or less, slope right now, sediment covered, fairly mounded, bioturbated. A few anemones, the purple, burrowing anemones, a few white stalked animals, not too much life. Again, the slope is going down in front of us. Not very well occupied by organisms, but heavily bioturbated.
04:40	3208	095	34	S	We're turning to head down slope, following the dredge track down the slope. I just took a picture of it, although it was about 10 or 12 ft beneath me.
04:43	3215	166	35	S	A picture of one of the mudstone mounds sticking up as we're turning to follow the dredge tracks downhill.
04:45	3221			P	End of Side one of tape. Turning tape over. (The following transcript is still from Side one of the tape. Some obvious operator error involved.)
04:47:45	3225	352		P	
04:51	3211			P	We've got the dredge track again. I can see the dredge track and I can see the track where the submarine sat down. A nice galatheid crab standing on the dredge track now. The dredge track is fairly wide, about 75 cm right here. We just made a full circle and crossed right back where we had been. (True end of Side one of voice tape.)
				P	(Start of Side two of voice tape)...there are some white outcrops of rubble. (To pilot) I can see where the dredge track went. It starts right here. It picked up and bounced, it was in the water column until right there so there is no dredge track in front of you until we go up a ways. The reason you couldn't find it is because it wasn't there.

04:51	3208	122		S	We're turning slowly to the right to proceed downhill in an attempt to follow the dredge track.
04:52	3213			P	I could see where the dredge track started. It dug in and went uphill. We landed the submarine on the dredge track about 10 ft from where it first started into the sediment after a bounce. We're now going over a flat sediment covered bottom. (To pilot) I'd go about 10°-15° to port to stay on the trend of the dredge track.
04:53	3216	122	36	S	Picture of a venus flytrap animal on the muddy bottom off the starboard side. Rob has more mudstones and is trying to follow the dredge track out the port side.
04:55:50	3222			P	Moving down hill. This is the start of Side 2 of tape one. Moving down a slope of about 20°, all sediment covered, no outcrop, bioturbated and burrowed. The slope is leveling out below us here. Depth now is 3224 m.
04:56	3224	119		S	Slope is dropping away to the starboard side. We're traversing slightly to the southeast across the southern flank of the north dome.
04:57	31227			P	Moving down a pretty steep slope all sediment covered.
04:57:37	3228			P	Just coming to a little channel-ike feature as we move down the slope. The channel is heading approximately 140°, we are moving down the channel now. I can see the side sloping up away from me to port and sloping down in front of us.
04:59	3236			P	Still coming down the same slope, fairly flat right here, bioturbated, lots of fecal pellets, very few creatures.
05:00:48	3234	094		E	Smooth flat sediment covered bottom.
05:01	3234	090		P	Traversing a heavily bioturbated sediment covered bottom. Abundant holothurians(?) fecal matter, more abundant than I usually see. A few fish.
05:01	3232	099	3,4	S	Two pictures of rock outcrops off to the starboard side. Some fan animals and a venus flytrap. The rocks, I saw them only briefly out the starboard side, looked reminiscent of some of the sulfides that we saw on the end of the dive yesterday (661). Those were frames three and four on the counter.
05:01:49	3232	096		E	Starfish and galatheid crabs on subcropping sulfide.

05:02	3232			P	Mark sees a possible hydrothermal outcrop out the starboard. Out the port we have a flat sediment covered bottom, mounded, sparse animals, well bioturbated. No evidence of outcrop or hydrothermal activity from my view point yet.
05:03	3231			P	Turning around to try to relocate possible hydrothermal outcrops. Well above the bottom here, I can just make a flat sediment covered bottom.
05:04	3235			P	Out my port is a sediment covered bottom, very flat, dipping away gently to the port, poorly colonized. Apparently out the front we might have some hydrothermal outcrop. I see a couple of stalked sponges.
05:04:55	3235	320		E	Sea fan and brisingid on sulfide.
05:06	3235	430		P	Flat sediment covered bottom. I can just barely see what might be a ledge of something sticking up. We are going to turn to the right so I can see the outcrop in front of us.
05:06:24	3235	343		E	Sulfide.
05:07	3235			P	Just looked out the front view port. I got a brief view of a black, dark looking, sulfide chimney. Almost no outcrop here. This stuff has grown up through the sediment. I can just see a couple of what looks like hydrothermal chunks out my view port. Too far forward to take a picture. Very isolated, little outcrop of sulfide. Little doubt that we are looking at a hydrothermal chimney sticking up here, but it is amazing how sparse the outcrop of it is. We are going to try to set down and sample this. There is a local concentration of stalked animals and anemones here. I can now just make out a crust, a hydrothermal crust, just barely outcropping from the sediment. Very thin, less than 1 cm thick, just barely exposed as we move into position to sample the chimney. Trying to take a picture of this crust, which is just barely exposed and may not show well in the picture.
05:07	3235	348	5	S	Just took a picture of a siliceous sponge off to the starboard side. We have come to rest in an area (Rob to Bruce: If you grab that chimney you'd be a hero) that certainly looks like sulfide outcrops. Fairly isolated small chimneys, maybe a foot high, several inches in diameter, with other sulfide-looking material

					around it. We'll get some good pictures of it as well as attempt to collect a sample.
05:09	3234			P	Just took a picture of the afore mentioned crust. There are a few glass sponges and a sea pen.
05:10	3235	010		S	We're sitting on the bottom. Just took a picture of one of the large white fan animals off the starboard side in the vicinity where we're attempting to sample sulfide.
05:10:11	3236	020		E	Sulfide.
05:13:42	3235	039		E	Mud stuck in claw after failed sampling attempt.
05:18	3235			P	Sitting at a sulfide site, one or two little chimneys, a couple of crust just barely visible, almost nothing else visible, completely sediment covered. We are unable to sample due to hydraulic problems.
05:20:45	3235			P	We attempted to sample the sulfide chimney, the manipulators are leaking hydraulic fluid, however Bruce did grab some material, and tried to put some in the basket, so we may have recovered some chips of this material. It was very friable and it crushed. The manipulators had to be stowed after that, but we may have recovered a small sample, scattered randomly through the baskets presumably.
05:21	3234	291		S	We're in the area of the sulfides. Because of hydraulic leaks (in the manipulators) we've been unable to take a sample. Going to turn around here as we hover and attempt to get some video footage of that particular outcrop.
05:22	3234			P	We are about 2 m off the bottom, trying to swing around so that we can take pictures of the sulfide. Swinging around so that we can get some video of the sulfide chimney out the starboard view port. Very isolated outcrop.
05:24	3235	052	6	S	We're in the sulfide area. Just took a still picture of the small sulfide deposits.
05:28	3230			P	Still at the same site where we attempted to sample sulfide. We stopped to change the video tape. We are making another bottom approach. I can see bottom off to the port. Very flat, fairly smooth. We are going to take some video of these sulfide chimneys.
05:30	3232			P	Mark is narrating video. (Mark: I've just noticed that we were more successful in getting a sample than we thought, Bruce has managed to get a piece up here on the rubber

				bands (of the critter box)...) We are at the sulfide site and looking out the port view port ; the slope is dipping away 10° to the port. Completely sediment covered. In the distance I can barely see a couple of chunks of outcropping sulfide a few centimeters long. Other than that, completely sediment covered and bioturbated bottom. In front of us are some sulfides we will try to video. Our heading 341°.
05:31	3180	010	P	Next picture will be will be picture 27. I'll try to photograph the sulfides as we come by them. Right now I see nothing but sediment covered bottom. Although I can see nothing out my view port but sediment, Mark is currently filming sulfides out the starboard. Low, barely outcropping sulfide. Heavily colonized by stalked animals, little mound-like structures, centimeters high.
05:34	3233	097	P	Mark is filming sulfide mounds out the starboard, out the port, nothing but sediment.
05:35:40	3234	136	E	Fish at ramming speed.
05:37:50	3236	234	E	Sediment covered bottom.
05:38	3235	250	P	Mark has just finished video taping the sulfide occurrence. All the time we were filming them I was never able to see anything out the port view port. A very small area of sulfide mineralization sticking up through the sediment.
05:40	3237	255	P	On a sediment covered bottom. We've got a slope running just about perpendicular to our bow. Dropping off away from us in the direction of 250°. Can't see how far down it went. It is a roll over type slope like we have seen at many of these sediment covered scarps. Totally sediment covered on the other side as well.
05:42	3241	015	P	Heading towards a CTFM target. I can just barely make bottom (out) about 2-3 m below us, very flat, sediment covered, a few holothurians. Just coming over some sulfide. Taking a picture of a mound of sulfide in the distance. Right below me is some nice crusty outcrop of sulfide.
05:42:54	3241	212	E	Wall of massive sulfide.
05:43	3242	080	P	This outcrop is fairly well sedimented over, but clearly hydrothermal. We've got some ledges of it sticking out here. We're not in a position to take a good picture here. We've got a fairly

				large mass of it. There are some sponges colonizing it. Taking a picture, the water column is a little murky here. Picture of some coalesced chimney structures sticking out of a slope of about 30°-40°. Dark looking sulfide. The bottom is dropping off steeply to this side, I can just barely see it. Next picture will be 29. Little mound like structures, in one case coalesced chimneys, sticking out from a slope of 20°-30°. Slabby nature to the outcrop with slabs of a meter or less, the biggest chunk may be a meter and a half. Saw a rather small occurrence again, sticking out at the crest of a 30° drop off, at the change of slope. Making a bottom approach again, I can see just sediment covered bottom now.
05:43	3232	191	S	We're back in additional sulfide deposits. I'm attempting to take some video out the starboard side. Might be too far away from the bottom on the starboard side for the video to show up.
05:43:32	3241	202	E	Sulfide mound.
05:45	3242	070	P	Out in the distance I can see a small mound of sulfide again. A few stalked creatures, very highly sedimented over, it is less than 1 m; the whole outcrop just barely sticks up above the sediment. In general the rest is all sediment covered. Picture of this outcrop. In the distance is a smaller outcrop with a sponge on it, and out here again another local block of sulfide sitting here on the sediment covered bottom. Most of this stuff could be mistaken for talus, but at the first sight we did see a definite chimney growing out, so these are probably the tops of little mounds sticking up that have been buried by sediment. Taking a picture of sulfide with an asteroid on it. Another little mound of sulfide outcropping, maybe 10 cm high, very heavily sedimented. Very difficult to see much at all because it is mostly covered with sediment, very sparse outcrop, I'd say 1% at best outcrop, the rest sediment covered, in my field of view. Now coming into view is a little larger mound. I'll have to wait until we turn a little bit to describe it. There is a beautiful large sponge on this outcrop. It is a fairly massive outcrop, about 2 m long. Taking several pictures of the sponge and the outcrop.

05:46	3242	309	S	Good video of one of the rattail type fish. Should be getting sulfides coming up in the starboard view port.
05:46	3242	329	S	O.K., there's sulfide on the TV camera now. The large irregular mounds are 6 to 7 ft across, quite sedimented as you can see, and providing a hard substrate to a variety of animals.
05:47	3242		P	Two pictures taken of a sulfide mound with a beautiful textured sponge on it. Out in the distance now I can see another outcrop of sulfide sticking up. Very heavily encrusted with sponges, asteroids, a brisingid star sitting on (it), also a big sea fan. As soon as we get in the right position, I'll take a picture of this outcrop. This outcrop is about 2 m long, 1 m high, and has a rounded texture.
05:48	3238	027	S	We're coming into some quite large outcrops of the sulfide material, much larger than we've seen actually to date. There's a large mound ahead of the vehicle. Should be able to get some good still pictures off the port side.
05:49	3240	040	P	We've got a pretty good slope in front of us, good outcropping now of massive sulfide, I can see some minerals sparkling at me. It is very heavily colonized by sponges and lots of other animals. Picture of a brisingid star in a sponge mass and a purple anemone colonizing the sulfide next to that. Rather slabby outcrops, almost some planer features to them. I see very few chimney like features on them. Fairly flat and rounded surfaces, I think they are probably highly weathered. They are certainly heavily colonized. We've come up in the water column now and I'm getting a much better view of a fairly massive mound of sulfide here. Pretty impressive looking structure. Another picture of heavily colonized sulfide outcrop with a stalked creature on it. The mound out in front of me, which I can't see the top of, is at least 3 m high, if not more.
05:50	3238	350	S	You can see in the video we're taking out the starboard side now a fairly large rampart composed completely of sulfide, and Rob has it in front of him. He's going to take some still pictures out the starboard side here and kill the video for just a minute. Time is 05:51.

