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Exhumation signals and forcing mechanisms in the Southern Patagonian Andes (Torres del Paine and Fitz Roy plutonic complexes)

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Late Miocene calc-alkaline intrusions in the back-arc of Southern Patagonia mark an eastward migration of the arc due to accelerated subduction velocity of the Nazca plate or slab flattening preceding active ridge subduction. Amongst these intrusions are the emblematic Torres del Paine (51°S) and Fitz Roy (49°S) plutonic complexes, crystalised at ca. 12.5 and ca. 16.5 Ma, respectively (Leuthold et al., 2012; Ramírez de Arellano et al., 2012). Both intrusions are located at the eastern boundary of the Southern Patagonian Icefield and form prominent peaks with steep slopes that are ~3 km higher in elevation than the surrounding low-relief foreland. Their exhumation has been proposed as a response to glacial erosion and associated glacial rebound since ca. 7 Ma (Fosdick et al., 2013), and/or by regional dynamic uplift between 14 and 6 Ma due to the northward migration of subducting spreading ridges (Guillaume et al., 2009). Here we present a new data set of apatite and zircon (U-Th)/He from both plutonic complexes, numerically modelled to unravel their late-Neogene to Quaternary thermal histories. Our results show three rapid cooling periods for the Fitz Roy intrusion: at ca. 9.5 Ma, at ca. 7.5 Ma, and since ca. 1 Ma. For Torres del Paine, inverse thermal modelling reveals short and rapid cooling at ca. 6.5 Ma followed by late-Quaternary final cooling. The 10 Ma cooling signal only evidenced in the northern plutonic complex (Fitz Roy) may represent an exhumation response to the northward migrating subduction of spreading ridge segments, causing localized dynamic uplift. Thus, the absence of exhumation signal before 6.5 Ma in the southern part (Torres del Paine) suggest that the spreading ridge

subduction must have occurred before its 12.5 Ma emplacement. On the other hand, rapid cooling by similar magnitude in both plutonic complexes between ca. 7.5–6.5 Ma, likely reflects the onset of late-Cenozoic glaciations in Southern Patagonia. Finally, the late-stage Quaternary cooling signals differ between Torres del Paine and Fitz Roy, likely highlighting different exhumation responses (*i.e.* relief development vs. uniform exhumation) to mid-Pleistocene climate cooling. We thus identify and distinguish the causes of rapid exhumation periods in the Southern Patagonian Andes, and propose a first Late Miocene exhumation pulse due to subduction of spreading ridge dynamics, and two Late Cenozoic exhumation episodes due to regional climate changes that have shaped alpine landscapes in this region.

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