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JD 278-288

CRUISE REPORT, SUBMARINE NR-1, OCT. 5-15, 1989

1. Ship name: Submarine NR-1, escort vessel, USS Sunbird

2. Cruise No. & Leg

3. Parent project: EEZ minerals

4. Funding agency: U.S. Navy

5. Funding amount: Navy cost . . . .$100,000+
USGS (travel funds, sampler cost)+or- $2000

6. Contract No. -

7. Start and end date: Oct. 5, 1989 to Oct. 15, 1989

8. Area of operations: Blake Plateau, 30.9 to 31.8^{0}N, 79.2 to 79.00W

9. Dates and ports: Start Oct. 5, Norfolk VA; end Oct. 15, Norfolk, VA

10. Chief Scientist: Peter Popenoe and Frank Manheim

11. Names and affiliations of scientific part: U.S. Geological Survey, Woods Hole, MA 02543

Submarine NR1

Ship's Captain: Lt. Cdr. Jay A. Wagner
Executive Officer: Lt. Sterling Greni
Chief Engineer: Lt. Cdr. Michael Matthes
MMC Mark Buckmaster
MM1 Kevin Giles
ETC Ray Wetmore
EM1 Jeff Fearn
Em1 Jeff Richards
ET1 Bryce Hart
MM1 Steven Smith
ETC Gary Hicks

Submarine Rescue Vessel USS Sunbird (ASR 15) Launched 1946, commissioned 1950, Length 251.4', displacement 2291 tons,, draft 19'6", max. speed 15 kn.

(partial roster) There were 82 Navy personnel aboard.

Lt. Cdr. Merrill C. Albury, Captain
Lt. Cdr. David Schmitz, Executive Officer
First Lt.(Ltug) Dobbs, Deck Officer
Lt. Wooda McNiven, Chief Engineer
LTJG Mat Bamrud, Salvage Officer

Ens. Steven Cox, Supply Officer
MS1 David O'Hara

12. Purpose of cruise: To study the deep scour pits on the northern Blake Plateau to determine nature of erosion or solution, the age and nature of the outcropping rocks; the nature of the biomass supporting large fish concentrations reported in this area; the thickness of phosphorite-manganese pavements over the Blake Plateau; the fracture patterns and their orientation; to visit the "Aluminaut Hole" and measure water salinity within erosional pits to determine possible presence of fresh water flow; to document the concentration and volume of manganese nodules and their occurrence. to determine if pavement underlies thin sand layer below nodules, or if pavement is discontinuous; to examine and groundcheck features seen on GLORIA long-range sidescan sonar mosaic; to measure current velocity, temperature and direction throughout area to determine the extent of south-flowing undercurrents have contributed to scour topography; to study the deepwater ahermatypic reef mounds.

13. Navigational techniques: Dead reckoning with digital computer, using ship's heading and ground speed from Doppler sonar or water speed, with accuracy of 1.5% of distance traveled; updating of dead reckoned position with transponder network from Loran and GPS on surface ship; obstacle avoidance with forward looking sonar 3-1500 yards (3 to 1370m) range and +/- 95o azimuth on CTFM (CTFM was not operating during this cruise due to electronic problems; therefore forward-looking sonar was available only in a vertical mode). . periscope TV camera with 350 azimuth coverage. * Viewport manning to report on starboard, port and forward topography.

14. Scientific equipment: view ports, incandescent lights, closed circuit television system, 10 underwater TV cameras, video tape recorder, 4 regular screens with two small enhanced screens fed to videotape machine along with date and time. Benthos 35mm external still camera with strobe light; 70mm external camera, (not working); viewport connection to provide external (powerful) strobe for hand-held viewer cameras; forward looking sonar (not working as noted above); 3.5 kHz subbottom profiler; manipulator arm, sample basket, sampling scoops (Sediment samplers were not placed into operating position in baskets because heavy seas (must be emplaced by divers); temperature-conductivity-salinity probe, Savonius rotor current meter; side-looking sonar.

15. Tabulated information:
Days at sea: 10 days (5 dive days)
Km of each type of continuous data:
Approximately 70 nautical miles (140 kms) were traversed in view of the bottom. Appr. 35 nm of the bottom were recorded on videotape. Appr. 50 nm were recorded with sidescan sonar. Appr 360 photographs of the bottom were made with hand held cameras; 633

pictures were taken with the external Benthos camera system.

Stations occupied: 9 stations preselected, 8 occupied.
Submersible dives: 3

6. Page-Size track chart: Appended as Figure 1.

STATION INFORMATION:

Dive 1: Area of Cretaceous outcrop. This dive was made to determine the nature of the bottom and if Cretaceous age rocks were exposed at the sea floor and could be sampled. Photographs of the area of bottom believed to be underlain by Cretaceous rocks within this same scour feature to the east suggested that the pavement was not extensive and that the bottom was composed mainly of calcareous sand and coral fragments. The GLORIA mosaic also showed the bottom in this area as being darker in tone than many other areas of phosphorite pavement (Fig. 3). The dive was to traverse the bottom and end at an area of bright return seen on the GLORIA sidescan sonar mosaic believed to be a scarp. We had hoped to obtain samples of Cretaceous calcareous siltstone of Maestrichtian and perhaps Campainian age for analyses.

Station 1
JD281
Date of occupation Monday, Oct. 8 1989, 11:50 - Tuesday,
JD282 Oct 9, 0700
Latitude/longitude ref. origin: 31o30N; 78o10'W
to end at 31o48.84' (11396) 78o26.99'(90863)
Water depth 2085'(636m) start within 100 m for duration of dive
Sampling device: mechanical arm
Number and type of samples: 2.

Comment: An attempt to sample a rock wall failed because the mechanical arm could not be deployed owing to wall-sub geometry. We found this to be true for much of the cruise. Slope areas where rock outcrops were observed could not be approached by the submersible, either because of strong currents, because the sub could not land on the bottom due to slope angle, or because the elevator-sample cage dug into the bottom as the outcrop was approached.

One phosphorite plate, about 10" across, similar to many plates observed in the area, was recovered at 1700 hours in an area of flat bottom and little current.
The second sample was recovered at 2100. This sample was white in color and fragile, and believed to be a sample of Cretaceous age rock, but possibly is only a fragment of cemented mongrel carbonate sand. It was recovered from an area of flat bottom in little current. An attempt to sample organic growths (sponge and brilliant yellow fan coral (check on species) failed because of breaking or slippage while sampling or placing in elevator.

Log Remarks and Notes: Transfer to NR1 from SUNBIRD in heavy seas 10:15, Oct. 8, 1989; towed to start of dive and began dive at 11:50. Landed on phosphorite -gravel and carbonate sand bottom with occasional slabs, some dendrophylla and alcyonarian coral, large sail-shaped sponges, large half-dish shaped and fan corals; also some funnel-shaped corals. Almost no current and visibility >50'. Slabs of pavement were about 1' and 3- 4" thick scattered 2-3' apart. Started traverse at 1300 across broken terrain with many scour holes 10m or more deep. Pavements draped down into holes as large broken slabs. Outcrop on side of holes seemed to be composed of layers of hard and soft material, each layer undercut by bio-or other erosion. Layers are about 1' thick. Each layer is stacked on lower layer.

Attempt at landing but sub slipped sideways down slope. On rising rear wheel caught on phosphorite slab and hung up. It came free when bow of sub was 18' off bottom. [note, need to check up on all flora and fauna]

En route to the scarp seen on the GLORIA mosaic we crossed a bottom with many phosphorite slabs and minor and minor sand and ooze. Sand was concentrated in the low areas, but even here projecting sponges suggested that pavement underlay sand at shallow depth. Stopped to pick up sample at 1700 and probed sand bottom with manipulator. Bottom only medium hard and manipulator went in two inches.