05:52	3238	009	7,8	S	Two still pictures in quick succession of the sulfide field that we're in, showing the very rough texture and blocky nature of the deposits.
05:53	3236	359	9	S	Another still picture of a large block in the foreground.
05:54	3236	322		S	Coming up on another outcrop.
05:54	3236	130		P	We are slowly moving around through a field of massive sulfide. Huge constructional features, 3-4 m high. No apparent chimneys sitting up here, few projections from the top of these massive mounds. If the chimneys were there they seem to have fallen over, plugged up, disappeared, or weathered away. Highly sedimented, highly colonized by animals. Taking video out both the forward and the starboard. Lots of starfish on here, some sea pens. Mostly rounded knobby forms, very few chimney like structures. When we first moved up this outcrop, mostly slabby forms, but here just large constructional mounds. Somewhat similar to the mounds at 21° N, East Pacific Rise.
05:56	3236	005		P	Coming by another mound, taking a picture. Fairly blobby looking mound, it almost has the appearance of pillow basalts if you didn't look carefully. There is one chimney like projection, which is closed, with a brisingid on the top. Just took a picture of that. Beautiful picture of...Several pictures taken in rapid fire succession as we moved right over a sulfide mound. Took some pictures of...we just touched down on that mound.
05:57	3235	025		S	We're making a very close pass on some of the sulfides out the starboard side now.
05:57:38	3236	037		E	Sponges on sulfide mound which shows weak layering.
06:00:36	3235	005		E	Sulfide mound.
06:01	3234			P	Huge mounds of sulfide everywhere we look. Very old, some of them very coarse grained, I can see crystal faces sparkling at me on some of them, irregular and slabby in places, very rounded in others, very heavily colonized by creatures, often sediment covered, very few chimney structures seen anywhere, but fairly impressive structures of sulfides 3-4 m high when you can see the tops of them. Many of them go off above our field of view.
06:02:26	3232	313		E	Sulfide mound with starfish.

06:03	3231	097	P	Still maneuvering around mounds of massive sulfide, just about everywhere we look. Right now out my porthole I've got a sediment covered slope, but from the texture of it, and the way we approached, it is obvious that most of it is underlain by massive sulfide. Off to the starboard, sulfide is clearly outcropping and Mark is taking pictures of it.
06:05	3230	016	P	Out to the port is a flat sediment covered bottom, there are sulfides out the starboard. We seem to have moved up above most of the sulfides now. Traversed up a mild slope with large, 1-3 m high constructional hydrothermal mounds tens of meters in diameter of massive sulfide.
06:07	3230	075	P	Bruce is turning the sub around to approach the large sulfide mounds, apparent chimney structures at the top are being viewed by Mark out the starboard. Out the port I have a sediment slope dipping away from me. We are heading approximately east; this slope is dipping away to port, approximately to the north. Completely sediment covered, but in places I can see subcrop of irregular material which is almost certainly sulfide.
06:09	3228	100	P	I can now see the edge of a mound which was just being videoed out the front porthole. The mound drops away at least 3 m below me. It is rough, irregular massive sulfide. We're backing off slightly. It comes up to a small conical pinnacle which is roughly pyramid shaped, certainly not chimney looking, very little of this looks very chimney like. Just massive sulfide...
06:10	3230		P	Picture 8 is a blocky massive sulfide mound, toward the base where it is sediment covered. I see the slope in the distance is sediment covered massive sulfide dipping away into a sediment covered slope.
06:19	3231	065	P	Mark is taking a picture of the Mesotech sonar display. The first picture was taken with a heading of 068°.
06:22	3232	158	P	Picture two of the Mesotech, taken with the starboard camera, was taken at a heading of 158°.
06:22:30	3232	152	P	Picture three of the Mesotech, heading 152°.
06:25	3232	158	P	Mesotech picture three or four? (Mark: Three). Heading 158°.

06:27	3234	257	P	Taking another picture of the Mesotech, picture four of the Mesotech, heading 257°.
06:30	3240	010	P	Mesotech picture five, heading 010°. Out the port view hole we have a sediment covered bottom, the slope is to the aft, mounded, bioturbated, not well colonized, no apparent outcrop or subcrop.
06:42	3240	070	P	Looking at the Mesotech display there is a strong linearity to the reflections from the sulfides. They extend at a trend of 075° for a distance of approximately 300 ft. The width of the trend would be approximately 10 ft, 20 ft. Checking that by changing scale. The trend at 075° is 240 ft long and the width of the outcropping sulfide is approximately 30 ft wide and widens outward.
07:08	3256	420	P	We have just finished a delicious peanut butter and jelly lunch. We are sitting on the bottom. We are about to go off and try to map the sulfides. I've just seen an eel-like fish swim up from the bottom past the window. It was about 3 cm long, a couple mm in diameter.
07:10	3256	180	P	Still sitting just a few feet off bottom. I've got a flat sediment covered bottom on my side. We're swinging the sub around to the starboard to look at some rock outcropping on that side.
07:11	3256		E	Flow folded sheet flow.
07:12	3256		P	Last picture was number 9, it almost looked like flat sheet flow crust, it could have been sulfide crust. It was sticking up nearly vertically, it was about 1 cm thick, and had two right angle bends in it. It almost looked like a man made object, it was buried in sediment, almost like a folded piece of thick metal. It could have been anything, probably sulfide I suppose.
07:14	3257		P	Just moving away from our lunch site, we've got lobate sheet flows coming up here. They are cracked. There are a bunch of talus blocks of mudstone, there are a few pillow-like forms coming up out of the sheet flow, sort of leakage pillows if you will. One picture taken of the lobate flows, another picture of mudstone talus sitting on sediment covered pillows and sheet flows, another picture of folded sheet flow, picture of a large pillow like form.

07:14	3257		E	Fissure in lobate sheet flow; recently deposited white mudstone talus on surface.
07:15	3256		E	Lobate pillows.
07:16	3255	100	P	We're still moving over sediment covered bottom with lobate pillow forms coming up through the sediment. They are pretty heavily sediment covered and fairly old. Some of the broken surfaces do appear to be altered, with a whitish alteration color, but mostly just look like old sediment covered pillows. Some trap door pillows with nice striation where they came through their trap door. As in the area we came over before, a lot of expansional pillows, bread crust type structure. Colonized by some stalked animals and anemones, but not heavily colonized, not as heavily colonized as the.picture just taken, slightly out of focus, of a venus flytrap tree with lots of little venus flytraps on its stalk. Each one about 2-3 cm in diameter. There must have been 15 of them on the same stalk. We've got a spider like crab or shrimp, he was about 10 cm across with white legs, I just took a picture of him. Going down a slope. Very strange black puff ball, like an urchin with no spines, but just bumps.
07:17	3256	125	P	
07:18	3256	111	P	Changing heading to 090. I can see pillow basalt in the distance, lobate flows and very bulbous pillows. Right now directly below me is a very heavily sediment covered and bioturbated bottom. The pillows and flows are on a scarp which goes up to the port side.
07:19	3258		P	Off in the distance towards the scarp I can see 1-2 m sized talus blocks which are essentially very large bulbous pillows which have broken off and dropped off of the fault scarp onto the floor. They are sediment covered, I can now see one of the white, legged holothurians, and a very large trumpeting anemone. Picture taken. May be.., I don't know what it is, very large purple anemones with an extremely large trunk sticking straight up in the air, I have not seen one of those before. Also, a nice sediment mound about 50 cm high with a little cone shaped top. A very large burrow. Nicely rounded cone shaped with a hole on top, I couldn't tell what was living there, too far away to take a picture. Still going over lobate sheet

				flows with leakage pillows coming out the top. I can see some very broken up terrain, a lot of fragmentation of them, some folded sheet flow in places. A galatheid crab out in the distance. Coming by a nice colony of sponges and some outcropping pillows. Now as we move away from the slope we're back on sediment covered bottom. Last picture read picture 16.
07:21	3259		P	On a flat sediment covered bottom.
07:22	3259		P	Still going over a flat sediment covered bottom. About to come up on some more outcrop, according to the pilot.
07:23	3259		P	We've just now come up on some predominantly sediment covered very flat sheet flow. The sheet flow crust is just slightly buckled and cracked or I wouldn't be able to see it, it is flat enough that it is completely sediment covered even though the sediment doesn't look to be too deep on most of it.
07:23 to 07:28			E	Sediment covered lobate pillows with some fissuring.
07:24:48	3259		P	Descending down a gentle sediment covered slope.
07:26	3258	023	P	Taking video out the starboard view port. We just took a little out the front view port of a very large stalked animal. A branched stalked animal like several I've taken pictures of, but nothing as large as this one. What one might call a saguaro cactus type structure, must be a good 2 m high. We're still coming over a very heavily sedimented volcanic terrain. Mostly sheet flow below us now, although we're too high for me to see bottom clearly now. We've come through lobate flows with some pillows, through sheet flow. There seemed to be a scarp that had some volcanic talus coming down it. The sulfides apparently are above us on the same scarp.
07:29	3260		P	Still coming over heavily sediment covered bottom, but some outcropping of lobate sheet flow, with some little leakage pillow-type protrusions sticking up as pillows here and there. Fairly heavily sediment covered, a few mounds, some bioturbation, some interesting stalked animals.
07:31	3259	165	P	We're just now crossing over a dredge track. The dredge track is going at 45° away from us to the forward starboard and behind us to the port aft. We just now crossed over the dredge

					track. It was about 75 cm wide a few cm deep. The dredge was sliding along the mud covered bottom.
07:33	3260	025		P	We are heading exactly parallel to the dredge track right now. The dredge track is off to the port side. The dredge track is heading about 025° or so. There is a nice furrow going through the sediment. We've got a completely sediment covered bottom. We are going to follow the dredge track with the submarine. Right here the dredge was not dragging, just the chain bag was dragging. You can just see a smoothed out path where the chain bag drug through. We've got a little bit of crusty mudstone punched up here and there, picture taken. About to take a picture of the dredge track showing the chain marks. Also a holothurian in that picture. We've got some talus blocks of white mudstone along the edges of the dredge track. They may have been brought in with the dredge because they don't seem to exist any where except near to the dredge track. Taking another picture of the dredge track showing the chain bag marks and large blocks of white mudstone. The white mudstone blocks only occur along the dredge track, away from that I don't see any outcropping of the white mudstone.
07:34	3259	055	3	S	Just took a picture of a muddy bottom and a very thin-rayed starfish. Next picture will be frame 4 on roll 3.
07:34 to 07:42				E	Dredge track.
07:35	3258			P	Following the dredge track, it makes about a 90° turn, being dragged along the bottom the whole time. You can see the chain drag marks. We might lose it here.
07:36	3258	086		P	We've got a pretty good scarp on the port side. The dredge diverted around a mound. The mound shows some outcropping mudstone, white chunks of mudstone, and apparently that explains the white mudstone which we saw distributed along the dredge track as talus blocks but nowhere else.
07:37	3260	670		P	Still following along the dredge track at angle of about 45° to the dredge track. Where it had dragged along, I can see a mark where the cable had laid down in the sediment and made an impression at a very large angle to the dredge. Obviously there was a big loop of

					slack cable (ship made a turn) before the dredge picked up and dug in along the dredge track. It takes a couple of quick turns in here as it went around a sediment mound. It is turning back around to the left, back toward its original course, which was 025 before. I'm over a flat sediment covered bottom which slopes away to the port. Again we have the dredge track out the starboard side and again there are mudstone blocks along the dredge track and nowhere else. It appears that the dredge builds up piles of mudstone in front of it just like a bulldozer. The bag must be filled with mudstone as it goes along the bottom and distributes these random blocks of mudstone all along its track. Some of them almost 1 m away from the track. You can see the chain bag marks behind. It seems to just fill up with mud as it drags along this kind of bottom, and as we experienced on our cruise most of that mud washes out before it gets to the top.
07:39	3254	343	4	S	Just took a picture of some of the mudstone blocks that have been disturbed by dredge that we're tracking.
07:40	3254	018	5	S	Two large piles of mudstone blocks, and there's the dredge track with the chain bag marks. I just took a picture of it with mudstone blocks associated with it.
			6-8	S	Three shots of the dredge track. You can see the chain bag marks in the sea floor and a place where the dredge paused, jogged slightly to the left, and then continued up slope.
			9	S	Another shot of the dredge track off to the starboard side of the ship.
07:41	3255	032	10	S	There's a shot of a large purple holothurian just for a marker.
07:41	3255	030		P	Still following along the dredge track.
07:42	3255	030		P	Essentially going along a dredge track which is essentially parallel to that, maybe 025°. Again we see disturbed mudstone along the edges of the track and chain bag marks along the track.
07:43	3254	010		P	We are starting to come up a steep sediment slope. I see rather blocky outcrops of mudstone now. We are following the dredge track up this slope. Here we do see blocks of mudstone sticking up randomly, not

