Improving the understanding of uranium isotopic variations using Uranium-bearing minerals

B. D. LIVERMORE, J. N. CONNELLY AND M. BIZZARRO

Centre for Star and Planet Formation, Natural History Museum of Denmark, University of Copenhagen, Copenhagen 1350 DK. E-mail: bettina@livermore.dk

Improving our understanding of uranium isotopic variations is essential in determining the absolute ages of rocks dated by the long-lived double decay U-Pb system. Variations have now been reported for both extra-terrestrial inclusions (Calcium-Aluminium-rich Inclusions) [1] and terrestrial samples [2-3]. With the continuous development of high-resolution multi collector ICP mass spectrometers and supporting methods, U isotopes can be measured with an order of magnitude improved external reproducibility over previous studies.

Zircon ($ZrSiO_4$) is a robust, uranium-bearing mineral that is nearly ubiquitous in the felsic crust of Earth. As such, it is widely used to study geological processes throughout Earth's history. However, the nearly 10 $\varepsilon^{238}U$ variations reported for zircons in different environments [2] place some limits on its use as a ultra-high resolution chronometer. We seek to verify this variation within zircons and other uranium-bearing minerals with varying formation ages, locations and histories through an expanded study employing high precision MC-ICP-MS supported by more extensive chemical separation procedures.

Uranium is separated by a four-step separation method – with two identical UTEVA resin steps and two different anion resin steps and measured by HR-MC-ICP-MS using a Thermo-Fisher Neptune Plus [4]. Results to date show less spread in the $^{238}U/^{235}U$ ratios compared to previous studies, with $\varepsilon^{238}U$ values ranging only from +1.8 to +2.7 compared to results from [2] with $\varepsilon^{238}U$ values ranging between -4.1 and +5.7 (all normalized to CRM145a).

Further work will investigate whether some component of the variations in reported U isotopic compositions can be attributed to analytical methods, especially a single stage chemical separation of U but also annealing, pre-cleaning methods, tracer addition routines, dissolution steps and MC-ICP-MS protocols.

[1] Brennecka *et al*. (2010) *Science* **327**, 449. [2] Hiess *et al*. (2012) *Science* **335**, 1610. [3] Stirling *et al*. (2007) *Earth and Planetary Science Letters* **264**, 208. [4] Connelly *et al*. (2012) *Science* **338**, 651.