

ANALYSIS OF "ECHO SOUNDING" DATA NORTH-CENTRAL PACIFIC  
(INCLUDING R/V VEMA MARINE GEOLOGY/GEOPHYSICS CRUISE IN THE NORTH PACIFIC)

Progress Report  
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July 1, 1975 - May 15, 1976  
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PROGRESS REPORT  
Contract E(11-1) 2430

ANALYSIS OF "ECHO SOUNDING" DATA NORTH-CENTRAL PACIFIC

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Associate Professor of Geology

Abstract

Marine geological and geophysical data have been collated and synthesized for the area in the North Pacific bounded by 29°N and 31°N; 156°W and 160°W. Particular emphasis has been given to assessing the disposition of the sediment blanket and underlying crystalline basement (layer 2) through the examination of a variety of seismic observations. In July 1975 a 15-day cruise aboard R/V VEMA focused on the collection of a suite of piston cores, heat-flow measurements, high and low frequency seismic profiling, wide angle seismic reflection/refraction using sonobuoys, special near-bottom seismic experiments bathymetric measurements, special heat-transfer experiments, and a variety of complementary marine geological and geophysical observations.

The preliminary results of the cruise and their interpretation in the framework of other existing data is summarized.

A synthesis of bathymetric data from several different sources has been underway. The resultant contour map at 50m intervals for the region 30°00'N - 31°41'N and 156°50'W - 159°10'W is enclosed.

A marine geological and geophysical assessment of potential waste disposal sites in the North Atlantic has progressed through continuing data library researches and synthesis.

The R/V VEMA cruise 32-11 departed Honolulu 1 July 1975 and ended in Honolulu on 16 July 1975. Most of the 15-day cruise was spent within an area about 200 km by 200 km, centered near 30°N; 159°W north of the Murray fracture zone (see Figure 1). Continuous 100 Hz seismic (airgun) profiling (see Figure 2) and 3.5 kHz echo sounding (see Fig. 3) was conducted throughout the cruise. In addition, 13 expendable sonobuoys were deployed to determine the compression wave velocities of the basement rocks. Ten of these experiments yielded useful results. Near-bottom seismic experiments using a 3.5 kHz bottom pinger and telemetered bottom hydrophone were conducted at five sites in an attempt to precisely delineate the geometry and seismic properties of the uppermost sediment blanket approximately 50 m thick (or less). Examples of these records are shown in Figure 4. This constitutes one of the first attempts to make this type of in situ velocity measurement and the preliminary analysis confirms that  $V_p$  for the uppermost sediments is equal to or slightly less than  $V_p$  for water ( $\sim 1530$  m/s).

Further analysis of these experiments is essential in order to evaluate certain in situ geotechnical properties of the sediments which relate to possible free-fall cannister emplacement techniques. The collective family of seismic observations will allow us to define the properties of the sediment blanket, their variability and predictability.

Additionally, ten piston cores, each approximately 10 m long, four large diameter gravity cores, heat flow stations, camera/nephelometer stations and other observations are summarized in Figure 1 and appendix 1 and 2.

Revised bathymetric and sediment isopach maps of the survey area incorporating the VEMA data are now in preparation.

A highly interesting and pertinent special heat transfer experiment was devised in conjunction with Marcus Langseth and successfully implemented at two sites within the survey area. The experiment is described in detail in appendix 3. The results of this pilot experiment are extremely important in evaluating the effectiveness of the sediment as a barrier for all potential exchange processes which have a significant temperature dependence.

Normal heat flow observations were conducted and show very consistent results with values ranging from about 1.24 HFU to 1.70 HFU, slightly higher than expected for crust of the age ( $\sim 100$  m.y. old). See also appendix 2.

