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Glacial and glaciomarine sedimentary successions from the southern Bellingshausen Sea: archives for environmental changes in the Antarctic Peninsula region since the last glacial period

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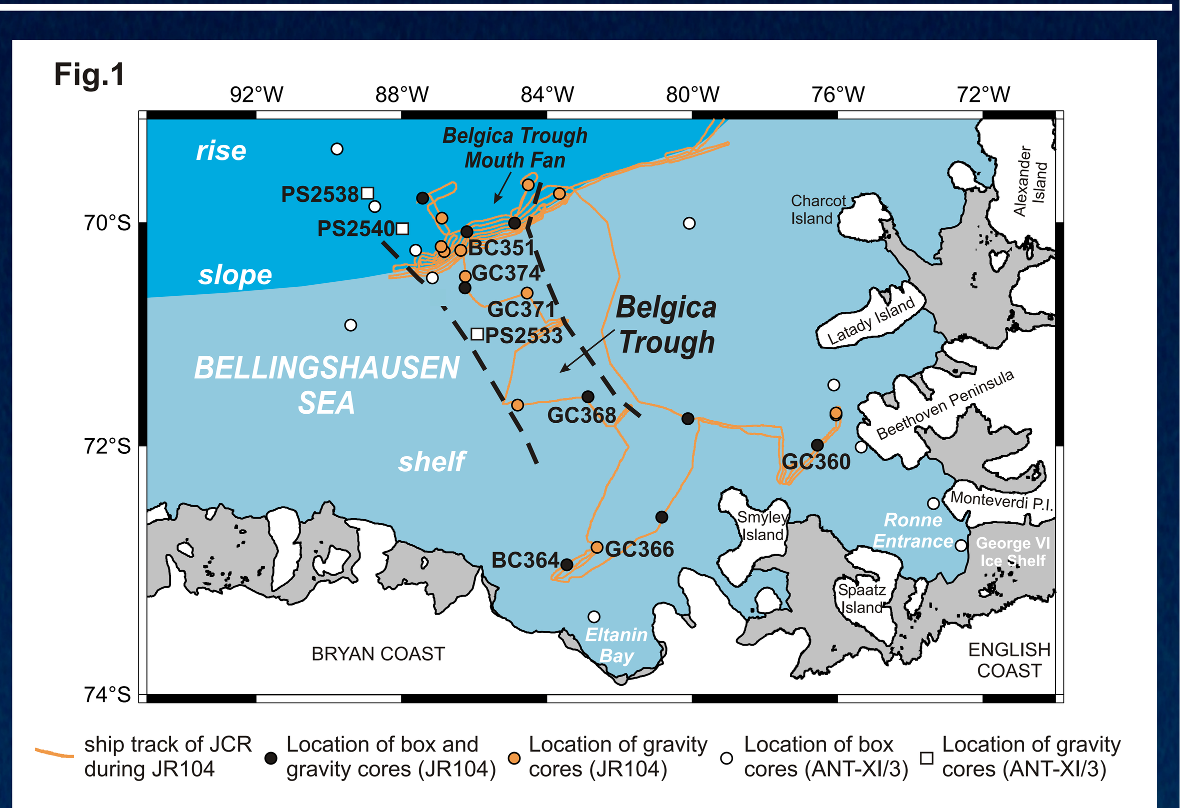
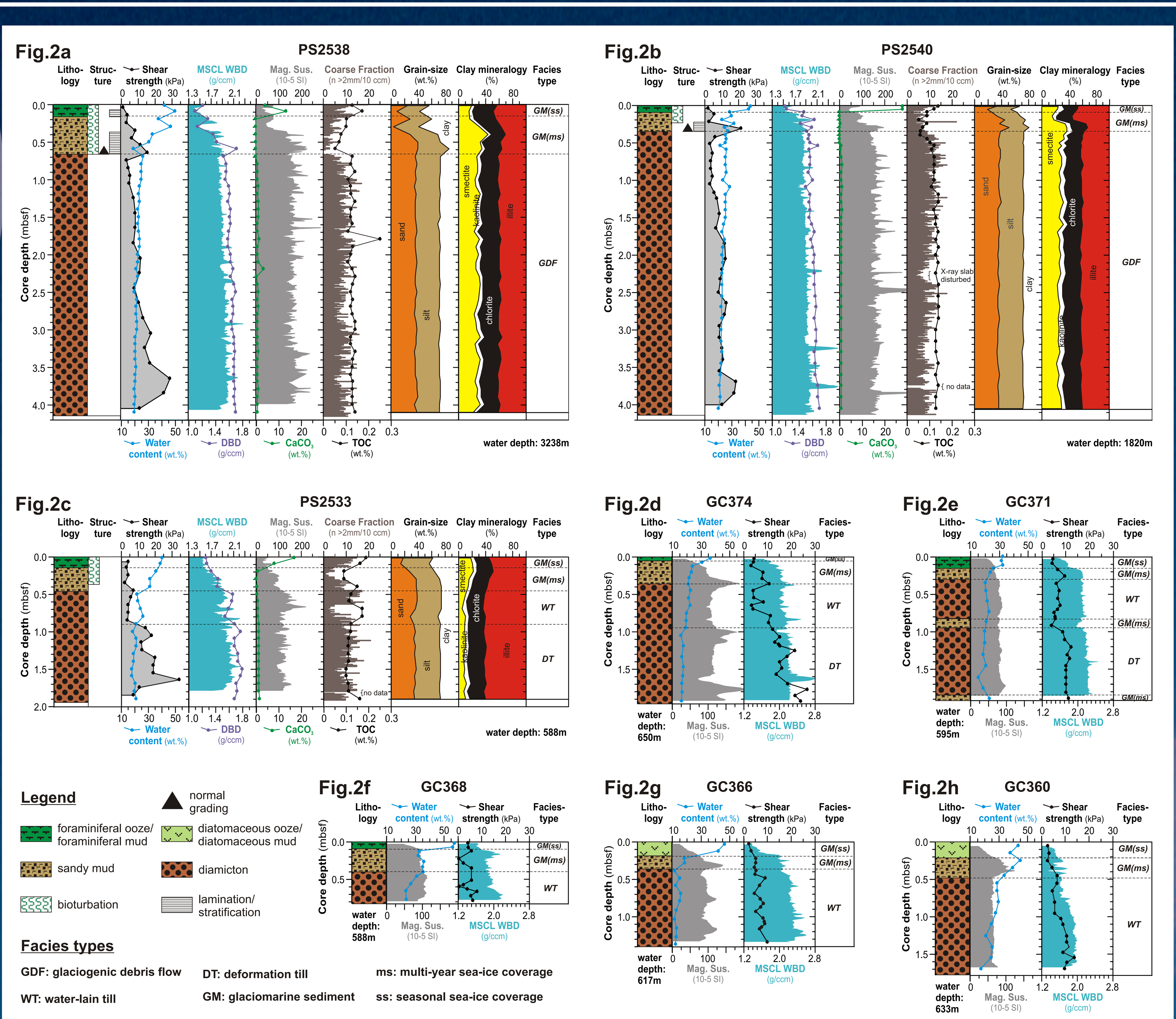
Background

