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Inherited zircon and the magmatic construction of oceanic crust

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The presence of magmatic zircon in oceanic crust provides an exceptional opportunity for understanding crustal accretion history at mid-ocean ridges. High-resolution Pb/U ion microprobe zircon ages permit the absolute dating of magma emplacement, with typical uncertainties of <1-2%. This technique provides unprecedented resolution of magmatic construction of oceanic crust.

Here we present new Pb/U ion microprobe zircon ages of in-situ lower crustal gabbro from Atlantis Bank, Southwest Indian Ridge. Pb/U zircon ages range between 11.9 ± 0.2 and 12.2 ± 0.3 Ma, with some zircon revealing inheritance (core ages ~1.5 myr older than their corresponding rims). This age range is significantly greater than anticipated by simple plate spreading models. We suggest that the inherited zircons originally formed in gabbroic bodies emplaced at depths of ~14 km in the cold, axial mantle lithosphere beneath the ridge. These gabbro bodies and surrounding mantle were then uplifted, intruded and assimilated by voluminous, shallow-level, crust-forming magmas during the creation of Atlantis Bank.

U-Pb dating of hydrothermal zircon: Fracturing and fluid flow in mantle peridotite at the MAR

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The recognition of hydrothermal zircon porphyroblasts from meta-peridotite collected along the mid-Atlantic Ridge (MAR) provides a new methodology for understanding the temporal history of fluid flow and faulting in slow spreading mid-ocean ridges.

Serpentinized mantle peridotite is commonly exposed on the seafloor at or near ridge segment ends in slow-spreading environments. Atlantis Massif, located at the ridge-transform intersection at 30°N on the MAR, forms a domal exposure of gabbro, diabase and peridotite denuded to the sea floor along a detachment fault system. Peridotite exposed to seawater, due to cracking along the detachment fault system, reacts strongly through exothermic chemical reactions to form hydrated mineral species and magnetite, and produce warm, alkaline fluids rich in hydrogen and methane. Circulation of the fluids drives hydrothermal systems with focused venting from brucite/aronite chimneys like those in the Lost City vent system found atop the massif. Focused or diffuse hydrothermal systems may also allow mobilization and concentration of less mobile elements including Zr, U, Th, La, Nd, Ce, and Ti.

Here we report hydrothermal zircon with a wide range of U (7 - 2827 ppm) and Th (4 - 4003 ppm) concentrations, in addition to apatite, monazite, and xenotime porphyroblasts from *in situ* meta-peridotite collected from Atlantis Massif. The host rocks for these trace minerals comprise tremolite, talc, serpentine, chlorite, magnetite and chromite. We present high-resolution Pb/U SHRIMP zircon ages that permit the absolute dating of fluid flow events and serpentinization associated with fracturing of mantle peridotite denuded to the seafloor. These ages range from 0.68 ± 0.21 to 1.69 ± 0.05 Ma in a transect normal to the ridge axis.