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# The behavior of the U-Pb system in apatite and Zr minerals in pristine lunar norite during infiltration by Imbrium impact melt

DENNIS M. VANDERLIEK[1], **HARRY BECKER**[1], ALEXANDER ROCHOLL[2], WINFRIED H. SCHWARZ[3] AND MARTIN WHITEHOUSE[4]

[1]Freie Universität Berlin
[2]GFZ German Research Centre for Geosciences
[3]Universität Heidelberg
[4]Swedish Museum of Natural History

Presenting Author: hbecker@zedat.fu-berlin.de

Dating large lunar basins is critical for understanding the lunar bombardment history and distinguishing different mass flux models such as the late lunar cataclysm or exponential decay. The former predicts that most lunar basins formed between 4.0 and 3.8 Ga, whereas the latter would be supported if a significant number of basins are older than 4 Ga. One basic condition is a better understanding of the possible resetting of geochronometer systems during later impacts. Recently, more age data have become available using in situ U-Pb and Pb-Pb ages of phosphates and zircon from impactites. These data can be used to identify the resetting behavior of these U-bearing minerals during short-term heating events induced by mixing with hot ejecta deposits or infiltration by impact melt. Here, we present in situ U-Pb data on the dimict Apollo 15 breccia 15455, which comprises pristine anorthositic norite cut by >cm-thick veins of KREEP rich impact melt. Disturbed Ar-Ar age spectra suggest that the melt veins may have formed during the Imbrium impact at 3.9 Ga. Evolved diopside-$SiO_2$ domains in the norite include apatite and granular zircon aggregates, the latter sometimes replacing baddeleyite. These phases occur at a distance of a few mm to several hundred µm near melt veins. Zircons (n = 11) and baddeleyites (n = 6) are concordant to reverse discordant and yield a similar range of Pb-Pb ages of 4.14-4.27 Ga. After correction for common Pb, most apatites yield reverse discordant U-Pb ages and Pb-Pb ages of 3.90-3.94 Ga (n=9). The data suggest that the Imbrium impact affected the U-Pb system of most apatites in the norite, presumably by heating from nearby impact melt veins or hot ejecta. In contrast, neither zircons nor baddeleyites display evidence for resetting of their U-Pb systems at 3.9 Ga, indicating their robustness against later heating events. The granular textures of zircons in 15455 are typical for impact-related recrystallization and thus their Pb-Pb ages are consistent with multiple basin forming events between 4.15 and 4.33 Ga (this work, [1]), consistent with exponential decay of lunar bombardment.

[1] Crow et al. (2017) *GCA* 202, 264-284