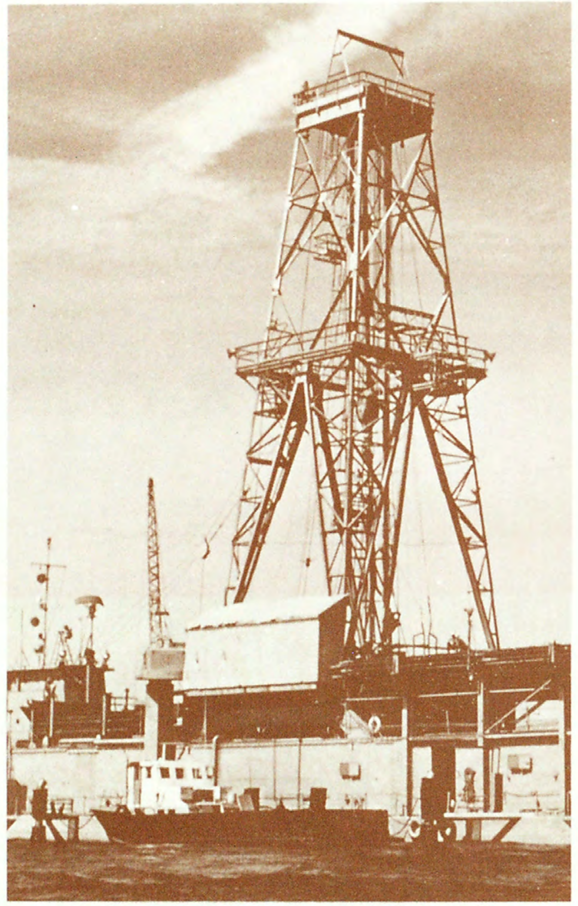
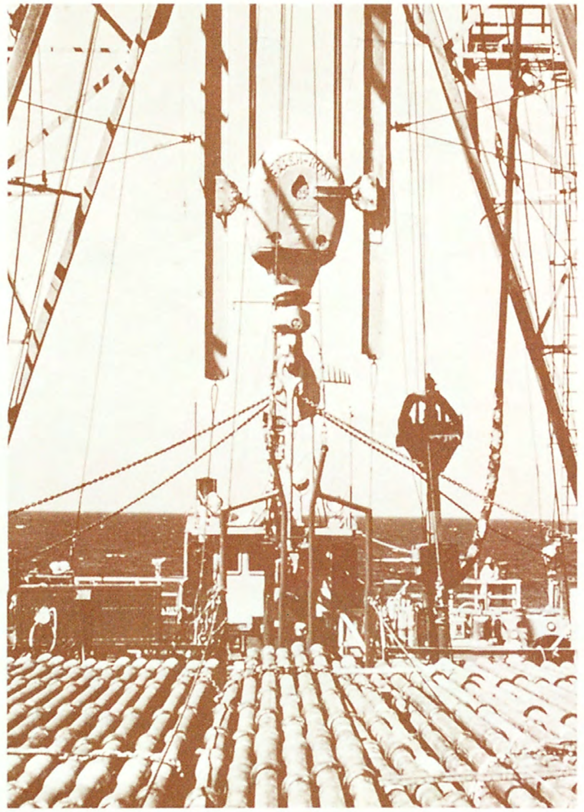
This maneuverable rig developed for deep-ocean drilling tests represents an early stage in a plan to penetrate the Earth's crust and reach the mantle.





Pressure and density at all depths are known to a fair degree of accuracy, but variation of temperature with depth is less well-known. Most of the Earth's heat is now believed to come from radioactivity of certain chemical elements, principally potassium, uranium, and thorium, rather than from a molten central mass.

The crust ranges in thickness from about 4 miles in places under the oceans to about 30 miles under high mountains. Rocks having the composition and geophysical properties of granite predominate in the upper part of the crust and rocks having the properties of basalt predominate in the lower part. Under the oceans the crust seems to be almost entirely basalt.

