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Density instabilities, melt remobilization and their relationship to volatile exsolution; Torres del Paine igneous complex (Patagonia, Chile)

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It is very well established that silicate melts have large amounts of water, yet granites contain only small amounts of hydrous minerals. Volatile exsolution and fluid transport must be very efficient during the evolution of those magmas, but they rarely leave a chemical or textural trace. So how do the fluids move and escape those highly viscous and crystalline magmas?
Structural and textural field evidence of fluid movements have been observed in the shallow crustal Torres del Paine igneous complex (TPIC; Chile). This bimodal intrusion represents an ideal place to study such features, due to, not only, its spectacular exposure, but also its shallow emplacement depth (0.7kbar) and lack of deformation, which may be essential in preserving the textures related to fluid escape. The granite intruded in at least three distinct batches of felsic magma in a time interval of about 70,000 years (Leuthold et al., 2012). Multiple pulses of slightly younger mafic magma forming a sheet complex under-accreted and intruded the granite in thin layers leaving intercalated felsic magma in between the mafic layers.
There is clear evidence of fluid separation from the magma with the presence of miarolitic cavities. They range from mm up to 1m in size, where the cavity walls support crystallization of free-grown crystals (predominantly quartz, but also alkali feldspars, fayalite, titanite to name a few). Such fluid movements can be observed in close association with local density instabilities, present at the interface of the granitic magma with the thin mafic sheets. At these interfaces, small "diapir"-shaped features of felsic magma start to form and rise through the denser, and still hot and unsolidified, mafic magma. This results in tube-like structures that move upwards; a miarolitic cavity is often associated with these structures towards the top or the central part of the tubes, as well as a transitioning granophyric and graphic micro-textural zone between the intrusive rock (s.s.) and the cavity. We suggest that these features represent remobilization of the felsic magma, which must have been in a mush state at the time of intrusion of the much hotter mafic magma, as the contacts are mostly ductile. Similar features were also observed locally within one of the granite batches, without any mafic heat source as a trigger. In this case, the density instabilities are solely driven by disparities in volatile concentrations.
The exact role of the volatiles and volatile exsolution is being explored regarding the formation of these structures; do they really represent the driving force, or are they a consequence of the process? Preliminary observations indicate that these fossil fluid pathways, which have been preserved in the TPIC, may represent an important mechanism in fluid transport through a magma.

Leuthold et al. .2012, EPSL, v. 325–326, p. 85–92, doi: 10.1016/j.epsl.2012.01.032.