Prydz Bay sediment drifts: Archives of modifications in East Antarctic climatic and oceanographic conditions

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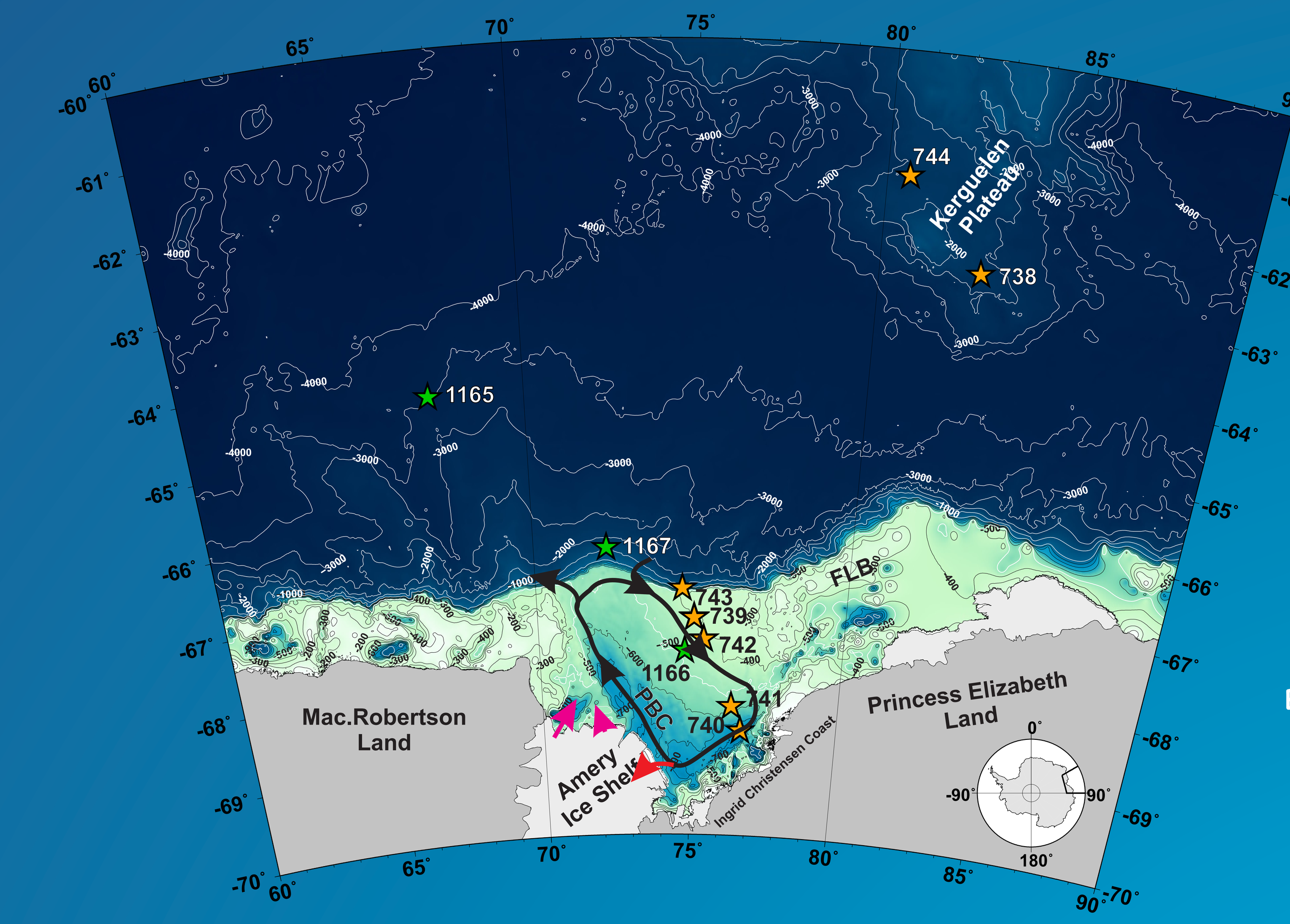