#### Brief Summary of Survey Results

1. Approximately 1200 n. mi. of continuous bathymetric and seismic data were collected in the survey area, largely along E-W oriented lines. Previous data in the area was confined almost entirely to N-S lines.
2. Numerous cores were obtained for sedimentation, chemical, and geotechnical studies.
3. An average of  $\sim 1.50$  HFU was established as the representative heat flux for the area and with little scatter among 10 observations.
4.  $V_p$  velocities were obtained for two main oceanic crustal layers (layer 2  $V_p \approx 5.0$  km/s; layer 3  $V_p \approx 7.0$  km/s). Uncertainties remain regarding the thickness of high velocity cherts and/or layer 2A ( $V_p \approx 4$  km/s) lying between the known low velocity, thin clay veneer and the crystalline basement layer 2. These uncertainties should be resolvable through further analysis of existing data.

5. Surface sediments within the survey area transfer heat conductivity for delta temperature at least as great as 50°C.
6. There are indications from sonobuoys of a subtle N-S grain or fabric (possibly the relief of the basement layer) that is not readily apparent from the bathymetric studies even though the area has rather high density of sounding lines.
7. Near surface sediments exhibit low  $V_p$  velocities very nearly equal to that of the overlying water layer.

#### Bathymetric Summary

Track coverage for most of the region is excellent although the preponderance of tracks lie north-south. Since most VEMA 32-11 data was collected along various azimuths other than north-south, this cruise provided significant additional bathymetric data.

The 5850 m isobath occurs more frequently than any other contour, suggesting that this is probably the average depth for the region. There is a gentle slope from northwest and southwest toward the east. A single seamount (relief  $>1000$  m) exists at 31°12'N 157°45'W and several abyssal hills greater than 300 m were mapped north of 31°. Individual peaks and deeps coalesce to form low ridges and troughs along a NNW-SSE trend, a feature that will be discussed in detail below.

In the progress report for July 1, 1975 - October 31, 1975, we noted that sonobuoy results suggested the presence of a subtle north-south grain or fabric in the basement layer that was not readily apparent from the bathymetric studies done at a 100 m contour interval. Subsequently, the region was recontoured at 50 m intervals and additional bathymetric data

were included. A topographic fabric is present in varying degrees for the region that trends slightly west of north, approximately perpendicular to the predicted direction of seafloor spreading.

Thus the sonobuoys and the bathymetry for the region suggest that subtle characteristics of the basement morphology have not been appreciably masked by 100 m.y. of sedimentation.

The line drawings from Figure 5 of the seismic reflection profiler records show the diversity of fabric that was indicated previously. In particular, note the frequency of slope reversals in profile AA' compared to BB'. AA' is orthogonal to the basement ( $\sim$ E-W line) Fabric while BB' parallels it ( $\sim$ N-S line). Another feature of the bathymetry that is evident from the line drawings is a zone of very low relief in the west central portion of the map. Abyssal hills are infrequent here and generally this is flatter than any other region in the study area. The dotted peak is a side echo from a peak slightly west of the ship's track.

Regional relief for the area is very low (1:500 - 1:1000) but much steeper gradients ( $>1:10$ ) occur near individual hills.

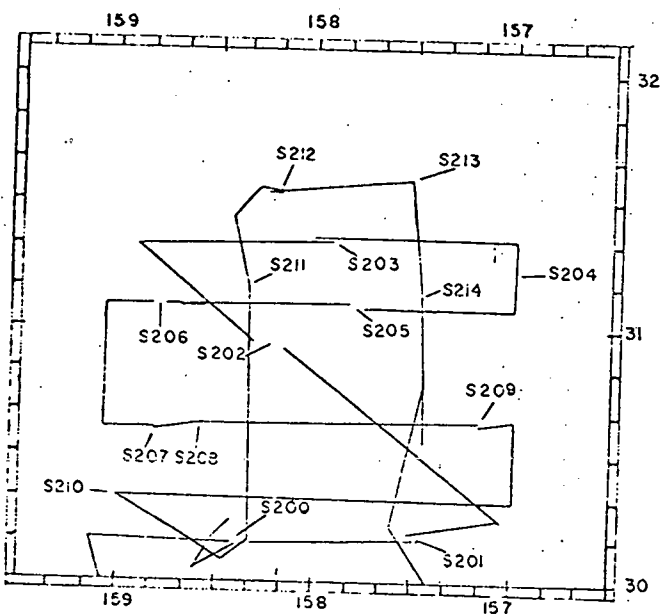
The remainder of Figure 5 is devoted to a schematic representation of the various seismic studies conducted to date. An attempt was made to interpret and extrapolate data from piston cores, seismic studies and Deep Sea Drilling Project results in a geologic framework. The upper 10 meters of sediment is predominantly red brown clay with minor amounts of coarse material and nothing from the seismic studies suggest that a significant change in lithology occurs in the remainder of the sediment column. An

