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Cenozoic landscape evolution in Terra Nova Bay region: new evidence from multiple cosmogenic nuclides

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Geomorphological surveys and cosmogenic nuclide analysis allow us to reconstruct the chronology of pre-LGM variations of the East Antarctic Ice Sheet (EAIS) and valley glaciers. In the Terra Nova Bay region, relict glacial features, such as glacially-scoured mountain tops and erratic fields are well preserved. The combination of noble gas (21Ne), and radionuclides (10Be and 26Al) are well suited to unravel the chronology of these glacial landforms.

Exposure ages based on 10Be, 26Al and 21Ne data from weathered bedrock from the highest rounded summits of the coastal area (Mt. Abbott, Mt. Keinath and Mt. Crummer) demonstrate that they have been free of ice since at least 6 Ma (Northern Foothills and Boomerang Glacier area) and 4 Ma (Larsen Glacier area). This implies that glacially-scoured coastal piedmonts represent relict features that have not been overridden by erosive ice since at least the Pliocene. A similar scenario can be deduced from an inland area (60 km from the coast), located at the margin of the polar plateau (Mt. Pollock and the Archaumbault Ridge). Our data set strongly indicates a continuous exposure history for the relict alpine morphology, which is shown to be older than 6 to 7.5 Ma. In addition, denudation rates inferred by our data show that erosion of granite summits has been negligible. Erosion rates, ranging from 11 to 24 cm/Myr in the coastal area and below 9 cm/Myr further inland, indicate long lasting cold and hyperarid climate conditions.

The combination of stable and radionuclide isotopes document complex exposure histories of the glacial drifts preserved in the coastal area. They allow us to identify different glacial phases which cannot be documented by geomorphic and glacial geologic evidence alone. Erratic boulders from 390 to 675 m asl, which are below the rounded summits of the coastal pedimonts and above the late-Pleistocene glacial drift preserved up to 350 m asl, yield variable exposure ages of 90 to 700 ka. This documents several glacial fluctuations, confirming the hypothesis that these complex drifts have been deposited by different glaciations. 21Ne ages are always older than 10Be and 26Al ages, indicating substantial periods of burial combined with minimal erosion. The coastal area of Terra Nova Bay has been repeatedly exposed and buried by expanding ice bodies. The overriding ice did not erode a sufficient thickness of rock surface to completely remove the cosmogenic nuclide inventory accumulated during previous exposure periods.

Our results demonstrate that a multiple nuclide approach, together with careful field observations, is necessary to study the glacial history of Antarctica, where cold and hyper-arid conditions dominate erosion, and the behaviour of cold-based glaciers controls depositional processes.