Project title: Plio-Pleistocene history of vegetation and aridity: linking climate, tectonics and monsoon evolution

Project code: OU10

Host institution: The Open University

Theme: Dynamic Earth

Key words: Palaeoclimate, Pollen and Charcoal, Monsoon, Ocean drilling, IODP Expedition 353

Supervisory team: Luke Mander (luke.mander@open.ac.uk), Pallavi Anand (OU), Shonil Bhagwat (OU), Kate Littler (Exeter University) and Claire Belcher (Exeter University)

Project partner: Marci Robinson (USGS)

Project Highlights:

- Reconstruct first vegetation and aridity history of Indian monsoons at Plio-Pleistocene transition
- Terrestrial and oceanic multi-proxy study
- Join an international team of the IODP Expedition 353

Overview:
The Indian Monsoon is an excellent example of coupling between solid Earth and atmospheric processes. However, its evolution during the Plio-Pleistocene transition (~3.5–2.5 Ma), when Northern Hemisphere Glaciation (NHG) was intensifying, is poorly constrained. A change in Asian monsoon intensity has been linked to NHG from terrestrial records [1, 2], but a clear association between them has not yet been demonstrated.

This project will apply multi-proxy methods to reconstruct vegetation, aridity and monsoon runoff records for the Plio-Pleistocene transition from the core monsoon region of the Bay of Bengal. These records will address the following key question: how were vegetation, aridity (related to northeast monsoon) and Indian summer monsoon runoff linked before, during and after the onset of NHG?

The new Indian monsoon records from this project will be compared with published terrestrial records from northern Tibet to identify the nature of the linkage between the Indian and Asian Monsoons. Further comparison of the timing of significant change in the Indian monsoon and active uplift of northern Tibetan plateau in the NE during 3.5–2.5 Ma [1] will provide valuable information about the linkages between tectonics and monsoon evolution.

Methodology:
The deep-sea mud samples will be extracted for macrocharcoal (>180 μm) and finer fraction for pollens, microcharcoal and spores in the fully equipped laboratories at The Open University using acid digestion techniques, and will be examined and classified using transmitted light microscopy. A split mud sample will be utilised for bulk sediment XRF and geochemical work (carbon, total organic carbon and...
nitrogen isotopes measurements). Coupled palynological and bulk sediment elemental composition records will be utilised to infer changes in vegetation on land and runoff due to monsoon variation. Detailed charcoal work will be carried out to reconstruct fire history (supervisor: Dr Belcher).

Training and skills:
The student will have the opportunity to gain experience in a wide variety of laboratory techniques including deep-sea sample processing, palynology (pollen identification) and geochemical techniques provided at the state of the art facilities at The Open University. Geochemical techniques include stable carbon isotope and bulk sediment geochemical analyses. In addition, the student will spend time at University of Exeter receiving specific training for charcoal work (Dr Belcher) and comparison with stratigraphy and organic proxies (Dr Littler).

CENTA students will attend 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 skill sets to master classes specific to the student’s projects and themes. Specific skills that will be acquired during this project include:

- Research on newly discovered deep-sea sediments (IODP Expedition 353) with an international team
- Palynology and geochemical analyses
- Data handling and interpretation from a wide variety of sources
- Scientific communication through writing, poster and oral presentations
- Online teaching opportunities via the Open University Virtual Learning Environment

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Partners and collaboration (including CASE):
This project will benefit from international collaborations and networking opportunities with IODP 353 expedition scientists. In particular there will be collaboration with co-chief scientists Steve Clemens (USA) and Wolfgang Kuhnt (Germany) and scientists working on the Plio-Pleistocene transition for stratigraphy (Marc Robinson, USGS) and oceanic proxies (Oscar Romero, AWI, Germany). In addition, there will be collaboration across CENTA.

Possible timeline:

Year 1: Obtain training in sample processing of core material for palynology (taxonomy) and bulk sediment (inorganic geochemical and light isotope techniques) proxies. Generate pXRF data from Sites U1445 and U1444 and process samples to generate a vegetation change record using elemental data.

Year 2: Present elemental results at IODP and Geochemistry Research in Progress meetings and prepare manuscripts. Generate vegetation and aridity records from two sites. Two week-long placement learning field work/other skills. Carry out statistical analyses of generated data set.

Year 3–3.5: Finish remaining analytical work, data analyses, and present results at an international conference and write up thesis and manuscripts.

Further reading:

Further details:
Students should have an interest in earth system processes, and enthusiasm for learning new proxies and their application in palaeoclimate. The student will join a well-established team researching palaeoenvironmental change at the Open University and Exeter University.

Please contact Luke Mander (luke.mander@open.ac.uk) for further information.

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
- 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