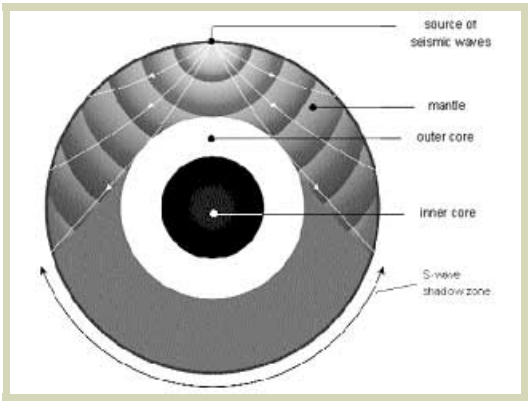
Inge Lehmann: Discoverer of the Earth's Inner Core

Dr. Inge Lehmann (1888-1993), discoverer of the Earth's inner core. Photo courtesy of B.A. Bolt.

How can we find out what's happening deep inside the Earth? The temperatures are too hot, pressures too extreme, and distances too vast to be explored by conventional probes. So scientists rely on seismic waves—shock waves generated by earthquakes and explosions that travel through Earth and across its surface—to reveal the structure of the interior of the planet. Thousands of earthquakes occur every year, and each one provides a fleeting glimpse of the Earth's interior. Seismic signals consist of several kinds of waves. Those important for understanding the Earth's interior are P-waves, (primary, or compressional waves), and S-waves (secondary, or shear waves), which travel through solid and liquid material in different ways.

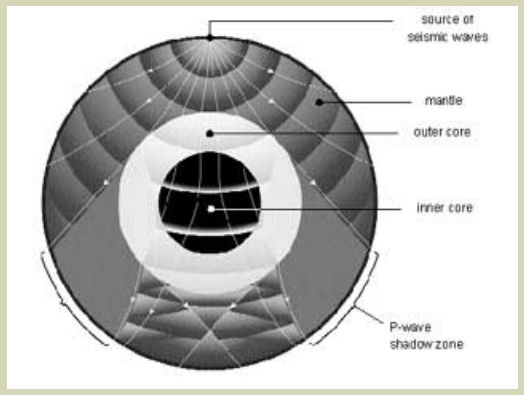
The seismograph, which detects and records the movement of seismic waves, was invented in 1880. By the end of that decade seismic stations were in place all over the world. At the time, geophysicists believed Earth to be made up of a liquid core surrounded by a solid mantle, itself surrounded by a crust, all separated by abrupt density changes in the Earth called "discontinuities."



The seismic waves called S-waves do not travel through liquid. We know that the outer core is liquid because of the shadow it casts in S-waves. Illustrations © American Museum of Natural History

In 1929 a large earthquake occurred near New Zealand. Danish seismologist Inge Lehmann "the only Danish seismologist," as she once referred to herself—studied the shock waves and was puzzled by what she saw. A few P-waves, which should have been deflected by the core, were in fact recorded at seismic stations. Lehmann theorized that these waves had traveled some distance into the core and then bounced off some kind of boundary. Her interpretation of this data was the foundation of a 1936 paper in which she theorized that Earth's center consisted of two parts: a solid inner core surrounded by a liquid outer core, separated by what has come to be called the Lehmann Discontinuity. Lehmann's hypothesis was confirmed in 1970 when more sensitive seismographs detected waves deflecting off this solid core.

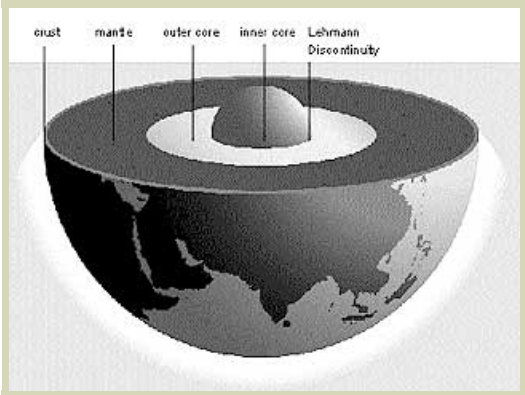
Born in Denmark in 1888, Lehmann was a pioneer among women and scientists. Her early education was at a progressive school where boys and girls were treated exactly



The seismic waves called P-waves pass through the core and are detected on the far side of the Earth. Indirect signals received in the P-wave shadow zone suggest there is a solid inner core deflecting some waves. Illustrations © American Museum of Natural History

alike. This was a sharp contrast to the mathematical and scientific community she later encountered, about which she once protested to her nephew, Niles Groes, "You should know how many incompetent men I had to compete with—in vain." Groes recalls, "I remember Inge one Sunday in her beloved garden…with a big table filled with cardboard oatmeal boxes. In the boxes were cardboard cards with information on earthquakes…all over the world. This was before computer processing was available, but the system was the same. With her cardboard cards and her oatmeal boxes, Inge registered the velocity of propagation of the earthquakes to all parts of the globe. By means of this information, she deduced new theories of the inner parts of the Earth."

A critical and independent thinker, Lehmann subsequently established herself as an authority on the structure of the upper mantle. She conducted extensive research in other countries, benefiting from an increased global interest in seismology for the surveillance of clandestine nuclear explosions. When Lehmann received the William Bowie medal in 1971, the highest honor of the American Geophysical Union, she was described as "the master of a black art for which no amount of computerizing is likely to be a complete substitute." Lehmann lived to be 105.



Cut away showing the four main layers of Earth: solid inner core, liquid outer core, mantle, and crust. Illustrations © American Museum of Natural History

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