

**Project AFI6/14**  
**GLACIAL-INTERGLACIAL SEDIMENT TRANSFER FROM THE ANTARCTIC  
CONTINENT TO DEEP OCEAN: A SHELF SLOPE-BASIN SYSTEM INVESTIGATED  
USING THE *ISIS* REMOTELY OPERATED VEHICLE (ROV)**

**Principal Investigator:** Prof. Julian Dowdeswell, University of Cambridge

**Co-Investigators:** Prof. Gwym Griffiths, University of Southampton, National Oceanography Centre  
Dr Rob Larter, British Antarctic Survey

**Rationale**

The modern continental shelves around Antarctica have been overridden intermittently by the ice sheet, which has reached the shelf edge a number of times over the last few million years. Therefore, the marine sediments on the Antarctic continental margin contain a unique long-term and, sometimes, continuous record of past ice-sheet and environmental changes. However, the understanding of this record is complex in terms of both the process environment in which sediments are deposited and reworked, and its palaeo-environmental interpretation. Furthermore, there are few areas where a reliable chronology has been established for retreat of the grounding line since the last glacial maximum.

The history of glacial-interglacial fluctuations in the extent of the two million km<sup>2</sup> West Antarctic Ice Sheet (WAIS) can provide clues about its future stability, with clear implications for global sea-level rise.

Detailed and high-precision morphological and sediment sampling using the instruments installed on the *ISIS* ROV (Fig. 1) will help to shed light on the nature of the processes, and the timing of the recession of a major ice stream from the West Antarctic shelf, and thus to understand the stability of ice which advanced onto continental shelf areas during glacial intervals.

**The aims of the project are:**

- a) to understand the nature of sea-floor processes and the resulting depositional record by deploying geophysical instruments on the *ISIS* ROV providing geophysical data with previously unprecedented resolution;
- b) to acquire supporting gravity cores, sub-bottom profiler and large-scale swath bathymetry from the JCR to provide a small- to large-scale sedimentary environmental context for *ISIS* ROV data acquisition and interpretation;
- c) to better understand the nature of the sedimentary and biological processes and the interaction between them, and to enhance the interpretation of the unique modern and past environmental record held in sediments on the Antarctic continental margin.

In order to address the above posed scientific questions concerning the history and processes associated with the recession of the last grounded ice sheet from the continental shelf edge, we collected swath bathymetric data, sub-bottom acoustic profiles and sediment cores, as well as high-resolution photo- and video imagery and samples of bottom biota on several sites on the continental shelf and slope of Marguerite Bay, west of the Antarctic Peninsula (Fig. 2).

**Preliminary results**

EM120 swath bathymetry and Topas sub-bottom profiler data were collected from several parts of the continental shelf and slope of Marguerite Bay area, and from Bourgeois Fjord, from the JCR (ship tracks marked with red lines in Fig. 2). Also, a number of gravity cores, up to 7 m in length were collected along these tracks.

The *ISIS* ROV conducted 16 dives during the cruise, in water depths from about 100 m to 3500 m (Figs. 1, 2). Locations for ROV surveys were strategically selected to cover a variety of sedimentary environments, ranging from present proglacial settings in front of the glacier margins in the innermost

part of the Bourgeois Fjord (Blind Bay) to channels cutting into sediment drifts on the continental rise off the Marguerite Trough.

The following features/structures/environments were surveyed using the ISIS ROV:

- Glacial sedimentary bedforms, including drumlins and the mega-scale lineations indicative of former ice streams on the shelf (Dives 2-3, Fig. 1);
- Outer shelf and upper slope sedimentary environments featuring iceberg keel scours relating to mechanical reworking of the outer shelf and gullies and channels indicative of mass wasting on the continental slope (Dives 4-6, Fig. 1);
- Sediment drifts, with associated bedforms such as sediment waves and megaripples, on the lower slope and continental rise (Dives 7-9, Fig. 1);
- Subglacially-eroded bedrock-channels on the inner shelf (Dives 10-11, Fig. 1)
- Glacial-marginal longitudinal and transverse ridges in front of the glacier margins in the innermost parts of the fjords of the Antarctic Peninsula (Dives 12-16, Fig. 1).

On the inner shelf, the ISIS video- and photo data provided images of steep and locally undercut margins of submarine channels deeply incised into the bedrock. These channel networks, with undulating longitudinal profiles, were most likely formed by pressurized subglacial meltwater flow. They represent a clear view of the subglacial channelised hydrological system beneath a former ice stream draining a large interior ice-sheet basin.

On the continental slope, images of coarse gravel and boulder lags and fields of distinct current ripples locally covering the bottoms of the gullies and channels demonstrate the presence of strong and presumably intermittent near-bottom currents within the gully-channel systems. Collapsed blocks of sediment at the base of steep sides of sediment drifts on the continental rise imply similarly strong bottom current activity there. The high-resolution swath bathymetric data should prove useful in quantifying the bottom currents using the bedforms, such as sand waves, megaripples and local scour marks, around larger rocks locally observed on the continental slope and rise.

In the inner part of the Bourgeois Fjord, MS2000 swath bathymetric data enabled us to map glacial-marginal longitudinal and transverse sediment ridges with an order of magnitude higher resolution than possible with a ship-mounted EM120 swath system. A set of push-cores collected from the area by ISIS ROV will be analysed to provide an age model for the formation of these ridges.



