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CRUISE REPORT

Ship Name: R.D. Conrad

Cruise No: RC21-16

Departure: 16 Nov. 1978 (Date)

from St. Georges, Bermuda (Port)

Arrival: 6 Dec. 1978 (Date)

at Roosevelt Roads, Puerto Rico (Port)

Days at Sea: 20
(Count day of departure but not day of arrival in port)

Days Foreign Port: 0 (2-3 hours)
(number of days in arrival port before next leg)

Area of Operation: Northwest Atlantic-Bermuda Rise and Eastern Nares Abyssal Plain

Program Description: Main objective was to determine origin of "transparent domes" in area of Eastern Nares Abyssal Plain. Alsok coring of DEEP-TOW site on southwest Bermuda Rise and retrieval of Bottom Ocean Monitor on Greater Antilles Outer Ridge was accomplished.

Program supported by what contract: T0210-Scope T

Participants: (All L-DGO unless otherwise specified)

Name	Title
Embley, Robert	Chief Scientist
Bryan, George	Co-Chief Scientist
Roach, David	Heat flow
Hobart, Michael	Heat flow
Abbott, Dallas	Graduate Student(Permeability of Sediments)
Hoose, Peter	Graduate Student (Physical Properties of Sediments)
Holland, David	OBH Technician
Iltzsche, Martin	Air Gun
McNamer, Robert	BOM technician
Mossman, Dwight	E.T.
Salcedo, Charles	E.T.
Stein, Arnold	E.T.
Svozzo, Robert	Computer
Zielinski, Gary	Visiting Scientist, Gulf Oil

All inquiries regarding cruise should be made to the chief scientist.

CRUISE NARRATIVE

AND RESULTS

CONRAD left St. Georges Bermuda on November 16 and headed southwest towards a site on the western Bermuda Rise which had been the location of a DEEPTOW survey in September 1978 (INDOMEDII-MELVILLE SIO). The object was to obtain a series of cores within and around the furrowed area which was discovered during INDOMED II. Two casten cores and five ($S^5$2-55 on Fig. 1) smaller gravity cores were taken. The casten cores, one within and one outside the furrowed area showed a distinct difference in sediment type. The core outside in the stratified, non-furrowed terrain, consisted of brown clays with one marl layer whereas the casten core in the furrowed area consisted of gray clays intermixed with brown clays. This tends to support the initial hypothesis that the furrows have been selectively formed in a distinct sediment type with different sedimentation rates and properties from the surrounding seafloor.

After completing the coring survey CONRAD steamed south to the Greater Antilles Outer Ridge where the Bottom Ocean Monitor was recovered (Fig. 1). This had been deployed on RC21-10 on June 5, 1978 and consisted of a current meter, long-term nephelometer, time lapse camera and two acoustic transponder releases. This was retrieved without difficulty and the camera and nephelometer have both been processed and are of high quality. Before recovery, a camera-nephelometer station was taken near the site for calibration of the BOM nephelometer.

The final and main phase of the program began after two more days of steaming to the easternmost end of the Nares Abyssal Plain. Here an intensive coring, digital heat flow and near bottom pinger hydrophone program was conducted to determine the nature and origin of the "transparent domes" which protrude through the abyssal plain in this area. Five piston cores, five digital heat flow stations, five core-mounted thermograd stations, two camera stations and five drift stations with a 3.5 kHz pinger and bottom hydrophone attached to the STD wire were made from 24 Nov. to 3 Dec. in this area. In addition, five sonobuoy and one long OBH refraction line were completed in the area and surveys were made with the 3.5 kHz and seismic profiler.

The most exciting result of the cruise was discovery of a very large heat flow anomaly over one of the dome structures. The heat flow increased from the regional value of about 1.3-2.5 on the flank to about 18 HFU over the top of the dome (assuming a constant conductivity). The total width of the anomaly was only about one kilometer. On subsequent stations the heat flow only varied between 1 and 3 HFU over the abyssal plain and the abyssal hills (Fig. 2).

