higher temperature of melting (probably biotite dehydration melting).

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Tectonic Environment and Magnetic Susceptibility of the West Carpathian Granites

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In the West Carpathians, there are two principal groups of granitic rocks that originated during the peak stadium of the Variscan collision processes and/or after the slab breakoff (or delamination). The older one is pretty peraluminous (ASI = 1.1 – 1.5) dominated by two-mica granites and granodiorites, whereas biotite granodiorites to tonalites being less common. Accessory mineral association comprising monazite and ilmenite and presence of host (metamorphic) rock xenoliths are typical of these rocks. From geochemical point of view, Ba, Sr and Rb range widely (up to 2000, 1000, and 200 ppm, respectively) with Rb/Sr generally <1. The REEs are moderate with fractionated pattern and small negative Eu anomaly. Initial Sr 0.706 – 0.708, $\varepsilon\ Nd_{(350)} = -0.62$ to -4.24, the $^{206}Pb/^{204}Pb$ ratios of the whole rock samples range from 18.39 to 19.28 and the $^{207}Pb/^{204}Pb$ ratios from 15.59 to 15.74, stable isotopes (O and S) with values $\delta\ ^{18}O_{(SMOW)} = 8.8 – 11.3‰$ and $\delta\ ^{34}S_{(CDT)}$ from -0.9 to $+5.7‰$. Magmatic intrusion age of these granites is between 350–330 Ma with majority around 340 Ma. These granitic rocks resemble in classical alphabetic nomenclature common S-type and/or Ilmenite Series granites.

The younger group of granites is rather metaluminous to subaluminous (ASI = 0.8 – 1.1) dominated by biotite tonalite to granodiorite with scarce hornblende. Muscovite-biotite granodiorite to granite are in less extent. Accessory mineral association of magnetite + allanite and occurrence of mafic microgranular enclaves (MME) are characteristic of this group. Lower SiO_2 concentrations are compatible with higher trace elements Zr, Ba, Sr, LREE and Fe group element contents. REE patterns are typically steeper with higher LREE and without Eu anomaly. The initial Sr = 0.704 – 0.707 with Rb/Sr = 0.05 – 0.7 which are consistent with Rb-poor crustal source and/or mixed lower crustal or mantle component. Few Nd data fall within the S-type group – $\varepsilon Nd_{(i)} = -1.7$ to -3.5 although mafic dioritic enclaves with $\varepsilon\ Nd_{(i)} = 1.8 – 0.5$ clearly indicate interaction with a basic or intermediate, dioritic lower crustal melt. The $^{206}Pb/^{204}Pb$ ratios of the whole rock samples range from 17.99 to 18.85 and the $^{207}Pb/^{204}Pb$ ratios from 15.53 to 15.70. Stable isotopes (O and S) with values $\delta\ ^{18}O_{(SMOW)} = 7.8 – 9.9‰$ and $\delta\ ^{34}S_{(CDT)}$ from -2.9 to $+2.3‰$ also support melting of more basic lower crustal protolith. Magmatic intrusion ages of these granites vary between 310 – 300 Ma and these granitic rocks can be compared to I-type and/or Magnetite Series granites.

Generally we suppose that collisional processes that result in the formation of crustal-scale nappe structures and generation of collision-related felsic “S-type” granite magmatism characterize the main Meso-Variscan collisional period. Neo-Variscan stage is connected with collapse of the collisionally thickened crust. The final collisional shortening was followed by the gravitational instability of thickened lithosphere, which resulted in the process of thinning of lithosphere (lithospheric delamination, detachment of lithospheric root from the light continental lithosphere, or slab breakoff). As a result of the slab-breakoff, the asthenosphere upwelled and thermal perturbation led to melting of the metasomatised lithospheric mantle and subsequent formation of “I-type” granites at the base of the crust. This period was characterized by a shift from compressional towards extensional tectonics.

Indeed there are small differences between both groups of granitic rocks in the isotopic picture, neither younger metaluminous nor older peraluminous granitic suites have typical geochemical characteristics of continental collisional granites. It is interesting that these isotopic characteristics suggest rather for the origin in volcanic arc with granite melting during subduction of oceanic crust under continental margin, than melting in the consequence collisionally thickened crust.

Magnetic susceptibility of granites worldwide displays a bimodal distribution, with one mode corresponding to the values of 10^{-3} to 10^{-2} and the other one to those of 10^{-5} to 10^{-4} [SI]. The former mode granites, with magnetite representing magnetic minerals, are often represented by an I (igneous) type. The latter mode granites, in which magnetic minerals are represented by ilmenite, often correspond to an S (sedimental) type.

