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# Microstructures and U-Pb ages of phosphates in Apollo 14 breccias

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Our current understanding of the early impact flux throughout the early Solar System is mainly based on studying lunar samples and therefore, dating large lunar basins is critical for understanding the lunar bombardment history. One of the fundamental research questions in planetary formation remains the exact timing and chronology of these large impact events.

Uranium-bearing materials, such as the minerals zircon and phosphate, occur widely as accessory minerals in planetary materials and has made U-Pb dating of these minerals an important tool to understand the impact history of the Moon. Several impact events were previously dated within zircon and phosphate grains from different Apollo landing sites, and an apparent age cluster around 3.94 to 3.92 Ga was noticed in the phosphate age distribution [e.g., 1, 2].

Little is known about microtextures in phosphate, despite of its wide application in geochronology and it remains poorly understood how shock deformation as the result of impact events leads to incomplete resetting of the U-Pb system in phosphate and zircon.

Several impact breccias from the Apollo 14 landing site were selected for the purpose of detailed microstructural, isotopic and geochemical analyses of Ca-phosphates and zircon. Band contrast images and texture component maps obtained by EBSD analyses reveal no signs of deformation of phosphate or zircon grains at the microscale. Merrillite grains within sample 14311 reveal internal texture in BSE and CL images, which resemble exsolution lamellae. The “lamellae” show darker CL and BSE contrast when compared to the surrounding merrillite crystal, which may indicate geochemical variations (Fig. 1). Further studies, i.e. by TEM, are necessary.

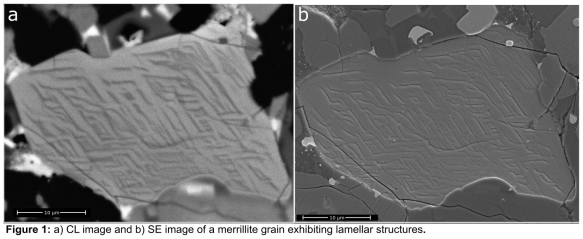

**Figure 1:** a) CL image and b) SE image of a merrillite grain exhibiting lamellar structures.

Preliminary SIMS U-Pb ages of Ca-phosphates give a weighted average age of 3941 ± 2 Ma (2σ), while the zircon ages range from 3.94 – 4.34 Ga. These ages are in general agreement with previously obtained ages for the Apollo 14 impact breccias [e.g. 3].

**References:**

[1] Snape et al. (2016), GCA, 174, 13-29.
[2] Thiessen et al. (2017), MAPS, 52(4), 584-611.
[3] Merle et al. (2014), MAPS, 49(12), 2241-2251.