9. SUBMERSIBLE OBSERVATIONS AT THE HOLE 332B AREA

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INTRODUCTION

During much of the summer of 1974 the submersible *Alvin*, with its tender Lulu and escort R/V *Knorr*, conducted dive operations on the Mid-Atlantic Ridge near the Leg 37 drill area, as part of Project FAMOUS. In June 1974 plans were made for *Alvin* to dive on one of the reentry drill sites after *Glomar Challenger* had left and while the submersible was returning to Woods Hole from the FAMOUS area. The primary purpose of the dive was to examine the reentry cone for damage that may have been caused during reentry, to see how deep the cone was sitting in the bottom sediments, and to observe the distribution of drilled material around the cone.

DIVE PREPARATIONS

The submersible *Alvin* can cover a distance of 1-2 km during a normal 8-hr cruise on the sea floor. If it has less time on the bottom, because of extended surface preparations or greater depth of water to transit, time and the corresponding range will be reduced. In addition, if it is planned for the submersible to stay in one location to make observations, its range for search will again be reduced. Accordingly, the launch position of the submerisble with respect to the drill cone must be considered very carefully. Also surface and subsurface water currents must be gaged accurately for the submersible to land near the desired location.

The R/V Knorr briefly visited *Glomar Challenger* on 4 July while she was drilling Hole 332B. Although *Glomar Challenger* had put a 37-kHz *Alvin* acoustic pinger on the drill cone, it was thought that it may have been damaged during drilling. When the *Knorr* next visited *Glomar Challenger* on 14 July, she was drilling Hole 333A. Another 37-kHz *Alvin* pinger was left with *Glomar Challenger* in case the dive would be at that site. Subsequent communications indicated that the dive should be at Hole 332B with coordinates of 36°52.67′N, 33°38.57′W, as determined by satellite navigation fixes, and in 1806 meters water depth. The coordinates on the *Discovery* and *Hudson* bathymetric maps show water depths of 1670 and 1650 meters suggesting the maps may be in error. The latitude and longitude grid of these surveys would have to be shifted about one mile to the south to make the coordinates and water depths match for *Discovery*, *Hudson*, and *Glomar Challenger*.

On 5 August, after conducting dredging operations nearby, *Knorr* made an excursion to Holes 332B and 333A to determine if the 13.5-kHz station-keeping beacons left by *Glomar Challenger* were still active. Both could be detected and the two beacons could be distinguished by their slightly different repetition rate. The repetition rates were determined by synchronizing each in turn to different sweep rates of the PGR recorder. In fact, an estimate of closure on the beacons could be determined from the doppler shift as recorded on PGR trace.

At the conclusion of the FAMOUS operations the *Knorr*, with *Lulu* (carrying *Alvin*) in tow, arrived in the vicinity of Hole 332B at 0300, 16 August to begin the dive operation. The tow was broken and *Alvin* readied for diving while *Knorr* surveyed the area. Although the 13.5-kHz station-keeping beacons were again detected, it was impossible to localize the distance of closest approach to less than about 0.2 n.m. (370 m). There was additional uncertainty of beacon position with respect to drill site. Since a good satellite fix could yield a better accuracy and several good satellite fixes were expected at that time, it was decided to rely on satellite fixes to determine an *Alvin* launch position.

A transponder string was then placed at what was believed to be the drill site. This string consisted of a 37-kHz (CTFM[2]) transponder on which *Alvin* could get bearing and range, of up to 1000 meters, while submerged and an AMF transponder from which *Lulu* could get bearing and range, and from which *Knorr* could get bearing only.

During the dive, satellite fixes on *Knorr* indicated that the transponder string had probably been dropped at 36°53.359′N, 33°38.551′W—1.3 km north of the drill site. This information was obtained after *Alvin* had picked up bottom targets on its CTFM sonar and was investigating those.

DIVE OBSERVATIONS

Alvin, with V. Wilson as pilot and Ballard and Heirtzler as observers, was launched about 1030. Immediately upon submerging it was discovered that there was an electrical problem with the line hydrophone used for tracking the submersible from *Lulu*. *Alvin* was recalled onboard, the hydrophone repaired, and she was relaunched at about 1400 with J. Donnelly replacing Wilson as pilot. Before reaching 500 meters depth the transponder string was picked up at 1145 meters slant range. Touchdown was at 1516 hr on a sediment-covered sea floor with about a 900 meter range to the transponder. The CTFM sonar scope immediately showed a distinct target bearing 120° and at a range of 800 yd.

[1]Contribution 2926 of the Woods Hole Oceanographic Institution.

[2]The CTFM sonar on *Alvin* sweeps through an azimuthal sector ahead of the submersible. The echo-sounding frequency varies with the azimuth of the emitted pulse.

