# Rochechouart hydrothermal overprint: disentangling the timing of events through Ar-Ar dating

## Conference or Workshop Item

# ROCHECHOUART HYDROTHERMAL OVERPRINT: DISENTANGLING THE TIMING OF EVENTS THROUGH AR-AR DATING

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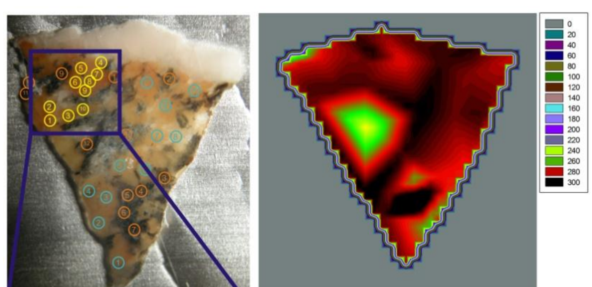
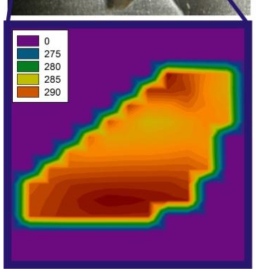
**Introduction:** There is a growing interest in the thermal evolution and fluid behavior of impact structures in the context of their possible influence on emergence of life both in the Early Earth and on other Planetary Bodies. This is largely related to hydrothermal mechanisms at work during the cooling of the hot materials produced and deposited in impact craters. Yet most of the research in this field is focused on theoretical approaches and mathematical models. Ground truth data of terrestrial craters are limited, despite the fact that they are by far the most accessible reservoir for testing models. Even on Earth, few of the 185 impact sites are sufficiently well preserved to yield material that can constrain the key processes of temperature evolution and water availability. The Rochechouart impact crater in the Massif Central region of France exposes rocks that recorded the hydrothermal system. Target rocks immediately below the crater floor are widely exposed within the ~24 km Rochechouart impact structure overlaid by the complete sequence of crater fill deposits in an inner zone ~15 km [1].

The post-impact hydrothermal system has recently been explored [2] and shows three main impact-generated hydrothermal alteration assemblages; argillic-like, carbonate, and oxide dominated, based on SEM investigation of ejecta. However, the duration of the post-impact heating is critically important. Post-impact hydrothermal veins intercepting pseudochylites at Rochechouart have been observed in the Champagnac quarry [3]. Pseudotachylites related to the impact display extreme heterogeneity both in composition and fluid contents. Kelley et al. determined an age based on a heterogeneous pseudotachylite [4] of 214±8 Ma, with the large errors reflecting scatter in the data. This study also demonstrated the presence of excess argon with variable $^{40}Ar/^{36}Ar$ composition. More recently an age of 201±2 Ma has been determined using alkali feldspar in impact-metamorphosed Variscan gneisses [5]. Thus the impact appears to have occurred close to the Triassic/Jurassic boundary and may have been associated with extensive tsunamite deposits in the Tethys ocean.




*Age variations in host rock adjacent to a calcite vein (top LH). Laser spot dating reveals both young ages and excess Ar in micas (top RH). Feldspars (lower LH).*

Thus the well exposed hydrothermal system at Rochechouart should be a good test for mathematical models, particularly in light of the potential for new drilled material in the coming years. However the age of the various hydrothermal veins and thus the extent and longevity of the hydrothermal system is not well determined. In addition, evidence for later burial and heating from Jurassic K-Ar measurements of impact melt and extensive shallow burial history indicate a potentially complex post-impact thermal history. Field evidence also indicates that black lenses and veins of amphibolites and hydrothermal veining, while they are identical both in mineralogy and texture with that of impact origin, are late Variscan in age.

In order to better characterize the post impact hydrothermal record at Rochechouart, it is critically important to develop criteria that distinguish pre-impact hydrothermal activity from impact related activity and later events. We will present data illustrating the issues, and show that Ar-Ar dating using a UV Laser-ablation system combined with high-resolution Nu-instruments Noblesse noble gas mass spectrometer, is capable of distinguishing pre- and post- impact hydrothermal veining when no spatial relationship with impact related pseudotachylite can be established. A situation that is prevalent for hydrothermal veins at Champagnac and will be the case at other localities and at other impact sites in crystalline rocks.

**References:** [1] Lambert, P. 2010. *The Geological Society of America; Special Paper* 465: 505–541. [2] Sapers, HM. et al. 2013. *Meteoritics and Planetary Science* 49: 2152-2168. [3] Reimold, U. 1987. *Journal of Geophysical Research* 92: E737–E748. [4] Kelley et al. 1997. *Meteoritics & Planetary Science* 32: 629-636. [5] Schmieder et al. *Meteoritics & Planetary Science* 45: 1225-1242.