exception to this may be the presence of very thin layers of volcanic ash scattered throughout the sediment column, and, near the basement/sediment interface, layers of chert or volcano-clastic debris. Future studies utilizing the near bottom seismic results will attempt to refine the stratigraphy.

- Figure 1 Index map, station chart and table.
- Figure 2 Sample 100 Hz, vertical incidence seismic profiler records.
- Figure 3 Sample 3.5 kHz echograms.
- Figure 4 Two wide angle reflection records for near-bottom seismic experiments conducted at 3.5 kHz.
- Figure 5 Acoustic characterization of MPG 1 sediments.  
Line A-A' approximately oriented E-W.  
Line B-B' approximately oriented N-S.

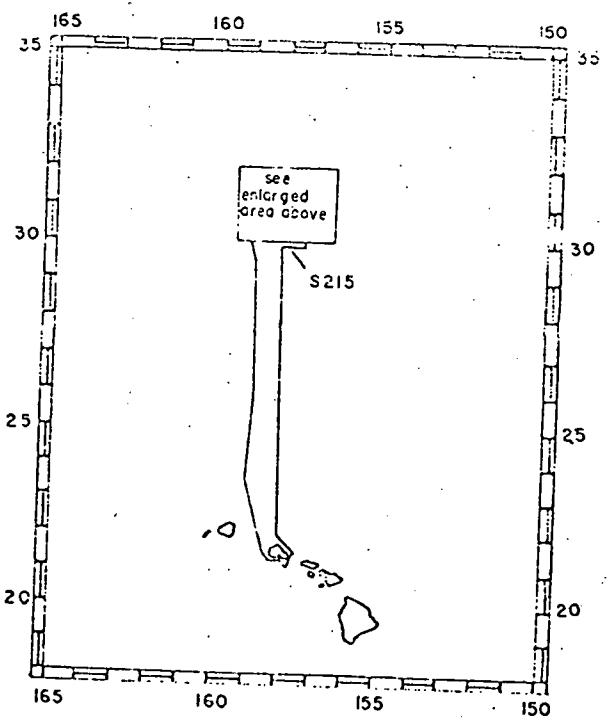
R/V VEMA  
 Cruise 32-11  
 Honolulu to Honolulu  
 July 1 - July 16, 1975

Dr. Dennis E. Hayes,  
 Chief Scientist



Ship Station	Core	Thermograd (heat flow)	Special heat transfer	Camera	Nephelometer	Near-bottom seismics	Gravity core	Pebble dredge	
S200	CI13	TG 22	SHF	K85	N52	NBS	GC	PD	JULY 4
S201	CI14	TG23A		K86	N53				4
S202			SHF1			NBS 1			5
S203				K37A	N54	NBS 2	GC 1		6
S204				K87	N55		GC 2		7
S205							GC 3		7
S206			SH2A						7
S207	CI15	TG 23				NBS 3			9
S208	CI16	TG 24		K88	N56				8
S209	CI17	TG 25		K89	N57	NBS 4			9
S210	CI18	TG 26		K90	N58			PD1A	10
S211			SHF 2						11
S212	CI19	TG 27		K91	N59	NBS 5		PD1	11
S213	CI20	TG 28							12
S214	CI21	TG 29							12
S215	CI22	TG 30		K92	N60	NBS 6	GC 4	PD 2	13

S893-105



LEG TOTALS:  
 STEAMING TIME 240.2 hrs.  
 STATION TIME 113.9 hrs.  
 DISTANCE 2247 mi.

