Thermal events documented in Hadean zircons by ion microprobe depth profiles

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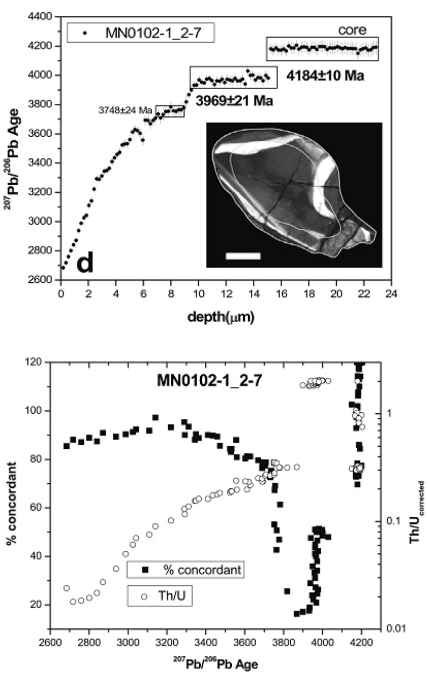
We report the first U-Th-Pb ion microprobe depth profiles for four Hadean zircons from the Jack Hills and Mt. Narryer supracrustal belts of the Narryer Gneiss Complex (NGC), Western Australia. This ultra-high spatial resolution technique probes the age and origin of sub-micron features in individual crystals that can record episodes of zircon growth. Near-surface grain dates 2700 Ma or older are coincident with post-depositional growth/modification. Some ages may coincide with documented pre-deposition metamorphic episodes for the NGC and igneous emplacement at *ca.* 3700 Ma. Separate events that do not correlate in time with known geologic episodes prior to the preserved rock record are also present within pre-4000 Ma zircons. We find evidence for a ~3.9 Ga event (Fig. 1), which is coterminous within age uncertainty with one or several large basin-forming impacts (e.g. Nectaris) on the Moon and attributed to the late heavy bombardment of the inner solar system.

Figure 1. Example depth profile data for a 4.18 Ga zircon from Mt. Narryer, Western Australia.



Chemical heterogeneity in the mantle: Inferences from seismology and mineral physics

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The first claims by geophysicists of significant chemical heterogeneity in the lower 1000 km of the mantle were made about 15 years ago. I will briefly review the evolution of ideas, which were mainly based on results from classical tomography. Classical inversion methods, however, are not free of caveats which can make interpretations ambiguous. Probabilistic tomography, on the other hand, allows to infer robust probability density functions (pdfs) for long wavelength models of bulk-sound and shear wave speed, density and boundary topography in the mantle. Using appropriate depth-dependent sensitivities, these pdfs can be converted into likelihoods of variations in temperature, perovskite and iron content throughout the mantle. The sensitivities are calculated using full uncertainties in mineral physics data and, more importantly, in the thermo-chemical reference state of the mantle. We find that bulk-sound speed (density) variations are an excellent proxy for perovskite (iron) variations, and that shear-wave speed is not highly correlated to temperature as is often assumed. Compositional variations are found to be essential to explain the seismic, gravity and mineral physics data. In particular, the regions of low shear-wave velocity in the deep mantle (> 2000 km) beneath Africa and the Pacific, usually referred to as super plumes, are mainly due to an enrichment in iron, which makes them denser than the surrounding mantle. We performed comparisons with some chosen models of thermo-chemical convection. A stable and ubiquitous layer of dense material is unlikely to be present at the bottom of the mantle. Models of piles entrained upwards explain the observations significantly better.