On a subsequent station a core was obtained on top of one of the domes (Fig. 3). The small size of the features (Fig. 3, top) and the water depth (3125 fms) made this a difficult and exacting operation. The pre-station survey (Fig. 3, top) showed that the dome was about 0.5 km in diameter where it outcropped above the abyssal plain and in plan view was roughly circular. Although the surface 3.5 kHz records only showed a very weak side echo from the top of the dome, the near bottom pinger record (Fig. 3, bottom) shows a rather reflective surface. The side of the dome is very steep, probably a 30°-40° slope. The core was taken near the top of the dome and it recovered about 5.5 meters of red clay. The bottom meter was very hard clay and in the cutting edge were pieces of manganese and possible basalt imbedded in a pinkish alteration product. This material is currently being analyzed to determine its origin (hydrothermal?).

The "transparent domes: are apparently very steep-walled dikes of basic rock which act as heat vents. The very high heat flow associated with at least one of them could be explained by the circulation of hot water within them. The origin of these features is not yet clear but it is fairly certain that they differ radically from and may be much younger than the surrounding abyssal hills. None of the other digital heat flow stations showd any values within an order of magnitude of the dome anomaly and the sediment over the dome also appears to be anomalously thin. These features may be related to (1) off axis volcanism (2) fracture zone tectonics (3) intrusions related to the Oligocene Bermuda Rise uplift.

The steepness of the walls of the dome and their small size account for lack of a coherent echo return from them although it is still rather difficult to account for the lack of stronger hyperbolic echo defining thier crest. A very important aspect of these features is that they may be present in many other areas but that their peculiar geometry make them nearly invisible to a surface ship PDR except under a favorable "acoustic environment" such as a distal abyssal plain where they contrast so vividly with the flat-lying sub-bottom reflectors. The very high heat flow associated with such features on 80 million year old crust raises some new questions on intraplate tectonics and the circulation of fluids within the ocean crust.

OBH

A successful OBH refraction station was made using three big airguns . Data was recorded on the tape but its quality is not yet known because of problems with the shipboard playback system.

Experiments with Bottom Hydrophone

A series of stations were completed using the bottom hydrophone on the STD wire with the 3.5 kHz pinger also attached to the wire and shooting with an airgun at the surface. After puttin the hydrophone in a special "muffled" cage wrapped with canvas we obtained relatively good quality low frequency and high frequency records.

Physical Property Measurements

Sound velocity, drill properties, shear strength and permeability measurements were made on all the cores taken on the cruise by Peter Hoose and Dallas Abbott.

CONDITION OF EQUIPMENT

Except for the usual minor breakdown etc. of the profiler, PDR's etc. there was no major loss of underway data during the cruise.

Winches, wire, etc.

There were several problems with the winches, while not resulting in major loss of data, did hamper the stations program to some extent. The hydrowinch had two problems. First, the control panel is in poor shape and should be properly repaired and cleaned. One of the push buttons literally disintegrated and we had to make do with a jury rig replacement. A more serious problem is the breaker switch in the stack room which badly needs replacement.

The STD winch was operative but there were weveral defects which could pose major problems in the near future. First, there is a small hydraulic fluid leak of which the exact origin was never found. Second, the main tension spring may be defective because during deep stations the shives crashed together several times. Either of these could lead to serious problems and result in loss of equipment if not corrected. Also concerning the STD winch, the mismatch of the level wind mechanism with the wire and spool which results in a slow and tedious two person winding operation on each station should be corrected since the operation results in extensive loss of ship time during some types of operations and also an excess wear on the wire.

The only serious difficulty with the core winch was the water brake. When engaged, speed control was essentially nil.

General Comments

The ship was in very good condition and the food was excellent. The recent renovation of the cabins makes for a much better working environment for the scientists. Al the officers and crew were very helpful during the cruise. I would especially like to thank Captain Jorgensen, Randy Sherman and Leslie McIntyre for their efforts during the stations and surveys and Howard Giddy for his tireless efforts at the core winch.

Robert W. Embley

To be added to C-21-16 Cruise Report

R/V CONRAD on Leg-16 arrived Roosevelt Roads, Puerto Rico 0700 December 6. The continuation of this leg to termination in Balboa, Panama December 11 may be referred to as Leg-16A.

