The mineral diversity of the Urdini Lakes and the glacial valley of the Urdina River (Rila Mountain) – an overview

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Abstract. An overview of different types of mineralization in the area of the Urdini Lakes and the glacial valley of the Urdina River (northwestern Rila Mountain) has been made. Currently, it is the only protected area for minerals in Bulgaria. In this area, mainly pegmatite, but also skarn and alpine-type mineralizations, have been found to date. Of particular interest are the hybrid desilicified type pegmatites containing emerald, aquamarine and chrysoberyl crystals and the extremely rare native aluminum. The skarn mineralizations from this area are characterized by wollastonite, diopside, garnet (grossular, andradite), zoisite, clinozoisite, scapolite, vesuvianite and others. In the alpine-type mineralizations, well-formed crystals of quartz, adular, epidote and pyrite, as well as nests of almandine with albite, were observed as recrystallization of the minerals previously formed in the cavities of the host rocks. These cavities may also occasionally contain zeolites.

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INTRODUCTION

The glacial valley of the Urdina River, northwestern Rila Mountain, is well known for its beautiful and plentiful nature. It contains rare endemic species, such as the Rila primrose (*Primula deorum*), the Bulgarian avens (*Geum bulgaricum*), the rhapontic rhubarb *Rheum rhaponticum*, and many others (see Asenov *et al.*, 2015, and references therein). This area is inhabited by diverse alpine fauna, including various large and small mammals, birds, reptiles and insects (*ibid.*). The richness of flora and fauna, as well the mineral diversity, was the reason this valley was declared a natural landmark for the protection of rare minerals, plants and animals (State Gazette, 1985). This is the first unique natural museum in Bulgaria among the rich inanimate and living natural diversity. This account is a brief over-

view of the various types of mineralization from the region of the Urdina River, which still remains the only protected area for minerals in Bulgaria. The minerals were genetically listed and some of the most characteristic mineral species were illustrated.

BACKGROUND AND PREVIOUS STUDIES

The current alpine landscape of the Rila Mountain was modeled during the maximum of the Würm glaciation, after which the characteristic glacial cirques, trough valleys, pyramidal peaks, as well as many glacier lakes (Fig. 1) were formed (*e.g.*, Yanakiev, 1957; Sinnyovsky, 2015). The glacial valley of the Urdina River, northwestern Rila, is located between the peaks Ushite, Malyovitsa, Golyam and Malak Mramorets, Dodov, Damga,

Fig. 1. Panoramic view of the Urdini cirque lakes from Damga peak, Rila Mountain.

and the ridge of Zeleni Rid. At its lowest point, it ends in the Golyama Urdina River (Fig. 2). The area of the valley is composed of various high-grade metamorphic rocks, such as biotite and amphibole-biotite gneisses, quartz-containing amphibolites, different types of magmatites and dyke rocks, as well as significant “pegmatite fields” (see Sinnyovsky, 2021, and references therein). In places, layered marble bodies and calcite-dolomite lenses occur. These lenticular bodies contain a rich association of more than 40 magnesium- and titanium-bearing minerals, *e.g.*, forsterite, spinel, gikilite (Fig. 3a) (see also Arnaudov *et al.*, 2012). Layered skarnoid bodies (Fig. 3b), genetically related to the regional metamorphism of clayey-calcareous sediments, are also present (Petrussenko, 1969). So far, 90 pegmatite minerals have been described from the Rila Mountain area (Arnaudov, 1975). Of them, more than 80 minerals are from the glacial valley of the Urdina River. In addition, about 35 skarn minerals, as well as minerals from ultramafic rocks and alpine-type veins, were also found (see Table 1).

On the slopes of the Zeleni Rid Ridge and the Golyama Urdina River, in gneisses, amphibolites

and marbles, small lenticular bodies of harzburgites, usually chloritized and alkalized, crop out (Bonchev, 1912; Dimitrova, 1960). They are associated with chromium spinelides and talc with numerous clinocllore and tremolite veins (Fig. 4a). The chromium content gives a deep green color in emerald and fuchsite (Zhelyazkova-Panayotova *et al.*, 1972).

