Geophysical Research Abstracts, Vol. 9, 10799, 2007
SRef-ID: 1607-7962/gra/EGU2007-A-10799

Origin and evolution of the Hadean crust

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The first 500 million years of Earth evolution was surely the most geodynamically vigorous in our planet's history, but relatively little evidence directly documenting this period has been available. Recently, insights into the Hadean Earth have been gleaned from >4 Ga detrital zircons from Jack Hills, Western Australia. For example, large deviations of $\varepsilon_{Hf(T)}$ from bulk Earth have been interpreted to reflect development of a Lu/Hf reservoir consistent with crust formation, perhaps as early as 4.5 Ga. The diminution of $\varepsilon_{Hf(T)}$ deviations by ~4 Ga appears to support the view that this early crust was rapidly recycled back into the mantle. We have expanded the characterization of initial ^{176}Hf/^{177}Hf in Hadean zircons by undertaking a further 74 LA-ICPMS analyses on samples in the age range 3.91-4.35 Ga to enhance resolution of the transition between highly heterogeneous Hadean $\varepsilon_{Hf(T)}$and the more uniform Archean. Most analyses involved coupled measurements of Hf and Pb isotopes during LA drilling which typically permits precise Hf isotope ratios (±45 ppm) and ^{207}Pb/^{206}Pb ages on the same crater. The ^{207}Pb/^{206}Pb ages are often within uncertainty of the SIMS U-Pb date by which the antiquity of the grain was first established, and in all but a few cases result in a calculated $\varepsilon_{Hf(T)}$ within error of that using the SIMS date. These results confirm and extend our earlier observation of significant negative deviations in $\varepsilon_{Hf(T)}$ during the Hadean but few results plot in the positive $\varepsilon_{Hf(T)}$ field. No clear correlations between $\varepsilon_{Hf(T)}$, temperature (from Ti thermometry), and δ^{18}O are seen in this dataset. In an effort to quantify the processes responsible for the disappearance of the anomalous Hadean Hf isotope ratios, we are investigating 2D thermo-compositional convection models for a range of buoyancy and thermal forces. By modifying the partial melting code to create continental material, we can

investigate the conditions in which creation/destruction of continental crust can be balanced to reproduce the time-varying Hf isotopic signal.