

The Variscan Nappe Tectonic in the Ještěd Range and Jizera Gneiss Units: an Example of Juxtaposition of the Autochthonous and Allochthonous Domains in the West Sudetes

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The Ještěd Range Unit (JRU) and Jizera Gneiss Unit (JGU) are situated along the westernmost margin of the allochthonous Krkonoše-Jizera Terrane (KJT), (West Sudetes, N margin of the Bohemian Massif), and form the KJT boundary with the autochthonous Lusatian domain. The latter domain comprises Cadomian basement intruded by Cambro-Ordovician granitoids and is unconformably overlain by Cambrian(?) to Lower Carboniferous.

The JRU is a classical region of the West Sudetes where all structural models of the West Sudetes were basically established (Gallwitz 1930, Kodym, Svoboda 1948, Chaloupský et al. 1989, Chlupáč, 1994, Kachlík, Patočka 1998). The reason is that the most complete lithostratigraphic record (extending since Neoproterozoic up to Late Carboniferous) is preserved there. The above mentioned models may be characterized according to roles of individual orogenic cycles taken into account: (1) main tectonometamorphic features of the West Sudetes originated during Caledonian orogeny (Bederke 1924, Kodym, Svoboda 1948, Oliver et al. 1983, Johnston et al. 1994), and Variscan orogeny had only limited influence; (2) the architecture of the West Sudetes is a result of superimposed Grenvillian, Cadomian, Caledonian and Variscan tectonometamorphic cycles (Chaloupský et al. 1989); (3) the West Sudetes are a collage of terranes specifically displaying (a) protracted Early Palaeozoic rift-related bimodal volcanism and initial Cambro-Ordovician granitoid magmatism, (b) Late Devonian/Early Carboniferous subduction and HP-LT metamorphism followed by rapid uplift of deeply-buried crustal slices, and exhumation-related equilibration of the HP-LT rocks in greenschist-facies conditions, and (c) an E to W oriented delay in the onset of flysch sedimentation recently dated as Late Devonian to Early Carboniferous (Chlupáč 1993, Franke et al. 1993, Kachlík, Patočka 1998, Franke, Żelaźniewicz 2001, Marheine et al. 2002).

In the Ještěd Range Unit Chaloupský et al. (1989) distinguished a set of five lithostratigraphic groups separated by unconformities and long hiatuses caused by Grenvillian, Cadomian, early and late Caledonian and Variscan orogenies: (1) Mesoproterozoic Velká Úpa Group, (2) Neoproterozoic Machnín G., (3) Neoproterozoic to Early Cambrian Radčice G., (4) Late Ordovician to Early Devonian Poniklá G., and (5) Late Devonian to Early Carboniferous Jitřava G.

According to detailed geological mapping survey of the JRU (in the scale 1:10,000), lithostratigraphic, structural, geochemical and radiometric dating evidences (e.g. Kachlík, Patočka 1998, 2001, Kachlík, Kozdroj 2001, Marheine et al. 2002) only four lithostratigraphic groups (numbered above 2

to 5) may be distinguished in the areas of the JRU and the adjacent JGU. However, in contrary with Chaloupský et al. (1989), the juxtaposition of these four groups is interpreted as a result of early(?) to late Variscan shearing and ductile thrusting.

The Lusatian autochthonous domain is exposed along the northern boundary of the JRU as the basement (foreland) of the overlying Palaeozoic lithotectonic units. The basement is composed of the Neoproterozoic flysch sequence of the Machnín G. intruded by Cadomian Lusatian granodiorites (of the Zawidów type) and Cambro-Ordovician porphyric granite (of the Rumburk type). The granitoids (exposed to the NW of the Ještěd Mt., in the Nisa River valley between Hrádek n. Nisou and Chrastava) are only weakly foliated and underwent Variscan LT cataclastic deformation and mylonitization which were usually associated with growth of white mica dated at 320 Ma (Marheine et al. 2002). The intensity of deformation and metamorphic grade increases to the E both in the Zawidów type granodiorite and the Rumburk type granite.

These porphyric granitoids are transformed to various types of the Jizera granitoid gneisses in the allochthonous JGU. In the high strain domains near the contact with late Variscan Krkonoše-Jizera Pluton the granitoid gneisses appear as various types of banded gneisses, pearl gneisses and sometimes even as fine grained ultramylonitic leucocratic gneisses marked as leptynites in the map by Chaloupský et al. (1989). The local LP-HT deformation and recrystallization of the granitoid gneisses was connected with heat energy provided by the Krkonoše-Jizera Pluton.