					necessarily having been redistributed by the dredge.
07:43	3253	057		S	We're following the dredge track up a steep slope. Mud bottom with a covering of organic debris, lots of holothurians. You can see mudstone blocks.
07:44	3252	315	11,12	S	Just took two pictures of the dredge track, or maybe it was the wire mark, off the starboard side.
07:44	3252			P	The earlier statement about the mudstone blocks sticking up not being associated with the dredge track appears to be incorrect. As we moved across away from the track there are no mudstone blocks. They do seem to be associated only with the dredge track.
07:46:51	3248	000		P	Still following along the dredge track. I see some random blocks of mudstone, some of which have left a slight trail down this slope of about 20°. They obviously are nearly neutrally buoyant when they come off the dredge bag which is distributing them, pushing them in front of it, and leave a slight trail going down the slope before they land. They are also very sediment covered, whereas the ones next to the dredge track are usually white, some of the rest are sediment covered due to sedimentation by the cloud of the mud kicked up by the dredge apparently.
07:48	3246			P	Picture of a lily like stalked creature whose stalk seems to have been encrusted with a venus flytrap. It seems like these venus flytraps on the stalks might just be parasites on other creatures, growing on other animals stalks.
07:49	3246			P	Still following along the dredge track. I've got a very smooth, heavily bioturbated and tracked sediment covered bottom with a few stalked sponges and some purple urchins, an occasional galatheid crab and now a white, legged holothurian.
07:49	3246	038		S	Taking video tapes of the dredge track.
07:52	3243			P	We've just come to the base of the steep scarp on the North Hill, following the dredge track up that scarp. We are now rising up in the water column following that hill upwards.
07:54:30	3242			P	Coming up the North Hill on a dredge track. I still have a nice clean sediment covered bottom, a few stalked sponges, some other stalked animals, bioturbated.

07:56	3241	001	13	S	Picture of a fairly complex stalked animal with one tentacle halfway up the stalk and then a large octopi-looking frond at the top.
07:58	3238	000		P	Flat sediment covered bottom, highly bioturbated.
08:00	3238	010		P	Continuing along sediment covered bottom. Slope is getting a little steeper. We're getting a little more of a hummocky bottom, some holothurians, lots of holothurian turds, very few other animals. Currently do not have tracking, but we are heading approximately north. Now see another stalked creature with a venus flytrap attached to it. That creature has a tulip like top and a venus flytrap attached to the stalk. Several other things, like an asteroid, attached to the stalk as well.
08:00	3238	010	14,15	S	Two shot of the dredge track as we're continuing uphill.
08:01	3237	000	16	S	Took a picture of an animal, quite far away actually, it was one of the translucent octopus-like creatures, of which we've seen quite a few. It may be a kind of coelenterate.
08:01:30	3235	010		P	Sediment covered slope up in front of us.
08:03	3234	001	17	S	And another attempt at a picture of the same kind of animal.
08:03	3234	349	18	S	A large brittle star in the dredge track. That was near the dredge track, not in it.
08:03:30	3234	055		P	Sediment covered bottom, hummocky terrain. Still following the dredge track.
08:04	3234	006	19	S	One of the large white fish.
08:05	3232			P	Last picture taken was of a very large purple urchin. We have been following a dredge track, probably the eastern most of the two dredge tracks that go up the North Hill, we followed it back to the base of the North Hill and part way up the North Hill. At this time we are going to turn around and head back at about 180-200° to reintersect the sulfides.
08:11:33	3232			P	Heading for a Mesotech target which is off to the port side.
08:12	3231			P	We are just passing over the dredge track. On the port side I can see a swirl where the bag rolled over. The chain bag went one way then the dredge rolled over and then the chain bag swirled the other way.
08:13:30	3233	026		P	Sediment covered bottom, bioturbated, mounded, sparse animals. Just looked at one of the white stalked creatures with the flow through, tubular, cellophane bag type top,

					cylindrical top, often lightly sediment covered (i.e. dirty brownish from adhering sediment), but semi-translucent, open at both ends. This one I could see was clearly growing around a star-like head on the creature which actually lived on the stalk and the bag head did not belong to the stalk itself.
08:18	3234	270		P	Just crested a small sediment covered ridge, looking at a spiral feature out here. Some brisingid star fish.
08:19	3233	060		P	Coming over the top of a ridge which drops off to the fore. Going through a little ridge and valley type terrain.
08:24				P	We just obtained a fix from the surface after rising 100 ft off the bottom. Making bottom approach. We're going to head 240 back to the sulfide targets.
08:29	3230	265		P	Taking a picture with the starboard side hand held camera of the Mesotech targets which are believed to be sulfides.
08:31	3239	280		P	Have just reoccupied the bottom after getting a fix to the sulfide site. The sulfide site lies at approximately 240, 200 m. We are heading that direction, heading over a flat sediment covered bottom. We are moving slightly uphill. We have a scarp coming up on the left side. Pretty interesting looking structure laying on it. Probably a basalt pillow flow. It is a very large lava tube I believe. We've got a flow that has come down on the sediments here. No, we have sulfides, we are sitting right on sulfides here. I think we might have a big fallen chimney right out here to the port. It looks like a big log, so I thought it was a lava tube.
08:32	3240			P	We have just hit sulfides at the base of a slope, I can just see some crusty sulfides.
08:36	3232			P	We have just reached an outcrop of massive sulfide. It was sediment covered bottom up until this point. We started up a slight slope, I saw a few crusts of sulfide, then a large ridge of sulfide, possibly a very large fallen chimney. We just got a bearing from the surface to our former sulfide site which is 240, the same direction we traveled to get here, at a range of 120 m. Possibility that we have significant sulfides from here to that point, maybe along a structure trending approximately 240°.
08:39	3238	298	X	S	We've come to the southwest down a slope and up onto the bench, and we're back into

				the sulfides now. Trying to get a better picture of their distribution. Taking some pictures of the Mesotech sonar.
08:39:30	3238	290	P	Can now make out bottom again, I've got rounded outcrops almost talus looking, at this point they could be either basalt or sulfide, I can't tell yet. We've kicked up a bit of a cloud, we've still got some stuff in the water.
08:40	3237	290	P	Looking at outcrop of slabby, apparently massive sulfide, large boulders.
08:41	3236		P	Taking a picture of a large sulfide boulder on top of a mound with a flower-like anemone-type structure with flowerlets on the ends of its tentacles. A galatheid crab. In the distance I can see a very large mound, meters long, several meters high. All massive sulfide. I see some galatheid crabs on it, some starfish. In between the mound we just went over and the one in the distance is sediment cover, with just a few blocks of sulfide sticking up above it. Very mound like structures here, no large chimney-like protrusions on the ones that I can see at the moment.
08:41	3234	271	S	Picture out the porthole of the nose of a large ridge of sulfides, covered with white starfish. It was a sort of a nose that was parallel to the track and pointing in the opposite direction, and approximately 20, make that 12 ft from the starboard port.
08:43	3234	348	S	Still looking over on the ridge of sulfide. Took a picture of one of those many-headed hydra-like colonial animals. I think it's the same type I took a picture of before. Also just took a picture of a block, about 2 m high, about 2 to 3 m in diameter, with a white siliceous sponge on the left and a sea anemone on the right. Also I believe that I've taken a picture of this before.
08:43	3234		P	Picture taken of a mound in the distance with a 1-1.5 meter wide colony of sponges. The next picture showed a closer rounded knob of massive sulfide. Out in the distance we have massive sulfide, highly sediment covered, but outcropping almost continuously in a scarp that moves up to the port.
08:44			P	All three observers see sulfide mounds and ridges going up in front of them, so we are in a cul de sac which is totally walled in all three directions by massive sulfide. Beautiful

				sponge out the starboard side. We are in between massive mounds of sulfide that goes up meters high. Essentially the entire terrain which isn't sediment covered is sulfide.
08:46	3232	083	S	I've just taken a picture of the Mesotech sonar display. The range across the display was 60 ft, 12 ft per range line. The zero line corresponds to our heading, which I have previously announced, and you can see the indications of sulfides by the high reflectively.
			S	...picture in this series...
08:47	3234		P	Multiple pictures taken of sulfide mounds, camera setting now on 30.
08:48	3234	042	S	Got the hand held TV camera out the starboard view port now.
08:49	3235	045	P	Changing heading. Still massive sulfide mostly in view. Out in the distance sediment covered hummocky terrain, probably underlain by massive sulfide. A lot of the outcrops I'm looking at right now are very slabby looking sulfide. A lot of sulfide talus. A lot of flat surfaces on much of this, and essentially no chimneys showing anywhere. A few small projections with creatures on them, but no major chimneys or even minor chimney structures are visible on much of this outcrop. Picture now of a small chimney like projection with a crinoid colonizing it on top of a mound, but that is the exception rather than the rule, mostly rounded outcrops.
08:51	3234	271	S	We've just intentionally rammed into a fairly substantial block of sulfide to see if we could shake anything loose. We didn't shake anything loose outside the submarine.
			S	Picture of a large sulfide block covered with organic debris, and on the right side rimmed with white animals - filamentous and white circular animals.
08:56	3234		P	Still hanging around the same sulfide mounds. We've rammed several of them trying to break off some chimneys and get them in the basket. Everything I look at is a very rounded and massive looking outcrop, I don't see any real structure to it, either chimneys or layering or anything else, just sort of rounded massive sulfide. There is a fresh break where the sub hit the one chimney-like projection in front of us, and it is very dark looking sulfide there, it may be sphalerite rich. Other than that

				it is sort of a brown weathered color. I can see that actually a large chunk was taken out, taking a picture of that. Last picture on roll 4 was of a fresh break in the sulfide caused by submarine ramming.
09:01	3236	250	S	We're maneuvering. We're in the area of sulfide where we were a couple of hours ago. We're attempting to find a small chimney or some other sample we can break off without (the use of) slightly cripple manipulators.
09:07	3238	214	S	A large sulfide mound out the starboard side.
09:06	3239	214	S	Close-up of sulfides off the starboard side, colonized by a variety of white cotton balls and the long stalked animals.
09:07	3238	214	S	Another picture in the same location. Probably hard to see in the foreground is a purple sea anemone with sulfide blocks, some with what looks like fresh unsedimented surfaces.
09:11	3238	238	S	A large chimney on an even larger block of sulfide. The chimney was totally overgrown with animals.
09:13	3238	025	S	Picture of the Mesotech sonar on 50 yard range, so that there was 50 ft per division, of the sulfides in the vicinity of the ship.
09:16	3238	321	S	Couple of close-ups of the sulfides off the starboard side, only about 2.5 ft away from the view port. In the field of view on those was a small white starfish and the circular white amorphous-looking animals.
09:16	3239	060	P	I have just been taking video out the porthole. I'm looking at massive slabby outcrops of massive sulfide. Large slabby blocks and protrusions growing up from them. No slender chimneys, just some rather massive ones, heavily colonized by animals, fairly heavily sediment covered. The mounds are tens of meters in diameter with heights of a few meters that come up into protrusions one or two meters across and one or two meters high.
09:22	3238	313	S	Hand held photo of the stub of a chimney from which we've ripped a sample. And another one of the same thing at 09:22. I'm going to activate the TV camera again.
09:24			S	End of the video, stopped it, put it on pause.
09:25	3238	291	S	We're essentially stopped near the bottom. In spite of the ailing condition of the manipulators, Bruce is going to attempt to ease the sample more firmly into the basket.

