Paper Number: 5295

Palaeozoic to Archaean zircons in rocks derived from the Galapagos mantle hotspot: where do they come from?

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The Galapagos volcanism is related to a raising mantle plume in the Pacific Ocean more than 1000 km away from the South America continent. Studies on Pb, Hf, Nd, and Sr isotope ratios and trace-element geochemistry of lavas in this archipelago have identified melting of several sources, including lower mantle, depleted asthenospheric mantle and recycled (subducted) oceanic crust and continental material. Here we provide, for the first time, physical evidence of recycled oceanic/continental crust. Our recent survey on the islands of Santa Cruz, Floreana, San Cristobal and Genovesa, discovered, for the first time, xenocrystic zircons within late Neogene to Quaternary lavas and beach sands with ages ranging late Devonian to Archaean (SHRIMP U-Pb analyses, 0.378 to 3.0 Ga; n = 18) and $\delta^{18}O$ values ranging mantle-derived to continental crust-derived sources (4.7±0.13‰ to 11.3±0.12‰ SMOW). The origin of such old zircons is enigmatic due to the fact that Galápagos is a young active volcanic hotspot with ages below 5 Ma for the oldest island [1]. In order to identify the potential source of these old zircons, we evaluate one or a combination of several processes such as (a) deep mantle mixing and emergence with the hot-spot related lavas [2], (b) derivation from a continental source despite the 1000 km distance, (c) xenocrysts from old, fragmented subcrustal mantle lithosphere as implied by magnetic anomalies [3], (d) zircons transported by strong currents such as the Humboldt and Cromwell, and even (e) zircons blown by strong winds similar to sands transported from the Sahara to the Alps [4].

Their origin as xenocrysts is revealed by a combination of geodynamic, mineralogical and isotopic arguments. The presence of inherited crustal zircons in the Galápagos lavas either indicates that these grains survived recycling through the mantle or they were derived from deep-sea oceanic sediments that became entrained in mantle melting processes in oceanic fracture zones near and on the Galapagos hot spot. Pb-Hf-Nd-Sr whole-rock isotopic data for Galapagos lavas support a mixing model most likely involving recycled (subducted) oceanic crust and lower mantle melts, mixed with recycled continent-derived material [5]. The origin of the old zircons will further be explored through Lu-Hf isotopes.

The old zircons in the beach sands may result from erosion of the lavas with the minerals being washed down in streams and into the sea. The heavy minerals were then carried back onto the beach by waves, which, in turn, dragged the lighter minerals back into the sea. Wind also helped to concentrate the heavy minerals by blowing away the lighter quartz sand. These processes were repeated many times over for millions of years.

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