17. Shore sampling on Ile de La Possession, Crozet, 8 January 2005

Gary Fones, Mike Lucas, Paul Morris, Hélène Planquette, Hugh Venables

Background

The major hypothesis of the Crozex programme is that phytoplankton productivity in the seas surrounding Crozet is enhanced because of natural Fe fertilisation of surface waters. One of the major objectives of the Crozex programme was to identify any shallow benthic source of iron and elucidate the pathways of vertical and horizontal dispersion of this iron to surface waters around Crozet. The hypothesis is that these sources of Fe could be rain run off from the islands, upwelling or from sediments. Therefore one of the strategies is to locate the source of Fe close to /at island. A key component of this work is the tracing of water masses that we anticipate will contain elevated Fe back to a sediment source. Two possibilities exist which are not mutually exclusive. One is that as deep water rises towards the surface as it flows northwards over the Crozet plateau, it brings Fe-enriched water to the surface. The other is that freshwater run-off following weathering from the islands introduces Fe and perhaps silicate and other nutrients into the near-shore surface waters.

To test these possibilities, a small team of scientists (Fig. 17.1) were brought ashore at Port Alfred to sample a small stream system located in the Crique du Sphinx for nutrients, Fe, radium and other biogenic parameters about 2 miles north east of the main base.

Fig.17.1 The Crozet sampling Team… From left to right: Hugh Venables, Hélène Planquette, Bart Van de Vijver, Mike Lucas, Paul Morris & Gary Fones. Thierry Deles took the picture.

Fig. 17.2 Crique du Sphinx

After we arrived in Baie de La Grande Manchotière (Port Alfred), Thierry Deles, Chef de District des Iles Crozet, and Bart Van de Vijver, a Belgian scientist welcomed us among a large King Penguin colony. They then guided us to the sampling site, La Crique du Sphinx (Fig. 17.2), located 2 miles north east to Port Alfred. After an hour walking in the hills, we arrived at the Crique du Sphinx.

