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# Chilean flat-slab subduction controlled by overriding plate thickness and trench roll-back

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**Abstract** How flat slab geometries are generated has been long debated. It has been suggested that trenchward motion of thick cratons in some areas of South and Cenozoic North America progressively closed the asthenospheric wedge and induced flat subduction (Fig. 1). Here we develop time-dependent numerical experiments to explore how trenchward motion of thick cratons may result in flat subduction. We find that as the craton approaches the trench and the wedge closes two opposite phenomena control slab geometry: the suction between ocean and continent increases, favoring slab flattening, while the mantle confined within the closing wedge dynamically pushes the slab backward and steepens it. We model the last 30 Myr of subduction in the Chilean flat slab area and demonstrate that trenchward motion of thick lithosphere, 200–300 km, presently $\sim$ 700–800 km away from the trench, reproduces a slab geometry that fits the stress pattern, seismicity distribution [1] and temporal and spatial evolution of deformation and volcanism in the region [2] (Fig. 2). Additionally, we suggest that varying trench kinematics may explain some differing subduction geometries along South America (Fig. 3). When the trench is stationary or advances, the mantle flow within the closing wedge strongly pushes the slab backward and steepens it, potentially explaining the absence of flat subduction in the Bolivian orocline.

## References

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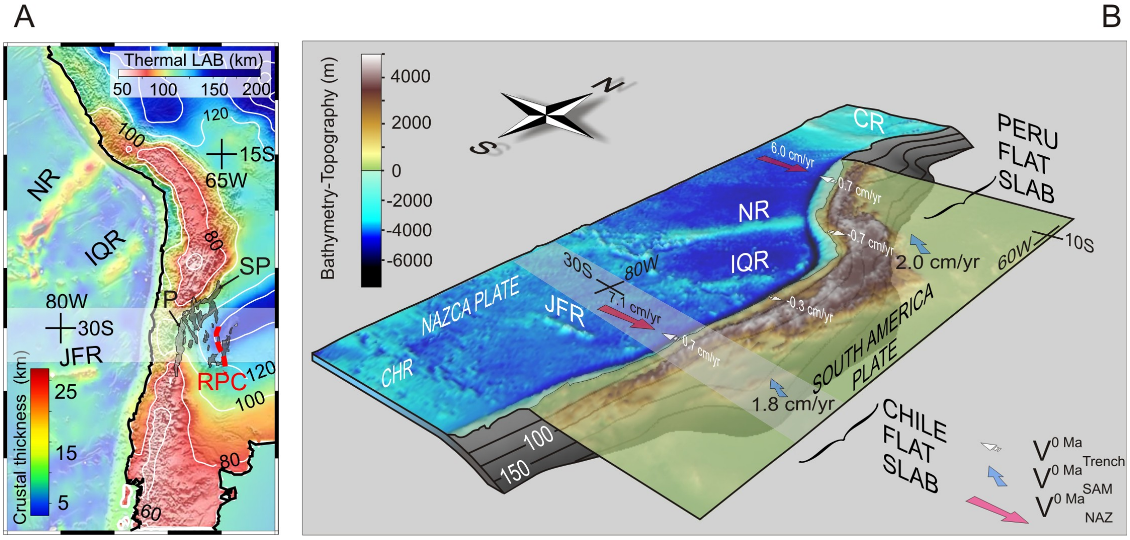

Figure 1: Relationship between observables and subduction style along the Andean subduction zone. A, Onshore – thermal lithosphere-asthenosphere boundary (LAB), defined as the depth to the 1300 °C [3], where the areas of flat subduction correspond with thick continental lithosphere. RPC: Rio de la Plata craton. SP: Sierras Pampeanas are shown in dark gray, P: Precordillera in light gray. Offshore – oceanic crustal elastic thickness derived from gravity modeling [3]. IQR – Iquique Ridge, JFR – Juan Fernandez Ridge, NR – Nazca Ridge B, 3-D view of the Nazca and South American plates showing contours of the depth in kilometres to the Wadati-Benioff zone. Red, blue and white arrows are the present plate velocities along the trench and of the Nazca, and South American plates in the Indo-Atlantic hotspot reference frame. East-West transparent bar shows the modeled area. CR-Carnegie Ridge, CHR-Chile Ridge.

