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METAMORPHIC EVOLUTION OF MOLDANUBIAN ROCKS

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Despite differences in lithology between the Bunte Series and the Gföhl Unit, common rock types within both units show paragenetic similarities that suggest comparable conditions of metamorphism. The assemblage Grt + Bi + Sill + Kfs + Plg + Q + Ilm + Ru (A), is common in migmatic gneisses within the "Bunte Serie", in blastomylonitic rocks comprising the tectonic boundary ("Granulite-lamella") between the "Monotone Serie" and "Bunte Serie", as well as in the Gföhl gneiss and the acid granulites (PETRAKAKIS & RICHTER, 1990). These types of rocks share further paragenetic and textural features such as (a) homogenised garnets showing cooling-and-resorption affected rims, (b) inclusions of kyanite, white mica, potash feldspar, quartz, plagioclase, rutile and biotite within garnet, (c) polymorphic transformation of kyanite into sillimanite and, (d) ilmenite overgrowing rutile. Nevertheless, textural differences among these rock types are also apparent and probably related to their tectonic position within the granulite terrain. Acid granulites and the rocks of the "Granulite-lamella" exhibit typical blastomylonitic fabrics characterised by sharp compositional banding (dark-coloured, Bi + Grt Sill-bands alternating with light-coloured, Fsp + Q-bands) and the occurrence of (a) porphyroclastic garnet and, occasionally, kyanite, (b) coarse-grained augen-perthite and, (c) ribbon-quartz, within a fine-grained matrix composed of quartz, feldspars, biotite, sillimanite, ilmenite and rutile. On the other hand, the gneisses of the "Bunte Serie" and the Gföhl-gneiss commonly show syn-tectonic migmatic features and are generally medium-grained. Textural transitions to intensively deformed fabrics with ribbon-quartz are occasionally developed at some margins of the latter rock type. This observation and the geochemical similarity between Gföhl-gneiss and acid granulites (VELLMER, 1992) suggest that the blastomylonitic granulites, which generally occur at the highest tectonic position within Moldanubia, represent a "tectonic facies" of the widespread Gföhl-gneiss.

Garnet or clinopyroxene amphibolites are common in the "Bunte Serie" and the "Gföhl Unit". The assemblage Grt + Cpx + Amp + Plg + Ilm + Ru + Q (B) is rarely observed in amphibolites in both units. In all known cases quartz is only accessory or forms inclusions in garnet. Opx + Grt-bearing assemblages are less abundant and characterize some gneisses and granulites in the "Gföhl Unit". The characteristic assemblage is Grt + Opx + Bi + Plg + Q + Ru + Ilm (C) for the former, usually migmatic rock type (LIEBERMAN & PETRAKAKIS, 1991) and Grt + Opx + Bi + Kfs + Plg + Q + Ru + Ilm (D) for pyroxene-bearing granulites (PETRAKAKIS & JAWECKI, 1994).

Conditions of metamorphism were estimated on the basis of petrogenetic grids and geothermobarometry. Migmatic and graphite-bearing gneisses from the "Bunte Serie" (assemblage A) typically contain garnets which preserve adjacent inclusions of the relic assemblage Mu + Kfs + Ky + Plg + Q, suggesting that the break-down of Mu + Q took place in the Ky-stability field. The textural and paragenetic relations as well as the characteristic assemblage (A) point to a prograde and/or decompressional P,T-path of the rocks at temperatures around 700 °C or higher and pressures higher than 6-7kbar for a_{H_2O} much lesser than 0.5 (PETRAKAKIS, 1986a). This model-P-T-path leads to generation of partial melts via dehydration melting of white mica and is consistent with the occurrence of graphite and the migmatic nature of the gneisses. Geothermobarometric determinations confirmed these results and yield $T = 700 - 770$ °C and $P = 7 - 9$ kbar. The application of internally consistent geothermobarometric methods that allow for the evaluation of the equilibrium state (BERMAN, 1991) on amphibolites, gneisses and granulites characterised by the assemblages B,C and D are, in view of the estimated uncertainties involved in the calculation, in agreement with the above estimates (LIEBERMAN & PETRAKAKIS 1991; PETRAKAKIS & JAWECKI, 1994). In the case of the pyroxene-bearing granulite from the Dunkelsteiner Wald a tendency to higher recrystallization pressures (~ 10.5 kbar) is obvious.

The estimated conditions generally confirm the uniform character of the recrystallization-event which affected both units. The estimated temperature of recrystallization most probably corresponds to T_{max} , whereas P_{max} is expected to be 1-2 kbar higher. Such high pressures imply a geotectonic environment characterised by appreciable crustal thickening, most probably due to collision. These data as well as the distinct lithological differences between the "Bunte Serie", exhibiting epicontinental affinities (HÖGELSBERGER, 1989), and the "Gföhl Unit", containing rocks of the lower crust, suggest, that the juxtaposition of both units might have taken place before this uniform recrystallization. Further evidence suggests that the Moldanubian rocks were subject to metamorphism and deformation predating the apparent (and obviously last) high-temperature overprint. It includes (PETRAKAKIS & JAWECKI, 1994) (a) corundum + spinel preserved within garnets of pyroxene-bearing granulites, (b) clinopyroxene-relics overgrown by orthopyroxene, and (c) the occurrence of garnet + Na-bearing-pyroxene corundum rocks intercalated within acid granulites. Interestingly, relic, Ca-rich cores in homogenised Fe,Mg-garnets (PETRAKAKIS, 1986a), and Grt + Cpx + Q-assemblages are also found in rocks of the "Bunte Serie". This evidence for older metamorphic episodes is in line with the late Proterozoic formation age of marbles within the "Bunte Serie" (FRANK et al., 1990).

The P,T-path of the Moldanubian rocks after the last high-temperature overprint is well constrained by the following textural and paragenetic criteria (PETRAKAKIS, 1986a, b; PETRAKAKIS & JAWECKI, 1994; HARLEY, 1989): (a) garnets in pyroxene-bearing granulites are generally isolated from orthopyroxene by moats of plagioclase. (b) Opx + Plg-symplectites are formed around garnet in amphibolites from the "Bunte Serie". (c) ilmenite generally rims rutile especially in the rock matrix. (d) syn-tectonic formation of partial melts are observed in many rock types. These textures demonstrate rapid, nearly isothermal decompression (ITD), most probably related to the **post-collisional intra-Moldanubian overthrusting**. This process might be responsible for the overprint of typical blastomylonitic fabrics in the rocks of the Granulit-lamella, and in the granulites that typically occur at the highest tectonic position (PETRAKAKIS, 1986a, b). The ITD-segment is followed by nearly isobaric cooling (IBC) of the rocks at considerable depth (5 - 6 kbar) as demonstrated by retrograde, undeformed intergrowths of zoisite + margarite around corundum inclusions in garnet and the diasporization of the latter (PETRAKAKIS & JAWECKI, 1994). Further uplift of the rocks probably involved new tectonic activity (ELLIS, 1987; HARLEY, 1989), possibly related to **Moldanubian overthrusting** over the Moravian zone.

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