Continental slope records indicate a grounded ice sheet margin during past glacials, South Shetland Trench, Antarctica

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First known study of the seafloor glacial geomorphology, and recent glacial history of the South Shetland Trench. Evidence of tectonic control of glacial geomorphology preserved on the sea bed.

Introduction

The South Shetland Trench (SST) is located around 100 km northwest, and parallel to, the South Shetland Islands, located between the Antarctic Peninsula and South America (Figure 1). Although a number of studies examining glacial history have been undertaken in the Bransfield Strait located between the South Shetland Islands and the Antarctic Peninsula to the south, the authors believe this is the first study of the seafloor glacial geomorphology, and recent glacial history of the SST. This paper presents the results from a EUROFLEETS2 expedition to the SST that took place in December 2015.

There is evidence from other sub-Antarctic islands such as the South Orkney Islands and Elephant Island for glaciations that extended well onto their continental shelves although a lack of age constraint from marine cores means it cannot be tied to a specific glaciation.

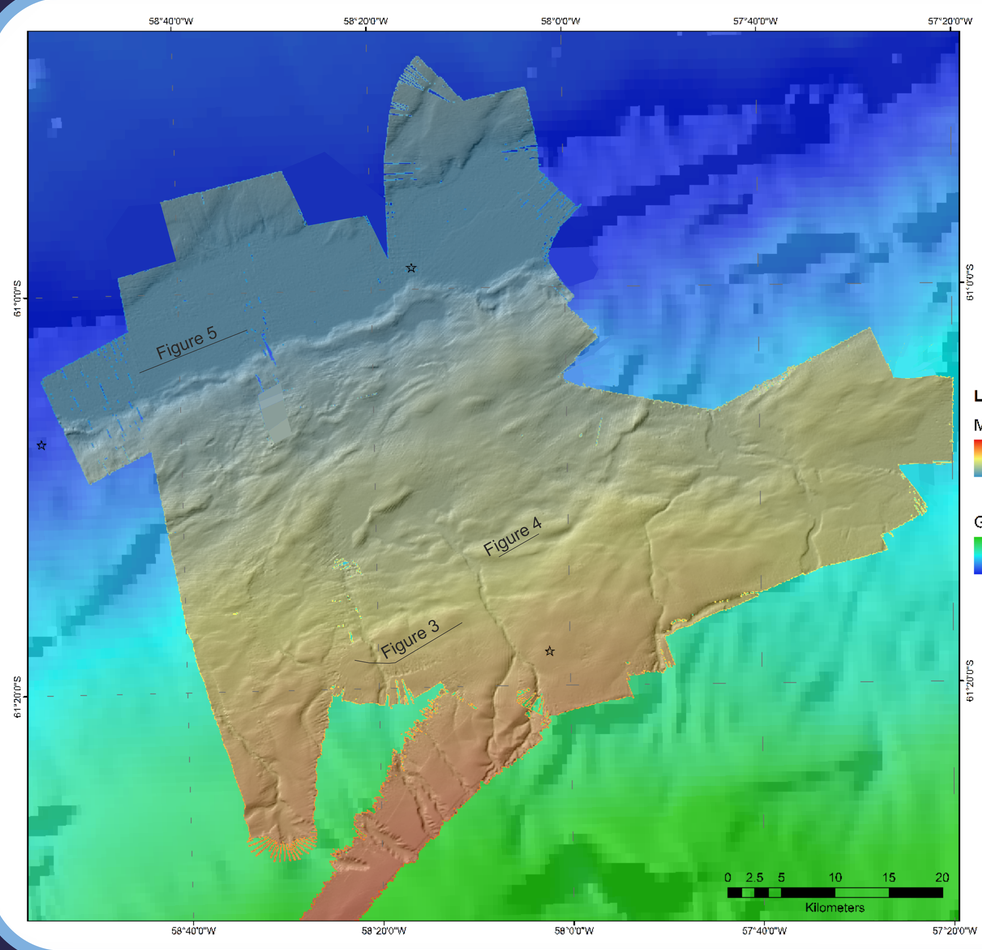

Figure 1. Multibeam bathymetry data acquired over the study area within the South Shetland Trench (for location see inset map below).

Data were acquired during the EUROFLEETS2 PHARMADEEP cruise on board the BIO Hespérides. EUROFLEETS2 is a Research Infrastructure Project under the 7th Framework Programme of the European Commission.

Methodology

Three primary equipment types were utilised during the course of this expedition to acquire geological data: gravity corer, EM120 full ocean depth multibeam echosounder with an optimum operating frequency of 12 kHz and Topas PS18 parametric sub-bottom profiler operated in 'Chirp' mode.

In total 3148 km^2 of multibeam echosounder data were acquired covering the southern flank and trench floor of the study area. Both high-resolution bathymetry and backscatter intensity data were acquired concurrently. Bathymetric data were processed using Qloud software from QPS. ArcGIS grids of the xyz data were produced at 25 m, 30 m, 40 m and 50 m resolution. Additional layers of slope, rugosity and aspect were derived from the bathymetry data and were generated in ArcGIS using the spatial analyst extension. Backscatter intensity data were processed using FM Geocoder. FM Geocoder corrects the backscatter intensities registered by the multibeam echosounder system, and then geometrically corrects and positions each acoustic sample in a backscatter mosaic.

