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Short Note

Deep Seismic Reflections beneath the Trans-Antarctic Mountain Front, from Reprocessed SERIS Seismic Data

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INTRODUCTION

Seismic data from the SERIS seismic reflection profile provide important information about the character and geometry of the crust beneath the Ross Embayment and the Trans-Antarctic Mountains (TAM) (ten Brink et al.,1993). The initial results from SERIS indicated that the crust gradually thickens from 22 km beneath the Ross Embayment to between 30 and 35 km beneath the TAM. The transition between the thin crust of the Ross Embayment and the thicker crust of East Antarctica begins 0 to 10 km inland of the mountain front, and is marked by a strong band of reflections that dip under the mountains, with the base of the crust dipping from 15-20°. ten Brink et al (1993) interpret these reflections as representing either ductile fabric, or increased scattering near the Moho.

In this note we present results from reprocessing the seismic data collected across the TAM front. In the reprocessing we take into account the large statics associated with the near-surface grounded glacier ice, and carry out new noise-attenuation processing on the data. The results from the reprocessing show the detailed morphology of the Robb Glacier, indicate the presence of sediments beneath the glacier, and also show increased coherency and definition for the band of deep reflections which dip under the TAM.

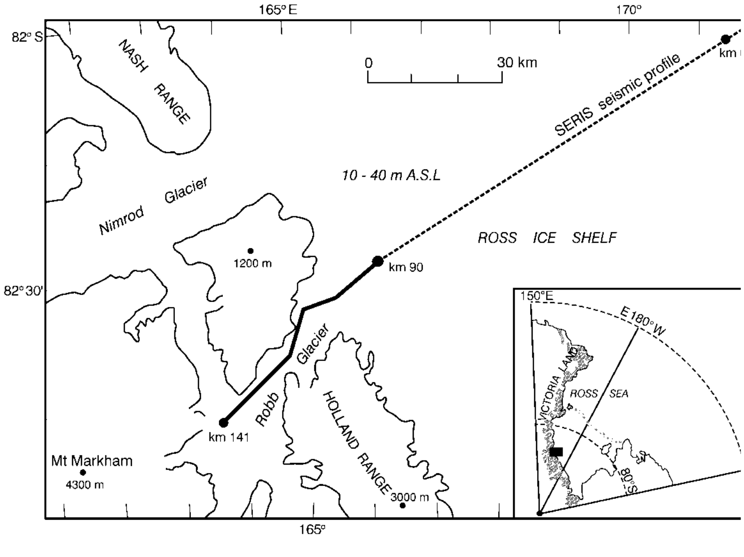

Fig. 1 - The location of the SERIS profile, across the TAM front and (inset) the Ross Sea region, Antarctica. The section of the SERIS profile discussed in this note is shown in bold, while the remainder of the SERIS profile is dashed. The Mountain front (and inferred sub-ice coastline) is approximately the NE side of Holland Range.

METHOD AND DISCUSSION

The SERIS seismic data consist of both near-vertical-incident data, with shot-receiver offsets ranging between 0.15 and 3 km, and wide-angle reflection data, with shot-receiver offsets ranging between 0.15 and 90 km (Melhuish et al., 1993, ten Brink et al., 1993).

In this current work we have reprocessed the near-vertical-incident seismic reflection data collected along the section of the SERIS profile across the TAM front, to enhance the seismic image of the shallow ice-rock interface at the base of the Robb glacier (Fig. 1). In the reprocessing, crooked-line cdp binning was used to fully allow for the crooked-line geometry of the seismic profile. A floating datum was used during processing to allow for elevation changes along the Robb glacier, and adaptive dispersive filtering was applied to suppress large amplitude dispersive surface waves associated with the high velocity gradient in the near-surface of the glacier. We used the technique of Herrmann and Russell (1990) for the dispersive-wave filtering, in which the dispersion relation is calculated using adaptive phase-matched filters designed from a single trace. This technique is particularly useful for attenuating dispersive noise trains when the shot gather data is spatially aliased, as it is for the SERIS data.

The stack after reprocessing is shown in figure 2, following post-stack time migration. Near horizontal streaks seen on the stack (*e.g.* at 0.6-0.7 s beneath the northeast end), are artifacts from processing aliased surface waves, which were not totally suppressed by the dispersive filter. The strongest reflector represents the glacier floor. Calculation of the glacier thickness using this reflector shows that the glacier varies in thickness from 380 m to 1600 m, the glacier thickness at times changing more than 1000 m in the space of 5 km, for example at the SW end of the profile. Some weak reflectors are evident immediately beneath the glacier floor reflector, indicating the presence of sediments beneath the glacier (Fig. 2).