Relics of metasediments are often imbricated within the JGU high strain domains (to the N of Libverda, in the Jeřice River valley NE of Chrastava). In contrast with older maps (Chaloupský et al. 1989) based only on lithology, the metasediment remnants may be assigned to the Machnín G. in the areas to the E of Chrastava and to the NE from Nové Město pod Smrkem. The metasediment relics situated near Horní Vítkov to the E of Hrádek nad Nisou and in the N surroundings of Libverda as well as in the area of Raspenava (where they show strong contact metamorphic overprint by the Krkonoše-Jizera Pluton) may be correlated with the Poniklá G. metasediments. An alternation of Neoproterozoic and Early Palaeozoic rocks within the JGU (the former involve the Machnín G. metasediments void of contact metamorphism!) suggests that several overthrust zones existed in the JGU prior to its updoming due to an emplacement of the Krkonoše-Jizera Pluton, and juxtaposed the Neoproterozoic and Early Palaeozoic rocks mentioned before. Following that, the JGU doesn't seem to be a simple

paraautochthonous unit exposed along a boundary dividing the Lusatian and KJT autochthonous and paraautochthonous domains (cf. Mazur, Alexandrowski 2000). On the contrary, it is suggested that some parts of the Jizera and Krkonoše granitoid gneisses as well as smaller gneiss bodies were involved (and phyllonitized) during large scale Variscan shearing and thrusting widespread throughout the KJT (from the JRU to the E Krkonoše Complex) – (cf. Kachlík et al. 1999, Kachlík, Kozdroj 2001, Marheine et al. 2002).

The structural relation of the Lusatian and KJT autochthonous and allochthonous domains may be illustrated in detail on the example of the JRU. Early Palaeozoic rocks (phyllites with metachert intercalations, Silurian Ockerkalk limestones) there were thrust over palaeontologically documented Middle to Late Devonian limestones (Chlupáč 1998) forming part of uncomformable cover of the Lusatian domain (e.g. Kachlík, Kozdroj 2001, Kachlík et al. 1999, 2002). The boundary of the autochthonous and allochthonous domains is marked by a number of small bodies of phyllonitized low-grade porphyritic granitoid gneisses (exposed to the SW of Machnín, and at the pálený vrch Hill to the E of Kryštofovo údolí). The phyllonitized gneisses together with the imbricated metasediments (limestones, \pm sericite quartzites) acted as tectonic lubricants both here and also further to the E (to the E of the Ještěd Mt., and along the JRU boundary with the S Krkonoše Complex).

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Ammonium Content in the Hercynian Granites of the Western Carpathians and its Petrogenetic Significance

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Ammonium is generally distributed as a trace constituent of sedimentary, metamorphic as well as igneous rocks. Inasmuch the pelitic metasediments frequently have ammonium contents of several hundreds of ppm, it was stated by Urano (1971) that these rocks can be a source of NH_4^+ in granitic magmas. Detailed geochemical studies within the last two decades have shown that ammonium may be a useful tool in igneous petrology because it is a sensitive petrogenetic indicator of sedimentary involvement in magmatic rocks (Iihara and Honma, 1983; Hall, 1987; summary in Hall, 1999) and/or a tracer of hydrothermal alteration of igneous rocks (Krohn and Altaner, 1987; Hall et al., 1991). The presence of the ammonium ion (NH_4^+) in igneous and metamorphic rocks has been detected by Stevenson (1962), Urano (1971) and Honma and Iihara

(1981). These studies have proved that most granites contain detectable trace amounts of ammonium in the rock-forming minerals (K-feldspar, muscovite and biotite) as an isomorphous substitute for potassium. It can participate in such processes as diagenetic recrystallization, metamorphic reactions or crystal fractionation. As the content of ammonium in granitic rocks is commonly variable (10–100 ppm) with the average value of 45 ppm (Hall, 1999), it may be also modified by contamination and hydrothermal alteration.

Granitic rocks form an important constituent of the basement of the Western Carpathians. Indeed, this mountain range represents a direct eastern continuation of the Eastern Alps and their present edifice is Alpine in age. The Hercynian basement within the Alpine–Carpathian orogenic belt was disrupted and