Around 600 line kilometres of Topas data were acquired within the study area. These data will be interpreted using the IHS Kingdom software suite.

A total of 4.54 m of core material was retrieved from three gravity core sites (maximum length 2.79 m) (Figure 1) with a further core catcher sample acquired at a further site. These cores have yet to be analysed.

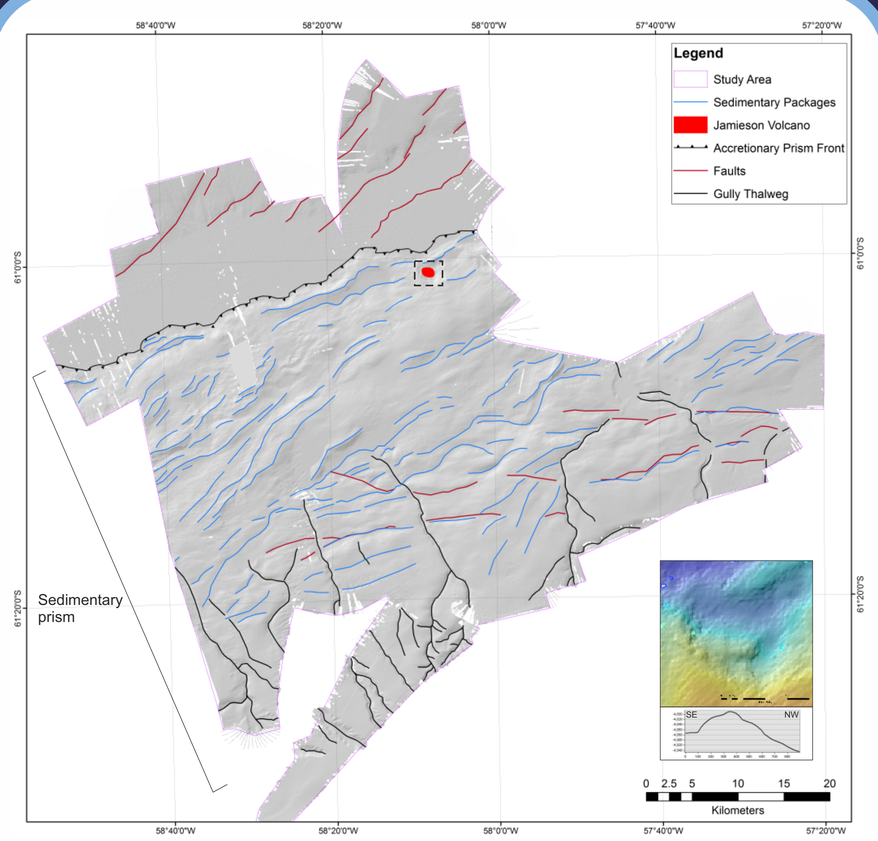

Figure 2. Initial geomorphological interpretation based on multibeam echosounder data. See inset for detail of the Jamieson Volcano.

Preliminary Results & Next Steps

The acquired data reveal the SST study area to host a system of linear downslope gullies, glacigenic debris flows and glacigenic deposits, transform faults, a volcanic edifice and an accretionary prism (Figure 2). Downslope gullies have been observed on other glaciated margins such as the Scotian slope offshore Canada, Ross Sea Antarctica, north-western Barents Sea and West Shetland Margin offshore north-western UK. The gullies are inferred as being eroded by turbidity currents comprising cold, dense, sediment-rich meltwater released from an ice front located at or near the continental shelf break. Glacigenic debris flows are found to extend from the continental shelf break to the lower continental slope. Sub-bottom profiler data penetrated up to 150 ms below seafloor in places and reveal a stacked sequence of debris flows suggestive of a fluctuating ice front that was grounded to, and retreated from, the shelf break on several occasions (Figures 3 & 4). The trench floor appears to be devoid of major geomorphological features as revealed by the multibeam echosounder data and comprise a relatively well layered sequence imaged by the sub-bottom profiler (Figure 5). A number of faults are clearly visible influencing the morphology of the sea floor.

The cores will be analysed on their return to the UK and combined with the acoustic data to produce a shallow geological model specifically looking at the fluctuating ice margin located north of the South Shetland Islands and the influence of shallow faulting on glacial deposits and the orientation of downslope gullies.

Figure 3 ***(right)*****.** Topas Line 27 (part) located on the continental slope in 2230-2430 metres of water. Data suggest presence of glacigenic sediments incised by downslope gullies. For location see Figure 1.

Figure 4 ***(below right)*****.** Topas Line 25 (part) located on the continental slope in 2900-3020 metres of water. Data suggest presence of stacked sequence of glacigenic sediments. For location see Figure 1.

