A method of determining uraninite U-Pb ages by SHRIMP II ion microprobe

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Previous U-Pb geochronological studies of the unconformity-type uranium deposits within the Athabasca (sedimentary) basin, Canada, indicate multiple formation events related to diagenetic and hydrothermal fluid activity, beginning ca. 1500 Ma (Fayek and Kyser, 1997). Due to pervasive Pb-loss and textural complexity, dating of this uraninite is best accomplished using *in situ* methods (e.g., Fayek et al., 2000). A method of uraninite U-Pb dating using a low resolution ion probe was established by Holliger (1988), but its application has not been reported using the new generation of high resolution ion microprobes.

Reference materials used include two Grenvillian uraninite megacrysts (z6897, z6893) with mean TIMS ^{238}U-^{206}Pb ages of 1043 Ma (1-2% discordant) and 965 Ma (1-5% discordant), respectively. SHRIMP analysis of 10 µm spots was carried out using O_2^-, R = 5500, and low energy ions. The $^{207}Pb/^{206}Pb$ ratios determined with SHRIMP were indistinguishable from the TIMS values, indicating no significant Pb isobars (e.g., hydrides) or fractionation. Although conventional approaches to U-Pb discrimination correction failed, calibration was accomplished using the primary-beam-normalized $^{206}Pb^+$ count rate ($^{206}Pb^+$ cps/nA) plotted against $^{206}Pb^+/UO_2^+$. The secondary ion yields of $^{206}Pb^+$ and UO_2^+ between uraninite fragments varied by up to 10x and 2x, respectively, but were relatively uniform within fragments. Experiments suggest that $^{206}Pb^+$ and UO_2^+ yields are controlled predominantly by crystal orientation. The secondary ion energy profile of $^{206}Pb^+$ is similar to that of UO_2^+ but not UO^+ or U^+, probably for crystal-structural reasons, and it is this factor rather than sample charging that appears to control the discrimination of U^+ and Pb^+ ions. The calibration method allows $^{206}Pb/^{238}U$ to be determined in uraninite with <5% (1 se) uncertainty per spot.

References

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Hf isotope composition of 3 Ga komatiites from Ontario, Canada

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Understanding the extent and timing of the chemical depletion of terrestrial mantle is essential to constrain early planetary differentiation processes. Moreover, the identification of possible secular variations in the degree of depletion of the mantle may suggest that present-day Earth evolved from different geodynamic regimes. The chemical nature of the early Archean mantle is inferred primarily from the Nd and Hf isotope data for the ~3.8 Ga meta-volcanic units from Isua, southwestern Greenland (e.g. Albarède *et al.*, 2000). However, interpretation of these data remains controversial due in-part to the potential disturbance of the Sm-Nd and Lu-Hf systems by post-crystallization processes.

We report high-precision Hf isotopic analyses determined by MC-ICP-MS (IsoProbe from Micromass) for a suite of 3 Ga komatiites from northwestern Ontario (Canada) in order to evaluate the extent of chemical depletion of the mid-Archean terrestrial mantle. Samples are from the Red Lake, North Spirit Lake and North Caribou Lake greenstone belts of Northern Ontario, and consist of relatively fresh, spinifex-textured komatiites and komatiitic basalts. All komatiites studied are of the Al-undepleted type with supra-chondritic $^{176}Lu/^{177}Hf$ values (i.e. from 0.033 to 0.060), reflecting the observed HREE-enriched patterns. Initial $^{176}Hf/^{177}Hf$ values correspond to εHf of +5.5 to +8.6 at 3 Ga, which are consistently more radiogenic than previous estimates of depleted mantle at 3 Ga. Moreover, the samples form a linear array in an isochron plot with a slope corresponding to the presumed crystallization age, suggesting that the Lu-Hf systematics were not perturbed following emplacement.

Our results combined with those of juvenile Archean rocks (from ~3.8 to ~2.7 Ga) from previous studies (Blichert-Toft and Arndt, 1999; Albarède *et al.* 2000; Bizzarro *et al.*, in press) indicate the existence of a large degree of isotopic heterogeneity within the early terrestrial mantle. This heterogeneity, more elusive in post 2.7 Ga juvenile rocks, may have been inherited from initial planetary differentiation processes (Albarède *et al.* 2000). Alternatively, preferential preservation of isotopic heterogeneity in the Archean suggests a fundamental change in the Earth's mantle convective regime at ~2.7 Ga, i.e. 'layered' versus 'whole mantle'.

References

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