parautochthonous 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 porphyric 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, ±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 (Itihara 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 Itihara (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 sliced into blocks, which were incorporated into the Alpine (nappe and/or terrane) complexes and subsequently uplifted to a different degree during the Alpine collisional tectonic events. This polyorogenic history makes the reconstruction of the Hercynian structures rather difficult, but provides excellent exposure of various levels of the Hercynian crust. The Hercynian granitic rocks occur in all three superunits of the CWC (the Tatricum, Veporicum and Gemericum) in various positions. In response to different geotectonic settings, different genetic types of granites were formed in the Western Carpathians over the time interval of 100 million years (360–250 Ma). Lower Carboniferous crustal thickening, Upper Carboniferous delamination, and Permian transtension resulted in S-, I- and A-type granite-forming events, respectively (Petrík and Kohút, 1997).

A reconnaissance ammonium study was carried out on 40 selected representative Hercynian granitic rocks from the Western Carpathians. Ammonium was separated by distillation, using the classical method of Urano (1971), and its contents were determined at Philips TU 8670 VIS/NIR spectrophotometer. Although ammonium content of the Western Carpathians granites is rather variable, our research confirmed the commonly accepted opinion that the content of ammonium increases from more basic to more felsic granitic rocks, with the following mean values: diorites 17.8 ± 3.8 ppm, I-type granites 25.4 ± 8.7 ppm, S-type granites 36.0 ± 17.6 ppm. Not surprisingly, muscovite-bearing leucogranites within the Western Carpathians S-type granites have the highest values of ammonium (47.2 ± 18.4 ppm). However, most of the $NH_4^+$ data overlap and a general dividing line between I- and S-type granitic rocks cannot be drawn. Noteworthy are the local differences within independent Core Mountains, e.g., ammonium content in granites of the Velká Fatra Mts. is generally low (11–36 ppm, aver. 19.5 ppm) but rather high in the Malé Karpaty Mts. (40–57 ppm, aver. 47.7 ppm). Interestingly, no principal differences were found between I/S type rocks albeit all ammonium values within each pluton are either low or high. Hall (1999) suggested that there is no significant correlation between $NH_4^+$ and any individual major and trace element, although some correlation with alumina saturation index (ASI) exists. This was fully confirmed by our research, where metaluminous granites yielded low ammonium contents and strongly peraluminous ones are dominated by higher values of $NH_4^+$, although an overlap within subaluminous and mildly peraluminous I/S-type granites is obvious. However, the wide variability of data can be also explained by the fact that additional ammonium was derived from the country rocks via assimilation processes.

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# Oblique Collision and the Evolution of Large-Scale Transcurrent Shear Zones in the Neoproterozoic Kaoko Belt (NW Namibia)

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The Kaoko orogenic belt represents a NNW–SSE-trending branch of the Damara orogenic belt system, which probably developed as a result of Neoproterozoic (ca. 550 Ma) collision between the Congo and Kalahari cratons of the present Africa, and the Rio de la Plata craton of the present South America. The most prominent structure of the Kaoko belt is the ~400 km long Puros shearzone (PSZ), which can be traced from southern Angola up to the Atlantic coast in central Namibia. In the central part of the Kaoko belt, the PSZ separates two units with distinct metamorphic and structural evolution. East of the PSZ, the tec-