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Thermochronology as a key to deciphering controls on landscape evolution in northern Victoria Land (Transantarctic Mountains)

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Northern Victoria Land constitutes the Pacific terminus of the Transantarctic Mountains (TAM) on the western shoulder of the Cenozoic West Antarctic Rift System. It is characterised by a distinct morphological transition from an elevated peneplain that dominates throughout most of the TAM to a strongly undulating relief with prominent narrow crests and alpine peaks. This contrast is associated with a lithological change from high-grade metamorphics and granitoids to low-grade metasedimentary rocks that contain only few scattered igneous bodies.

New high-resolution thermochronological data (fission-track and (U-Th-Sm)/He) from more than 60 locations in the Southern Cross Mountains and Mountaineer Range of northern Victoria Land provide the basis for studying regional exhumation and uplift with particular focus on the establishment of landscape contrasts. In an integrated approach, differences in topography are examined with respect to regional and local controls including tectonics, lithology and climate to identify differential trends and quantify the morphological evolution of the TAM and West Antarctic Rift System.

Two coastal profiles covering 2 to 3 km in elevation reveal apatite fission track ages from 23 to 45 Ma with mean track lengths of 13.3 – 14.7 µm. Corresponding (U-Th-Sm)/He apatite and zircon data range between 19 – 32 Ma and 24 – 27 Ma, respectively. The dates show distinctive spatial trends of increasing ages from north to south and at greater distance to the coast whereby younger cooling ages correlate with stronger terrain segmentation and higher topographic relief.

Thermal history modelling of the combined data indicates that accelerated cooling commencing at 35 Ma proceeded at progressively higher rates reaching >25°C/Ma in late stages. This cooling episode continued until at least 20 Ma and refers to exhumation from burial depths of more than 5 km, clearly exceeding the calculated overburden on adjacent crustal blocks to the south. Although rapid upper lithospheric cooling is a generic feature of northern Victoria Land, the

current data demonstrates that Cenozoic exhumation dynamics were highly differential. Understanding these patterns requires thorough balancing of structural against isostatic factors, lithological against climate parameters and focussed local incision against large-scale denudation and levelling processes.