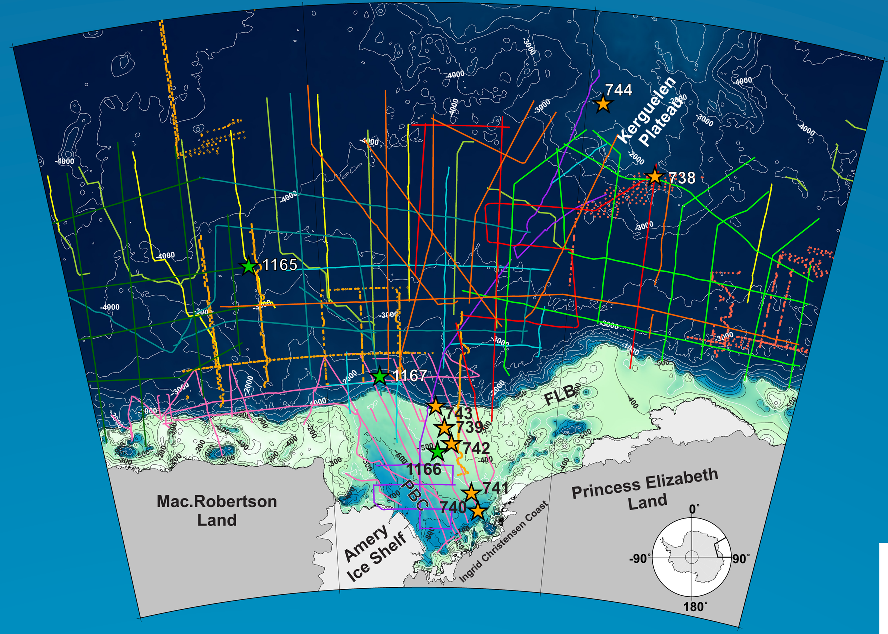
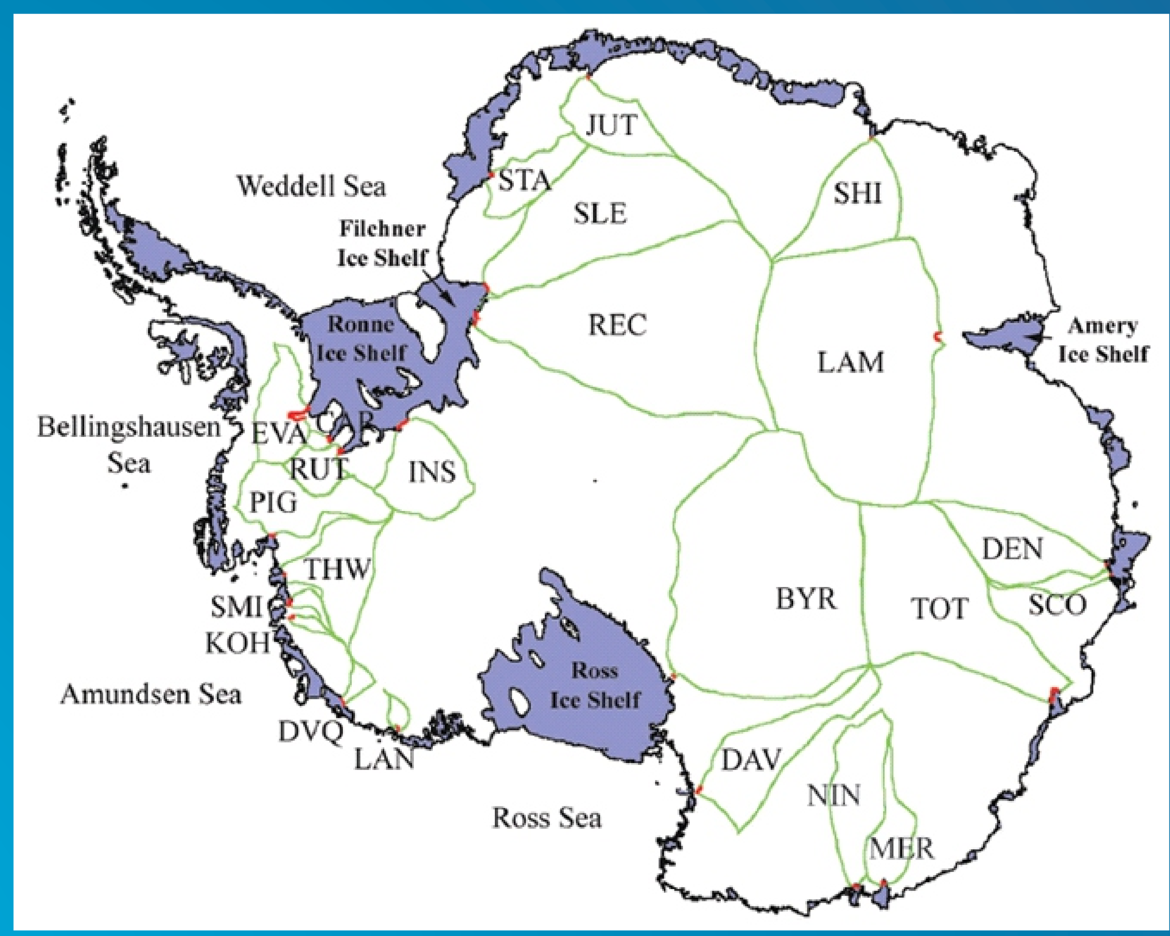
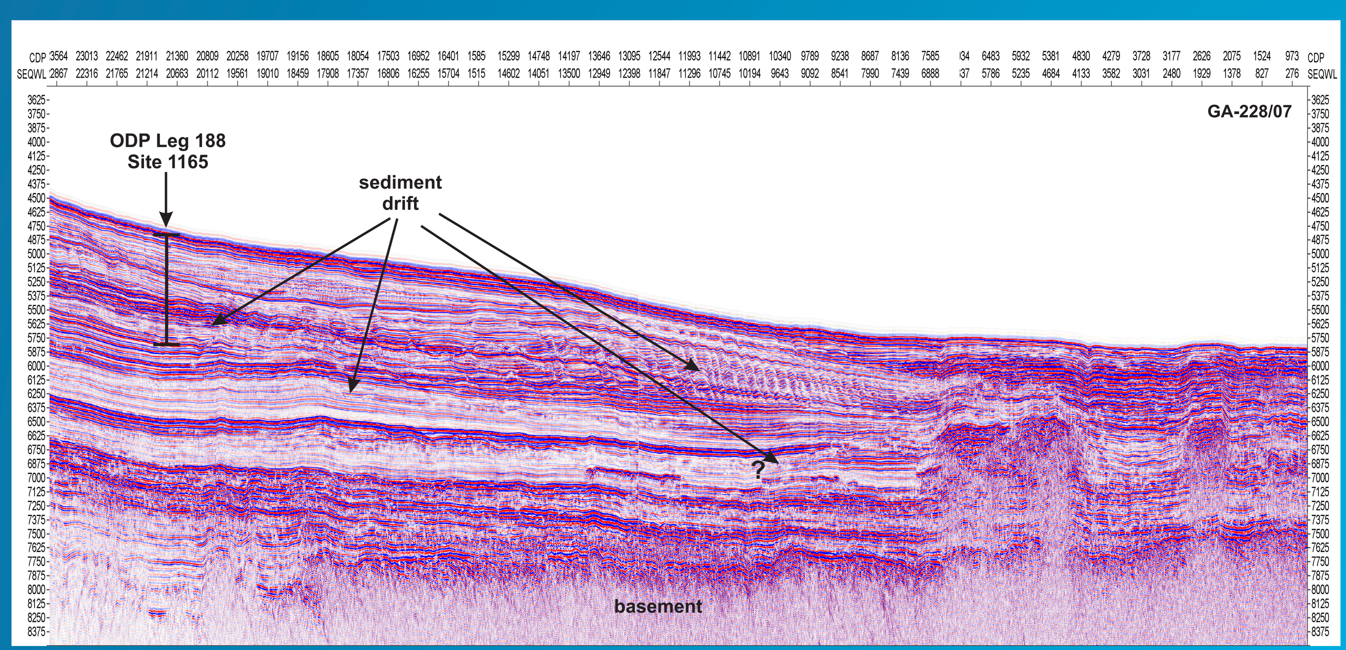




