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To: IPOD, DSDP, USGS Staff

13 Nov. 1974

From: R. Markl (IPOD/L-DGO) and J. Grow (USGS)

Subject: Cruise Report of IPOD - USGS Multichannel Seismic line
between Cape Hatteras and the Mid-Atlantic Ridge crest.

Description of Cruise

Between 17 October and 8 November 1974 a continuous 2100 statute mile (3400 km) multichannel seismic reflection profile was shot from Cape Hatteras (34.8°N;76.0°W) to the rift valley of the Mid-Atlantic Ridge (22.8°N;45.0°W). Digicon Inc., under contract to the Deep-Sea Drilling Project (JOIDES) shot the line with the M/V Gulf Seal. The objective of this seismic line was to provide data on the deep sedimentary structure of the continental margin as well as the basement and sub-basement structure along a flow line between the margin and the ridge crest; this information will provide the basis for choosing deep-sea drilling sites of the International Phase of Ocean Drilling (IPOD). The seismic line was planned by IPOD Site Survey Management (L-DGO) and jointly funded by the National Science Foundation (via DSDP) and the U.S. Geological Survey (USGS).

Ancillary sonobuoy and magnetics data were collected by client representatives R. Markl (IPOD/L-DGO) and J. Grow and F. Jennings of the USGS/WHOI.

After a four day delay, Gulf Seal departed Savannah, Ga. on 15 October. Loran C was calibrated at Diamond Shoals tower (Cape Hatteras) and the "IPOD" line was begun in excellent weather on 17 October. Approximately 250 statute miles down the line bad weather caused a three day delay during which the hydrophone cable broke off twice and was recovered (the second time nine 50 m sections had to be replaced). Also during this time, a discrepancy was noted between the pre-plotted line and that laid out by IPOD Site Survey Management (L-DGO); communications pertaining to this discrepancy caused an additional one day delay. No further delays were incurred as a result of weather conditions, however, several 3-4 hour circles had to be made for routine checks and for repairs. The 3400 km line (68,020 "pops" of the airgun array) was completed on 8 November; the best daily production achieved, 151.25 statute miles, exceeded Digicon's prior record by about 15 miles. The ship proceeded to St. Croix, V.I., a six day run, to replenish food and water - the client representatives were also debarked.

The Gulf Seal is a twin-screw, 165 foot, relatively flat-bottomed "mud" boat of less than 300 tons which was built in 1966 for coastal doodle-bugging. The boat, which is leased by Digicon from Seal Fleet, Inc., proved to be quite adequate for extended operations in the deep ocean. It carried over 50,000 gallons of fuel (consumption about 1000 gal/day while shooting at 5 kts). Although it has no evaporators, ample fresh water is carried. Although there is a holding tank for used engine oil, over 1000 gallons were pumped into the sea on this cruise...

The ship is operated by a crew of only 7 (Seal Fleet) men; the Digicon complement was 14. With the addition of 3 client representatives (a total of 24 persons) living space was cramped.

Description of the Multichannel Seismic System

The Gulf Seal tows a 3600-meter-long hydrophone streamer consisting of 24 groups of 100 m length and 24 groups of 50 m length (the latter comprise the tail end). There are 20 hydrophones (each comprised of two crystals) in each 50 m section; the streamer is made up of 50 m sections which are connected by specially made 120 pin stainless steel couplings. Fluid ("Moroma" brand is used) can be added and air and sea water bled out of the sections quickly by means of fittings in these couplings. Minor holes in the streamer tube are repaired "on line" in much the same way as a bicycle tube is "hot patched". The cable is deployed from a 10 foot diameter reel on the fantail; it normally takes 3 hours to lay the cable out and 1 hour to bring it in. The cable is maintained at a depth of about 60 feet by ten "birds" (pressure controlled ailerons) and the use of lead sheet wrapped around some forward sections; the depth, which cannot be adjusted from the ship, is monitored by eight transducers distributed along the cable. The noise level and sensitivity of each of the 48 hydrophone groups is monitored every 2 hrs via a 48 trace galvanometer camera.

The airgun array is comprised of 23 Bolt Associates PAR guns having a total capacity of 1700 in³ (one 300 in³; fourteen 80 in³; four 40 in³; and four 30 in³ guns). The 300 in³ gun and three strings of the smaller guns are towed by four steel cables; the guns are mounted on individual steel plates which are connected by chains. Each gun has a separate air hose ("Parker" brand is preferred) and firing line; each string has its hoses and lines gathered in a harness made of streamer tubing. The tail end of each of the four strings is held up by a large (4 ft diameter) polyethylene balloon ("Norwegian" brand) which tows at or near the surface. Two Gardner-Denver four-stage air compressors (145, 200, 700, and 2000 psi) driven by Detroit V6 diesel engines provide the 1800 psi firing pressure used. A clutch failure on one of the drive trains caused a delay of 17 hours two-thirds of the way down the line. With a fixed firing interval of 50 m and a typical ship speed of 5 kts, the repetition rate varied between 18-20 seconds; the capacity of the compressors is insufficient to fire the full 1700 in³ array faster than every 16.5 sec. The firing instant of each gun can be adjusted at the "blaster" (seismic source controller); the smaller guns are delayed by 10-20 msec with respect to the 300 in³ gun so that the peak pressure pulse of all guns coincides (the delays are checked periodically, especially after gun repairs). The guns can be automatically or manually fired either singly or in any combination desired.

