Research reveals secret to interaction between Earth's core and mantle

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Leslie Hayden's research into deep Earth interactions has led to some important findings, particularly for someone so new to the field, and the scientific world is paying attention. Hayden, a graduate student at Rensselaer Polytechnic Institute, is first author on a paper to be published in the scientific journal *Nature*. The findings will be published in the Nov 29, 2007 edition of the journal.

Hayden performed her research under the guidance of Bruce Watson, Institute Professor of Science at Rensselaer.

Hayden used some powerful equipment and creative techniques to uncover a potential pathway for metals to move between the core and mantle of the Earth. "Core-mantle interactions are a hotly debated topic," Hayden said. "Some scientists believe that there is no chemical interaction at all between the Earth's molten metal core and solid silicate mantle. Others believe they see signs of such interaction, but no mechanism or pathway has been found that could deliver metal atoms over distances of more than a few meters. "

Hayden's experiments may have uncovered such a pathway. If true, the findings could have broad implications on how geologists understand the deep Earth. They could also one day provide important information on how valuable elemental resources like gold and platinum are deposited.

Hayden and Watson developed an experiment that simulated the interface between the core of the Earth and the mantle. The highly pressurized core consists mostly of iron and nickel and is also believed to contain other "iron-loving" elements like gold and platinum. The mantle is comprised of silicate rocks rich in magnesium. For the experiments they placed a rock that is representative of the material found in the Earth's mantle in between what they refer to as a source and a sink layer. The source layer was one of the metals found in the core, such as gold, platinum, copper, and other lesser known metals like ruthenium and tungsten.

For each metal, the miniaturized core/mantle boundary was then heated to extreme temperatures and pressures to represent conditions in the deep Earth. Following the experiments, each source metal was found in the sink, proving that the metals could in fact find a pathway through the mantle rock that is believed to be impenetrable by some scientists.

Hayden and Watson hypothesize that the metal atoms move along the surfaces formed between adjacent grains of the mantle rock. Like a sugar cube, mantle rocks are comprised of individual crystals squeezed tightly together into a larger structure. The atoms of the core metals are too large to diffuse through the structured arrangement of atoms that make up an individual crystal or grain of rock. But, the boundary between each grain is less crowded with atoms, according to the researchers, and could be a fast pathway for metals to migrate between the mantle and core.

"[In our experiments], some of the metals moved through grain boundaries at surprisingly fast rates—about as fast as sodium ions move through water," Hayden said. "This shows that metals can in fact travel over great distances through mantle materials. Over geologic time, this diffusion of metals could have a significant impact on their distribution in the Earth." Their experiments revealed that some elements could move up to 100 kilometers through the Earth's mantle in a billion years.

The findings have implications for the field, but also for broader economic reasons, Hayden explains. If these metals are able to move out of core and into the mantle as their findings suggest, they would enter the geologic upwelling of mantle convection and could be gradually moved toward Earth's surface, potentially leading to valuable deposits. "As we learn more about the movement of precious and base metals through the Earth, we could at some point find out how they are deposited, where, and why," she said.

Source: Rensselaer Polytechnic Institute

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