

□ R/V Mirai

**Cruise Report –Leg 6  
BEAGLE (Blue Earth Global Expedition)**

**From Fremantle to Kerguelen Plateau and return  
January 27<sup>th</sup> to February 19<sup>th</sup> 2004**



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## **OCEANOGRAPHY RESEARCH VESSEL(R/V MIRAI)**

The oceanographic research vessel (R/V MIRAI) is one of the largest Oceanographic research vessels in the world and is owned and operated by The Japanese Marine Science and Technology Center (JAMSTEC).

The Mirai conducts large-area and long duration oceanic observations around the world. The large sturdy hull permits scientific observations to be made throughout summer ice sea and other rough sea state regions. The vessel has state-of-the-art oceanography equipment for gathering information to study global environment change, specifically climate change and global warming.

The Mirai can accommodate a total 80 people, including up to 28 scientists and 18 scientific technicians. It has 13 laboratories on board, permitting extensive analysis of data whilst sampling.

Its oceanographic research equipment includes:

- Multi – narrow beam echo sounder
- Acoustic Doppler current profiler (ADCP)
- Subbottom profiler
- Ocean lidar system
- XBT
- XCP
- XCDT
- Water sampler
- 20 m piston core sampler
- Proton magnetometer
- Deck gravity meter
- Deck magnetometer

To deploy and manage the core and water sampling equipment the Mirai has:

- A 22-ton A-frame crane
- 11 ton Gallows crane
- 7 Observation winches
- 3 Traction winches
- 3 Swell compensators
- 1 Multi-joint deck crane
- Jib-type deck crane
- Buoy handling system
- Rosette water sampler handling system
- Shipboard data management system

In addition, to permit the meteorological observations it is also equipped with 3 meteorological observation laboratories, air sampling and a satellite receiver system (NOAA, GMS etc).

The gross tonnage of the Mirai is approximately 8.600 tons, it is 128 meters long and has a breadth of 19 meters. It averages a speed of 16 knots underway and has a

range of 12,000 nautical miles and is therefore capable of year-around use in high latitude seas.



Fig1.The Research Vessel Mirai.

### **OUTLINE OF THE LEG SIX OF BEAGLE 2003**

As part of the 2003/2004 season, The Japan Marine Science and Technology Center (JAMSTEC) organized an international oceanographic research cruise. It comprised of 6 Legs, starting in Brisbane, Australia in August 2003.

Leg 6, from 27<sup>th</sup> January 2004 to 19<sup>th</sup> February 2004, departed and returned to Fremantle, Australia. Station 1 of Leg 6 of the Mirai cruise was at the South East Indian Ridge (SEIR) of the Indian / Southern Ocean. From there, the voyage headed south to Kerguelen Plateau at approximately 58S 83E, before returning via the SEIR to Fremantle.

The objectives of the cruise were:

- To detect and quantify temporal changes in the Antarctic Overturning System corresponding to the global ocean and the Southern Ocean warming during this century through high quality and spatially dense observations along old WHP (World Ocean Circulation Experiment Hydrographic Program:1991-2002 ) lines
- To estimate the anthropogenic carbon uptake by the Antarctic Ocean.

Selected scientific priorities included:

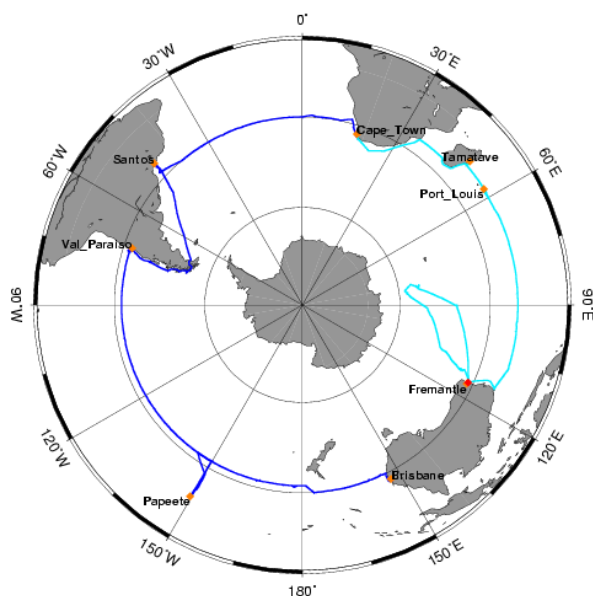
- Changes in inventories of heat and freshwater
- Carbon and nutrients transport
- Data base for model validation
- ARGO sensor calibration and its deployment in the Western south Pacific and the Indian Ocean

To enhance research activities in Southern hemisphere in accordance with the Sao Paulo declaration (POGO 2000) Proposed scientific sampling included:

