THE SUB-BOTTOM SEISMIC STRUCTURE OF THE GULF OF LA SPEZIA
(A preliminary report)

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The sub-bottom seismic structure of the Gulf of La Spezia has been explored by an acoustic reflection technique. This acoustic reflection technique is capable of providing a continuous record of the locations of acoustic discontinuities that underly the sea floor. Acoustic discontinuities can be caused by sediment layers, buried boulders or man-made objetcs, gas pockets, biogenic formations such as shell or coral reefs, and bedrock. Coring operations have already taken place and are continuing in the Gulf of La Spezia to establish the nature of the various acoustic discontinuities that have been located by the acoustic reflection technique.

The instrument used in the acoustical survey was a « Mud Penetrator » (Ref. 1) which is a commercially obtainable instrument that is produced by the firm of EDGERTON, GERMESHAUSEN and GRIER, in Boston, Massachusetts. This instrument operates on the principale of electronically generating an acoustic pulse in the water and recording the arrival times of the acoustic echoes from the bottom and sub-bottom on an analogue correlation recorder. Echoes returned from acoustic discontinuities are synthesized by the correlation recorder so that a graph of the bathymetry and sub-bottom structure along a profile is directly obtained. The principle features of the « Mud Penetrator » that give it the capacity to penetrate the sea floor and resolve fine structure are its high peak power output (about 105 dB//1 dyne/cm^2), short pulse length (about 0.1 millisecond), and high repetition rate (10 or 20 pulses per second).

The seismic survey was performed with the 65 foot work-boat of the SACLANT ASW Research Center; the recorder-driver unit of the « Mud Penetrator » was placed in the wheelhouse, the transmitting and receiving transducer, mounted in a towable « fish » was towed alongside the boat, and a 500 watt gasoline generator which provided power for the entire system was installed on deck. The survey was conducted with the boat underway at 2 or 3 knots. A plot of the cruise track over which « Mud Penetrator » recordings were obtained is presented in figure 1. The solid lines represent track made with navigation consisting of optical angular bearings of land objects at 5 minute intervals. The dashed lines represent track made with navigation consisting solely of shore line observation and distance estimation.

A photograph of an actual « Mud Penetrator » record (references 2 and 3) is presented in figure 2 to demonstrate some features of the sub-bottom structure in the Gulf. This record was taken along a west to east profile along roughly the 44°05' latitude line. The layer of maximum penetration occurs at a depth (all depths referenced to the sea floor) of 10 to 14 meters on the westerly half of the profile, rises midway along the profile, and occurs at a depth of 3 to 4 meters on the easterly half of the profile. This layer seems to be rough (long echo), is a good acoustic reflector (relatively dark mark on the record), and a poor acoustic transmitter (termination of penetration). It therefore appears to represent bedrock. Three intermediate depth

