A survey of zircon microtextures in the Rochechouart impactites

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Background Rochechouart

The Late Triassic (207 Ma [1]) Rochechouart impact structure is located in South Western France at the western margin of the Hercynian Massif Central [1,2]. The target rock consists of granitic-gneissic crystalline basement with cooling ages of 300-400 Ma [2] (fig. 1). Impactites range from lithic breccias to melt-bearing breccias and coherent melts [2,3], and are preserved in a c. 12 km zone within the eroded crater (fig. 1). This study is carried out within the scope of the Centre for International Research and Restitution on Impacts and on Rochechouart (CIRIR) [4].

Aim of study

This is a study of zircon microtextures and their variations within and between three impactites and a control sample from Rochechouart (fig. 1). It is important to determine the response to shock in zircon since this mineral is a candidate for impact age determination, e.g. see recent work on shocked zircons from Rochechouart [5].

Samples: Zircon microtextures are analysed in the following samples: (1) a control sample of an unshocked gneiss from below the crater floor – Moulin la Brousse, (2) a shocked gneiss-clast sampled from within a melt bearing breccia from Puy de Chiraud, (3) a melt-bearing impact breccia – Chassenon, and (4) a coherent vesicular impact-melt – Babadous.

Method

From the collected samples (1-4; fig. 1), thin sections and zircon separates were imaged and analysed using a (FE)-SEM, equipped with an EDS detector and an EBSD system at the Department of Geology, Lund University. Both rough and polished surfaces of individual zircon grains were imaged. Prior to EBSD-analyses, samples were polished with colloidal silica and coated with 5 nm carbon. The EBSD data was processed using the HKL Channel5 software. The noise reduction only included removal of wild spikes. Index-data for reidite includes Mincryst structure-files (in GPa): 0.69, 10.78, 20.93, 30.88 and 40.61 [8].

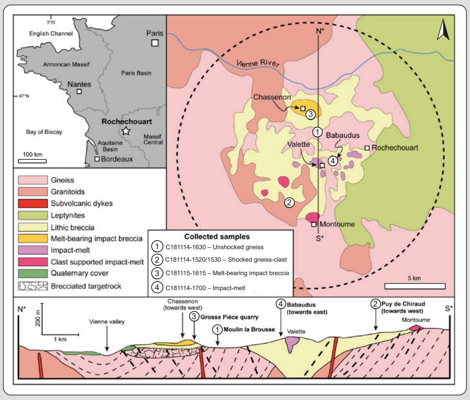

Figure 1. Simplified geological map of the Rochechouart impact structure – displaying various target bedrock, impactites and location of the investigated samples (1-4). Modified after [3] and [6].

Results

Zircons from the impactites has a wide range of textures, including shock-induced features, described below and in figures 2.(1) - 2.(4):

- **GRANULAR TEXTURE:** Partially to fully granular grains are mainly found in the impact-melt (4) and also, but scarce, in the melt-bearing impact breccia (3) – commonly propagating from structural grain weaknesses i.e. the PFs and lattice termination.
- **PLANAR FRACTURES:** Grains with planar fractures (PFs) are found in the shocked gneiss-clast (2) and the melt-bearing impact breccia (3).

Typical zircon features in the different samples

- **(1) UNSHOCKED GNEISS** – ***Moulin la Brousse***: Prismatic to ovoid zircons with rugged surfaces dominates, no shock features.
- **(2) SHOCKED GNEISS-CLAST** – ***Puy de Chiraud***: Elongated to ovoid zircons dominates, rich in PFs – where partial granularization occasionally occurs.
- **(3) MELT-BEARING IMPACT BRECCIA** – ***Chassenon***: Mainly elongated to irregular zircons with rugged surfaces, rich in PFs.
- **(4) IMPACT MELT** – ***Babaudus***: Elongated to ovoid zircons with fully granular textures dominates. Faint ghost zonations are also preserved.

EBSD analyses of selected zircons

Analyses were made on granular grains from (3) and (4) – identifying them as likely FRIGN zircons, as their pole figures reveal a systematic high-angle orientation relationship of c. 90° between the three neoblastic clusters – coinciding between {001} and {110} pole projections (c.f. [7]; fig. 3a-b). Shock-lamellas with reidite has, so far, been identified in two grains from the melt-bearing impact breccia (fig. 2 (MS3) and fig. 3c-f).

