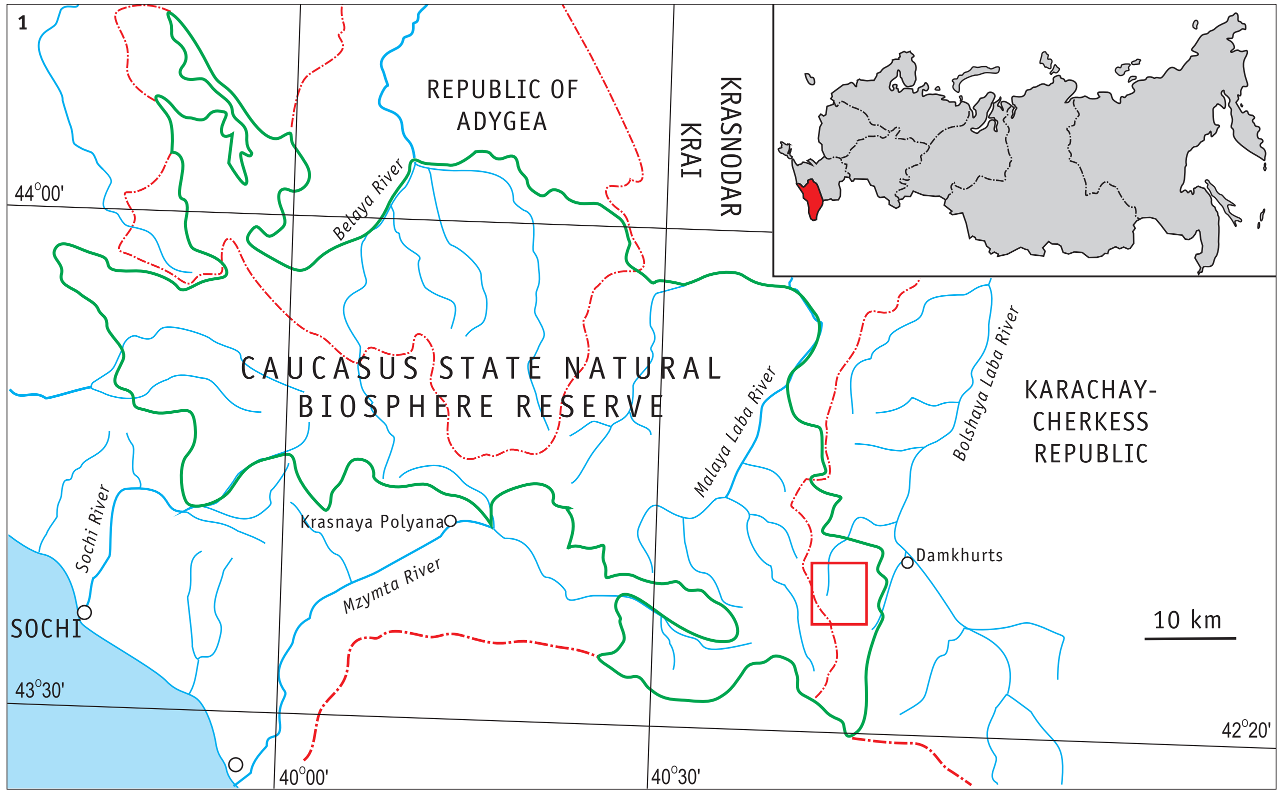

NEW MINERAL LOCALITY IN RUSSIA – SHAPOSHNIKOV CAUCASUS STATE NATURAL BIOSPHERE RESERVE (IMERETINSKY SITE)

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1. Geographical location of the Shaposhnikov Caucasus Biosphere Reserve, scheme by A.S. Nemtsev. *Boundary of the reserve is marked by green line.* The Imeretinsky site is marked by red square.

2. Imeretinka glacial lakes. View of 2700 m a.s.l. August, 2021. Photo: Lubov V. Badyanova.

3. Imeretinka upstream. September 2020. Photo: Lubov V. Badyanova.

The Caucasus State Natural Biosphere Reserve named after Khachatur G. Shaposhnikov is located in the western part of the Great Caucasus in the Belaya, Malaya Laba, Bolshaya Laba, Shakhe, Sochi, and Mzytma Rivers upper reaches. It is demarcated with 43°30'–44°05' N and 36°45'–40°50' E. The Reserve is located in the territory of three regions of the Russian Federation: Krasnodar Krai, Republic of Adygea and Karachay-Cherkess Republic, covering an area of 2803 km^2 (*Fig.* 1).