PEGMATITE MINERALIZATION

Of the various types of pegmatites found in north-western Rila, the most widely represented in the glacial valley of the Urdina River are those of microcline-plagioclase, with basic plagioclase, potassium feldspar, quartz, muscovite $\pm$ biotite and garnet (Arnaudov, 1974). Another type of pegmatites is the so-called hybrid pegmatites, *i.e.*, desilicified and skarnoid pegmatites (Petrussenko *et al.*, 1966; Arnaudov and Petrussenko, 1968; Arnaudov, 1975, 1976). The desilicified ones were formed after the interaction between solutions rich in Si, K, Na, Ca, P, Be, Nb, Ta, and the basic rocks, which in turn have a contrastingly different elemental composition and are enriched in Fe, Mg, Mn, Cr, Ti,

Fig. 2. Distribution of minerals in the Urdini Lakes protected area and the glacial valley of the Urdina River. Legend: 1 – border of the protected territory; 2 – border between the Rila National Park and the Rila Monastery Natural Park; 3 – marked tourist route; 4 – path; 5 – characteristic point with GPS coordinates; 6 – river; 7 – lake; 8 – alpine-type mineralization; 9 – ultrabasite with talc, tremolite and clinocllore; 10 – beryl-bearing pegmatite; 11 – skarn mineralization; 12 – emerald.

and V. Some new minerals, such as phlogopite and amphiboles, were formed. Potassium feldspar disappeared, the presence of quartz is limited, and the predominant mineral is plagioclase (oligoclase). Various titanium minerals, as well as chlorites, talc, prehnite and corundum also occur (Petrussenko *et*

al., 1966). In these pegmatites, there are also dark green emeralds and aquamarine (Fig. 4b–e), associating with chrysoberyl (including alexandrite), fuchsite, apatite, bismuthite, as well as with the extremely rare native aluminum (Fig. 4f; see also Arnaudov, 2006).

Table 1
Mineral species and varieties discovered in the glacial valley of the Urdina River, Rila Mountain

Mineral species and varieties	Distribution rate	Types of rocks and mineralizations	Mineral species and varieties	Distribution rate	Types of rocks and mineralizations
Native aluminum	x	4	Magnetite	+	1, 2, 3, 4, 5
Actinolite	+	3,4	Microcline	+	1, 5
Adular	x	6	Moissanite	*	4
Albite	+	4	Molybdenite	*	4, 5
Amphibole	+	1, 3, 5	Monazite	*	4
Anatase	*	4, 6	Muscovite	+	1, 4
Anthophyllite	+	3, 4	Olivine	+	3
Apatite	*	1, 2, 4, 5	Oligoclase	+	1, 4
Beryl		4	Opal	+	6
– Aquamarine	*	4	Orthite	*	1, 4
– Emerald	*	4	Pennine	x	3
– Goshenite	*	4	Periclase	*	2
Margarite–Be	*	1	Picroilmenite	*	2
Bismuth	*	4	Pyrite	+	1, 4, 5
Bismuthinite	*	4, 5	Pyrrhotite	*	3, 4
Bismuthite	*	4	Rutile	*	1, 2, 4
Vesuvianite	+	5	Serpentine	+	3
Wollastonite	*	5	Sillimanite	x	1
Gahnite	*	4	Scapolite	+	
Galena	x	4	– Meionite	+	4, 5
Galenobismutite	x	4	– Mizzonite	+	4, 5
Geikielite	*	5	Talc	+	3, 4, 5
Garnet	+		Columbite–Tantalite	*	4
– Almandine	+	1, 4	Titanite	+	1, 2, 4, 5
– Andradite	+	5	Thomsonite	x	6
– Grossular	+	4, 5	Tremolite	+	3, 4, 5
– Spessartine	*	4	Phlogopite	+	2, 3, 4, 5
Diopside	+	2, 3, 4, 5	Fluorite	*	4
Kyanite	*	1, 4	Forsterite	*	2
Dolomite	x	2, 3	Fuchsite	*	4
Enstatite	*	3	Chabazite	x	6
Epidote	+	1, 3, 4, 5, 6	Chalcopyrite	*	4, 5
Ilmenite	*	1, 2, 3, 4, 6	Hastingsite	x	1
Calcite	+	1, 2, 3, 4, 5, 6	Hematite	*	1, 4, 5, 6
Quartz	+	1, 4, 5	Chlorite	+	3, 4, 6
– Amethyst	*	6	Chrysoberyl	*	4
– Milky quartz	+	6	Chromite	*	3
– Rock crystal	+	6	Zircon	+	1, 2, 4
Clinocllore	+	3, 4, 6	Zoisite	x	1
Clinozoisite	*	4, 6	Cirrolite	*	4
Columbite	*	4	Spinel	*	2, 4
Xenotime	*	4			

