

EEES Project Proposal Form – 2021 entry

Project Title	OU22 - Nature and origin of new runoff tracers in planktic foraminifera
Key words	
Supervisory team (including email address)	PI: Pallavi Anand Co-I: Frances Jenner (OU), Phil Sexton (OU), Katrina Nilsson-Kerr (Herriot Watt), Mel Leng (BGS), Damon Green (Teledyne) Collaborators: Mel Leng (BGS), Damon Green (Teledyne), Ed Hathorne (GEOMAR) and Marci Robinson (USGS)
Is the PhD suitable for part time study?	Yes <input type="checkbox"/> No <input checked="" type="checkbox"/>

Project Highlights:

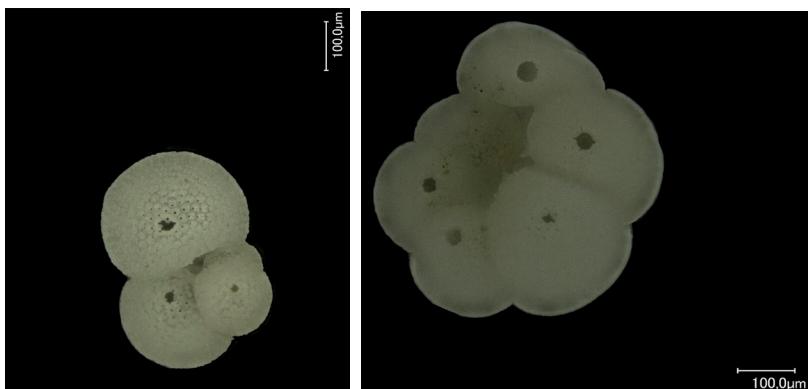
- Measure multi-elemental temperature, salinity and runoff proxies on
- Training in geochemical and micropaleontological reconstructions
- International collaboration with IODP expedition scientists

Overview (including 1 high quality image or figure):

The river system draining in the Bay of Bengal brings particulate and dissolved load of chemicals from the continent during the Indian Summer Monsoon (ISM) months. During these months major rivers (including the Ganges-Brahmaputra-Meghana and Irrawaddy-Salween river systems) bring approximately 943×10^9 m³ sediments into the Bay of Bengal and Andaman Sea¹. Not surprisingly, these sediment input, and dissolved component, alters seawater composition affecting planktic foraminifera shells that grow in these waters. Our recent work has captured some of these elements (Mn, U and Nd) being incorporated in planktic foraminifera tests which were collectively applied as runoff tracers². This project aims to carry out individual foraminifera analysis (IFA) to test the distribution of Mn, U and Nd (and other trace elements) in planktic foraminifera tests to assess their fidelity as runoff tracers. Commonly applied planktic foraminifera trace elements such as Mg, Sr, Ba and Na data will also be obtained during the analysis³. Further, targeted samples from International Ocean Discovery Programme (IODP) expedition 353 sites (U1445, U1444 and U1443) will be utilised to reconstruct seasonality of seawater temperature, salinity and runoff over a range of time scales.

This project will apply laser ablation inductively coupled plasma mass spectrometer (LA-ICPMS) tool to assess distribution of trace elements within planktic foraminifera tests to evaluate runoff proxies. Further, ablated planktic test will be used for measuring oxygen and carbon isotopes to obtain multi-proxy signals for assessing seasonality of seawater temperature, oxygen isotope composition and runoff variability from the core ISM region of the Bay of Bengal (BoB). The project will address following key questions: What is the nature and distribution of runoff tracers (Mn, U and Nd) in planktic foraminifera? What are the seasonal extremes of seawater temperature, oxygen isotope of seawater and runoff during the past cold and warm intervals? How does reconstructed extremes compare with seasonality, guided by modern seasonal mixed layer changes and inferred from multi-species oxygen and carbon isotopes data, during different time scales?

