Cadomian Versus Variscan Fabrics in the Desná Dome Basement Rocks, East Sudetes

Andrzej ŻELAŹNIEWICZ[1], Robert BACHLIŃSKI[2], Izabella NOWAK[1] and Sergey A. SERGEEV[3]

[1] Intytut Nauk Geologicznych PAN, Podwale 75, 50-449 Wrocław, Poland
[2] Instytut Nauk Geologicznych PAN, Twarda 51/55, 00-818 Warsaw, Poland
[3] Center of Isotopic Research VSEGEI, Sr. Prospect VO 74, St. Petersburg, Russia

In northern Moravia, the Czech Republic, the so-called Silesian units form two antiformal domes in which NE-SW elongate Neoproterozoic basement cores are flanked by medium and low grade metasediments of Devonian age. The eastern unit is referred to as the Desná dome (DD) and its cover on the east and north is known as the Vrbno Group (VG). In the DD core, medium to high grade metamorphosed schists, paragneisses, orthogneisses, migmatites, and amphibolites occur, dated isotopically on zircons between 644 Ma and 502 Ma (Pb-Pb evaporation, Kröner et al. 2000). The VG comprises Devonian quartzites, arenites and mudstones which underwent multiphase deformation and low grade metamorphism dying out easterly in Late Carboniferous times. Although an Alpine-type nappe stacking is the most commonly accepted explanation of the Variscan tectonics in the Silesian units, many problems like kinematics and sequence of deformations and metamorphism, direction of thrusting, extensional vs. compressional regime during dome formation, backthrusting, etc. are still unclear and debated. In the basement rocks, migmatitic fabric is usually interpreted as a Precambrian feature while mylonitic fabric is usually taken as a Variscan overprint, but no more detailed discrimnating criteria have been given.

In the Głuchołazy area, East Sudetes, SW Poland, there are isolated outcrops of Neoproterozoic basement and its Devonian cover considered a continuation of the DD i VG from the Jeseníky Mountains. In one of the outcrops, biotite paragneisses contain disrupted and folded layers and pods of quartz-amphibole-epidote schists. There are also subalkali tholeiite sills turned to amphibolites boudins. The latter resemble the Písečna-type massive amphibolites from the nearest part of the Jeseník Amphibolite Massif assigned to the Devonian. In the outcrop, the three types of rocks are crosscut by felsic injections of muscovite pegmatites to grt-bearing aplites which later underwent folding and shearing. Such relationships help to distinguish pre- and post injection episodes in the structural history of the gneisses and allow to constrain timing of the two deformational episodes. The new data help to clear some of the above problems and create some new ones.

The felsic injections range from up to 40 cm thick dykes pegmatite dykes down to < 1 cm quartzo-feldspathic variably discordant to concordant veinlets. Thinner veins are deformed in open asymmetric to ptygmatic folds. Larger folds have in their opposite limbs "z-type" and "s-type" parasitic folds respectively, which testifies to buckling and flexure. The relevant strain ellipsoid indicates an overall top-to-the W kinematics of folding. Besides, strain appears to be localized in narrow shear zones that displace the veins W-ward by up to 70 cm. Parts of the veins which got into the shear zones may acquire geometry of sigma–type clasts with top-to-the W sense of transport. Such high strain shear zones are heterogeneously distributed with spacing of 50 to 120 cm. The intervening areas are subject to flattening which accomodated the other part of the overall shortening.

The biotite paragneiss is composed of bi-pl-qtz-grt(chl) assemblage forming the excellent foliation dipping gently to the east. On the foliation, biotite flakes are arranged in one direction which defines mineral lineation plunging gently E-ward (parallel with weak corrugation lineation related to late kink folds). In sections perpendicular to the lineation, asymmetric pods and sigma clasts derived from the foliation-parallel quartz segregations show variable sense of movements, top-to the E and top-to the W. The latter is interpreted as concurrent with the deformation of the veins. The former is clearly older than the felsic veins as they intersect quartz-amphibole-epidote layers and pods which were earlier folded and/or dismembered by the top-to-east shearing. The same is true about asymmetric boudins of the metabasite sills.

