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Sedimentary architecture of the Amundsen Sea Embayment shelf, West Antarctica, from pre-glacial to glacial processes

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Studies of the sedimentary architecture and characteristics of Antarctic shelves provide clues of past ice sheet advance-retreat cycles and help improve constraints for paleo-ice dynamic models since early glacial periods. A first seismostratigraphic analysis of the Amundsen Sea Embayment shelf and slope of West Antarctica reveals insights into the structural architecture of the continental margin and shows stages of sediment deposition, erosion and transport history from pre-glacial times to early glaciation and to the most recent glacial periods. The shelf geometry consists of a large pre- and syn-rift basin in the middle shelf region between outcropping basement of the inner shelf and basement ridges and highs beneath the outer shelf. A middle shelf sub-basin exists which may have formed as a result of motion along an early West Antarctic Rift System branch. At least 4 km of pre-glacial strata has been eroded from the present inner shelf and coastal hinterland by ice sheet advances since the onset of glaciation. Some of the eroded sediments were deposited as a progradational wedge extending the outer shelf by 25 to 65 km oceanward of the pre-glacial shelf-break. Comparing the observed seismic characteristics with those of other Antarctic shelf sequences, we assign an Early Cretaceous age for bottom sedimentary unit ASS-1, a Late Cretaceous to Oligocene age for unit ASS-2, an Early to Mid-Miocene age for unit ASS-3, a Mid-Miocene age for unit ASS-4, a Late Miocene to Early Pliocene age for unit ASS-5, and a Pliocene to Pleistocene age for the top unit ASS-6. The survival of buried grounding zone wedges in the upper part of unit ASS-5 of the outer shelf is consistent with the onset of a long warming phase and a retreated ice sheet in the early Pliocene as observed for the Ross Sea shelf and reconstructed from paleo-ice sheet models. Our data also reveal that the paleo-ice flow paths of the central Pine Island Trough system have remained stationary across the middle and outer shelf since early glacial advances. This study and its stratigraphic constraints will serve as a basis for future drilling operations required for an improved understanding of processes and mechanisms leading to West Antarctic Ice Sheet retreats, such as the rapid ice retreat presently observed in the Amundsen Sea Embayment.