Journey to the center of the earth: Discovery sheds light on mantle formation

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The mantle rock was collected during an expedition to the North Pole aboard a 400-foot-long icebreaker, a research vessel designed to break through the ice. Credit: Heinz Feldmann, Max-Planck Insitut fuer Chemie, Mainz, German

Uncovering a rare, two-billion-year-old window into the Earth's mantle, a University of Houston professor and his team have found our planet's geological history is more complex than previously thought.

Jonathan Snow, assistant professor of geosciences at UH, led a team of researchers in a North Pole expedition, resulting in a discovery that could shed new light on the mantle, the vast layer that lies beneath the planet's outer crust. These findings are described in a paper titled "Ancient, highly heterogeneous mantle beneath Gakkel Ridge, Arctic Ocean," appearing recently in *Nature*.

These two-billion-year-old rocks that time forgot were found along the bottom of the Arctic Ocean floor, unearthed during research voyages in 2001 and 2004 to the Gakkel Ridge, an approximately 1,000-mile-long underwater mountain range between Greenland and Siberia. This massive underwater mountain range forms the border between the North American and Eurasian plates beneath the Arctic Ocean, where the two plates diverge.

These were the first major expeditions ever undertaken to the Gakkel Ridge, and these latest published findings are the fruit of several years of research and millions of dollars spent to retrieve and analyze these rocks.

The mantle, the rock layer that comprises about 70 percent of the Earth's mass, sits several miles below the planet's surface. Mid-ocean ridges like Gakkel, where mantle rock is slowly pushing upward to form new volcanic crust as the tectonic plates slowly move apart, is one place geologists look for clues about the mantle. Gakkel Ridge is unique because it features – at some locations – the least volcanic activity and most mantle exposure ever discovered on a mid-ocean ridge, allowing Snow and his colleagues to recover many mantle samples.

"I just about fell off my chair," Snow said. "We can't exaggerate how important these rocks are – they're a window into that deep part of the Earth."

Venturing out aboard a 400-foot-long research icebreaker, Snow and his team sifted through thousands of pounds of rocks scooped up from the ocean floor by the ship's dredging device. The samples were labeled and cataloged and then cut into slices thinner than a human hair to be examined under a microscope. That is when Snow realized he found something that, for many geologists, is as rare and fascinating as moon rocks – mantle rocks devoid of sea floor alteration. Analysis of the isotopes of osmium, a noble metal rarer than platinum within the mantle rocks, indicated they were two billion years old. The use of osmium isotopes underscores the significance of the results, because using them for this type of analysis is still a new, innovative and difficult technique.

Since the mantle is slowly moving and churning within the Earth, geologists believe the mantle is a layer of well-mixed rock. Fresh mantle rock wells up at mid-ocean ridges to create new crust. As the tectonic plates move, this crust slowly makes its way to a subduction zone, a plate boundary where one plate slides underneath another and the crust is pushed back into the mantle from which it came.

Because this process takes about 200 million years, it was surprising to find rocks that had not been remixed inside the mantle for two billion years. The discovery of the rocks suggests the mantle is not as well-mixed or homogenous as geologists previously believed, revealing that the Earth's mantle preserves an older and more complex geologic history than previously thought. This opens the possibility of exploring early events on Earth through the study of ancient rocks preserved within the Earth's mantle.

The rocks were found during two expeditions Snow and his team made to the Arctic, each lasting about two months. The voyages were undertaken while Snow was a research scientist at the Max Planck Institute in Germany, and the laboratory study was done by his research team that now stretches from Hawaii to Houston to Beijing.

Since coming to UH in 2005, Snow's work stemming from the Gakkel Ridge samples has continued, with more research needed to determine exactly why these rocks remained unmixed for so long. Further study using a laser microprobe technique for osmium analysis available only in Australia is planned for next year.

Source: University of Houston

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