Bathymetric map of the Prydz Bay/Cooperation Sea (Arndt et al., 2013). Stars show the locations of ODP Leg 119 and 188 sites. Left panel: arrows= flow of modified Circumpolar Deepwater (mCDW) on shelf and under AIS. Right panel= coloured lines show the locations of the available seismic profiles. FLB= Four Ladies Bank, PBC= Prydz Bay Channel.

Antarctic glaciers and ice shelves with drainage basins outlined in green and ice shelves and floating tongues in blue (Rignot and Jacobs, 2002). The marine based Lambert Glacier (LAM) via the Amery Ice Shelf drains 14 % of the East Antarctic Ice Sheet into Prydz Bay and the Cooperation Sea, the marine based Pine Island Glacier (PIG) and the Thwaites Glacier (THW) drain part of the West Antarctic Ice Sheet into the Amundsen Sea.





Seismic profile crossing the location of ODP Leg 188 Site 1165. The site penetrated the sedimentary column up to early Miocene. Sediment drifts in older sedimentary sequences can be observed, which indicate bottom water activity prior to Miocene times.

A careful link of the available seismic data with geological information from ODP Leg 119 and Leg 188 drill sites via the computation of synthetic seismograms will allow the dating of prominent reflections, e.g., late Eocene at Site 1066, and a correlation with their origin (erosion, change in lithology, etc). Although recovery was low, e.g., 18.6 % at Site 1166, downhole logging data were collected at all sites and will thus allow a correlation with the seismic data. We will thus be able to map the distribution of sedimentary units and sedimentary features to identify sediment transport patterns and pathways and their modifications. This will provide insight into the early evolution and dynamics of the ice sheet in the Prydz Bay/Cooperation Sea area, which unfortunately is lacking from the ODP Leg 119 and Leg 188 drill cores.

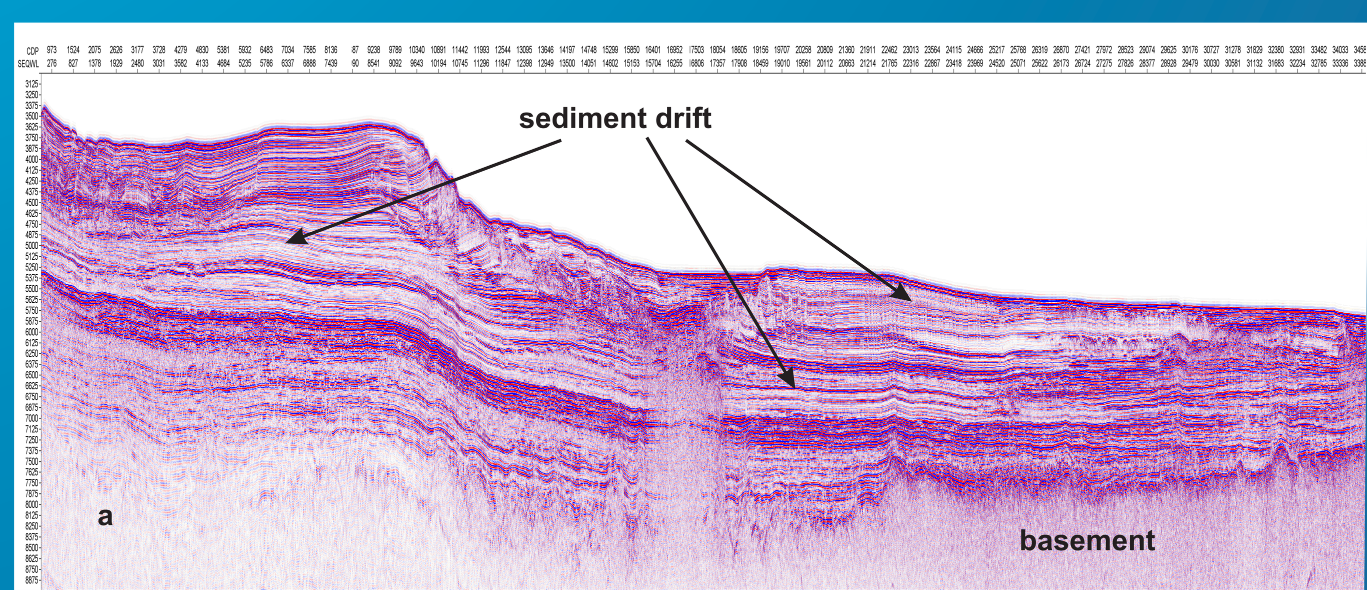
To answer those questions the seismic data available in the Prydz Bay/Cooperation Sea will be analysed with respect to horizon depth, distribution of sedimentary units, and sedimentary features such as sediment drifts and MTDs. Modifications in number of occurrence and location as well as orientation of sedimentary features will provide information on the prevailing sediment transport process: down-slope as the result of glacial erosion or along-slope due to bottom current activity.

