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A 14.5 million-year geologic record of East Antarctic Ice Sheet fluctuations in the central Transantarctic Mountains, constrained with multiple cosmogenic nuclides

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The distribution of relict moraines in the Transantarctic Mountains affords geologic constraint of past ice-marginal positions of the East Antarctic Ice Sheet (EAIS). We describe the directly dated glacial-geologic record from Roberts Massif, an ice-free area in the central Transantarctic Mountains, to provide a comprehensive record of ice sheet change at this site since the Miocene and to capture ice sheet response to warmer-than-present climate conditions. The record is constrained by cosmogenic ^{3}He, ^{10}Be, ^{21}Ne, and ^{26}Al surface-exposure ages from > 160 dolerite and sandstone erratics on well-preserved moraines and drift units. Our data set indicates that a cold-based EAIS was present, and similar to its current configuration, for long periods over the last ~14.5 Myr, including the mid-Miocene, Late Pliocene, and early-to-mid Pleistocene, with moraine ages increasing with distance from and elevation above the modern ice margin. We also report extremely low erosion rates over the duration of our record, reflecting long-term polar desert conditions at Roberts Massif. The age-elevation distribution of moraines at Roberts Massif is consistent with a persistent EAIS extent during glacial maxima, accompanied by slow, isostatic uplift of the massif due to subglacial erosion. Although our data are not a direct measure of ice volume, the Roberts Massif glacial record indicates that the EAIS was present and of similar extent to today during periods when global temperature was believed to be warmer and/or atmospheric CO_2 concentrations were likely higher than today.