TERRESTRIAL IMPACT ZIRCON TEXTURES: IMPLICATIONS TO IMPACT GEOCHRONOLOGY.
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Introduction: The bombardment history of our planet has major implications for Earth's atmosphere, habitability, near surface conditions, and the delivery of the building blocks of life over its four and a half billion years. Constraining the impact flux to the Earth-Moon system was highlighted by the National Research Council's 2007 report "The Scientific Context for the Exploration of the Moon" as the top priority goal for lunar research. Evidence of the early impact flux has largely been based on interpretations of ^{40}Ar-^{39}Ar ages of lunar samples which can be problematic due to the presence of relic clasts, incomplete Ar outgassing, diffusive modification during shock and heating, and exposure to solar wind and cosmic rays [1]. Recent studies [2, 3] have utilized zircon from Apollo samples as well as lunar meteorites to better constrain the impact history of the Moon. Sieve textures found in zircon within lunar meteorite SaU 169 have been identified as "poikilitic impact melt zircon formed during equilibrium crystallization of the impact melt" and used to better constrain the age of the Imbrium impact [3]. Such textures had previously not been observed in terrestrial zircon and have been suggested as the best candidate grains with which to identify an impact age [4]. We report SIMS U-Pb analysis on the first terrestrial sieve textured zircons isolated from Vredefort impactites to investigate the use of such grains as probes of planetary impact history.

Results: Zircon grains were isolated from a sample of granophyre dike collected near the Kommandonek Game Reserve of the ~2 Ga Vredefort impact structure in South Africa. Separated grains show an intimate relationship with Mg-rich pyroxene, similar to that seen in the lunar samples (inset Fig. 1). Multiple grains show fractures and embayment's infiltrated with pyroxene in what appears to be resorption of the zircon rather than equilibrium crystallization during the impact. Similar textures have been observed in plagioclase during rapid decompression and could be indicative of the swift unroofing during an impact event [5]. However, U-Pb analysis of such grains (Fig. 1) clearly shows that the zircons have been inherited from the target and are not neo-formed zircon that crystallized from the impact melt and thus should not be used to identify impact ages. Pb-loss is highly variable in these samples and the lower intercept age of ~1985±150 Ma agrees well with that previously reported for the Vredefort impact [6, 7].

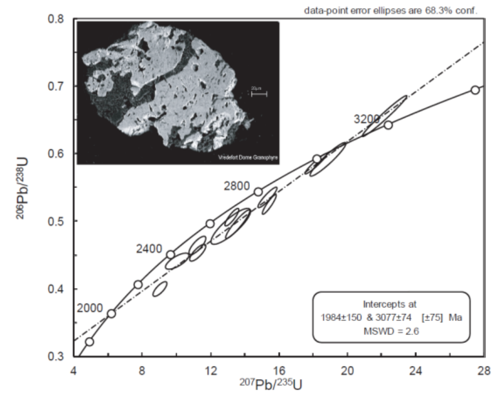

Figure 1. U-Pb concordia diagram of 12 zircons with sieve textures (see inset of BSE of single zircon; scale bar is 20µm) showing that the grains are inherited from the Archean basement and thus should not be used to identify an impact age. Lower intercept age within error of the impact suggests the grains did experience Pb-loss during the impact event.

Discussion: Although zircon geochronology offers an exciting new tool with which to constrain planetary impact histories the effects of impacts on zircon remain poorly understood and need to be explored terrestrially prior to making interpretations on extraterrestrial samples. Sieve-like textures found in terrestrial and extraterrestrial zircon are the result of resorption of pre-existing grains into new melts possibly due to rapid decompression during an impact. U-Pb ages of such grains isolated from the ~2 Ga Vredefort impact structure show clear inheritance from the Archean target and thus should not be used to date impact events in terrestrial or extraterrestrial samples. Pb-loss within these zircons appears to have been affected by the impact however no grains show complete resetting and such age resetting appears to be very rare within terrestrial impact events.

References: [1] Fernandes et al. (2013) *MAPS 48*, 241-269. [2] Nemchin et al. (2008) *GCA 72*, 668-689. [3] Liu et al. (2013) *EPSL 319-320*, 277-286. [4] Grange et al. (2013) *GCA 101*, 112-132. [5] Nelson et al. (1992) American Mineralogist 77, 1242-1249. [6] Kamo et al. (1996) *EPSL 144*, 369-387. [7] Wielicki et al. (2012) *EPSL 321-322*, 20-31.