The upper and lower layers of the mantle are believed to consist chiefly of iron magnesium silicates, but the details of their composition and structure are not known. The boundaries beween the layers are gradational.

The core of the Earth is believed to be from 80 to 85 percent iron. This estimate is based on the densities of the core's layers, the behavior of seismic waves through them, the known abundance of iron in meteorites, and the measured proportion of iron in the Sun and stars.

The Earth's magnetic field may be produced by electric currents generated by circulating molten iron of the outer core.

The study of the Earth's interior is exceedingly complex. Scientists of the U.S. Geological Survey, using the latest equipment and techniques, continue to search for answers to questions posed by each new discovery.

As the Nation's principal conservation agency, the Department of the Interior has responsibility for most of our nationally owned public lands and natural resources. This includes fostering the wisest use of our land and water resources, protecting our fish and wildlife, preserving the environmental and cultural values of our national parks and historical places, and providing for the enjoyment of life through outdoor recreation. The Department assesses our energy and mineral resources and works to assure that their development is in the best interests of all our people. The Department also has a major responsibility for American Indian reservation communities and for people who live in Island Territories under U.S. administration.

☆U.S. GOVERNMENT PRINTING OFFICE: 1975-587-033/24

For sale by the Superintendent of Documents, U.S. Government Printing Office
Washington, D.C. 20402 - Price 25 cents

The INTERIOR of the EARTH

UNITED STATES
DEPARTMENT OF THE INTERIOR
GEOLOGICAL SURVEY

USGS: INF-73-16 (R. 1)

