

## Research Experience Placement (REP) Scheme

**Project Title:**

Automating the identification and quantification of soot particles to improve historic chronologies in palaeoecology

**Project Supervisors:**

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**Host Organization and Department (if applicable):**

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**Project Description:**

Spheroidal carbonaceous particles (SCPs) are soot particles produced by incomplete combustion of fossil fuels. Their widespread distribution and well-defined chronology makes them an unambiguous indicator of atmospheric pollution. The accurate identification and quantification of SCPs in peat and lake sediments is important for bridging the gap between palaeoenvironmental and long-term observational datasets. However, traditional methods involve microscope inspection of prepared material, with labour-intensive counting to quantify the abundance of soot and thus derive age estimates from the SCP curve. This limits the application of this method and number of sites that can be examined, since analysts make a trade-off between the time spent on dating and on producing environmental indicator records (e.g. pollen data), which are also time-consuming. A semi-automated system for the detection and quantification of SCPs using a FlowCAM imaging system has recently been proposed (Liu et al. 2026) but has yet to be more widely tested or applied. This project aims to test the capacity of the method identified in Liu et al. (2026) to increase the efficiency of SCP counting at sites with differing signal strength. The objectives are (1) to compare method performance across two peatland sites, one in lowland Scotland, with higher levels of industrial pollution, and the other in the Highlands, where concentrations will be lower, and (2) assess the potential to develop this method to detect SCPs and cryptotephra to improve the robustness of historical age-depth models. The peat cores have already been obtained, but there is potential to visit the lowland site to gain fuller understanding of the connections between field and lab-based methods.

**Skills and Career-Development Opportunities:**

The project will develop the following skills:

- Build familiarity in a range of state-of-the art lab techniques and working in a lab-environment, including sample preparation and analysis
- Develop image analysis skills using ImageJ software
- Statistical skills and data handling skills (e.g. using Excel and R)

**Wider context of research:**

The Industrial Revolution is recognized as a turning point for human-environment interactions. As this pre-dates ecological and environmental monitoring, historic palaeoenvironmental evidence has an important role to play in helping understand the legacy of resource intensification on contemporary ecosystems (e.g. Swindles et al. 2019). This makes high-resolution historic dating methods a key concern to enable palaeo-records to be compared with historical (documentary) sources and integrated with observational data. Spheroidal carbonaceous particles (SCPs) are an established dating method, resulting from incomplete combustion of fossil fuels, which can be used to achieve this. Indeed, they have been proposed as a chronological 'Golden Spike' for dating the 1950s Great Acceleration (Swindles et al. 2015). While methods for SCP extraction and quantification from peat and lake sediments are well-established, automated methods can speed up this process and allow palaeoecologists to make more effective use of the historic record and the lengthening overlap with long-term environmental monitoring data.

**Project Timeframe:**

Weeks 1-2. Preparation of peat to extract SCPs and tephra  
Week 3. Training on FlowCAM use  
Week 4. Image collection  
Week 5. Image interpretation and quantification  
Week 6. Analysis of outputs and write-up of the technique.  
Flexible or part-time work is possible.  
Work cannot take place over 3-5 or 9-23 June.