Geophysical Research Abstracts
Vol. 16, EGU2014-4173, 2014
EGU General Assembly 2014

New insights into crustal evolution studies from Sr isotopes

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Because of the poor preservation of rocks and minerals after billions of years of crustal evolution, major uncertainties still remain about the composition of new/juvenile continental crust and hence the conditions and tectonic setting(s) under which it was formed. One way to evaluate the composition of the new continental crust is to estimate the time-integrated parent/daughter ratios of isotope systems in crustal melts derived from that new crust. ^{87}Rb decays to ^{87}Sr with a long half-life ($\sim$48.8 Ga) relative to the age of Earth, and because of the different partitioning characteristics of Rb and Sr within the crust ($D^{Rb} < D^{Sr} << 1$), crustal differentiation processes produce a large range of Rb/Sr ratios. As a consequence there is a strong positive correlation between the Rb/Sr and the SiO_2 content of the crust, and thus the time-integrated ^{87}Rb/^{86}Sr ratio can be used as a proxy for the bulk composition of the new continental crust through time.

The time-integrated Rb/Sr in crustal material (whole rock samples) with Nd model ages ranging from the Hadean to the Phanerozoic suggest that new continental crust was principally mafic over the first 1.5 Ga of Earth's evolution, and that it subsequently took on a more evolved composition. A key test is to obtain high precision ^{87}Sr/^{86}Sr from mineral inclusions in well-dated archives. We have undertaken a pilot study using laser ablation MC-ICP-MS on apatite inclusions in zircons from $\sim$420 Ma granites sampled in the Northern Highland Terrane (Scotland). Despite analytical issues related to the small size of the apatites (typically $<$30-40 μm) and isobaric interferences, their Sr isotope composition is consistent with the whole rock data. This approach should open new perspectives in crustal evolution studies, when applied to apatite inclusions in zircons with a large range of crystallisation ages and Hf isotope ratios.