The Reserve was established by a decree of the Council of People's Commissars of the Russian Soviet Federation Socialist Republic on May 12, 1924 as Caucasus Bison Reserve, as its main purpose was to preserve the Caucasus bison. In the 1940–1960s, the population of this rare animal was restored, and today there are more than a thousand bisons in the reserve.

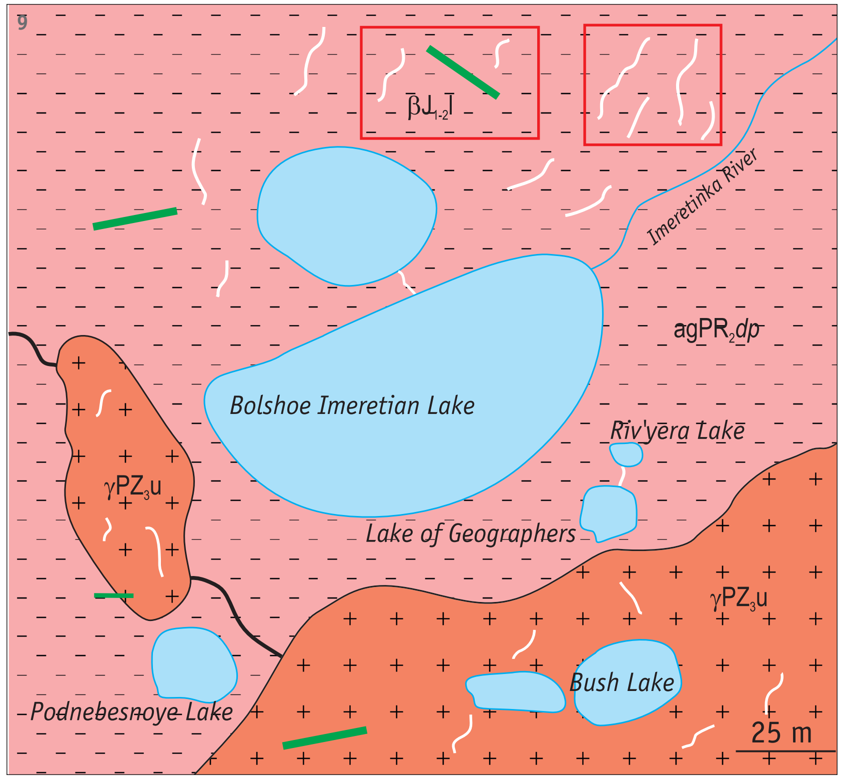
In 1979, by decision of UNESCO, the Caucasus Reserve was given biosphere status among the first six Soviet reserves. It was included in the International Network of Biosphere Reserves, representing the world's major ecosystems. In 1999, the Caucasus Reserve was one of the first in the Russian Federation to receive the highest international status, which can only be granted to specially protected natural areas – the status of the UNESCO World Natural Heritage Site.

In 2007, the reserve was named after Khachatur (Christopher) Georgievich Shaposhnikov (12.03.1872–25.01.1938), the Soviet biologist who founded the reserve.

Currently, the Reserve is a nature protection, research and environmental education institution operating on the basis of the Charter approved by the Order no. 181 of the Ministry of Natural Resources and Environment of The Russian Federation of April 11, 2014. The main objective of the Reserve is the preservation and studying of natural processes and phenomena, the genetic stock of plant and animal life, individual species and communities of plants and animals, typical and unique ecological systems.

The Reserve's scientific activities are extensive and include a wide range of research in the fields of biology, geophysics, soil science, meteorology, monitoring of ecological systems, etc. These studies are actively popularized on tourist routes: the most interesting information about the flora and fauna of the reserve is posted on banners and contained in booklets.

On the territory of the reserve originates beautiful mountain Imeretinka River (*Fig.* 3), and there are extremely picturesque relic glacial lakes, called Imeretinskie (*Figs.* 2 and 4),



9. Geological sketch map of the Imeretinsky site, modified after Lavrishchev *et al.* (2002).
Legend:
(1) granites of the Ullukam Complex (γPZ_3u);
(2) Duppukh amphibolite-gneiss Complex ($agPR_2dp$);
(3) laura dolerite dike complex ($\beta J_{1-2}l$);
(4) waters;
(5) fault (bold black line);
(6) quartz veins.
Collecting and sampling areas are outlined by red.