Figure 1: Pictures of two planktic foraminifera species showing laser ablation pits (samples from Bay of Bengal)



Methodology: The deep-sea mud samples will be washed and the coarse fraction ($>150\text{ }\mu\text{m}$) will be used for picking planktic foraminifera species for geochemical work (trace element and oxygen and carbon isotopes measurements). Depth dependent planktic foraminifera species (from mixed layer, halocline, upper and lower thermocline) will be picked and weighed for individual shell size and mass measurements using microbalance from the same interval on a split of the same sample (as part of the ongoing IODP project) in the fully equipped laboratories at the Open University. Targeted intervals will also be selected for multi-species planktic foraminifera IFA to obtain coupled trace elements and oxygen isotope data to reconstruct seasonality of seawater temperature, oxygen isotope (due to salinity) and runoff in response to ISM strength and changes in water column stratification.

Training and skills:

The student will receive specific training on LA-ICPMS from Dr Jenner and foraminifera specific knowledge from Dr Nilsson-Kerr (and Dr Hathorne).

The student will receive project specific training with supervisor (PA/FJ) and OU offers a diverse set of training courses throughout their PhD.

Specific skills that will be acquired during this project include:

- Cutting edge geochemical techniques
- Data handling and interpretation from a wide variety of sources
- Scientific communication through writing, poster and oral presentations to academic and non-academic audiences
- Co-supervision on your own devised OU's master's project and teaching research methods to A level Nuffield funded summer students.

Partners and collaboration: This project will benefit from international collaborations and networking opportunities with IODP 353 expedition scientists. In particular, there will be collaboration with scientists working on IFA Ed Hathorne (GEOMAR), planktic foraminifera species depth habitat in Bay of Bengal (Marci Robinson, USGS), and monsoon modelling (Phil Holden, OU).

Possible timeline:

Year 1: Obtain training in sample processing on laser ablation sample preparation. Measure shell mass and size of depth dependent planktic foraminifera species from Holocene samples. Present data at UK-IODP annual meeting.



Year 2: Generate multi species planktic foraminifera IFA for time slices across Miocene to present from the BoB sites. Present geochemical data at the Geochemistry Research in Progress meeting or Palaeopercs seminar.

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

Further reading:

1. Varkey, J.M., (1996) Physical oceanography of the Bay of Bengal and Andaman Sea. *Ocean. Mar. Biol. an Annu. Rev.* 34, 1–70
2. Nilsson-Kerr, K., Anand, P., Sexton, P. F., Leng, M. J., Misra, S., Clemens, S.C. and Hammond, S.J. (2019) Inter-hemispheric climate controls on late Pleistocene Asian summer monsoon subsystems, *Nature Geoscience*, 12, pp. 290-295.
3. Groeneveld, J., Ho, S. L., Mackensen, A., Mohtadi, M., & Laepple, T. (2019) Deciphering the Variability in Mg/Ca and Stable Oxygen Isotopes of Individual Foraminifera. *Paleoceanography and Paleoclimatology*, 34(5), 755–773.
<https://doi.org/10.1029/2018PA003533>

Further details:

Students should have a strong background in palaeoclimate, and enthusiasm for lab based geochemical methods.

If you're not sure whether your academic background is suitable, please contact one of the supervision team or Olivia Acquah at STEM-EEES-PhD@open.ac.uk. We'd be happy to hear from you.

The successful student will join well-established teams researching in Palaeoenvironmental Change at the Open University and researchers at BGS.

Applications should include:

- A covering letter that includes:
 - Your motivation to study for a PhD in general
 - Your interest in this project in particular
 - The project-specific skills, aptitude and experience you bring to the project
- an academic CV containing contact details of three references, one of whom should be able to comment on your academic abilities.
- and an Open University application form.
 - If you are British, please use the [Home form](#)
 - If you are not British, please use the [International form](#)

Applications should be sent to STEM-EEES-PHD@open.ac.uk by 12 noon on Monday 1st March 2021.