Ancient Earth crust stored in deep mantle

April 24 2013

Scientists have long believed that lava erupted from certain oceanic volcanoes contains materials from the early Earth's crust. But decisive evidence for this phenomenon has proven elusive. New research from a team including Carnegie's Erik Hauri demonstrates that oceanic volcanic rocks contain samples of recycled crust dating back to the Archean era 2.5 billion years ago. Their work is published in *Nature*.

Oceanic crust sinks into the Earth's mantle at so-called subduction zones, where two plates come together. Much of what happens to the crust during this journey is unknown. Model-dependent studies for how long subducted material can exist in the mantle are uncertain and evidence of very old crust returning to Earth's surface via upwellings of magma has not been found until now.

The research team studied volcanic rocks from the island of Mangaia in Polynesia's Cook Islands that contain iron sulfide inclusions within crystals. In-depth analysis of the chemical makeup of these samples yielded interesting results.

The research focused on isotopes of the element sulfur. (Isotopes are atoms of the same element with different numbers of neutrons.) The measurements, conducted by graduate student Rita Cabral, looked at three of the four naturally occurring isotopes of sulfur—isotopic masses 32, 33, and 34. The sulfur-33 isotopes showed evidence of a chemical interaction with UV radiation that stopped occurring in Earth's atmosphere about 2.45 billion years ago. It stopped after the Great Oxidation Event, a point in time when the Earth's atmospheric oxygen levels skyrocketed as a consequence of oxygen-producing photosynthetic microbes. Prior to the Great Oxidation Event, the atmosphere lacked ozone. But once ozone was introduced, it started to absorb UV and shut down the process.

This indicates that the sulfur comes from a deep mantle reservoir containing crustal material subducted before the Great Oxidation Event and preserved for over half the age of the Earth.

"These measurements place the first firm age estimates of recycled material in oceanic hotspots," Hauri said. "They confirm the cycling of sulfur from the atmosphere and oceans into mantle and ultimately back to the surface," Hauri said.

More information: Research paper: dx.doi.org/10.1038/nature12020

Provided by Carnegie Institution for Science