The main scientific objective of RRS *James Clark Ross* cruise JR104 (January-February 2004) was the investigation of the Belgica Trough representing the pathway of a major palaeo-ice stream in the southern Bellingshausen Sea (Fig. 1). Here we present the first results of sedimentological investigations of gravity cores recovered from Belgica Trough and the adjacent continental margin during JR104 and RV *Polarstern* cruise ANT-XI/3 (1994) (Fig. 1). In combination with multibeam and subbottom profiler data (see poster Ó Cofaigh et al. in this session) these results form a comprehensive data set allowing the reconstruction of palaeoenvironmental changes in that area during the last glacial cycle.



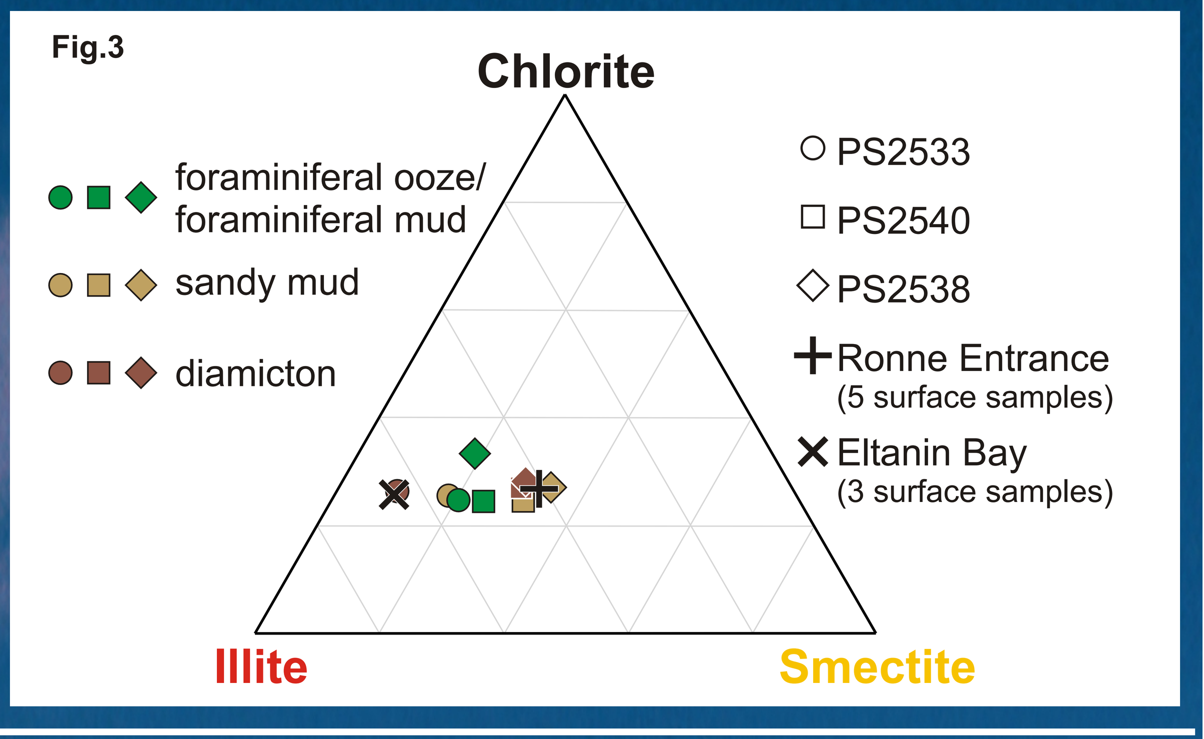
The last glacial period

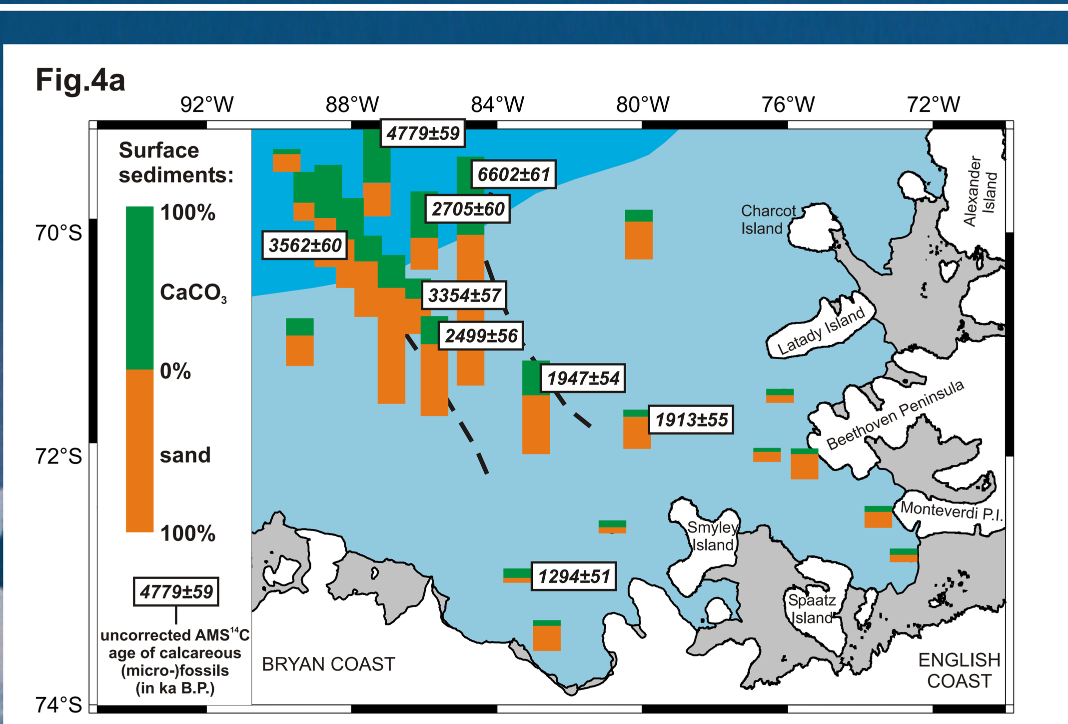
The lowermost sediments recovered on the shelf, slope and rise, which are assumed to have been deposited during the last glacial period, consist of grey, massive, lithogenic diamictons (Fig. 2) with the diamictons on the slope and rise representing glaciogenic debris flow deposits (Figs. 2a,b). In contrast, we interpret the diamictons on the shelf as deformation tills and water-lain tills, respectively (Figs. 2c-h). The water-lain tills differ from the deformation tills by lower shear strength (<10 kPa), greater variability of physical properties and normal down-core consolidation. Furthermore, greater variability of other sedimentological parameters, such as TOC content, a minor content of coarse-grained components (>2mm), and the presence of a few, but obviously autochthonous benthic foraminifera (*Bulimina aculeata, Cassidulina biora*), suggest deposition of the upper section of the diamicton at site PS2533 under an ice shelf (Fig. 2c). The occurrence of deformation tills within Belgica Trough (Figs. 2c-e) points to the advance of an ice stream to the outer shelf. The water-lain tills normally overlay the deformation tills documenting the floating ("lift off") of the formerly grounded ice masses. The clay mineral assemblages of the debris flows (Figs. 2a,b) indicate an origin of the glaciogenic detritus in Ronne Entrance (Fig. 3) and thus suggest that ice draining Eltanin Bay and Ronne Entrance (locations see Fig. 1) converged within Belgica Trough. In contrast, the clay mineral assemblage of the diamicton at site PS2533 (Fig. 2c) corresponds to the modern assemblage found in Eltanin Bay (Fig. 3) indicating that the till deposition was unrelated to the deposition of the debris flows.

