Study sheds light on Earth's early mantle

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Credit: NASA

(Phys.org) —An international team of researchers, led by scientists at Boston University's Department of Earth and Environment, has found evidence that material contained in young oceanic lava flows originated at the Earth's surface in the Archean (>2.45 billions years ago). The new finding helps constrain the timing of the initiation of plate tectonics, the origin of some of the chemical heterogeneity in the Earth's mantle, and may shed light on how the chaotically convecting mantle could preserve such material for so long.

The study appears in the April 25 issue of the journal *Nature*.

Tectonic plates at the Earth's surface move around and collide at areas called subduction zones. In these areas, one plate is forced beneath the other and is transported into the Earth's mantle. It has long been suggested that this subducted material must be re-erupted at a later time. However, the residence time of the subducted material in the mantle is uncertain and convincing evidence of its return to the surface has been lacking.

Sulfur isotopes provide the key to the authors' discovery. According to the researchers, because mass-independently fractionated (MIF) sulfur isotope signatures were generated exclusively through atmospheric photochemical reactions until about 2.5 billion years ago, material containing such isotope signatures must have originated at the Earth's surface in the Archean. In the new study, the researchers found MIF sulfur-isotope signatures in olivine-hosted sulfides from relatively young (20-million-year-old) ocean island basalts (OIB) from Mangaia, Cook Islands (Polynesia), providing evidence that material once at the Earth's surface has been recycled through the mantle and re-erupted at a young ocean island.

"The discovery of MIF-S isotope in these young oceanic lavas suggests that sulfur—likely derived from the hydrothermally-altered oceanic crust—was subducted into the mantle more than 2.5 billion years ago and recycled into the mantle source of the Mangaia lavas," says Cabral.

The data also complement evidence for sulfur recycling of ancient sedimentary materials to the subcontinental lithospheric mantle previously identified in diamond inclusions.

More information: doi:10.1038/nature12020

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