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Early to mid-Miocene palaeoclimate of Antarctica based on terrestrial records

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Paleontological and stratigraphic studies of sites in the Transantarctic Mountains (TAM) are advancing knowledge of the landscape, vegetation and climate that existed immediately before the growth of the modern East Antarctic Ice Sheet. The sites are located in the Friis Hills and the western Olympus Range in the McMurdo Dry Valleys. In both localities, parts of ancient landscapes are preserved on upland surfaces high above modern valley floors. The early to mid-Miocene interval is bracketed by 40Ar/39Ar ages on volcanic ashes of 19.76 $\pm$ 0.11 Ma to 13.85 $\pm$ 0.03 Ma. Like all glacial records it is discontinuous but even so several trends can be detected. The record is one of an evolving glacial system during which ice caps coalesced to form an ice sheet. Initially, small alpine glaciers flowed southwestward toward the continental interior eroding shallow troughs into granitic bedrock. By the close of the interval, large glaciers flowed eastward from the continental interior to the Ross Sea. The interval was marked by numerous glacial advances and retreats. Tills are matrix-rich, and outwash sands and gravels ripple-laminated and cross-bedded, typical of those associated with wet-based glaciation. The vegetation during the interval was in a dynamic flux retreating downslope during glacial advances and recolonizing valleys after retreats. Fossils accumulated in peat beds and organic silts representing lacustrine, fluvial and paludal environments. Fossils include diatoms, fungal ascomycetes, pollen and spores, lycopod megaspores, mosses, wood and leaves of Nothofagus (southern beech), fruits of vascular plants, and insect skeletal parts of Diptera (flies) and Coleoptera (beetles). The vegetation was a tundra, initially shrub- and later moss-dominated. During the interval there was a marked decline in biodiversity. Initially, there were 4 species of Nothofagus represented by different leaf types and at least 9 species of vascular plants by their seeds. At the close of the interval neither Nothofagus fossils nor seeds of vascular plants occur in the fossil assemblages which are bryophyte- and lycopod- dominated. During the interval, mean summer temperatures (Nov. – Jan.) are estimated to have declined from about 8° to 4° C. Precipitation during the interval was also likely over 1000 mm.

In general, the terrestrial record is in agreement with the dynamic record of glacial advances and retreats described from the ANDRILL 2A shallow marine core. In the larger picture of Antarctic glaciation, however, it is difficult to reconcile the terrestrial record from the McMurdo Dry Valleys with interpretations from Oligocene and early Miocene marine isotopic and modeling studies which indicate Antarctic ice volumes 125% of those of modern values. Interpretations show the Oligocene and early Miocene ice sheet overriding the TAM. To the contrary, the early Miocene glacial record in the TAM indicates no large ice sheet in the interior. Instead, the record begins with alpine glaciers flowing towards the interior. This suggests that the Oligocene ice sheet had a lower profile and different aerial configuration than modeling currently suggests. Research supported by NSF grant no. 0739693.