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Architecture and construction mechanisms of an incrementally built, vertically layered pluton (Punta Falcone, Sardinia)

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The granite-hosted mid-crustal mafic pluton of Punta Falcone, northern Sardinia, had been interpreted in the past as a one-shot magma chamber with in-situ differentiation. The (sub-) vertical fine-scale (∼3cm) rhythmic magmatic layering prominent in the central part of the intrusion was attributed to the rotation of a initially horizontal layering formed by mineral segregation and accumulation due to gravity forces.

Field investigations allowed us to identify a dozen of different gabbro cooling units with contrasting structures and grain-sizes. The intrusion is built symmetrically, with the external parts being emplaced first. Opx and/or cpx as well as ol (one unit) are found only in the central units, where they occur together with plg, amph and minor qtz and bt. An overall enrichment in CaO, Al2O_3 and Mg-# coupled with a depletion in FeO and TiO_2 is observable towards the central part of the intrusion. Part of this zonation is explained by the accumulation of plagioclase (up to 75 normative %) in the central part. The depletion in Fe and TiO_2 could be linked to fractionation of Fe-Ti oxides (mag & ilm), in relation with higher fO_2 values, which would also explain the presence of opx in these central units.

Concerning the rhythmic magmatic layering, several parameters have been identified:
- Layering occurs in a ∼50m thick unit in the central part; it is thus located in a thermally preheated environment.
- Layering is roughly parallel to most of the contacts between the different units and to the long axis of the elliptical intrusion, indicating a structural and/or a thermal control.
- Intensity of layering decreases from the contact with the neighbouring unit inwards.
- White bands consist of high-An plg rimmed by lower-An borders and minor interstitial qtz; dark bands consist of high-An plg without rims enclosed in big poikilitic amphiboles or pyroxenes.
- Crystallization of up to 5mm big, poikilitic amphiboles with a patchy chemical zoning, occurs at the moment of development of layering in a water-saturated system. Crystallinity is expected to increase dramatically from ∼40 to 70 vol-% over a small interval of temperature at this stage of evolution of the magma.
- No preferred mineral orientation is visible in the white or dark layers.
- AMS measurements yield oblate ellipsoids oriented parallel to the layering; this signature could reflect the concentration of magnetite in the dark layers.

Given these parameters, we are currently considering a slowly migrating crystallization front acting together with element diffusion: amph crystallizes at the borders of the intruding unit, triggering the migration of amph-forming elements. This would lead to the development of a “depleted” white band once reached by the crystallization front. This process would be repeated sequentially until the thermal gradient gets too diffuse.