Types of mineralizations and rocks: 1 – gneisses, amphibolites, shales; 2 – marbles, calcifications; 3 – ultrabasites; 4 – pegmatites, aplites; 5 – skarn mineralization; 6 – alpine-type mineralization. Distribution: x – rare; * – common; + – widespread.

Fig. 3. Forsterite and spinel in dolomite marble (a); skarnoid containing diopside, grossular, scapolite, vesuvianite and quartz (b) from the Urdini Lakes area.

Fig. 4. Characteristic minerals from the Urdini Lakes area: a) tremolite (Zeleni Rid); b) emerald crystal with plagioclase and phlogopite; c) the largest emerald crystal found in Bulgaria; d) aquamarine crystal in pegmatite; e) emerald subparallel aggregate at the base with goshenite; f) native aluminum in desilicified pegmatite (courtesy of Asen Ignatov).

Fig. 5. Characteristic minerals from the Urdini Lakes area: *a*) scapolite (Golyama Urdina River); *b*) scapolite (Urdini Lakes); *c*) optically anisotropic andradite (cross-polarized light, $\times 100$); *d*) vesuvianite, long-prismatic crystal and whiskers (Golyama Urdina River); *e*) grossular in skarn.

SKARN TYPE MINERALIZATION

Upon the contact of pegmatite solutions, in an environment rich in Ca and Mg, typical skarn minerals, such as diopside, grossular, scapolite and vesuvianite, were formed. Rarely, beryl is also present. During such interaction, K-feldspar disappeared, but plagioclase, allanite and zoisite remained. The skarns are represented by calcium-magnesium and iron-bearing minerals: wollastonite, diopside, garnet (grossular, andradite), zoisite, clinozoisite,

scapolite and vesuvianite (Petrussenko, 1987). According to a previous paragenetic analysis, these minerals were formed in the temperature range of 600–540 °C at depths of 1–1.5 km, as the source of heat and hydrothermal solutions was granite magmatism (Zharikov, 1985; Petrussenko, 1987). Under conditions of sodium metamorphism, plagioclase in pegmatites became unstable and was replaced by scapolite (Fig. 5*a, b*), up to 30 cm, and optically abnormal andradite crystals (Fig. 5*c*). From the alkaline metasomatic solutions, an abun-

dant contribution of Mg, Al, Ca and Fe came, and the increased amount of volatile components, such as F and OH, led to the formation of vesuvianite in the form of long-prismatic up to 10 cm zonal crystals and whiskers (Fig. 5d). Recrystallized grossular crystals (Fig. 5e) on diopside were also discovered.

ALPINE-TYPE MINERALIZATION

The alpine-type mineralization displays scarce occurrence. It is observed mainly as recrystallization of previously formed minerals in cavities in the form of well-formed individuals of quartz, adular, epidote, and pyrite, or as layered strips and nests of almandine with some albite in pegmatites. Thomsonite and habazite may also occur. In places, among the alpine-type of mineralization, there are light green beryl crystals grown in cavities of leached emerald, turning into water-clear crystals (goshenite) (Fig. 4e).

CONCLUDING NOTES

The area of the Urdini Lakes and the glacial valley of the Urdina River, Rila Mountain, is a site of special scientific interest, in which more than 140 different minerals have been discovered to date. Of these, pegmatite minerals are of particular significance. Of no less importance are also the skarn minerals, as well as those of the alpine-type mineralizations. A notable part of them have made the Rila Mountain region famous in the world of mineralogy and collections. Therefore, the mineral diversity of this area is an integral part of the geological heritage of the Rila-Rhodope massif, which requires careful preservation and publicity.

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