Magnetic susceptibility of the West Carpathian granites is in general low, in the order of 10^{-4} [SI]. In the minority of specimens it is in the order of 10^{-5} and in exceptional specimens it is higher, in the order of 10^{-3}. The susceptibility values of the most West Carpathian granites correspond to the values typical of S-types. This is in contradiction with the granite origin revealed geochemically. The preliminary explanation of this contradiction is that magnetite originally present in the I-types was destroyed during Alpine deformation indicated by magnetic fabric.

Development of the Gföhl Migmatites through Partial Melting and Textural Annealing of High-Grade Orthogneiss via Process of Disintegration of Solid State Texture

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The Gföhl gneiss is an important lithological unit of the most deeply buried part of the Moldanubian root domain. It is suggested by some authors that this gneiss complex together with HP granulites, eclogites and mantle fragments form the highest structural position of the Moldanubian zone due to exhumation associated with large-scale nappe tectonics (Matte, 1990, Petrakakis, 1995). The Gföhl gneiss complex is rather heterogeneous in composition, and consists of nebulitic migmatites, stromatitic biotite-rich migmatites and locally of banded orthogneisses. The detailed outcrop observations reveal gradual transitions from porphyritic orthogneiss via high-grade mylonites to entirely molten rock. The question arises, whether the large volumes of felsic medium-grained migmatites originate through partial melting of orthogneiss protolith or whether the main proportion of migmatitic domain was originally formed by fertile metasediments rich in hydrous minerals (Thompson, 2000).

Several key outcrops were investigated from the structural, textural and petrological point of view. The earliest structures are represented by steep solid state high-grade foliations in strongly sheared orthogneisses marked by alternations of monomineralic feldspar and quartz layers and large amount of biotite. This first fabric is W dipping (at an angle of 60–80º) and N-S trending. The early fabric is folded and transposed by flat foliation associated with the development of fine-grained mylonites. These high-grade mylonites progressively pass into migmatitic gneiss rich in sillimanite and garnet, and finally into completely molten felsic leucosomes. The new planar system is E-W trending (at an angle of 15–40º) and bears N – S oriented mostly subhorizontal lineation.We sampled two sections in which the above transition from banded orthogneiss to nebulitic migmatite was observed. The aim of this work is to understand the melting process of high-grade orthogneiss, i.e., relatively refractory rock using a detailed petrologial and textural analysis.

We have distinguished and documented four textural stages from the orthogneiss to nebulitic migmatites. The first one is represented by fine-grained banded ortogneiss with distinctly separated monomineral layers. The K-feldspar layers 0.75–2 mm thick consist of grains 0.5 mm in size with straight boundaries. Numerous rounded inclusions of quartz (0.01 mm in size) occur mostly at triple points. A polygonal mosaic of well-equilibrated plagioclase 0.2–0.3 mm large forms layers 0.25–1.25 mm thick. Quartz occurs in 0.7–0.1 mm thick polycrystalline ribbons. Large flakes of biotite, locally overgrown by sillimanite (< 5%), form bands separating quartz from plagioclase aggregates. Small garnet (0.07–0.1mm in size) is associated with biotite aggregates.

The second stage is characteristic of grain coarsening and disappearance of monomineralic layering. The K-feldspar-rich aggregates are composed of K-feldspar (80%) grains (0.6 mm in size) with straight boundaries and numerous inclusions of quartz (20%) and biotite. Plagioclase-rich layers are composed of plagioclase (80%), quartz (20%), biotite flakes, and rounded garnet grains (0.5 – 0.9 mm in size) + sillimanite. Quartz forms irregular aggregates composed of large grains (0.4–0.6 mm in size) with strongly lobate boundaries.

The third stage is marked by change in the proportion and size of individual minerals and by the increase in sillimanite content. Former plagioclase-rich layers show almost granite-like texture being composed of almost equivalent amount of plagioclase and quartz as well as minor amount of K-feldspar. The K-feldspar layers consist of large irregular grains of K-feldspar and small plagioclase grains. The K-feldspar/quartz ratio is 1:1. The plagioclase and K-feldspar layers are separated by sillimanite aggregates. No relics of original layering can be observed in the nebulitic migmatite.

The grain boundaries of minerals in individual stages were “traced” in the GIS Arc View environment and analysed using The Matlab™ Poly LX toolbox (Lexa, 2001), where statistical analysis of grain size, grain contact frequencies, modal compositions and grain boundaries and shapes were performed. This study permits to quantify the textural evolution of mineral aggregates from solid state to random anatectic structure. The detailed microprobe work, currently in progress, is carried out to estimate the PT conditions of textural annealing and melting. Basing on these data, an attempt is made to propose a model of textural annealing and melting explaining the disintegration of