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The regional thermochronological record as evaluation criterion for uplift models of the Transantarctic Mountains

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The Transantarctic Mountains represent the exposed shoulder of the Cenozoic West Antarctic Rift System. Their uplift has been explained by various models that can be divided into three general groups: thermally driven uplift, mechanically driven uplift (and the combination of these two), or topographic reversal due to the collapse of a Mesozoic West Antarctic plateau. These models usually rely on geophysical evidence and numerical experiments, but not all of them are supported equally by field observation, structural geology, and thermochronological data. Conversely, each of the general uplift mechanisms produces a characteristic range of potential thermal histories for different crustal levels, stratigraphic positions and segments of the Transantarctic Mountains. Accordingly, thermal history modelling of existing thermochronological data and the generation of synthetic data sets are useful tools to evaluate and refine uplift models.

The thermochronological record of the Transantarctic Mountains comprises more than 500 apatite fission track ages between $\sim$25 and $\sim$350 Ma and associated proxies, and a few apatite (U-Th)/He ages that are usually 10-20 Ma younger than corresponding fission track ages (43 – 92 Ma). So far, most published thermochronological data were interpreted qualitatively, while thermal history modelling has hardly been conducted yet. First systematic inverse thermal history modelling of representative vertical profiles from basement rocks beneath $\sim$180 Ma Ferrar volcanoclastics in the Terra Nova Bay region rely on a well-established thermal frame. The model suite reveals that the Jurassic surface was heated to temperatures of 60° – 100°C before cooling again to surface temperatures in late Paleogene times. The analogy of the geological setting between Scott Glacier and northern Victoria Land suggests that the Transantarctic Mountains experienced a rather homogenous geological history and landscape development along its entire length. The region was dominated by Mesozoic subsidence and basin evolution including Ferrar magmatic event at $\sim$180 Ma. Rapid Neogene basin inversion was then compensated isostatically and triggered uplift of the present mountain chain.

A complementary approach consists on the generation of synthetic apatite fission track data sets modelled directly from potential individual low-temperature histories and their comparison with the factual thermochronological record of the Transantarctic Mountains. The match of modelled and observed data as well as inverse thermal history models and supplemental geological observation clearly exclude the existence of a Mesozoic highland plateau in the western Ross Sea and would not relate the uplift of the Transantarctic Mountains to mainly thermal processes. Instead, mechanically driven uplift appears the main cause of regional uplift in the Ross Sea sector.