Zircon separates

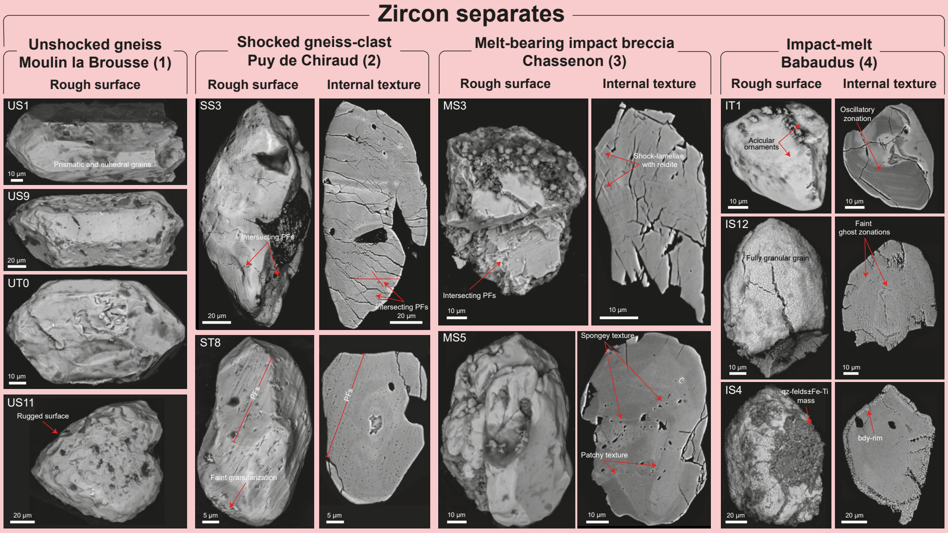

Figure 2. SEM-BSE images of zircons in: 1) control sample and (2-4) the impactites. 1) No shock features are present, mainly prismatic, euhedral grains with rugged surfaces. 2) Well defined intersecting PFs (SS3) and PFs (ST8). 3) Shock lamellae with reidite (MS3) and an altered grain with patchy and spongey texture (MS5). 4) Rare grain with oscillatory zonations and acicular ornaments (IT1), fully granular grain with preserved ghost zonation (IS12) and a fully granular grain with a baddeleyite rim, partially covered with a quartzofeldspathic(±Fe-Ti oxides) microcrystalline mass (IS4) similar to the groundmass of the impact-melt.

EBSD data

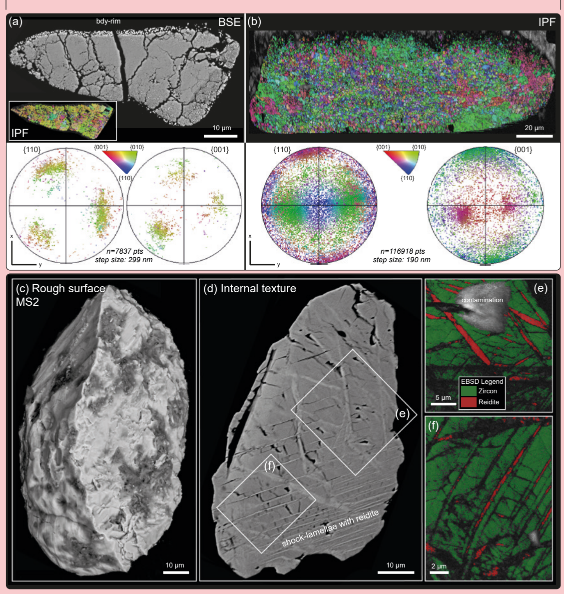

Figure 3. EBSD analyses: granular zircons with baddeleyite rim(?) from (a) melt-bearing impact breccia (thin section) and (a) impact-melt (separate), yields three main clusters with high angle arrangements towards each other – coinciding between {001} and {110} pole projections (fig. 3a and 3b; IPF colours represent neoblast orientations), indicative of FRIGN zircon. BSE-images on rough surface (c) and internal texture (d) of zircon MS2 from the melt-bearing impact breccia (3). EBSD analysis indexing reidite within several intersecting planar shock-lamellas (fig. 3e-f).

Research opportunity! Potential target for impact U-Pb dating

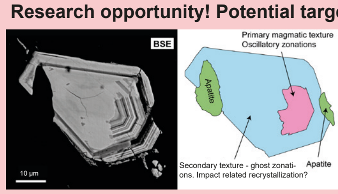

Figure 4. Zircon from (3). One of several grains with recrystallized domains and ghost zonation (blue). Here, the primary magmatic texture is also preserved (pink). Impact related (?) recrystallization fronts has likely experienced a reset of the U-Pb system.

Discussion and conclusions

The three investigated impactites (2-4) displays a range of shock-induced mincrotextures that are most likely shock induced:

- Planar deformations (PFs).
- Partial granularization to fully granular grains.
- Planar shock-lamellae with reidite.
- FRIGN zircon in two impactites (3 & 4).

The FRIGN zircons could be suitable for dating the impact event via zircon U-Pb geochronology [c.f. 5]. P-T conditions can be estimated by the presence of bdy-rims (fig. 2 (IS4) & fig. 3a) and FRIGN zircons (fig. 3) – indicating a pressure of ≥30 GP and a temperature of ≥1673 °C [9,10].

References

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