(U-Th)/He dating of impact structures – the big, the small, and the potential limitations.

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Introduction: ~80% of the known terrestrial impact structures have either never been dated, or have poorly constrained ages (i.e., >10% errors) [1]. The reason for these poor age constraints, and the main challenge in dating impact structures, is that the U-Pb, Rb-Sr, K-Ar systematics in 90% of the target rocks are not completely reset during an impact event [e.g., 2]. We have employed the (U-Th)/He technique to date terrestrial impact events because this low-temperature fast-diffusivity geochronometer has many advantages over traditionally used dating techniques.

We report the latest results from (U-Th)/He single crystal zircon and apatite dating of terrestrial impact structures, including Manicouagan (90 km, Canada), Charlevoix (54 km, Canada), Lake Saint Martin (40 km, Canada), Ries (24 km) paired with Steinheim (3.8 km, Germany), Bosumtwi (10 km, Ghana), Wetumpka (6.25 km, Alabama, USA), Karikkoselkä (~1.5 km, Finland), and Monturaqui (350 m, Chile). These impact structures vary greatly in size from as large as 90 km in diameter to as small as 350 m, and we have dated zircon and apatite crystals from many different types of samples, e.g., impact breccias, suevites, and impact melts.

Results: We have obtained (U-Th)/He ages that are in agreement with radiogenic or stratigraphic ages, including: Manicouagan - 213.2 ± 5.4 Ma (2 SE) [3]; Charlevoix - 416-426 Ma; Lake St Martin - 213.8 ± 3.0 (2σ); Wetumpka - 84.4 ± 1.4 (2σ) [4]; and Monturaqui - 663 ± 90 ka (95% conf.) [5]. (U-Th)/He results from Ries and Bosumtwi are complicated by a slightly younger age population. Unlike the successful results from the 350 m diameter Monturaqui crater, preliminary (U-Th)/He dating of borehole samples from the 3.8 km Steinheim crater did not give an impact age, instead yielding partially reset zircon ages of 247-282 Ma. The youngest ~8.7 Ma (U-Th)/He age from Karikkoselkä may suggest a Miocene or younger age for this impact structure.

Discussion: (U-Th)/He dating has shown excellent results [3-5], especially for smaller impact structures that preserve little or no impact melt material. However, potential complications of the technique have been discovered and will be discussed.

References: [1] Earth Impact Database. 2012. *http://www.passc.net/EarthImpactDatabase/*. [2] Deutsch A. & Schärer U. 1994. *Meteoritics* 29:301-322. [3] van Soest M. C. et al. 2011. *Geochemisty Geophysics Geosystems* 12:1-8. [4] Wartho J-A. et al. 2012. *Meteoritics & Planetary Science* in press. [5] Ukstins Peate I. et al. 2012. *Earth & Planetary Science Letters* submitted.