Zircons retrieved from the foliated pegmatitic vein were analyzed by SHRIMP II machine. They have typical magmatic Th/U ratio of 0.2-0.9 and on the concordia diagram show 3 clusters of U-Pb ages at: 1420 Ma, 615 Ma, and 575 Ma. The youngest group is interpreted as a time of pegmatite injection in the post-tectonic period. The other Neoproterozoic age group likely reflects the main thermal event (anatexis, magma underplating) in the basement connected with the reworking of Mesoproterozoic crust (the oldest group). Accordingly the deformational structures produced with top-to-east kinematics (normal at the present-day orientation of the foliation) must be considered Precambrian and related to Cadomian tectonics, the termination of which is constrained by the pegmatite intrusion of late magmatic stages at ca. 575 Ma. It is suggested that a remarkable share of mylonitic features observed in basement rocks and attributed to Variscan orogeny is in fact Cadomian, although these may be hard to distinguish in the field.

Muscovite fractions from the same foliated pegmatite yielded an Rb-Sr isochron age of 289±2 Ma. The result shows that the Rb-Sr system in the analyzed micas was presumably totally reset in Palaeozoic times. The obtained data seems to imply post-tectonic cooling and uplift (influence of the Žulová granite is unlikely because of 10 km distance) after the deformation that involved an important phase of W-vergent tectonics in which the felsic veins became foliated and folded. Regionally, this corresponds well with Ar-Ar cooling ages of ~290 Ma obtained for amphiboles and micas from the Žulová granite pluton (Maluski et al. 1995) and with Ar-Ar cooling ages of 285–279 Ma determined in white micas from the Devonian Jegłowa Beds in the Fore-Sudetic Block (Szczepański 2002). They all point to uplift of the Moldanubian Fault Zone footwall at the Carboniferous/Permian turn when the the easterly tectonic transport was eventually stopped. Timing and significance of the W-vergent phase are not well constrained. Considering the E/NE-vergent piling of Devonian-Carboniferous flysch, it may represent the retrothrust/fold deformation in the Desná basement backstop. This explanation would correspond well with the presence of the W-vergent Andělská hora thrust identified by Cháb (1990).

In general, the Carboniferous deformation of the Silesian units has been defined as top-to-the NE thrust movements (D2) and dextral transpressional shearing (D3) in narrow, steeply dipping NE-trending shear zones (Schulmann and Gayer 2000). In northern part, in the continuation of the Vrbno Group to Poland, the WNW/NW-trending folds with predominant SSW vergence (D2), NE-trending folds with NW vergence (D3) and NW-trending folds with NE vergence (D3) have been described by Żaba et al. (2005). Our observations in the Vrbno quartzites and quartz-staurolite-garnet schists next to the Desná gneiss outcrop indicate early contractional deformation with ~S-vergent folding and thrusting followed by transpressional deformation which gave rise to the moderately to steeply plunging folds developed in the N/NW-dipping steep shear domains with dextral kinematics (or E/SE-vergent folds if foliation is gently dipping). However, none of those observation is consistent with the formation of the W-vergent structures (giver their Variscan origin) in the basement gneisses and veins. Therefore, we expect a significant detachment to exist between the Precambrian basement and the Devonian-Carboniferous cover units on the eastern side of the Desná dome (part of the Andělská hora thrust system?).

Some doubts probably can also be cast on the assumed Devonian age of the Jeseník amphibolites. If the observed massive metabasite sills in Głuchołazy are truly equivalent to the Písečna amphibolites, than the Jeseník massif amphibolites, or parts of it, must be assigned to the Precambrian units, and the metabasists are only folded and thrust together with basement paragneisses and Devonian metasediments.

Yet another constrain for the regional geology may come from the K-Ar analyses of the muscovite samples from the studied pegmatite (M. Banaś, Kraków K-Ar Lab). They yield an age of 233 Ma. Having accepted that the K-Ar system in muscovites (with the blocking temperature of ~250 °) was also entirely homogenized till post-Variscan times, this data may imply that the slow uplift and cooling of the area was punctuated by Triassic event, possibly related to the onset of Pangaea rifting and break-up. Similar Ar-Ar low temperature extraction ages around 220 Ma were determined in the Silesian units by Maluski et al. (1995).

A by-product of our data is a strong confirmation that the Silesian crust does not originate from West Africa Craton in contrary to the Saxothuringian and Moldanubian crust. This would mean that the Ordovician rift zone envisaged in the Staré Město belt (Schulmann and Gayer 2000) went beyond the stage of the thinned continental crust, reached the stage of full oceanic separation, and the pre-rift Cadomian counterparts of the Silesian units cannot be located in the so-called Lugian domain of the West Sudetes.

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