At 19:30 crossed steep topography and stopped to examine a circular hole with a tilefish ? looking out. Hole about one meter across and perhaps two meters deep. Smaller fish could be seen and several side caves were visible. A 3-4' eel-like fish (ratfish?) swam under a pavement ledge and two large wreckfish were seen. The steep topography was on the side of a scour hole perhaps 50 feet deep whose sloping sides were composed of what appeared to be layered cemented sand with a tan-greenish color. The cemented sand layers were undercut forming ledges, perhaps excavated by the fish. The softness of the tan-green bottom in this area was evident since the tilefish? was able to excavate its circular hole. Little pavement was seen on the sides of the depression. At 20:20 Sub developed thruster trouble and three fuses were found blown. These were replaced at 20:35.

At 2100 we stopped to inspect the bottom which appeared to be coral rubble, but scraping with the manipulator we found about 2" of sand above pavement just below the coral rubble. A squid sitting on bottom watched us. While on the bottom Frank took sample of cemented carbonate sediment. One piece broke off in early recovery attempts, revealing dark pebbles or inclusions. May be phosphorite aiding cementation.

Phosphorite plates lay around us like cowpies, and while on the bottom a wreckfish swam around the sub. Between 2200 and 2230 we passed over a flat and uninteresting bottom. It consisted mainly of sand, minor broken coral, and large sponges about every 10 meters.

At 2300 we crossed a ridge 40-50' high. Its sides were covered with large broken phosphorite slabs, some undercut. We could not get close enough to take a picture because of the steep rise and sampling was out of the question. Slope angle of ridge was measured from submersible. The transducers, measuring 125' apart, showed the bow at 13' and stern at 55'. This yields a bottom angle of about 22 degrees.

Monday 0100, October 9 we stopped at a flat bottom and tried to sample what appeared to be a cemented carbonate outcrop at the base of a 10' high rise. The bottom was chiefly coral rubble and a large horn-shaped coral fan, about 1.5 m across was directly below us. We rolled over to outcrop and tried to extend manipulator, but the slight rise in slope prevented arm from extending. We scraped bottom with claw and found clean carbonate sands beneath coral rubble. Took a number of pictures. 0200-0600 Manheim on watch, traversed to bright reflector on "Gloria image" where slope about 60' high found. Attempted to recover sponge (fingers broke off on upper part and we could not reach base), and bright yellow fan coral. Grasped coral front but first fronds broke off, then whole remaining organism slipped out of manipulator jaws as it was being placed into elevator. The ease of breakage of the coral poses question why organism survives high current bursts. At 0800, Oct. 9, we surfaced to be towed by Sunbird to Site 2.

General impressions: Most of the traverse was characterized by a relatively flat bottom, overlain by about 2" of calcareous sand. Sponges and fan coral projected through the sand at an incidence of 1 or two per 100 m2 or more abundant. Nowhere would the bottom be considered lush. On close inspection as when the submarine lay on bottom, we could discern a more numerous fine flora and fauna, including delicate transparent alcyonarian corals, hydroids, and sponges.

The sand was overlain in perhaps 30% of the area by coral rubble and fragments. When these were scraped away with the manipulator they made a crunching sound and clean tan sand was found underneath. This somewhat barren terrain was broken in places by both hills projecting 10-35' above the bottom, and large scour? holes into the bottom. Slope angles were steep. As one approached a hill cemented carbonate slabs would begin appearing. The sides of the hills were overlain by large cemented carbonate plates that conformed with topography like a pieces of a broken onion. The broken edges had a rough, random pattern. Most were undercut so that they created overhangs. Some were breached by tilefish holes and shallower holes, suggesting that the plates were relatively soft material.

The hills were capped by phosphorite gravel and some pavement. Steep topography did not permit the NR1 to sit on bottom and sample these slopes directly. When we tried to land on a gentle slope the sub skidded sideways. When we approached an outcrop

ead-on the slope angle confined the manipu
not able to extend it. On two occasion
phosphorite pavement projected 1/3 m above
that stretched out of sight on both sides of
ridges appeared to be fractures. Along the
coral and sponges were more abundant becaus
area for attachment. During the dive two Pep
plate, and a bag of trash were seen.

Station 2 31o47.5'N, 78o24.0'W. End of dive 1
scarp.

Dive No. 2. High-relief scarp and scour featur
Charleston Bump to sinkhole-like feature seen on G
foot of Charleston Bump.

Date of occupation: 1420, 9 October, 1989 to 0600
1989

Latitude/longitude: Sta. 1 31o 23'N, 78o41'W; Sta. 2
28'W; Sta. 3 31o 21'N, 78o 24'W.; Sta. 4 31o13'N, 78o
31o01'N, 78o18.2'W; Sta. 6 31o00.6N, 78o16'W (not achi

Water depths: start 643m to 517 to 680m. end 900 m. (s

Sampling device: claw.

Samples: One large slab

Remarks:

The purpose of this dive was to investigate a lar
depression that was evident on both the GLORIA sidesca
image and on seismic profiles from both the ISELIN 78-3
and the FARNELLA 87-5 cruise. The south wall of the
depression appears near vertical on seismic records (Fig.
ascends from depths of 680 m at its base to 580 m at its to
4). We had originally hoped to obtain samples of both Pal
and Eocene age rocks that outcropped on this cliff. Samplin
not possible, however, because steep topography and s
currents.

The continuation of the dive was to traverse an are
unbroken phosphorite pavement to a prominent scarp seen on
GLORIA image partway up the Charleston Bump (Fig. 2). Here m
sampling and observations were to be made.

The dive was then to continue to the foot of the Charlest
Bump where large, circular scour? features resembling sinkhole
were evident on both the GLORIA image (Fig. 2) and on seismi
profiles across this bottom. Here we were to investigate the
nature of the features to determine, if possible, their nature of
formation (scour or karst?).

Comments and log observations:

Station 1

We arrived at dropoff point at 1420 Oct. 9. On bottom at 15:30 at
1698 (517m) depth. One knot current from 285o. We observed a live
bottom, many corals and sponges. Bottom was sand with classic
phosphorite slabs. Small branching corals were abundant. Our

bottom position was 31o22.78N 78o38.67W'. Sitting on the bottom the currents varied from .5 to 1.0 knot, all corals were in motion. Proceeded on traverse and at 17:30 crossed scarp where the bottom dropped vertically over 40 meters. On passing the edge the submersible was buffeted by strong currents. On a rapid flyby the vertical cliff appeared undercut (Fig. 5). We circled several times to try to get a better view but because of strong currents ENE at 240o and velocities up to 2 knots we were not able to get close enough for thorough observations. On second pass we could see that the edge was undercut about 10 m. for as we passed our lights first showed a shadow then progressively showed deeper and deeper into the undercut. The undercut part of the ledge was seen on both viewports to pass beyond the field of visibility on both sides. The second time we passed a more rounded dropoff, followed by a vertical cliff of perhaps 15 m (fig. 5B). We attempted several other crossings, but there were very strong down-drafts and eddies, making the submersible difficult to control.

