NEW FINDINGS OF RARE MINERALS IN RUSSIA. PART II

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In 2019, *Mineralogical Almanac* published our paper about new findings of rare minerals from Former Soviet Union countries (Kasatkin, 2019). Most of those findings came from the Russian Federation, with many mineral species being discovered here for the first time and their description accompanied by analytical information led to substantial replenishment of mineral cadastre of our country. Over the past two years, domestic collectors and mineral amateurs found new specimens at various deposits and occurrences and sent to the author of these lines for identification. We also followed our work on restudy of old specimens from museums and private collections by modern analytical methods. As a result, a number of rare mineral species were identified including those, which were not previously mentioned in the Russian Federation. A clear need to document these findings was the reason to continue the theme begun in the aforementioned publication of 2019. In addition, the present article considered as the second part of that paper (Kasatkin, 2019) includes a description of several rare minerals found before 2019, but not listed in the first part for various reasons. In this connection, it is worth to mention charoite. It is hard to find collector who did not hear this name. Magnificent specimens of this world-famous mineral, which was considered as endemic of the Murun alkaline complex in the Eastern Siberia are deposited in any serious collection. However, not everyone knows that in the summer of 2018, we discovered charoite for the second time at Patynskiy massif in Kemerovo Oblast and those data without special emphasis were published in the paper on a new mineral patynite. Even if charoite from Patynskiy massif is not comparable to the one from Murun Massif in beauty, grain size, and amounts of produced material, the new finding of this mineral in Russia is very noteworthy and certainly deserves a special description.

In contrast to the first part describing findings from not only Russia, but other republics of the Former Soviet Union, this paper is focused on the minerals discovered in our country only. The description of 58 minerals species is given below; almost two thirds of this number were found in the Russian Federation for the first time.

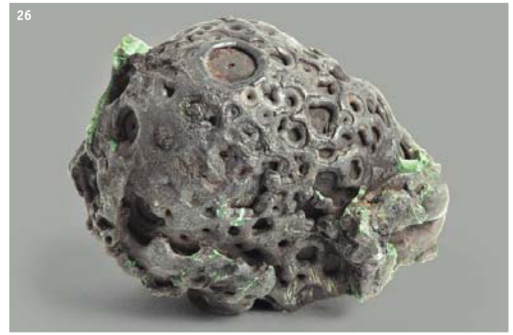
Like the first part, the described minerals are grouped under regions, within which minerals follow in alphabetical order. At some important localities (Kamenushinskoe, Murzinskoe, Khovy-Aksy deposits and Patyn massif), several rare minerals were found. In such cases, the minerals are described in the framework of corresponding locality.

Karelia

Boltwoodite $K(UO_2)(SiO_3OH) \cdot 1.5H_2O$ and **sklodowskite** $Mg(UO_2)_2(SiO_3OH)_2 \cdot 6H_2O$, the two rare uranyl silicates, have been identified in the sample #71337 from the collection of the Fersman Mineralogical Museum, Russian Academy of Sciences. The specimen was donated by Alexander N. Labuntsov and registered in the museum collection in 1968 as "clarkeite" from the Chkalov pegmatite vein in the Chkalovskoe pegmatite field, Loukhskiy District, Northern Karelia; however, we were unable to confirm clarkeite using analytical instruments. The orange-yellow transparent segregations up to 1 mm in size, which are probably pseudomorphs after uraninite crystals, turned out to be boltwoodite, while pale-yellow powdery very thin crusts and coatings – sklodowskite. Boltwoodite is embedded in rock composed of albite, calcite, and annite while sklodowskite and associated yellow fine-grained uranophane overgrow it (*Figs* 1, 2).

The chemical composition of boltwoodite containing minor Ca and Pb is (wt. %; the H_2O content is calculated by stoichiometry): K_2O 7.13, CaO 2.02, PbO 5.56, SiO_2 13.34, UO_3 63.29, H_2O 8.16, total 99.50. It corresponds to the empirical formula: $(K_{0.67}Ca_{0.16}Pb_{0.11})USi_{0.98}O_5(OH) \cdot 1.5H_2O$ calculated on the basis of 7.5 O atoms.

Sklodowskite contains minor Cu probably substituting Mg; its chemical composition is (wt. %; the H_2O content is calculated by stoichiometry): MgO 2.94, CuO 3.52, SiO_2 13.40, UO_3 65.01, H_2O 14.28, total 99.15. This composition corresponds to the empirical formula: $(Mg_{0.64}Cu_{0.39})_{\Sigma 1.03}U_{2.01}Si_{1.97}O_{10}(OH)_2 \cdot 6H_2$calculated on the basis of 18 O atoms.



26. Black powdery crusts of **crednerite** with subordinate **pyrochroite** overgrow large botryoidal **malachite**. Kamenushinskoe deposit, Gurievskiy District, Kemerovo Oblast. 6 x 5 x 3 cm. Specimen: Anatoly V. Kasatkin. Photo: Anastasiya D. Kasatkina.

27. Small hexagonal prismatic crystals of sea-green **spangolite** (*left*) on black **delafossite** with blue acicular crystals of **cyanotrichite** (*right*) which is overgrown by spherulite of light green acicular **brochantite**. Kamenushinskoe deposit, Gurievskiy District, Kemerovo Oblast. Field of view 1.5 x 1 cm. Specimen and photo: Vladimir S. Lednyov.

28. Cluster of **spangolite** crystals. Kamenushinskoe deposit, Gurievskiy District, Kemerovo Oblast. Field of view 1.9 x 1.9 mm. Specimen: Anatoly V. Kasatkin. Photo: Maria D. Milshina.

Pyrochroite, $Mn^{2+}(OH)_2$, has been identified from powdery crusts developed after malachite stalactites and nodules using the X-ray diffraction (*Fig.* 26). Crednerite is the major constituent of these crusts, whereas pyrochroite is subordinate.

According to electron microprobe data, Mn and Cu strongly dominate (with Mn > Cu) while Ca and Zn are detected in traces amounts. A number of strong reflections of crednerite and pyrochroite are overlapped in the powder X-ray diffraction pattern of this mixture; however, pyrochroite is unambiguously determined from reflections at 4.74, 1.83, 1.66, and 1.23 Å, which are absent in crednerite. The hexagonal unit cell parameters calculated from the powder X-ray diffraction pattern are a = 3.3114(3), c = 4.758(1) Å, V = 45.18(1) Å^3.

Spangolite, $Cu_6Al(SO_4)(OH)_{12}Cl \cdot 3H_2O$, has been found as sea-green transparent hexagonal prismatic crystals up to 1 mm overgrowing delafossite or limonite and associated with azurite, brochantite, gibbsite, carbonate-cyanotrichite, cuprite, and cyanotrichite (*Figs* 27, 28).

The chemical composition of spangolite is (wt. %; the H_2O content is calculated by stoichiometry): CuO 60.11, Al_2O_3 6.32, SO_3 10.14, Cl 3.10, H_2O 20.77, O = Cl -0.70, total 99.74. It corresponds to the empirical formula: $Cu_{6.00}Al_{0.98}S_{1.01}O_4(OH)_{12.31}Cl_{0.69} \cdot 3H_2O$ calculated on the basis 17 anions and 3 H_2O molecules. The hexagonal unit cell parameters are a = 8.2884(19), c = 14.669(4) Å, V = 872.7(4) Å^3 (single crystal X-ray diffraction data).

Spangolite was previously described by Popova and Popov (2003) as blue micrograins embedded in "cuprononthronite" from products of weathered serpentinites at the Ishkininskoe deposit in the Southern Urals. Our finding is probably second at the territory of Russian Federation.