Figure 1



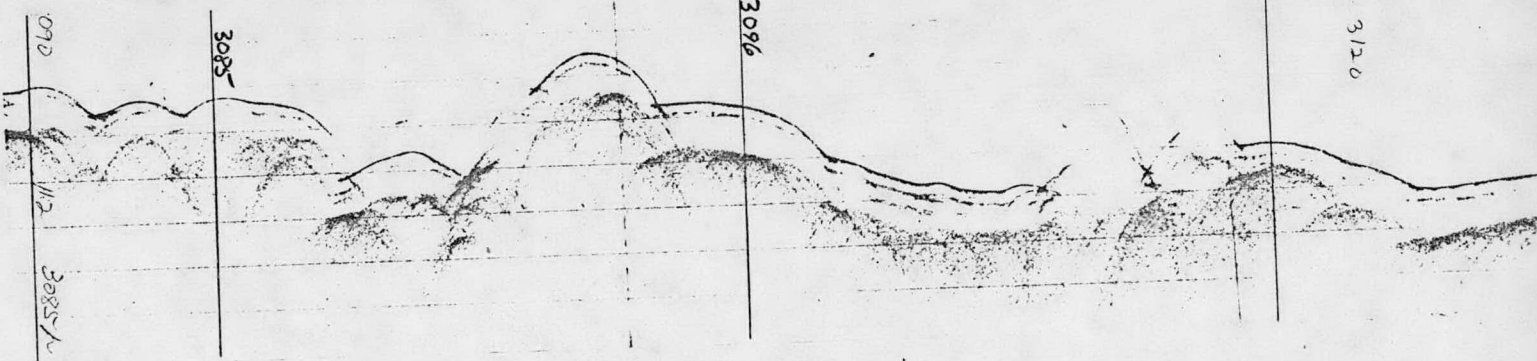