After deliberations with Lt. Cdr. Wagner it was decided that to come close to the cliffs in the strong currents was dangerous. The decision was made to proceed East to Station No.2. at 31o25'N, 78o28'W, a location near the base of the cliff, to try again, hopefully in less current. At 20:15'N, 31o23.83N and 78o35.06'we stopped and took pictures of a phosphorite slab-covered hill about 10 m high. We circled and tried to land the sub but a 1 knot current prevented us from landing. The hill was covered with broken slabs and phosphorite 1-2' thick and all sizes. In other areas unbroken pavement capped the hill. Near the base of one phosphorite-capped hill there was a ledge. We hovered about 5' above the surface and took a number of pictures. the overhanging outcrop seemed to have two phosphorite layers separated by cemented sand.
From 21:04 Oct 9 to 02:30 Oct. 10 we traversed at high altitudes to the base of the scarp at 31o24'N., 78o29W.

Station 2 At location 31o24'N, 78o29'W, depth 2110'.

Because of strong currents the pilot did not want to observe the scarp to the South, except at an angle where he was headed into the current. Proceeded toward Sta. 3. At 0300 we descended to near bottom to observe a slab 3 meters across, tilting out of the sand. 3 fish were observed beneath the slab, including an eel-like fish, and a reddish, large-eyed carp- like fish (probably an orange roughie), 2.5-3' long. Took pictures.

0345 ascended scarp. Near the base of the scarp layered cemented calcareous sands of tan color were breached and undercut creating shallow overhangs and caves. Many wreckfish in this area. At the top of the scarp there was a vertical drop of about 100', and a large overhang was observed beneath a hard layer that capped the ridge (fig. 6). The overhang created a cave about 30-40' deep. We circled in a 2 knot current to examine it. In places the top of the slope was capped with a 1' thick phosphorite layer. A slightly rounded slope covered with corals growing outward formed

an almost vertical wall. This descended to a second 1', dark layer, that was cut into a rugged edge crenelated like a jig-saw puzzle (fig. 7). The solution-riddled appearance of this second ledge suggested that it was not phosphorite, but may have been a siliceous limestone layer (see fig. 7). This second layer was deeply undercut and underlain by tan, calcareous sand.
Here, a difference in depth of over 400' was measured between the bow over the cliff and the stern of the submersible over the abyss. The second ledge was undercut 10 to 20m. Wreckfish were also observed in this area.

General discussion. At Station 2 the bottom was mainly calcareous sand with scattered phosphorite slabs. As we proceeded southward and approached the base of the scarp large phosphorite slabs lay broken on the sea floor. Above these broken slabs the slope was underlain by onion-layers of gray-greenish cemented carbonate sands, forming overhangs crevices and holes. These were occupied by wreckfish and other fish. Farther upslope large undercuts on the slopes were excavated from material that had the color of uncemented calcareous sand. Two hard and extremely rigid and unfractured layers capped the slope; the top layer was no doubt phosphorite, and the rigidity of the second layer suggested phosphorite, but its crenelated and solution-riddled edge suggested that it was composed of some other material. We did not observe a similar crayon edge on any phosphorite layer during the dives. The extent of the overhang showed that these rigid were very strong and rigid layers. The two hard layers were separated by a partly lithified layer, probably in- situ outcrop of cemented calcareous sand. This intervening strata was about 10 feet thick and strong enough to form a steep slope to which corals could attach.

During ascent of the slope a strong downdraft was encountered near the top, which the submersibles's thrusters could not overcome. In order to have positive buoyancy against these downcurrents, the vessel had to pump out water ballast of over 1000 pounds.

Seen from the edge of the cliff, the abyss below was a gray-black void, where no bottom could be seen. The water masses at the cliff face varied considerably in transparency, partly depending on current velocity. This was probably due to sands being swept across the bottom and over the cliffs edge.

Station 3 31o 21'N, 78o 24'W. A point at the top of the scarp from we began a transit to Sta. 4.

At about 06:30 On Oct. 10 we began the traverse down the south flank of the Charleston Bump, maintaining a height over bottom at about a 30-35'. En route to station 3 we observed a linear feature on our side-scan sonar, and stopped to investigate it **(A)** The feature consisted of an area where the phosphorite pavement, two to three feet thick, abruptly terminated (fig. 8). Below the termination the bottom dropped about 50'. Broken slabs several meters across lay downslope and at its base. The phosphorite cap was undercut to six feet or more and a cemented layer projected out of the overhang about 1/3 of the way downslope. This also was undercut six feet or more. The subbottom profiler indicated that a second very hard layer, probably phosphorite pavement, underlay the unconsolidated sand at the base of the slope.

At 0800 we passed a similar termination of the phosphorite pavement with a 90' dropoff(**B**). We did not stop to investigate this area but on crossing it with the 25 kHz subbottom profiler it was seen to be similar to the 0630 stop. A recording was made of the subbottom profiler record on the videorecorder.

At 31o19.57'N, 78o26.37'W at 1750' we started passing by a number of squid, past several other pavement terminations at 0941. A sharp temperature and change in current occurred about 1007 at 1840-1875' depth. We lost one knot of current (from 1.5 knot), gained buoyancy and rose to 1779. Five minutes later conditions changed and the sub dropped to its former depth. Current changed again at 2153' depth, 31o16.4N, 78o23.3'W. We lost one knot of current and our crab angle (sideward drift) went to zero. Another sharp break in slope was observed at 31o16.24'N, 78o28.15'W .
At 1035 we regained 30o crab angle and currents returned to about 1.5 knot as they had been for much of the traverse from 0941.In the above current drops we must have been in the current shadow of a bathymetric feature.

<u>Station 4</u> 31o13"N, 78o20'W, Depth 725m

At 1022 we arrived at the large scarp observed on the GLORIA image (fig. 2), where we indeed observed a large scarp capped by phosphorite pavement. We started to investigate but because of strong and unpredictable currents created by the steep topography could not get close. Since this scarp appeared to be identical to those previously investigated and differing only in height, we continued the traverse southward.

At approximately 1130 we inspected a scarp at 31o13'N, 78o20'W. The scarp was similar to those previously described but the phosphorite blocks lying on the slope were much more massive (2' or more thick), and were well rounded. We landed on a bottom of sand and phosphorite cobbles. Current was .5 knot from 315o. Took many pictures. While on the bottom an approximately 8 thresher-type shark passed just below our viewports.

<u>Station 5</u>. 31o01'N, 78o18.2W (approximately)

We arrived at station at approximately 1900-2100 (check). This location was a prominent "sinkhole" - like dish seen on the GLORIA mosaic (fig.2). We descended to near bottom (<u>check</u> depth) to try to delineate the bottom and sides of the feature. The bottom was very rippled iron-stained sand. A few (very) phosphorite slabs lay on bottom. The bottom had a number of small ledges, about 1 m. high, of what appeared to be cemented carbonate sand outcrop. Downcurrent there were brighter rippled sands, along with areas of outcrop that appeared whitish and were composed of clay-like material and orange-red-brown material. We searched for the feature seen on the GLORIA image, but could not find it. We determined that we must be in the wrong location.

Station 6(not achieved). 31o00.6'N, 78o16.0'W.

The decision was made to proceed to a second sinkhole-like feature (as noted on GLORIA mosaic, fig. 2)(Station 6). We turned in that direction. En route we encountered a sharp rise of about 20 m. Climbing this rise the floor flattened somewhat and appeared underlain by a white clay-like material. About 500 meters SE we encountered a second steep rise of 20 m. Topping this rise another bench and third rise was encountered. We circled to align the submarine with the current. The rise that we were crossing was in definite steps.

