**PhD studentship Project information**

**Funding Source:** CENTA DTP

**Proposed start date:** 25th September 2023

**Closing date for applications:** 11th January 2023

**Eligibility:** UK/International

**Department/School:** SGGE

**Supervisors:** **PI: Dan Smith, UoL,** [**djs40@le.ac.uk**](mailto:djs40@le.ac.uk)

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**Project Title:** Image analysis and mass petrography

**Project Description:**

**Project Highlights:**

* Work with a ground-breaking new instrument to modernise traditional petrographic techniques in geology and archaeology.
* Form relationships with academic and industrial partners and build case studies that demonstrate the value of automated image analysis and mass petrography.
* Establish novel areas of research and new directions for mineralogy and petrology.

**Overview:**

Petrography – the optical microscopic analysis of thin sections of materials – is the fastest and most cost-effective tool for investigating the mineralogy and microtexture of rocks, ceramics, and other solid materials. Rock, soil and archaeological thin sections have been studied for over 150 years, with samples in archives around the world. The data produced from petrographic analysis underpins the exploration for and processing of natural resources – including the metals we will need for renewable energy technologies – materials used in construction, and forensic studies of objects both recent and ancient.

Petrographic analysis has traditionally required an appropriate optical microscope, access to the physical thin section samples, and an expert user to classify, measure and interpret the specimen. Samples could be viewed, and thus analysed, only one-at-a-time. Expert users can obtain qualitative data within minutes using a basic microscope, but quantitative analysis is time consuming. However, ground-breaking new optical microscopy technology (see figure) allows multiple sections to be scanned simultaneously to produce high quality images very rapidly. We will pair this advance with computer-based image analysis for classification and quantification, enabling thin section archives and previously-unavailable derived data to be brought into a digital environment.

Image shows a comparison between a traditional microscope that rotates a sample, and a schematic of the Zeiss Axio Scan microscope that rotates two polarisers to achieve the same effect on a multichannel image.


*The Zeiss Axio Scan can be loaded with up to 100 thin sections, which are digitised at high resolution with little to no user intervention. A rotating analyser lens combined with multiple motorised polarisers collects a multi-channel image with transmitted light and crossed polarisers at a series of apparent sample rotations.*

This PhD will develop a new, highly automated, workflow that will unlock the full value of optical analysis and combine human levels of identification and classification with superhuman levels of speed and reproducibility. These approaches will allow for quantitative and statistically-robust approaches to mineralogy and petrology, and for the rapid development of reference databases for archaeological materials. These in turn unlock the potential for new research in geology, archaeology and material science, with deeper insight into textural and mineralogical diversity of natural and archaeological materials.

**Methodology:**

*Image Capture –* The Zeiss Axio Scan is a recently-developed instrument that offers some inherent advantages over traditional optical microscopes for image capture. It is automated, and can capture multi-channel images from multiple thin sections rapidly. However, there is a need for workflow development, including the standardisation and calibration of images.

*Image Analysis –* Computer-based image analysis in petrography is often dependent on an expert user “training” an artificial intelligence, which can subsequently automate processes. Within this PhD, you will need to curate training datasets, and investigate the various approaches for image analysis available, with a critical assessment of their suitability for geological and archaeological applications.

*Case studies in geology* – quantitative analysis supports new directions in petrology. For example, the distribution of crystal sizes in igneous rocks can be used to interpret cooling histories, the mineralogy and fabric of metamorphic rocks can be used to interpret tectonic history, and the mineralogy and fabric of sedimentary rocks can be used to interpret depositional environment and diagenetic evolution. Such interpretation has traditionally been applied to a single specimen, but the mass petrography approach opens up opportunities for analysis of hundreds of samples over much wider field areas.

*Case studies in archaeology* – the identification of artefacts such as pot sherds depends on petrographic analysis of their components and textures. The ability to produce accessible libraries of both images and quantitative data can enhance the identification and provenancing of artefacts, the techniques used to make them, and hence the spread of people and their technologies.

**References:**

**Further reading:**

Ye, Z., MingChao, L. and Shuai, H., 2018. Automatic identification and classification in lithology based on deep learning in rock images. Acta Petrologica Sinica, 34(2), pp.333-342.

Berrezueta, E., Domínguez-Cuesta, M.J. and Rodríguez-Rey, Á., 2019. Semi-automated procedure of digitalization and study of rock thin section porosity applying optical image analysis tools. Computers & Geosciences, 124, pp.14-26.

Zeiss Axioscan product page: <https://tinyurl.com/3dxsrypw>

**Funding details:**

NERC CENTA studentships are for 3.5 years and are funded by NERC. In addition to the full payment of your tuition fees, you will receive the following financial support:

* Annual stipend, currently set at £ 17,668 (2022/3 – new figures to be confirmed spring 2023)
* Research training support grant £8,000 (RTSG)

\* If you do not meet the criteria for UK Fees you will need to fund the difference between UK and International fees for the duration of your studies.

\* A limited number of top up studentships to fund the difference between UK and International fees may become available but are not guaranteed.

For more details of the CENTA consortium please see the CENTA website: [www.centa.org.uk](http://www.centa.org.uk) .

**Entry requirements:**

Applicants are required to hold/or expect to obtain a UK Bachelor Degree 2:1 or better in a relevant subject or overseas equivalent.

The University of Leicester [English language](https://le.ac.uk/study/research-degrees/entry-reqs/eng-lang-reqs) requirements apply where applicable.

**Application advice:**

To apply please refer to

<https://le.ac.uk/study/research-degrees/funded-opportunities/centa-phd-studentships>

With your application, please include:

* CENTA Application form - available to download on the How to Apply section of the above link
* CV
* Personal statement explaining your interest in the project, your experience and why we should consider you
* Degree Certificates and Transcripts of study already completed and if possible transcript to date of study currently being undertaken
* Evidence of English language proficiency if applicable
* In the reference section please enter the contact details of your two academic referees in the boxes provided or upload letters of reference if already available.

In the funding section please specify that you wish to be considered for Ref CENTA2-SGGE12-SMIT

In the proposal section please provide the name of the supervisors and project title (a proposal is not required)

**Project / Funding Enquiries to:** [**CENTA@le.ac.uk**](mailto:CENTA@le.ac.uk) **or** [**djs40@le.ac.uk**](mailto:djs40@le.ac.uk)

**Application enquiries to** [**pgradmissions@le.ac.uk**](mailto:pgradmissions@le.ac.uk)

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