Project title: Cooling and hydrothermal history of Rochechouart Impact Crater

Project code: OU23

Host institution: The Open University

Theme: Dynamic Earth

Key words: Impact cratering, mineralization, water-rock interaction, Ar-Ar dating

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Project partner: Philippe Lambert, Centre for International Research on Impacts and on Rochechouart, lambertbdx@numericable.fr (France)

Project Highlights:

- Training in, and becoming an independent user of, analytical methods (optical microscopy, electron microprobe, noble gas mass spectrometry)
- Investigating water-rock interactions and element mobility at a wide range of temperatures
- 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 energy provided 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 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. This crater will allow the temperature evolution and water availability in a terrestrial crater to be determined, thus allowing the significance of impact craters to life on the early Earth to be determined.

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-geo-chemical history of Rochechouart impact crater to assess the effects of such cratering events on the habitability of the Early Earth’s surface.

Methodology:

1. Optical microscopy and electron microprobe analysis will be used to study mineralogical and geochemical 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 will be used to add the information that cannot be measured, e.g., fluid temperature and chemistry.

4. The new data and heating 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:
CENTA students are required to complete 45 days training throughout their PhD including a 10 day placement. In the first year, students will be trained as a single cohort on environmental science, research methods and core skills. Throughout the PhD, training will progress from core skills sets to master classes specific to CENTA research themes.

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.

Partners and collaboration:
This project will be in collaboration with Philippe Lambert, the initiator and head of Centre for International Research on Impacts and on Rochechouart (CIRIR) created in 2016. He is currently finalizing 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, early 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-analytics 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 for further information (susanne.schwenzer@open.ac.uk).

Applications should include:
- a cover letter outlining why the project is of interest and how their skills match those required,
- an academic CV containing contact details of three academic references
- a CENTA application form, downloadable from www.centa.org.uk/media/1202/centa-studentship-application-form.docx
- and an Open University application form, downloadable from: http://www.open.ac.uk/students/research/sites/www.open.ac.uk.students.research/files/documents/Application%20form.docx

Apologies that some bits of information are requested multiple times on different forms. Please fill in everything requested.
Applications should be sent to STEM-EEES-PhD-Student-Recruitment@open.ac.uk by 5 pm on 25th January 2017