09:28	P	Just dropped ascent weights and heading to the surface. Recovery at 0500 (local) 28 Aug., 1986

Dive 663

Location: SESCA
Port observer: Zierenberg
Starboard: Wiltshire

Julian day: 240
Date: August 28, 1986
Pilot: Ruppert

Time (GMT)	Depth (m)	Hdg	Photo	Obs	Comments
16:57	3210			P	Making bottom approach, 160 ft off the bottom.
17:04	3270	065		P	Just made bottom contact. We are about 6 ft off the bottom. Very flat, sediment covered, bioturbated, poorly colonized. There is a cork screw whip coral, a white shrimp with very large antennae, some holothurians, some sediment mounds including fairy rings, not heavily populated by biota, but heavily bioturbated.
17:04	3271	105		S	Contact on bottom, fine grained mud.
17:06	3271			P	On the bottom, flat sediment covered bottom, very few stalked organisms, a few anemones, fairly heavily bioturbated, some mounds and fairy castles.
17:07	3270			P	On the bottom, I can just barely see one or two rounded rocks laying on the sediment out the port view port. They are too far away to see them clearly, but they are heavily colonized by sponges and stalked animals with venus flytraps attached to the stalks. They could be sulfide talus. They do seem to be sitting on the sediment rather than rocks sticking up through the sediment.
17:10	3271			P	About to head to target K on the 3170 Hill, at a heading of 180°. Still on a flat sediment covered bottom, there are some rocks sitting on the bottom which can't be seen clearly yet.
17:11	3269	215		P	Moving over a flat sediment covered bottom, heavily bioturbated, there are some holothurians, including a white, legged holothurian, a fairly large rattail fish, some large anemones, bioturbated bottom with not too many stalked organism.
17:12	3271	206		S	Video on, possible sulfide outcrops in view, photos of bottom burrow morphology.
17:13	3272	160		P	Flat sediment covered bottom, a few stalked animals, some of them inhabited by venus flytraps, some purple urchins, some coral-like animals.
17:14	3271	180		P	Flat sediment covered bottom, a few stalked animals, most of them with venus flytraps attached. One venus flytrap seen on the

				bottom with a wider anemone-like base, similar to venus flytraps seen at NESCA.
17:16	3274	250	P	Still transiting to target K over a flat sediment covered bottom.
17:17	3273		P	Flat sediment covered bottom about 2 m below me.
17:18	3275	170	P	Flat sediment covered bottom with some anemones, some venus flytraps attached to the bottom, in the distance a coral-like animal, with a venus flytrap attached, some large sediment mounds, 30 cm high perhaps, but generally a normal muddy bottom other than that.
17:20	3275	150	P	Flat sediment covered bottom, some stalked organisms.
17:20	3273	187	S	On bottom, proceeding up slope.
17:21	3274	190	P	We are going to go over a slope that goes down now. We just crossed a sediment covered knoll, the slope goes down to the starboard fairly steeply, about 20°.
17:22	3275	195	P	Over a sediment covered bottom, slightly rolling with up steps to the south as we head up the 3170 Hill.
17:23	3272	180	P	Coming up a scarp. Picture one on roll one was of a flat, purple, disk shaped animal on the sea floor, it could have been an anemone. Coming up a fairly steep slope, 30°-40°, completely sediment covered, still bioturbated, a few stalked animals on it, no outcrops seen yet.
17:24	3268		P	There are Sea Cliff tracks out the starboard view port which are being video taped.
17:25	3266	150	P	Still transiting up a slope of about 10° coming up the 3170 Hill.
17:25	3265	165	S	Crossed dredge track.
17:26	3263		P	(To Pilot: I'm looking at the chain bag marks from a dredge track. It was sliding down hill, yes that's a dredge track.) Dredge track shows some disturbed sediment. It has kicked up a few blocks of mudstone. We're heading for target K, essentially following along the dredge track which I can see out my porthole. Taking a picture of the dredge track. That picture includes an anemone that the dredge track went over, he was still alive. I see some blocks of mudstone now that the dredge has pushed up.

17:26	3262	140	3	S	Picture of dredge track and bioturbation, some discoloration in mud, possibly due to heavy iron staining.
17:27	3259	164		S	Dredge track running uphill on starboard side, sulfides in view.
17:27	3260	160		P	Still moving uphill to J-K, a slope of about 20° now. The dredge track is off to the starboard.
17:28	3256			P	Moving up a steeper slope now, about 30°. I now see a talus block of sulfide sitting on the sediment, just barely exposed. The pilot sees sulfide, and sulfide is being videotaped out the starboard side. Mostly minor crust which are sediment covered. Now coming into view is a small mound-like structure, also fairly sediment covered, picture 3 and 4 on roll one. We've got a substantial ridge of sulfide here. We're on top of a ridge of sulfide that stretches away to port. (To pilot: I'd like to turn about 90° to the port and then you will be looking at the peak of a very large sulfide mound. You want to turn before you get there. It is out in the distance about 20 ft from you, and you'll be looking at a nice sulfide mound when (you) turn around. You've got no obstacles right below you to block your turn.)
17:28	3255			S	Proceeding uphill, sulfides in view on hillside, recording video as we come up to hill top.
17:28:35	3253	137		E	Massive sulfide, oxidized and sediment covered.
17:29	3253			P	We just crossed over a ridge of sulfides. It is a continuous ridge of sulfide exposed on both sides, I can see both sides of the ridge. It drops off at least 8 m on either side, and is continuous for as far as I can see. It has some huge stalked animals sitting on it. It is weathered, rounded. Some dead sponges, a hole field of dead sponges laying on the bottom, sediment covered. Very massive deposit, a large sea fan, taking several pictures.
17:29:49	3254	076		E	Massive sulfide, oxidized and sediment covered.
17:30	3253			P	Still moving along the sulfide. Now at the top of the mound. The mound is sloping away. I can see continuous exposure of massive sulfide along this ridge. Taking pictures like mad.
17:30	3252	074	4	S	Frame 4 of sulfide mounds.

17:31	3253	060	S	Video taken out of bow porthole of mounds. Sulfides in very weathered condition.
17:31	3253		P	(Pilot: It looks like it goes away to the right, I'm going to turn to the right and try to follow this slope.) That's beautiful, just try to follow that outcropping rock if you can. We are trying to follow this mound. We are directly over a sulfide mound on the port side that is dipping down. Heavily sediment covered, rounded, weathered, heavily colonized, exposed along fairly steep faces. On the top of some of the flatter lying sulfide, completely sediment covered with very little showing through. On the steeper faces you can see that it is totally massive sulfide.
17:32	3253		P	Still transiting along massive sulfide outcrop. Very substantial ridges and mounds of massive sulfide. Compared to Dive 662, this material is nearly as massive, but shows much more sediment cover, it appears to be older, more deeply buried, more flat surfaces, less rugged and fewer projections coming up, other than that it is very similar.
17:33	3253		P	Now we are about 4-5 m off the bottom. I no longer see massive sulfide out the port, just a sediment covered bottom. (Pilot: I've lost it now, it's gone and I'm getting a slope away from me. I'm going to come back to 180°.)
17:34	3256		P	We are now on a sloping sediment covered bottom. No signs of outcrop. Slopes range from 20°-30°. There is a fairly substantial scarp in front of us on the Mesotech. We are now climbing up that slope of about 30°. (To pilot: We are going to hit a very strong current when we come over this (rise). I can see stalked animals leaning over.) (Pilot: They're leaning both ways though.) Just coming to the crest of this ridge. At the top I see a little bit of mudstone debris, some brisingids, heavily bioturbated. Now the slope is dipping away in front of us instead of behind us, we've crossed a ridge, the slope in front of us is about 20°. The water depth at the top is 3201 m.
17:34	3255	208	S	Major scarp. Turning to go back to sulfide site and sample.
17:34:13	3256	062	E	Sediment covered bottom.
17:34:32	3255	059	E	Animal on sediment covered bottom.
17:35	3255		P	We are changing course. We've come over a sediment covered ridge. We are going to

				change course and go back the way we came and reintersect the massive sulfide outcrops that we came over on the way up the hill. Currently over sediment covered bottom with holothurians, some urchins, somewhat bioturbated. Taking a picture of a stalked sponge, looking down into its cup. Taking a picture of what I thought was a brisingid, but was actually a stalked crinoid, or some other stalked creature with arms sticking up, but bent back, it could have been a brisingid on a stalked animal. We're about 1 m off a soft bottom on the port side. There are a lot of mudstone clasts sitting on the sediment here. They are generally only 2-3 cm, fairly insubstantial, but they suggest some down slope movement.
17:37	3252	000	P	Still moving up a slight slope which dips off to port, sediment covered with minor whitish mudstone chips.
17:39	3251		P	Picture of a very large galatheid crab, trophy sized. Also in that picture was a stalked animal with a venus flytrap on it. Taking a picture of another stalked animal with a venus flytrap, right next to a purple urchin. I see a little mudstone outcropping with a sponge, taking a picture, mudstone was just kind of punched up through the sediment. Coming up slope now.
17:40	3250		P	
17:40:20	3246	180	P	Picture of an outcropping white layer of mudstone with a dark layer in it, it may be manganese stained. There is a slope coming up steeply to the port side. Sediment covered, sloping 20°-30°. We're swinging around at about 180°.
17:41	3242		P	We've just come to the crest of the ridge. Still sediment covered with some mudstone chips.
17:42:14	3240	147	E	Steep slope with mudstone talus.
17:42:39	3238	155	E	Mudstone talus on steep slope.
17:43	3236		P	Last picture was a white mudstone block with a broken face, that almost looked like black basalt. It was sitting on the sediment surface as though it had been transported, possibly dropped out of a dredge. We've just touched bottom at 3182 m. It is mud covered with some mudstone chips, sloping very steeply up to the fore, our heading 189°. This is the slope

					which is uphill, above the first encounter of the sulfides.
17:44	3235	247		P	Coming back down the slope, we're going to reoccupy the sulfide site.
17:45	3237	270		P	The slope is dipping very steeply away in front of me. It is smooth, dipping at 30°-40°. I see a dredge track where the dredge has come down the slope, and has been rolling as it came the slope. There is a cut and a roll, a cut and a roll, and a cut as it just rolled itself down this sediment covered slope. As we move down, I can see the slope steepens very significantly here, it is going to drop off a near vertical scarp. The slope is steepening to about 45° until it gets to the scarp. I can't see down the scarp, it probably has a near vertical face. There is some mudstone outcropping near the scarp. There is mudstone outcropping across the toe of the scarp, which has a near vertical face that drops down several meters, and now I can't see bottom.
17:44	3247	026		P	Sediment covered scarp pictured with outcropping mudstone. Some of the mudstone shows a bit of manganese staining. Picture of a floating purple jellyfish. Picture of a cellophane bag type animal colonizing another stalked animal.
17:48	3246	067		P	We are going to set down and do some electrical checks.
17:49	3246	075		P	Directly in front of the submarine is a dredge track which is essentially perpendicular to 075. We are sitting on top of a ridge which slopes away to the port. The main hill is off to the starboard. We also have a slope ahead of us, this is a little saddle area. The dredge track was just from dragging the chain bag mostly. It cuts down a few cm and heads off into the distance
17:49:08	3246	074		E	Dredge track.
17:55	3246	078		S	
17:56			5-6	S	Following sulfides along hill. Frames of sulfide mounds.
18:02				S	Sulfide outcrop on edge of hill, very weathered.
18:02	3246	075		P	We have just completed electrical checks and communication with the surface. We are going to head 000 down the slope to intersect the sulfides.
18:05	3246	268		S	Coming back around to sample sulfides.