The main scientific objective of C-2116A was to test packaging and fantail launching of 1 ton shots for the future Rose Experiment and the burn time of fuse at detonation depth 300'. The track Figure 2 was a straight run from Puerto Rico to Panama. Routine geophysical data, magnetics, seismic and gravity were recorded.

Ater discharging scientists R. Embley, G. Bryan, P. Hoose, R. Mc Name, D. Roach, D. Abbott with instruments and data at Roosevelt Roads, CONRAD proceeded to Vieques. Approximately 20 tons 40896 lbs. of Tetrytol in 24 lb. haversacks were loaded into CONRAD's magazine. She departed 1400 December 6 for sea again via Roosevelt Roads. Geophysical gear was streamed at 1630. Profiling commenced 2000 after repairs to a faulty air line.

December 7 was spent preparing for the experiment which was carried out on December 8. It took roughly one hour for seven people to do the following: 1) Convey 80 haversacks from the magazine to the fantail pallet, 2) Box and band the pallet which had previously been placed on the launch platform. The launch platform, a tilt table, appears to be well designed. The float consisting of two empty oil drums with welded eyes had been prepared the previous day. The bbls. were separated for the experiment by 20' of line. 300' of line was attached from the bottom bbl. to slings around the pallet. The bbls. were launched and the platform tilted by chain fall to roughly 40' of inclination. The pallet was held until launch with one restraining rope. With rope release the pallet slid free. It took one minute and three seconds for the first bbl. to submerge completely indicating sinking rate of roughly 50 fathoms or 300' per minute. The second bbl. barely floated staying 80% submerged in troughs and completely submerged under swells. CONRAD was maneuvered to recover the package via floating tag lines to be connected to a runner to the hydrowinch. One tag line was hooked but not through its eye splice before the ship was set by the wind over the bbl. To prevent the bbl. or tag lines from fouling the prop or rudder the ship was backed. The bbl. did not appear off the bow as expected. Divers were put over to assure that no ropes had fouled under the ship then a search of the area was conducted but to no avail. We assume the prop wash while backing probably sank the lower bbl. to implode depth or sufficient depth to increase water intake through small leaks.

Fuse burn time experiments were conducted. As burn time decreases with depth the 3 lb. charges were tethered at 300' depth. Floats were designed to tip up when charges reached their depth. Ballast and various tether materials cod line-cotton line, available mono filament and copper wire were used to assimilate the 50'/min sinking rate. See following table -

Shot #	Size lb.	Ballast lb.	Sink Time Min.	Sink Time Sec.	Burn Time at 300' Min.	Burn Time at 300' Sec.	Total Burn Time Min.	Total Burn Time Sec.	Fuse Length
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2	3	2	1	38	1	44	3	22	10'
3	3	3	1	35	1	53	3	28	10'
4	3	3		50	5	59	6	49	20'

On the last shot thin copper wire was the tether and the 50 sec. sink time approximates the 1 min. 3 sec. time of the large charge. Comparing the 20' fuse total burn time to the two previous 10' burn times adds confidence to the figures. I think we can accurately fire one ton charges within 10 seconds of prescribed times using 20' fuse. If speed over the ground is 10 kts. while launching the ship will be 6,750' from the shot in 6 min. and 45 seconds. I propose we launch shots 7 minutes before the prescribed detonation time with bbls. launched 12 seconds before the charge is released from the platform.

The remainder of the leg was routine and CONRAD anchored off Cristobal awaiting canal transit roughly 2200 December 10.