The major objectives of the proposed research are to identify the prevailing currents active in the Prydz Bay area in the Paleogene, i.e. before onset of the major glaciation, to fill the information gap on the early Oligocene-early Miocene evolution of the ice sheet in the Prydz Bay area to identify the earliest traces of ice sheet and bottom water induced sediment transport, and to extend the Miocene-Quaternary drill information spatially to reconstruct the interplay of ice sheet dynamics and oceanic circulation in the Prydz Bay/Cooperation Sea area.

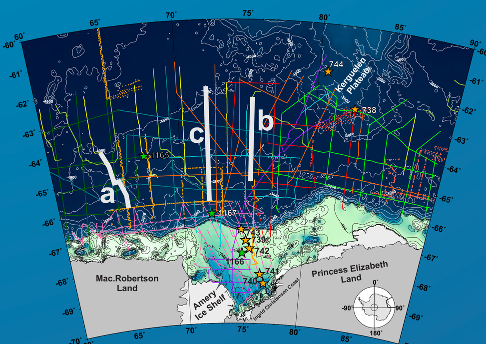
Hypothesis 1: While colder bottom water activity can be observed east of the Tasman gateway already in the Paleogene, warm water masses, and hence no bottom water, prevailed west of the gateway in the southern Indian Ocean prior to the Eocene-Oligocene boundary.

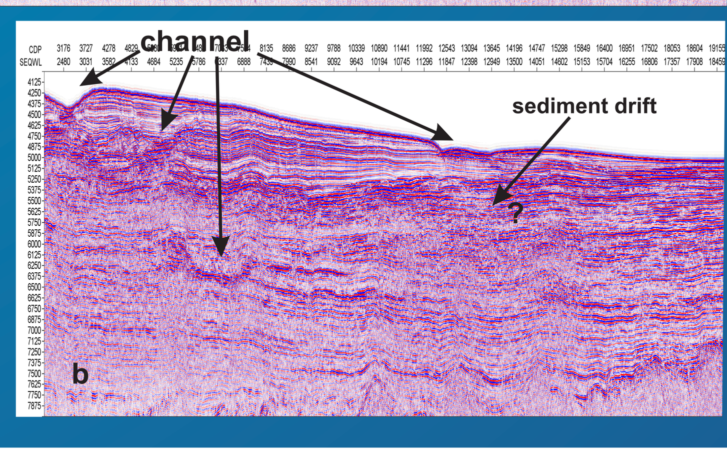
Hypothesis 2: Following the opening of the Tasman Gateway, Prydz Bay and the Cooperation Sea show the same interplay between ice dynamics and oceanic circulation as the Amundsen Sea.

