Fully funded
NERC Research Studentship

Royal Holloway University of London

Fire and peat-forming environments in the Eocene greenhouse.

Supervisors: Prof. Margaret Collinson, Prof. Rich Pancost (Chemistry, Bristol), Prof Andrew Scott.

Applications are invited for a fully funded NERC research studentship for 42 months starting in late September 2012. The studentship, to be based at Royal Holloway University of London, is linked to a NERC standard grant entitled "Terrestrial methane cycling during Palaeogene greenhouse climates" led by Pancost (Bristol) with Singarayer (Bristol), Beerling (Sheffield) and Collinson & Scott (Royal Holloway) and including project partners from various countries.

The student will undertake palaeobotanical and coal maceral analyses, including study of charcoals, on lignite samples to determine peat-forming vegetation types and the importance of fire in the Eocene greenhouse climate. In addition, the work of the student will contribute to the overall grant (and result in co-authored publications with the grant team) by providing insight into peat forming environments that will inform interpretation of wetland biogeochemistry and provide an additional mechanism for testing model outputs.

Project description & aims
The Paleogene (c.65-34million years ago) is characterised by a greenhouse climate punctuated by hyperthermals. Study of one of these, the Paleocene-Eocene thermal maximum (PETM), at Cobham UK revealed increased methane release from continental wetlands at the onset of global warming (Pancost et al. 2006) linked to wetter conditions in the mire, changes in vegetation and cessation of a previously established episodic fire regime (Collinson et al. 2007, 2009; Steart et al. 2007). These results are yet to be tested elsewhere or in mire sediments from other warm intervals (such as the Early Eocene Climatic Optimum (EECO)). We have obtained multiple Eocene lignite samples from the old and new world palaeotropics and the mid palaeolatitudes of the northern and southern hemispheres. Charcoals are the product of ancient wildfires (Scott 2010) and trial samples from France, Germany and Indonesia have demonstrated charcoal presence in these Eocene lignites.

The student will:-

- Characterise the Eocene greenhouse fires and establish if fire characteristics are locally distinct or globally widespread.
- Document the major components of Eocene peat-forming vegetation and establish which types of plants were burning.
- Determine if there are links between fire occurrence and peat-forming conditions or peat-forming vegetation.
- Test the hypothesis that the Eocene greenhouse was a low fire world.
- Contribute these data to the main grant, and collaborate on resultant publications, to better constrain peat-forming conditions and their associated biogeochemistry. The fire proxy data can also help to test the vegetation model outputs on fire occurrence.

Reflectance microscopy on stratigraphically intact pillars or slabs of lignite will be used to document lignite constituents and charcoal occurrences in situ through the lignites at sub mm resolution. Data will be gathered on the extent (throughout or localised), distribution (scattered or layered), clast size (>/<200μm), reflectance values, state of decomposition prior to charring, and botanical origin (e.g. wood, cuticle) of in situ charcoals. Respectively these data will determine if fires were frequent or rare, episodic or irregular, widespread or localised, burned the peat surface or living biomass, and what was burning. Fire temperatures and fire signatures will be obtained using reflectance value histograms. Burned components will be analysed by macerating lignite to release charcoal and using SEM to identify plant tissues, organs and taxon groups (e.g. trees, ferns, mosses). For further details on all these methods please consult our published work (see further information and literature below).

Key environmental indicators will be used. These include, but are not restricted to, *Sphagnum* (*Stereisporites*) spores (mire moss), *Pediastrum*, *Botryococcus* & Zygnemataceae (open water algae), *Inaperturopollenites hiatu*s papillate forms (conifer swamp trees), *Azolla* & *Salvinia* megaspores (open water ferns), *Typha* seeds, *Sparganiaceapollenites* pollen & *Minerisporites* megaspores (marsh herbs) and dinoflagellate cysts (e.g. *Apectodinium*, *Senegalinium* indicate brackish incursions). Proportions of cuticles and uncharred wood and the macerals liptinite and vitrinite (in polished slabs) will also be recorded. Palynological data will be obtained in collaboration with, or provided by, various project partners. In combination these data will reveal major changes in peat-forming vegetation and conditions.

