Origin of Felsic Migmatites by Ductile Shearing and Melt Infiltration

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The Gföhl migmatite-gneiss complex forms the largest anatectic unit of the Variscan orogenic root domain. The origin of this migmatitic unit was classically attributed to the anatexis and the different degree of migmatitization explained by the variable degree of partial melting.

A new petrogenetic model of an origin of this felsic migmatites is proposed on a basis of the microstructural and petrological study. The detailed observation reveals that the migmatites originated by melt infiltration and contemporaneous shearing of the banded orthogneiss in a crustal scale shear zone. They are marked by gradual transition from the high-grade solid state banded orthogneiss with distinctly separated monomineralic layers via the migmatitic gneiss, the gneissic migmatite characteristic by disappearance of monomineralic layering to sheeted foliation parallel bodies of the granitic gneiss with no relicts of gneissosity. The disintegration sequence is characterized by: (i) progressive destruction of well equilibrated banded microstructure of the high-grade orthogneiss by a crystallization of new interstitial phases (Kfs, Plg and Qtz) along the feldspar boundaries and by a resorption of relict feldspars and biotite, (ii) variations of modal proportion of felsic phases reflecting the increasing amount of melt in the originally mono-mineralic aggregates, (iii) systematic grain size decrease of all felsic phases together and crystal size distribution curves (CSD) indicating increase of the nucleation rate coupled with preferential removal of large grains for all felsic phases with the increasing melt proportion. This evolutionary trend is connected with a decrease in grain shape preferred orientation (SPO) of all felsic phases, an increase of regular grain boundary distribution (dominance of unlike boundaries) and a decrease of grain boundary preferred orientation (GBPO) of unlike boundaries.

Melt topology reveals well oriented melt seems and pools at low melt fraction consistent with dislocation to diffusion creep regimes. At high melt fractions the absence of preferred orientation of melt patches corresponds to the distributed granular flow associated with a breakdown of rigid skeleton close to rheological critical melt percentage (RCMP).

SEM images show plagioclase zoning displaying non-diffusive 2–10 µm more sodic rims (An0-10) around oligoclase cores (An10-30). The whole textural sequence displays continuous increase of Na content in plagioclase cores and rims, increase of XFe in biotite and garnet coupled with decreasing Ti content in biotite towards the granitic gneiss. The increasing amount of discrete albite rims and complete disintegration of original banded texture are compatible with melt infiltration into progressively deformed rock. Additionally, the petrological observations indicate that the melt infiltration is connected with crustal exhumation along retrograde pressure and temperature path.

The Role of Melt Infiltration in the Formation of Migmatitic Orthogneiss

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The Gföhl orthogneiss is a widespread lithology in the Moldanubian orogenic root domain of the Bohemian Massif. Its apparent textural variations were classically attributed to the variable degree of anatexis, however, a recent textural study interprets some of the variations to be due to different degrees of melt infiltration. In this contribution, we describe mineral and bulk rock chemical changes from the original banded orthogneiss (textural type I) to granite-looking gneiss (type IV) and determine equilibration P-T conditions. We characterize what sort of fluid is involved, calculate its composition and deduce how it interacts with the original rock.

The mineral assemblage in all the rock types is garnet-biotite-sillimanite-K-feldspar-plagioclase-quartz. As muscovite is absent, the infiltrating fluid must be a melt and not an aqueous fluid. Garnet in the studied sequence displays the following changes: $alm_{75=>94}py_{17=>0.8}grs_{2.5=>1.2}sps_{2=>11}$; X_{Fe} 0.80=>1, and biotite X_{Fe} increases (0.45=>0.99). Plagioclase in the original aggregates has higher anorthite content ($An_{25=>5}$) than interstitial grains or films tracing the K-feldspar boundaries and plagioclase rims ($An_{18=>0}$). In an AFM diagram, the assemblage garnet-biotite-sillimanite is divariant, in the presence of quartz, K-feldspar and melt, a systematic increase in X_{Fe} of the phases indicating a decrease in equilibra-