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Pliocene glacial cyclicity in deep-sea sediment drifts (Antarctic Peninsula Pacific Margin)

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Giant deep-sea sediment drifts are widespread features along the continental rise of the West Antarctic Peninsula. Such drift bodies are the most proximal continuous sedimentary recorders for West Antarctic ice events and glacial cyclicity. Sedimentary descriptions, geochemical and geophysical data derived from ODP Leg 178 Site 1095 (Sediment Drift 7) show characteristics of glacial cyclicity and associated sedimentary processes during the Early Pliocene. By defining the transitions from interglacial-to-glacial and glacial-to-interglacial intervals it was possible to correlate proxy data to glacial stages and to compare sedimentation processes against the background of climatic conditions along the Pacific margin of the Antarctic Peninsula. Despite high turbidite frequencies in Early Pliocene glacials we observed almost balanced glacial/interglacial interval lengths. Compared to the Late Quaternary the relative glacial sedimentation rates seem to be significantly reduced. So far, turbidite events and their frequencies have been directly correlated with grounded shelf ice extending to the continental shelf edge and the termination of IRD events has been linked to sea-ice coverage. However, continuos high opal contents in the Early Pliocene, with values corresponding to those determined for isotope stages 5 and 7, indicate that a permanent sea-ice cover occurred neither in glacial nor interglacial intervals. Late Quaternary glacial/interglacial opal mass fluxes are balanced in magnitude indicating a terrigenous dilution effect during glacials. In contrast, during the Early Pliocene the glacial/interglacial opal flux ratio is two to one, despite the addition of terrigenous shelf input during glacials. Disregarding the largely mass neutral lateral re-deposition, the high opal fluxes within the turbiditic glacials indicate an addition

of transported biogenic opal. This opal addition is most obvious in turbidites close to the glacial/interglacial transition that exhibit no magnetic signature. The steep West Antarctic Peninsula slopes with their small pelagic net accumulation areas are an unlikely source for vast opal masses. Hence, in the Early Pliocene the shelf itself acted as a major opal source and was not permanently ice covered, even during full glacial conditions. Further aspects emphasize the idea of a largely ice free Early Pliocene shelf. Dry-based shelf ice extending to the shelf edge would lead to a significant increase in glacial sedimentation rates. Correspondingly high sedimentation rates for glacial isotope stages 2-4 and 6 are known for the Quaternary but have not been found in the Early Pliocene intervals. If dry-based shelf ice did not reach the shelf edge during glacials, turbidite free conditions similar to those in interglacial phases could be expected, since the landward dipping shelf would prohibit slope loading. In contrast, wet-based shelf ice at the shelf edge, characterized by active meltwater plume release, would supply massive mud flows and large fans of coarse-fraction material. We conclude that other mechanisms than advancing shelf ice to the shelf edge have been responsible for slope loading resulting in frequent Pliocene turbidites. Even if shelf ice might have been located on the landward dipping inner shelf during glacial intervals, the particle-loaded base can produce large amounts of meltwater, which, in turn, can be transported by an intensified current system through old glacial channels to the slope. A current system such as this could, for example, be driven by katabatic winds. In this manner, the slope will be loaded with relatively fine and well-sorted terrigenous material, which, in turn, would lead to increased levels of slope failure. These increased levels of slope failure are reflected in high levels of turbidite frequencies. The fine fraction of sediment deposited on the drift is not necessarily different from sediments deposited by Quaternary turbidites, since only the silt fraction is deposited by overspill mechanisms on the distal portions of the drift. Concluding we favor the existence of a significantly reduced Early Pliocene West Antarctic ice sheet, with wet-based shelf ice which for most of the time did not extend to the shelf edge.