In retrospect, we probably had landed in the center of the sinkhole-like dish seen on the GLORIA mosaic at Station 5, but because of the enormity of the feature, did not recognize it as a depression. The GLORIA image indicated that the depression was about 3 km across. In traversing the feature, we saw no evidence of karstic units, other than many semi-circular ledges on the bottom. The steps encountered en route to Sta. 6 must be the sides of the feature centered at Sta. 5. They consisted of a series of steps composed of whitish, rounded material without any sign of "onion-layering", overhangs, or phosphorite plates.

We proceeded towards the second sinkhole at 2115, October 10. At 2150, however, the Captain informed us that there was not enough reserve air in the submarine to reach the depth of the second sinkhole. We decided to return to the first sinkhole location (Station 5) to map it in more detail and find another edge. At 2300 we bottomed the submarine in a field of dark brown, iron-stained, rippled sand that appeared to be consolidated in large part. The ripples looked distinctly relict. This is the same sand we had believed to be lithified when we observed it to be overlain by drifted lighter-colored sand. In order to determine the bottom hardness we backed the sub on its wheels across the bottom and examined the track. The wheel left tracks up to 3 inches deep. The dark sand was not lithified. The iron-stained color was a surface coating on the top layer. Light-colored tan sand underlay the surface.

Areas near this location recorded a distinctly reticular bottom on the sidescan sonar. This pattern was found to be caused by 1-3' high tan sand waves having a barchan-like shape. These extended over large areas of rippled, iron-stained sand and were recorded on the videocamera.

At 2358, Oct. 10 we prepared to recover a phosphorite slab with the retrieval claw of the submersible. This consisted of traversing the bottom in a northwestward direction until a suitable area of phosphorite boulders and slabs was found, selecting a target, and descending for a pickup. Unfortunately, currents arriving from a southwesterly direction at speeds of about 1 knot or more frustrated efforts to recover slabs at 3 different locations. Finally, at about 0400, Oct. 11 a 2x3x1' slab was successfully retained after two unsuccessful passes and gathered securely to the submersible. From its dark black color and highly rounded shape the slab was indicated to have a phosphorite nucleus thickly encrusted with ferromanganese oxide.

In order to find the western wall of the sinkhole-like feature we proceeded westward at about 0500, Oct. 11 for 1.5 - 2 miles. Along this traverse we were unable to find significant relief other than a rise of about 50' near the end of the traverse. At 0735 we began surfacing for the tow to the Aluminaut Hole (Dive 3).

Dive 3, The "Aluminaut Hole" and "wreckfish hole"

Date of occupation: Oct 11, 1620 to Oct. 12, 0730
Latitude and longitude: 31 17'N, 78 55'W
Water depth: 630 to 500 m

Remarks:
The purpose of this dive was to investigate the area where the submersible ALUMINAUT had experienced a loss of buoyancy while traversing a depression on the Blake Plateau. The loss of buoyancy reported by the ALUMINAUT was believed to have possibly been due to a submarine discharge of fresh or brackish water (Manheim, 1967). A previous dive in 1967 with the submersible ALVIN (Milliman and others, 1967) had failed to find the "hole".

Fishing boats were recently reporting large wreckfish catches in this same area and south of this area along a sharp dropoff of 50 fms in .2 miles (reportedly catches up to 6,000 lbs/boat/day). We hoped to establish whether a submarine discharge was present, and whether it may be influential in the support of the biomass on which the wreckfish feed, and to determine the habitat of the wreckfish. We also wished to observe and sample outcrops of strata on the steep scarp south of the Aluminaut hole. and determine its origin and nature.

Station 1 31o17',78o55'W. Depth appr. 640 m

On bottom 1620, October 11, approximately one mile from the published coordinates of the Aluminaut Hole. The bottom is 90% rippled iron-stained sand. When the submersible rolled over it with the wheel we left a track m one inch or less. Cobbles run over by the wheel were also not pressed far into the substrate, indicating that the unconsolidated sand layers are thin. Scattered phosphorite slabs, 1-2" thick and 1' across were scattered over the surface like cow pies. These were dusted over with ooze. The currents .1 to .2 knot on the bottom.

1810. We traversed chiefly sand bottom with scattered coral and sponges, with occasional slabs. One large phosphorite ledge protruded up to 2' from bottom. It extended as far as the eye could see to either side. The bottom was almost featureless on sidescan sonar.

2340 As we approached the Aluminaut hole we crossed a ledge of broken phosphorite pavement and blocks perhaps 10 feet high. The ledge was undercut and both it and the broken block area were inhabited by wreckfish and other fish. Manheim, looking from the port viewport counted 25 fish in sight. About 16 were wreckfish and the remainder were "redfish"(probably orange roughies) and other undefined species. Water clarity was excellent, with visibility at least 40'. Popenoe saw about 10 fish from the starboard viewport.
At this visit current was about .5 knot.

Station 1 Aluminaut Hole

We arrived at the published location of the Aluminaut Hole and found no bottom relief. Sidescan sonar showed a featureless, flat bottom. We turned into the current and went southwestward toward a location where a steep scarp was suspected from the bathymetric chart, a distance of about 1.5 miles. On the traverse the bottom became progressively deeper to a depth of over 2100'[check], and was featureless sand with scattered corals. About 1.5 miles from the Aluminaut location the slope increased upward. Soon we saw a sharp rise in the forward sonar, and grayish cemented sands projected in overhangs, layer after layer upslope (see fig. 9). Wreck fish as well as orange roughies? were abundant along and under the overhangs. We rose about 150' to a bench, traversed the bench to another rise, another bench, and finally crossed a phosphorite cap layer, which projected outward from the cliff and overhung the slope by up to 30'. Wreckfish were abundant here also. We took many pictures on the way up. A second hard phosphorite? layer occurred about 10' above the big overhang. We followed this back to another point on the cliff edge where the two phosporites merged into a near- vertical dropoff. We measured the partial cliff height with the submersible and found the drop to be 90' in the length of the sub (125'). Here also the merged phosphorite formed a large overhang with a deep excavation underneath. We had climbed approximately 400' from the base of the cliff. In order to make sure that we had reached the top of the cliff we traversed southward for .5 mile, without encountering additional relief. Currents were approximately 1.5 knots from the southwest.

Returned to the "Wreckfish Ridge", near Aluminaut Hole, Sta. 1, and followed it somewhat more than 0.5 miles south and north. In all cases we found a single undercut phosphorite layer and large broken blocks and plates lying on the slope below the ledge (to 30'), along with many wreckfish, orange roughies, and other fish. This traversing continued until 0400, at which time we returned to the Aluminaut location to survey more to be sure we had not missed a hole. We began surfacing and concluded the dive about

0730, October 12. We did not record and salinity or temperature anomalies or significant bottom relief during any traverse.

Current discussions.

Bottom currents are one of the most prominent features of the Blake Plateau, having shaped most of its present topography. The following discussion utilizes the available data and assistance from Commander Wagner in recreating observed current phenomena during traverses across the bottom and ascent of prominent scarps. In general, the observed currents varied between 0.1 knot and 2.5 knots. Source directions included East, South and West and all points between. We found that the coral on the bottom usually faced into the observed current, which implied that the currents we saw approximately correspond to long-term trends. The same was true to a considerably lesser extent with ripple-marked bottoms, the trend of the ripples being perpendicular to observed currents. There was no evidence of southward-flowing countercurrents.

Topographic steering of currents was a prominent phenomenon. On occasion currents of .5 knot were amplified to 1.5 knots by small topographic features. The following provides examples of this current activity, recreating current observations by Cdr. Wagner while climbing the large scarp at Dive 2, Station 3 to 4, and the large scarp south of the Aluminaut Hole, Dive Site 3, Station 1.

