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Using glacial morphology to constrain the impact of the Chile active spreading ridge subduction in Central Patagonia

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The Central Patagonian Cordillera is a unique laboratory to study interaction between oceanic and continental lithospheres during the subduction of an active spreading ridge beneath a continent. The subduction of the South Chile spreading Ridge, which separates the Nazca plate from the Antarctic plate, started ca. 15-14 Ma at the southern tip of Patagonia (55°S latitude). The northwards migration of the Chile Triple Junction induces the subduction of several segments especially around 46°S latitude. There, three segments subducted at ca. 6, 3 and 0.3 Ma, leading to the formation of a large asthenospheric slab-window beneath Central Patagonia.
Contemporaneously, the Central Patagonia reliefs are undergoing major glacial events since at least 7 Ma. These events are evidenced to the east of the Central Patagonian morphotectonic front within perched relict surfaces. Inset in these perched glacial surfaces are found mid-Pleistocene glacial valleys, as the Lake General Carrera-Buenos Aires amphitheatre (LGCBA), which formed between 1.1 Ma and 16 ka.
We used the relationships between the glacial valleys and the volcanism associated with the asthenospheric slab-window to better constraints the structural evolution of the Patagonian Cordillera related to the subduction of the Chili active spreading Ridge. The present work focused within two well-preserved perched flat surfaces named Meseta del Lago Buenos Aires and Meseta del Cerro Galera:
(i) The meseta del Lago Buenos Aires defines a plateau made of interbedded units of tills and lavas dated between 12 Ma and 3 Ma. The top surface of the meseta, ∼2000 meters high is dated at 3 Ma, and is shaped by four NE-SW trending glacial lobes characterized with kettles, lineations and moraines. The glacial valleys are beheaded westwards and define perched valleys 200 to 400 meters higher than the western Cordillera. This suggests recent vertical movement along N160 extensive/transtensive corridor located between the morphotectonic front and the western side of the meseta del Lago Buenos Aires.
(ii) Further north, the meseta del Cerro Galera exhibits a sequence of more than 200 m thick tills and fluvio-glacial deposits which top of is at 1500 m. This perched sequence shows accumulation of polygenic material, which sources are situated 100 to 150 km westwards. The glacial sequence of Cerro Galera is situated more than 1000 meters above the tectonic-controlled depression of Coihaique where younger (Pleistocene) glacial deposits have been identified. As observed along the western margin of the Meseta del Lago Buenos Aires, the till is presently disconnected from any former glacial morphology to the west. This feature can be attribute to a major fault zone west to the meseta del Cerro Galera.
In summary, we demonstrate that the location of pre-Quaternary glacial markers found as preserved on perched relict surfaces at around 1500-2000 meters whereas the location of Quaternary glacial deposits are 1000 meters below within the present-day glacial valleys suggest a drastic change in the glacial drainage network of the Central Patagonia. This change can be attributed to the extensional/transtensional tectonics responsible for the formation of transverse depressions and oblique tectonic corridors, which occurred between 3 Ma and 1 Ma. Geodynamically, this recent phase has been closely related with the subduction of the South Chile Ridge. The development of a large slab window beneath the Central Patagonian Cordillera since 3 Ma allowed hot mantle to reach sub-lithospheric regions, producing a weakening of the crust triggering in turn localized collapse.