R. Leyden

RL:rh
12/13/78

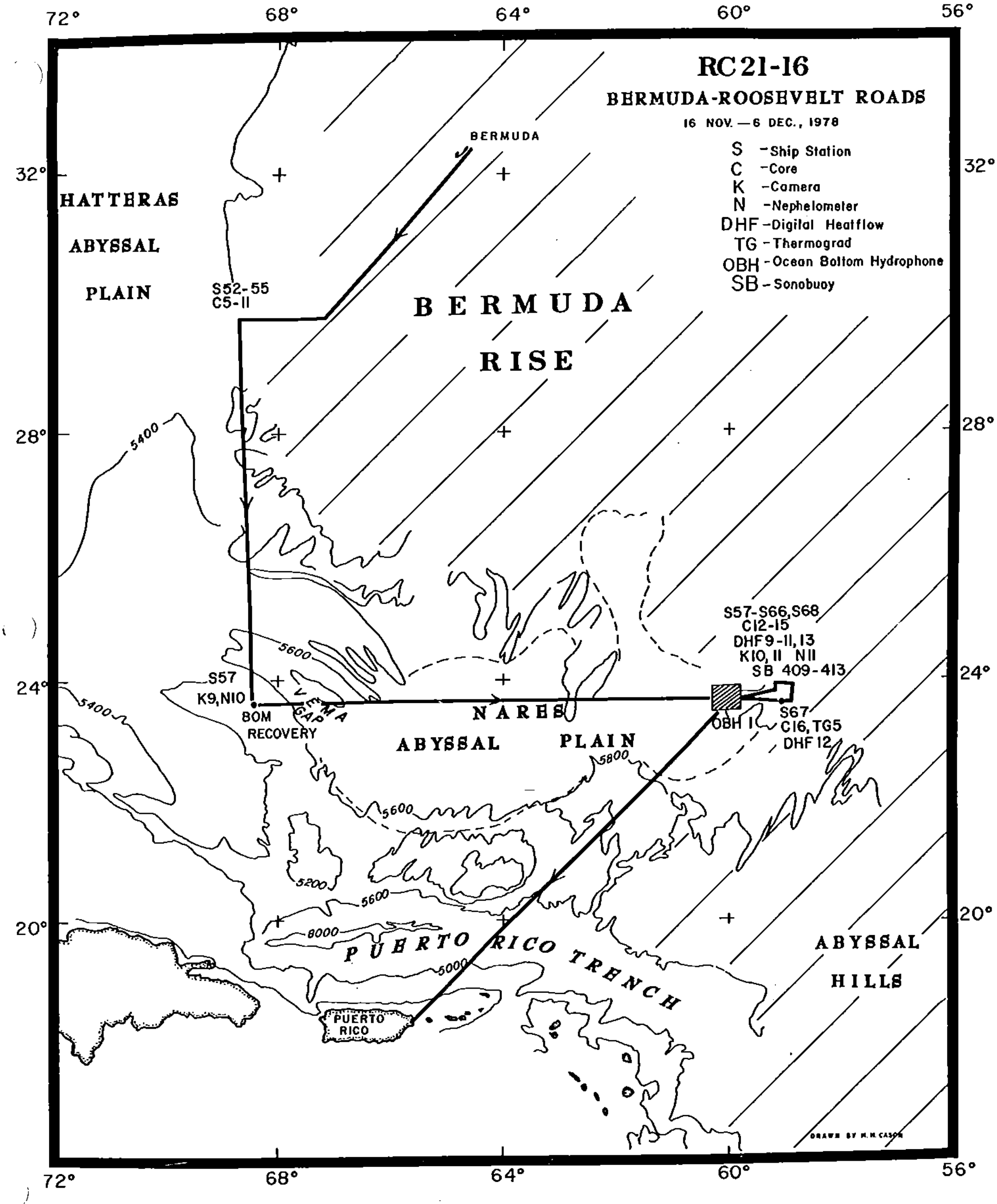


Fig. 1- Cruise Track of RC21-16

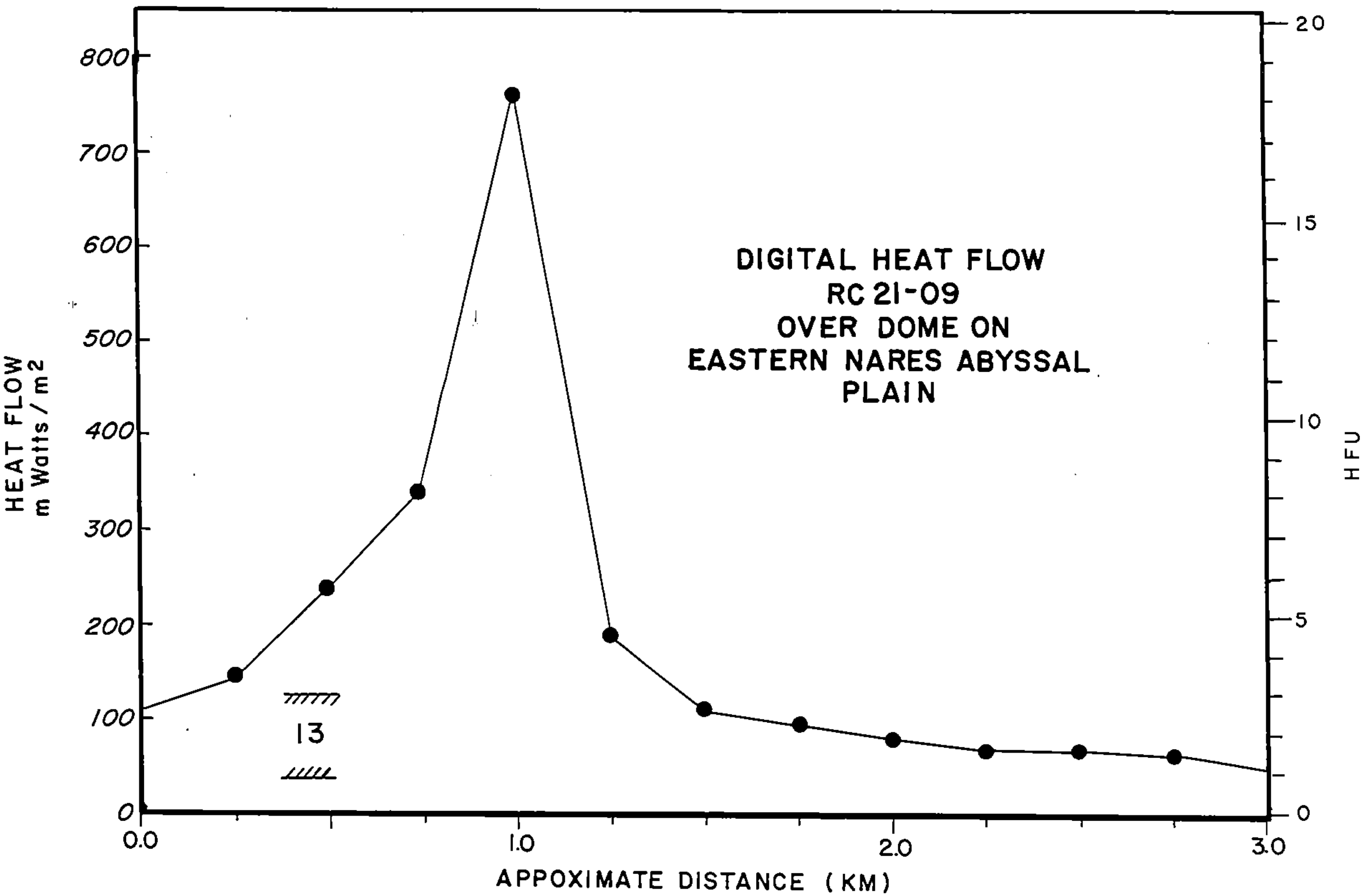


Fig. 2- Heat flow profile over dome on eastern Nares Abyssal Plain. Hachured lines with the number 13 in the middle shows the maximum range of heat flow during station 13 which was taken over abyssal hills to the west of station 9. Station 9 was taken over a dome similar to that shown in Fig. 3.