At Dive 2, Sta. 3 to 4 we climbed a large scarp (see schematic Fig x)running from 90o to 270o. Some distance from the base of the scarp currents were from the southwest (roughly 225o) at about 1 knot. As we approached the scarp currents swung to 270o. The submarine had to change its orientation to face this direction in order to maintain its position. As we approached the top of the scarp a strong downdraft was felt by the submersible, as noted in previous discussion. At this point the submarine's upward thrusting screws could not overcome the current, and it was forced to release about 1000 lb of water ballast in order to rise above the scarp. At the top of the scarp currents swung again to the southwest at about 1.5 knots. Considerable turbidity was noted just below the edge.

At Dive Site 3, climbing the scarp to the south of Station 1, the scarp again ran about E-W. Currents were from 190o at 1.5 knots below 2100'. As we approached the scarp the currents swung to 90o, 180 degrees opposite what they hade been during dive 2, about 30 kms east of us. At a ledge at 2100' currents swung to 110o, and as we topped the scarp at 1700' currents swung back to 180o. A strong downdraft was also experienced near the top of this cliff.

In addition to the major current activity described above, sharp minor fluctuations, both up and down, were apparently caused by the rudder effect of ledges and overhangs on major currents.

SUMMARY AND CONCLUSIONS

The NR1 dives contributed to resolution of several outstanding scientific and resource questions.

1. Aluminaut hole and "fresh water discharge"

The Aluminaut submersible traversing the Blake Plateau in 1966 suddenly lost 1000 lbs of buoyancy on crossing an approximately 50 m deep depression in the vicinity of 31o17', 78o55. The general depth in the area was described as 510 m. The submarines personnel assumed that the loss of buoyancy might be due to freshwater discharge as they entered a sinkhole. At a time very close to the Aluminaut's cruise fresh water was confirmed deep beneath the sea floor up to 120 km off Jacksonville in Deep Sea Drilling Project coreholes. Thus, the fresh water hypothesis, though problematical far out on the Blake Plateau, gained a measure of credence. The Alvin expedition of 1967 had as one if its goals the confirmation or denial of fresh water influence in the Aluminaut location. Dive 200 landed near the reported coordinates but no fresh water was found, nor was a sinkhole found.

The present results show clearly the probable events in the Aluminaut case. There is only a flat ocean floor in the reported Aluminaut location, as already noted in the Alvin dives of 1967 and our dives. Water depths in the reported area of the Aluminaut hole are greater than 600m, almost 100 m greater than the ambient depth of the hole reported by the Aluminaut. However, the type of topographic feature noted by the Aluminaut at the correct water depth is found 1.5 miles south of the reported coordinates at the east-trending scarp that we traversed on Dive 3. From these observations it is apparent that the Aluminaut's coordinates were in error by 1.5 miles, and the east-trending scarp we traversed on dive 3 was the feature traversed by the Aluminaut, across which they lost buoyancy. As the Aluminaut crossed over the lip of this cliff, they encountered the same downdraft currents that we encountered on our dive. Their consternation can be understood, for below them was only a gray bottomless void. By discharge of much ballast, much like our discharge noted above, they regained buoyancy against the downdraft.

2. The Blake scarps and their danger to submersibles.

If the Alvin in its 1967 dives had landed on the scarp its power might not have been sufficient to overcome either the scarp following currents or the downdraft, since the vessels had only about a 1.0 knot forward speed at that time. This might have been a dangerous situation indeed. Though not immune to risk in this kind of terrain, the greater forward speed (2.5 - 3 knots) and essentially unlimited ability of the NR1 to sustain maximum power output from its nuclear reactor gives it a special advantage in maneuvering in strong current conditions.

3. The fish "holes"

State fishery officials from South Carolina and Georgia have acknowledged discovery by fishermen of small holes in the Blake Plateau near the Aluminaut "hole" where dramatic catches of fish, primarily wreckfish, have been recorded. The main area has yielded up to 60,000 lb. (this figure seems excessive from what we saw during the dives but was the figure obtained from Glen Ulrich of the S.C. Wildlife and Marine Resources Dept., Charleston) of fish per day. Although temporary Navy restrictions precluded our visiting a site of large wreckfish catches whose location was furnished by the Georgia Dept. of Fisheries, the data from our cruises help explain how such extraordinary fisheries resources could have been developed and where they are found.

First, the recorded "fish" hole is not a hole at all, but represents an approximately 15 mile segment of scarp, a sharp linear feature, where the sea floor suddenly drops from a local depth of about 500 m to more than 600 m. Our data show that the scarps have near-vertical drops and generally feature overhangs of phosphorite pavements and cemented carbonate sediment, and slabs, all festooned by corals, sponges, hydroids and other organisms. The overhangs and associated caves and complex surfaces are the principal habitats for larger fish, primarily wreckfish of great size, but also orange roughies and tilefish and other smaller species. At one remarkable site (Dive 3, Sta. 1) about 30 fish were counted along a linear segment of about 50 ', having a height of only 10-20'. Although extrapolation of such populations to larger areas may not be valid, average weights of up to 30 lb per fish and common sighting of fish of one hundred pounds or more, make it easy to sea how yields of many thousands of pounds of fish per day could be achieved over longer segments of the ridge.

Although the Blake scarps can be seen to have a important fishery potential, we must recognize that unlike halibut, haddock and other ground fish, the wreckfish and orange roughie are a reef-type species, i.e. are bound to a specific bottom habitat. When a population is fished out, there is little migratory spawning stock that can renew it within a few years, and the fishery is essentially destroyed. If wreckfish are like other members of the bass family in longevity (grouper, jewfish, etc), the larger fish that we observed are probably 10's of years old. It would therefore appear to be essential to establish some kind of management system quickly. Otherwise, the scarps can become a one- time bonanza for a few years, with their fishery resources and potential resources denied to future fishermen and fish-loving consumers. The beauty of these spectacular natural features is also properly accompanied by their residents, the wreckfish and their associated species.

