In situ $\delta^{94/90}$Zr variations in zircon

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Zr isotopes have long been studied in extraterrestrial materials as they hold clues to the chronology of, and stellar contributions to, the early Solar System [e.g., 1,2]. Recently, investigations of mass-dependent effects in igneous samples have revealed significant $\delta^{94/90}$Zr variability at both the mineral [3] and bulk-rock scales [4], indicating that Zr isotopes may be tracers of magmatic differentiation.

Here we present the first in situ analyses of $\delta^{94/90}$Zr in zircon. Among the advantages of SIMS are the high lateral resolution (~8 μm using the *ims*1290 with a Hyperion II ion source [5]), short analysis time (~4 min/ analysis to attain ±0.1‰, 2σ SE), and small sample consumption (~100 μm^3). We analyzed zircon standards OG-1, Oracle, FC-1, 91500, R33, Temora, Plešovice, 94-35, Fish Canyon, Mud Tank, and KL1, as well as zircons from two I-type granites (Big Bear, CA), one S-type granite (Strathbogie Range, Australia), and 8 Hadean grains.

We observe large (~7‰) inter- and intra-grain variations in several zircons, illustrating the value of using a high spatial resolution method to identify spatial heterogeneity. Samples showing uniform $\delta^{94/90}Zr_{NIST}$ between grains by SIMS (e.g., 91500) were also measured by solution using a double spike [6] to confirm the accuracy and precision of our in situ analyses. In excellent agreement with double-spike solution data [3], we found 6.5‰ variation in $\delta^{94/90}Zr_{NIST}$ among FC-1 (Duluth Complex, MN) zircons. Hadean zircons show a limited range with an average $\delta^{94/90}Zr_{NIST}$ of -0.4±0.5‰. Zircons from the Strathbogie Range vary over 1.8‰ in $\delta^{94/90}Zr_{NIST}$ while the two Big Bear samples differ by 1.1‰. Interestingly, we did not observe a strong correlation between $\delta^{94/90}$Zr and whole rock SiO_2, but the large isotopic variations appear due to magmatic processes. Further work is underway to identify the underlying fractionation mechanisms and thus allow translation of these signals into petrogenetic interpretations.

[1] Schönbächler et al. (2002) *Science*, *295*.1705; [2] Akram & Schönbächler (2016) *EPSL* **449**, 302; [3] Ibanez-Mejia & Tissot (2018) Goldschmidt abstract #1115; [4] Inglis et al. (2019) *Geochim Cosmochim Acta* **250**, 311; [5] Liu et al. (2018) *Int J Mass Spectrom* **424**, 1; [6] Ibanez-Mejia & Tissot (2018) Goldschmidt pre-conference workshop.