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Emplacement of Syenite Intrusion into Transtensional Pull--Apart Domain: Structural Evidences and Magnetic Fabric of the Jihlava Pluton, Moldanubian Zone (Bohemian Massif)

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The Jihlava pluton crops out as NW-SE elongated Variscan intrusion in the high grade gneisses of the Monotonous and Gfohl Units of the Moldanubian Zone. It is composed of high K melasyenitoids comprising two main textural varieties: equigranular medium grained melasyenites and very fine grained syenitoid. Moldanubian country rocks, adjacent to the intrusion, are represented by biotite-sillimanite paragneisses. Further to the E, migmatized paragneiss occurs with small bodies of amphibolite, quartzitic and locally graphite gneiss. The boundary between Monotonous and Gfohl Units, delineated by numerous lenses of eclogites and interpreted as a deep-level thrust, is not clearly exposed in the study area. The main migmatite body is intruded by numerous small syntectonic bodies of leucocratic granitoids. The thermal aureole of the intrusion is patchily developed and marked by extensive melting of host gneisses and cordierite bearing nebulites. The syenite intrusion contains stoped blocks of host rocks predominantly composed of migmatised paragneisses up to 300 m in size.

In this study, we present structural and AMS data in order to asses structural evolution of the country rock – intrusion system and to interpret the possible emplacement mechanism of the Jihlava pluton. Structures of the pluton are characterised by the transition from magmatic to subsolidus fabric developed along intrusion margins. In general, the magmatic fabric is weak and its intensity varies across the pluton, from very weak in the central part to more intensely developed along intrusion margins. Magmatic foliation pattern is different in southern and northern parts of intrusion. In the southern part the magmatic foliations dip SE at steep angles, whereas in the north they dip NW. Magmatic foliation trajectories show sigmoidal geometry being locally sub-parallel to the margins of large stoped blocks. Other primary magmatic structures are rare, scarses chlieren layering, where preserved, is mostly parallel to the magmatic foliation.

Structures in Moldanubian country rocks are dominated by pervasive development of S2 regional metamorphic foliation with relics of isoclinaly folded earlier S1 foliation. The S2 foliation is dipping steeply NE and it bears sub-horizontal mineral lineations trending SE and NW-SE. Regional metamorphic fabric is affected by 2–5 km wide steep greenschist facies mylonitic shear zone (the Přibyslav mylonite zone). Mylonitic deformation reactivates or cross cuts the regional S2 fabric in anastomose manner. New mylonitic foliation generally dips steeply towards the N, NE, E and SE and bears sub-horizontal stretching lineation. S3-S2 foliation trajectories form sigmoidal pattern which is consistent with overall dextral kinematics of the shear zone, as indicated by numerous sense-of-shear criteria.

Magnetic fabric was investigated along two E-W oriented transects across the pluton and roughly corresponds to the orientation of observed mesoscopic magmatic fabric. Magnetic foliations are dipping at moderate angles to the SE, S and SW in the northern part of intrusion with magnetic lineations plunging at moderate angles to the SW. To the S, magnetic foliations are dipping to the NE, N and NW, magnetic lineations plunge moderately to the NW. Degree of anisotropy is very low throughout the intrusion suggesting magmatic origin of the AMS fabric. Magnetic ellipsoids are mostly oblate in the northern part, whereas along southern transect display both oblate and prolate shapes.

Based on our structural and AMS data we propose the following emplacement scenario for the Jihlava pluton. Uniform petrography and small textural variation suggest that the entire pluton was emplaced as a single magma batch. Our structural analysis indicates that the intrusion is independent from and very likely postdates sealing of the Gfohl Unit and Montonous Unit, since it does not follow the westerly deep-level thrust boundary between both units. We assume, that syenitoid magmas intruded syntectonically along a major shear zone and were emplaced into a dilational pull-apart jog. This dilational domain was opened as a result of local dextral transtension along the transcurrent shear zone which operated synchronously during pluton ascent. At the time of pluton emplacement, the high grade rocks of mostly lower crustal origin were already brittle, this fact indicates that the emplacement of plutons took place after exhumation and cooling of high grade rocks in shallow crustal levels. Our model is kinematically consistent with magma emplacement into pull-apart voids associated with transcurrent tectonics. (e.g. D´Lemos et al, 1992; de Saint Blanquat et al., 1998; Olazabal et al., 1999).

