Scientist's Award Allows Her To Probe the Earth's Mantle

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(PhysOrg.com) -- Sandwiched between the liquid iron outer core and the thin rocky crust we live on, the Earth's mantle is more than 1,800 miles thick, and comprises more than three-quarters of the planet's volume and nearly two-thirds of its mass. Yet surprisingly, scientists don't know exactly what it's made of.

Now Kanani Lee, an assistant professor in the Department of Geology and Geophysics, has secured a CAREER Award — the National Science Foundation's most prestigious honor for junior faculty who excel at integrating research with education — to help her find out.

Lee studies the interior of the Earth by investigating the properties of different materials at extremely high temperatures and pressures. Using a vise-like device that crushes samples between diamonds to more than one million times the ambient pressure at the surface of the Earth, she then heats the samples to thousands of degrees Kelvin using an infrared laser, recreating the conditions found thousands of miles below the surface.

By subjecting different mineral compounds to these extreme environments, Lee aims to learn more about which minerals are present in the deep mantle and might have resulted in the rock samples that are spewed up by volcanic eruptions.

"These rare, essentially unmelted rocks are the only examples we have from the mantle," Lee says, noting that the crust, which is 20 to 30 miles

thick, is too deep for drilling.

Geologists have some guesses about what the Earth's mantle is made of. They know it involves a combination of magnesium, iron, silicon and oxygen — the most simple mixture of which is a compound that geologists call "pyrolite" — but the exact mineral composition remains elusive.

Seismologists offer a piece of the puzzle, providing models of mantle density based on how quickly or slowly seismic waves, caused by earthquakes, travel through the rocky layer. But pyrolite isn't dense enough to match up exactly with those seismological models, which scientists believe to be accurate over long distances, Lee says, so there must be something else going on. For instance, there are other elements involved that have been mostly ignored in compositional models, Lee says, such as calcium, aluminum and sodium, which could change the density of the mantle mineral mixture. Or perhaps scientists are wrong about the temperatures they think exist in the deepest layers, she notes.

Whatever the missing piece, uncovering the composition of the Earth's mantle would tell scientists a lot about how our planet formed and evolved over time, and could even shed light on the formation of other planets in our solar system and beyond.

"This is a very fundamental question that we should know the answer to," Lee says. "The chemical makeup of the mantle is crucial for understanding the thermal evolution of the Earth — how it cooled and evolved after it formed about 4.5 billion years ago — as well as how the continents grew and how the oceans and the atmosphere were created."

In addition to the research, Lee also has plans for education and outreach — one of the requirements for CAREER Award grants. Inspired by her husband, a comic book illustrator, Lee hopes to produce a short comic

book about earth science for middle school students in New Haven, which would also be available online for other teachers and the general public.

Provided by Yale University