#### Leg6 (Biogeochemistry (BGC and Piston Coring))

The main activities undertaken on Leg 6 were:

- 1) Measurements of temperature, salinity and oxygen profiles using CTD/O<sub>2</sub>.
- 2) RMS water sampling and analysis of salinity, oxygen, nutrients, CFC11, 12, 13 total alkalinity, DIC, TOC and pH.
- 3) RMS water sampling for <sup>14</sup>C and <sup>13</sup>C.
- 4) RMS water sampling for dimethylsulfide (DMS(P)) phytoplankton pigments and heterotrophic bacterial production .
- 5) Underway measurement of pCO<sub>2</sub> DIC temperature salinity and nutrients.
- 6) Underway measurement of surface current, bathymetry, meteorological parameters.
- 7) XCTD and XBT casts
- 8) Collection of piston and multiple



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Fig 02 cruise Track

In this leg there were 5 participants from different countries (USA, Brazil, Australia, Sri- Lanka) and ( ) Japanese scientists from JAMSTEC and Japanese Universities.

The overall objective was to detect and quantify temporal changes in the Antarctic Overturning System corresponding to the global ocean and the Southern Ocean warming during the 20<sup>th</sup> century, through high quality and spatially dense observations along old WHP (World Ocean Circulation Experiment Hydrographic Program 1991-2002) lines 4), by estimating the amount of anthropogenic carbon up taken by the ocean.

This leg also provided a training environment in which students could get hands-on experience in collecting biological and optical data samples. In order to achieve the objectives of this leg there were several measurement and sample collections performed as follows:

### 1 CTD..measurements.

Measurement of temperature, salinity, oxygen profiles(RMS) water sampling and analysis of salinity , Oxygen, nutrients CFC11, 12, 113,, total alkalinity, DIC,TOC,and pH.



Fig 3.CTD Rosette.

### 2. BIO-Optical measurement. (Samplings were carried out at the following stations)

Date	Time GMT	Latitude	Longitude
28-01-2004	03:22:00	34° 31' 2 S	108° 52' 2 E
29-01-2004	04:42:00	37° 24' 6 S	37° 25' 7 E
30-01-2004	06:00:00	40° 03' 1 S	94° 57' 6 E
31-01-2004	01:54:00	42° 00' 5 S	89° 59' 9 E
01-02-2004	05:38:00	41° 32' 9 S	90° 24' 9 E
02-02-2004	05:15:00	45° 48' 8 S	87° 41' 8 E
03-02-2004	06:00:00	50° 11' 7 S	84° 41' 7 E
04-02-2004	01:16:00	53° 39' 9 S	82° 05' 4 E
05-02-2004	05:00:00	53° 48' 6 S	81° 52' 9 E
06-02-2004	04:55:00	54° 59' 6 S	80° 15' 1 E
07-02-2004	01:32:00	58° 14' 3 S	82° 19' 6 E
08-02-2004	04:00:00	58° 03' 2 S	82° 37' 3 E
09-02-2004	07:45:00	57° 52' 2 S	83° 00' 7 E
10-02-2004	12:00:00	57° 44' 8 S	83° 14' 9 E
11-02-2004	05:00:00	57° 40' 6 S	83° 22' 9 E
12-02-2004	05:40:00	57° 34' 5 S	83° 37' 5 E
13-02-2004	05:30:00	57° 24' 8 S	83° 30' 8 E
14-02-2004	05:01:00	46° 15' 8 S	104° 04' 3 E
15-02-2004	05:06:00	43 16 4 S	107 58 7 E
16-02-2004	04:52:00	39 24 8 S	110 35 7 E
17-02-2004	03:23:00	35 53 5 S	111 58 1 E

**Sampling and methods** (All samples are taken at the surface of the ocean. On board analysis included:

- CDOM absorption, chlorophyll , PI incubations.....

The measurements undertaken on the voyage were:

- a) **Photosynthesis –Irradiance (PI's) Measurements**
- b) **Sample collections for HPLC pigment determinations.**
- c) **SIMBADA radiometer measurements.**
- d) **Fluorometric Measurement of Chlorophyll-a using a Turner Fluorometer.**
- e) **CDOM Absorption Measurements**
- f) **Particulate Absorption Measurements.**
- g) **Continuous measurements with the PAR sensor.**

#### **Photosynthesis – Irradiance (PI's) Measurements.**

The sample collected was a 9 litre surface water sample. It was then combined with a (C13) solution and water bath and adjusted to the surface water temperature. Then it was placed in 45(03 of dark) 42 bottle into the PI light box and remaining 3 bottles were dark bottles placed in a black bag in the water bath. A light source was turned on for three hours and then switched off after filtering the bottles 1,2,3 combined GF/F filter & three dark bottles 14 filters from light bottles and one filter from dark bottles ID labeled in set of 14 & dark envelopes & dried before storage.

