The laser and the damage done

JEREMY K. HOURIGAN[1]* AND ALEXANDER STEELY[1]

[1]Earth and Planetary Sciences, UC Santa Cruz, 1156 High St. Santa Cruz, CA 95064

*correspondence: hourigan@ucsc.edu

Rapid proliferation of LA-ICP-MS laboratories that engage in U-Pb analysis of zircon has resulted in data generation multiple orders of magnitude faster and easier than ever before. The analytical throughput and spatial resolution, however, comes at the expense of accuracy and precision. While significant advances in data acquisition and processing and rigorous error propagation have been made over the past five years, age bias at the 1-3% level for well-known standards remains a common phenomenon[e.g., 1].

We hypothesize that radiation damage alters the laser ablation process and contributes to variability in laser-induced elemental fractionation producing the observed age bias in otherwise concordant zircon standards. Allen and Campbell [2] showed that annealing of radiation damage produces up to 3x improvement precision and accuracy. A basic understanding of photochemical processes that generate fractionation differences is an analytical imperative. To this end, we interrogate two potential processes responsible for this differential elemental fractionation. First, we expect that lattice disorder and laser absorption scale directly producing variable pit morphology, and consequently down-hole fractionation [3]. Second, the radiation damage may modulate the efficiency of phase separation of the ablated aerosol into high T zirconia rich in U and Th and silica rich in Pb [4,5]

We couple LA-ICP-MS analysis with vertical scanning interferomtery for pit metrology, Raman spectroscopy for lattice damage characterization and (U-Th)/He dates to quantify retained alpha dosage. The experiments target a range of new untreated Sri Lankan gem zircons ranging from 15-2000 ppm U [6] as well as other extant international standards. Our data reveal a strong correlation between lattice damage and pit depth and volume. Ongoing work seeks to illuminate the photochemical processes that occur in the ablation pit walls. This contribution will examine whether damage-matching is required to get beyound 1-2% accuracy threshold.

[1] Klotzli *et al* 2009, *Geostandards*, **33**, 5-15 [2] Allen and Campbell, 2012, *Chem. Geol.* **332**, 157 [3] Horn *et al* 2000, *Chem. Geol.*, **164**, 281–301 [4] Kosler *et al* 2005, *JAAS*, **20**, 402-409 [5] Kuhn *et al JAAS*, **20**, 21-27 [6] Steely, Hourigan, Juel, in Review, *Chem. Geol*