Gravity field features

As the densities of lithologies in the study area vary within a relatively wide interval of 2.00–2.90 gcm^{-3}, numerous geological structures are emphasized in the gravity maps (eastern edge of the Bohemian Massif, the front line and the inner structure of the Carpathian Flysch Nappes, northeastern limit of the Vienna Basin). The NE–SW density boundary indication lines reflect primarily younger tectonic structures of the West Carpathians while the NW–SE indications reflect structural elements of the Brunovistulian basement and its platform cover. Large positive gravity anomalies correspond to the Metabasite Zone of the Brno pluton and to the huge Paleozoic sedimentary cover of the basement in the eastern part of the Jeseníky Mts. The Outer West Carpathian complexes such as the Flysch Zone, Molasse Zone and the Vienna Basin cause distinct gravity lows.

Magnetics

In general, three different belts of magnetic field can be defined in the area under study. The first positive magnetic belt is developed between the Hrubý Jeseník Mts. (W) and the vicinity of Karviná (E). It continues to Poland and to Slovakia. The second large belt of positive anomalies covers the whole S and SE part of the Czech Republic from the Moldanubian Zone (SW) to the Beskydy Mts.(E). It continues to Austria and Slovakia (S) and also to Slovakia and Poland (NE).

Between the two vast positive belts, a magnetic low is developed covering a substantial part of the areas built by Late Paleozoic rocks of the Drahanská vrchovina and the Oderské vrchy Highlands and the northern piedmont area of the Beskydy Mts. All the three large anomalous belts (two positive and one negative) represent the magnetic response of the mostly buried crystalline basement belonging to the Brunovistulian Unit.

Most of the smaller and near-surface magnetic sources occurring along the W margin of the area studied belong to the Moldanubian (SW) and Sudetic (NW) units. The pattern of the magnetic source rocks is completed by young volcanics such as basalts in the Nízký Jeseník Mts., teschenites in the northern piedmont of the Moravskoslezské Beskydy Mts. and andesites in the Bílé Karpaty Mts.

Seismics

Reprocessing of the 15 seismic lines was focused to the area of two new crucial geological cross-sections; the first one between Šternberk (NW) and Lysá p. Makytou (SE) and the second one between Blansko (NW) and Hodonín (SE). The reprocessed and newly migrated seismic profiles defined reliably the base of both Neogene and Paleogene Formations as well as the top of the crystalline basement. Devonian, Carboniferous and Jurassic, mostly carbonate sequences could be locally reliably fixed, too. The find of several thrust planes within the crystalline basement and in its Paleozoic to Mesozoic cover brought evidence of a complicated structure of the contact zone of the Bohemian Massif and the West Carpathians.

The complex seismic interpretation (together with gravity, magnetic and borehole data) was finally summarized in a map showing the top of the buried crystalline basement (Brunovistulian Unit).

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Hydraulic Fracturing Control of Melt Migration in Pervasively Molten and Deformed Crust: AMS Fabric Study, Central Vosges

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The common spatial and also temporal relation between migmatites and crustal scale shear zones led several authors to propose a mechanism of magma ascent by exploiting crustal weaknesses. This deformation enhanced ascent model called also ‘tectonic pumping’ suggests that magma is driven upward by buoyancy, which is assisted by contemporaneous deformation. It is argued that the magma intrudes pervasively, parallel to main anisotropy represented by foliation planes, fold hinges and boudin necks. It is generally accepted that the melt migration rate is compatible with deformation rate, and the duration of the whole process is basically controlled by thermal evolution of the given area. The other mechanisms of tectonically driven melt migration proposed recently is called magma wedging into low viscosity country rocks. This model assumes that the hot and anisotropic country rocks prevented the melts from freezing and allowed its pervasive flow through the country rocks in the form of leucogranite sheets.