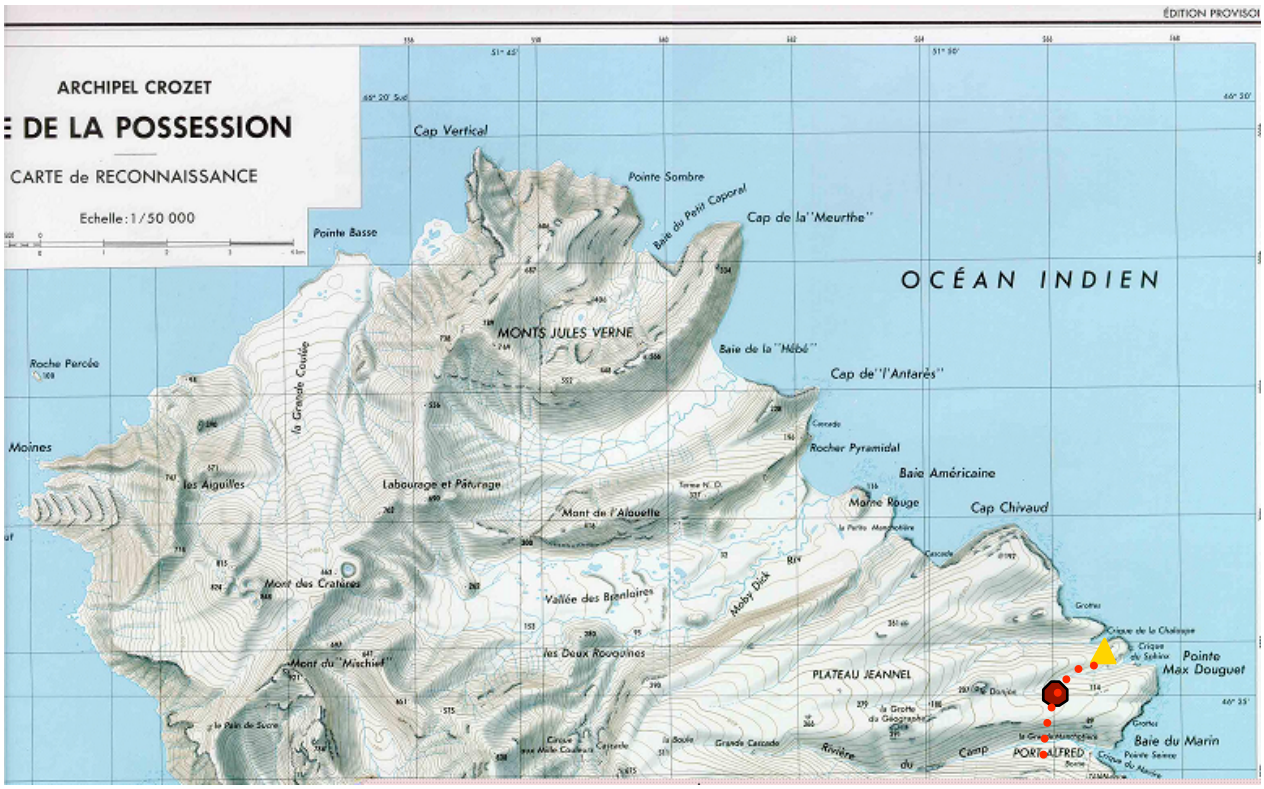

Fig. 17.3 Map of Ile de La Possession, given by Thierry Deles.
▲ Crique du Sphinx : 46.414°S 51.866°E
● Rock sampling: 46.413°S 51.864°E
····· Our route

Table 17.1 Summary of the sampling in Crique du Sphinx.

Site	1. Surf-zone	2. Waterfall	3. Top seal	4. Freshwater
Position		46.413°S 51.866°E		
Dissolved Fe	500 mL LDPE	500 mL LDPE		500 mL LDPE
Fe Speciation		500 mL Teflon		500 mL Teflon
Fe sediments				3 core syringes
Ra		40 L		
REE	1 L			1 L
Mixing Expts	500 mL			500 mL
Nutrients	□	□	□	□
Salinity	□	□	□	□
Chl-a (Total)	119	120	121	122
Chl-a (<20 µm)	123	124	125	126
HPLC	250 mL	250 mL	250 mL	250 mL
POC/N	310 mL	310 mL	470 mL	595 mL
Lugols	123	124	125	126
Formalin	160	161	162	163

Sampling strategy

We decided to set up four sampling sites between the surf-zone and a point about 400m upstream beyond the highest excursions of the elephant seal or penguin populations.

Various samples were taken to better understand the islands geochemistry and biology. With one of the major objectives being Fe, clean samples were taken at the four sites (Fig. 17.4c), this will enable an Fe gradient entering the surrounding waters to give an estimate of the importance of island run-off on the Crozet region Fe budget. Core syringe sediment samples were taken by Bart Van de Vijver (Fig. 17.4d), these will be used to undertake re-suspension and Fe release experiments at SOC. A sample was also taken for Radium, this fresh water sample was filtered at the sampling site at the Crique du Sphinx (Fig. 17.4b).

After collecting the water samples (Table 17.1), we trudged wearily (and sadly) back to the La Grande Manchotière carrying our heavy but precious water in 10L carboys, 2L polycarbonate bottles and in small 500 mL sample bottles. On the way back to the La Grande Manchotière, rock samples were collected for Dr. Rachel Mills to determine Fe content and weathering on the Plateau Jeannel (Fig. 17.5).

Fig. 17.5 Plateau Jeannel

Fig. 17.4 (below) Crique du Sphinx

Fig. 17.4a) Chlorophyll: surf zone and freshwater site

Fig. 17.4 b) Radium: waterfall and filtration


Fig. 17.4c) Iron


Fig. 17.4d) Sediments

Shore to ship transect

Just before leaving the island, two sediment cores were taken and a radium sample (40L), which was then filtered on the ship. After saying goodbye to our hosts, we left the island (sadly, again…) and another radium sample was taken as well as an iron and a neodymium sample, half way between the shore and the ship (Table 2).

Table 17.2 Summarises the samples, sample number and volumes taken or filtered during the transect.

Site	Position	Fe		Ra	Nd + REE	Nuts. & Salini
		Dissolved Fe	Speciation			
1.Surf-zone	46.426°S 51.862°E	500mL LDPE		40L		□
2.Half-way	46.427°S 51.868°E	500mL LDPE	500mL Teflon	40L	1L	□

This transect will hopefully give a better indication of Ra input and dilution and thus potential Fe input from Crozet to surrounding waters.