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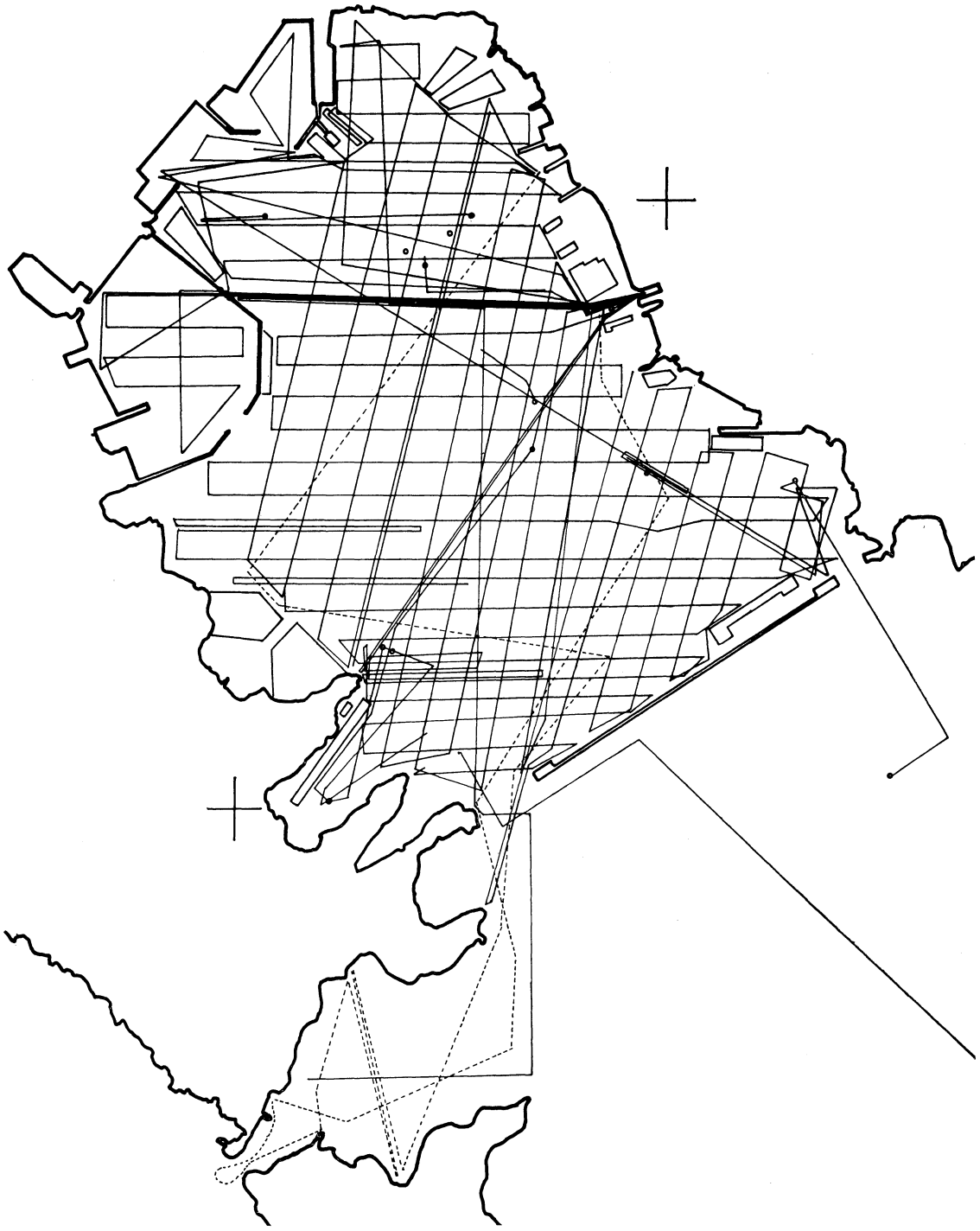

FIG. 1. — *Cruise tracks. Gulf of La Spezia.*

layers are present on the westerly half of the profile. The shallowest of these layers occurs at a depth of 5 to 6 meters and extends all the way across the westerly half of the profile, and terminates abruptly against the rising bedrock (actually on a « light hill » in this record). It seems to have a smooth surface (short echo), is a moderate acoustic reflector and transmitter (both a strong return and penetration), and has a uniform aerial distribution (constancy of tonal shading on the record). The other two intermediate layers occur at a depth of about 8 and 10 meters, are present only at the extreme western edge of the profile, and appear to pinch out toward the