Migmatites of the Central Vosges allow to study complex behaviour of solid state rocks including granitic melts in a region of fertile magma segregation in metasedimentary and gneissic migmatites. The metasedimentary metatexites and diatexites were deformed by homogeneous viscous flow, but showing a complete continuity between pre-rheological critical melt percentage AMS fabrics and AMS fabrics associated with viscous magma flows. Metatexites with low proportion of melts (<50%) and metagraywacke mesosomes exhibit rather high degree of anisotropy associated with plane strain to oblate ellipsoid shapes. The leucosomes show plane strain ellipsoid shapes and weaker degree of anisotropy reflecting strain and complex deformation history associated with boudinage process. The diatexites and granites (>50% of melts) show very weak degree of anisotropy and highly variable ellipsoid shapes which may reflect undisturbed rotation of carriers of magnetic anisotropy (biotite) in freely moving melts. The AMS study of diatexites and heterogeneous granites showed consistent directions with regional extension, which was further used as direction of main pervasive flow.

Mechanical behaviour of rocks with low ability to melt also depends on the volume of granitic magma. This was examined in two large gneissic domains surrounded by diatexites and heterogeneous granites. These domains show different AMS pattern of solid state gneissosity with respect to main pervasive magma flow. Detailed AMS study of rocks with low volume of melts confirmed presence of original steep anisotropy oriented in E-W direction preserved in the core of large gneissic domain. Towards the margin of this megaboudin (10 km in length and 5 km in width), the AMS of solid state annealed rocks document folding of original anisotropy by 100 m large buckle folds with long limbs close to the direction of surrounding pervasive magma flow. In addition, the AMS fabrics of leucocratic magma provide evidence that the anatectic leucosomes are aligned approximately parallel to the axial surface of folds suggesting magma injection perpendicular to the direction of active contraction (Vernon and Paterson, 2001). The study confirms connection between regional shortening and melt segregation along contractional localized shear zones clearly associated with process of buckling.

The second megaboudin of gneissic rocks shows significantly higher proportion of magma. The AMS of solid state annealed rocks confirmed existence of large scale (10 to 100 metres) recumbent folds with hinges parallel to main stretching direction of surrounding pervasive flow. However the fabric study of leucocratic melts show distribution along conjugate zones oriented in obtuse angle with respect to the solid-state anisotropy intersecting perpendicularly to the axes of large-scale folds. We follow Cosgrove (1997) in assumption considering hydraulic fracturing in anisotropic material, which was based on layer-normal compression analogous models introduced by Kidan and Cosgrove (1996). We suggest that the anisotropy and magnitude of differential stress are the main factors influencing melt distribution at this stage. We also argue that the melt moved through and out of the partially molten anisotropic system by hydraulic fracturing along the planar, horizontal stretching fabric and gently inclined normal kink-bands (extensional shears).

This study shows that the AMS method is a powerful tool to investigate the tectonically driven magma mobility. We believe that the degree of deformation connected with early buckling and later on with shortening perpendicular to the main anisotropy are the main factors controlling magma behaviour and distribution in partially molten crust.

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Tourmaline from the NYF Pegmatites in the Třebíč Durbachite Massif

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Pegmatites of the Třebíč durbachite massif represent a distinct type of granitic pegmatites within the Moldanubian territory (Novák et al., 1992). Pegmatites form relatively small bodies (up to 1 m in thickness) enclosed in durbachites. Čech (1957) distinguished two types on the basis of different internal structure and mineral assemblages: I) small homogenous pods and segregations composed of K-feldspar, plagioclase, quartz, biotite, allanite, zircon and rutile, and II) more evolved, symmetrically zoned dykes. Zoned dykes consist of marginal, medium-grained granitic zone (Kfs + Qtz + Pl + Bt) locally transitional to the host durbachite, graphic zone (Kfs + Qtz ± Bt), blocky K-feldspar (locally amazonite) zone and occasionally quartz core. Medium- to coarse-grained albitic unit is either emplaced between quartz core and block zone, or forms irregular nests within blocky K-feldspar. Accessory minerals include: tourmaline, allanite, zircon, REE-Nb-Ta-Ti oxides, ilmenite, pseudorutile, Nb-rutile, titanite, beryl and phenakite (Čech et al., 1999; Novák and Čech, 1995). The presence of REE-Nb-Ta-Ti oxides, overall mineral paragenesis, characterized by scarcity of primary muscovite, spatial and genetic relations to the durbachite, suggest that these types of pegmatites may belong to the NYF family (see Černý, 1991), rare-earth type (Novák et al., 1992) and – according to the classification of NYF pegmatites (Wise, 1999) – to the euxenite subtype. Pegmatites are mostly metaalu-