



SCAR Fellowship Report

May-August 2019

Pleistocene-Holocene Variability in ACC Strength and Agulhas Leakage Intensity



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Dates of Activity

May-August 2019

Introduction

The current project aims to understand past Southern Ocean changes and its influence on surface ocean circulation and other climate systems. To be specific, the proposal attempts to study the impact of latitudinal shifts of the Antarctic Circumpolar Current (ACC) and associated fronts on Agulhas Leakage during the past. This will provide an insight into the response of the Southern Ocean to past climate changes of Antarctica and the low latitude region. Such paleoceanographic reconstruction was proposed through the estimation of paleo-sea surface temperature (SST) using the microfossil group known as radiolarians. The purpose of visiting GNS Science was to get trained on radiolarians identification.

Project Objectives

The project had the following objectives:

- Latitudinal variability of surface ocean fronts and their relation to ACC intensity;
- Importance of ACC variability and Southern Ocean overturning circulation changes for global ocean circulation reorganizations;
- Monitoring the impact of ACC variability on maxima in Agulhas leakage from the Indian to the Atlantic Ocean for multiple glacial-interglacial cycles;
- Past changes in the latitudinal position of the Subtropical Front and their contribution to the occurrences of major climatic transitions (terminations, cooling at terminations, warming during glacial cycles, etc.).

Methods, Execution and Results

I planned to visit the host institute with the aim of learning radiolarian identification and use this skill to generate radiolarian counts for SST reconstruction. To achieve this, samples from two sediment cores from the Southern Ocean were worked upon. Everything went as per our plan and the results generated comprised of paleo-SST records. A few Highlights of the work done are detailed as follows:

- A total of around 200 species of radiolarians from the Indian Sector of Southern Ocean were studied as per the guidance of Dr. Giuseppe Cortese (Senior Scientist and Radiolarian expert, GNS Science, New Zealand). Considerable amount of time was spent in discussing taxonomy of Southern Ocean radiolarians species before and during the counting under the light microscope. This was to perfect the taxonomic concepts of highly diverse Southern Ocean radiolarians.
- An established lab protocol involving chemical treatment was followed to extract the radiolarians from the 2 Southern Ocean sediment cores (SK 200/17 and SK 200/23). A total of 16 sediment samples were used for radiolarian extraction from both the sediment cores. Around 6400 radiolarians were counted in these 16 sediment samples (i.e. 400 radiolarians per samples) from each of the cores under the light microscope.
- The radiolarian counts from the two sediment cores were used along with modern surface sediment records (radiolarian counts) and modern

Southern Ocean SST to generate the past SST from the two core sites through a computer program called transfer function.

- A quantitative data set of radiolarian absolute abundance was generated from each sediment core samples. Such records help in understanding the radiolarian paleoproductivity from the Southern Ocean.

Project Outcomes

This research project has given me the proficiency in radiolarian taxonomy and the skill to use this microfossil group for past oceanic reconstruction. The addition of this particular microfossil proxy to the micropaleontology and past climate group at National Centre for Polar and Ocean Research, India, where I work, will improve our understanding and interpretation of past oceans. Such understanding about past ocean conditions are vital for the model-based prediction of future climatic trends. This is a priority area for the paleoclimate group in both host and home institute. The project will also be a building block towards a scientific collaboration leading to further joint projects and publications. On a personal level, I got to learn a lot about the work culture in GNS Science, which will definitely help me and my colleagues at the home institute to improve the way we conduct our scientific research.

Publications, Presentations and Products

As a result of this project there is a manuscript under preparation and there have been presentations made by me during and after the fellowship. The academic highlights of the visits are as follows:

1. Participated in an inhouse GNS Science staff conference from 15th May to 16th May 2019 in Lower Hutt, New Zealand.
2. Presented a talk on "*Influence of Antarctica and Southern Ocean on changing Asian Monsoon during the past: A possible high–low latitude teleconnection*" at GNS Science, Lower Hutt, New Zealand.
3. Presented a talk on "*Radiolarian-based paleoceanography: Understanding the latitudinal shifts of Southern Ocean fronts*" during the National Conference on Polar Sciences held between 20th-22nd August 2019 at National Centre for Polar and Ocean Research, India.

Capacity Building, Education and Outreach Activities

No outreach activities were carried out during the project by me. However, in the future I am looking forward to explaining the outcome of this project to the young researchers and school students who often visit the home institute.

Future Plans and Follow-ups

The visit to GNS Science, New Zealand broadened my academic horizon through good training on radiolarian identification skills and Southern Ocean paleoceanography. Studying the microfossil group "radiolarian" has brought an additional micropaleontology skill to the Polar Micropaleontology and Past Climate section in NCPOR which will help better understand Southern Ocean paleoceanography. In the future, additional sediment cores from the Southern

Ocean will be studied using radiolarians abundance variation and SST reconstruction in collaboration with Dr. Giuseppe Cortese, host institute. This will allow us to address Southern Ocean circulation and frontal positions in the past. And also enhance and broaden our understanding of the polar ocean and its connection with other low latitude climate system.

Personal Impact

My visit to GNS Science, New Zealand was a good way to broaden my research expertise. GNS Science houses good scholars on paleontologist and paleosciences, and the kind of research they are involved in has inspired me to work on new and vital scientific problems. One of the things I learnt working at GNS Science is to set high priority towards the health and safety while working in the lab and on the field. Also, during my visit I was fortunate to participate in a GNS Science conference, this gave me a platform to interact with various scientific and non-scientific staff. Such interactions gave me an understanding about the different research areas of the host institute and will foster future collaborations.

Financial Statement

The SCAR Fellowship was used to cover the flights to and from New Zealand, accommodation and transport costs in Lower Hutt, Wellington, New Zealand for the three-month visit. Prior to my, the funds were also utilized for transporting the samples to the host institute and the application of the New Zealand visa.

Acknowledgements and References:

Firstly, I thank the Scientific Committee on Antarctic Research for selecting my proposal and funding this research. Also, I express my sincere gratitude to Dr. M. Ravichandran, Director, National Centre for Polar and Ocean Research, India for supporting me. Thanks to Dr. Giuseppe Cortese, GNS Science for mentoring the project and hosting me. Also, thanks to Dr Rahul Mohan, Senior Scientist, NCPOR, India for supporting me during the preparation of the project. Thank you, Dr. Xavier Crosta for your assistance and support. Lastly, thank you Ministry of Earth Sciences, Govt of India and National Centre for Polar and Ocean Research for supporting me to carry out this project.