CORNELL CHRONICLE

Study presents new clues about the rise of Earth's continents

By Chris Dawson, Cornell Engineering

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New research from Cornell and the Smithsonian Institution deepens the geological understanding of Earth's continents by testing and ultimately eliminating a popular hypothesis about why continental and oceanic crusts have contrasting compositions.

The study, published May 5 in Science, uses laboratory experiments to show that the iron-depleted, oxidized chemistry typical of Earth's continental crust likely did not come from crystallization of the mineral garnet, **as some scientists have theorized** (https://www.science.org/doi/10.1126/sciadv.aar4444). The iron-poor composition of continental crust is a major reason that vast portions of the Earth's surface stand above sea level as dry land, making terrestrial life possible today.

The research was led by Megan Holycross, assistant professor of Earth and atmospheric sciences in Cornell Engineering, and Elizabeth Cottrell, research geologist at the Smithsonian's National Museum of Natural History.

To recreate the massive pressure and heat found beneath continental arc volcanoes, Holycross and Cottrell grew samples of garnet from molten rock under pressures and temperatures designed to simulate conditions inside magma chambers.

Next, the team collected garnets from Smithsonian's National Rock Collection and from other researchers around the world to use as reference materials. Crucially, this group of garnets had already been analyzed so the researchers knew the concentrations of oxidized and unoxidized iron.

Finally, the study authors took the materials from their experiments and those gathered from collections to the Advanced Photon Source at the U.S. Department of Energy's Argonne National Laboratory in Illinois. There the team used high-energy X-ray beams to conduct X-ray absorption spectroscopy, a technique that can tell scientists about the structure and composition of materials based on how they absorb X-rays.

The tests revealed that the garnets had not incorporated enough unoxidized iron from the rock samples to account for the levels of iron-depletion and oxidation present in the magmas. The results suggest the garnet crystallization model is an unlikely explanation for why magmas from continental arc volcanoes are oxidized and iron depleted, according to the researchers.

"There was no experimental data to test the hypothesis before this, so this research and this paper certainly add to our understanding of what is going on in these places we cannot see," Holycross said. "At the same time, we are left with a lot of questions we still need to answer before we can say what is oxidizing the iron in these magmas."

One hypothesis researchers are investigating is that an oxidizing agent is being transferred from the material on the subducting slab that descends into the Earth beneath continental magma chambers.

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Chris Dawson is a writer for Cornell Engineering. This article was adapted from an original version with permission from the Smithsonian's National Museum of Natural History.

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