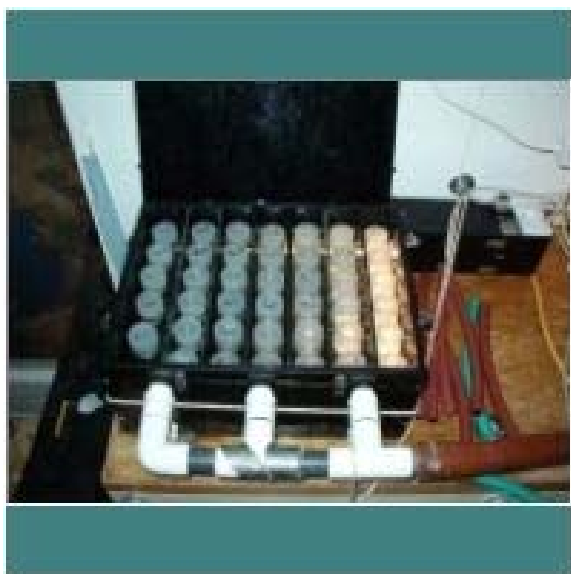


Fig4.PI.Box.

#### **Samples collection for HPLC pigment determinations.**

##### **Methodology:**

Duplicate samples for the determination of phytoplankton pigment composition by HPLC (High Performance Liquid Chromatography) should be collected daily. These samples will then be kept frozen at  $-80^{\circ}\text{C}$  for later analysis back in the laboratory. Water should be taken directly from the carboy (collected using the hand-held Niskin bottle or the flow-through system). If not sampled immediately, the carboy contents should be mixed well by inverting several times and stored in the dark.

**Mirai Activities:**

Two samples (2 Litres) were filtered through a GF/F filter for analysis. These samples will be analyzed in two countries; Cape Town (South Africa) and Hobart (Australia). The two samples were labeled foil and placed in liquid nitrogen and stored in two separated bags into a deep-freeze.

**CDOM Absorption Measurements****Methodology:**

Water samples for measurement of absorption by coloured dissolved organic material (CDOM) should be taken directly from the carboy (collected using the hand-held Niskin bottle or the flow-through system).

**Mirai Activities:**

Water samples for Measurements of absorption the colored –dissolved –organic matter were filtered through 0.2µm membrane HCL solution was rinsed with super Q water.

Sample sea water was filtered repeated three more times after that filtered sea water immediately scanned in a spectrophotometer.

Storing: files are in LEG 06 /JAMSTEC folder.

**Fluorometric Measurement of Chlorophyll-a using Turner Fluorometer**

Three sea water sample of 100ml filtered GF/F filters after filtered, filter papers placed in 10ml acetone fill glass bottle and were stored in the freezer 24 hours for later analysis.

**SIMBAD radiometer. measurements**

The SIMBAD radiometer measures Direct Sun, Dark, Sea, The Instrument has internal GPS antenna , This instrument can only be used in clear-sky (sunny) conditions.

Storing: The files are in JAMSTEC folder/leg6.



Fig 5.SIMBAD Radiometer.

### Particulate Absorption Measurements

Two samples of 2 litres each were filtered through GF/F filters. One sample was then analysed on board and other was stored in liquid nitrogen for later analysis in Canada

### Continuous measurements with the PAR sensor

A PAR sensor was mounted on the ship to continuously record the photosynthetically active radiation PAR data which was logged on a Licor Li 1400 data logger.

### 3 Multiple and piston core sampling stations

Sediment coring activities were performed at the South East Indian Ridge (SEIR) and Kerguelen Plateau.

Diatomaceous Mud (clay) cores taken during this cruise focused on the .....



**Fig 6 Piston core & Gravity core.      Fig.7 Sediment Sample.**

### **Acknowledgment**

I would like to thank POGO (Partnerships for Observation of the Global Oceans) and IOCCG (International Ocean Color Coordinating Group) for the scholarship enabling me to participate in this research cruise and to JAMSTEC (Japan Marine Science and Technology Center) for this opportunity.

Particularly I would like to mention Ms. Tony Payzant, Secretary POGO, Dr. Shubha Sathyendranath, Director POGO her support during preliminary arrangements . CRMP Coastal Resources Management Project is greatly acknowledged for financial support for the return air ticket .

Also I would like to thank NARA management for nominating me to participate in the above excellent program .Lastly, but definitely not least I would like to express my



deepest gratitude to the Head of Oceanography Dr.T.K.D.Tennakoon Dr.Shuichi Watanabe Chief Scientist, Dr.Robert Frouin Bio-Optics Specialist, and I would like to give my deepest thanks to Captain Dr.Masahuru Akamine and the Crew of MIRAI.

