

Crustal Thickening, Partial Melting, and Strain Localization: Insights from the Leo Pargil dome, NW India

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Mid-crustal processes are recorded in gneiss domes that were exhumed within the transition zone between crustal shortening in the foreland and extension in the Tibetan plateau. The Leo Pargil dome, in NW India, is located within a zone of localized transtension between the South Tibetan detachment to the southwest and the Karakoram fault to the northeast. The elongate dome is bounded by the Leo Pargil shear zone to the northwest and the Qusum shear zone to the southeast [1,2]. The pressure-temperature-time-deformation history of these rocks implies burial was followed by partial melting then exhumation along a distributed shear zone during localized doming.

Prior to doming, recumbent northwest-trending folds and crenulation cleavage characterized deformation during Eocene-Oligocene crustal thickening. Burial resulted in the growth of porphyroblasts that define a metamorphic field gradient from garnet-grade through staurolite-grade and kyanite-grade adjacent to the Leo Pargil dome. In-situ (LA-ICP-MS) U-Th/Pb monazite geochronology and thermobarometry indicates that Barrovian metamorphism in the Haimanta Group reached 530-630°C, 7-8 kbar and ended by 30 Ma [3, 4]. These rocks remained in the mid-crust for a 5-7 m.y. period before initiation the Sangla detachment to the southwest and Leo Pargil shear zone to the northeast at 23 Ma [3,4,5].

U-Th/Pb monazite geochronology constrains the crystallization ages for deformed and undeformed leucogranite sourced from a zone of semi-continuous partial melting [4, 5]. These new ages, together with data from other studies [7], define a protracted period of melting between 30-18 Ma. Within this system of partial melt, a localized area around Leo Pargil dome experienced isothermal decompression to approximately 4 kbar by 23 Ma during exhumation along the Leo Pargil shear zone [4].

The Leo Pargil shear zone occurs within schist, quartzite, marble, and leucogranite from the Haimanta Group with shallower structural positions of the Haimanta Group and Tethys sedimentary rocks in the hanging wall. Quartz and feldspar microstructures as well as quartz LPO data record an early stage of deformation at high temperatures (500-650°C) that was overprinted by moderate temperatures (500-280°C) during continued exhumation [8]. Displacement on the Leo Pargil shear zone decreases to the south where it transitions to a low-strain domain within the Haimanta Group [8].

These new data from the Leo Pargil dome have several implications for mid-crustal processes and doming. Crustal thickening buried rocks to positions in the crust that were conducive to regional partial melting. The overlap between partial melting (30-18 Ma) and the initial stages of localized decompression at 23 Ma suggests that an early stage of melting could have potentially weakened the crust and contributed to buoyancy-driven flow. Essential to this feedback was the localization of strain within the high temperature, distributed shear zone to accommodate vertical movement during exhumation.

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