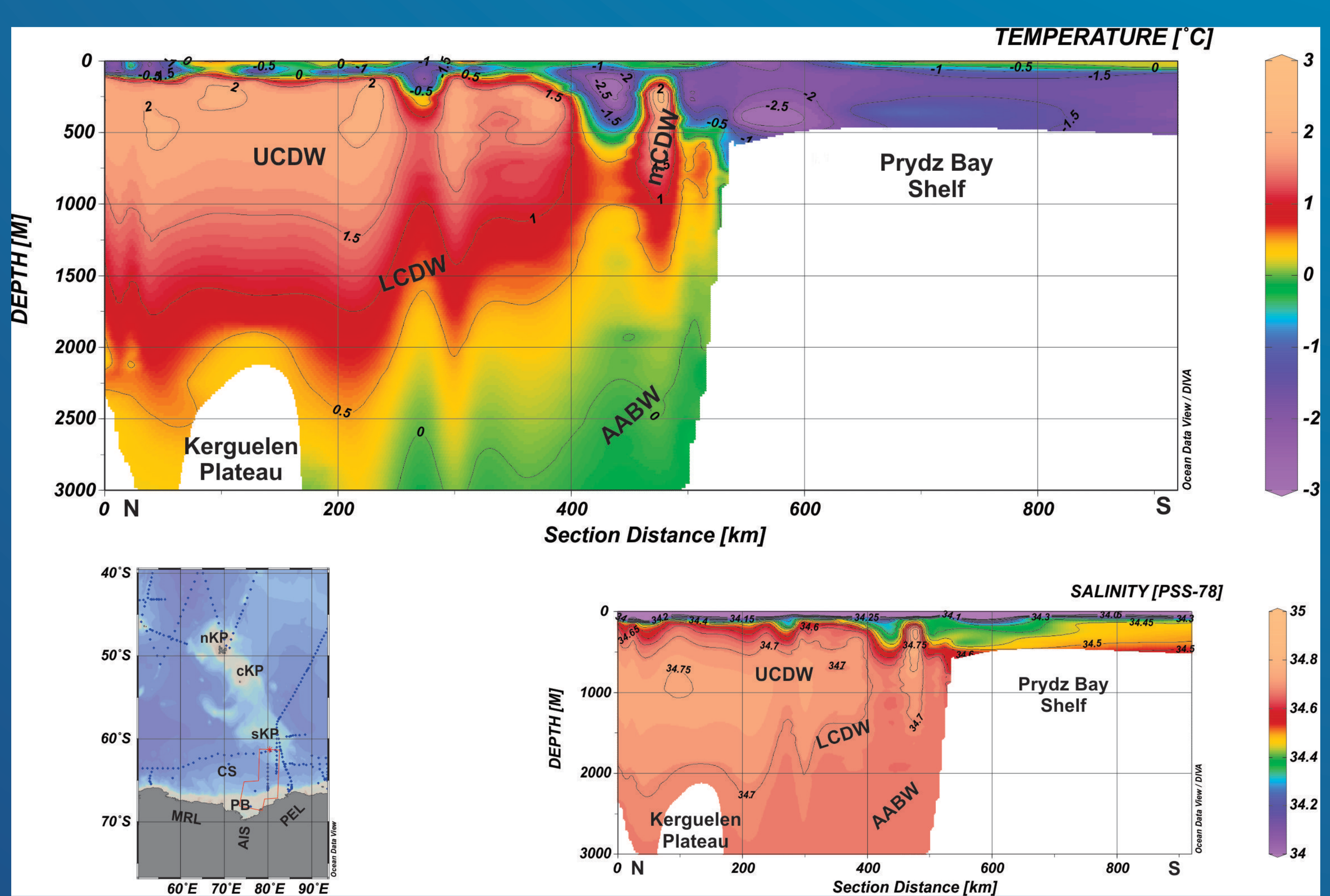
- If the Lambert Glacier-Amery Ice Sheet today shows a similar behaviour as the Pine Island/Thwaites Glacier system in the Amundsen Sea, is this also true for the development during the Miocene with the warming phase of the Mid Miocene Climatic Optimum (MMCO, 17-15 Ma) and the following cooling during the Mid Miocene Climatic Transition (MMCT, 14.8-12.9 Ma)?
- Did the LG-AIS show increased melting during the Mid Pliocene Warm Phase (MPWP, 3.3-3.0 Ma), which is documented in increased down-slope material input?
- Do the seismic data show increased material input for the early Oligocene in form of thicker depocentres, which are oriented parallel to the shelf break and extend farther northwards?
- Can we then identify a takeover of current-controlled sedimentation during the late Oligocene, when the climate became warmer and the ice sheet supposedly retreated?
- In comparison to the Amundsen Sea, can we identify a corresponding series of predominantly down-slope or along-slope sediment transport as the result of ice advances or strong oceanic circulation for the Eocene to recent time periods? How much material was input from the continent during periods of ice advance?