The two-way-travel-time associated with the glacier varies between 0.2 s and 0.82 s along the 50 km length of the profile shown in figure 2. As this is the same length as the spatial aperture of the wide-angle reflection recording spread, it is clear that the statics

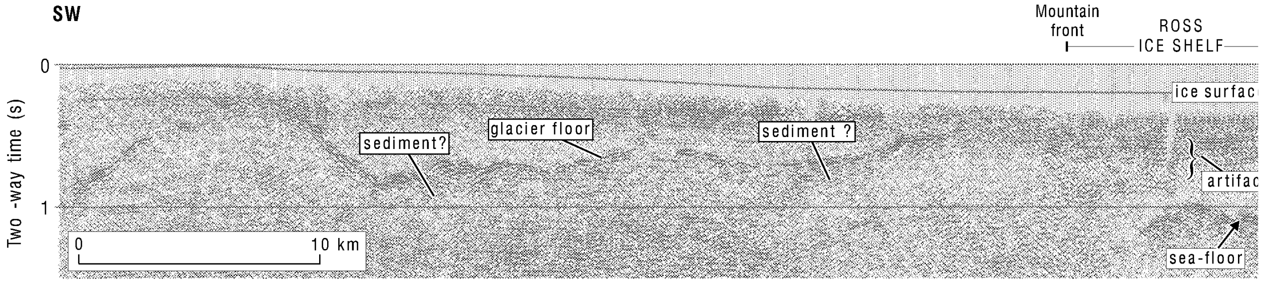

Fig. 2 - Migrated stack of the near-vertical-incident seismic data, showing large changes in the thickness of the Robb Glacier. Some horizontal streaks (e.g. at 0.6-0.7 s at the northeast end) are artifacts associated with aliased surface wave energy.

associated with the glacier need to be taken into account when examining the deep wide-angle data. In addition the water layer beneath the Ross Ice Shelf, at the north-eastern end of the profile, also has a large static effect. This effect can be estimated by calculating the thickness of the floating ice layer, and the water layer beneath it, using two-way-times of the ice-water-seafloor multiples (*e.g.* Jarvis & King, 1993)

The wide-angle SERIS seismic data were reprocessed using the above information provided by the stack of the near-vertical-incident shallow data. Two-way-time statics associated with the Robb glacier, Ross Ice Shelf and water layer were calculated using the stack (Fig. 2), and were then applied to the wide-angle seismic data, assuming vertical travel paths in the near-surface layers. Adaptive dispersive filtering was applied to the wide-angle data, as for the shallow data, to suppress surface waves.

The reprocessed wide-angle data are shown in figure 3 for the section of the SERIS profile beneath the TAM Front (Fig. 1, bold line). The wide-angle data are plotted after a moveout correction using a hyperbolic moveout of 6 km/s, the average crustal velocity; this correction is clearly an approximation but the low-fold and spatial aliasing problems preclude using prestack migration.

Results from the reprocessing show increased coherency and definition for the band of deep dipping reflections noted by ten Brink et al. (1993). The strongest amplitude reflections are observed at the top of the reflection band, at approximately 22-23 km depth at spatial position km 115.6 (Fig. 3). The reflection band is approximately 1 s thick, and changes in apparent dip from 6 to 32°, dipping to the south-west. It is likely that this recorded band of reflections represents the combined effect of only a few deep primary reflectors, with secondary scattered energy generated by the large near-surface effect of the glacier ice and firn layer, the scattered energy increasing the apparent thickness of the reflection band. We note that if this reflection band represents Moho then it is ca.5 km shallower than the Moho interpreted from ACRUP data (Della Vedova et al.,1997) across the TAM front approximately 600 km to the north of SERIS.

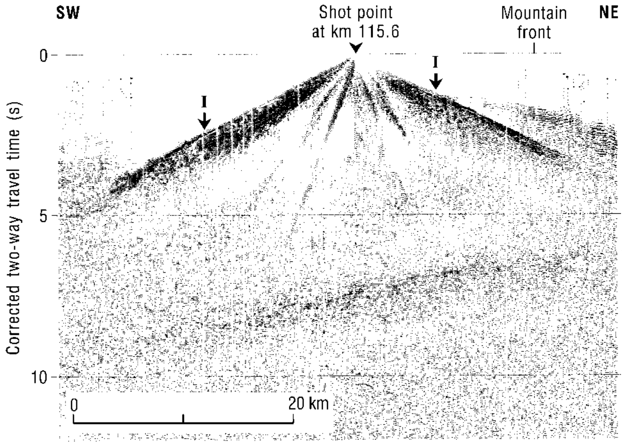

Fig. 3 - Multi-fold image of dipping reflections beneath the TAM from wide-angle reflection data, after processing. Travel time was corrected with a hyperbolic moveout of 6 km/s. Abbreviations : I, direct wave within the ice layer; M, deep reflections (inferred Moho).

CONCLUSIONS

Reprocessing of SERIS near-vertical-incident seismic data has greatly improved the definition of the glacier-rock interface in the segment of the SERIS profile beneath the TAM, providing detailed morphology of the Robb glacier bottom. The improved stack also indicates the presence of pockets of sediment immediately beneath the glacier ice.

Prominent deep reflections previously observed beneath the TAM now show increased coherency following reprocessing. This strong reflection band, inferred as the Moho, is at approximately 22-23 km depth beneath km-115.6, and dips to the south-west at between 6 and 3°.

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