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Short Note
Glacial trough under Larsen Ice Shelf, Antarctic Peninsula

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Introduction

The Antarctic Peninsula rises to an ice-capped plateau approximately 1000 m a.s.l. at its northern end and 3600 m at its southern end. Most of the glaciers on the eastern side drain into Larsen Ice Shelf (Fig. 1), the northernmost part of which was called "Larsen A" (Vaughan & Doake 1996). This part of the ice shelf was estimated to be 180–250 m thick (Skvarca 1993) until its break-up in 1995 (Rott *et al.* 1996).

The continental shelf east of the Larsen Ice Shelf, which extends *c.* 300 km offshore between Seymour Island and Jason Peninsula, was the site of marine geophysical research by Anderson (1992), Anderson *et al.* (1992) and Sloan *et al.* (1995). During those surveys, considerable submarine relief was discovered, with mean depths of *c.* 350 m. Three glacial troughs of more than 500 m depth were mapped.

Most current glaciological and geophysical research programmes (e.g. British Antarctic Survey; Instituto Antártico Argentino; Aero-Geophysical Programme USAC) on the Larsen A sector of the ice shelf were started before 1995, prior to its break-up, and when the sea bed topography of the Weddell Sea underneath the ice shelf was unknown. During the 1997 summer, Greenpeace and the Instituto Antártico Argentino carried out an oceanographic cruise in the area of the continental shelf (adjacent to the Larsen A sector of the ice shelf) covered by the Larsen Ice Shelf until 1995. The bathymetric soundings were made by the MV *Arctic Sunrise* (Greenpeace), covering approximately 240 nautical miles (450 km) along track lines (Fig. 2).

The survey area was located in the north-eastern part of the Weddell Sea adjacent to the Antarctic Peninsula between: Cape Sobral (64°36'11.22"S; 59°38'35.22"W), Cape Worsley (64°39'42.4"S; 60°21'818"W), Larsen Nunatak (64°58'6.05"S; 60°04'0.16"W), and Lindenberg Nunatak (64°55'3.44"S; 59°41'4.32"W) (Fig. 2). The survey included simultaneous recording of depth and GPS positioning.

Results of the bathymetric survey

A large glacial trough, with an approximate maximum depth of 1000 m and an ENE orientation (Fig. 3), and a submarine peak of possible volcanic origin were found on the sea bed of the survey area (Fig. 1). The main submarine morphological features are described below.

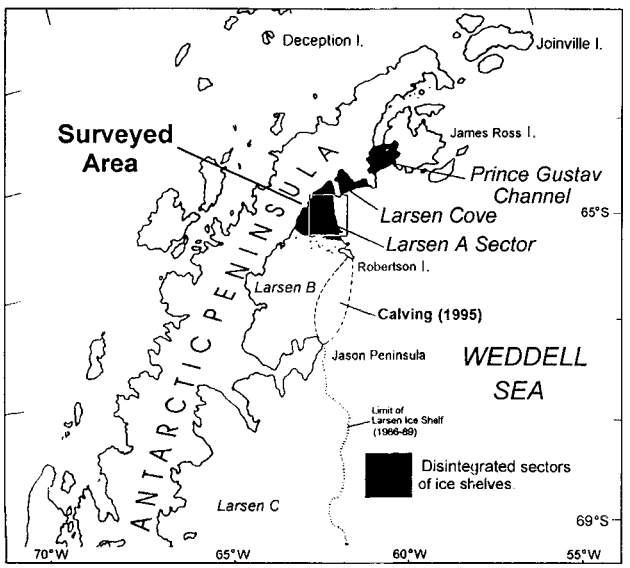

Fig. 1. Map of northern Antarctic Peninsula, showing the study area, the parts of the ice shelves that collapsed recently and the calving of a large iceberg from Larsen B 1995. Front of Larsen Ice Shelf after Skvarca (1993, fig. 2).

