The SELFRAG Lab is a laboratory scale solution for the selective fragmentation of composite materials. The Lab uses high voltage electric discharges to fragment materials along internal phase boundaries, liberating individual components from the surrounding matrix. This study highlights the application of electric pulse fragmentation (EPF) in the liberation of apatite from valuable samples.

Liberation of apatites from from the McKinney Meteorite using electric pulse fragmentation.

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Purpose of Study

When asteroids collide, a textural and chemical record of the conditions of impact is often left behind. Meteorites that sample shocked asteroids provide a way to reconstruct the nature and timing of impact events that occurred during the early history of the Solar System.

The textural context and U-Pb ages of highly shocked apatite grains found in meteorites can help to reveal both the specific conditions and timing of impact events. Ultimately, such an understanding would help us fingerprint dramatic events, for example debris scattering in the aftermath of the Lunar Giant impact (circa 4.45 Ga).

In order to obtain the most accurate U-Pb impact age for a shocked meteorite yet determined, we isolated apatite grains from the highly shocked McKinney meteorite (L4) for analysis by Isotope-Dilution Thermal Ionisation Mass Spectrometry (ID-TIMS) at the Scottish Universities Environmental Research Centre (SUERC).

Sample Treatment

The samples was pre-crushed into pieces with a maximum diameter of 10 mm and then treated in the SELFRAG Microprocess Vessel (MPV) using a stainless steel electrode. All material was processed in three batches each receiving 10 discharges at 90 kV. All material was sieved at 1 mm and oversize returned to the MPV and reprocessed in a further 2 batches each receiving 10 discharges. After processing all material was then dried overnight at 65°C.

Quality of treated product

The apatite grains recovered from SELFRAG-crushed samples were typically of large (100s of microns) and had cleanly separated from other phases during the EPF treatment. This is ideal for whole-grain ID-TIMS, which provides no spatial resolution and is sensitive to contamination by foreign phases. Overall, the treatment was successful and has aided our ability to obtain good quality whole-grain, clean apatite separates for ID-TIMS analysis.

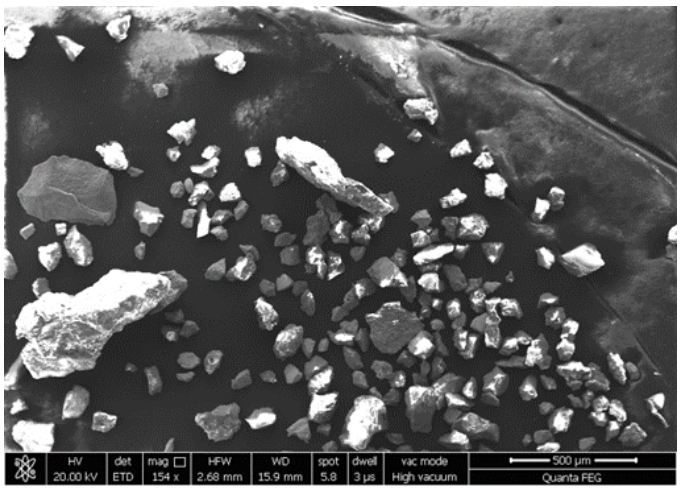

Figure 1 SEM Image of mixed grains of material following dense mineral separation steps.

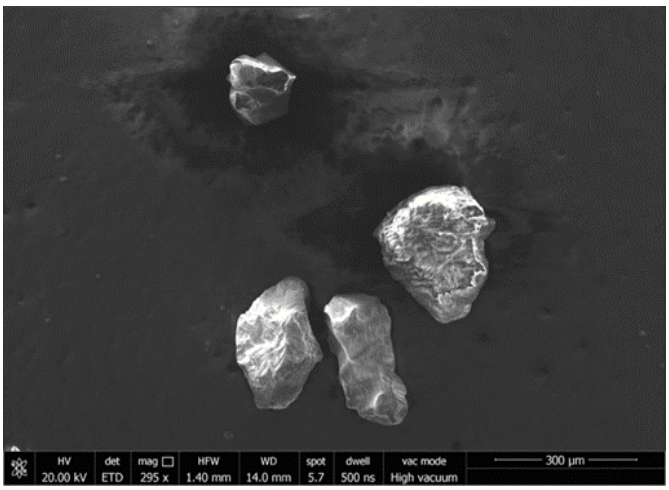

Figure 2 SEM image of apatite grains after complete mineral separation.