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Primitive oxygen-isotope ratio recorded in magmatic zircon from the Mid-Atlantic Ridge

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Abstract

The oxygen-isotope composition of the Earth's upper mantle is an important reference for understanding mantle and crust geochemical cycles. Olivine is the most commonly used mineral for determining the influence of crustal processes on the oxygen-isotope ratio ($\delta^{18}O$) of primitive rocks, however it is an uncommon mineral in continental crust and readily alters at or near Earth's surface. Here we report the first measurements of oxygen-isotope ratios in zircon from oceanic crust exposed at a mid-ocean ridge. Measurements of $\delta^{18}O$ and trace elements were made by ion microprobe on zircon in polished rock chips of gabbro and veins in serpentinized peridotite drilled from the Mid-Atlantic Ridge. The zircon grains contain both oscillatory and sector growth zoning, features characteristic of magmatic zircon. Values of $\delta^{18}O$ (zircon) = 5.3 ± 0.8‰ (2 st. dev., n = 68) for the population are consistent with the interpretation that these grains are igneous in origin and formed in high-temperature isotopic equilibrium with mantle oxygen. The $\delta^{18}O$ values demonstrate that zircon in oceanic crust preserves primitive $\delta^{18}O$ in spite of sub-solidus alteration of the whole rock. The fact that the primitive $\delta^{18}O$ (zircon) values fall in a narrow range (5.3 ± 0.8‰) strengthens the use of oxygen isotopes in zircon as a tracer to identify processes of exchange in a wide range of modern and ancient crustal environments, including subducted oceanic crust (eclogite), and also in the oldest known pieces of Earth, >3900 million-year-old detrital zircon grains from Western Australia.

Keywords: Zircon, ODP, MARK, oxygen isotope, oceanic crust, ion microprobe