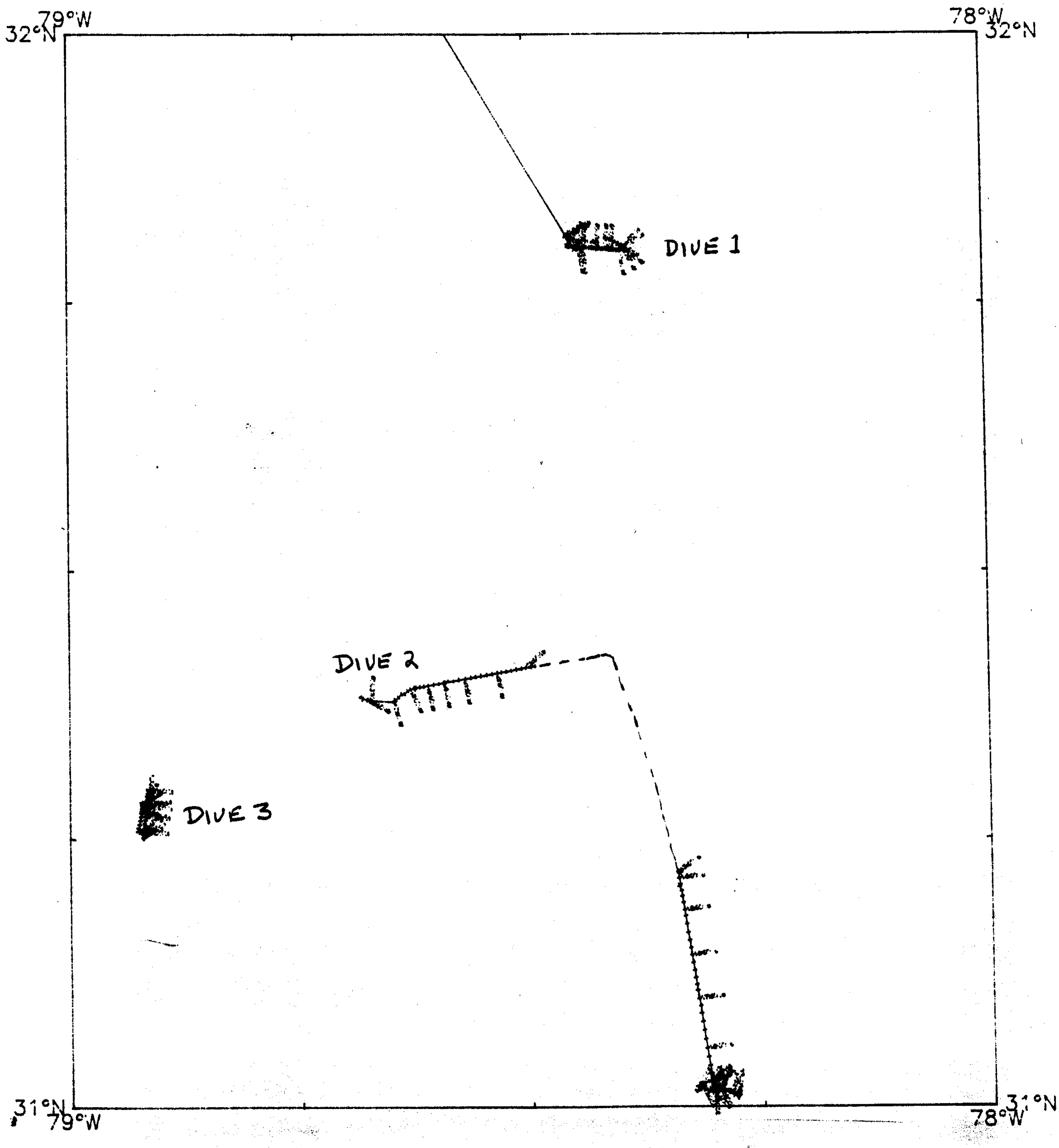
4. Origin of the pavements and plates

One of the major questions hoped to be illuminated by the NR1 cruise was the thickness and extent of the phosphorite pavements on the Blake Plateau. Previous investigations have been frustrated by inability to penetrate the hard pavements.

The first major observation was the wide extent of scattered plates small pieces, boulders up huge slabs, and continuous unbroken pavement, often covered over by thin blankets of soft sediment. In some areas soft sediments were unbroken by the darker phosphorites, and there were no corals, whose presence might suggest a hard attachment surface at a shallow depth. However, here too, subbottom profiler indicated a hard substrate. Thus, in conclusion, the phosphorite is assumed to be ubiquitous in the areas investigated, but the pavement is not necessarily continuous.

The second major observation was that there are multiple layers of phosphorite pavement. At the major scarps at least two hard and rigid layers could be observed in the upper parts of scarps in Dive 2 and Dive 3, each layer being from 1 to 2' thick. However, one layer was also observed at the large scour depression north of these scarps at a much lower elevation. The unbroken character and continuity of this topographically lower phosphorite pavement suggests that it was not broken off from the upper scarp level at an earlier erosional period, but was deposited on an already dissected erosional surface, separate from the uppermost phosphorites. The onion layering observed between Station 3-5, Dive 2, also clearly showed that there were multiple extremely hard layers, probably phosphorite, separated by unconsolidated sands.

Figure 1 - Track Chart



TRACK CHART NR-1 DIVES 10/8-12/1989

Figures 2, 6, 8, 10
are photocopies of
photographs and are
too poor quality to scan

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Figure 3, 3.5 KHz record near Dive 2, Stations 2 to 3 (from Farnella 77-5 cruise) showing Scarp traversed by the submersible. General bathymetry of the scour depression is shown on Fig. 4

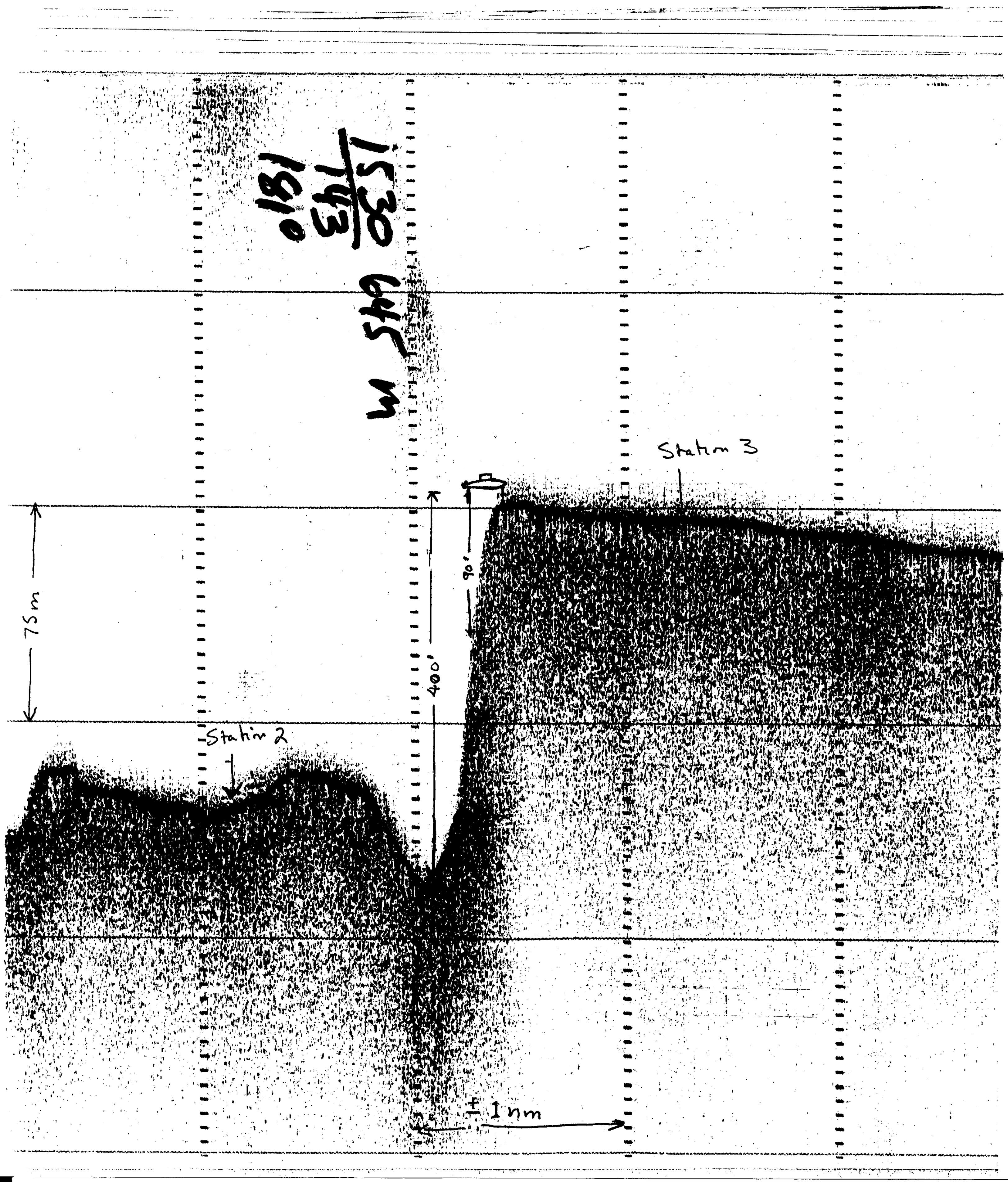


Figure 4

Location sketch map, Dive 2 showing the scour depression traversed by the submarine in stations 1 through 3, and stations 4, 5, and 6