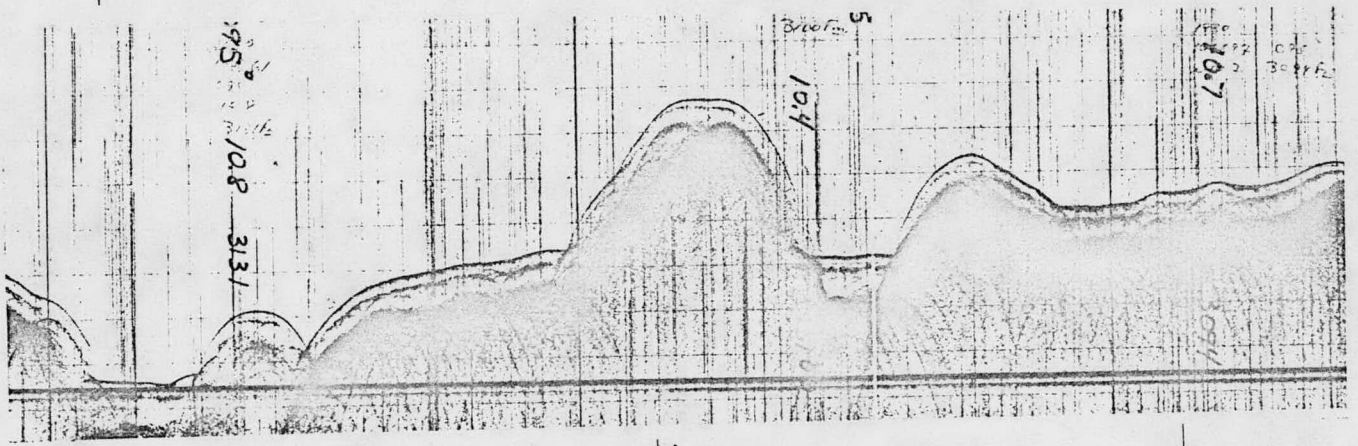
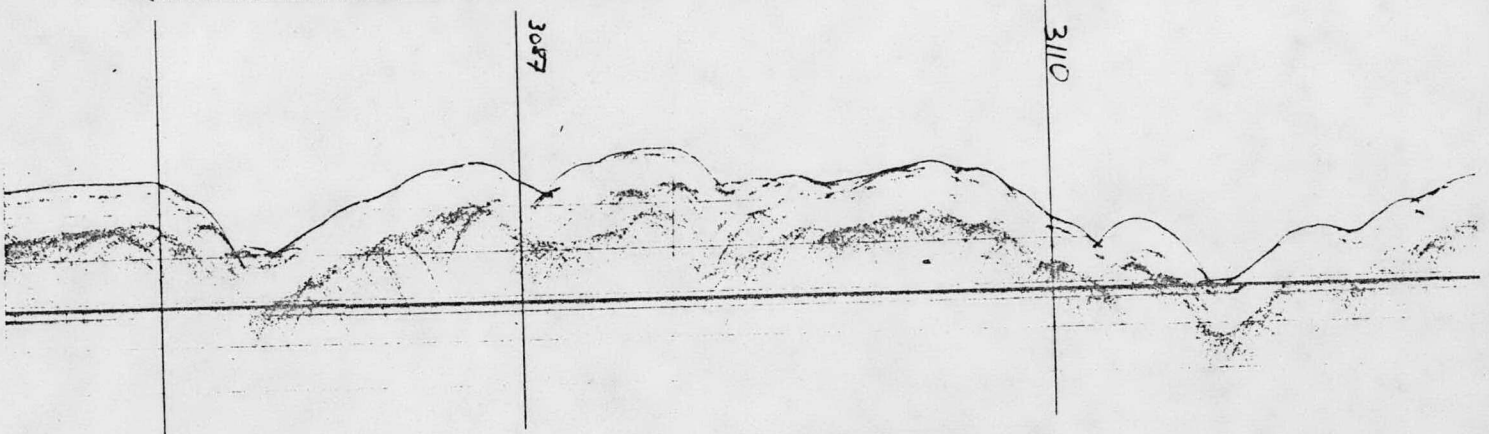