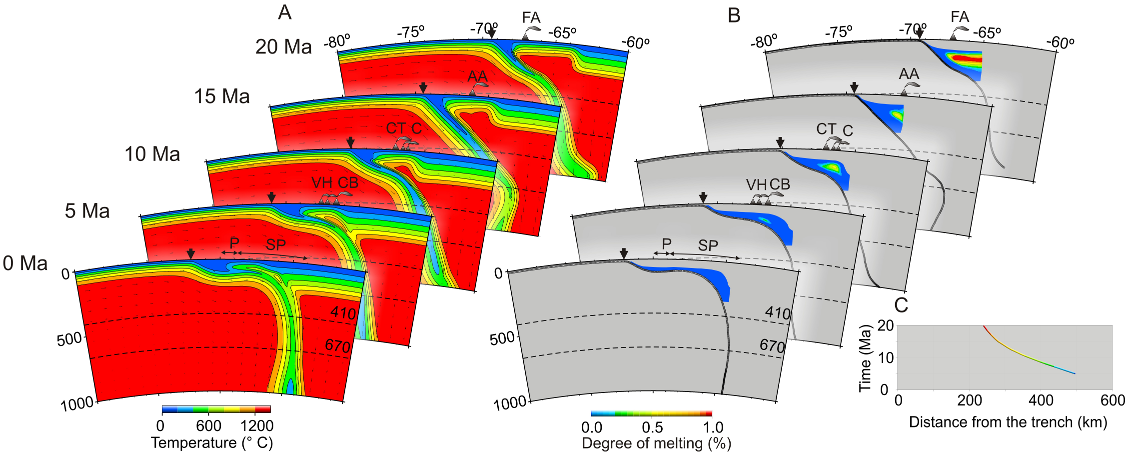

Figure 2: Evolution since early Miocene of, A: the temperature field, B: the degree of melting in the mantle wedge, and C: the distance from the trench to the surface projection of the maximum mantle wedge melting for our best fitting model. FA - Farellones Arc, AA- Aconcagua, CT-Cerro de las Tortolas, C – Calingasta, VH - Vacas Heladas, CB - Cerro Blanco, P - Precodillera, SP - Sierras Pampeanas.

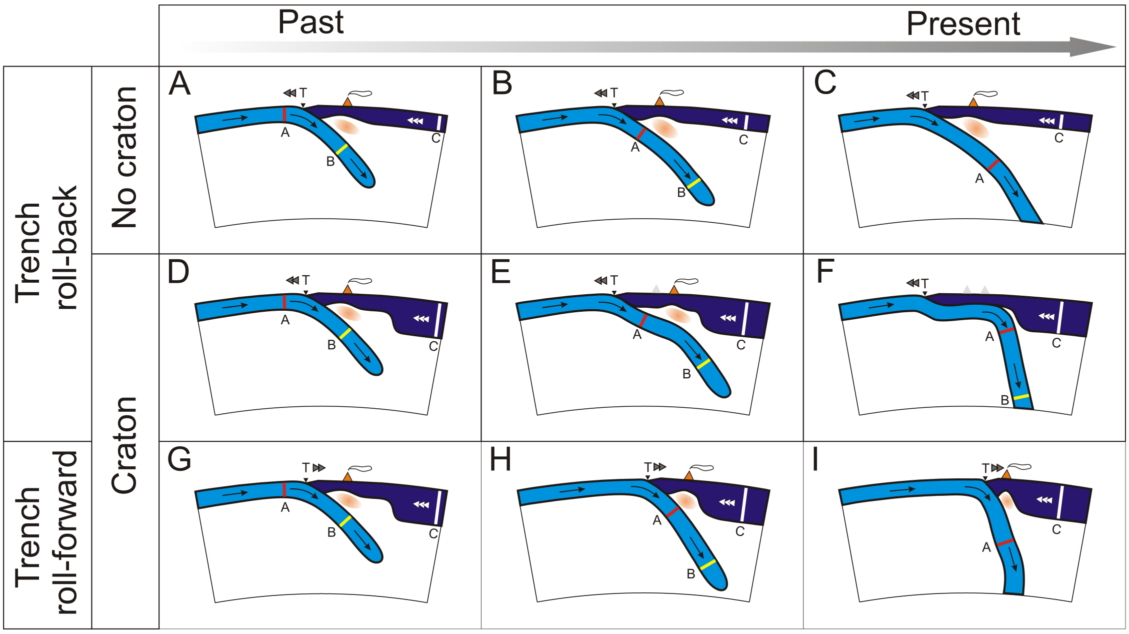

Figure 3: Conceptual models for the evolution of subduction of oceanic lithosphere beneath a trenchward moving continent, without (A-C) or with a craton, C (D-I) and trench, T, retreat (A-F) and advance (G-I).