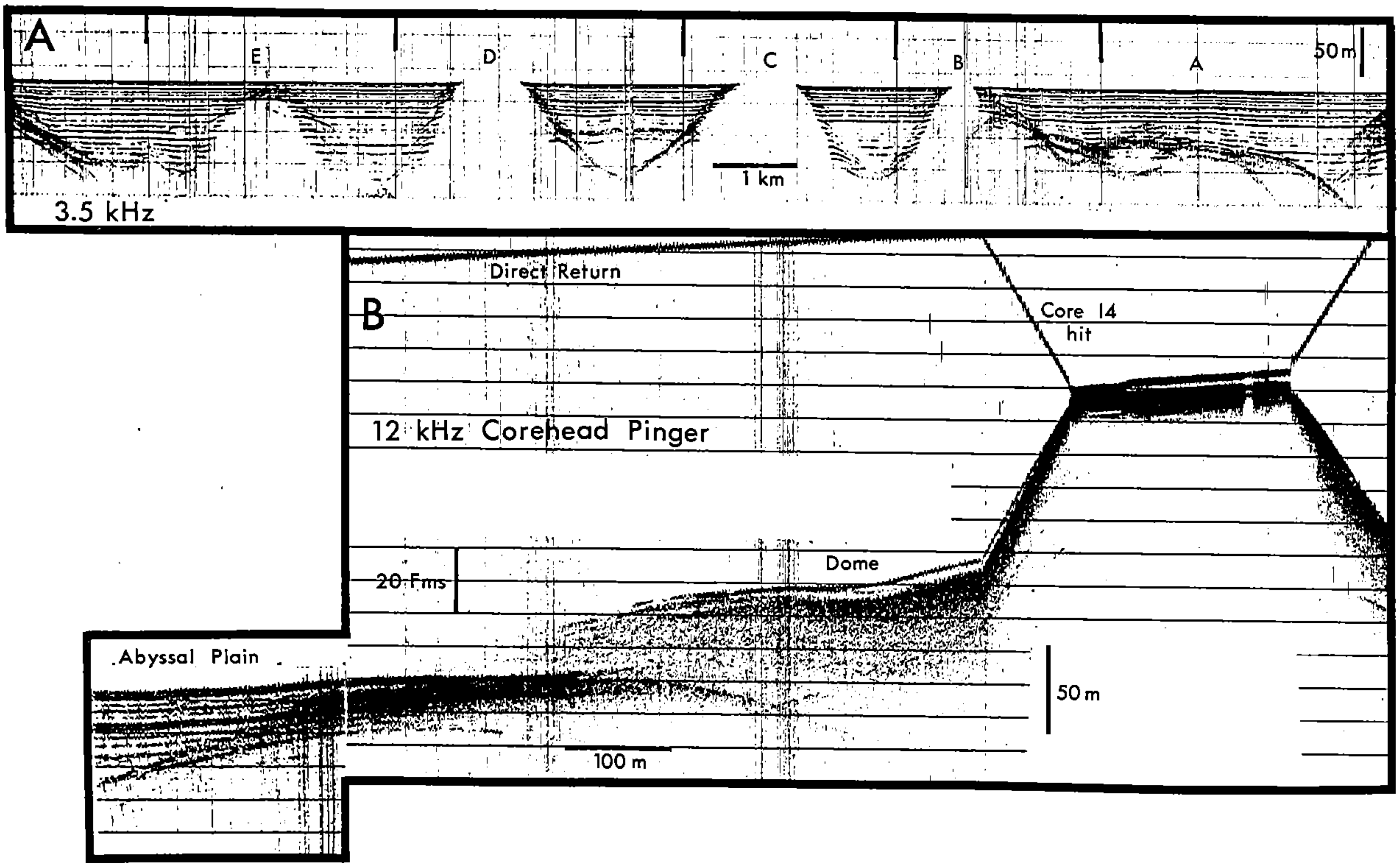


Fig. 3- (A) Pre-station survey over dome on eastern Nares abyssal plain. Crossings of same features are shown by letters A-E. The tracks' spacing was about 0.3 - 0.5 km.
(B) Bottom 12 kHz corehead pinger record during Station 63. The slope of the side of the dome is 30°-40°.

November 29 1977

Procedure for firing large charge

Shot to go off at 400' depth, 3 bbls. of charge total approximately 1800 lbs. (600 lbs. each bbl.). Charge BBL tied and bolted together. Lids cut open and pried up to put charge in, fuse and primacord out, then lids pressed back. If water tight or banded lids are used holes could be cut for fuse and primacord. The charge BBLS are set on a sturdy tilted platform. BBLS held on the ship by a restraining rope. The platform location and dimension/naturally vary for each ship. The platform could be a tilt plank if space permits. On TIKI we used the sliding platform with restraining rope.

