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Garnet as a monitor for assimilation processes in the deep crust. An example from the Ivrea zone (Italy)

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The Ivrea Verbano zone (IVZ) is famous for its almost complete exposure of metasedimentary lower crust from lower amphibolite to granulite facies metamorphism[1] intruded by a Permian Mafic Complex. High grade metamorphic metasediments, known as 'Septa' can be mainly found in the lower part of the Mafic Complex in the Paragneiss-bearing Belt (PBB). Models how such septa have been incorporated and assimilated have been proposed[2] but the processes of assimilation are poorly understood and mainly based on structural data and regional whole-rock geochemistry[3]. In the PBB, garnet is ubiquitous in the different lithologies of the metasediments as well as in the surrounding gabbros and norites. Garnet is also ubiquitous in the granitic rocks related to the Mafic Complex, but exposed in shallower levels of the crust. Metasedimentary 'Septa' have also been found in garnet-bearing granite. Here we explore the geochemical record of assimilation and present preliminary results on transects from gabbros to metasediments.

We sampled complete gabbro-septa transects in the deepest part of the Complex and also in shallower levels to evaluate the variability of rocks and associated garnet. Septa may display a large variability in lithology from resititic assemblages (grt + plg + cor + spl + ru $\pm$ bt) to crystallized charnockitic liquids (qz + pl + gt + opx + ru $\pm$ bt) with intermediate migmatite indicating local in-situ partial melting. Restites have very low silica content (38% wt. SiO_2) contrasting with charnockite (64% wt. SiO_2), all together on centimeter scale. From the contact with the septa, the gabbro shows mineralogical variability, first by the disappearance of garnet and quartz, followed by clinopyroxene appearance and increasing modal amounts. Adjacent to metasediments ($\sim$3cm) the igneous rocks are cpx-free norites.

Garnet is found in almost every lithology with grain sizes ranging from 3 cm to less than 2 mm in gabbro, and smaller grain sizes ranging from 5 to 2 mm in septa. Depending on the location garnet may be idiomorphic or xenomorphic, or both. SEM and X-ray micro-tomography reveal different morphology. Electron microprobe analyses on garnet cut through the center indicate gradients in major element chemistry (50-60% Alm with variation in pyrope and grossular, $>$10% gross for restitic garnet, $\approx$13% gross for charnockite and $\approx$17% for gabbro). Chemical maps and detailed quantitative profiles show small zoning as rim enrichment in grossular in charnockitic garnet. These data show that garnet chemistry is controlled by the host rock, and magma-sediment interaction is mostly a local process without homogenization on the dm to cm scale.

[1]Schmid & Wood, 1976: CMP 54, 255-279.

[2]Voshage et al., 1990: Nature 347, 731-736.

[3]Sinigoi et al., 2011: CMP 162, 691-707.