BLUE EARTH GLOBAL EXPEDITION (BEAGLE)
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Experiences aboard the R/V *Mirai*

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## INTRODUCTION

The Blue EArth GLobal Expedition (BEAGLE) 2003 is an oceanographic research program that was developed by the Japan Marine Science and Technology Center (JAMSTEC). The main aim of this program was to enhance oceanographic research activities in the Southern Hemisphere, in accordance with the Sao Paulo Declaration (POGO, 2000). Under this program, a Southern Hemisphere cruise was initiated along the World Ocean Circulation Experiment (WOCE), Hydrographic Program (WHP) lines in the southern hemisphere with the oceanographic research vessel RV Mirai (Fig. 1). Furthermore, this cruise was undertaken to commemorate the 30th anniversary of the establishment of JAMSTEC (Chijiya, 2003).

The RV Mirai is a state of the art ship and is the largest research vessel of its class in the world. This vessel is designed to carry out a variety of oceanographic research in the World's Oceans, even under the most severe sea conditions. The whole expedition comprised of six legs, in which the first leg departed from Brisbane, Australia in August 2003 and the last leg scheduled to arrive in Fremantle, Australia in February 2004. All in all, she sailed across three oceans, namely the Pacific, the Atlantic, and the Indian Oceans for seven months performing oceanographic and meteorological observations (Fig. 2).

In particular, the BEAGLE survey is expected to contribute significantly to, and enable the promotion of, the study of future climate change and the exploration of water temperature and density changes in the Antarctic overturn system. Another key aspect of the survey is to help provide an estimate of the amount of carbon dioxide transported by the Antarctic Ocean. The cruise also investigated the transport of water through the ocean basins as well as giving young scientists the opportunity of hands-on experience in water-sampling (CTD) and in the collection of bio-optical data. Data collected from the whole cruise are also essential to the creation of a high-fidelity climate model with the Earth Simulator (Chijiya, 2003). JAMSTEC aims to have this significant data published within two years once the data quality controls are complete.

## PARTICIPANTS FROM SOUTH AFRICA:

Scientists from different countries were offered full financial support either from JAMSTEC or from the Partnership for Observation of the Global Ocean (POGO) program to participate and to be trained in different disciplines. Ms Nonkqubela Silulwane completed the fourth leg from Santos to Cape Town, 6 November – 5 December 2003. Ms Jean Mwicigi and Ms Tamaryn Morris completed leg 5a from Cape Town to Port Louis, 9 December – 27 December 2003.
Mr. Benjamin Wigley participated on behalf of the University of Cape Town on leg 5a as well.

**SAMPLING**

In the course of the cruise, JAMSTEC conducted an unprecedented large-scale survey that included the measurement and analyses of water temperature, salinity, dissolved oxygen, nutrients, carbon dioxide, carbon isotopes and so on from the sea surface to the bottom of the ocean from about 500 stations. The following sampling was carried out on each leg of the cruise:

- Measurements of temperature, salinity, oxygen, current profile, fluorescence and transmission using CTD (SBE 35 sensors) with LADCP, fluorometer and altimeter (Fig. 3);
- RMS water sampling and analysis of salinity, dissolved oxygen, nutrients, CFC, $SF_6$, total alkalinity, dissolved inorganic carbon (DIC), dissolved organic carbon (DOC) and alkalinity;
- Sample water collection for $^{14}C$, $^{13}C$, $^{3}He/^{4}He$ and Argon;
- Measurements of autotrophic biomass (epifluorescence and chlorophyll a) by surface LV;
- Water samples for radionuclides;
- Bio-optical measurements;
- Underway measurements of $pCO_2$, temperature, salinity, nutrients, $N_2O$, surface current, bathymetry, and meteorological parameters; and
- ARGO floats deployment

A few differences between the sampling and analysis procedures of JAMSTEC and MCM are highlighted below:

- Temperature readings are taken during every dissolved oxygen sample by means of a digital thermometer. The temperature of the sample at depth and the temperature on the surface may differ, which will in turn negatively affect the mass of the sample and thus the dissolved oxygen value.
- Replicates are performed on 10% of the samples according to WOCE requirements.
- Precision is paramount on this vessel and trainees were shown video footage on the correct procedures of sampling as well as demonstrations and “practice runs.”
- Most of the samples taken were also analyzed at sea: dissolved oxygen, salinity, nutrients, CFC, DIC, alkalinity. MCM only analyses dissolved oxygen at sea at the moment.

