Marine geophysical investigations of past ice flow in Pine Island Bay, West Antarctica

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Marine geophysical data were acquired from the continental margin of Pine Island Bay during the recent 'AutoSub Under Ice' cruise of the James Clark Ross in March 2003 (Fig. 1). These data has enabled us to investigate the past extent and flow of the ice sheet in outer Pine Island Bay (PIB). Swath bathymetric data show that the shelf deepens inshore, and that a cross-shelf trough is present on the outer shelf at about 113ºW.

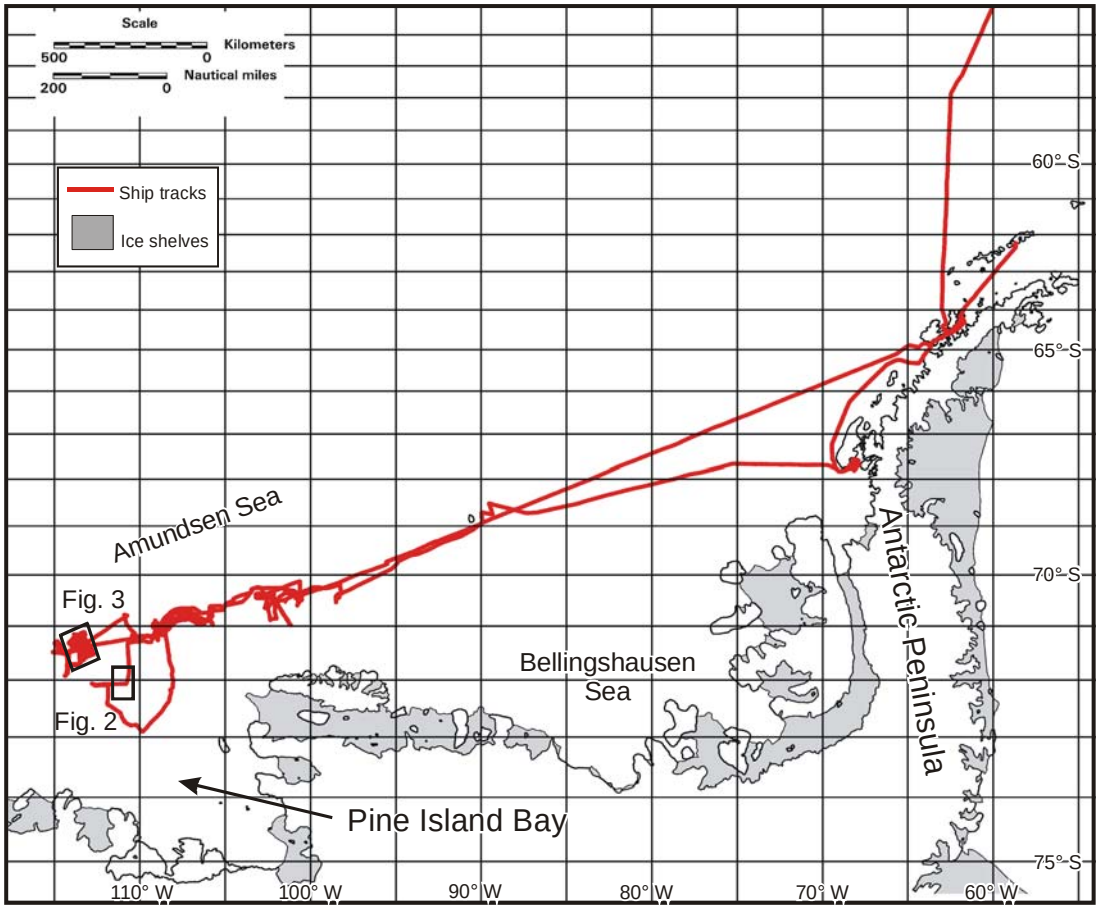
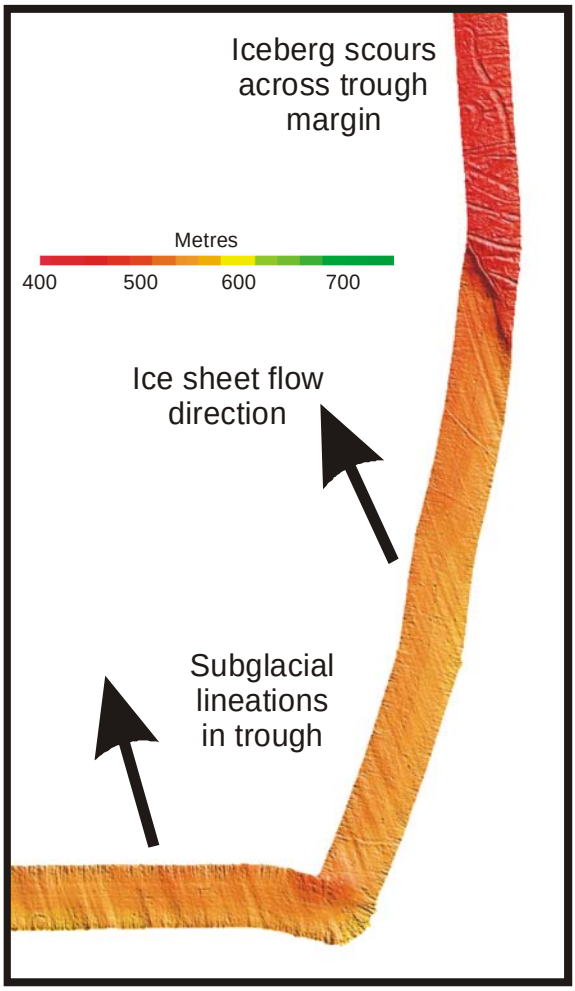