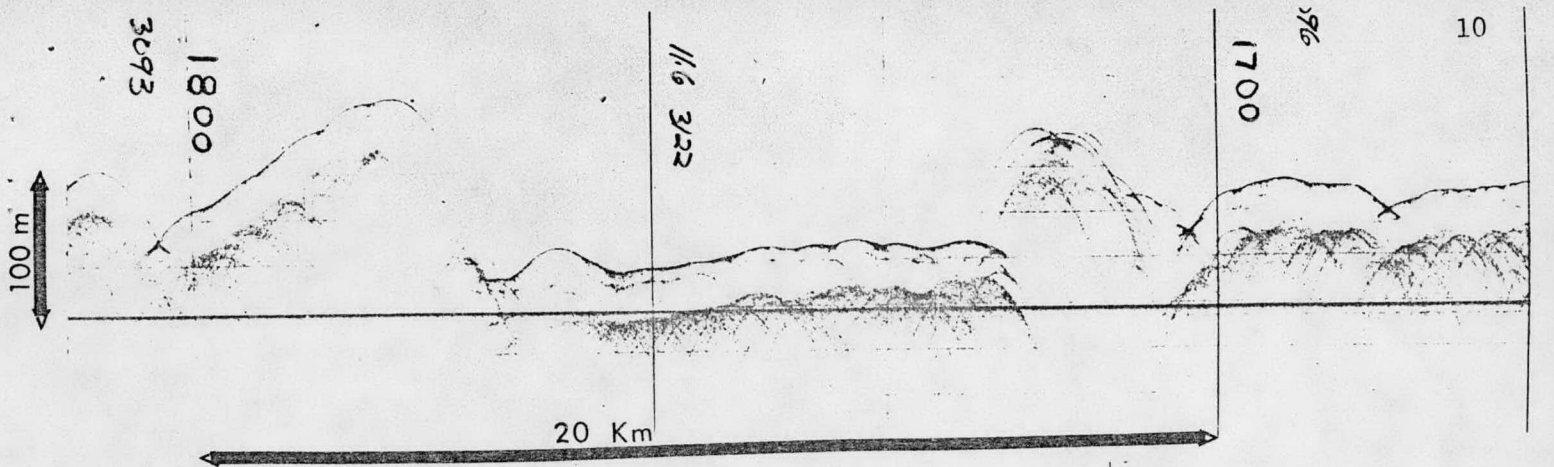
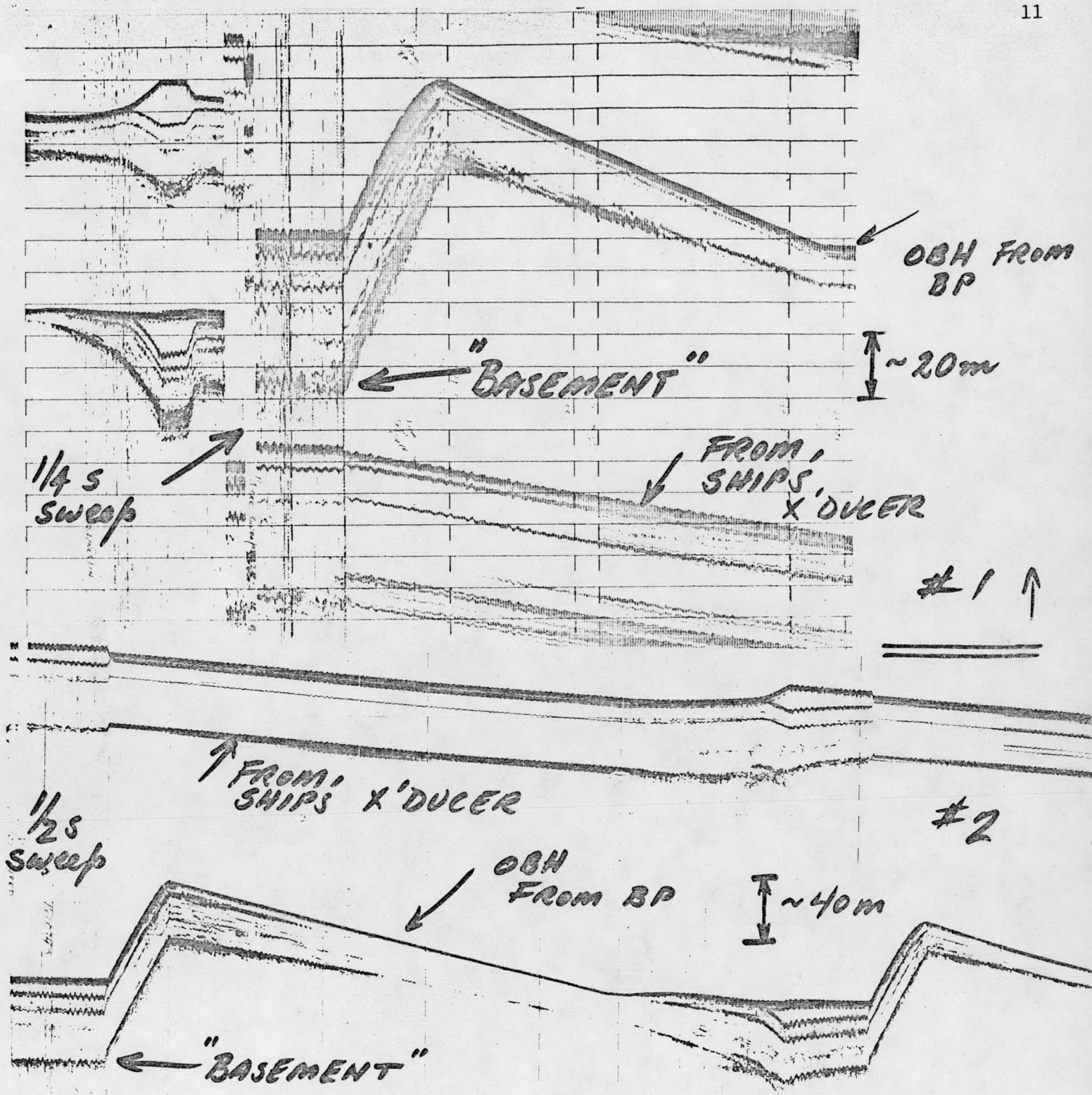