Analyses

Nutrients and Chlorophyll

Nutrients and chlorophyll analyses have been completed on board. HPLC samples have been frozen at –80°C and will be transported first to Cape Town (c/o Mike Lucas) and then to SOC for later analysis. POC/N samples have been frozen at –20°C and they will

be transported to Cape Town (c/o Mike Lucas) where they will be oven dried and pelleted in readiness for analysis on a CHN analyser back at SOC. Lugols and Formalin samples of preserved phytoplankton and micro-zooplankton will be shipped back to SOC for later enumeration of cells.

Preliminary Results

Crique Du Sphinx					
Site	NO_3	Si	PO_4	Total Chl	<20µm C
1.Surf-zone	17.63	31.21	1.96	1.44	0.73
2.Waterfall	0.49	119.92	0.13	0.90	0.53
3.Top seal	0.13	121.71	0.07	0.37	0.18
4.Freshwater	0.18	123.26	0.05	0.17	0.15
Shore to ship transect					
Site	NO_3	Si	PO_4	Salinity	
5.Surf-zone	19,31	32,83	4,7	27	
6. Half way	26,34	17,08	2,22	32	

Interpretation of Results

For all the parameters, there was an increasing concentration gradient from the upper freshwater stream down towards the surf-zone. The chlorophyll concentrations within the upper stream region were very low, ranging from ~0.1µg l-1 at the upper site but increasing to ~1.0 µg l-1 in the surf-zone. However, the GF/F filters were very coloured (for POC & for chlorophyll) and on that basis, much higher chl-a values were expected than the one obtained. This observation strongly suggests that much of the material observed on the filters was either lithogenic, or more likely, biogenic and consisting of detrital material originating from the surrounding bogs. Clearly too, elephant seal activity and the presence of King & Gentoo Penguin colonies lower down towards the shore were increasing the detrital input to the stream. It was noticeable too that the filters from the surf-zone were heavily loaded with particulate material. Much of this will originate from the fragmentation of kelp (*Durvillaea spp., Macrocystis spp*.) in the heavy shore break surf-zone. Research at Marion Island ~200nm to the west of Crozet has shown that *Macrocystis* grows at ~ 4cm per day and that kelp-bed productivity makes a substantial contribution to overall near-shore productivity. [see Attwood CG., Lucas MI., et. al., (1991) Production and standing stocks of the kelp *Macrocystis laevis* (Hay) at the Prince Edward Islands, sub-Antarctic. *Polar Biol.* **11**: 129-133]

Therefore, POC/N analyses should confirm that there is a high load of detrital particulate material. It will be important however to subject the filters with fuming HCL to remove any inorganic lithogenic carbon sources.

Conversations between Mike Lucas and Dr. Bart Van de Vijver on the walk to the sampling site were most revealing. His research on Crozet is to identify and assess the importance of freshwater diatoms on the Islands. Apparently all the diatoms are benthic, not pelagic, and that there are a number of different taxa represented, including some endemic species. Surprisingly, the pH of the water is close to 7 rather than acidic as expected. He also has nutrient data that demonstrate that nitrate concentrations in the freshwater reaches of all the streams are close to zero or undetectable. In conclusion, they agreed to stay in touch and to exchange research findings as he clearly has a lot of information of value to us.

Radium and Iron

Radium is acting as a proxy of water that has been in contact with sediments or other Ra sources. The two samples taken on the shore to ship transect were filtered back on board Discovery and analysed. (See Ra section)

The island clearly has a high content of iron, there are some hydrothermal sources and there are lots of indications of the presence of iron everywhere (Fig. 17.6). We have stored the samples in a freezer and they will be analysed back to SOC, as well as the sediments cores.

Fig. 17.6 Evidence of the presence of iron in Crique du Sphinx-"rusty rocks"

Future Requirements

To translate the nutrient, Fe, Ra and other parameter concentrations into input rates to the near-shore marine environment, we will clearly need to have some knowledge of seasonal flow rates over an annual cycle. The most likely way of getting this information is through our French colleagues on Crozet, in particular Dr. Bart Van den Vijver and Thierry Deles.

Acknowledgements

We would like to thank Thierry and Bart for their help in the sampling and their kindness. We had a fantastic day…