18:08	3251	070		P	Over outcropping massive sulfide again. It is a very flaky, tabular outcrop. Taking pictures. Lots of little sponges, some brisingids. It is highly weathered, it has a recessed look to it like glacial ice that has been melted away.
18:09:44	3249	061		E	Massive sulfide.
18:10	3247			P	We have just scraped sulfides into the basket. Trying to get a position from the surface to mark this sampling site. We have massive sulfide ridges dipping off in every direction as far as I can see, some projections sticking up from it.
18:10	3246	047		S	Sample station 1, scraped sulfides into basket on stbd side, very weathered and friable.
18:10:32	3246	044		E	Massive sulfide.
18:11	3246	050		P	We are sitting on top of a mound of massive sulfide. As far away to the port as I can see are several ridges of massive sulfide sloping away. It is highly weathered, somewhat tabular. It shows recessed weathering where minerals have been selectively weathered out forming rough projections like ice melting by the side of the road. It has a jagged look to it. It is old and sedimented. We have scraped some into the sample basket as we came up the slope. We are attempting to get a position. Several pictures taken.
18:21	3246	048	7-10	S	Sampling sulfide, photos of mounds in sample area.
18:23				S	Position X=12599 Y=13622 from surface.
18:27:45	3246	065		P	We are still sitting on the same sulfide outcrop. We just got a position from the surface. We are very near position K, between targets J and K. We are going to head to the east and map out the sulfide deposit. Picture taken of the sulfides with a starfish in the field of view. As far as I can see in any direction is massive sulfide with sediment between the outcropping mounds. There is a mound out in front of me which is the highest point I can see. As we turn and head off of that mound the slope is very steep, somewhat sediment covered but still underlain by massive sulfide.
18:32	3255	025		P	Transiting across sediment covered bottom. We just flew off of the sulfide mound, got out of our sediment cloud and just now reoccupied the bottom. It is flat with a slope up to the bow. Now the slope is increasing, but sill sediment covered. As the slope becomes steeper I am

				beginning to see some mudstone talus. Fairly bioturbated, but as we move up the steeper slope with the mudstone talus there is less bioturbation. The mudstone talus is 1-3 cm in size. We are coming into another sediment cloud and we also have a pretty good slope to the port, we might touch down. I can't see anything. OK, I don't think we are going to touch down. There is a vertical scarp right out the port view port.
18:32	3253	020	S	Steep slope, weathered very porous sulfides along side of mound, mounds 3 to 10 feet high, 5 to 20 feet long.
18:33	3250	025	P	
18:34	3248		P	We are again back in our own sediment cloud. We are going to pick up off the bottom, move over a ways, come back down and try to reoccupy the sulfides.
18:35	3247	120	P	We are making a bottom approach. We are about 2 m up. Smooth sediment covered. Now the slope is increasing out to the port side. I see blocks of mudstone talus again, a few animals. We are back along the scarp. Coming over some mudstone and taking a picture showing some dark edges and a dark, round mushroom-like creature on it. Another picture of mudstone outcrop showing some manganese staining on the outcrop.
18:36	3245	125	P	I've got a dredge track coming right at me.
18:36	3248		P	I take that back, it is too narrow to be a dredge track, it is a Sea Cliff track.
18:36:16	3244	124	E	Fine mudstone talus on steep slope.
18:36:48	3242	105	E	White "legged" holothurian and 1 m long "stick" animal on sediment covered bottom.
18:37	3241	090	P	Picture of a sediment covered bottom dipping away to port showing a little furrowed ridge which was probably a Sea Cliff skid track.
18:37:21	3240	105	E	Dredge track showing dredge roll over.
18:38	3244		P	Face-on picture of a big white fish.
18:39	3246		P	Sediment covered bottom, fairly good slope or scarp away to the port. Out in the distance I can see some mudstone outcropping, or subcropping. We are going along a little bench with the fault dipping well off to the left.
18:40	3246		P	There is a possible dredge track or Sea Cliff track here.
18:40	3247	000	P	Moving along the slope, sediment covered, a few sediment mounds a few meters high, rounded knolls, some of them with

				outcropping mudstone. I see a large mound of sediment out in front of us here, a mudstone mound, taking a picture of it.
18:41	3246	254	P	Some crusty material around that outcrop, but I couldn't make out what it was. Coming back into sulfides now. It is a weathered outcrop with a lot of asteroids. Coming over a fault scarp, dipping very steeply down in front of us.
18:41:56	3247	257	E	Sediment covered massive sulfide.
18:42	3246		P	So we now have sulfides at a significantly shallower water depth than the formerly occupied site. This is probably closer to sight J.
18:42	3246	264	S	On sulfide pinnacle.
18:42:33	3246	263	E	White material on massive sulfide.
18:44	3246		P	Swinging around to approximately 090° . We just landed on a sulfide target. We are going to turn around and follow the sulfide to the east and try to map the extent of it.
18:44	3246	060	P	I can see the bottom again. We have outcropping massive sulfide everywhere as far as I can see. Mounds and ridges, heavily weathered, sediment covered, similar to what we've seen so far on this dive.
18:46	3252	083	P	We are sitting directly in front of a large mound of massive sulfide, taking pictures with the forward looking camera. As far away as I could see to port as we occupied this site was outcropping massive sulfide.
18:48	3249	100	P	Coming out of our sediment cloud, beginning to see some sulfide again. Everything I see is partially sediment covered massive sulfide with some stalked animals on it. Some projections coming up, but no real chimneys. They look like projections left from the weathering down of the sulfides rather than constructional features coming up.
18:48:01	3249	102	E	Vertical face of massive sulfide.
18:49	3247	105	P	Super scooper Mike Ruppert has just dragged the basket up the front of another massive sulfide and we probably have some samples from a second site now, mixed in with the ones from the first, but we'll take them any way we can get them.
18:51	3246	171	P	One of the samples is in the critter basket. I now see the bottom. It is sediment covered with some mudstone outcrop. I don't see any massive sulfide at the moment. The slope is

				dipping steeply away to the fore, completely sediment covered.
18:54	3251		P	On a very steep bottom which is completely sediment covered except for a few outcrops of mudstone. Picture taken of this steep slope with evidence of down slope movement. Picture of a pretty tulip shaped stalked sponge. Next picture of a big white fish. End of roll one.
18:55	3246	090	P	Coming up a very steep slope. Just passed an outcrop of mudstone, much of it white but manganese stained along some of the edges. Now we are back over a completely sediment covered hill. The slope isn't quite as steep. Coming up on a knoll here or a little ridge, it is flattening out a bit, fairly bioturbated here, lots of mounds. Passing a track right below us. It looks like the same Sea Cliff track I saw before, yes there is another skid mark, and off in the distance is a dredge track coming down. It may be another Sea Cliff track. There are several tracks here, I can't take a picture because I'm out of film. I see a chain bag track now, and I see where the dredge has rolled down the hill. The other track may be a wire mark, it goes through the brown sediment to the whitish sediment below.
18:57	3236	090	P	Climbing up a fairly steep sediment covered slope, 30°-40° in places, with outcropping mudstone. I saw a dredge track with several side tracks. The side tracks were either Sea Cliff tracks from the first dive here, or they were marks where the cable had fallen into the sediment. The dredge was clearly rolling. Where the cable marks went in they exposed whiter colored mudstone. We are still coming up slope on this rounded sediment covered knob. Up at the top there is some outcropping mudstone, small pieces, it almost looks current winnowed, like a lot of the fines have been removed from the top here. There are some blocks of mudstone outcropping.
18:58	3232	085	P	Now we are at the top. The slope has flatten out here at the top. There is more bioturbation. It is a fairly flat slope, it does dip up gently to the port. A slow moving rattail fish moving away from me. We are going to sit down on the bottom so the pilot does not go home as a cripple.

18:58	3237	140	S	Camera jambs, unloaded; start roll 2. Sample 2, sulfide scraped into basket, very weathered chimney held in place with manipulator.
19:08	3232		P	We have traversed up the hill from the sulfide site. We came up a sediment covered slope which went from steep to near vertical. As we came up the near vertical part we saw outcropping mudstone. We are now at the top of a knoll, close to the top of the hill. We are trying to get an X-Y position. Around us is possibly a current winnowed hill with some blocks of mudstone and coarser looking sediments in general. Fairly well bioturbated, but not too well colonized by animals. We will take a little video of this before we leave.
19:11	3232	089	S	Resting on bottom to get position from surface.
19:16:48	3232	089	E	Wine goblet sponge on sediment covered bottom.
19:22	3232	116	S	Crossing top of hill.
19:22	3232	090	P	We have finished our house keeping chores. We have picked up off the bottom and are leaving the site where we sat down at the top of the last scarp. We are going to head up the hill at a course of 150°. That should take us across the very top of the hill and back down the other side to a sulfide site picked up on the camera run.
19:24	3231	150	P	Very steep sediment covered slope going uphill to port. Traversing along the side of this scarp I see some small rounded mudstone blocks sitting on a sediment covered bottom. Fairly well bioturbated, but not too many stalked animals. A few little mound like outcrops of mudstone. As the slope gets steeper I see more blocks of mudstone laying on the slope.
19:24:16	3232	122	E	Outcropping mudstone.
19:25	3228	130	P	Still traversing along this slope, there is a very steep scarp trending up to the port side with mudstone talus and little bits of mudstone subcropping below the sediment covered bottom.
19:27	3226	160	P	Still traversing along this very steep slope. We have a Mesotech contact. I can see some outcropping mudstone here. I'm taking some pictures of some manganese staining. Picture one on roll two is mudstone with dark staining, probably manganese, but not definite. I see some talus, some down slope flow of these

				blocks of mudstone, but not much movement here.
19:28:56	3226	126	E	Steep face with mudstone.
19:29	3226	155	P	Picture of general mudstone talus outcrop. Picture of suboutcropping mudstone showing a little layering. Some black, probably manganese staining on it. Should have been picture 3 on roll 2. Pilot has just seen a pop top on the bottom. A nice fossil horizon dating this sediment as being pre-Pulltabian in age, before punch in tops.
19:29	3222	130	S	Running along edge of a steep mudstone slope.
19:30	3220	130	P	Still coming up a sediment covered very steep slope. Slope here is 30°-40°. The slope increases uphill. Some subcrop of whitish mudstone and some talus blocks of whitish mudstone.
19:30:17	3221	128	E	Steep face with mudstone.
19:31	3213	127	P	Another picture of blocks of mudstone which have come just slightly down this slope, very steep. They have rolled off of these outcrops and subcrops, no major mass movement, just breakage of blocks from the near vertical scarp above, which I can just barely see when we get the right angle. They have rolled down the hill.
19:32	3207	126	S	Coming to top of a steep slope, extensive grey-brown mudstone outcrop, extensive sediment cover.
19:33	3207	125	P	We are still coming up what is becoming a 60°-70° slope now as we approach the top. Out the port side I can just barely make out the top of the scarp with outcropping mudstone. The rest of the scarp is sediment covered with random blocks of mudstone. We seem to be approaching the top of this hill. Taking a picture of a 1 m high near vertical break in slope. It is the head of this mass wasting scarp, the slope is more gentle above that. On other picture taken looking down at the 1 m drop off where some blocks have come from. The slope above that is more gentle, 30° perhaps, with some mudstone clasts on it.
19:34	3203	095	P	
19:34	3201	093	P	Still coming up the very steep slope, we had a little break in slope, with about a 1 m drop off on the steep side, then the slope leveled out then the slope increased again. We are again

				getting some subcropping of mudstone sticking out here on the steep slope.
19:35:57	3197	097	E	Ripple marks on sediment.
19:36	3197	100	P	We are approaching the top of the hill now. The slope is starting to roll over and level out. Out to the port there is no outcrop or subcrop now. Essentially no mudstone talus. Fairly well bioturbated here, but not very well colonized by other animals.
19:36	3197	101	S	Heading uphill, current ripple perpendicular to subs tracks, ripple height several inches.
19:37	3194	090	P	We are just coming up to the top of the knoll now. I can see the top out the port. Another slight rise ahead of us. Fairly gentle slopes now, much more heavily bioturbated. It appeared to me that the current picked up, is that true? The pilot says we just increased our speed. Scratch that current bull. The area is not very well colonized by animals, it is fairly sparse. We have a hummocky terrain, now after coming up a little plateau the slope is increasing a little more. It does look bioturbated, but it is not very heavily colonized.
19:38:44	3190	090	P	We seem to be just about at the top of this from the view out the port. Flat bottom with a few stalked sponges. I can see a little bit of a rise off to the port, it goes up about 2 m above where we are now. A couple of sediment mounds around burrows with open hole at the top, too far away for a picture.
19:39	3189	095	S	Top of hill, sediment covered bottom, highly bioturbated mounds.
19:39:30	3188	115	P	Again we came over a flat spot and then up a steeper slope with some talus blocks of mudstone. Picture of some talus blocks with a stalked sponge, and maybe also in the field of view a stalked creature colonized by a venus flytrap.
19:40	3187		P	I see Sea Cliff tracks. There was one out the port and then another one just past it.
19:40:00	3187	114	E	Sea Cliff track(?) from dive 656.
19:41	3184		P	Still coming up the slope, it looks like we're getting near the top this time. It is rounding off after coming up another steep part.
19:42	3181	086	P	Now on a fairly flat sediment covered area, mounded, bioturbated, not too well colonized. (To pilot: Do you see any more hills or do you think we are at the top? Pilot: I think we are at

