

Exploring past and modern bottom current pathways along the continental margin: the Ross Sea survey 2017

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Abstract

The Ross Sea 2017 survey carried out with the OGS Explora, in the frame of the 32nd Italian National Antarctic Research Program (PNRA) campaign and including an EU-EUROFLEETS 2 leg, was mainly aimed at investigating the morphobathymetric setting along the pathway of the Antarctic along-slope current (ASC), at the location of the Circumpolar Deep Water (CDW) intrusions on the shelf and the outflow of the Ross Sea bottom water and super-cold Ice Shelf Water (ISW, meltwater from below the ice sheet).

The survey focused on key areas along the continental shelf margin and along the slope, where the heat exchange between the open ocean and the Antarctic ice sheet is believed to occur. One of the goals was to provide evidence on how the ocean dynamics influences today, and influenced in the past, the depositional and erosional processes and the Antarctic ice-sheet and shelf dynamics. Similar processes probably impacted the stability of the West Antarctic Ice sheet numerous times over the last 5 million years, at the end of glacial maxima and during past warm climate time intervals, causing ice sheet and shelf collapse. The new data have been instrumental in locating deep drilling sites for providing older paleoclimate and paleoceanographic record in the frame of the International Ocean Drilling Project (IODP) Expedition 374 in the Ross Sea in January-February 2018.

CDW intrusions were observed onto the continental shelf and the ASC was measured along the slope. In the same areas, the past ocean dynamics and ice sheet meltwater pathways imprints in the margin were captured by means of reflection seismic and subbottom profiles, multibeam sea floor mapping as well as sediment gravity cores and box cores. The preliminary analysis of the data collected during the campaign revealed different type of sediment drifts and gullies along the continental shelf margin in each of the investigated areas. The origin of them may be related to different regimes of ice-sheet flows as well as ocean water mass inflow and outflow.

Multibeam data and subbottom chirp data from the sea bed were constantly recorded in combination with Acoustic Doppler Current Profiles (ADCP). Single channel seismic reflection profiles and more punctual measurements using Extendable Bottom Temperature profiles (XBT) and Current Temperature Depth (CTD) were collected across four continental shelf edge transects (from ca. 74°S to 76°S and 160°E to 160°W) and along the Ross Ice Shelf at ca. 78°S, West of the Iselin Bank.

The complexity of capturing ocean processes at different timescales was challenging. It implied, on one hand, measuring the in-situ ocean currents dynamics and water properties as well as detecting the various water mass pathways across the continental shelf edge, and on the other hand, finding past imprints of the same ocean dynamic features in the marine sediments and in the paleo-morphology of the Ross Sea continental margin. The multi-disciplinary specificity of the scientific and technical team proved to be highly strategic to define and discuss the adjustments of the survey areas, adjust the technical aspect of data collections or integrate the acquired data in a common framework.

The successful OGS Explora – PNRA campaign is hopefully pioneering future projects to complete the sea bed mapping and record the water column evolution that are crucially needed to understand mechanisms of present and past heat exchange via shelf-to-slope processes, ocean water masses mixing and ice sheet dynamics.

Keywords: sediment drift, gullies, Antarctica, Antarctic Bottom Water, Antarctic slope current, oceanographic and geophysical surveys.