

Glacial and marine features in the recent sedimentary deposits of the Joides Basin (Antarctica)

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Summary This detailed seismostratigraphic analysis of recent sedimentary deposits in the Joides Basin and the determination of the seismic facies provided new information about paleoclimate events and the effects of the ice sheet oscillations on the deposition of sediments in the Central Trough/Joides Basin during the last glacial and grounding zone translations. We hope it provides a useful contribution to the study of the near-surface units of the continental shelf in terms of depositional sequences at the scale of a glacial/interglacial cycle. The acquisition of new very-high-resolution seismic profiles using a 400-900 J 120-Tip Sparker array and a 3.5 kHz Sub Bottom Profiler in the Joides Basin allowed us to obtain a detailed picture of the sub-bottom seismostratigraphy and seafloor morphology. The study was aimed at identifying sedimentary bodies in the area datable to the last 40,000-50,000 years. The analyses permitted us to distinguish between sediments deposited during the last glacial maximum and post-glacial sediments. Thus, the study should provide us with the area covered by the ice sheet during the Last Glacial Maximum, contributing to distinguishing postglacial sediments, and a better understanding the sedimentation processes following the advance/retreat of the ice sheet. The data obtained from the analyses of the geometry of the deposits and their seismic facies revealed a great variation in shelf deposits in relation to the complex sedimentary processes.

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Introduction

The East Antarctic Ice Sheet (EAIS) drains into limited western sectors of the Ross Sea and along the coast of Victoria Land. The fluctuations in the volume of EAIS ice in relation to the glacial dynamics and neo-tectonics are recorded in the sedimentary deposits of the Northern Basin and, in a more complex way, in those of the Central Trough (Cooper et al., 1991; Anderson et al., 1992). In fact, the West Antarctic Ice Sheet (WAIS) and the Ross Ice Shelf (RIS) drain into this area, where the stratigraphic record is quite well preserved. Current research focuses on establishing the

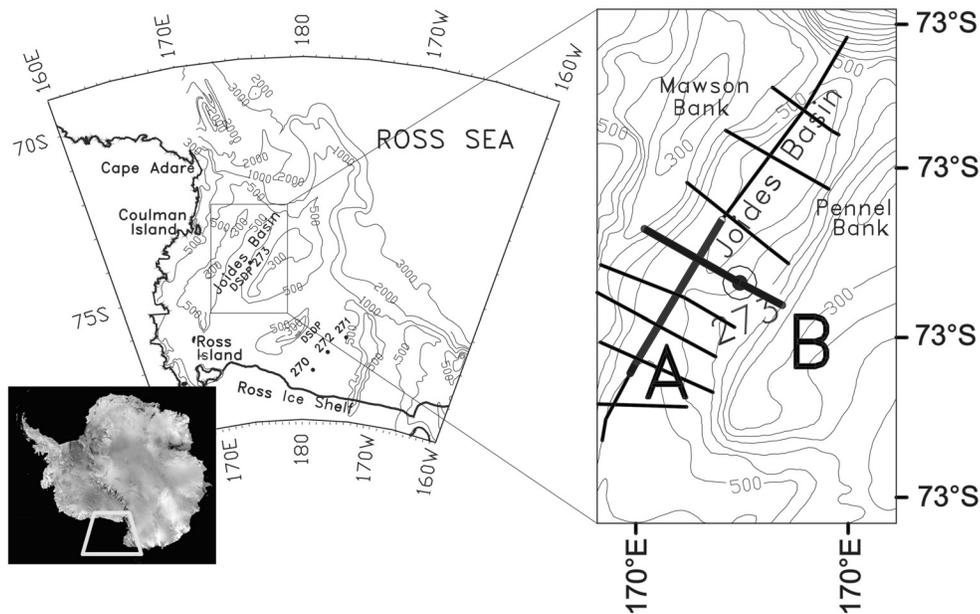


Figure 1. Map of the Ross Sea (bathymetry in metres) (Davey and Stagpoole, 2003) including the Joides Basin data grid of the high-resolution seismic profiles collected during the 2004-2005 PNRA Cruise. Bold black lines (A and B) mark the location of profiles shown in the Figures 2 and 3 respectively.

timing of deposition of features in the Ross Sea and the relationship between the deposits and features associated with the last glacial expansion (Licht et al., 1999; Bart and Anderson, 2000; Shipp et al., 2002). Various authors have proposed acoustic facies (Shipp et al., 1999; Corradi et al., 2003) on the basis of external geometry, similarities in characteristics, width of unconformities, intensity of seismic signals and the geometry of internal reflectors. Here we present the high-resolution seismic data (Figure 1) recorded during the 2004-2005 Programma Nazionale di Ricerche in Antartide (PNRA) Oceanographic Cruise in the Joides Basin in the western sector of the Ross Sea. These seismic results provided us with a detailed determination of near-surface units, aimed at recognizing the different sedimentary bodies in the area subjected to the action of the ice sheet during and since the Last Glacial Maximum (LGM).