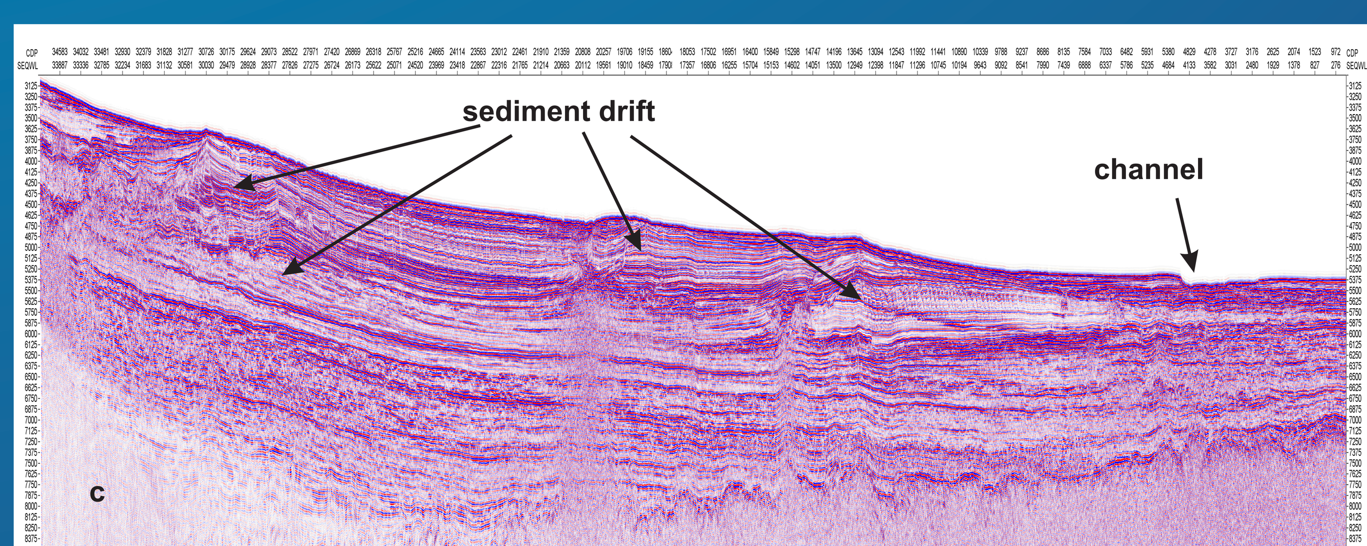


Examples for seismic lines collected at the Prydz Bay margin imaging deposits of ice sheet induced down-slope (MTDs, channels) and current induced along-slope (sediment drifts) sediment transport.









Oceanographic profile (Temperature, Salinity) from Prydz Bay northwards across Cooperation Sea onto the southern Kerguelen Plateau (red box in map) showing the active water masses Antarctic Bottomwater (AABW), Lower (LCDW), Upper (UCDW), and modified (mCDW) Circumpolar Deepwater. AIS= Amery-Ice Shelf, CS= Cooperation Sea, MRL= Mac.Roberston Land, PB= Prydz Bay, PEL= Princess Elizabeth Land, n/c/sKP= northern/central/southern Kerguelen Plateau.

References

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