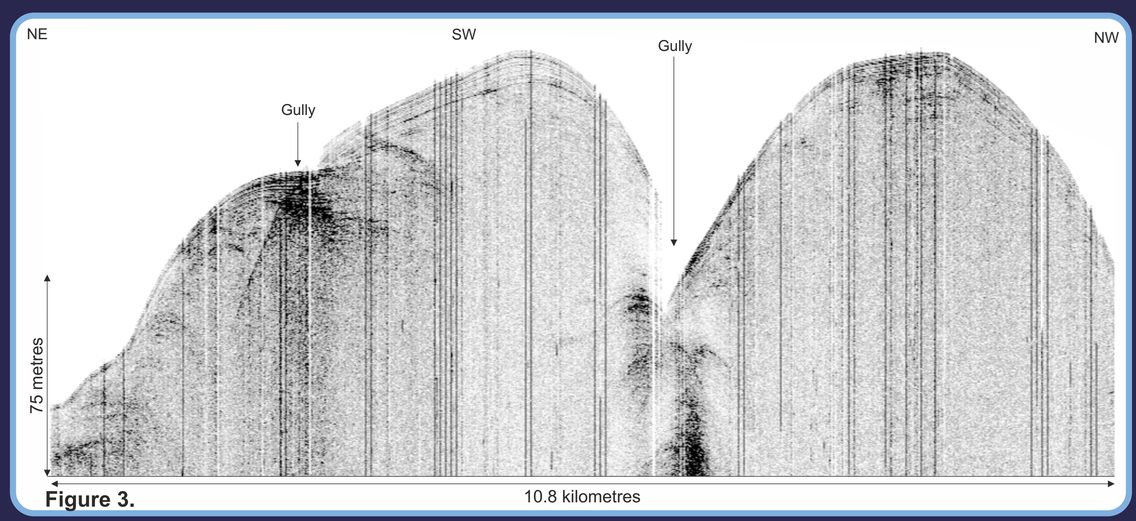

Figure 3.

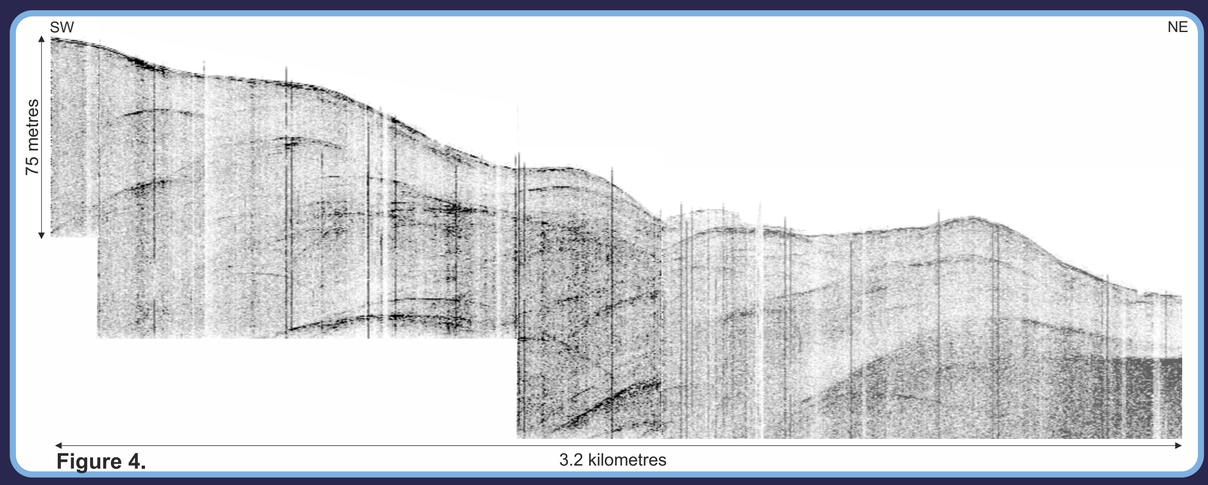

Figure 4.

Figure 5 ***(below)*****.** Topas Line 19 (part) located on the trench floor, parallel to the axis of the trench in 5214-5220 metres of water. Data suggest presence of a well layered sequence with minor faults. For location see Figure 1.

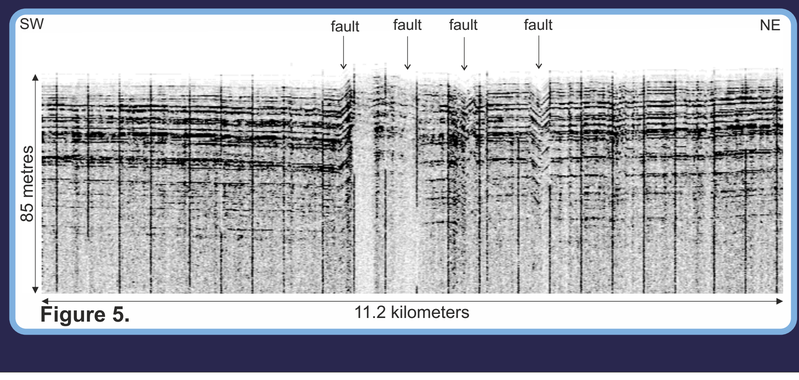

Figure 5.

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