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Geological Position of Metabasites of the Kłodzko Metamorphic Unit

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The Kłodzko metamorphic unit occurs south of the Sowie Góry gneiss block. The pre-metamorphic sedimentary series were likely represented by tuffogenetic-sedimentary rocks associated with effusive-magmatic ones. The sedimentary sequence started with sandy and silty deposits which were subsequently metamorphosed into sericite phyllites having intercalations of graphite phyllites, metalydites and quartzites. The thickness of this sequence is unknown but certainly greater than 600 m. The sandy-silty deposits were overlain by 400–600 m thick sequence of sedimentary-pyroclastic-effusive deposits, which during regional metamorphism were transformed into chlorite, chlorite-epidote and epidote-amphibole slates, amphibolites with numerous interlayers of crystalline limestones, porphyroides and metarhyolites. This assemblage was in turn covered with (400–600 m) thick sequence of metadiabases, accompanied locally by metarhyolites, and graded northwestwards into gabbroid rocks (gabbro--amphibolite assemblage). Hence subaerial volcanism was accompanied by hypabyssal volcanism.

Mineral parageneses point to metamorphic transformations under conditions of greenschist facies (of Barrowian type?). A degree of metamorphism increases west- and southwards as manifested by the presence of almandine-amphibolite facies mineral assemblages (presence of garnet-bearing amphibolites – Wojciechowska, 1966). Recently, the petrological study of the Kłodzko metamorphic unit are provided by Kryza and Mazur (2001).

The geochemical studies of metabasic rocks of the Kłodzko metamorphic unit indicate that just within this metavolcanic complex represent a preserved fragment of submarine initial rift series (Fe, Ti-rich alkali basalts – Narębski, 1981; Narębski et al., 1988, 1989).

Examination of tectonic mesostructure (foliation, mesofolds, lineation) allowed to distinguish their mutually superposing generations. This indicates successive stadial development of deformations of successive phases D1-D4 (Wojciechowska, 1970, 1979). The age of metamorphism in the Kłodzko metamorphic unit can be determined indirectly as pre- Upper Devonian because in the eastern margin of the unit nonmetamorphosed Upper Devonian deposits are directly transgressively overlapping the crystalline basement (Bederke, 1924; Wojciechowska, 1966, 1979; Gunia, 1977). In the bottom part, these sediments contain a conglomeratic horizon consisting of poorly rounded and unsorted fragments of rocks of crystalline basement.

Three separate members were described in the crystalline basement of the Kłodzko metamorphic unit (Wojciechowska, 1966), each probably of different age: the lower member consists of blastomylonitic gneisses and amphibolites with distinct marks of diaphtoresis; to the intermediate member belong the sedimentary-pyroclastic-effusive deposits; and the youngest member includes the granitoids represent elements of the lower and intermediate member rejuvenated by granitization.

The Kłodzko metamorphic unit is cut by a number of dislocations that bear a character of overthrust or normal faults, which subdivide unit into a number of separate blocks (Wojciechowska, 1966). Among the more important dislocation lines distinguished in the Kłodzko metamorphic unit are the overthrust of Ścinawka, where the dynamic deformations have been partly affected by later blastesis; and overthrust of Łączna-Pagórek.

The sedimentary-pyroclastic-effusive deposits of the Kłodzko metamorphic unit correlate well with Silurian/Devonian rock series of the Central Europe. Good correlation of the Kłodzko metamorphic unit rock sequences with Barrandien and Ponikla Group of the eastern cover of the Karkonosze granite is especially important for any paleographic reconstruction. In recent data the pyroclastic-effusive sequence (Fe, Ti-rich alkali basalts) suggests the existence of a regional W-E running zone, probably boundary zone (suturing) between the Moldanubian zone