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Subglacial processes of an Antarctic palaeo-ice stream

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Break-up of ice shelves along the eastern coast of the Antarctic Peninsula in the last 10-20 years has given access to the seafloor and underlying sediments. To interpret varying bed conditions below ice grounded on the shelf NE of the Antarctic Peninsula during the last glacial period and during subsequent ice sheet retreat, multibeam bathymetric data, sub-bottom profiler (TOPAS/3.5 kHz) data and sediment cores were analysed. Highly attenuated bedforms at the surface of an acoustically transparent layer (ATL) were observed in several cross-shelf troughs indicating that the Antarctic Peninsula Ice Sheet was drained by ice streams flowing towards the shelf break. Micromorphological analysis of a soft and stiff diamict recovered in sediment cores from the troughs shows closely associated poly-deformational structures indicating a subglacial origin (tills). The ATL is most widespread and thickest on the outer shelf and is formed by saturated, low shear strength sedimentary units including sub-ice shelf diamictons and the soft till recovered in the cores from the troughs. A prominent reflector at the base of the ATL indicates the surface of a stiff till. Increased porewater pressure and saturation of the surface of the stiff till led to its mobilisation and deformation into a soft till layer facilitating rapid ice flow. Near to the crystalline to sedimentary substrate boundary on the inner shelf, localised areas of the sea floor without an ATL may indicate parts of the palaeo-ice sheet bed where stiff till was either not mobilized or mobilized only in a thin soft till layer (<0.4 m), and basal sliding occurred. The high spatial variability of basal processes between and within troughs is also indicated by patches of deforming sediment along with more stable areas of the bed, similar to the bed mosaic model of conditions observed under contemporary ice streams.