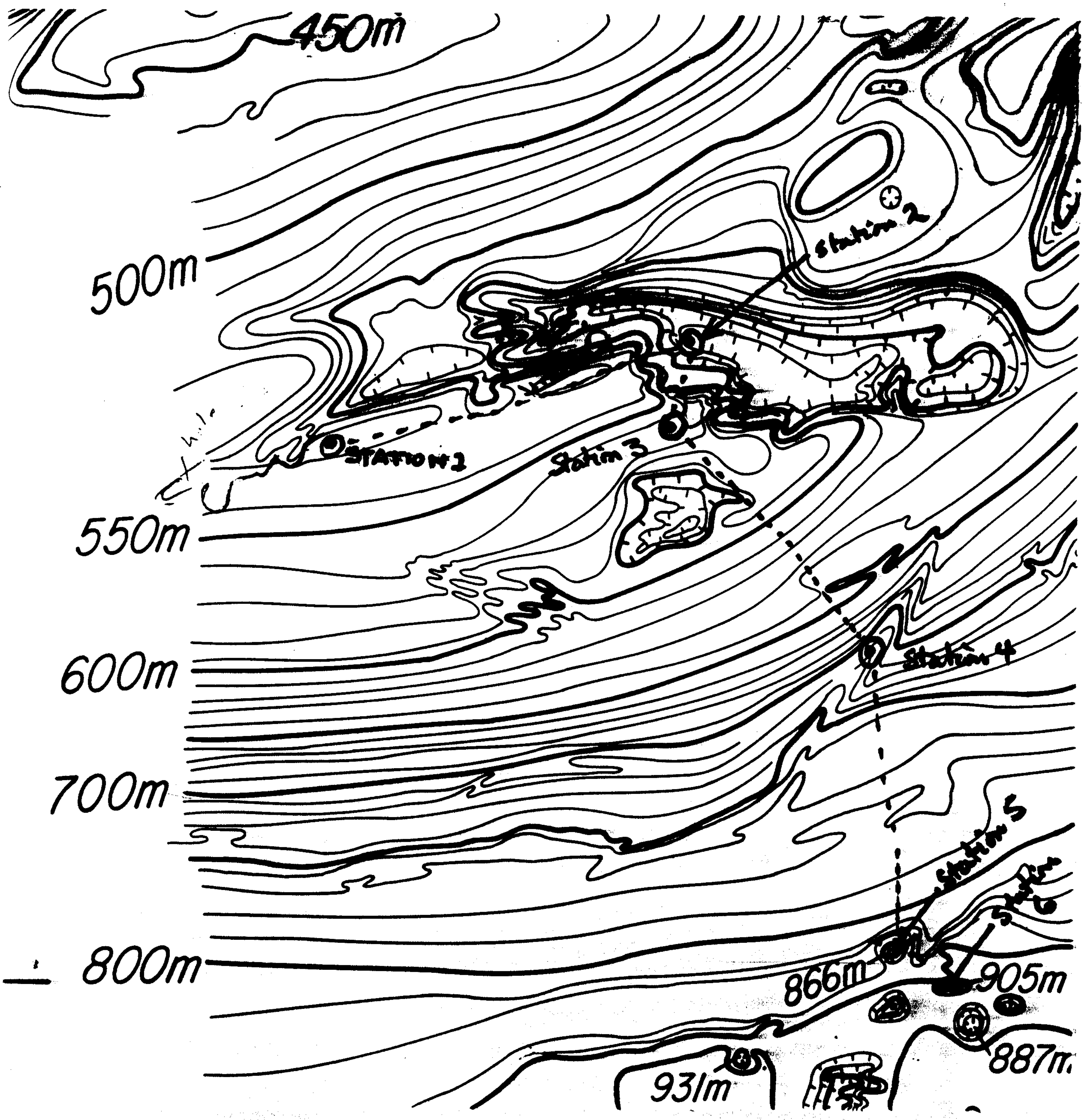
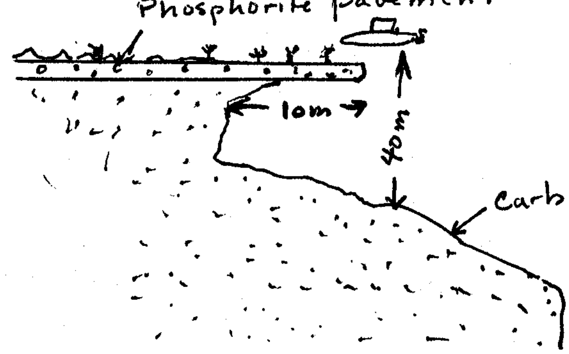


