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Petrological evolution of Permian magmatism in Central Alps (SE Switzerland, N Italy)

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Understanding which processes are active and quantifying their relative influence during the differentiation of intracontinental magmatic systems remains a major challenge, as these processes can either (1) involve magmas and their crystallization products (fractional crystallization, reactive melt flow…) and/or (2) crustal contamination through various vectors (bulk assimilation, reactive assimilation, host-rock partial melting…). Whereas the influence of some of these processes can be inferred from field evidence, it needs to be constrained and quantified. This question can be addressed in the Central Alps (N Italy, SE Switzerland), where a complete, crustal-scale post-Variscan (Permian) magmatic system has been documented from lower crustal (Braccia gabbro, Malenco unit) and mid-crustal intrusives (Sondalo gabbro, Campo unit) to upper crustal intrusives and extrusives (Bernina unit). We present preliminary results, combining field work to petrological and geochemical characterization and modelling.

Petrological investigations on major element bulk-rock composition shows a complete differentiation trend from the less differentiated lower crust intrusive mafic rocks (Ol-gabbro, gabbro: 40-50 wt.% SiO□, Mg# 45-75, 0.1-0.8 wt.% K□O; and diorite: 45-60 wt.% SiO□, Mg# 45-55, 0.15-0.5 wt.% K□O), to upper crust felsic rocks (granite/rhyolite: 55-85 wt. % SiO□, Mg# 5-50, 1-6 wt.% K□O). By contrast, middle crust intrusive rocks encompass the full compositional range from Ol-gabbro and gabbro (45-50 wt.% SiO□, Mg# 35-90, 0-3 wt.% K□O), to alkali-rich diorite (50-60 wt.% SiO□, Mg#: 40-55, 0.5-2 wt.% K□O) and granite (50-85 wt.% SiO□, Mg#: 5-50, 1-6 wt.% K□O). To test the role of equilibrium and fractional crystallization, thermodynamic models were run using Rhyolite-MELTS software, and compared to experimental results in the 0-1 GPa pressure range from the literature. Some correlations between our samples compositions and the models (e.g., for CaO contents and Mg#) can be seen, but the latter fails at reproducing SiO_2 and K_2O differentiation trends.

Bulk-rock compositions indicate that magmas follow a composite differentiation trend between

tholeiitic and calc-alkaline series, and the low abundance of olivine, even for the most primitive rocks indicates that before reaching the lower crust, magma was already fractionated during it ascent through the mantle. However, major differentiation does not seem to occur in the lower crust, being set fertile by previous tectono-metamorphic events. Instead, most of differentiation occurs in the fertile middle crust, since a wide major elements compositional range is observed. Both experimental and modelling results show that the observed diversity of composition cannot be attributed to fractional crystallization solely, notably by the high K□O content at high Mg#. This suggest a potential role on crustal contamination; although evidence for contamination can be documented in the field (e.g., garnet, cordierite-bearing gabbro surrounding xenoliths), the extent of this contamination and its vectors remains to be constrained.