				the top.) I don't see any more hills in front of me. We seem to be at the top of the 3170 Hill right now.
19:42	3182	092	S	
19:43	3182	098	S	Heading for point H, travelling slightly up slope.
19:44	3182	090	P	Traversing across the top of the hill. Very flat sediment covered, somewhat mounded, not well colonized by organisms.
19:44:15	3182	098	E	Sediment covered bottom.
19:45	3182	090	P	Coming up on a slight knoll, but no significant change in elevation from our previous position. Sitting at the top of the 3170 Hill trying to get a range and bearing to the sulfide targets.
19:48	3181		P	Sitting on the bottom at, or very near the top of the 3170 Hill, waiting for a range and bearing to target H, which is a sulfide site on the south-west side of the 3170 Hill.
19:55	3178	094	S	Reached top of hill, course to H 130°, 450 yards.
19:56	3179	150	P	We just picked up off the bottom after communicating with the surface to get a range and bearing to target H. It appears that we have just crested the top of the hill. We are going to fly across the hill and try to pick up the sulfides on the other side.
20:56	3266		E	Rattail fish over sediment covered bottom.
19:57	3179		P	We are just passing a Sea Cliff track again, I can see it out my view port. Picture taken. Definite pair of tracks there, Sea Cliff skids.
19:58	3179	170	P	Cruising across the top of the hill.
20:00	3177	155	P	Flat sediment covered bottom, bioturbated, tracked (feeding traces), some pyramid urchin tracks with pyramid urchins at the ends of them, a few fairy circles, a few stalked animals.
20:02	3177		P	Cruising along a flat sediment covered bottom. I just watched a five legged star fish, white, about 10-15 cm in diameter, moving along the bottom at a fairly rapid pace for a star fish, throwing a couple of legs out in front, picking himself up and moving ahead, trucking right along.
20:03	3176	140	P	Flat sediment covered bottom as before. I've just seen a galatheid crab out in the distance, other than that just a few brisingids here and there, a rare urchin here and there, nothing unusual about the bottom population, not too many creatures.

20:05	3175	130	P	Just came over a slight depression, only 1 m or so deep, climbing up a slight hill now. Picture taken of a stalked animal with a venus flytrap growing right on the top of it.
20:07	3164	140	P	Still a flat sediment covered bottom, moving up a slight slope.
20:07	3173	139	S	Flat sediment covered bottom, bioturbated.
20:08	3172	140	P	Still traversing a flat sediment covered bottom. It may drop off up ahead.
20:09	3172	140	P	Still traversing a flat sediment covered bottom at the top of the hill. Taking a picture of a large brisingid with his arms up.
20:11	3119	135	P	Still traversing flat sediment covered bottom.
20:12	3172	150	P	Flat sediment covered bottom. A few brisingids rare holothurians, a few pyramid urchins, very little else, sparsely populated, pretty well mounded.
20:13	3170	155	P	.
20:16	3170	130	P	Still flat sediment covered bottom.
20:16	3171	127	S	Transiting flat, biologically sparse bottom, extensive infauna mounds.
20:16:45	3171	155	P	Mud covered bottom as before. Very slight ridge and swale type topography now. Only a few meters relief between the bottoms and tops of ridges.
20:17	3179	234	S	Hit end of mound structures, bottom drops away.
20:17:38	3172	110	P	There is a big fish. It looks like we have just now reached the edge. We have a very steep scarp going away in front of us. Just at the edge was a very large fish, almost 1 m, swimming into the current coming up over the top of that scarp. The hill is dropping away now, we have turned around to face back towards it.
20:19			P	Flying up off the top of the hill, we've come to the edge. We are going to fly up in the water column, fly out about 500 m towards the target H sulfides, drop down and then work back up the slope.
20:20	3170		P	We have just passed over the edge again, heading for H.
20:21	3168	045	S	In water column.
20:26	3168	100	S	Rising for position fix.
20:26	3169	120	P	We are flying out to target H. Well up in the water column, flying out off the edge of the hill trying to occupy the sulfide site on the south-west side.

20:36	3186		P	Still up in the water column. We are ending our traverse, about to make a bottom approach to go down and find target H, which our last control from the surface was at 200°, 100 m.
20:36	3186	238	S	
20:41	3236	490	P	On the bottom. Very strong current. (Pilot says current indicator says less than one fourth knot.) Very muddy bottom. We landed on a holothurian who is probably not very happy about it.
20:46	3266	349	P	We are just sitting on the bottom where we landed after making a bottom approach. It is a flat sediment covered bottom. A gentle slope in the general north direction. Bioturbated, not heavily colonized. We are sitting right on bottom, I can't see too much right now.
20:46	3342	349	S	Transiting to site H.
20:48			P	End of side one of tape. Turning tape over to side two.
20:48	3266	349	P	This is the start of side two, tape one port observer. I've just turned the tape over. We are sitting on the bottom taking some readings before heading on.
21:04	3266	050	P	We are going to pick up in the water column to get a fix, I'm going to try to get a description of the bottom as we pick up. Dusted, no bottom description.
21:15	3191	345	S	Holding at 300 feet off bottom.
21:20	3224		P	Ascent weights dropped, terminating the dive due to low battery power. Last picture taken on roll 2 was picture number 10. This is the end of the dive; The end of the dive program. Jan Morton, sorry you're not here, but we certainly thank you for the ground work you did to get this program going. We couldn't have done it without you, we appreciate it.
21:21	3227	211	S	Dive terminated due to low battery power.
			P	Recovery at 17:30 (local) 28 Aug., 1986

III. LOG OF HAND HELD VIDEO RECORDER TAPES

DIVE 658

Location: NESCA — Julian day: 235
Port observer: Zierenberg — Date: August 23, 1986
Starboard observer: Holmes — Pilot: Owen

Counter	Description
0-484	Inside of sub.
484-876	Sediment covered bottom.
518	Venus flytraps and anemones.
877-1050	Sulfide.
1050-1094	Water column.
1100-1184	Sulfide.
1184-1230	Sulfide.
1230-1240	Dark, inside of sub with lights off.
1245-1375	Sulfides out front view port, good picture.
1375-1435	Sulfides, unidentified animal runs away from sub.
1440-1480	Mesotech sonar.
1480-1515	Sulfides, good view of constructional mound.
1515-1535	Black.
1535-1570	Sulfide mound and talus, good picture.
1570-1580	Black.
1600-1650	Sulfides and black.
1650-1690	Sulfide talus, good picture.
1700-1842	Inside of sub during assent.
1824-1826	Sign-off, good picture.
1848-1890	Inside of sub with lights off.
1890-2145	Recovery of sub.
2150-2490	Tour of *Sea Cliff* on dock in Eureka.

Dive 659

Location: NESCA — Julian day: 236-237
Port observer: Zierenberg — Date: August 24, 1986
Starboard Observer: Wiltshire — Pilot: Bosshard

Counter	Description
0-77	Static.
77-150	Good picture of octopus on sediment covered bottom.
160-375	Sediment covered bottom and water column.
375-	Good picture of Sediment covered bottom.
432	Good picture of scarp.
470	Good picture of channels.
545-600	Mudstone talus on scarp, sulfides and animals at top, good picture.
635	Animals at top of mudstone scarp.
865-1045	Black.
1045-1070	Sulfide, large blocks.
1070-1090	White out, animal swimming by.

1090-1300	Black.
1300-1320	Sulfide and venus flytraps.
1320	Sediment covered bottom.
1381-1415	Scarp with venus flytraps.
1415-1470	Good picture of animals on sulfide.
1470-1480	Sediment covered bottom.
1480-1550	Good scarp, lithified rock then sediment covered.
1550-1565	Mudstone talus on scarp.
1570-1600	Dark.
1600-1625	Mesotech sonar.
1625-1645	Mudstone talus and animals.
1650-1785	Animals on sulfide.
1785-1825	Sulfide buried by sediment.
1825-1860	Sulfide, brown derby jellyfish.
1860-1870	Mudstone talus.
1870	Sediment cloud.

Dive 660

Location: NESCA
Port observer: Wiltshire
Starboard observer: Grocki
Julian day: 238
Date: August, 26, 1986
Pilot: Ruppert

Counter	Description
0-115	Dark.
115-570	Inside of sub, science training for Navy.
570-1540	Pillow basalt.
670	Good pictures of pillows.
1090-1150	Good pictures.
1270-1310	Good pictures.
1365-1370	Sheet flow crust, broken into plates.
1540-1590	Dark.

Dive 661

Location: SESCA
Port observer: Holmes
Starboard observer: James
Julian day: 238-239
Date: August 26, 1986
Pilot: Owen

Counter	Description
0-200	Dark, sonar display of transponder.
200-245	Mesotech sonar.
260-340	Cutting polypropylene line to release transponder to surface, line cut at 319.
340-380	Sediment covered bottom.
380-405	Black.
405-830	Sediment covered bottom.
830-840	Sulfide in sediment.
840-960	Sediment covered bottom.
960-1015	Sediment cloud.

1015-1020	Sulfide.
1020-1080	Sediment cloud.
1080-1135	Sulfide.
1135-1230	Water column and sediment cloud.
1230-1690	Dark.

Dive 662

Location: SESCA Julian day: 240
Port observer: Zierenberg Date: August 27, 1986
Starboard observer: Holmes Pilot: Bosshard

Counter	Description
0-130	Inside of sub.
130-330	Launch filmed out front view port.
340-380	Inside of sub.
380-390	Dark.
390-980	Inside of sub.
980-1045	Mesotech sonar.
1045-1300	Sheet flow locally cut by fissures, good picture.
1050	Fissure.
1112	Fissure.
1187	Fissure.
1250	Good picture of fissure.
1300-1445	Steep sediment covered slope with dredge track.
1390	Pyramid urchin crossing dredge track.
1445-1520	Sediment covered bottom, mudstone talus dropped from dredge.
1520-1585	Massive sulfide and animals
1570-1585	Good pictures of sulfide.
1585-1605	Dark.
1605-1850	Sulfide.
1790	Good picture of venus flytraps.
1850-2475	Sulfide and Sediment covered bottom.
2100-2145	Good picture.
2380	Good picture.
2475-2560	Mesotech sonar showing sulfide deposit.
2560-2625	Lunch.
2625-2635	Mesotech sonar.
2635-2700	Sediment and sulfide.
2700-2750	Basalt.
2762-2845	Sulfide? Sediment and basalt.
2845-3105	Dredge track in sediment.
3105-3125	Sediment covered bottom.
3125-3195	Sulfide.
3195-3350	Sulfide.
3233-3270	Sulfide chimney structure, shot out front view port, sampled by ramming basket into chimney, good picture.
3270-3290	Chimney sample in basket, good picture.
3390	Sulfide
3315-3350	Chimney, good picture.

3360-3620	Inside of sub.

Dive 663

Location: SESCA	Julian day: 240
Port observer: Zierenberg	Date: August 28, 1986
Starboard: Wiltshire	Pilot: Ruppert

Counter	Description
0-50	Sediment cloud.
50-180	Sediment covered bottom.
180	Sediment covered slope.
290-330	Good picture of dredge track.
400	Good picture of purple anemone.
440	Dredge track.
495	Sulfide, good picture.
545-680	Dredge track through sulfide.
680-695	Sediment cloud.
695-760	Sediment covered slope with mudstone talus.
760-770	Sulfide.
770-890	Sediment covered slope.
830-835	Rounded sediment covered hill, good picture.
890-930	Sediment covered bottom.
930-1100	Sediment cloud.
1105-1225	Sulfide.
1140-1160	Good picture of sulfide.
1180	Bacterial mat in water column.
1225-1380	Mesotech sonar, out of focus.
1380-1430	Sulfide viewed out front view port, sampling with edge of basket.
1430-1470	Sulfide out starboard view port.
1470-1480	Dark.
1480-1510	Sediment covered steep slope.
1510-1560	Flat sediment covered bottom.
1560-1605	Sulfide.
1605-1650	Sediment covered slope.
1650-1710	Good picture of sediment covered slope with mass flow apron.
1710-1720	Sediment cloud.
1720-1730	Sulfide with wine goblet glass sponge in distance.
1730-1755	Dark.
1760-1850	Near top of 3170 Hill.
1800-1815	Good picture of ripple marks at top of sediment hill.
1850-2311	Steep sediment covered cliff with outcropping mudstone.
2020-2060	Ripple marks.
2190	Sub tracks in sediment.
2311-2325	Sediment cloud.
2325	Dredge track? Sub track?
2325-2380	Flat sediment covered bottom.
2380-2405	Sediment cloud.
2405-2420	Sediment covered bottom.
2425-2440	Sediment covered bottom.