Figure 5 Sketch of 2 crossings of the Scarp edge near Station 1, Dive 2

5A



5B

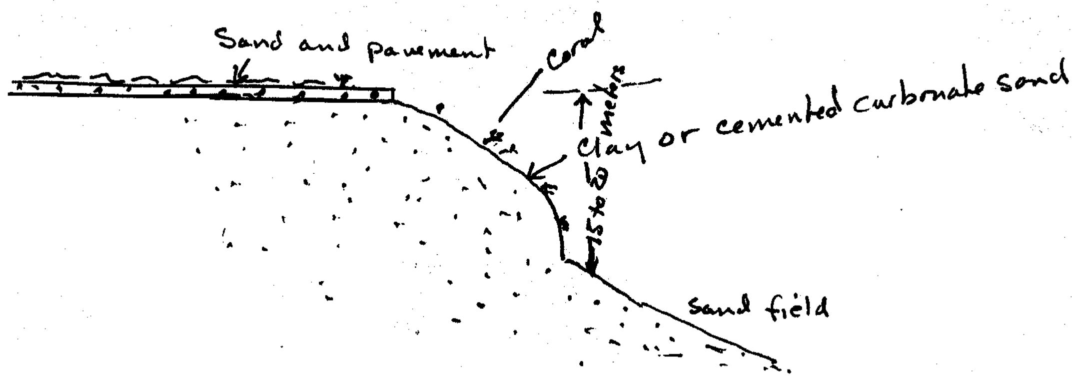


Figure 6

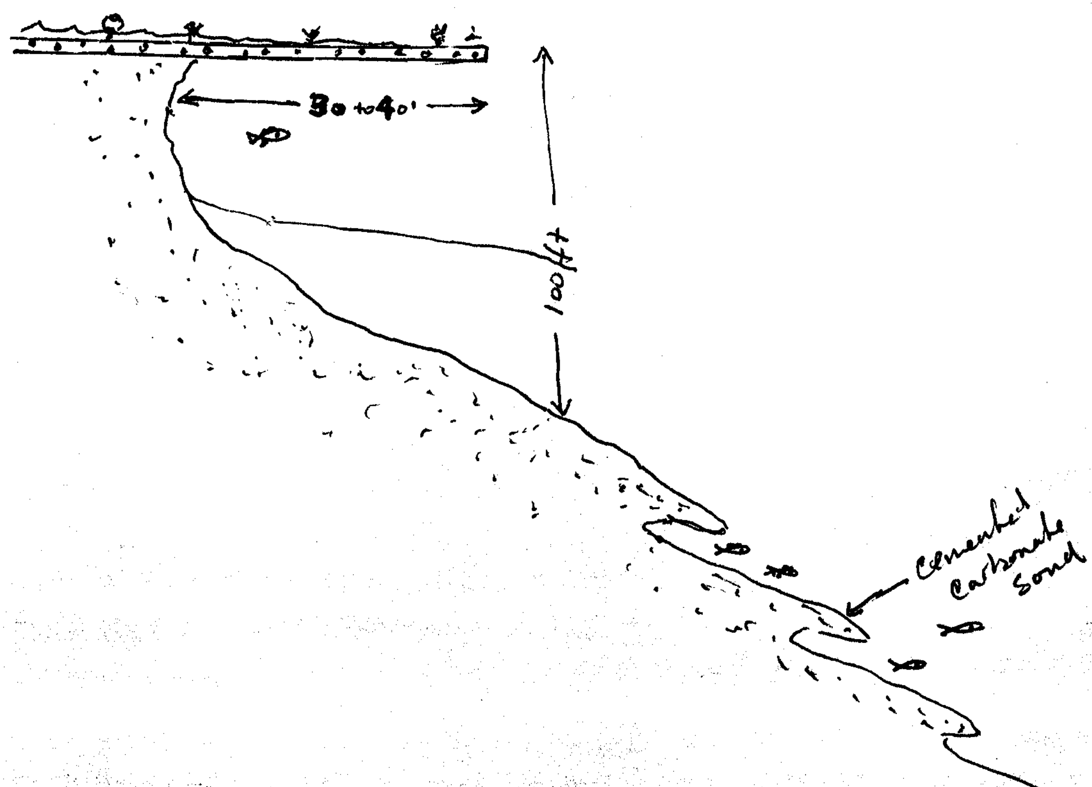


Fig. 7 Diagramatic sketch of cliff between stations 2 and 3, Dive 2

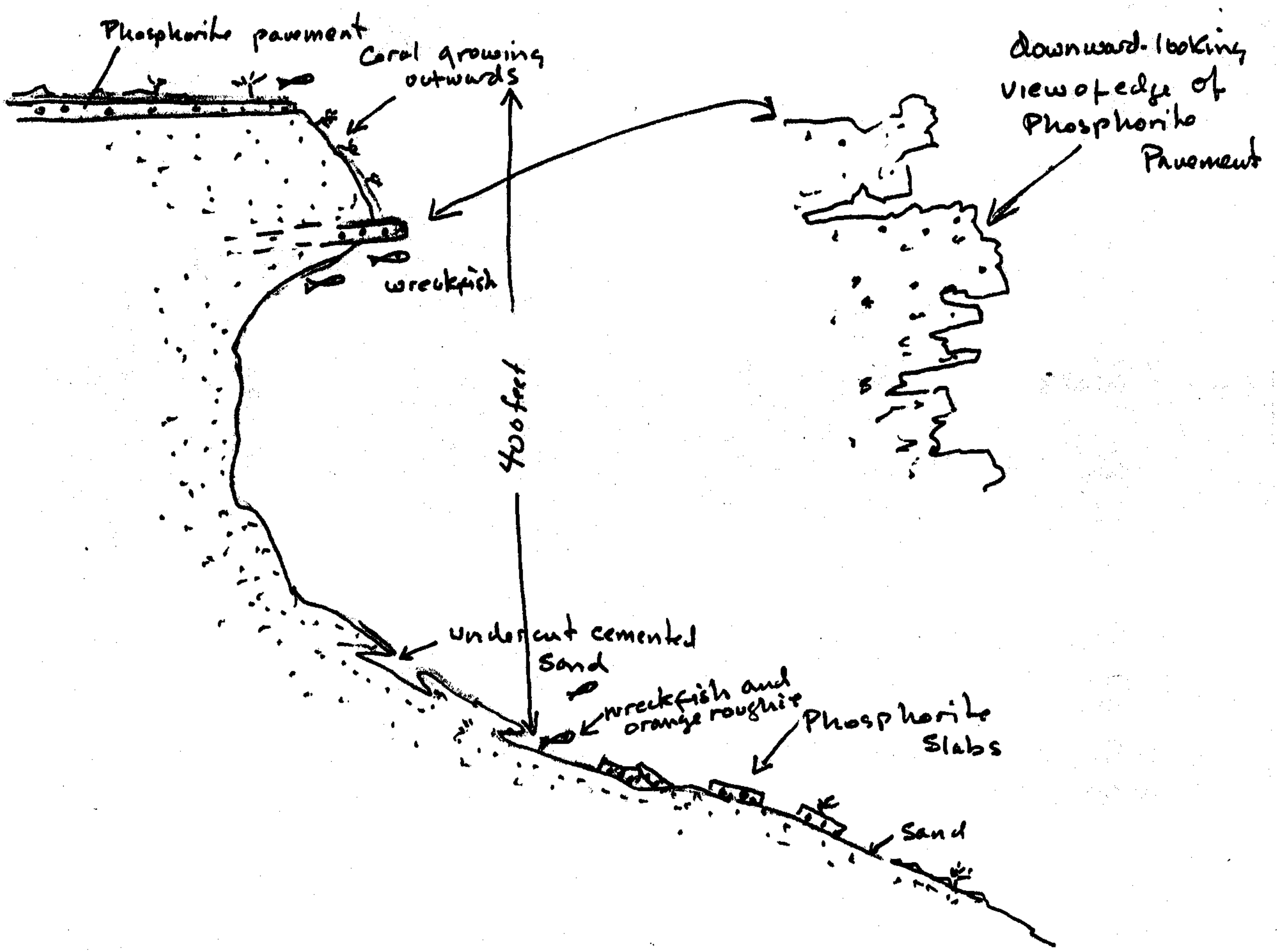


Fig. 8

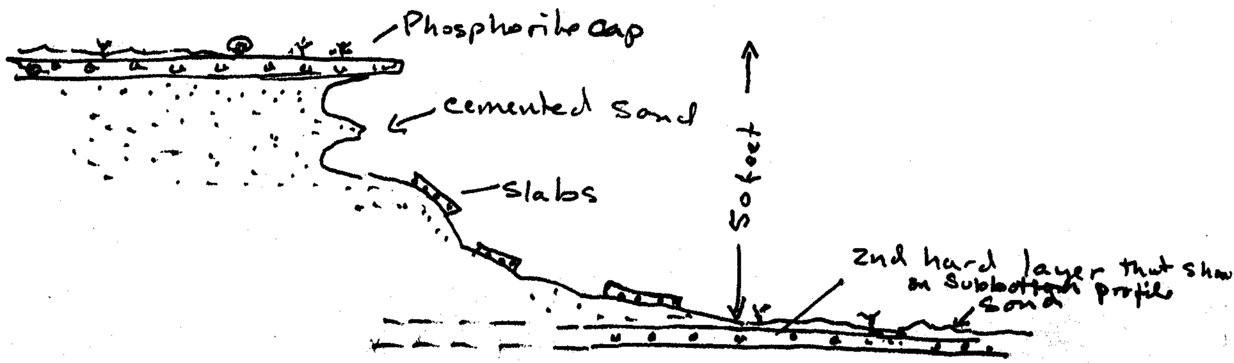


Figure 9. Scarp south of Aluminaut Hole - sketch (not to scale).