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Recent ideas and controversies on granitoid melt generation and piecemeal assemblage of plutons and batholiths: How does the Adamello suite fit in?

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Models accounting for the generation of granitoids include differentiation from a parental mafic magma in shallow magma chambers, differentiation in deep crustal hot zones or partial melting of crustal protoliths either in the lower crust or in the upper crust. According to petrological and geophysical studies on volcanic provinces magmas successively stall in the crust at different levels. Mafic magmas are almost always associated with more evolved plutonic rocks and in the Adamello massif (Italian Alps), as in many other intrusive suites emplaced in the upper crust, mafic magmas are present as enclaves and dykes in the mainly tonalitic and granodioritic rocks or as minor satellite intrusions. However, at the exposed levels in the upper crust, the volume of mafic relative to silicic rocks is too low for the mafics to produce in-situ the tonalites and granodiorites. Thus the differentiation process must occur at deeper levels, which, in Adamello, is confirmed by the rock geochemistry.

The combination of petrological experiments and numerical simulations shows that magma diversity can be generated by crystallisation of basalts in lower crustal hot zones and that compositional modality depends on the H_2O content of the parental magma. Bimodalism and compositional diversity do not require melting of the crust, although isotopic ratios often indicate a crustal contribution. In Adamello, the crustal signature increases from South-West to North-East as the rocks become younger, which can be explained by different fertilities or initial temperatures of the crustal rocks at the contact with the mafic magma. In Southern Adamello, an opposite trend is locally observed with magma becoming more juvenile with time (Schaltegger et al., 2009) probably reflecting the local maturation of the hot zone.

Geochronological data suggest a slow and sequential assembly of plutons and batholiths ($\sim$10 Ma for the Adamello batholith). However, the existence of magma chambers implies that over short timescales magma fluxes in the upper crust are at least one order of magnitude higher than the average flux that builds up plutons and batholiths. The geometry of magma pulses and the way they are assembled are controversial. Rock fabrics as revealed by Anisotropy of Magnetic Susceptibility can help to understand the emplacement dynamics by revealing magma flow direction. In addition, the degree of enclave deformation can be used to constrain emplacement timescales of the magmatic units. Our thermal models suggest that the shapes of mafic enclaves in the Lago della Vacca tonalites in Southern Adamello can be explained by an emplacement of this 4.5 km wide unit over less than 150'000 years.

Schaltegger, U., Brack, P., Ovtcharova, M., Peytcheva, I., Schoene, B., Stracke, A., Marocchi, M. and Bargossi, G.M., 2009. Zircon and titanite recording 1.5 million years of magma accretion, crystallization and initial cooling in a composite pluton (southern Adamello batholith, northern Italy). Earth and Planetary Science Letters, 286(1-2): 208-218.