IMPACT-GENERATED HYDROTHERMAL CIRCULATION AND METASOMATISM OF THE ROCHECHOUART ASTROBLEME: MINERALOGY AND MAJOR AND TRACE ELEMENT DISTRIBUTION. Sarah L Simpson, Martin R. Lee and Paula Lindgren, University of Glasgow, University Ave, Glasgow, Lanarkshire G12 8QQ, UK; S.Simpson.1@research.gla.ac.uk, Martin.Lee@Glasgow.ac.uk, Lindgren.Paula@Glasgow.ac.uk

Introduction: The energy released during a hypervelocity impact on Earth can generate high temperatures in the target rock. There are currently 170 known impact structures worldwide, of which over one-third contain fossil hydrothermal systems [1]. Results from the analysis of these hydrothermal systems have many implications for the study of the origin of life on Earth and potential thereof on Mars. Hypervelocity impacts are also of particular economic interest as they may produce, expose or concentrate high commodity resources such as hydrocarbons, precious metals and ore minerals.

The Rochechouart impact structure: The Rochechouart impact event has been dated to 201 ± 2 Ma [2]. Its target rocks are primarily of granitic composition and are exposed in the Limousin region of south-central France. The structure has been eroded to the basement and little to none of the original morphological features or allochthonous units have been preserved. The latest research has identified the projectile to have been an iron meteorite [3]. The fact that this structure has been so eroded gives researchers a unique opportunity to observe the effects of hypervelocity impacts on the target below the transient crater floor. It also can provide an insight into the deeper levels of the subsequently produced hydrothermal systems.

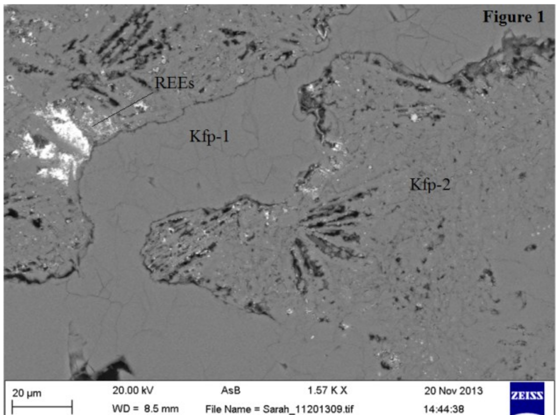
Previous work: Previous work has focused on detailed classification of the Rochechouart target and autochthonous and allochthonous impactites [4, 5], identification of the projectile component [3], and dating the structure employing Ar-isotope techniques [2]. They have also noted geochemical evidence of metasomatism, which is pronounced throughout all lithologies as enrichment in K_2O and depletion in CaO and Na_2O [3, 4, 5]. This indicates a pervasive hydrothermal system, whose effects throughout the structure have yet to be studied in detail, particularly in those parts below the transient floor.

Study purpose and methods: The purpose of this study is to classify the mineralogical and geochemical effects of the hydrothermal system on what remains of the overlying impactites as well as the basement below the crater floor. By classifying the resulting mineral assemblages and comparing them to that of the protolith, an attempt will be made to constrain the temperature and compositional conditions of the system responsible for the alteration, mobilization and reprecipitation of minerals.

Samples were collected directly from the Rochechouart impact structure via permission from the Réserve Naturelle de l'Astroblème de Rochechouart-Chassenon [6]. Sample selection was based on the presence of secondary mineralization in hand sample. They were prepared for SEM/EDS and Raman imaging and analysis using the facilities available through the University of Glasgow.