2440-2505	Inside of sub, dark.
2505-2510	Sediment covered bottom.
2520-2620	Inside of sub during assent.
2620-2884	Recovery, bad quality video.

IV. DESCRIPTION OF SULFIDE AND SULFATE SAMPLES

Dive-Sample	Sample Site and Time	Location and Depth	Sample wt. Hand Sample Description	XRD Mineralogy
658-R1	Site 1 18:28 to 19:44	X-58800 Y-55812 3265 m	0.65 kg. Three larger angular pieces up to 8 cm and ~20 smaller rounded pieces. Predominantly medium to coarse grained pyrrhotite and marcasite inverted from pyrrhotite, Cu-Fe sulfide fairly abundant, minor sphalerite, barite common. Outer weathering rind of Fe-oxide ~1 mm thick. Some samples were colonized by gelatinous biota, probably tunicates, which were sampled separately.	658-R1-4.1: Major barite. 658-R1-4.2: Major barite, sphalerite. Minor galena. 658-R1-4.3: Major pyrrhotite (hex.), isocubanite. Minor barite, sphalerite, lepidocrosite. 658-R1-4.4: Major sphalerite, barite. Minor galena. 658-R1-5-silver-grey euhedral xls: Major barite, sphalerite, pyrrhotite. Trace chalcopyrite.
658-R2	Site 1 18:28 to 19:44	X-58800 Y-55812 3265 m	5.4 kg. Oblong barite chimney ~25 cm long and 10 cm in diameter. The chimney is very porous and has radial texture defined by growth of dendritic to plumous barite aggregates growing outward from a small central conduit. There is a poorly developed concentric texture which can be seen more clearly by fluorescence under UV light. The central conduit has a diameter of 2-4 mm on the cut section at the base of the sample and does not breach the top. The conduit contains some fine clear yellow crystals of sphalerite, but the chimney is nearly monomineralic barite. The outer surface of the chimney has a 1-2 mm thick crust of sooty Mn-oxide and was heavily colonized by gelatinous biota,probably tunicates, and a few small sponges.due to alpha decay of ^{226}Ra incorporated in the barite structure.	658-R2-yellow xls from central conduit: Major sphalerite. Trace barite.

658-R3	Site 2 20:49 to 20:59	X-58862 Y-55375 3238 m	9.5 kg. Rounded talus block of massive pyrrhotite. The sample has irregular zones of porous coarse bladed pyrrhotite within more compacted zones of fine bladed to massive pyrrhotite. Some Cu-Fe sulfides and sphalerite are visible. The sample is coated with a 1 to 2 mm thick leathery orange to red Fe-oxide rind and was colonized by some biota.	658-R3-yellow Fe oxide: Major goethite. 658-R3-dark vitreous band: Major sphalerite, marcasite. Minor barite, natrojarosite.
658-R4	Site 1 18:28 to 19:44	X-58800 Y-55812 3265 m	2.7 kg. Four large flat slabs about 20 cm in diameter and a few smaller pieces of massive medium to fine grained pyrrhotite and marcasite inverted from pyrrhotite, with some zones of coarser blade pyrrhotite. Samples have an irregular 1 cm rim of very fine grained black friable sulfide and contain minor Cu-Fe sulfide, sphalerite and barite.	658-R4: Major pyrrhotite (hex.), isocubanite. Minor goethite.
659-R1	Site 3 03:34 to 04:24	X-58810 Y-57430 3322 m	3.5 kg. Massive sulfide chimney approximately 25 cm high and 10 cm in diameter. The upper portion is constructed of chimney walls of fine grained pyrrhotite. The irregular walls show that the fluid conduit changed location several times during the growth of the chimney. The fluid channel ways are filled with coarse grained porous aggregates of pyrrhotite plates. The outer surface of the chimney is an alteration rind of fine grained Fe-oxide. The base of the chimney formed at the sediment-water interface. The top layer is predominantly fine grained pyrrhotite. Below this is a layer composed predominantly of Cu-Fe sulfide. The bottom of the sample is mostly coarse pyrrhotite and secondary native sulfur. The bottom layer incorporates pellets of sediment composed of clay, quartz, feldspar and mica.	659-R1-Fe oxide: Major goethite (poorly crystalline). 659-R1-bottom of chimney, middle layer: Major native sulfur. 659-R1-bottom of chimney foot: Major native sulfur. 659-R1.1-sediment clasts in chimney base: Major native sulfur, quartz. Minor muscovite, sphalerite. 659-R1.2: Major sphalerite, pyrrhotite (monoclinic), native sulfur. 659-R1.3: Major isocubanite. Trace native sulfur. 659-R1.4: Major isocubanite, native sulfur. 659-R1.5: Major native sulfur,..Minor natrojarosite. 659-R1.6: Major sphalerite, native sulfur. Minor quartz.
659-R2	Site 1, 23:30 to 00:05	X-59000 Y-57934 3322 m	0.7 kg. Fragments of partially oxidized pyrrhotite-rich massive sulfide composed of medium to fine grained pyrrhotite with variable amounts of sphalerite, Cu-Fe sulfide and barite. Some samples incorporate sediment pellets and smell of hydrocarbon. Alteration phases include native sulfur, sulfates, and Fe-oxide.	659-R2-Mn-oxide on barite: Major barite.

659-R2-6	Unknown	Unknown	0.03 kg. Sample from rear skeg of submarine. Pyrrhotite and sphalerite with incorporated clasts of sediment.	659-R2-6: Major sphalerite, quartz, native sulfur, muscovite. Trace chlorite, Fe-sulfate?
659-R3	Site 3, 03:34 to 04:24	X-58810 Y-57430 3322 m	1.0 kg. Fragments of partially oxidized pyrrhotite-rich massive sulfide composed of medium to fine grained pyrrhotite with variable amounts of sphalerite, Cu-Fe sulfide and barite. Some samples incorporate sediment and smell of hydrocarbon.	659-R3-fine grained: Major sphalerite, marcasite, pyrite. Minor lepidocrosite. 659-R3-coarse interior: Major pyrrhotite (hexagonal). Trace marcasite. 659-R3-2-mud fragment in sulfide: Major quartz, sphalerite, pyrrhotite (monoclinic), muscovite. Minor plagioclase, chlorite. Sample 659-R3-9 is more similar in appearance to 659-R4 and may have fallen in to the sample basket with 659-R3 during sampling.
659-R4	Site 3 03:34 to 04:24	X-58810 Y-57430 3322 m	0.4 kg. Fragments of pyrrhotite-rich massive sulfide, generally less oxidized then 659-R2 or 659-R3. Fragments include a few pieces of small chimney tops with partially open fluid channels. Sl is common in some fragments.	659-R4: Major pyrrhotite (hexagonal), sphalerite. Minor isocubanite.
660-R1	Unknown	Unknown	0.006 kg. Small fragment of basaltic glass found in skeg of the submarine.	NA
661-R1	Unknown	Unknown	0.17 kg. Sample consist of 4 chips, each 2 to 4 mm thick and 2 to 3 cm across, with upper and lower surfaces of orange Fe oxide and a 1 mm thick black vitreous to metallic inner layer.	NA
662-R1	9:00 to 9:30	X-13549 Y-15550 3237 m	6.3 kg. Multiple fragments of a large, stubby chimney-like projection atop a massive sulfide mound. The sample broke apart when the sub surfaced. The outer surface is predominantly fine grained massive pyrrhotite. The interior is medium grained Po which forms porous comb-like aggregates, with interstitial Cu-Fe sulfide. Some fragments contain barite. The outer surface contains secondary Fe-oxide and native S.	662-R1-A-outer crust: pyrrhotite (hexagonal and monoclinic), chalcopyrite, sphalerite. Minor native sulfur. 662-R1-black interior ribs: Major pyrrhotite (monoclinic and hexagonal), chalcopyrite. 662-R1-I-interior barite: Major barite.
663-R1	Site 1, 18:00 to 18:26	X-12419 Y-13700 3246 m	1.2 kg. Fragments of porous and weathered, originally pyrrhotite-rich massive sulfide. Much of the material is altered to marcasite and Fe-oxide.	663-R1-3.1-inside crystalline lining: Major marcasite. Minor natrojarosite. Trace pyrrhotite. 663-R1-3.2-middle: Major marcasite. Minor natrojarosite. Trace pyrrhotite. 663-R1-4-red Fe-oxide: Major goethite. Minor hematite (poorly crystalline).

663-R2	Site 2, 18:49 to 18:51	X-12353 Y-13695 3246 m	0.5 kg.	Weathered, porous, Fe-stained, white rubble, predominantly talc with some Fe-oxide. One fragment was darker and smelled petroliferous.	663-R2-white: Major talc. 663-R2-Fe-Mn crust: Major goethite, gypsum. 663-R2-5-white: Major talc.

V. Thin Section Description

659-R2-B 98% dendritic and plumous aggregates, up to 2 mm long, formed of 0.1 to 0.3 mm prisms of barite which branch from and radiate around the elongate axis of growth. The cores are generally dark, probably metamict, with clear barite at the edge of the crystals. There are also some 1 to 2 mm platy crystals of barite which overgrow the dendrites. Some patches of fine granular amorphous silica(?), which has concentric, thumbprint-like texture which curves perpendicular (concave inward) to the direction of dendrite elongation. There are minor amounts of Py and trace amounts of sphalerite and chalcopyrite with some Fe- and Mn- oxides interstitial to the barite.

658-R3-A1 Predominantly massive pyrrhotite, compact, fairly massive with ~20% porosity, 0.3 to 0.7 mm grain size. Some fresh pyrrhotite remains, but the sample is highly altered to marcasite with some Fe-oxide. Isocubanite is fairly abundant as grains interstitial to pyrrhotite with grain size ranging up to 0.7 mm. Chalcopyrite is virtually absent except as rare lamellae in small grains of isocubanite and as very minor replacements of isocubanite grain edges. Sphalerite is common, but less abundant than isocubanite and occurs in a habit similar to isocubanite. There are patches rich in marcasite, with minor paragenetically late pyrite. The exterior edge of the sample is rimmed by intergrown botryoidal marcasite (80%) and pyrite (20%) averaging 1 mm thick. Outside of the marcasite band is a discontinuous layer of goethite containing some patches of crystalline lepidocrocite. The botryoidal marcasite cross cuts and overgrows some remnant pyrrhotite. Sphalerite is a more common near the weathered edge of the sample. Some of the sphalerite near the edge of the sample contains euhedral galena, which was not observed elsewhere in the sample.

658-R3-A2 Massive sulfide with ~25% pore space, 30% pyrrhotite, 40% sphalerite, and 8% isocubanite. Pyrrhotite occurs as 1 to 3 mm bladed crystals with abundant open space, and as 0.1 to 1 mm blades in the more compact zones of the section. The areas with finer grained pyrrhotite are mostly infilled with sphalerite. Pyrrhotite is about 60% fresh and shows abundant worm-like veins of alteration cutting irregularly through grains. These alteration veins have outer edges that are dull grey and grade in to very fine grained white marcasite replacement which accentuates the pyrrhotite cleavage. Some have a central core of crystalline marcasite. Sphalerite occurs interstitial to pyrrhotite and contains abundant isocubanite as inclusions, epitaxial overgrowths, and as incipient "isocubanite disease" replacements. Sphalerite also contains abundant pyrrhotite blades including very fine needle-like pyrrhotite which tends to have a weakly developed dendritic habit and has aspect ratios of >30 with grains that are often less than 5 microns wide. Isocubanite occurs both in sphalerite grains and as coarser grains interstitial to coarse

pyrrhotite. Isocubanite contains only trace amounts of chalcopyrite. There is also 1 to 3% paragenetically late marcasite which overgrows pyrrhotite. The exterior of the sample contains a botryoidal rim of marcasite which overgrows and replaces pyrrhotite. The marcasite rim is over grown by a rim of goethite. There appears to be traces of very fine grained arsenopyrite in pyrrhotite and a few grains of galena.

