# Shocked baddeleyite as a new tool for Lunar chronology

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Separating the ages and effects of shock metamorphism from those of endogenic geological processes is a major challenge for the study of planetary materials. Our recent work on Martian meteorites and terrestrial impact structures has identified new links between shock-induced microstructures and U-Pb isotopic resetting in baddeleyite [1,2]. This robust accessory mineral is common in Lunar rocks, and undergoes a series of phase transitions during shock-metamorphism [3,4] some of which may promote Pb-loss and hence provide a powerful approach to resolve the timing of impact and igneous endogenic events.

Here we illustrate how different processes acting during the complex history of Lunar rocks can be deciphered by combining electron nanobeam (CL, EBSD, TEM) and in-situ U-Pb isotope (SIMS) analyses of micro-baddeleyite and zircon. We present new data for NWA 2200, a Lunar anorthositic breccia [5]. Baddeleyite grains from a thin-section show a wide-array of deformation microstructures. These include fracturing, amorphization, plastic deformation and recrystallization, which reflect differences in the shock pressures and temperature paths experienced by each grain. SIMS U-Pb isotope analyses reveal a narrow range of baddeleyite $^{207}Pb/^{206}Pb$ ages (4.05-3.85 Ga), significantly younger than zircons with shock-microstructures from the same sample (4.42-3.95 Ga). We are investigating the degree to which these young ages reflect differing shock-response of the U-Pb system in the two phases. By integrating new microstructural criteria to resolve the shock-state of each grain, the isotopic data provides bracketing ages for major shock metamorphic events and igneous events recorded in NWA 2200, and offers the potential of a more refined micro-accessory mineral record of Lunar geological history.

[1] Moser *et al*. (2013) *Nature* **499**, 454-457. [2] Darling *et al*. (2015) *LPI Contributions* **1861**, 1081. [3] Garvie *et al*. (1975) *Nature*, 258, 703-704. [4] Ohtaka *et al*. (2005) *J. Appl. Cryst*. **38**, 727-725. [5] Nagaoka *et al*. (2013) *Polar Science* **7**, 241-259