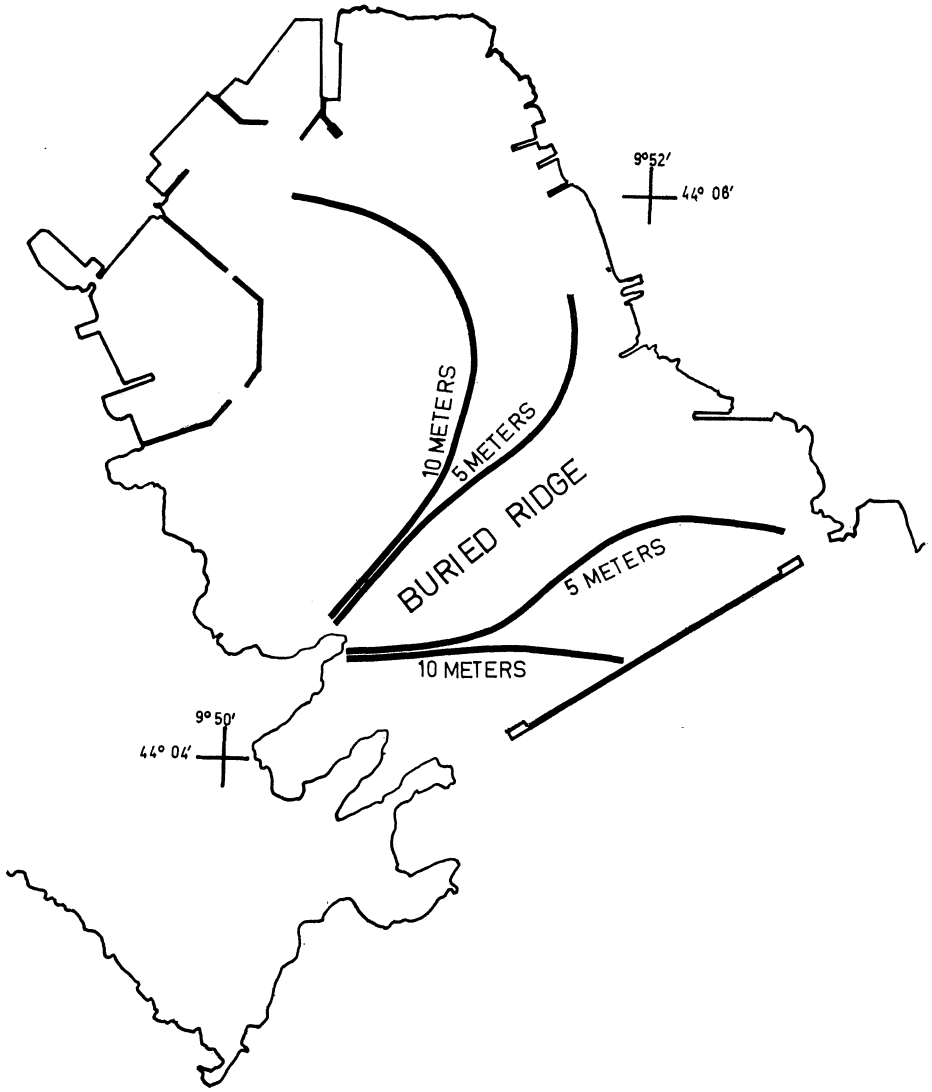

FIG. 3. — *Topographical chart of the bedrock in the gulf of La Spezia* (depths referenced to distance below the present sea floor).

east. They seem to have a rough surface (long echo), and an irregular aerial distribution (variable tonal shading on the record). A shallow layer at a depth of 2 meters is present throughout the entire length of the profile, though it is barely visible on this figure. It appears to represent a very slight change in sediment type (weak echo). It is not certain at present that this layer is real; perhaps it is an extraneous reflection from the boat. Two other interesting features on this profile are the buried « light hills » and « dark hills ». The « light hills » are caused by something which is a good acoustic reflector (strong echo) and a poor acoustic transmitter (no penetration).

