

NATIONAL ACADEMY OF SCIENCES

NATIONAL RESEARCH COUNCIL

DIVISION OF EARTH SCIENCES
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The AMSOC Project to Drill a Hole to the Mohorovicic Discontinuity

The M discontinuity is that between the Earth's crust and the mantle. It is found at about 35 km under the continents but may be as close as 4 km under the sea floor.

History of Project

At a meeting of the Earth Sciences Panel of the National Science Foundation in March 1957, the members of the Panel observed that of the 100 or more requests for grants considered during the year, the majority were very good or excellent projects but that no one of them attempted courageously to break through to new ground on major problems of the science. They dealt in general with small though highly desirable pieces of research.

Dr. Walter Munk suggested that we should consider what project, regardless of cost, would do the most to open up new avenues of research and suggested that a sample of the mantle would be the single most significant item. The project to drill a hole and get such a sample was thus born. The present writer strongly favored Munk's idea and suggested referring it to the American Miscellaneous Society for action. This was done and a meeting was held in California in April to discuss the proposal. It was enthusiastically endorsed.

On April 27, 1957 at a meeting at the Cosmos Club the following AMSOC committee was set up to attempt to put the program into action:

Mr. Gordon Lill	Office of Naval Research (designated Chrm.)
Dr. M. Ewing	Columbia University
Dr. W. W. Rubey	U. S. Geological Survey
Dr. Carl Alexis	Office of Naval Research
Dr. H. H. Hess	Princeton University
Dr. R. R. Revelle	Scripps Institution of Oceanography
Dr. H. S. Ladd	U. S. Geological Survey
Dr. J. I. Tracey	U. S. Geological Survey
Dr. Walter Munk	Scripps Institution of Oceanography

The American Miscellaneous Society has no officers, no constitution, no by-laws and consequently can act expeditiously and without red tape when action is appropriate. It is an organization which warrants respect. Note that five of its nine-man committee are members of the National Academy of Sciences. Its organization is not such that it can accept funds from the National Science Foundation and therefore it comes to the Academy-Research Council for sponsorship.

The Executive Committee of the Division of Earth Sciences, NAS-NRC, considered the proposal at its last meeting and passed it on to the Governing Board, NAS-NRC, with approval and a strong recommendation to accept up to \$50,000 in funds to study the feasibility of the project.

The project was also supported by the Associations of Seismology and Oceanography of the International Union of Geodesy and Geophysics in a resolution which was passed by the General Assembly, IUGG, in Toronto in September 1957.

Evaluation of Objectives in Drilling a Hole to the M Discontinuity

There probably is no project, within the scope of present capabilities, which would give more information concerning the broad picture of the Earth

as a planet than drilling a hole through the sediments, and the so-called "basalt" layer and finally into the upper mantle. It can be looked upon as a courageous attempt to broaden the base on which the most fundamental of Earth problems rests.

A. If an authentic sample of the material below the discontinuity were obtained one could establish the following attributes for the following purposes:

1. Density. The density of materials from the surface to the center of the Earth has been computed by Bullen and more recently by Bullard. These computations are based on the moment of rotational inertia of the Earth and are highly sensitive to the initial density assumed at the top of the mantle. If an exact figure could be given to this, the validity of the rest of the column would be greatly enhanced. The density values could also be used to great advantage in analyzing gravity anomalies in oceanic areas.

2. Composition, bulk and mineral phases. If the composition and mineralogy of the top of the mantle were known a much more valid Earth model could be constructed. High pressure and high temperature research could be concentrated on the type of material found rather than on some hypothetical preference. The validity of the meteorite analogy as a model for the Earth's interior could be tested. The hypothesis of a high pressure phase of basalt existing below the discontinuity could be proved or disproved, or the olivine nodule hypothesis could be similarly dealt with.

3. Radioactivity. Some clue to explain the anomalously high heat flow from the floor of the ocean might be obtained.

4. Age. Possibly the M discontinuity represents the primordial surface of the Earth and the rock material found there formed at the beginning of the Earth's history. If some means of determining its age could be found the result might be highly significant.

5. Isotopes of Pb, and the total Pb and U. If primordial, the isotopic composition of the Pb corrected for the radiogenic Pb from U and Th present would significantly enhance the understanding of all Pb isotope age work.

B. What is the layer immediately above the M discontinuity with a seismic velocity near 6.5 km/sec? While it is generally said to be basalt, there is no evidence to substantiate this hypothesis other than that the velocity is appropriate. It would also be appropriate for a variety of other materials. What is the origin of this layer?

C. The sedimentary column from the sea floor to the material mentioned above could be sampled. Such a sample in the deep sea might give a complete sedimentary column stretching back to the beginning of the oceans. The fossil flora and fauna in this column back to the first appearance of life in the sea would be extremely interesting if it could be obtained. Or perhaps one would find that the oceans are relatively recent features on the Earth's surface. In any case here is a whole new world to explore.

D. Overall properties of the materials through which the hole passed could be measured to great advantage.

1. Thermal. One would like to obtain figures on the temperature gradient, conductivity and a consequent better understanding of heat flow.

2. Seismic Velocity. A seismic velocity log could be obtained which would form a better basis to understand seismic results at sea and perhaps test for seismic anisotropy in different directions around the hole.

3. Magnetism. The magnetic properties of the materials in the hole could be obtained. This would certainly lead to a much better means of interpreting the magnetic anomalies at sea. The direction and sign of the remnant magnetism of the rock samples progressively down the hole could be determined, perhaps shedding some light on paleomagnetic problems.

4. Electrical properties. Various types of electric logging could be done coupled with laboratory measurements on the samples.

Above are most of the obvious objectives but no doubt in probing into new and unexplored territory, the unexpected discoveries might play a large role in the final outcome.

The discussion has been limited to a site of drilling in the deep sea. Some months ago it seemed possible that a site on an atoll might be equally fruitful. This seems much less likely since Raitt's seismic profiles around Eniwetok have appeared. Such a site always had the disadvantage of drilling through the underpinnings of a volcano. It now has the additional disadvantage of being considerable deeper to the M discontinuity than had been supposed - well in excess of the 30,000 feet of the older estimate.

Prepared for the AMSOC Committee by H. H. Hess

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