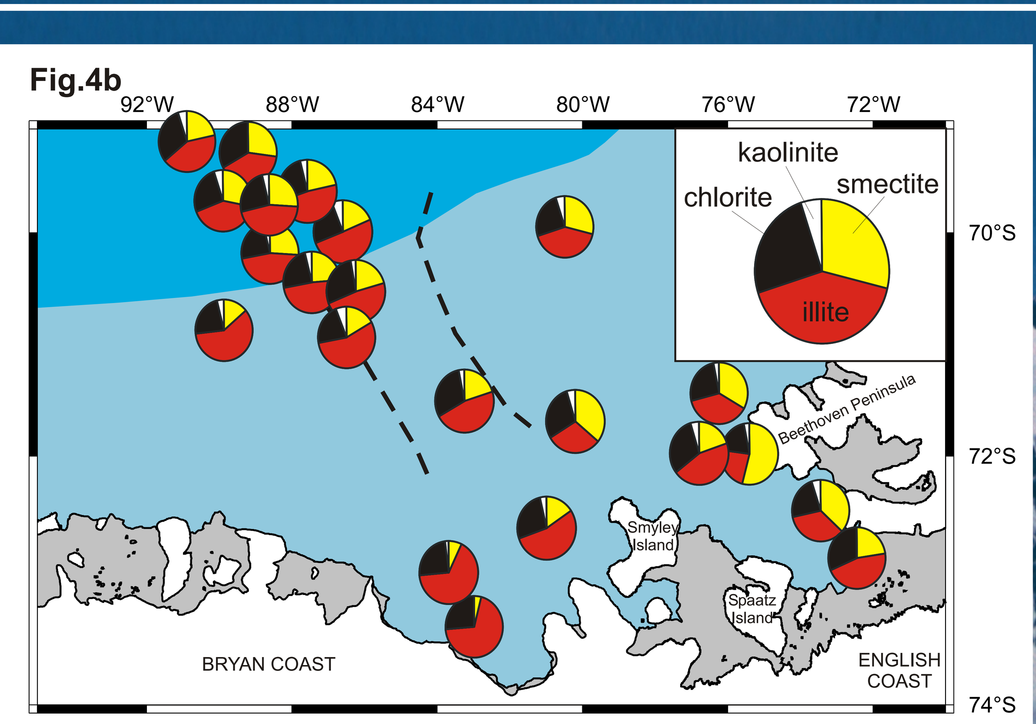


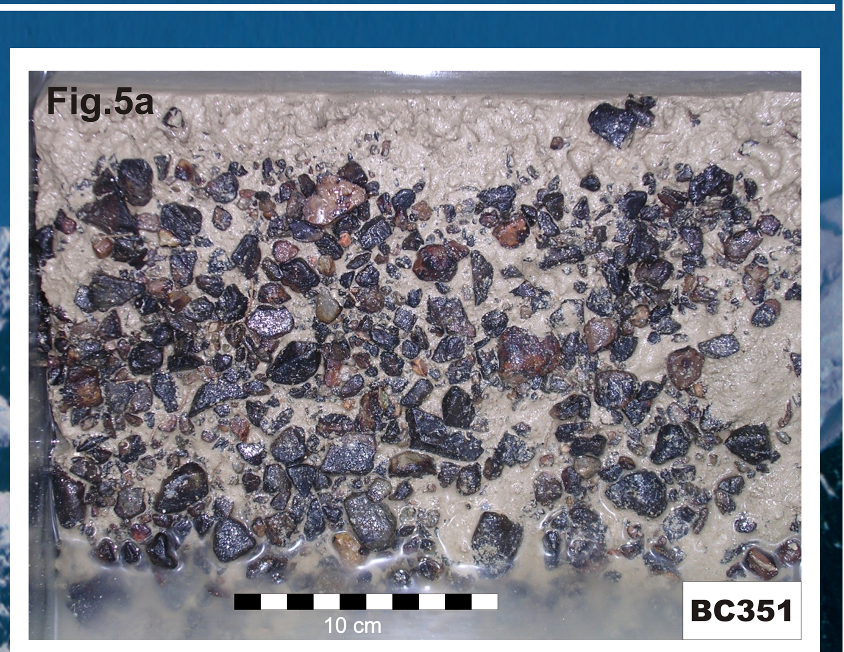
The phase of deglaciation

The diamictons are overlain by brown lithogenic sandy muds. Their grain-size composition and slight bioturbation point to a glaciomarine depositional environment with the dominance of lithogenic detritus suggesting a multiyear sea ice coverage (Figs. 2a-h). On the slope and rise, lamination and normal grading at the base of the sandy muds (Figs. 2a,b) document deposition by turbidity currents. The clay mineral assemblage of these distal turbidites is very similar to that of the underlying glaciogenic debris flows pointing to Ronne Entrance as a source area (Fig. 3). The deposition of the turbidites indicates a lower supply of glaciogenic debris from the shelf. The sandy muds on the shelf were likely deposited by settling from suspension in marine currents and/or in buoyant meltwater plumes originating from ice shelves located to the south. The up-core increase of smectite throughout the sandy mud unit at site PS2533 (Fig. 2c) documents the enhanced input of fine-grained lithogenic detritus originating in Ronne Entrance and thus further retreat of grounded ice draining through Belgica Trough (Fig. 3). Thus, the deposition of the sandy mud units in the southern Bellingshausen Sea can be attributed to a phase of grounding line retreat on the shelf.



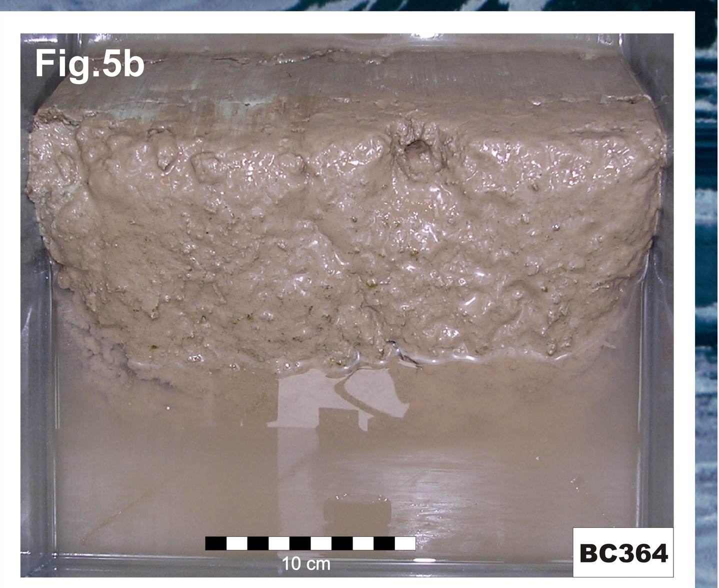






The present interglacial period

