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

Milan KOHÚT1 and Adam PIECZKA2

1 Dionýz Štúr Institute of Geology, Mlynská dolina 1, 817 04 Bratislava, Slovakia
2 University of Mining and Metallurgy, Mickiewicza 30, 30-059 Krakow, Poland

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 NH4 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 (Iithara and Homna, 1983; Hall, 1987; summary in Hall, 1999) and/or a tracer of hydrothermal alteration of igneous rocks (Krohn and Altaner, 1981; Hall, 1991). The presence of the ammonium ion (NH4) in igneous and metamorphic rocks has been detected by Stevenson (1962), Urano (1971) and Homna and Iithara (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 diageneric 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 Gemenicum) 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 Carpathian 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 NH₄⁺ 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 NH₄⁺ and any individual major and trace element, although some correlation with alunina 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 NH₄⁺, 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.

References


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

Jiri KONOPASEK¹, Stephan KRÖNER¹, Shawn-Leslie KITT², Cees PASSCHIER¹, Alfred KRÖNER¹ and Karl-Heinz HOFMANN²

¹ Institut für Geowissenschaften – Tektongophysik, Universität Mainz, Becherweg 21, 55099 Mainz, Germany
² Geological Survey of Namibia, P.O. Box 2168, Windhoek, Namibia

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-