Sausages of explosive slit open and charge poured into BBLS. Each safety fuse 40', fused with cap to booster. Two additional boosters taped to capped booster. 8' primacord to each of the additional boosters. Primacord all knotted with overhand knot approximately 3' from their bitter ends. (Knot besides providing primer link, discourages water from seeping down primacord.) Three fuses and three primacords must be well separated coming out of the BBLS. 1/2" poly pro rope slung around and between 3 BBLS before loading charge and primers. 300' 1/2" polopro rope, with assorted drogues attached, flaked in box. Drogues (small cablereel, orange crates, ammo boxes) outside box and their order of deployment memorized. Charge forward of drogues and flaked line which are in turn forward of buoy BBLS. Drogues keep line running clear and slow the sinking rate but should not be too buoyant.

At 300' 2 mt BBLS lashed by sling and smaller line to assure their intergrity at 400' single mt BBL attached by sling and small line. Flag and mast if desired.

Ship at approximately 8 kts. Prearranged time for deploying shot with shore station with alternate times agreed on.

Fuses lit and restraining rope cut, drogues thrown over in order with line free to unflake. Double BBLS thrown next and single BBL last. All lines must be outboard of deck stanchions etc. Axe ready in case of fouling. By throwing the first drogue with the charge the line is really pulling out initially at speed of the ship not the sinking rate. With no delays or snags each drogue will submerge in order, succeeded by the double BBL, well astern of the ship. Single BBL marks the location.

After the shot fires the double and single BBL should be recovered with most (99%) of the line. Besides being an economy measure recovery is necessary as the polypro rope floats and becomes a hazard to navigation.

Eye splice on mainline or bowline 1/2" polypro line used for main line and all lashings.

