COMPOSITIONAL EVOLUTION OF Nb-Ta-OXIDE MINERALS FROM ALKALI-FELDSPAR MUSKOVITE GRANITES HOMOLKA AND ŠEJBY, SOUTHERN BOHEMIA, AND ITS COMPARISON WITH OTHER RARE-ELEMENT GRANITES

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Several new occurrences of leucocratic rare-element granites have been found during the last decade within the southern Bohemia region. They are located mostly along the western margin of the Central Massif of the Moldanubian Batholith, and the Homolka (S of Jindřichův Hradec) and Šejby (S of Nové Hrady) stocks are suggested to be most outstanding ones. Both localities exhibit many similar features in their geology, petrology and geochemistry, indicating them to be close relatives. They form post-tectonic bodies, up to 3 km in size spatially associated with granitoid rocks of the Central Massif of the Moldanubian Batholith and metasediments of its envelope (Šejby). Predominant medium-grained to locally fine- and/or coarse-grained alkali-feldspar muscovite granite seems to be relatively homogeneous in a mineral composition; major minerals include quartz, albite, K-feldspar, and muscovite to lithium muscovite; minor to accessory minerals - topaz, apatite, Mn-, Fe-phosphates, biotite, cassiterite, ferrocolumbite, ilmenite, and fluorite. Fine-grained varieties of the muscovite granite and muscovite + K-feldspar + quartz pegmatite (Stockscheider) are typical in marginal endocontact zones. Relatively abundant granite porphyry, as well as rare greisen (Homolka) are also present. Abundance and geological setting of single rock types at both localities indicate that Šejby represents a rather less eroded apical part of granite cupola. Placer deposits rich in cassiterite, ferrocolumbite, wolframite, and ilmenite are common, particularly in the vicinity of the Homolka stock.

Geochemistry of granites at both localities is characterized by high contents of SiO_2: 72.6 - 74.1 (73.2 - 76.1), Al_2O_3: 14.7 - 15.6 (14.3 - 16.0), P_2O_5: 0.70 - 0.97 (0.32 - 0.70). Na_2O: 3.82 - 4.76 (3.70 - 4.24), Rb: 1060 - 1560 (525 - 967), Nb: 47 - 150 (30 - 54) and low contents of CaO: 0.28 - 0.64 (0.29 - 0.72), MgO: < 0.05 (0.04 - 0.08), Ba: 50 (30), and Zr: 20 - 30 (5 - 27); (data from Šejby in parentheses, oxides given in wt.%, elements in ppm). Geochemical characteristics summarized above demonstrate that both localities represent highly fractionated peraluminous granites, and rather less degree of the geochemical fractionation of the Šejby granite is suggested.

Rare Nb-Ta-oxide minerals commonly form microscopic inclusions within abundant cassiterite, and within rare niobian rutile (both in Homolka), however, isolated grains, mostly below 1 mm but sporadically 10 mm in size (Šejby), occur at both localities. The inclusions are W, Ti, Sn, Fe^{3+}-rich in cassiterite and, Ti, Fe^{3+} rich in niobian rutile, almost homogeneous to slightly heterogeneous. Isolated grains of ferrocolumbite, mostly characterized by low W, Ti, Sn, Fe^{3+} contents, display

oscillatory zoning and locally associate with ferrotapiolite (Šejby). All types of ferrocolumbite from the Homolka granite exhibit similar ranges of composition in terms of Mn/(Mn + Fe) = 0.01 - 0.31, and Ta/(Ta + Nb) = 0.03 - 0.05; titanian ferrocolumbite inclusions in niobian rutile are Mn-low. Ferrocolumbite-ferrotantalite at Šejby yielded almost the same degree of fractionation in Mn/(Mn + Fe) = 0.06 - 0.31 (two analyses 0.42 - 0.45), but increase ratio Ta/(Ta + Nb) = 0.11 - 0.55. Ferrocolumbite from Homolka is characterized by wide compositional ranges: WO_3 = 10.11 - 1.04, TiO_2 = 6.48 - 1.01, and SnO_2 = 4.10 - 0.00, whereas the Šejby ferrocolumbite-ferrotantalite yielded relatively low contents of WO_3 = 2.79 - 0.33, TiO_2 = 3.52 - 0.71 and SnO_2 = 0.23 - 0.00 (all oxides given in wt.%). Two distinct trends of compositional evolution of minor elements were recorded. Ferrocolumbite inclusions in cassiterite from Homolka exhibit a good positive correlation Ta/(Ti + Sn), and rather insignificant positive correlation Ta/W. However, isolated grains of ferrocolumbite from both localities do not show any correlation of these elements with the major oxides. Increased W, Ti and Sn contents in the columbite inclusions, and abundant wolframite and Ti-oxide minerals such as niobian and tantalian rutile, rutile, ilmenite and pseudorutile indicate high activity of these elements in the Homolka region. On the contrary to the less fractionation of granitic rocks in Šejby, composition of Nb-Ta-oxide minerals from this locality exhibits rather higher degree of fractionation, particularly in the Ta/(Ta + Nb) ratio.

A comparison of both studied localities and other rare-element granites, based on overall mineral paragenesis and chemical composition of Nb-Ta-oxide minerals, yielded two distinct types. 1. Muscovite granite (Homolka and Šejby, Czech Republic; Greer Lake, Manitoba, Canada) contains abundant ferrocolumbites and rare ferrotantalite (ferrotapiolite), whereas pyrochlore is absent. 2. Lepidolite-bearing granite (Meldon, Great Britain; Beauvoir, France) is characterized by predominant manganocolumbite to manganotantalite and abundant microlite (pyrochlore). Muskovite granite from Phuket (Thailand) with predominant manganocolumbite may represent an intermediate member, as well as zinnwaldite to protolithionite granites from Cínovec (Czech Republic), characterized by abundant ferrocolumbite and pyrochlore. However, presence of common Fe-Li-micas and pyrochlore might rather indicate an independent type. The suggested classification of rare-element granites is based on the compositional evolution of Nb-Ta-oxide minerals and overall mineral paragenesis of granite. Despite the fact, that both types of rare-element granite are significantly distinct in their paragenesis, and compositional trends of Nb-Ta-oxide minerals in rare-element granites are similar to those of rare-element pegmatites; e.g. muscovite granite - beryl pegmatites (with muscovite), lepidolite granite - pegmatites of the lepidolite subtype, more thorough study of numerous rare-element granites is required to confirm and precise this classification.