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Multi-stage accretion of high pressure rocks and thermal changes in a subduction channel: evidence from Diego de Almagro Island (Chilean Patagonia)

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The remote Diego de Almagro Island, Chile (51° 30' S) exposes one of the rare vestiges of the Cretaceous paleo-subduction system of western South America. It is constituted by two main tectonic units formed by mafic rocks and metasediments: the high temperature/middle pressure Lázaro unit to the East and the high pressure-low temperature Almagro Complex to the West. We herein focus on the Almagro Complex, a pluri-kilometer thick subducted sequence comprising dominantly metatuffs, but also Grt-micaschists, meta-pillow lavas (showing MORB and OIB signatures) and metacherts (transformed to quartz+garnet-rich layers). Despite its apparent homogeneity, the Almagro Complex is actually composed of two distinct units (Willner et al., 2004) with distinct pressure-temperature-time paths.

The Garnet Amphibolite unit (GA) shows three chemically and microstructurally distinct garnet generations that grew and (re)-equilibrated between 1.1 GPa and 1.7 GPa (35−55 km) and between 500°C and 600°C. We report for the first time in Chilean Patagonia the presence of rare relicts of omphacite in equilibrium with garnet in mafic layers together with the finding of chloritoid inclusions in garnet from metasediments, and omphacite and glaucophane inclusions in metatuffs. Our P-T estimates, based on pseudosection modeling, single/multi-equilibrium estimates and Raman spectroscopy of organic matter, demonstrate that rocks from the GA unit reached eclogite facies at around 1.7 to 1.8 GPa. Rb-Sr mineral data for Grt-amphibolites indicates that the amphibolitization overprint – which varies in intensity throughout the GA unit – took place at c. 120 Ma.

The Blueschist unit, structurally below the GA unit, comprises lithologies similar to the GA unit but finer grained than the former. On other hand, the Blueschist unit (i) does not show garnet with multiple overgrowths and omphacite crystals as seen in the in GA unit; (ii) exhibits slightly lower peak metamorphic conditions than the GA unit (c. 500 °C, 1.4 GPa); (iii) has not suffered the strong amphibolitization visible in the GA unit, and (iv) records blueschist facies deformation at ~80 Ma (Rb-Sr mineral data). Importantly, this cool 80 Ma old event heterogeneously overprinted the GA rocks as shown by silica-rich (Si = 3.5 pfu) rims around phengite (Si = 3.33 pfu) crystals and glaucophane overgrowths around amphibolite-facies hornblende.

The amphibolitization stage recorded by GA unit reveals the presence of a transient warming up of the subduction thermal gradient from 9 °C/ km to c. 14 °C/km at c. 120 Ma. We propose that the GA unit has been subsequently cooled down at around 80 Ma coevally with peak metamorphism in the blueschist unit. Dissolution-overgrowth patterns visible in GA unit garnets may be viewed as the record of short-lived thermal pulses associated with discrete basal accretion events. Lately, GA and blueschist units have been tectonically juxtaposed near the root of the accretionary wedge (at c. 30 km depth) and exhumed coherently. Our P-T-t reconstructions for Diego de Almagro rocks bear implications for reconstructing the physical nature of the subduction interface as well as for the understanding of transient, deep accretionary processes taking place near the roots of the seismogenic zone.