Figure 3



(OBH) OCEAN BOTTOM HYDROPHONE SIGNALS  
 FROM: A) BOTTOM 3.5 KHZ PINGER (BP)  
 B) SHIP'S 3.5 KHZ TRANSDUCER  
 FOR TWO SEPERATE OBH EXPERIMENTS

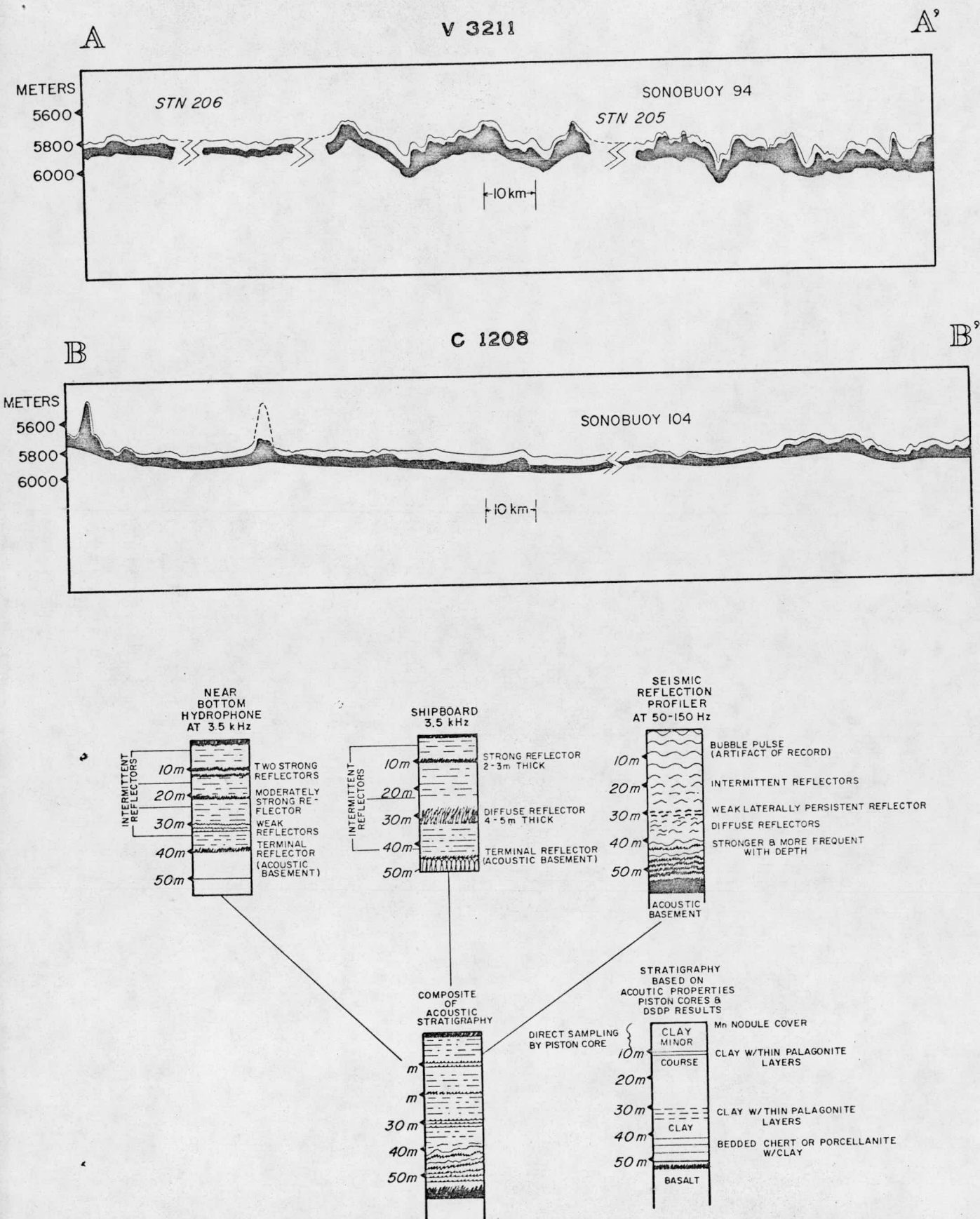


Figure 5