SCAR Visiting Scholar Scheme

Report

Quantifying past temperature change from Antarctic lake sediments: Links to wind strength and CO_2 degassing of the Southern Ocean (SO) over the last 40,000 years (SO-TEMP)

Visiting Scholar: Dr. Mahesh Badanal
Designation: Project Scientist
Affiliation: National Centre for Polar and Ocean Research
Country: India

Period of Visit: 4-September to 10-October

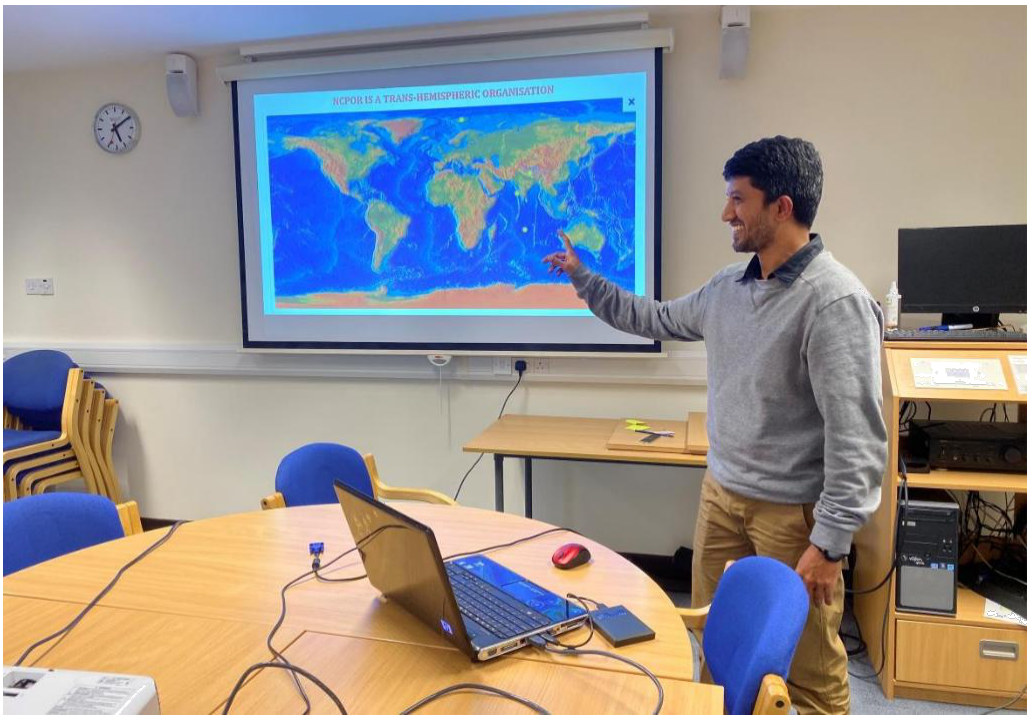
Host Details

1. **British Antarctic Survey**
    a. Dr. Stephen J Roberts, Quaternary Geologist
    Email: sjro@bas.ac.uk
    b. Prof. Dominic Hodgson, Senior Sediment Scientist
    Email: daho@bas.ac.uk

2. **University of Bristol**
    a. Dr. David Naafs, Research Fellow
    Email: David.Naafs@bristol.ac.uk
    b. Dr. Ian Bull, Research Fellow
    Email: ian.d.bull@bristol.ac.uk

3. **Ghent University**
    a. Prof. dr. Elie Verleyen, Professor
    Email: Elie.Verleyen@UGent.be
    b. Prof. dr. Wim Wyerman, Professor
    Email: wim.vyverman@UGent.be

4. **Newcastle University**
    a. Dr. Emma Pearson, Scientist
    Email: Emma.Pearson@newcastle.ac.uk



Presenting my research work on Antarctic Paleolimnology at BAS on 09-October-2019

Extracting pigments from sediments at Ghent University

Summary of Visit

My visit as a SCAR Visiting Scholar was primarily based on acquiring two sets of skills viz., (a) to learn different proxy techniques that can be applied to derive past climate data from lacustrine/marine sedimentary archives in East Antarctica and (b) to develop a strong international core research group on Antarctic paleolimnology and initiate and strengthen collaborations for future work in East Antarctica. To accomplish these two objectives, I planned my visit over five weeks visiting: (1) British Antarctic Survey-Cambridge; (2) Organic Geochemistry Unit, School of Chemistry-University of Bristol; (3) Protistology & Aquatic Ecology-Ghent University; and (4) School of Geography, Politics & Sociology-University of Newcastle. The summary is being presented below in accordance with the visit to the host-institutes.

