

Reservoirs of ancient lava shaped Earth

July 27 2011

Geological history has periodically featured giant lava eruptions that coat large swaths of land or ocean floor with basaltic lava, which hardens into rock formations called flood basalt. New research from Matthew Jackson and Richard Carlson proposes that the remnants of six of the largest volcanic events of the past 250 million years contain traces of the ancient Earth's primitive mantle—which existed before the largely differentiated mantle of today—offering clues to the geochemical history of the planet. Their work is published online July 27 by *Nature*.

Scientists recently discovered that an area in northern Canada and Greenland comprised of flood basalt contains traces of ancient Earth's primitive [mantle](#). Carlson and Jackson's research expanded these findings, in order to determine if other large volcanic rock deposits also derive from primitive sources.

Information about the primitive mantle reservoir—which came into existence after the Earth's core formed but before the Earth's outer rocky shell differentiated into crust and depleted mantle—would teach scientists about the geochemistry of early Earth and how our planet arrived at its present state.

Until recently, scientists believed that the Earth's primitive mantle, such as the remnants found in northern Canada and Greenland, originated from a type of meteorite called carbonaceous chondrites. But comparisons of isotopes of the element neodymium between samples from Earth and samples from chondrites didn't produce the expected results, which suggested that modern mantle reservoirs may have evolved

from something different.

Carlson, of Carnegie's Department of Terrestrial Magnetism, and Jackson, a former Carnegie fellow now at Boston University, examined the isotopic characteristics of flood basalts to determine whether they were created by a primitive mantle source, even if it wasn't a chondritic one.

They used geochemical techniques based on isotopes of neodymium and lead to compare basalts from the previously discovered 62-million-year-old primitive mantle source in northern Canada's Baffin Island and West Greenland to basalts from the South Pacific's Ontong-Java Plateau, which formed in the largest volcanic event in geologic history. They discovered minor differences in the isotopic compositions of the two basaltic provinces, but not beyond what could be expected in a primitive reservoir.

They compared these findings to basalts from four other large accumulations of lava-formed rocks in Botswana, Russia, India, and the Indian Ocean, and determined that lavas that have interacted with continental crust the least (and are thus less contaminated) have neodymium and lead isotopic compositions similar to an early-formed primitive mantle composition.

The presence of these early-earth signatures in the six flood basalts suggests that a significant fraction of the world's largest volcanic events originate from a modern mantle source that is similar to the primitive reservoir discovered in Baffin Island and West Greenland. This primitive mantle is hotter, due to a higher concentration of radioactive elements, and more easily melted than other mantle reservoirs. As a result, it could be more likely to generate the eruptions that form flood basalts.

Provided by Carnegie Institution

Citation: Reservoirs of ancient lava shaped Earth (2011, July 27) retrieved 2 May 2024 from <https://phys.org/news/2011-07-reservoirs-ancient-lava-earth.html>

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