Deposition during the present interglacial is controlled by glaciomarine conditions with only seasonal sea-ice coverage, which is indicated by significant contents of microfossils and the activity of benthic organisms reflected by bioturbation (Figs. 2a-h). Surface sediments on the outer shelf, slope and rise consist of brown, bioturbated foraminifer-bearing muds and foraminiferal oozes with high concentrations of $CaCO_3$, whereas olive to brown, fine-grained diatomaceous muds were recovered from the inner shelf (Figs. 4a; 5). Apparently, repeated winnowing by currents associated with an oceanographic front (southern boundary of the Antarctic Circumpolar Current) is accumulating coarse-grained particles, such as foraminiferal tests and sand (Fig. 4a), on the outer shelf, slope and rise, thereby favouring the dissolution of siliceous tests by reducing sediment accumulation rates. This hypothesis is corroborated by the increase of radiocarbon ages of surface sediments with distance from the coast (Fig. 4a) and the abundance of dropstones coated with manganese (Fig. 5a). Clay minerals in the interglacial sediments on the outer shelf, slope and rise form a mixed assemblage, pointing to supply of detritus from Ronne Entrance and Eltanin Bay by marine currents and iceberg-rafting, with higher smectite contents suggesting delivery of detritus derived from volcanogenic rocks mainly exposed on western Alexander Island (Figs. 2b,c; 3; 4b). A slight enrichment of chlorite on the rise (Figs. 2a; 3; 4b) is caused by supply of fine-grained detritus from the mainland of the Antarctic Peninsula via a bottom current flowing westward along the base of the slope.



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