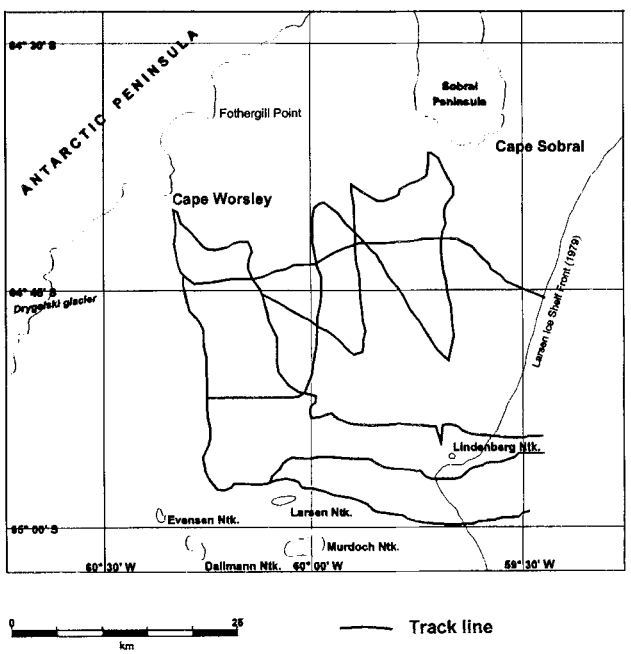

Fig. 2. GPS recorded cruise track-lines. Irregular track-lines due to heavy pack ice during the survey.

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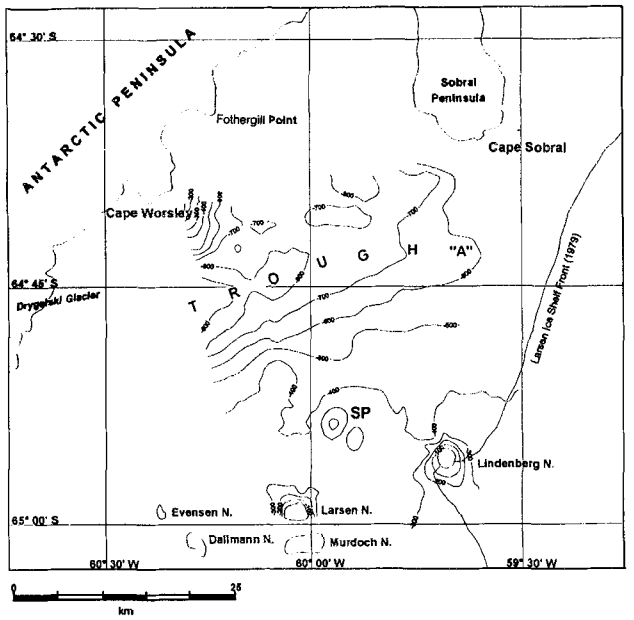

Fig. 3. Bathymetry of the area surveyed by Greenpeace and the Instituto Antártico Argentino during the 1997 joint project, showing the large submarine trough and the submarine peak (SP).

a) An extensive trough ("Trough A") is oriented N261°, has a maximum depth of approximately 1000 m, is 30 km long and has an average width of 10 km (Fig. 3). The eastern end of this feature is located 15 km to the south of Cape Sobral, where it reaches a depth of 600 m. From there, it slopes gently towards the Drygalski Glacier (Antarctic Peninsula). Offshore of this glacier the channel reaches its maximum width (18 km) and maximum recorded depths of 985–990 m. The greatest measured depths are relatively constant, suggesting that at least at the western end the bottom of the channel is nearly flat.

b) The continental shelf north of Larsen and Lindenberg nunataks (Fig. 3), which are of volcanic origin (Smellie 1990), extends 10–15 km to the north with mean depths in the 350–450 m range. This platform, located in the southern reaches of the survey area, slopes gently to the north-west.

c) The submarine peak, which possibly rises to ~114 m, is located at the southern part of the survey area (SP in Fig. 3). From their morphology and location, this peak is possibly a volcanic cone similar to Larsen and Lindenberg nunataks, which are composed of Cenozoic basaltic rocks (Fleet 1968, del Valle *et al.* 1983).

The overdeepened continental shelf over most of the surved area, specially at Trough A shows a reverse morphology, which is unusual on low-latitude continental shelves (where depth usually increases progressively from coast to shelf edge depths of 150–200 m). According to ten Brink *et al.* (1995), this reverse morphology is exhibited usually by the continental shelf around the Antarctic continent despite the diverse geological and tectonic histories of different Antarctic margins. The reverse and overdeepened continental shelf morphology in Antarctica may be not due to loading of the adjacent ice sheet, but it can be formed by the general pattern of inner-shelf glacial erosion and outer-shelf deposition related to the position of the seaward edge of the grounded ice (ten Brink *et al.* 1995). If the formation of Trough A was related to erosional processes related to ice stream action (cf. Bentley 1987, Alley *et al.* 1989), the direction of ice transport would have been to the east in this trough.

Acknowledgements

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