Distribution of sulphides, carbonates, oxides, phyllosilicates and trace elements: *Sulphides, sulphates and carbonates* The majority of the sulphides are constrained to mineral veins below the crater floor, and are found in a variety of basement rocks. In allochthonous samples, authigenic barite has been observed within vesicles of melt-rich rocks. Breccia dikes have been found with a "cement", or secondary intraclastic mineralization, composed of coarse crystalline, euhedral, authigenic carbonates and sulphides. Due to their nature and location within the structure, these dikes have been classified as impact-generated, and will be used for forthcoming sulphur and oxygen stable isotope analysis. *Oxides* Euhedral Fe and Ti oxides are the most abundant, and appear to have formed from the cooling of vapour phases within vesicles and *in situ* with the secondary phase of K-feldspar. *Phyllosilicates* Fractured granitic target rocks below the transient floor show evidence of sericitization, which is highly characteristic of potassic alteration. Melt-rich, vesicular allochthonous lithologies show signs of heavy argillization and some vesicles have been completely occluded by clay mineralization. *Trace elements* The concentration of REEs has been observed within the primary K-feldspar phase of the melt rocks, and accumulates around the periphery of vesicles. These aggregates are not believed to be a direct product of hydrothermal processes, but it is clear from the distribution pattern that they have concentrated within the intracrystalline voids left by depletion of potassium in the primary groundmass phase of the melt rocks.

Alteration texture of impact melt rocks: The most pronounced type of alteration observed in melt-rich impactites is consistent with low temperature, potassium metasomatism in the form of a secondary phase of authigenic K-feldspar. The groundmass exhibits a "skeletal" texture with large intracrystalline voids, which appears to have been the source of alteration for a further generation of authigenic K-feldspar that fills veins and vesicles (Figure 1). REE's have accumulated in this void space around the periphery of vesicles. A similar texture has been observed within the Reis crater melt rocks [7]. The unusual texture and phases observed in this lithology appear to be the result of a dissolution-recrystallization regime, but further study is required.



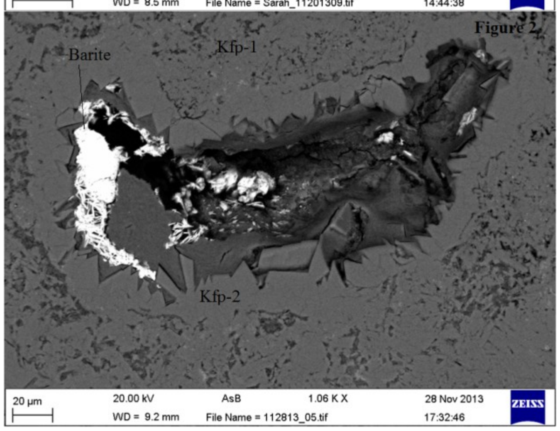


Figure 1: Melt-rich impactite, type Babaudus, showing unusual "skeletal" texture of altered K-feldspar groundmass (Kfp-1), a secondary phase of euhedral K-feldspar filling vesicles (Kfp-2) and the accumulation of REE's around vesicle peripheries (white).
Figure 2: Vesicle in melt-rich impactite, type Babaudus, also displaying "skeletal" texture of K-feldspar groundmass (Kfp-1) and secondary phase of euhedral K-feldspar (Kfp-2), with euhedral barite (white).

Implications for system conditions: Based on the distribution and types of assemblages found within the structure, an attempt will be made to classify the conditions of the hydrothermal system. Many trace elements, particularly REE's, are very useful in constraining environments of alteration and petrogenesis, as they tend to be highly immobile and immiscible under most conditions [8]. Contamination from the projectile may also have influenced the geochemistry of alteration assemblages, which will also be a component of this study.

Implications for the search for extra-terrestrial life: Hypervelocity impacts have long been of interest in the search for extraterrestrial life, as the conditions they produce are associated with the release of heat and water, whether held in the crystalline structure of target rocks or frozen close in proximity to the surface. While the amount of energy released is dependent on size and velocity of the projectile, even smaller complex craters (>2-4km in diameter on Earth, >5-10km on Mars [1]) are capable of initiating the warm, wet environments favourable to the formation and support of life [1, 9]. Hydrothermal systems in particular are believed to be "cradles of life" here on Earth, and possibly on other terrestrial planets, as some of the most seemingly minimalist organisms are now known to thrive in the hot, chemically extreme environments produced therein [1, 10].

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