In the dataset of Glasspool and Scott (2010) Eocene coals have the lowest charcoal abundances of the Phanerozoic. In contrast to the Cretaceous greenhouse high fire world (Brown et al. 2012) these data suggest that the Eocene greenhouse was a low fire world. However, our unpublished work on in situ charcoals from polished pillars from four Eocene lignites from Indonesia and Germany has revealed abundant charcoal. Unpublished preliminary results by some of our project partners (Riegel, Wilde, Lenz), on the German lignites document variable abundances of charcoal. Therefore, a new dataset quantifying in situ charcoal will be obtained for each lithotype unit and for a lignite seam average. For comparison with industry standard coal maceral quantification techniques, charcoal abundance will be measured in crushed lignite. This work will expand the geographical coverage and double the existing dataset of Glasspool and Scott (2010) to determine if the Eocene can be generally characterised as a low fire world.

Training opportunities

Funding is available within the grant to allow the student to attend specialist short courses, such as the Palaeoclimates summer school, Urbino, Italy and for the student to visit and shadow (2-3 weeks each) the PDRA's working on modelling at Sheffield and Bristol and become involved in data-model comparisons. Most lignite samples are already available in the UK but funding is available for 10 days collecting in a German working open cast mine (in collaboration with Wilde, Riegel and Lenz). In addition to these opportunities, the student will receive training at Royal Holloway in sampling strategies; light, scanning electron and reflectance microscopy and photomicroscopy; plant mesofossil and coal maceral identification and analysis; palynology; charcoal analysis and its wildfire implications; and in producing scientific lectures and publications.

Further information and literature

Polished slabs from lignite pillars enable charcoals to be studied in situ by reflectance microscopy, a method pioneered at Royal Holloway and applied to refute the global wildfire hypothesis at the K/Pg boundary (Belcher et al. 2005) and the biomass burning hypothesis at the PETM (Collinson et al. 2007, 2009) and to develop an approach to determing fire return intervals in deep time (Hudspith et al. 2012). Reflectance value histograms can be used to further characterise fires (as in McParland et al. 2009). The variety of approaches to be used in this project are documented in our palaeobotanical studies on the PETM (Collinson et al 2007, 2009; Steart et al. 2007 and Collinson et al. submitted). The latter manuscript, including mesofossils extracted from the lignites, is not available yet for wider circulation and other work involving plant mesofossil studies from our group using similar components that may be consulted includes Barke et al. (2012), Brown et al. (2012) and Batten et al. (2011).

Barke et al. 2012. *Palaeogeography, Palaeoclimatology, Palaeoecology* 337-328, 108-119.
Batten et al. 2011. *International Journal of Plant Sciences*, 172, 1087-1100**.**
Belcher et al. 2005. *Journal of the Geological Society of London* 162, 591-602.
Brown et al. 2012. *Cretaceous Research* 36, 162-190.
Collinson et al. 2007. *Journal of the Geological Society of London* 164, 87-97.
Collinson et al. 2009. *Grana* 48, 38-66.
Hudspith et al. 2012. *International Journal of Coal Geology* 89, 13-25.
Glasspool and Scott 2010. *Nature Geoscience* 3, 627-630.
McParland et al. 2009. *Archaeological and Anthropological Sciences* 1:249–261.
Pancost et al. 2006. *Nature, London* 449, 332-335.
Scott 2010. *Palaeogeography, Palaeoclimatology, Palaeoecology* 291, 11-39.
Steart et al. 2007. *Acta Palaeobotanica* 47 109-125.

Eligibility

Please see criteria on NERC website (http://www.nerc.ac.uk/funding/application/studentships/)
In summary of our interpretation these indicate that the applicant must :- (i) be a UK citizen; or (ii) have leave to remain in the UK (= permanent residence, no restrictions) ***and*** have been resident in the UK for the last three years but ***not*** in full time education; or (iii) for an EU student, must have been resident in the UK for the previous three years, including years of full time education.

Application and deadline

Please make an online application from this link http://www.rhul.ac.uk/studyhere/researchdegrees/applying/home.aspx.
Applicants ***must also*** send their CV, a short supporting statement and a copy of their application to Professor Margaret Collinson m.collinson@es.rhul.ac.uk **by July 27th.**
Please contact Margaret with any specific questions on the project.

For information about the Earth Sciences Department consult http://www.rhul.ac.uk/earthsciences/home.aspx.
Please contact the Postgraduate Programmes Co-ordinator, Kathryn Hardy if you have additional questions about the department or application procedures (Kathryn.Hardy@rhul.ac.uk fax: 01784-471780; tel: 01784-443581).

Deadline – 12 noon July 27th 2012. Interviews will be held on August 8th please ensure you can be contacted between the deadline and that date.