# 1. Overview

CROZEX (CROZet circulation, iron fertilization and Export production experiment) is a complex, multidisciplinary project to examine the causes and consequences of the annual bloom that forms north of the Crozet Plateau in the southwest Indian Ocean sector of the Southern Ocean. The field phase, described here, consisted of a pair of cruises, D285 and D286, funded by SOC Core ship time for the George Deacon Divisions's (GDD) Core Strategic Project BICEP (Biophysical Interactions and Controls on Export Production). An extra 6 days (identified as D287) spread between the two cruises were funded as part of "benthic Crozet", a NERC responsive mode project led by Prof George Wolff of Liverpool University, for which the main cruise will be D300 in December 2005. The contents list testifies to the breadth of work undertaken, which tested the capacity of RRS Discovery to the limit. Nevertheless, the cruises overall were highly successful.

## 1.1 Objective

The overall objective of the project is

**To examine, from surface to sediment, the structure, causes and consequences of a naturally occurring phytoplankton bloom in the Southern Ocean**

Detailed objectives for different parts of the project will be given in the appropriate section.

## 1.2 Cruise overview — Raymond Pollard

RRS Discovery cruise 285 departed from Cape Town, South Africa on 3 Nov 2004, docking at Port Elizabeth 37 days later on 10 Dec. Leg 2, cruise 286, departed on 13 Dec and docked at Durban 39 days later on 21 Jan 2005.

Details of day by day operations are given in the cruise diary (1.4), supported by track plots (Fig 1.1), station maps (Fig. 1.2) and weekly time series plots of meteorological parameters, annotated ship heading and speed, water depth and near surface chlorophyll (Figs 1.3.1-10). A Julian day v. date lookup table is provided (Table 1.1) but participants are encouraged to use date rather than day-of-year in plots and references. Satellite images (1.3) were of considerable value in planning operations and in interpreting results, so a series of composites is presented in Fig. 1.4.

Stations were all numbered using the Discovery station numbers, initiated on the original Discovery cruises and now in the 15 thousands, which on our cruise ranged from 15486 to 15634. Each CTD cast was given a new station number, but associated nets, SAPS deployments, etc usually took the same station number as the associated CTD cast. Pelagra, SeaSoar and coring were also given station numbers, though all cores in a sequence were sub-numbered within a single station number. A complete list of CTD casts is given in Table 1.2. A useful aid through the cruise was the complete list of stations, which was updated regularly by watchkeepers and later typed in by the BODC representatives. These tables are included, unedited, as Tables 1.3 and 1.4.

Much of the cruise was planned around a series of Major Stations (labelled in red in Table 1.2) every two or three days. At each Major Station (M1 to M10 in Fig. 1.2) a series of CTD casts was made, typically a full depth CTD with the stainless steel rosette (sCTD) to sample physical parameters, currents (LADCP) and nutrients through the whole water column and phytoplankton down to 500m; a cast with the titanium rosette (tCTD or

TiCTD) (not always to full depth) for iron and phytoplankton productivity sampling; a second sCTD cast for $^{234}$Th sampling and a SAPS deployment. The order of casts depended on time of day to ensure that samples for on-deck incubations were drawn in darkness or low light conditions. Other work at each Major Station included zooplankton nets, radium samples, Pelagra deployment and occasionally other sampling such as LHPR tows, neodynium, mooring deployment, coring, Argo float deployment and water collection for bioassay experiments. In between Major Stations there were some additional sCTD casts to fill in hydrographic details and SeaSoar tows. Underway measurements included thermosalinograph and fluorimeter, hull-mounted ADCP, surface nutrients, iron from a special TMS (trace metal) fish, $CO_2$, analytical flow cytometry, aerosols and rain.

After a 6-day passage at the start of D285, only one sCTD of a planned line from J to M3 (Fig. 1.2) was worked before bad weather stopped all work for over a day. M1 was worked on the way to M3, where a mooring was set (recovered at the end of D286). A planned 3.5-day SeaSoar survey extended to 5 days because of bad weather and M3 was reoccupied. Over the next 6 days Discovery ran south via M2 to M6, including a site survey and a few megacores at M6 followed by a dog-leg SeaSoar run back to M3. In a major change of plan, it was decided not to work east to M5, but to survey the bloom area to the northwest of M3. Major Stations M7, M8E, M8W and M9 were occupied in that order over the next 9 days, with SeaSoar runs in between to allow two 41 hour Pelagra deployments. A line of 4 sCTD stations was occupied at the start of the 5 day passage to Port Elizabeth.

On D286, SeaSoar was deployed about 4 days after leaving PE in order to survey across the SubAntarctic Front (SAF) that bounds the bloom area. Major Station M9 was repeated and a line of CTDs worked to M10, where the first sediment trap mooring was deployed. Before re-occupying M3, ten days into the cruise, an aborted attempt was made to land on Ile de la Possession, but several stations were worked in and near the Baie Americaine. Discovery spent the next 7 days (including passage) working at the easternmost site, M5, including mooring deployment and coring, with a SeaSoar run out to M5 and CTDs back to M3. The next 8-day excursion (including time lost to weather) was south to M6, the "control" benthic site, again including mooring deployment and coring, with the final mooring deployed at M2 on the way back to the islands. After a sampling party had gone ashore at Port Alfred on 8 Jan, a Major Station was occupied three times over the next 5 days in an intense new bloom in a cyclonic eddy north of the islands and close to M3, with spatial surveys in between and recovery of the M3 mooring. The final SeaSoar survey was on passage to the final Major Station, a repeat of M10, where a few cores were taken. The final passage to Durban took 5 days.

### 1.3 Satellite images

Satellite images (2.5) show that the bloom began (Fig. 1.4a) and peaked (Fig. 1.4b) before the start of the cruise, and gradually decayed during D285 (Figs 1.4c, d, e). At the start of D286, a "new" bloom was beginning (Fig. 1.4f), clearly tied to the bathymetry of the Crozet Plateau and Islands. The 10 Jan 2005 image (Fig. 1.4g) shows a small cyclonic eddy close to M3, which was occupied with a Major Station three times on 8, 10 and 12 Jan. The final image on 27 Jan (Fig. 1.4h) shows that the bloom continued for at least a month.