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Impact-Generated Zircon and the History of Lunar Breccia 67955

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Isotopic age data from early studies of ancient lunar breccia were often lacking sufficient petrological background information. In-situ U-Pb dating of accessory phases in lunar rocks not only provides precise ages but also preserves their petrological context. This information is crucial to reconstruct geologic events in the early lunar timeline, notably the history of basin-forming impacts. Here we present our results for lunar impact breccia 67955 using mineralogical mapping by QEMSCAN and U-Pb data by SIMS to emphasize the importance of coupling textural and mineralogical information with age data.

Thin-section 67955,48 shows three texturally and mineralogically distinct domains (D1-D3). D1 consists of up to 2 mm large plagioclase phenocrysts with interstitial pyroxene and olivine. D2 comprises mm-sized clasts with varying plagioclase-pyroxene-olivine ratios, grain sizes and textures. D3 comprises mineral fragments and fine-grained material forming the matrix around the clasts of D2. Accessory Fe-Ni metal and troilite grains occur frequently intergrown in D1 and as up to 3 μm-size disseminated grains in clasts of D2. Troilite is nearly absent in D3, however Fe-Ni metal occurs locally. Apatite occurs in all three domains but is most abundant in D3, forming clusters or necklaces around clasts. Twenty-six zircon grains (3 to 15 μm) have been identified exclusively in clasts and clast remnants of domain 2. Zircons are anhedral, irregular and a few show irregular zoning patterns in BSE and Cl images. Dating of seven zircons (max. spot size 4 μm) using a CAMECA IMS 1280 HR SIMS (GFZ Potsdam) yields a mean $^{207}Pb/^{206}Pb$ age of 4.210 ± 0.014 Ga (2sd, n = 7) and concordant U-Pb ages.

Due to the presence of Fe-Ni metal grains in the three domains we conclude that all rock types (and the zircons) crystallized from impact melt within a narrow time interval. The concordant ages of ~4.21 Ga and the textural and mineralogical variations between clasts indicate one or several large-scale impact events that produced chemically diverse impact melt pools, or, alternatively, chemically stratified impact melt sheets. Our study indicates that zircons may form during the crystallization of impact melts in a range of melt compositions and textural settings.