6.2.P04

Sr – Nd isotope and trace element geochemistry of Precambrian zircon: A potential new source of information on early Earth mantle evolution

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Nd and Hf isotopic compositions of juvenile Precambrian igneous rocks provide important constraints on the timing of early crustal formation, and chemical evolution of the earth's mantle. The Sr isotopic composition of Precambrian rocks is also of interest but is poorly constrained. The greater relative enrichment of Rb over Sr in the crust, and higher solubility of Sr in seawater, should provide a sensitive tracer for early crustal recycling and hydrothermal processes. However, the Rb-Sr system is often disturbed in post-magmatic alteration events, and few (if any) reliable initial $^{87}Sr/^{86}Sr$ values exist on early Precambrian rocks. In many Precambrian samples zircons may be the only component of the rock that maintains an undisturbed isotopic composition. With slow diffusion rates (Cherniak et al., Chemical Geology, 1997) and a high resistance to weathering and metamorphic alteration, zircon can preserve some isotopic compositions for over 4 billion years (Wilde et al., Nature 2001). However, with the exception of U-Th-Pb and O, relatively little is known about zircon geochemistry and its resistance to secondary processes. Zircons may provide a unique source of Sr-isotopic information for the early Earth, and potentially could be useful for study of other mobile elements.

Zircon populations are being studied from mantle derived igneous rocks with ages of 0.1, 1.7, and 3.8 Ga. Those from the 1.7 Ga Yavapai province of Arizona (initial epsilon Nd = +4.7) were dated using SHRIMP and characterized in terms of trace elements by LA-ICPMS. Primary magmatic zoning is preserved, and the grains show uniform ages (1727±27 m.y.) from core to rim with little to no lead loss. As Nd and Sr are largely carried in inclusions within the zircon, leaching is required to remove grain boundary and/or altered phases. We have conducted preliminary ID-TIMS $^{87}Sr/^{86}Sr$ and $^{143}Nd/^{144}Nd$ measurements on leached and unleached zircon separates from these well characterized zircon populations to evaluate the practicality of extracting useful Sr-isotopic compositions of the early mantle and Sm-Nd age information.

6.2.P05

Evolution of the depleted mantle: Hf isotope evidence from Archaean zircon grains from West Greenland

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Combined studies of Lu-Hf and U-Pb isotopes on rock samples and single crystal grains have over the last years become increasingly more important in the investigation of the Earth's early history of crust-mantle evolution. We report $^{207}Pb/^{206}Pb$-ages and initial $\varepsilon_{Hf}(t)$ for zircon grains from two metasediments and from one orthogneiss from the Christianshåb area, West Greenland. The data was obtained using a laser ablation system interfaced to a multi-collector inductively coupled plasma mass spectrometer (MC-ICPMS).

$^{207}Pb/^{206}Pb$ ages were determined for the analysed zircon grains. The orthogneiss shows a population of zircon grains interpreted as igneous and formed at ~2.86 Ga and two later populations formed by metamorphic zircon growth around 2.8 Ga and 1.85 Ga, respectively. The two supracrustal samples yield detrital zircon populations with Archaean $^{207}Pb/^{206}Pb$ ages ranging from 3.65 Ga down to ~2.4 Ga. This indicates that older Archaean continental crust contributed detritus to the sediments.

$^{176}Hf/^{177}Hf$ and $^{176}Lu/^{177}Hf$ rations were determined from the same zircon grains with 2σ less than 2 ε_{Hf} units (for $^{176}Hf/^{177}Hf$). The Lu-Hf isotope data were used to calculate initial $\varepsilon_{Hf}(t)$ values assuming that the $^{207}Pb/^{206}Pb$ ages of the grains represent time of crystallisation and using λ_{176Lu} and $^{176}Hf/^{177}Hf$ initial chondrite vales of Scherer et al. (2001) and Bizzarro et al. (2003), respectively. The orthogneiss igneous zircon grains have positive $\varepsilon_{Hf}(t)$ values of ~10 at 2.86 Ga indicative of derivation from a depleted mantle source. The oldest detrital zircon grains at 3.65 Ga have $\varepsilon_{Hf}(t)$ of ~7, and are interpreted to have derived from a highly depleted mantle reservoir. A highly depleted Hf isotopic signature of the mantle already at 3.65 Ga implies that Early Archaean mantle evolution was characterised by a markedly higher Lu/Hf-fractionation compared to a time-integrated Hf evolution inferred from extrapolating the hafnium isotopic evolution of Post-Archaean basalt samples back to Early Archaean time.