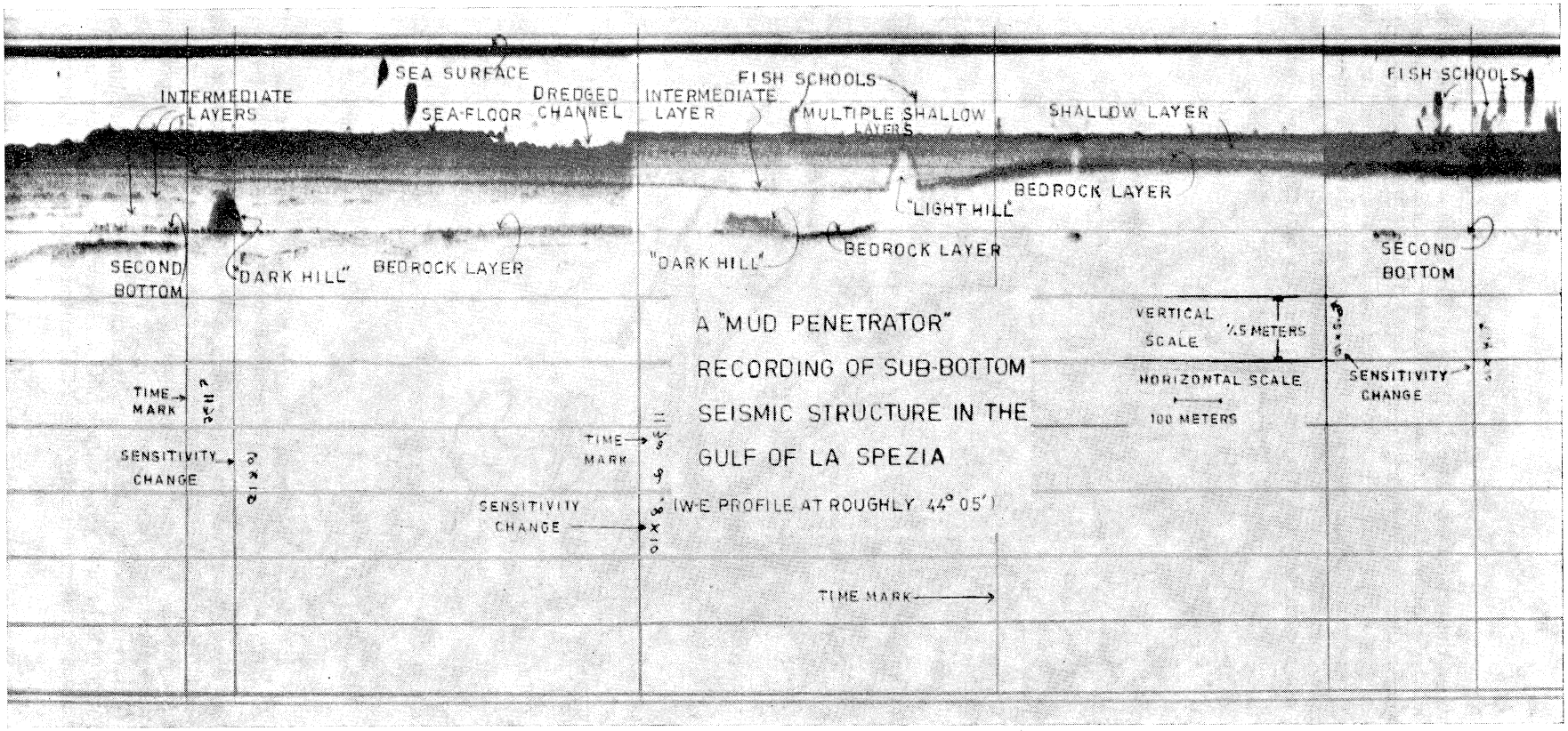

FIG. 2. — *Mud Penetrator record.*

The « dark hills » are caused by something which provides a long and strong echo. This could be on extremely rough and acoustically opaque surface. It also could be a concentrated assemblage of small but good reflectors (note the similarity to the fish schools also present on this record).

A topographical chart of the bedrock in the Gulf of La Spezia is presented in figure 3. This was constructed from an analysis of most of the « Mud Penetrator » records obtained and represents the depth to the maximum depth layer. Note that a buried ridge extends across the mouth of the inner gulf. Two cores were taken on this ridge with the following results : (1) an upper meter of mud, followed by a tenth of a meter of sand and fiber; nose of coring tube nicked; (2) same as (1) but nose of coring tube completely smashed. This of course is a confirmation that the maximum depth layer is bedrock.

The aerial distribution of the shallow layer, intermediate layers, « light hills », and « dark hills » was plotted. The shallow layer is found everywhere in the gulf while the intermediate layers are found only on the landward side of the buried ridge. Apparently the source of sediment for the intermediate layers was landward of the buried ridge and the zone of sedimentation was terminated by the ridge. The « light hills » are almost always found where the bedrock is shallower than ten meters and the « dark hills » are almost always found where it is deeper than 10 meters. Both types of « hills » tend to be distributed in patches, in fact, some of them obviously represent traverses across elongated structures. Two cores were taken in a patch of « light hills » with the following results : 1) two meters of mud and 2) two meters of mud and fragments of branching coral; the coral constituted about half the core by volume and some individual fragments were of a length approaching the diameter of the coring tube (about 50 m). It appears that the « light hills » represent coral reefs. No coring has as yet been done on the « dark hills ». It is suspected that they are biogenic and perhaps represent accumulations of shell debris.

As mentioned in the title, this is a preliminary report. A final report must await a more thorough perusal of the acoustic records in hand and subsequent coring operations in the Gulf.

Discussion.

M. Breslau. I do not know what the « white hills » that are in the seismic record are. They are acoustic discontinuities of course and *could be* caused by ignious intrusions or buoy moorings or buried bombs. We intend to core the area in two weeks. I do not think they are gas pocket because of their small aerial extent.

M. Sègre : demande à M. Breslau s'il a une idée au sujet de la nature géologique de la dorsale qu'il a reconnue transversalement au golfe de La Spezia.

M. Breslau. Selon l'opinion des géologues de l'Université de Pise qui ont été consultés à ce sujet, ce serait du rocher du substratum.

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