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Petrological constraints on the recycling of mafic crystal mushes, magma ascent and intrusion of braided sills in the Torres del Paine mafic complex (Patagonia)

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Cumulate and crystal mush disruption and reactivation are difficult to recognise in coarse grained shallow plutonic rocks. Mafic minerals included in hornblende and zoned plagioclase provide snapshots of early crystallization and cumulate formation, but are difficult to interpret in terms of the dynamics of magma ascent and possible links between silicic and mafic rock emplacement. We will present the field relations, the microtextures and the mineral chemistry of the Miocene mafic sill complex of the Torres del Paine intrusive complex (Patagonia, Chile) and its sub-vertical feeder-zone.

The mafic sill complex was built up by a succession of braided sills of shoshonitic and high-K calc-alkaline porphyritic hornblende-gabbro and fine grained monzodioritic sills. The mafic units were over-accreted over 41$\pm$11 ka, underplating the overlying granite. Local diapiric structures and felsic magma accumulation between sills indicate limited separation of intercumulus liquid from the mafic sills. Anhedral hornblende cores, with olivine + clinopyroxene $\pm$ plagioclase $\pm$ apatite inclusions, crystallized at temperatures >900°C and pressures of $\sim$300 to $\sim$500 MPa. The corresponding rims and monzodiorite matrix crystallized at <830°C, $\sim$70 MPa. This abrupt compositional variation suggests stability and instability of hornblende during mafic roots recycling and subsequent decompression.

The near lack of intercumulus crystals in the sub-vertical feeder zone layered gabbronorite and pyroxene-hornblende gabbronorite stocks testifies that melt is more efficiently extracted than in sills, resulting in a cumulate signature in the feeding system. The emplacement age of the sill complex topmost granitic unit is identical, within uncertainties, to the feeder zone mafic cumulates. Granitic liquids formed by AFC processes and were extracted at high temperature (T>950°C) from the middle crust reservoir to the emplacement level.

We show that hornblende-plagioclase thermobarometry is a useful monitor for the determination of segregation conditions of granitic magmas from gabbroic crystal mushes, and for monitoring the evolution of shallow crustal magmatic crystallization, decompression and cooling.