659-R4-1 Predominantly fine grained (0.1 to 0.3 mm) stubby pyrrhotite crystals cut by vein-like zones of coarse bladed pyrrhotite crystals up to 3 mm long. Approximately 60% open pore space. Pyrrhotite is very fresh with only minor alteration along cracks, but most of the pyrrhotite blades have a thin surface alteration coating of goethite. These goethite rims are generally thin, but near one edge of the slide there are areas of interstitial goethite with marcasite. Isocubanite makes up about 7% of the sulfide grains and occurs as coarse, anhedral grains interstitial to pyrrhotite. No chalcopyrite was recognized in this section, except as thin rims which appear slightly different in color under partially crossed polars. Isocubanite also has thin alteration rims of goethite. Sphalerite was not observed in this section.

659-R1-A This sample is from the base of the chimney near the sediment-water interface. The interior of the chimney (Zone 1) is coarse grained (1-4 mm) bladed pyrrhotite which has been nearly totally replaced by native sulfur. This portion of the sample is an infilling of the major fluid channel. There is ~10% interstitial isocubanite which occurs as subhedral 1-2 mm grains that contain minor intergrowths of chalcopyrite. Isocubanite is often rimmed and partially replaced by sphalerite. There are a minor amounts of pyrite and marcasite which occur as clusters of concentrically laminated colloform intergrowths. This interior zone is separated from the bulk of the sample by a 5 mm wide band of isocubanite (Zone 2). This band is concave into the center of the chimney and is subdivided into an inner zone (Zone 2a) and an outer zone (Zone 2b). Zone 2a is massive compact isocubanite. It is less porous than 2b, and the pores occur as relatively large voids. Arsenopyrite occurs as euhedral to subhedral included grains and is more common than in zone 2b. Arsenopyrite observed under the SEM contains inclusions of native bismuth. Small euhedral galena crystals are also present in this zone. The inner edge of Zone 2a is partially replaced by native sulfur with remnant patches of isocubanite. Zone 2b is more porous; locally the porosity is caused by small euhedral voids with cubic and occasionally rhombic cross-sections. Pyrrhotite inclusions are common in this zone, and there is some arsenopyrite. Chalcopyrite is more abundant in zone 2b than 2a, but is rare in both zones. The outer rim edge of the sample (zone 3) is similar to zone 1. It was composed of coarse-grained pyrrhotite with interstitial isocubanite and sphalerite. Zone 3a is still predominantly pyrrhotite, while zone 3b is mostly altered to native sulfur. Other then alteration the major

difference in the zones is a coarser grain size for zone 3a. Pyrrhotite in zone 3a contains some lamellar inclusions of chalcopyrite; native sulfur pseudomorphs of pyrrhotite in zone 3b also have floating lamellar inclusions of chalcopyrite. Isocubanite originally comprised about 10% of the sample, and is generally not altered. Isocubanite in this zone contains more chalcopyrite than in zones 1 and 2. Sphalerite is common (~3%) interstitial to pyrrhotite. Early formed sphalerite often shows isocubanite or chalcopyrite disease. Trace amounts of fine-grained arsenopyrite occur in this zone. Low birefringence Fe-sulfate and high birefringence Cu-Fe-sulfate (identified by SEM) occur interstitial to native sulfur, and there is a minor amount of goethite replacing pyrrhotite at one end of the slide. One area of the sample contains yellow hydrocarbon. Some patches of hydrocarbon have three dimensional network intergrowths of a thin, thread-like opaque mineral, probably pyrrhotite, that apparently grew in the hydrocarbon. They do not appear to be bacterial filaments; they could be bubble wall sulfide coatings.

659-R1-E This section was cut from near the top of the chimney. The sample is predominantly pyrrhotite with a strongly developed radial growth fabric defined by elongated pyrrhotite crystals oriented perpendicular to the chimney wall. There are bands of cross cutting isocubanite up to 1 mm wide which are generally concentric to the chimney wall. Theses bands locally replace pyrrhotite. Isocubanite composes about 5% of the sample and contains only minor chalcopyrite. There is 1-2% interstitial sphalerite, and a trace of arsenopyrite. The interior portion of the chimney is native sulfur, which pseudomorphs pyrrhotite. Both high and low birefringence secondary sulfate minerals occur with native sulfur. Isocubanite bands and interstitial sphalerite generally extend into the region of pyrrhotite replacement by sulfur without showing signs of alteration. Two regions of the sample consist of massive fine grained banded goethite and amorphous Fe-oxide.

659-R1-H This section was cut across the foot of the chimney and extends across the sediment-water interface. Zone 1 formed below the sediment-water interface and is composed of clay-rich sediment incorporated in a network of bladed pyrrhotite. There is approximately 60% porosity between the pyrrhotite blades. The pyrrhotite ranges from 0.5 to 2 mm, and the coarser grains are generally fresh. There are multiple 1 to 3 mm oval shaped void which are filled with yellow hydrocarbon. 1 to 2 mm pelloids of incorporated sediment also are stained with yellow hydrocarbon. The sediment pelloids are composed of clay with quartz and muscovite silt grains. Sphalerite is common interstitial to the pyrrhotite (~15%) and is generally anhedral. Galena is fairly common (~3%) as subhedral grains up to 0.02 mm, both with sphalerite and as inclusions in pyrrhotite. Goethite replaces fine grained pyrrhotite and occasionally sphalerite. Isocubanite, with minor chalcopyrite, occurs in only minor

amounts, usually in sphalerite, but also in pyrrhotite. Zone 2 is a semicontinuous band of isocubanite approximately 2 mm thick which formed near the sediment-water interface. There are trace amounts of pyrrhotite and arsenopyrite included in this band and trace chalcopyrite. Arsenopyrite observed under the SEM contains inclusions of native bismuth. Native sulfur occurs, predominantly as a pseudomorphic replacement of pyrrhotite, on both sides of zone 2. Zone 2 grades into zone 3 by increased intergrowth with pyrrhotite. Pyrrhotite grains were up to 3 mm, but have been completely replaced by native sulfur. Wispy lamellae of isocubanite include in pyrrhotite remain as floating inclusions in the sulfur. Interstitial to the sulfur are at least two sulfate minerals, one with high birefringence and one with low birefringence. Isocubanite is the dominant remnant sulfide in zone 3. Chalcopyrite intergrown with isocubanite varies form about 5 to 20% of the grain volume. Sphalerite is common in this zone and forms about 10% of the remnant sulfide. Sphalerite is intergrown with, overgrows and is replaced by isocubanite. There are trace amounts of galena toward the top of the slide. There are also 0.1 mm spheres of concentrically laminated pyrite and acicular blades of barite present at the top of the slide.

659-R2-6 The section marked 659-R2 was taken from this fragment. Zone 1 is a 1 mm thick layer of massive isocubanite which forms one corner of the slide. Arsenopyrite is the most common accessory mineral in this zone where it occurs as clusters of subhedral to euhedral crystals. Inclusions of pyrrhotite are rare and there are trace amounts of chalcopyrite, often developed along cracks. Zone 2 is predominantly massive pyrrhotite or native sulfur formed from massive pyrrhotite (zone 2a). The pyrrhotite in zone 2 is generally very fresh and occurs as a porous open network of blades up to 2 mm long. Some of the pore space contains hydrocarbons. Sphalerite is abundant (~20%) and galena is common (~5%). Sphalerite is generally anhedral and occurs interstitial to pyrrhotite. Sphalerite has inclusions of chalcopyrite and isocubanite and often has very fine web-like "isocubanite disease"; possibly also "pyrrhotite disease". Galena is often intergrown with the edges of sphalerite grains and is common as inclusions in pyrrhotite. Arsenopyrite is locally common as clusters of euhedral grains which often occur in short linear splays which cut across pyrrhotite. Loellingite was observed intergrown with some arsenopyrite by SEM. Some arsenopyrite contains inclusions of native bismuth. Chalcopyrite is more common than isocubanite and occurs as lamellae in pyrrhotite blades, and as edge replacements of pyrrhotite and sphalerite. A thin rim of chalcopyrite commonly separates pyrrhotite and sphalerite. Most of the isocubanite in the sample occurs in sphalerite as "isocubanite disease" replacements, but also as small inclusions with chalcopyrite lamellae and rims. Zone 2a is similar except that most pyrrhotite has been replaced by native sulfur. Arsenopyrite is locally common and appears to cross-cut other phases. Galena is not common except near zone 3. There

is a minor amount of fine grained goethite, and highly birefringent sulfate is common interstitial to and overgrowing native sulfur. Zone 3 is mineralized sediment with disseminated and vein sulfide. The sediment is mostly clay, generally as coarse sand sized pellets. Quartz and mica silt is common and much of the sediment is oil stained. Sulfide veins cutting the sediment are very similar to zone 2 except galena is more abundant. Most veins have fresh pyrrhotite, but they can be traced into altered veins similar to zone 2a. Sulfide minerals disseminated in the sediment include sphalerite, isocubanite, chalcopyrite, galena, and rare arsenopyrite and pyrrhotite. Most pyrrhotite is altered to marcasite and pyrite with goethite and some native sulfur and secondary sulfates. Sphalerite is the dominant sulfide. Some has grown in oil droplets and has the form of curving, branching, poorly developed dendrites. Galena is fairly common in zone 3, especially near the boundary with zone 2. Isocubanite and chalcopyrite are also common. Near the top edge in the center of the slide is a patch of alabandite. Some are the grains are subhedral and show both green and deep red-brown color in transmitted light. Other grains of alabandite are skeletal and appear to be the remnants of grains which have been partially dissolved.

659-R3-9 The sample is predominantly fresh pyrrhotite. The sample shows crude banding caused by preferential elongation of pyrrhotite blades perpendicular to alternating bands of medium to coarse and medium to fine grained pyrrhotite. Pyrrhotite is generally unaltered except for one corner of the slide where there is complete replacement by native sulfur with interstitial sulfate. There are 1 to 2% interstitial isocubanite with minor chalcopyrite, and 3 to 4% interstitial sphalerite. Sphalerite often includes isocubanite, and there is often a chalcopyrite rim separating sphalerite from isocubanite. There are trace amounts of galena, which are generally included in pyrrhotite. There appears to be some interstitial yellow hydrocarbon.

662-R1-A Zone 1 is the fine grained outer chimney wall. It is composed predominantly of fresh bladed pyrrhotite with ~5% sphalerite and ~3-4% isocubanite. Isocubanite is interstitial and subhedral and contains 10 to 15% chalcopyrite lamellae, more than most Gorda Ridge samples. Sphalerite generally occurs as late botryoidal overgrowths. It is dark orange and shows growth banding or twinning, but not color banding. Galena is common in the sphalerite as small euhedral crystals. Sphalerite preferentially overgrows isocubanite. Locally, the outer most wall of the sample is fine grained dendritic pyrrhotite overgrown by botryoidal sphalerite with galena crystals. There are some patches of pyrrhotite overgrown by goethite. Zone 2 is the comb like ribs of the interior of the chimney. They are composed predominantly of dendritic pyrrhotite. Fine grained pyrrhotite dendrites are especially well developed. Typically, a thin central spine of pyrrhotite with an aspect ratio >30 will be decorated with branching overgrowths of pyrrhotite. Coarser pyrrhotite is also generally dendritic, but occurs as large plates in subparallel

alignment which define the comb-like structure of the chimney interior. Isocubanite is more common (~5%) than in the chimney wall and has 10 to 15% intergrown chalcopyrite. Sphalerite is much less common than in zone 1 and galena is absent. Some of the finer grained pyrrhotite is overgrown by goethite. Marcasite is common (~5%) in zone 2. It occurs as late botryoidal masses 1 to 2 mm thick that overgrow all phases along the length of the pyrrhotite fingers and help to accentuate the comb structure.