A POGO/IOCCG (Partnership for Observation of Global Ocean / International Ocean Colour Co-coordinating Group) research program on bio-optical measurements was conducted on-board with one specialist in-charge for each leg. A major aim of this program was to collect water samples for bio-optical measurements and carry out various sampling procedures to get invaluable, high quality data that can be used to validate satellite ocean-colour, and to improve satellite-derived estimates of phytoplankton biomass and primary production. Under this project, young scientists and students from different countries were offered scholarships to get hands-on training on different suites of bio-optical, oceanographic measurements and data processing. The following set of bio-optic experiments were conducted: Light Measurements (Fig. 4), Phytoplankton Pigments (Chlorophyll-a and HPLC pigments), Phytoplankton Absorption, CDOM Absorption, Flow Cytometry and Photosynthesis-Irradiance experiments. Further information on the program and reports from

different legs can be found on the site:
http://www.ioccg.org/training/pogo_ioccg/beagle/.

**PERSONAL EXPERIENCES ONBOARD THE VESSEL**

Nonkqubela Silulwane:

The BEAGLE 2003 Expedition was a major highlight of my sea-going experiences. I got hands-on training in different bio-optic sampling techniques and oceanographic sampling. Such an excellent training experience came at a crucial time of my career when I am faced with a challenge of starting my own bio-optic research project. The hard work, perseverance and dedication from leg-4 bio-optic team, Dr Vivian Lutz and Ms Valeria Segura (both from Argentina), deserve a mention. In addition to the scientific training, a major challenge was to live in an environment with people from diverse cultural backgrounds, and being under a very strict Japanese diet for a month; and all this was a unique experience. Special thanks go to JAMSTEC for their full financial support and for giving me the opportunity to be trained on-board their state-of-the-art vessel. The training provided under POGO/IOCCG program is highly appreciated.

Jean Mwicigi:

The BEAGLE 2003 Expedition was a thoroughly rewarding experience. I not only participated and learnt how to do proper oceanographic sampling, but also volunteered an additional 6 hours in the bio-optical lab. It was a very worthwhile experience as the sampling strategy onboard was conducted very meticulously. My only regret was that our section of the cruise was too short to really master the bio-optical sampling techniques. I would like to thank my supervisor Mike Roberts for recommending me to go on this amazing cruise. I would also like to thank the research committee and fraternity at MCM for facilitating my participation on this cruise. I would like to thank the JAMSTEC staff especially Prof. Masao Fukasawa the Chief Scientist on Leg 5a for his support and very warm hospitality. Special thanks to Dr. Margareth Kyewalyanga and Ms. Pru Bonham- they were a pleasure to work with in the bio-optics lab. Thanks to the Captain and officers on the RV Mirai; all crewmembers and technicians for all their hard work and dedication and for making our short stay as enjoyable as possible.

Tamaryn Morris:

The BEAGLE 2003 Expedition onboard the R/V Mirai was a truly wonderful experience. Not only is the vessel of world class standards in terms of their sampling and analysis techniques, equipment and calibration, but also the Japanese people are very friendly, well disciplined and for want of a better word – awesome. We learnt a phenomenal amount about WOCE quality data collection and analysis as well as benefiting from a multi-cultural experience that has left all of our lives enriched. I would like to thank the officers and crew of the R/V Mirai as well as the scientists and technicians of JAMSTEC, in particular Professor Masao Fukasawa, our chief scientist, and Dr. Takeshi Kawano, Deputy Chief Scientist, for the wonderful experience they have awarded us. May there be many more collaborations in years to come and I hope that young scientists in this country get similar experiences to the ones we have just had.

**References cited:**

Chijiya, M. 2003. Beagle 2003 HP. http://www.jamstec.go.jp/beagle2003

Figure 1: The R/V *Mirai* in Tamatave, Madagascar.

Figure 2: Cruise plan for BEAGLE 2003.

Figure 3: The 36-bottle rosette CTD being deployed.

Figure 4: Instrumentation used for the bio-optical and light measurements.