

The interpretation of magmatic contacts or lack thereof in incrementally emplaced plutonic bodies

CATHERINE J. ANNEN¹, MR. NICOLAS ESTEVES²,
MELANIE BARBONI³, JULIEN LEUTHOLD⁴, DR.
LYDÉRIC FRANCE⁵, BLAIR SCHOENE⁶, PIERRE
BOUILHOL² AND MARIAN B HOLNESS⁷

¹Institute of Geophysics of the Czech Academy of Sciences

²Université de Lorraine, CNRS, CRPG

³Arizona State University

⁴No affiliation

⁵Université de Lorraine, CNRS, CRPG /// Institut Universitaire de France (IUF)

⁶Princeton University

⁷University of Cambridge

Boundaries in intrusions are often marked by sharp or diffuse compositional changes. In other cases, different magma batches are compositionally homogenous. Clear contacts between the units of a plutonic body are interpreted as meaning that the older unit was fully solidified (straight contact), or a mush (wavy contact), when the younger unit was intruded, while the absence of visible contact is interpreted as evidence for melt being still present in the older unit. Thus, the presence or absence of contacts inform on the time elapsed between successive magma injections and can be used to estimate the construction timescale of an incrementally built pluton.

We present three case studies of incrementally emplaced granitoids where solidification timescales were estimated with numerical models. In the ~1 km thick laccolith of Torres del Paine (Patagonia, Chile), sharp contacts delimit three units. Numerical models calibrated by geochronological data confirm that each unit fully solidified before the next one was emplaced. In contrast, in the ~800 m thick Beauvoir granite (France), 18 units are identified by variations in composition, but contacts are either not visible or sutured. Absence of mixing between units suggests that the magma was crystal-rich or fully solidified between the successive units, which, with the observation of non-equilibrated textures, supports rapid cooling of the units. Although the granite may have solidified between units emplacement, numerical models suggest that remelting of the host granite following new injection could have erased former contacts. In ~2.4 km thick Mt. Capanne (Elba, Italy), three units are identified by variations in geochemistry and feldspars phenocrysts abundance, but there are no clear contacts between units. Yet, geochronological data indicate a protracted emplacement of the body over at least 250,000 yr and numerical simulations show a complete solidification between successive units.

In conclusion, while the presence of contacts is evidence for magma intrusion in a fully or partially solidified rock, the reverse is not necessarily true, and the absence of contact is not evidence