The 48 hydrophone channels are recorded on a Texas Instruments DFS III (Digital Field System) composed of 4 binary gain amplifiers (12 traces/module), 2 multiplexers (24 traces/module), 2 nine track tape transports using $\frac{1}{2}$ inch, 1600 bits/in, 3200 FCI tape (609 tapes were used on the IPOD line), 2 "Read-Write" Controllers for the tape transports, one "Format and System Controller", and one system testing module. The DFS III system covers a 7 x 15 foot wall. The data were filtered (8-62 Hz) and sampled every 4 msec. A single channel analog monitor record was simultaneously recorded from trace 47. Unfortunately, the monitor data were offset a few tenths of a second (vertically) each time tape transports were switched, approximately every 15-20 minutes; this was the inexplicable result of the last minute addition of a delay system (to eliminate recording of water travel) and the offset did not affect the taped data.

3" tubing
with 1/8" wall thickness
phones are
between bulk-
heads; the latter
keep tubing
round &
provide
flexibility
there are 6
dead sections
at ship end
of streamer;
tail end has
one complete
dead section
and rope to
tail buoy

Echo-Sounding

A Raytheon 3.5 kHz system was installed just prior to sailing from Savannah, however, it could not be made to work, nor did sufficient parts and know-how exist to fix it. Finally, the recorder was used to record the airgun return via a special 6-foot-long hydrophone section installed near the head of the cable (as was done on the previous USGS lines); in this mode the recorder could not track the sea-floor in water depths greater than 8 sec. Subsequent attempts to remedy this situation resulted in the demise of the recorder. Consequently, almost no useful depth data were obtained and water depth must be determined from the galvanometer records.

Navigation

Two separate navigation systems are in continuous operation: Loran C and satellite navigation combined with sonar-doppler. Loran C, the prime system, is used to follow the pre-plotted trackline. The navigators, who also control the airgun repetition rate, give verbal course corrections to the Bridge; they assert that they normally are within 150 feet of the line and rarely more than 300 feet off it. A troublesome factor on this cruise (again, resulting from the installation of new equipment) was the fact that the shot point number indicated on the Loran navigator's (as opposed to the observer's) display console was affected by extraneous pulses caused by plugging in equipment or turning it on or off. Since the shot point number is related to the supposed position of the ship, this affects the navigator's feeling for drift, etc. and thus causes momentary consternation. Also, for unknown reasons, the IPOD line was pre-plotted only for every other shot point (i.e., every fourth pop) instead of for every shot point, as is usual; this also worked a hardship on the navigator's "feeling" for the position of the ship. Loran C began to fade (initially only at night) about 1300 statute miles down the line and satellite navigation was used for the remaining 800 miles. The satellite system is made by Satellite Positioning Corp, model phase 4. The receiver is an IIT model 5001; the computer is a Systems Engineering Labs. SEL 810B; the magnetic tape unit is SEL 700; the gyro is a Sperry Mark 227; the sonar doppler unit is by Marquart. The satellite receiver is used in the short doppler mode (20 sec). The sonar system works in "water track" mode below 100-120 fms depth. All in all, the concern shown for precise navigation is impressive.

Sonobuoy Measurements

The sonobuoy program, which employed Oceanography International M41-A buoys, was not a success. We had 60 buoys - of 21 buoys launched only 9 worked adequately. All buoys were tested on deck before launch; 5 buoys so tested were not thrown because of excessive rf noise, because they transmitted on several frequencies, or because they could not transmit voice intelligibly. A few of the post-launch failures may be attributed to fouling with the streamer, although the orientation of the tail buoy as well as wind and swell were assessed prior to launch. The identical L-DGO receiving/recording equipment was used successfully on the USGS lines shot in September - the only difference was the use of Navy SSQ-41 sonobuoys. Early on the IPOD line a Navy aircraft inexplicably dropped a pattern of buoys near the ship - these buoys recorded very well; thus it is clear that the fault lies with the Oceanography International buoys. The data were recorded both on the L-DGO profiler and the USGS-provided magnetic tape recorder.

Magnetometer Program

The Varian magnetometer equipment provided by USGS (WIOI) performed flawlessly. Both analog and magnetic tape recordings were made (polarization interval: one minute). Magnetic intensity data were also recorded for five days from the end of the IPOD line to shoal water east of St. Croix, V.I.

