



## **Geochemical study of self-restoration of soils and plants after mining of the Urup copper-zinc pyritic deposit in the Northern Caucasus**

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The geochemical study of self-restoration of soils was conducted for mine wastes consisting of rocks and ores being stacked for 50 and more years at the Urup copper-zinc pyritic deposit in the Northern Caucasus. Initial processes of soil formation were described at rare spots of mine spoils with the sizes up to 15×15 m. Such technogenic soils are distinguished by the raised contents of Ag, Cd, Cu, Li, Mn, Mo, Ni, Pb, V, W, and Zn relatively to the averaged abundances of the elements in the Earth's soils. However, some high contents may be explained by geochemical properties of the regional undisturbed forest soils: when comparing natural and technogenic soils, the latter is characterised by the elevated contents of Ag, Cu, Ni, Pb, Sn, W, and Zn.

Geochemistry of the forming soils is influenced not only by the composition of rocks making up the dumps but also by pollution coming from the enrichment factory and tailings. Thus, soils at the territory of the Urup factory (less than 0.1 km<sup>2</sup>) are exposed to air emissions of ore processing and characterised by accumulated Ag and Cu (enrichment factor = 100s), Zn, Ba, and Pb (10s), Cd, Co, and Mo. Analogously, contents of the metals in the tailings (97 ha) correlate to the levels in poor ores. The metals migrate to the surrounding areas via air and water pathways.

Botanical and biogeochemical peculiarities of plants are important features describing changes and restoration of soils and landscapes in general. Local spots of a plant cover exist at the fifty-year-old dumps of the Urup mine and close to the nearby tailings; slopes of dumps and tailings are totally bare. Not more than 10 % of the species variety succeeded to inhabit the mine site and not more than 5 % of the species survived at the dumps.

At the moment, rare disintegrated plant communities consisting of 1 to 5 trees of 3 to 10 species (*Quercus petraea* (Matt.) Liebl., *Carpinus betulus* L., *Pinus kochiana* Klotzsch ex K. Koch., *Betula pendula* Roth, *Picea orientalis* (L.) Link, etc.), without grasses and bushes, up to 10 m in height, occupy spots that measure 30 to 300 m<sup>2</sup>. Intra-level green mosses and *Cladonia* bushy lichens are sporadically distributed at the spots of soil formation. The plants are morphologically disturbed: dwarfism, dry tops, necrosis of leaves and needles, slowed growth and development of shoots, and several branches of a tree. Average contents of Ag, Ba, Li, Ni, Pb, Sr, and Zn in the ash of plants of the dumps at the Urup mine are higher than in the averaged ash of terrestrial plants. Contents of Ag, Co, Cu, Li, Mn, Mo, Ni, Pb, W, and Zn in plants of the dumps surpass the levels in surrounding forests.