1. **Palaeo Environments, Ice Sheets and Climate Change (PICC) - British Antarctic Survey, Cambridge - United Kingdom**
   Hosts: Dr. Stephen Roberts and Prof. Dominic Hodgson

   The PICC team's main aims are to improve understanding of the mechanisms of past change in ice sheets, oceans and global climate. The focus is to reduce uncertainty in predictions of future climate and sea level change, informing Government strategy for mitigating against the risks of these changes. The PICC group has been active in Antarctic paleoclimate research over the last two decades. My SCAR Fellowship kick started at BAS. The focus was to strengthen links between our existing research activities and to initiate future collaborative programs.

2. **Organic Geochemistry Unit (OGU), School of Chemistry - University of Bristol** *Hosts: Dr. David Naafs and Dr. Ian Bull*

   The OGU is an international research group that uses high-end analytical techniques such as gas chromatography mass spectrometry and compound specific light stable isotope mass spectrometry to investigate Earth systems at the molecular level. My objective was to measure the GDGTs in the Sandy Lake sediment core from East Antarctica to quantify past changes in the strength of the westerlies and to understand their role in the degassing of CO_2 during the past 36 kyr. There have been couple of studies to reconstruct past water temperature from the Sub-Antarctic islands through the GDGT temperature reconstruction method while this is our first attempt to reconstruct from an Antarctic lake sediment. The primary premise of this tool is that the microbial communities adjust the chemical structure of their cell membranes in response to environmental temperature. This enables the development of lipid-based paleothermometers such as the glycerol dialkyl glycerol tetraether (GDGT) proxies. Surface-sediment calibrations shows a strong empirical relationship between the relative distribution of GDGTs and temperature. GDGT proxies can be used in marine, lacustrine, and paleosol sequences as long as the organic material is not thermally mature. Thus far, GDGT proxies have been applied to sediments dating back to the middle Jurassic. Many of the key uncertainties of these proxies are related to our emerging understanding of archaeal (and for the branched GDGTs, bacterial) ecology.

3. **Protistology & Aquatic Ecology (PAE) - Ghent University**
   Hosts: Prof. Elie Verleyen and Prof. Wym Wyerman

   The research group for Protistology and Aquatic Ecology of the Department of Biology of the Ghent University studies the diversity, taxonomy and biogeography of protists.

The PAE research facilities consists of a scanning electron microscope, an HPLC, a GC/MS, culture rooms and provides state of the art services to other labs and institutes. The group has also been working in different ice-free regions of East Antarctica over the last two decades. My main objective was to measure and reconstruct the fossil pigments over glacial-interglacial time-scales. The same samples (Sandy Lake sediment core) that were used to extract GDGTs were used to extract fossil photosynthetic pigments. This provided us with a multi-proxy data using which we can not only reconstruct past water temperature but also the past biotic community in the lacustrine system. The samples extracted for fossil pigments were measured by High Performance Liquid Chromatography (HPLC).

4. **School of Geography, Politics & Sociology-University of Newcastle**
Host: Dr. Emma Pearson

The Geography Department at Newcastle University is a premier research area with a major focus on the fields of social science and physical geography. The group has been working on the GDGT-paleothermometer technique over the last decade and a half. It's focus has been to develop a global calibration equation to measure the temperature from lake sedimentary organic matter (biomarkers). Through the SCAR visit, we look forward to collaborating with this group on future projects in Antarctica and Sub-Antarctic Islands by contributing to strengthen the global calibration curve and to generate paleotemperature data from Antarctic lakes which would be an excellent alternative to the existing ice-core data.

Capacity Building, Education and Outreach Activities

Meeting on Antarctic Climate, Ice sheets, Eco System and Paleolimnology

a) A meeting was hosted by Prof. Elie Verleyen at Ghent University on 1st and 2nd October. Prof. dr. Wim Wyerman, Prof. Dominic Hodgson, Dr. Stephen Roberts, Dr. Anish Warrier (on Skype) and Dr. Mahesh Badanal. The group discussed future projects and research areas in Antarctic and sub-Antarctic regions and joint field campaign in Antarctica. In view of the forthcoming collaborations and coring expeditions at Schirmacher Oasis and Larsemann Hills, variables on climate change per se lake sediments, water chemistry of lakes, sill heights of lakes, shoreline data, beach profiles, escarpments and ice sheet dynamics were discussed together with the need to include more proxies to strengthen the climate records. The absence of lake records in the recently published IPCC reports was noted and the importance of increasing such records in the coming decade was stressed upon. Due focus was to reconstruct more temperature records from lake sedimentary archives which would be an excellent additions in regions where no ice-core temperature records are available.

b) A talk titled "Paleolimnological investigations from ice-free regions of East Antarctic: an overview from the Indian context" was presented at British Antarctic Survey, Cambridge on 9-October. The talk was presented in three segments viz., (a) India's presence in Antarctica, (b) the paleolimnological research in India over the last seven years and (c) the outcome and collaborations initiated during the SCAR visit.

c) I also took this opportunity to meet researchers from diverse fields and interacted with them and tried to understand their research. I happened to meet couple of researchers with

whom I could initiate collaborations not only on Antarctic region but also the Southern Ocean, Indian Ocean and Himalaya.