LINKING SHOCK MICROSTRUCTURES AND GEOCHRONOLOGY WITH ZIRCONIA (ZrO_2)

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Introduction: Monoclinic zirconia (a.k.a. baddeleyite) is a highly valuable tool for the dating of igneous rocks using U-Pb isotope methods. As the silica-deficient cousin of zircon (tetragonal $ZrSiO_4$), it shares many of the desirable properties for geochronology. These include U contents up to thousands of ppm, largely excluding initial common-lead, and having very low volume diffusion rates for both uranium and lead [1]. However, unlike zircon it commonly occurs in a wide-range of mafic magmas, including shergottites [e.g. 2,3], Lunar meteorites and Apollo samples [e.g. 4,5], asteroidal achondrites [6] and ordinary chondrites [7]. Although relatively common, the small size (typically ≤10–40 µm long by a few µm wide) of zirconia grains in these materials has presented a major analytical challenge for geochronology. However, developments in micro-analytical techniques have opened up tremendous opportunities to date these samples, using in-situ approaches to U-Pb isotope ratio measurement by secondary on mass spectrometry (SIMS; [8]) and laser ablation inductively coupled plasma mass spectrometry (LA-ICP-MS; [9]).

Recent studies have also identified a wide range of new shock-microstructural phenomena in baddeleyite, and demonstrated that these can be linked with variable Pb-loss and hence disturbance of the U-Pb system [2,10]. This opens up exciting possibilities to resolve the extent of isotopic disturbance caused by impact events from primary age information in planetary materials, and hence tease apart the timing of both impact and igneous events within highly-shocked samples.

From field to atomic scale analysis: We will summarize the potential of zirconia as a planetary chronometer, including recent advances in the understanding of its shock-microstructral evolution from studies of terrestrial impact craters and meteorites. Significant emphasis will be placed on practical considerations in zirconia microanalysis, including the location and preparation of micro-zirconia grains, microstructural analysis by electron backscatter diffraction (EBSD) and transmission electron microscopy (TEM), *in-situ* U-Pb isotope ratio measurement by SIMS and LA-ICP-MS, and new nanoscale analytical possibilities with atom probe tomography (APT). In combination, these structural and isotopic tools are providing exciting new insights into the behaviour, and possible future applicaitons, of this widespread accessory mineral.

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