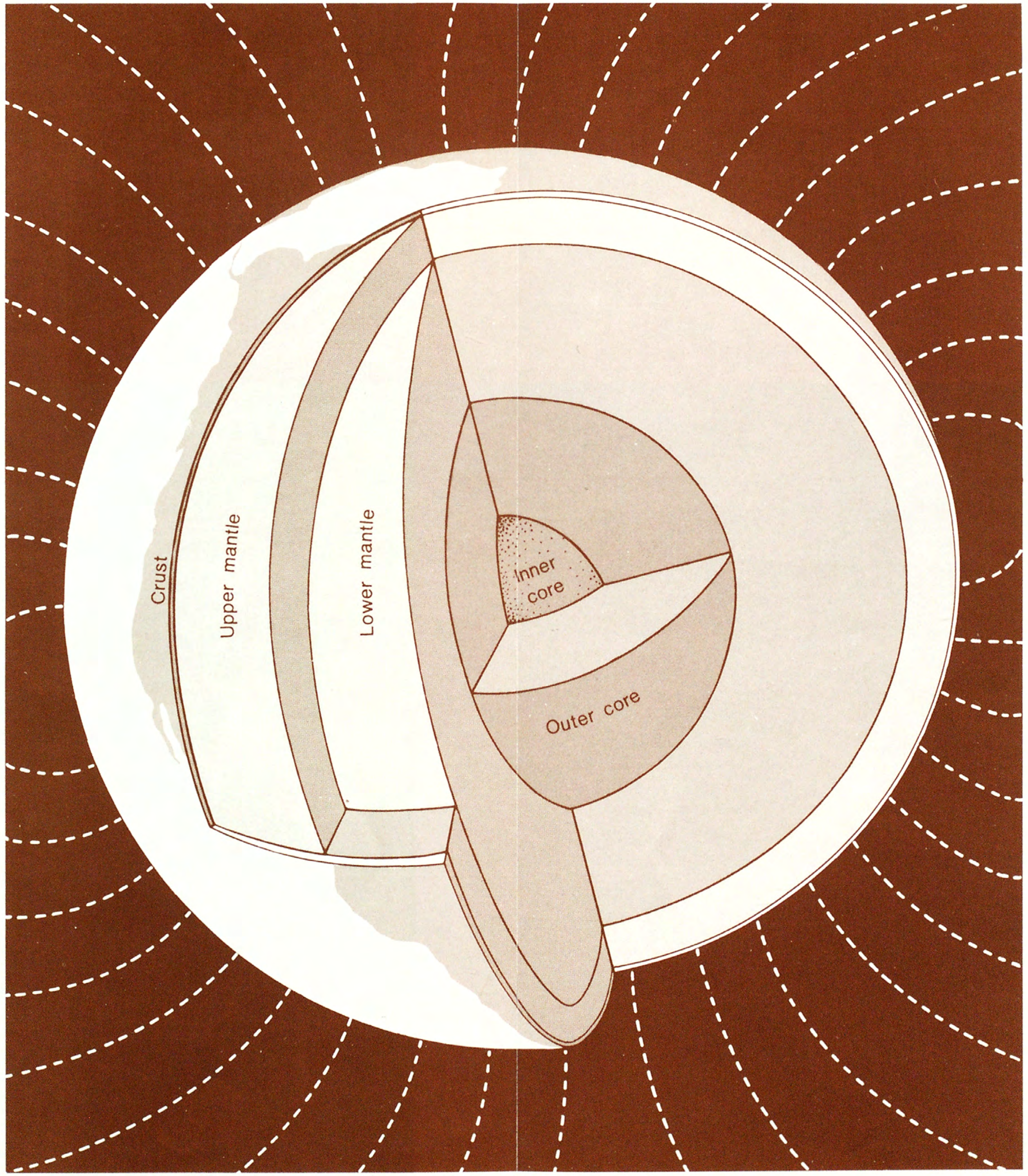
The INTERIOR of the EARTH

The center of the Earth lies nearly 4,000 miles beneath our feet. At present the nature of the Earth's interior is known only from indirect evidence collected from studies of rocks and minerals, seismic waves, heat flow from the interior, and the Earth's gravity and magnetic field and through comparisons of the Earth with other planets, with meteorites, and with the Sun and other stars.

From such evidence, scientists have deduced that the Earth has a heavy core surrounded by concentric layers. The three main parts of the Earth are: the crust, which is a thin surface skin; the mantle, which extends from the crust about halfway down toward the center; and the core. The crust makes up less than 1 percent of the Earth by volume and about four-tenths of 1 percent by weight. The mantle is 84 percent by volume and 67 percent by weight, and the core 15 percent by volume and 32 percent by weight.

To date, man has drilled about 5 miles into the Earth, but it is unlikely that a hole can be drilled into the deep interior. It is believed possible, however, to drill a hole that will penetrate the crust and enter the mantle, passing through the narrow region between crust and mantle known as the Mohorovičić discontinuity. Such a hole would provide much data on the nature of the Earth's interior.

Studies indicate that seismic waves from earthquakes and man-made explosions change their speed and direction as they travel through the Earth and encounter different kinds of material. Seismic waves are of two principal



types: surface waves, which travel along the surface of the Earth, and body waves, which travel through the Earth. Body waves are further divided into two types: compressional waves, which compress and dilate the rock as they travel forward, and shear waves, which shake the rock sideways as they travel forward. The more rigid the material, the faster both kinds of body waves travel. Compressional waves move through both solids and liquids, but shear waves move through solids only.

The boundaries of the principal layers of the Earth are defined by abrupt changes in the behavior of seismic waves. A sudden increase in seismic velocity marks the boundary between the crust and the mantle. Wave speed reaches a maximum in the lower part of the mantle, but at the boundary of the Earth's core, a striking change takes place: the velocity of compressional waves drops sharply and shear waves stop altogether. From this evidence the outer core is believed to be liquid. The compressional waves regain their velocity as they approach the center of the Earth, so the inner core is thought to be solid.

Cross section of the Earth, showing the paths of some earthquake waves. Compressional waves (P, solid lines) are refracted sharply by the core, as shown by the PKP trajectory. Shear waves (S, dashed lines) end at the core, although they may be converted to P waves, traverse the core as a compressional wave (K), and emerge in the mantle again as P and S waves, that is, SKP and SKS. The waves may be reflected back into the Earth at the surface and be picked up further on, as in trajectories PP, PPP, and SS.