Geophysical Research Abstracts
Vol. 16, EGU2014-8694-1, 2014
EGU General Assembly 2014

Intrusion mechanisms of mafic plutons in the middle crust: insights from the Permian Sondalo gabbroic complex (Central Alps)

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Across Western Europe, Late Carboniferous to Permian bimodal magmatism is one of the last manifestations of the Variscan orogenic cycle. Whereas acid magmatic bodies are mostly restricted to upper and middle crustal levels, mafic intrusions are emplaced through the entire continental crust. In contrary to the well-studied lower-crustal plutons, mid-crustal mafic intrusions remain poorly described. The shallow intrusion level of such basic magmas remains enigmatic, as buoyancy shall not be the main driving force. In order to understand the emplacement of mafic magmas at this rather uncommon level (< 20km), we characterized the structure and AMS fabric of the intrusion of the Permian Sondalo gabbroic complex which is exposed in the Alps, in the Austroalpine Campo unit (N-Italy).

Macroscopic foliations, anisotropy of magnetic susceptibility (AMS) data and lithological variations allow to subdivide the pluton into three concentric domains. From the core composed of Ol-Gabbro to the dioritic margin, the mean magnetic susceptibility (Km) decreases from 3.54*10-3 S.I. to 4.25*10-4 S.I.. The mean anisotropy (P) ranges from 1.006 to 1.151 without regardless of the domain. Structural and AMS data reveal a vertical magnetic and magmatic foliation associated with a vertical magnetic lineation in the centre of the pluton. The foliation is parallel to the steep fabric which is observed in both granulite-facies metapelitic septa and host-rocks. In contrast, the dioritic margin shows a moderately dipping magnetic fabric roughly parallel to the margins of the pluton. This magnetic and magmatic foliation is parallel to the localized zone of migmatized metapelites forming a narrow structural aureole rimming the mafic pluton.

Our data suggest that the onset of magma ascent was facilitated by the mechanical anisotropy provided by the sub-vertical fabric of the metapelitic host-rock. Further ascent of magma is characterized by the presence of a structural aureole at the margins and around the pluton indicating activity of material transfer processes between the pluton and its host-rock. The assimilation of H_2O-rich melts derived from the surrounding metapelites may also have decreased the viscosity of the migmatitic aureole thereby enhancing localized mechanical coupling between magma and host rock at late stages of magma emplacement. The mechanism driving ascent of the dense mafic magma is probably related to regional variations in pressure gradient related to Permian extensional tectonics described in the study area.