Times-Standard
Times-Standard / Humboldt Beacon

Not My Fault: How low can you go? Try watching 2003's 'The Core'

Lori Dengler/For the Times-Standard
Posted: February 20, 2019

Last week I wrote about Inge Lehmann and how her seismic observations led to the discovery of the inner core. In late November, the topic was the Mars Insight Mission and its primary objective of delineating the Martian core. In January, I lead the discussion of the Humboldt County Library's "Dumb Movies with Smart People" airing of The Core, recognized by some as the worst science fiction movie ever made.

How does one goes about determining what's inside an inaccessible body like the earth? Geophysicists call this an inverse problem, working backward from data to infer how that data was produced. The direct approach would be to cut it open and examine the contents. That's not an option when it comes to the earth.

So what about drilling a hole? That has been tried. The first serious attempt was Project Mohole in the fifties and sixties that aimed to penetrate the Moho, the more pronounceable term geologists use for the Mohorovičić discontinuity, the boundary between the earth's crust and mantle. Like Lehmann two decades later, Croatian seismologist Andrija Mohorovičić observed seismic wave arrivals that could best be explained by an abrupt change in rock types.

Mohorovičić was in the right place at the right time. First interested in meteorology, he had a solid mathematical and scientific background. In 1880, the Croatian capital Zagreb was devastated by an earthquake and Mohorovičić became involved in the Earthquake Committee of the Yugoslav Academy. About the same time, early seismographs began to be installed in Europe.

Mohorovičić deployed the first seismograph in Croatia in 1906, just in time to record the 1906 San Francisco earthquake (Seismogram #9 in the Appendix of the Lawson Report on the 1906 earthquake). He purchased more instruments and when a moderate earthquake occurred in October 1909, was able to record it and a number of aftershocks at different distances from the epicenter. This enabled him to construct a travel-time curve, a plot of seismic wave arrival times versus distance from the source.

Travel-time graphs provide are the meat of seismology. In uniform material, they show a straight line, the slope giving the velocity of the subsurface material. Interfaces at depth cause reflection and refraction. Mohorovičić noticed a distinct change in the slope of the wave arrivals at a distance of about 125 miles from the epicenter and in a 1910 paper, proposed a major discontinuity at a depth of 30 miles beneath the surface.

Once noticed, other researchers found that the Moho was a global phenomenon but not uniform. Beneath the ocean, it was only about four miles deep and under mountain ranges, reaching down as far as 60 miles. But everywhere it marked a contrast between the relatively lightweight granite and crustal rocks we live upon and much more compact mantle rock.

Project Mohole was funded by the National Science Foundation to drill a hole through the sea floor to reach the Moho. Phase one was completed in the early 60s off the coast of Mexico, and reached 600 feet below the seabed. Although considered very deep at the time, this was well less than a third of the way to the boundary, and Congress disbanded the project before deeper drilling could commence.

The Soviet Union attempted a more ambitious project. In 1970, drilling began at the Kola Superdeep Borehole in northwestern Russia near the Norwegian border. The hole, only nine inches wide, reached an astounding 40,230 feet (7.6 miles) in 1989, and remains to this day the deepest human penetration of the earth's surface. If the hole had been on the sea floor, it would have easily pierced the Moho. But on continental crust, it was barely a third of the way down. Drilling at such great depths posed great challenges. Temperatures at the drill head reached 356° F, and the Soviets abandoned the project in 1992. The project did yield scientific benefits, delineating changes in the crust to help explain seismic variations and finding plankton fossils at a depth of over four miles.

There have been other drilling projects. In 1990, Germany launched the German Continental Deep Drilling Program in Bavaria and reached a depth of six miles before running out of funds. The deepest offshore drill hole was the ill-fated Deep Water Horizon, which penetrated to five miles in the Gulf of Mexico. The Gulf of Mexico is floored by continental crust and the bottom of the Deep Water Horizon well was still 15 miles above the Moho location.

Hollywood to the rescue! In the movie "The Core," scientists make a drilling machine out of unobtainium and

not only whiz past the Moho in minutes, reach the core in a few days. With a deep mantle geode, a core that has stopped rotating, and sequential nuclear explosions to start it up again, unobtainium might be the most plausible part of the story. No worries, geophysicists. You still have job security – no one is going to be getting direct samples from the deep earth anytime soon.

Note: Seismology nerds, you can get a more detailed description of Mohorovičić's contribution at http://www.seismosoc.org/Publications/SRL/SRL_78/srl_78-6_hs.html. More about deep drilling projects at https://www.smithsonianmag.com/smithsonian-institution/ask-smithsonian-whats-deepest-hole-ever-dug-180954349/

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