Comments on the Single-Channel Monitor Record

On the continental shelf and out to a water depth of 3500 m, the water bottom multiple obscured the deep sedimentary and basement structure, however, further east, where the multiple comes in after the basement reflection (at about 3900 m water depth), the basement is visible beneath 4.2 sec (two-way time) of sediment; Horizon A can also be traced from this point. The mouth of the Hatteras Transverse Canyon was crossed; the so-called "Hatteras Outer Ridge" is clearly an erosional feature. As usual, Reflector "X" is not a sharp, coherent reflection, however, it can be traced out beneath the Hatteras Abyssal Plain, where it appears to pinch out. From the Bermuda Rise to the Mid-Atlantic Ridge the single channel monitor provides no obvious revelations. The line passed through North Pond, as planned, and after a last minute extension of a few miles while awaiting a terminal fix, ended just east of the floor of the rift valley. The monitor reveals no evidence that we inadvertently crossed a fracture zone. Considerable imagination would be needed to infer the existence of sub-basement reflectors from the monitor...

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Client S.L.A.C. 174

Area Batteras East

1. No. of 165' lead-in sections 5-164' plus 143' = 968'

2. Length of gun array 23'

3. Distance from stern to nearest gun 45'

4. Depth transducer sections are in front of groups Behind Group 1 and
in front of groups 12, 24, 30, 34, 40, 44, and 48.

5. Birds are in front of groups 4, 8, 16, 20, 26, 28, 32, 36, 38, 42, 46, and all Xdr sections.

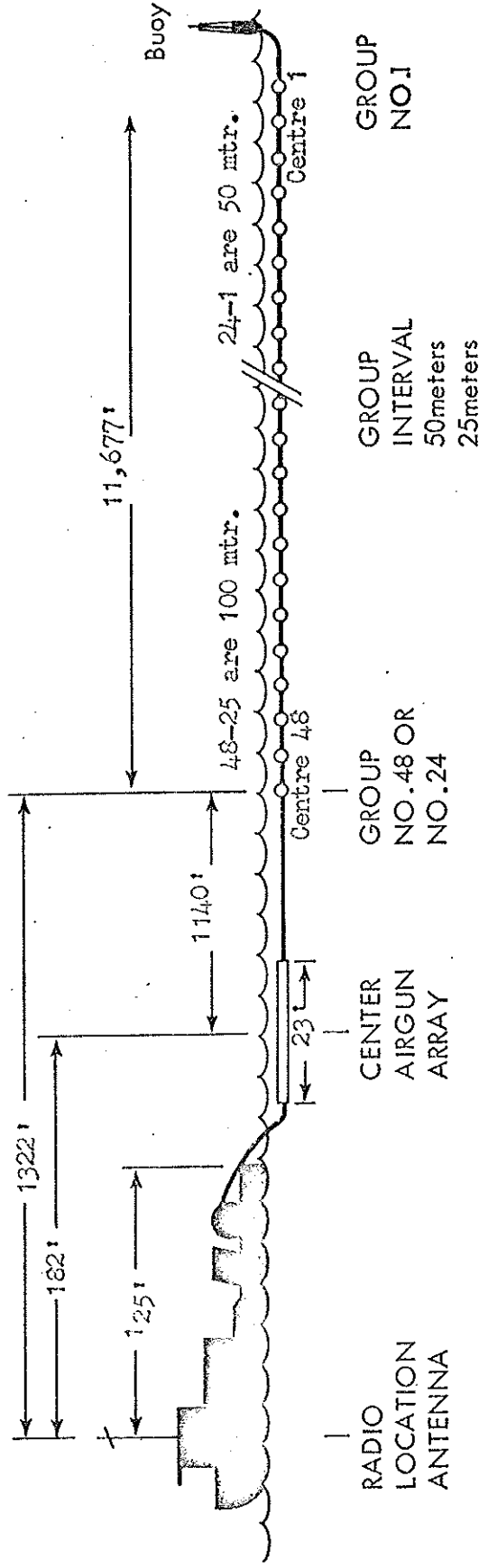
6. 2 weighted sections of length 26' each.

7. 1 Bottom tracker section length 6'



HOUSTON, TEXAS 77006

Note: Xdr and bird sections 6' long
Adapters 3" long.



AIRGUN ARRAY SKETCH

Vessel Gulf Seal

Date: October 23/74

Note: Prior to Oct. 23, offset distance was 1134' (16' bottom tracker added on that date)

Gun Array Minimum with spares 1920 cu. ft.

Maximum used 1700 cu. ft.

Minimum 1400 cu. ft.

← DEPT TO BOAT ← WEIGHT TRACKER ← DEAD

WEIGHT TRACKER 148