10. Talus 50 m higher of quartz veins. Host rock is quartz-mica schist of the Duppukh Complex. Elevation 3000 m a.s.l. September, 2020. Photo: Lubov V. Badyanova.

11. Outcrop of dolerite of the Laura dike complex. Podnebesny Pass, 2900 m a.s.l. August, 2021. Photo: Lubov V. Badyanova.

led by calcite and rimmed by chlorite are present in the last rock (Lavrishchev *et al.*, 2002).

The mineralized hydrothermal veins are hosted by the Neoproterozoic and Late Paleozoic rocks. Less than ten vein outcrops were observed. The disoriented veinlets up to 25 cm thick are more abundant than large veins up to 1 m thick. The veins are composed of white medium to coarse-grained (grain size up to 1 cm) and massive quartz, although most veins are limonitized and therefore are ochre-colored. Rounded druse cavities up to 20 cm in diameter are observed in the veins. Veins are complicated by numerous apophyses, a system of small veins. Fragments of the Duppukh rocks are present within the veins. Visible thickness of quartz veins is up to 1.5 m and length is 15–20 m.

Galena, pyrite, and chalcopyrite are the major sulfide minerals in quartz veins. All ore minerals are highly oxidized; chalcopyrite is mostly replaced by malachite.

According to Lavrishchev *et al.* (2002), copper mineralization is genetically related to the Early to Middle Jurassic basic magmatism. At the Imeretinsky site, this mineralization is related to dolerites of the Laura dike complex (*Fig.* 11).

Minerals

As of November, 1, 2021, we identified 50 mineral species at the Imeretinsky site of the Caucasus Reserve with equal number of hypogene and supergene species – 25 each (Table 1). They are all described in varying degrees of detail in this chapter. Minerals are arranged by chemical classes and within classes – alphabetically.

Sulfides

Sulfides are abundant in hydrothermal quartz veins and veinlets.

Galena occurs as lead-gray cubic crystals up to 1.5 cm, aggregates, and granular masses often covered by iridescent films. The largest crystals are present within druse cavities in quartz veins. Galena is overgrown by white powdery coatings and fine-grained crusts of anglesite and cerussite.

Covellite is the only supergene sulfide that we observed at the site. It occurs as segregations up to 0.1 x 0.1 mm developed after anglesite, including at the contact of the latter with galena and is associated with caledonite, linarite, and cerussite. The mineral was identified using electron microprobe (only Cu and S with the 1:1 ratio) and by its typical optical properties.

Pyrite is ubiquitous; it forms cubic crystals up to a few mm, aggregates of the crystals, and compact fine-grained masses up to 3–4 cm across. Pyrite is coated by brownish thin films of iron hydroxides. Some pyrite crystals are completely replaced by limonite.

Sphalerite is less frequent than other hypogene sulfides. It occurs as black fine-grained segregations up to 1 mm in size in quartz and is associated with anglesite, beaverite-(Zn), goethite, malachite, cerussite, and Zn-bearing chamosite. Sphalerite is a source of Zn for some rare supergene minerals, which we observed

Table 1. ***Minerals of the Imeretinsky site of the Shaposhnikov Caucasus State Natural Biosphere Reserve***