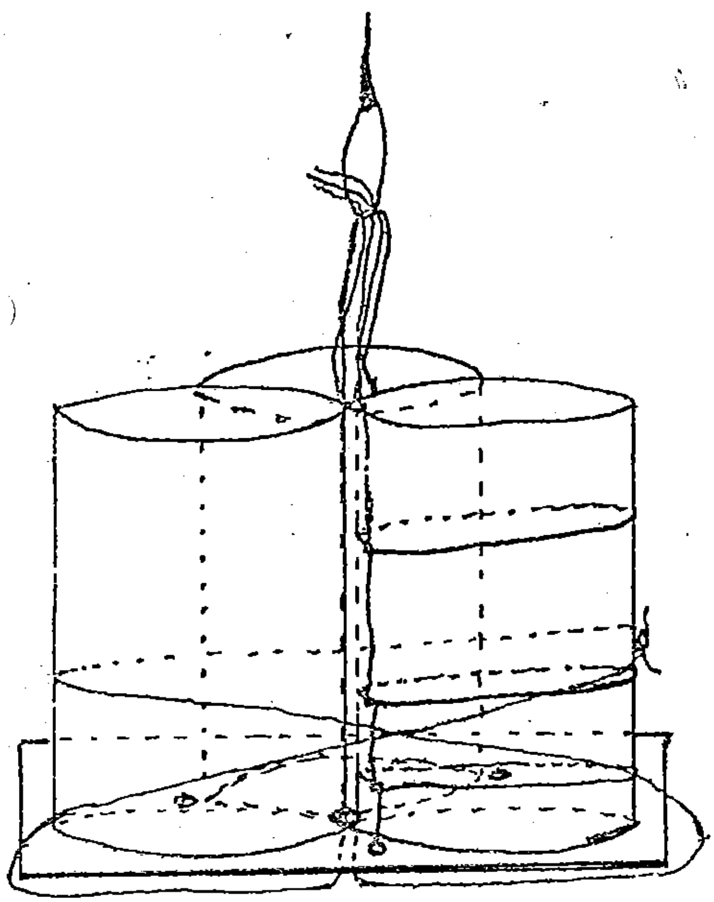
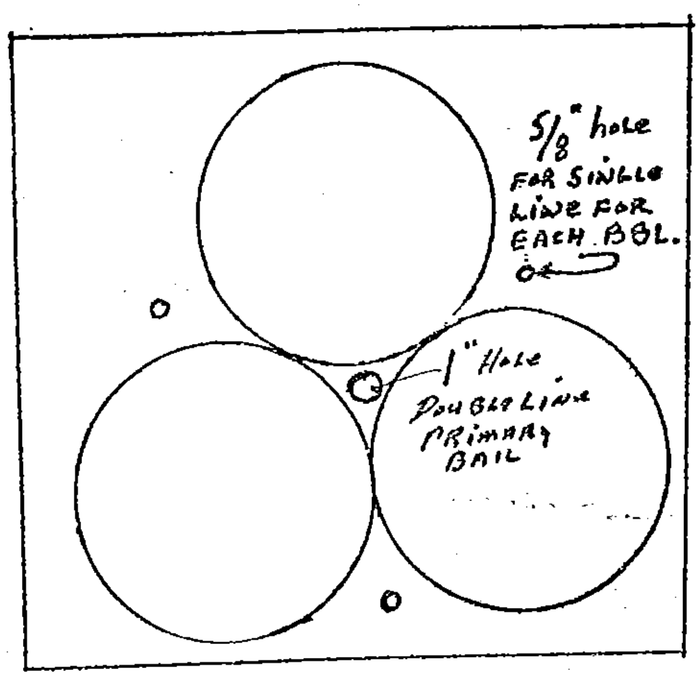
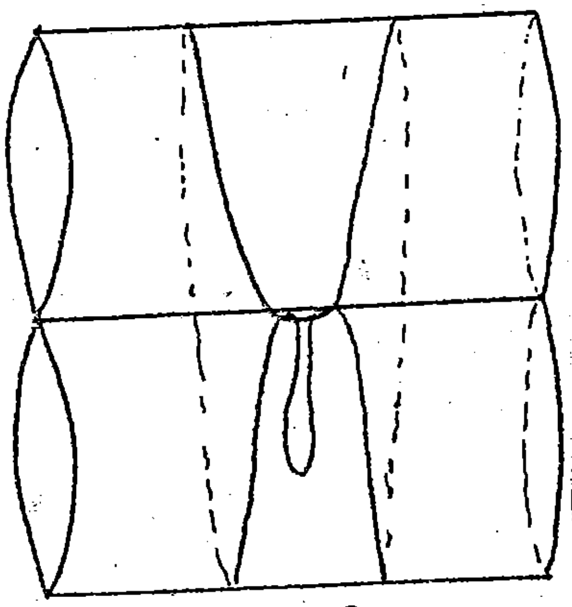


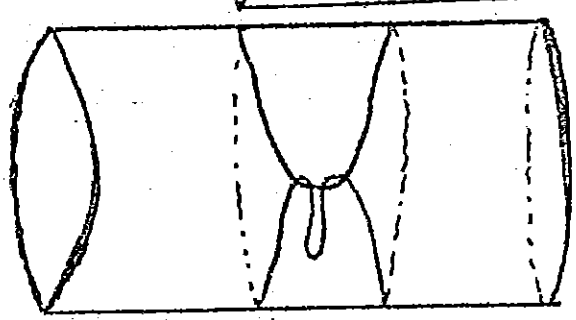
Illustration: Single line knotted through 5/8" hole hitched around 1 BBL then up through center. Double line through center hole first then hitched around all BBLS. All lines pass through and secured to main line eye splice.



3 BBLS tied together then bolted. Piece of 5/8 or 3/4" plywood with 5/8" holes. 1/2 hitches on each BBL with 3 single lengths of polypro made fast through 5/8" holes with other ends meeting over center. These 3 lines tied together after passing through main line splice are the secondary bail. The doubled center line is tied around all 3 BBLS after passing through center 1" . This doubled line is the primary bail. Bolt BBLS together as final securing device with 3/8" bolts with washers.



The double BBL float which submerges to 100'. BBLS tied together with spliced rope sling. Small lines used to hold sling in place until tension snugs sling fast.



Single BBL surface float held to main line by spliced rope sling. Small lines used to hold sling until tension snugs sling fast.

On main line use eye splice or bowline at surface single overhand eye for double BBL sling.

R. Embley G. Bryan P. Pomeroy
E. Herron S. Goddard

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