Petrogenesis of Associated Metaferrolites and Graphitic Metaquartzites (Southern Veporicum Basement, Slovakia)

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Layers of graphitic metaquartzites and metamorphosed ferruginous schists (Šuf, 1938; Zoubek and Nemčok, 1951; Korikovskij at al., 1989) occur approx. 3 km W of Kokava n./Rimavicou. They are associated with various types of garnet-biotite gneisses, migmatites, granitoides, pure quartzites and amphibolitic rocks in subsidiary amount. Fundamental metamorphic reworking constrained to the middle amphibolite facies (ca. 600 ± 50 °C, 4–5 kb, according to Miyano and Klein, 1986; Fonarev, 1985; Ghent and Stout, 1981, a.o.) took place during the Hercynian regional metamorphism. In places, magmatic assimilation occurred, with orientated relics of graphitic substances enclosed in granitic rocks. Monotonous graphitic metaquartzites are composed of 90–95 vol.% of quartz and of variable amount of graphite, muscovite (phengite) and plagioclase in some domains. Graphite is more-or-less uniformly distributed in the rock texture, indicating a large amount of nucleation centres. It is mostly randomly orientated and grew along the boundaries of quartz grains. The average grain-size is 0.2–0.3 mm; local coarse crystals (up to 1 mm) appear mainly at contacts with micas. Noteworthy is the very fine carbonaceous pigment scarcely enclosed in some quartz grains. This textural phenomenon expresses relic inclusions of organic matter, which did not migrate during the metamorphism. Two important factors controlling the higher accumulation of graphitic matter are to be mentioned: primary organic matter, preferentially concentrated in some nearly pure quartzite layers/laminae or at contact with muscovites, and ductile shearing in quartz-rich rheology (partial dissolution of quartz grains due to strong flattening) led to parallel alignment of graphite crystals and to the increase in graphite content. Arithmetic mean of $\delta^{13}C$ in the examined graphites give the value of −27.78 (n = 11, s.d. = 0.66). Neither the metamorphism nor the local granitic injections changed the $^{13}C/^{12}C$ ratios, which should reflect the original isotopic character of organic matter. As suggested by isotopic data (Hoefs, 1973; Hladíková, 1988) and petrographic textures, the most probable carbon protolith is bituminous material, particularly that of planktonic origin.

Magnetite is a frequent constituent in characteristic metamorphic mineral assemblages: garnet (almandine) – amphibole (grunerite) – apatite (1–3 vol.%) ± biotite (annite), quartz, chlorite (brunsvigite), graphite and allanite. At least six basic petrographic rock types of ferruginous gneisses can be distinguished. Locally, fine-grained magnetite, apatite, grunerite, (biotite, chlorite) enclosed in the garnet, can indicate their pre- and/or early-metamorphic origin. Grunerite is present in different petrostructural positions (porphyroblasts, fine-grained aggregates, needles, swarms), which reflect polygenetic metamorphic reactions. The occurrence of magnetite results from a complex combination of many factors. A case study of ferruginous rocks shows an affinity of magnetite to more pronounced pelitic lithologies (indicated mainly by higher content of Al_2O_3), which also corresponds to the higher amounts of Fe^{3+}. The original Eh of certain beds seems to determine the character of crystallization (e.g., ilmenite vs. magnetite or grunerite vs. magnetite) in the process of regional metamorphism. Ferrolites of sedimentary (to diagenetic) mineral assemblage like chamosite – Fe-oxides (incl. magnetite?) – quartz – siderite are presumed as the pre-metamorphic source of these rocks. Deposition of sandstones, ferruginous accumulations, black quartzites, and the presence of apatite-rich laminae in these rocks support an idea about a shallow marine sedimentary facies (e.g., Kukal, 1991). The unique presence of (meta)ferrolites among the more common gneissic rock assemblages indicates a specific depositional environment, which can be attributed to a bay or a deltaic system prograding to a shelf area. It may be assumed that these rocks marked a regressive phase of the Early Paleozoic (Devonian?) sedimentary cycle.

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