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THE PAMPEAN SLAB IS NOT FLAT

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In seismological studies of subduction zones in the Andes it has been proposed that the Wadati-Benioff zone has nearly horizontal dip where there are discontinuities or gaps in volcanic activity. Flat slabs have been proposed in central western Argentina (the Pampean “flat-slab” in the Cuyania terrane), in Peru and Ecuador, but examining rheological results concerning brittle and ductile regimes it was concluded that the “flat” portions of seismic activity in all these regions is occurring in the continental mantle Muñoz (2005). With new thermal data a high-pressure failure mechanism (Shimada, 1993; Zang et al., 2007) where the critical stress difference s1 - s3 = Bo[1 + K(P/Bo)**m] [1 + a(logT/To)**b] [1 + clog ((de/dt)/(deo/dt))] has now been examined. P, T and de/dt are confining pressure (MPa), temperature (Kelvin) at depth z and strain rate; To = 298 (K); deo/dt) = 10-5 sec-1 is a normalizing parameter; Bo, K, m, a, b and c are empirical high-pressure failure parameters, each one with values for the upper crust, the lower crust and the upper mantle (Zang et al., 2007). Geotherms T(z) are calculated by an iteration algorithm that follows the variations of thermal conductivity and radiogenic heat generation in the crust and upper mantle. Heat flux in the Cuyania terrane between about 30.4-32.8 °S is less than 36-40 mWm-2. The “Grenvillian” basement in the region where seismic activity is observed lying almost horizontally at 100-115 km depth (Marot et al., 2013) has a radiogenic heat generation of 0.77 +/- 0.60 (10-6Wm-3) that increases eastwards to 1.39 +/- 0.39 (10-6Wm-3) (number of sites: 23; number of rock samples: 54). For de/dt ranging between 10-15 sec-1 and 10-17 sec-1, and for crustal thickness between 50 and 64 km, it is found that the high-pressure failure mechanism better explains the seismic activity that nucleates in the upper continental mantle at about 100-120 km depth. From tens of models, the brittle/ductile transition temperature TBD in the continental mantle at these depths is found to be TBD = 632 +/- 30 ºC. Seismic activity in the crust at maximum depths of about 30-40 km is also explained applying a linear frictional fracture criterion, and TBD in the crust is 343 +/- 43 ºC. On the basis of the crustal geotherm, Curie point depths of about 25-35 km obtained in the area (Ruiz and Introcaso, 2004; Collo et al., 2018) imply Curie temperatures of 300-350ºC that should indicate a composition of the crust in correspondence to intermediate members of the magnetite – ulvöspinel solid solution series (Hunt et al., 1995; Popov et al., 2015), i.e., a mafic/ultramafic composition. The cold lithosphere is caused by very low radiogenic heat generation, and is not due to a flattening of the slab. It is also noted that a thermochronological approach contradicts the current hypothesis that the exhumation of the Pampean ranges is completely related to the assumed Neogene flat-subduction (Bense et al., 2013). Moreover, the along-strike variations of the Cenozoic uplift and exhumation of the Frontal Cordillera between 30° and 35° S are explained without recourse to the change in subduction dynamic from flat to normal subduction (Lossada et al., 2018). And relating subduction of oceanic ridges to the formation of flat subduction zones is generally not in accordance with several studies, e.g., the lack of correlation with bathymetric impactors both in South America and Mexico (Skinner and Clayton, 2011; 2013), new seismological observations in Ecuador (Manchuel et al., 2011), and conclusions regarding no clear deformation linked with the subduction of the Carnegie Ridge (Michaud and Witt, 2009). In Peru, the area of present volcanic gap was subjected to relatively little volcanic activity also prior to ridge subduction; instead, several volcanic centres were active at 6-4 Ma at the region above the subduction of the Nazca Ridge, and there was no clear volcanic gap during the subduction of the Inca Plateau (Rosenbaum et al., 2005).