

**(⁸⁷Sr/⁸⁶Sr)₀ isotope and geochemical
(F, Cl, REE) heterogeneity in apatite
and titanite mineral populations from
magmatites of Shakhtama Cu-Mo
porphyry deposit, Eastern
Transbaikalia, Russia**

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⁴⁰Ar/³⁹Ar and Rb-Sr dating at the Shakhtama Cu-Mo porphyry deposit (Eastern Transbaikalia, Russia) documents complex and prolonged development of magmatic events. Several pulses of magmatic events are established at the deposit (based on ⁴⁰Ar/³⁹Ar analyses): 202±1.8, 193±3, 167±1.6 Ma – host granitoids of plutons; 159-157 Ma – granite porphyries; 151±152 Ma – dikes of ore-bearing diorite porphyries; 147±145 Ma – postore dikes. Rb-Sr dating yielded an age of 187±7 Ma for the host granitoids. A significant time gap between porphyry magmatites and preceding host granitoids determines in many respects geological features of the deposit, heterogeneity of isotope and geochemical characteristics in accessory and rockforming minerals.

Apatites and titanites from unaltered host rocks (granodiorites, aplites) yield ⁸⁷Sr/⁸⁶Sr range from 0.70717 to 0.70747 close to initial 0.70734 (Rb-Sr isochron). Apatites from hydrothermally altered rocks (potassic alteration, sericitization, argillization) are characterized by ⁸⁷Sr/⁸⁶Sr ratios between 0.70712 and 0.70802. Early generations of titanites (magmatic) yield ⁸⁷Sr/⁸⁶Sr range from 0.70772 to 0.70850, late generations of titanites (secondary) - before 0.71232±22.

Elevated ⁸⁷Sr/⁸⁶Sr values in secondary minerals can be explained as reflecting contamination of radiogenic ⁸⁷Sr, extracted from biotites and amphiboles of host rocks under the influence of later porphyry magmatic events. The difference in ⁸⁷Sr/⁸⁶Sr between secondary apatites and titanites can be explained by the difference of forming processes: titanite was formed under the influence of metasomatic solutions; apatite was formed mainly according to topotaxial mechanism.

Igneous and metasomatic minerals differ in Cl, F and REE contents. Metasomatic minerals are characterised by relatively elevated F contents and relatively lowered Cl and REE (especially Ce) contents. F, Cl and REE distribution in minerals is complicated by multistage magmatic processes and the influence of overprinted metasomatic mineralizing processes. Such processes resulted in recrystallization of minerals and redistribution of elements.

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**Petrology of tourmaline-rich
pegmatites from the Ravne district
(Slovenia).**

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In the Ravne district (Eastern Alps, northern part of Slovenia) more than 300 pegmatite veins, ranging from few centimetres to more than ten metres, are found within the metapelites and metacarbonates, which were formed during prograde Variscan metamorphism and were reworked by the Eoalpine event. Tourmaline-rich pegmatites and metamorphic rocks are part of the Ravne crystalline that appertain to the south-eastern part of the Austroalpine Crystalline Complex of Lower Paleozoic age. The pegmatite veins are massive and mostly concordant within the host metapelites and metacarbonates. No systematic structural, textural or compositional zoning has been observed.

Pegmatites consists of albite, quartz, K-feldspar, muscovite, tourmaline (schorl-dravite series), and trace of garnet (almandin, with high spessartine content), beryl, apatite, zircon, sphene and uraninite. Pegmatites have SiO₂ in the range 64.4-88.8 wt.%, are peraluminous, (A/CNK_{mol} up to 1.6), and are enriched in Na relatively to K (Na₂O/K₂O up to 8.60). Major and trace elements show poor correlation with SiO₂, except for Al₂O₃ (r = -0.85), Cs (r = -0.92), Ta (r = 0.93) and Sn (r = -0.96). Total REE content ranges from 2.09 to 70.59 ppm, with Eu/Eu* ranging from 0.82 to 2.47.

Mineralogical and chemical characters of the investigated pegmatites are consistent with a continental collision -type tectonic setting (Maniar and Piccoli, 1989). Although no absolute radiometric age is at present available for pegmatite, field and stratigraphic relationships suggest they were formed during Variscan orogeny. Sodium-rich granitic melts, which produced tourmaline-rich pegmatites could have been produced by partial melting of greywacke protoliths under H₂O-saturated conditions in the presence of a chloride solution (Kilinc, 1972). As an alternative, the greater amount of normative albite may have been obtained by high level of boron in the melt (Breaks and Moore, 1992).

References

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