At 1549 *Alvin* reached this target. It was a small conical structure of volcanic rocks, 4 to 5 meters high and 10 to 20 meters in circumference at the sea floor. It was relatively free of sediment cover and consisted of basalt pillows with no small loose pieces that could be sampled (see Figure 1). The few pieces that were small enough to be grabbed by the manipulator were apparently cemented to the other adjacent rocks, although manganese coating was not in evidence. The sediment at the base of this pile was quite undisturbed, and there were no rock chips anywhere to be seen. *Alvin* made a complete circumnavigation of this pile on the sea floor and inspected the top. There was a potato chip bag resting on one of the rocks. Several photographs of the rocks and adjacent sediments were made.

At 1643 hr two new piles of rocks were investigated (see Figure 2). At 1645 a small cliff was observed, with rocks (probably pillows) protruding from heavy sediment cover. This appeared to be a flow front, with the flow direction in the present downhill direction. New rock structures were investigated at 1652, 1655, 1707, 1722, and 1826 hr (the last was the same as the first investigated).

There were some dozen or two items of debris observed along the route traversed. These items included paper cups, paper bags, glass bottles, metal drink cans, a white shirt with red paint on it and four silver buttons around the wrist, a Spic and Span box, etc. There seemed to be somewhat more debris on the western side of the area searched and, for this reason, it was decided at 1810 hr to go in a southerly direction. Our ships (*Knorr* and *Lulu*) had been experiencing a northerly set during most of the summer in this area, and it was believed that the debris must have drifted north. Accordingly the southerly course was begun at 1744. The water depth during the transverse was 1800 ±20 meters as recorded on *Alvins*'s depth sensor.

The dive was terminated at 1855 hr due to approaching darkness at the surface. The transponder string was recalled by *Knorr* at this same time and later recovered by them. Two rolls of black and white and one roll of color film were taken by the observers with hand-held cameras. This was Dive No. 536 for *Alvin*.

DISCUSSION

Predrilling site surveys by *Discovery* and *Hudson* indicated a sediment pond approximately 1 mile in diameter around Hole 332B. Although both those ships and *Glomar Challenger* used satellite navigation, the navigational uncertainty approaches the width of the