Figure 1. Ship tracks James Clark Ross, March 2003.

Streamlined, elongate bedforms formed in soft sediments are found mainly in the trough on the outer shelf and extend to the shelf edge (Figs. 2, 3). These features are interpreted as glacial lineations, inferred to be a product of soft-sediment deformation beneath former ice streams. They allow reconstruction of past ice-flow direction, and may also define former ice streams (Figs. 2, 3). Their presence at the shelf edge confirms that ice filled PIB probably at the last glacial maximum. Sub-bottom profiler records show that the sea floor is sedimentary and that there are, in some places, reflectors at a few metres depth defining an upper unit in whose surface the lineations are formed.



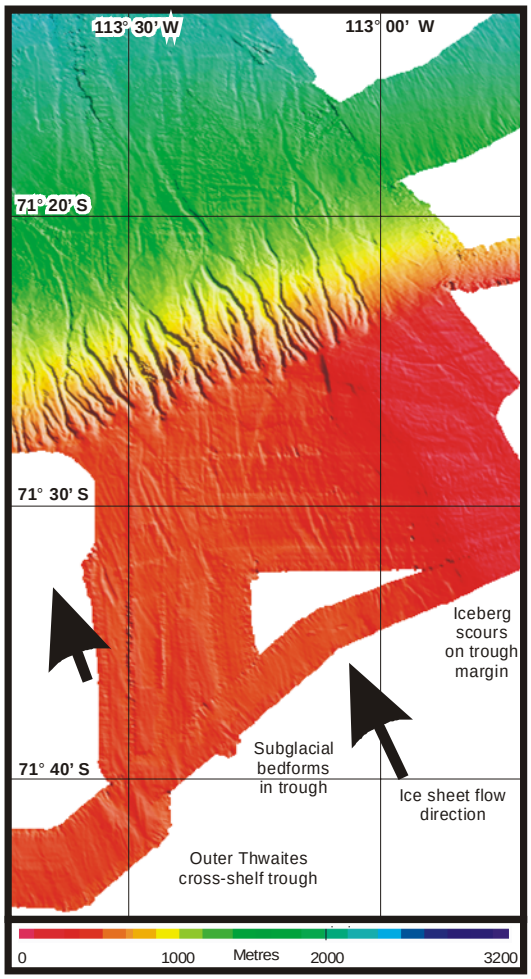


Figure 2.

Figure 3.

Sometimes several reflectors appear to cross-cut one another, each with a similar acoustic unit above, suggesting shifting paleo-ice stream margins. A highly irregular pattern of linear scour marks is found in water depths <450-500 m, representing sediment reworking by iceberg keels produced from the 500 m or so thick floating tongues of the modern Pine Island and Thwaites glaciers.
Geophysical evidence from the continental slope beyond PIB between 107º to 115ºW shows several sets of gullies or channels, up to about 100 m deep and 30 km long (Fig. 3).

The gullies are found mainly in two 50 km-wide groups at 113º20'W and 108º40'W. On the mid-slope and beyond, in over 2000 m of water, there is some evidence of wider channels, indicating that downslope transfer of glacier-derived sediments has taken place from the continental slope to the Amundsen Sea abyssal plain. During full-glacial conditions, sediments and meltwater would have been delivered from the ice front directly at the shelf break, leading to downslope mass-wasting, probably as turbidity currents and debris flows. It is likely that the gully or channel systems were formed by mass-flow activity, driven by either sediment-laden glacial meltwater or cold and saline water associated with sea-ice formation in a semi-permanent polynya at the former ice-sheet margin.