A TALE OF TWO CRATERS: (U-Th)/He DATING AND MODELLING OF AGE RESETTING OF TWO SMALL/LOW ENERGY IMPACT STRUCTURES.

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Introduction: (U-Th)/He single apatite and zircon crystal dating has been successfully undertaken on two small/low-energy impact structures: Wetumpka (a ~5 km diameter shallow-marine structure [1]) and Monturaqui (a 350 m diameter structure [2]). A range of ages was obtained, but the youngest cluster of apatite/zircon ages yielded impact ages of 84.4 ± 1.4 (2σ) for Wetumpka [3] and 663 ± 90 Ka (95% confidence) for Monturaqui [2]. These (U-Th)/He ages are in agreement with previous stratigraphic [1] and cosmogenic/palaeomagnetic ages [4-5].

However, the target rocks of these two small size/low energy craters experienced heterogeneous and relatively low shock metamorphism conditions of 5-15 GPa (Wetumpka [6]) and <10-65 GPa (Monturaqui [7]) that relate to temperatures of 100-150°C and 100->1500°C, respectively [8]. Therefore, how did the radiogenic ^{4}He in ~10% of the apatite and zircon crystals we have analysed become reset during these short-lived impact events?

Mathematical modelling of He diffusion in apatite and zircon has been undertaken to better understand how these grains can become reset during impact events, and how the (U-Th)/He technique can be successfully applied to the dating of small impact structures.

Results: Mathematical modelling of the % of He diffusion loss from apatite and zircon crystals, has shown that (a) short, but high temperature fireball [e.g., 9], (b) very localized short high shock metamorphism events [e.g., 10], (c) longer duration but lower temperature hydrothermal events [e.g., 11] or (d) a combination of all three processes (a-c) are all capable of resetting (U-Th)/He ages in apatite and zircon grains during the formation of low energy or small impact structures.

Conclusions: As the He diffusion modelling shows, the unique fast diffusion properties of He in U-bearing minerals (e.g., apatite and zircon) make the low-temperature (U-Th)/He geochronometer a powerful tool for dating impact structures, especially low energy and small impact structures.

References: [1] King D. T. Jr. et al. 2006. *Meteoritics & Planetary Science* 41:1625-1631. [2] Ukstins Peate I. et al. 2010. Abstract #2161, 41st Lunar & Planetary Science Conference. [3] Wartho J-A. et al. 2011. Abstract #1524. 42nd Lunar & Planetary Science Conference. [4] Valenzuela M. 2008. *Jaresbericht Annual Report* 27. [5] Valenzuela M. 2008. Abstract #5185, 72nd Meteoritical Society. [6] Neathery T. L. et al. 1976. *Geological Society of America Bulletin* 87:567-573. [7] Bunch T. E. and Cassidy W.A. 1972. *Contributions to Mineralogy & Petrology* 36:95-112. [8] French, B. M. 1998. *Traces of Catastrophe*. Lunar & Planetary Institute. p.p. 120. [9] Collins G. S. et al. 2005. *Meteoritics & Planetary Science* 40:817-840. [10] Biren M. B. et al. 2010. Abstract #2314. 41st Lunar & Planetary Science Conference. [11] Jõeleht A. et al. 2005. *Meteoritics & Planetary Science* 40:21-33.