Mineral	Formula	Abundance I	Abundance II
Sulfides			
Galena	PbS	++++	
Covellite	CuS		++
Pyrite	FeS_2	++++	
Sphalerite	ZnS	+++	
Chalcopyrite	$CuFeS_2$	++++	
Halidys			
Buttgenbachite*	$Cu_{19}(NO_3)_2(OH)_{32}Cl_4\bullet 2H_2O$		+
Pseudoboleite*	$Pb_{31}Cu_{24}Cl_{62}(OH)_{48}$		+
Chlorargyrite	$AgCl$		+
Oxides and hydroxides			
Bayerite	$Al(OH)_3$		+
Vernadite	$(Mn^{4+},Fe^{3+},Ca,Na)(O,OH)_2\bullet nH_2O$		+++
Goethite	$FeO(OH)$		++++
Doyleite*	$Al(OH)_3$		+
Ilmenite	$Fe^{2+}Ti^{4+}O_3$	+++	
Quartz	SiO_2	++++	
Nordstrandite	$Al(OH)_3$		+
Rutile	TiO_2	+++	
Chromite	$Fe^{2+}Cr_2O_4$	++	
Carbonates			
Azurite	$Cu_3(CO_3)_2(OH)_2$		+++
Aurichalcite	$(Zn,Cu)_5(CO_3)_2(OH)_6$		+++
Bastnäsite-(Ce)	$Ce(CO_3)F$	+	
Hydrozincite	$Zn_5(CO_3)_2(OH)_6$		++
Calcite	$CaCO_3$	+++	
Malachite	$Cu_2(CO_3)(OH)_2$		+++
Rosasite	$(Cu,Zn)_2(CO_3)(OH)_2$		+
Cerussite	$PbCO_3$		+++
Carbonate-sulfates			
Caledonite	$Pb_5Cu_2(SO_4)_3(CO_3)(OH)_6$		++
Leadhillite	$Pb_4(CO_3)_2(SO_4)(OH)_2$		++
Sulfates and selenite-sulfates			
Anglesite	$PbSO_4$		+++
Beaverite-(Cu)	$Pb(Fe^{3+}_2Cu)(SO_4)_2(OH)_6$		+
Beaverite-(Zn)*	$Pb(Fe^{3+}_2Zn)(SO_4)_2(OH)_6$		+
Brochantite	$Cu_4(SO_4)(OH)_6$		++
Linarite	$PbCu(SO_4)(OH)_2$		++
Cyanotrichite	$Cu_4Al_2(SO_4)(OH)_{12}\bullet 2H_2O$		+++
Munakataite*	$Pb_2Cu_2(Se^{4+}O_3)SO_4(OH)_4$		+
Phosphates			
Xenotime-(Y)	YPO_4	+	
Monazite-(Ce)	$CePO_4$	++	
Silicates			
Augite	$(Ca,Na)(Mg,Fe,Al,Ti)(Si,Al)_2O_6$	+++	
Allanite-(Ce)	$CaCe(Al_2Fe^{2+})[Si_2O_7][SiO_4]O(OH)$	++	
Albite	$Na(AlSi_3O_8)$	+++	
Hemimorphite	$Zn_4Si_2O_7(OH)_2\bullet H_2O$		++
Diopside	$CaMgSi_2O_6$	+++	
Clinochlore	$Mg_5Al(AlSi_3O_{10})(OH)_8$	+++	
Muscovite	$KAl_2([AlSi_3O_{10}](OH,F)_2$	++	
Titanite	$CaTi(SiO_4)O$	++	
Ferri-barroisite	$\square(NaCa)(Mg_3Fe^{3+}_2)(Si_7Al)O_{22}(OH)_2$	+	
Ferri-kaersutite	$NaCa_2(Mg_3Fe^{3+}Ti)(Si_6Al_2)O_{22}O_2$	+	
Forsterite	Mg_2SiO_4	+++	
Hingganite-(Y)	$Y_2\square Be_2[SiO_4]_2(OH)_2$	+	
Chamosite	$(Fe^{2+},Mg,Al,Fe^{3+})_6(Si,Al)_4O_{10}(OH,O)_8$	+++	
Epidote	$Ca_2Al_2Fe^{3+}[Si_2O_7][SiO_4]O(OH)$	+++	

Notes: (I) hypogene minerals, (II) supergene minerals.
Mineral abundance:
(++++) major gangues and ore minerals, (+++) common minerals,
(++) minor minerals, (+) rare minerals.
(*) first finding of the mineral at the territory of Russian Federation.

at the Imeretinsky site, such as aurichalcite, hydrozincite, rosasite, beaverite-(Zn), and hemimorphite.

Chalcopyrite is common as small brass-yellow fine-grained aggregates with bright iridescence on the surface. The grain size is up to 2–3 mm. The mineral is associated with galena, pyrite, goethite, linarite, and malachite.

Halides

Buttgenbachite is a minor constituent of pale blue powdery crust on the surface of quartz-schists (*Fig.* 12 a,b). This fine-grained crust of 2 to 3 mm in thickness is composed mainly of a mixture of three $Al(OH)_3$ polymorphs: bayerite, doyleite and nordstrandite, while buttgenbachite small admixture causes its pale blue color.