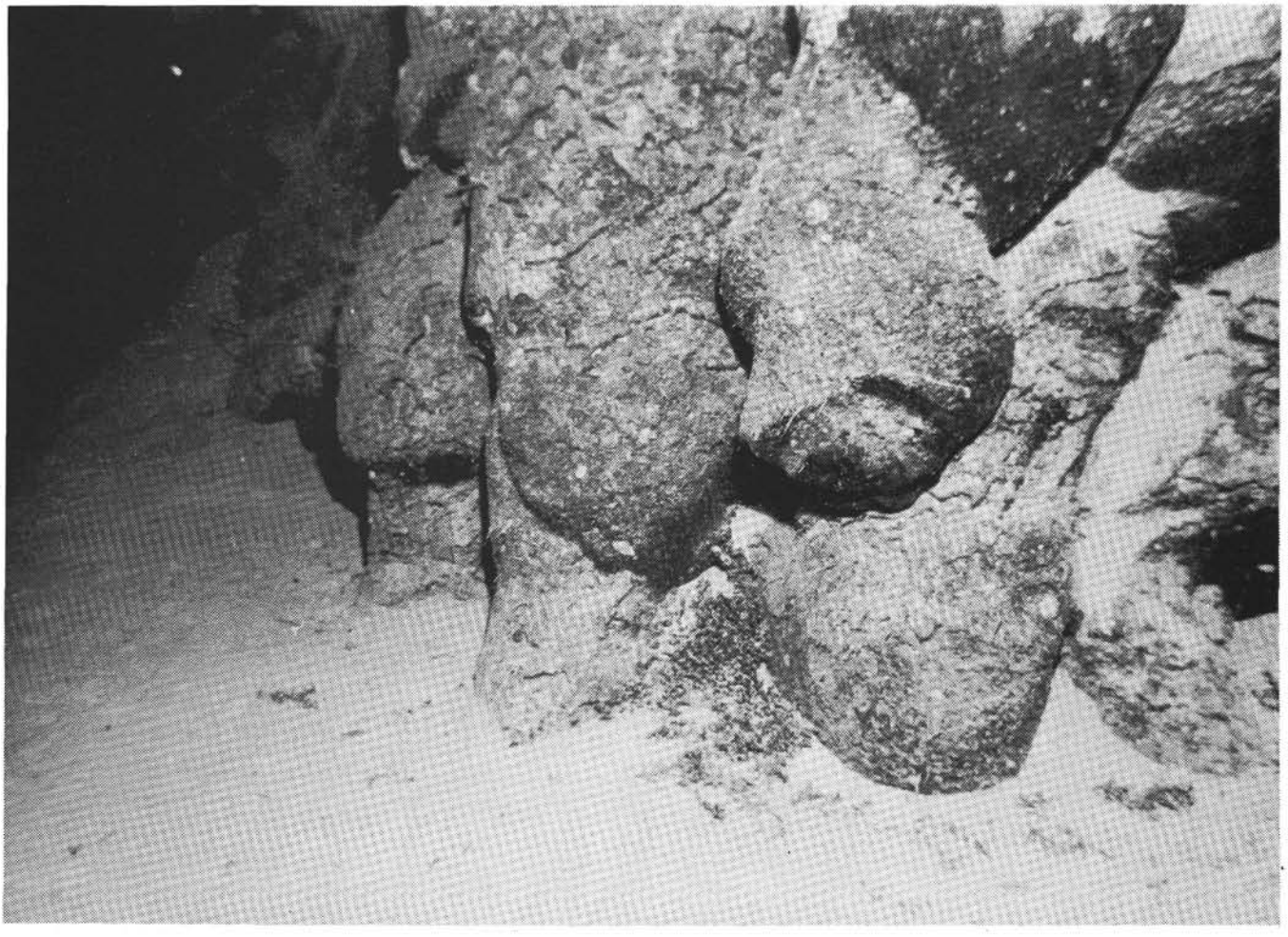

Figure 1. *A small pile of pillow basalts resting on a flat sediment-covered terrain. Seven similar structures were found.*

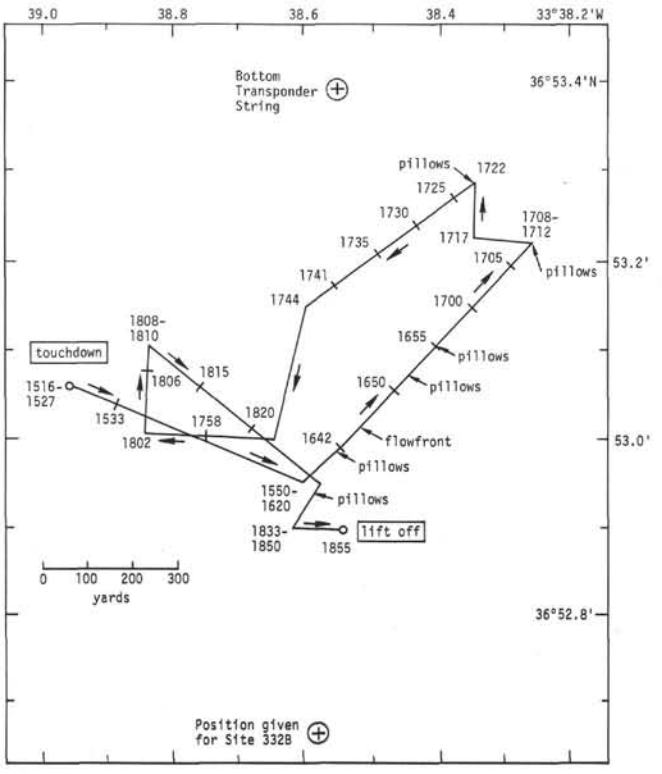

Figure 2. *Track of submersible* Alvin *over the bottom on Dive No. 536, August 16, 1975 near* Glomar Challenger *Hole 332B.*

sediment pond. Thus there is some question about what part of this pond was drilled. This is evident by the discrepancy of depth for a given latitude as mentioned earlier.

In addition, one should remember that for the usual depth sounders on a research vessel the beam width on the sea floor is nearly equal to the water depth. For the Hole 332B area this beam width is approximately equal to the dimensions of the entire sediment pond. It is clearly impossible to detect small structures rising above the sea floor. The resolution of seismic reflection profile instruments is even less than that of echo sounders. Even though isolated volcanic structures may have a larger dimension beneath the sea floor than above, they are not likely to be detected by profiling equipment.

The existence of the small conical basaltic structures came as a surprise for two reasons.

First, they had not been observed before in this or similar off-axial regions. The size of them makes them difficult to photograph in their entirety with the usual bottom camera, and the relatively small percentage of the sea floor occupied by these structures makes a chance photograph of any part of them unlikely. As indicated above, they cannot be detected by echo-sounding or profiling instruments.

Secondly, it was intuitively thought that tectonism would have homogenized such coherent pillows. The age of the pillows cannot be determined, but they are presumably no older than 3.5 m.y.—the magnetic anomaly age of the site. In appearance they resemble certain pillows of the FAMOUS rift valley. The spalling of the surface suggests they are older than rift valley rocks, but their lack of sediment cover suggests that they may be younger than neighboring basement. The cone, like the rift valley, was probably formed above a magma source and the surrounding sediments built up around the cone.

If *Challenger* drilled into such a volcanic structure and such a structure is not typical of the rock basement of the region, very erroneous results could be obtained for the nature of the oceanic basement.

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