Project Title | After the dust has settled: The post-impact hydrothermal system at Rochechouart impact crater.
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Host University | The Open University
Theme | Dynamic Earth
Key words | Impact events, hydrothermal systems, early Earth
Supervisory team | **Pl:** Susanne P. Schwenzer, The Open University, Susanne.schwenzer@open.ac.uk  
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**Project partner:** Philippe Lambert, Centre for International Research on Impacts and on Rochechouart, lambertbdx@numericable.fr (France)

| Is the PhD suitable for part time study? | Yes |

**Project Highlights:**

- Becoming an independent user of cutting edge as well as industry-standard analytical and modelling methods (optical microscopy, electron microprobe, Geochemist Workbench, noble gas mass spectrometry)
- Investigating how water-rock interactions and resulting element mobility shape environments
- Understanding processes on the Early Earth at a time life first emerged – with potential applications to other celestial bodies

**Overview:**

Large hypervelocity impacts that cause craters in the Earth’s crust are catastrophically destructive. Research in recent years has therefore understandably focused on the potential for large meteorite impacts to cause mass extinctions. But the heat deposited by these impacts may also have provided new habitats for microbial life on Earth, especially in its very early history. The main barrier to testing this in nature is that plate tectonics has erased these early potential habitats and so our knowledge of them is derived from models that have little ground truth. This project will investigate Rochechouart crater, a younger crater that was not eradicated by plate tectonic processes, and will quantify the following key processes: (1) the dissipation of heat and the duration of the heating, derived from the hypervelocity impact (2) the generation of a hydrothermal system, with heat from the impact and ground- and surface-waters in the immediate environment and (3) the mobility of elements within the shattered rocks. Among the population of preserved impact structures on Earth, Rochechouart provides a complete sequence of impactites including impact melt rocks and direct access to both the deposits and the underlying target rocks through a set of drill cores. This will allow the temperature evolution and water availability in a terrestrial crater to be determined, thus lead to a much improved understanding of the significance of impact craters to life on the early Earth.
In order to test the hypothesis that early life was sustained and shielded beneath and within large impact craters, the successful candidate will investigate the time/temperature, volatile, fluid flow and associated bio-geochemical history of Rochechouart impact crater to assess the effects of such cratering events on the habitability of the Early Earth’s surface.

![Figure 1: Qualitative assessment of the impact heat distribution, water flux and alteration minerals for a crater in basaltic target lithology. The goal of this project is to quantify this qualitative picture of impact-aftermath to assess the contribution of such craters to habitability of early Earth.](image)

**Methodology:**

1. Optical microscopy and electron microprobe analysis will be used to study mineralogy and geochemistry of the alteration in the different crater settings and to understand the alteration mineralogy using.
2. Noble gas mass spectrometry will be used to measure Ar-Ar- ages of minerals from detailed profiles below the Rochechouart crater floor along traverses from the melt/impactite sequences into the country rock, to learn about its cooling history.
3. Thermochemical modeling using industry standard and research software (Geochemist workbench, CHIM-XPT) will be employed to add the information that cannot be measured, e.g., fluid temperature and chemistry.
4. The new data and models will be used to test and refine existing hydrothermal models and to quantify the concentrations of elements acting as nutrients in the hydrothermal fluid and the environmental conditions for microbial life.

**Training and skills:**

Specifically to the project, the student will be trained in optical microscopy, electron microprobe and noble gas mass spectrometry, to the level of independent user. In addition, field work will provide planning and sampling skills. With the international nature of the project, team work and collaboration is an essential aspect of the work. Special emphasis will be on the oral and written communications skills, ranging from e-mail and phone negotiations, e.g., in the planning of the field work, to conference presentations, report writing and publication in peer reviewed papers.

Students will be awarded CENTA2 Training Credits (CTCs) for participation in CENTA2-provided and ‘free choice’ external training. One CTC equates to 1/2 day session and students must accrue 100 CTCs across the three years of their PhD.
Partners and collaboration (including CASE):

This project will be in collaboration with Dr. Philippe Lambert. He is the initiator and head of Centre for International Research on Impacts and on Rochechouart (CIRIR) created in 2016. He has overseen the first campaign of scientific drillings at Rochechouart funded by the National Reserve and he is in charge of the coordination of the scientific valorization of the cores, which will be made available to the project and to the scientific community at large, in late 2018.

Possible timeline:

**Year 1**: Oct to March: Literature work, familiarizing with mineralogy, petrology, geochemistry of impactites (with P. Lambert), familiarizing with cooling and thermochemical modelling, and initial models based on estimated temperature values and rock compositions from the literature, preparation of the field trip; March-July: field trip, sampling of cores, sample preparation; petrologic characterization. July to October: Project report writing, summarizing petrological data in writing, preparation for Ar-analyses and more detailed geochemical work.

**Year 2**: Detailed petrological and geochemical work and Ar-Ar analysis, understanding the cooling history from data obtained from the rock samples studied. Prepare a conference presentation and publication.

**Year 3**: Thermochemical modelling to find out about fluid conditions upon formation of the minerals formed and using the thermal history deduced from the samples. Prepare a second conference presentation and initial publication. Write up and submit thesis.

Further reading:


Further details:

Students should have a strong background in Earth sciences and enthusiasm for laboratory work and data analysis. Experience of thermochemical modeling is desirable. The student will join a well-established team researching into fluid rock interaction on Earth and Mars and working within the world leading Ar-laboratory at the Open University.

Please contact Dr. Susanne P. Schwenzer (susanne.schwenzer@open.ac.uk) for further information.
Applications must include:

- a cover letter outlining why the project is of interest and how your skills are well suited to the project
- an academic CV containing contact details of three academic references
- a CENTA application form, downloadable from: http://www.centa.org.uk/media/1202/centa-studentship-application-form.docx
- and an Open University application form, downloadable from: https://tinyurl.com/y73hrfou

Applications should be sent to STEM-EEES-PhD-Student-Recruitment@open.ac.uk by 12pm (noon) on 21st January 2019