Discussion

The dataset includes approximately 1,000 miles of high-resolution profiles using a 400-900 J 120-Tip Sparker array and a 3.5 kHz Sub Bottom Profiler (SBP), recorded simultaneously. The configuration of the geophysical instruments adopted, the advanced technology and the recording equipment (D-Seismic Acquisition Platform Version 2.0.8) used to record the geophysical data allowed us to obtain high-resolution areal and vertical sections. The vertical resolution of these devices (sub-metric resolution and penetration of 300 ms (TWTT) for the Sparker and decimetric resolution for the SBP) made them particularly useful for the study of the most recent depositional events, specifically to seismostratigraphically identify a data imaged of the seafloor of a few metres depth that is still little known. The high resolution allowed us to distinguish postglacial sediments and better understand the sedimentation processes following the oscillations of the ice sheet, on the basis of the geometry, and to estimate the thickness of the deposits and their various seismic facies. These new seismic lines intersect high- and low-resolution seismic profiles collected during previous PNRA cruises. Seismic correlation with the Leg 28 DSDP 273 drill site was used to calibrate the series following the Late Pleistocene unconformities (U2/U3). A dip and strike profiles of the Joides Basin (Figure 2 & 3 respectively) showed the different seismostratigraphic features of the inner shelf. The sedimentary structure corresponding to the grounding zone wedge associated with the LGM, demonstrated that the deposits are more variable than those of the Northern Basin, which has thick sequences only in particularly deep sectors.

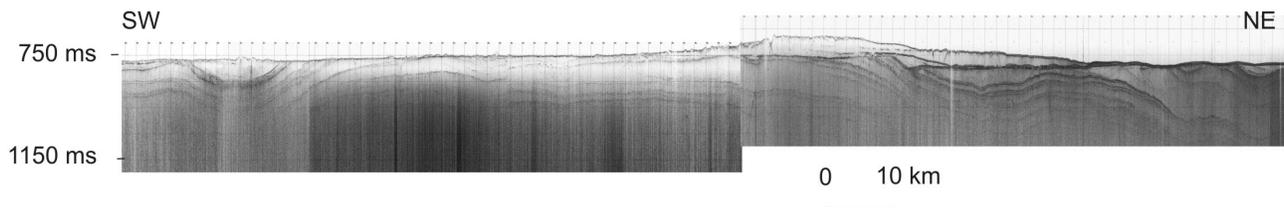


Figure 2. Dip immersion-oriented Sparker profile (see Figure 1 for the location, A) showing the inner shelf to the south of the Grounding Zone Wedge Threshold. 760 ms = two way travel time - TWTT.

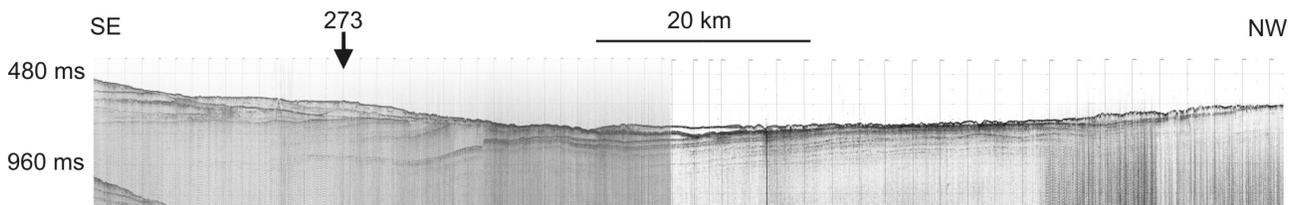


Figure 3. Cross sections Sparker profile shows the complex morphology of the Basin close to the DSDP 273 site. 760 ms = two way travel time – TWTT. See Figure 1 for the location (B).

On the inner shelf, south of the threshold, is a sector where the LGM grounding zone wedge and the ice sheet advance, eroded the previous deposits. This advance is also represented by subglacial till (Shipp et al., 1999; 2002; Corradi et al., 2003). The erosive surface truncates other unconformities associated with preceding advances and retreats. It is sometimes well preserved, perhaps due to the structure of the basin. The LGM erosive episode overlies all the preceding sedimentation episodes, indicating a lateral contribution as well, with the development of basins cut across the present-day axes. The sedimentary series following the LGM is represented by a discordant erosional unconformity overlying the preceding ones and sub-glacial till deposits (facies 4a from Shipp et al., 1999), and covered with hummocky glacial-marine deposits (Facies 2 and 3). Facies 1, a draping pelagic deposit, is the uppermost unit

overlying all the other facies. This section is characterised by transparent seismic facies with variable thickness (maximum, circa 12 ms TWTT, recorded in the middle shelf, along the axis of the Joides Basin).

Conclusion

The acquisition of new very-high-resolution seismic profiles allowed us to obtain a detailed picture of the role of ice flow, seafloor morphology and sediment deposition in the evolution of this sector of the Ross Sea. In particular some of these glacial/marine events are probably the direct stratigraphic record of the grounding zone wedge, morainial ridges, mega scale glacial lineations, drumlins, gullies, etc. associated with iceberg-furrows, referring to significant periods in the growth and disintegration of the ice sheet.

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