MINERALS

More than 80 mineral species are found in hydrothermal veins and the oxidized zone of the Belorechenskoye deposit (Table 1). It is expedient to subdivide them, with some arbitrariness, into three groups: "veiny", ore and hypergenic. They are characterized in this present section in that order.

Veiny Minerals

Barite is not only the single commercial mineral resource of the deposit, but it is also the most famous among the collectible minerals of the Belorechenskoye. It has a wide variety of morphologies and occurs as beautiful specimens. Despite its various habits, its "face" is characteristic and easily recognizable.

The main mass of barite is concentrated substantially in barite veins. It is represented here by aggregates of intimately intergrown platy individuals, often filling the whole vein body. The axial parts of the veins are characterized by numerous cavities whose walls are covered by crusts of barite crystals, sometimes excellently formed, overgrowing fluorite and galena crystals, and yet again often covered by aggregates of calcite crystals.

It is possible to distinguish three barite generations. The earliest among them is represented by two types of segregations, different in occurrence conditions, morphologiy and color. The first one is represented by fine-grained pink barite (1-a), composing extensive parts of symmetrically zoned veins. The size of its individual crystals does not exceed a few tenths of a millimeter. The second type (barite 1-b) is represented by coarsely crystalline aggregates of light grey color. It is the main component of most veins. Along with compact and massive accumulations of individuals, it forms spheroidal, platy aggregates, reaching several centimeters across. Simultaneously with the barite 1-b, galena and sphalerite crystallized. Barite crystals of the same generation incrust walls of most cavities.

The second generation had two stages of nucleation. Earlier prismatic crystals (barite 2-a) form groups, overgrowing the barite nd fluorite of the first generation. Later barite (2-b) occurs as flattened crystals, ingrown at their bases into crystals of the barite 2-a and forming inductive surfaces of simultaneous growth with them.

The latest generation (barite 3) is represented by platy crystals overgrowing all previously formed minerals in cavities.

Goniometric measurements on the Belorechenskoye barite crystals revealed faces of 20 different crystal forms. In the barite veins of the deposit. one might distinguish three main morphologic crystal types of this mineral. The first type are individuals of prismatic habit with the most developed faces being {102},

Parallel intergrowth of **calcite** crystals upon **barite** with sprinkling of **marcasite**. 5 cm. Collection and photo: B.Z. Kantor.

Table 1. Minerals of the vein complex and oxidation zone of the Belorechenskoye deposit

Mineral	Formula	Distribution			
		I	II	III	IV
	Native elements				
Silver	Ag		+		
Arsenic*	As		++		
Graphite	C	++			
Sulfur*	S				+
	Arsenides, antimonides, sulfoarsenides and sulfoantimonides				
Nickeline*	NiAs		++++		
Breithauptite*	NiSb		++		
Rammelsbergite*	$NiAs_2$		+++		
Pararammelsbergite	$NiAs_2$		+		
Krutovite**	$NiAs_2$		++		
Nickelskutterudite	$NiAs_3$		+		
Gersdorffite*	NiAsS		+++		
Ullmannite*	NiSbS		++		
Arsenopyrite	FeAsS	++			
	Sulfides and sulfosalts				
Chalcocite	Cu_2S	+		+	
Galena*	PbS		++	++++	
Sphalerite*	ZnS	++	++++	++++	
Metacinnabar ?	HgS		+		
Cinnabar	HgS		+	+	
Pyrrhotite	$Fe_{1-x}S$	++			
Millerite*	NiS		++		
Realgar**	AsS		++		
Stibnite**	Sb_2S_3			+	
Molybdenite	MoS_2	++			
Marcasite*	FeS_2		++	++++	
Pyrite*	FeS_2	++	+++	++++	
Vaesite	NiS_2		+		
Chalcopyrite*	$CuFeS_2$	++	++	+++	
Violarite	$FeNi_2S_4$		+		
Polydymite	$NiNi_2S_4$		+		
Proustite	Ag_3AsS_3		+		
Pyrargyrite*	Ag_3SbS_3		++		
Pyrostilpnite*	Ag_3SbS_3		+		
Miargyrite ?	$AgSbS_2$		+		
Aramayoite ?	$Ag_3Sb_2(Bi,Sb)S_6$		+		
Fahlerz ?	$Cu_{10}M_2X_4S_{13}$, where M = Fe, Zn, X = As, Sb		+		
Geocronite ?	$Pb_{14}Sb_6S_{23}$		+		
	Fluorides				
Fluorite*	CaF_2		+++	++++	
	Oxides and hydroxides				
Arsenolite**	As_2O_3				++
Hematite	Fe_2O_3		++		++
Uraninite*	UO_2		++++		
Quartz*	SiO_2	++++	+++	+++	++
Hausmannite**	$Mn^{2+}Mn_2^{3+}O_4$			+	
Coronadite**	$Pb(Mn_7^{4+}Mn^{2+})_{\Sigma 8}O_{16}$				++
Goethite*	FeOOH		+		+++
Oxides of Ti	TiO_2	++			

	Carbonates				
Calcite*	$CaCO_3$	++	+++	++++	+++
Siderite	$FeCO_3$	+			
Dolomite*	$CaMg(CO_3)_2$	+	++++		
Ankerite**	$CaFe(CO_3)_2$		++		
Aragonite**	$CaCO_3$				++
Strontianit*	$SrCO_3$			++	
Cerussite**	$PbCO_3$				++
Malachite*	$Cu_2CO_3(OH)_2$				+++
Azurite*	$Cu_3(CO_3)_2(OH)_2$				++
Schröckingerite**	$NaCa_3(UO_2)(CO_3)_3(SO_4)F•10H_2O$				++
	Sulphates				
Barite*	$BaSO_4$		++	++++	
Anglesite**	$PbSO_4$				++
Gypsum*	$CaSO_4•2H_2O$				+++
Melanterite**	$FeSO_4•7H_2O$				++
Brochantite**	$Cu_4(SO_4)_2(OH)_6$				+
Antlerite**	$Cu_3(SO_4)_2(OH)_4$				+
Devilline**	$CaCu_4(SO_4)_2(OH)_6•3H_2O$				+
Serpierite**	$CaCu_4(SO_4)_2(OH)_6•3H_2O$				+
Jarosite*	$KFe_3(SO_4)_2(OH)_6$				+++
Plumbojarosite**	$PbFe_6(SO_4)_4(OH)_{12}$				+
	Phosphates				
Fluorapatite	$Ca_5(PO_4)_3F$	++			
Autunite	$Ca(UO_2)_2(PO_4)_2•10\text{-}12H_2O$				+
	Arsenates				
Pharmacolite**	$Ca(AsO_3OH)•2H_2O$				++
Rösslerite**	$Mg(AsO_3OH)•7H_2O$				+
Hörnesite**	$Mg_3(AsO_4)_2•8H_2O$				++
Parasymplesite**	$Fe_3(AsO_4)_2•8H_2O$				+
Annabergite*	$Ni_3(AsO_4)_2•8H_2O$				+++
Picropharmacolite**	$Ca_4Mg(AsO_3OH)_2(AsO_4)_2•11H_2O$				++
Nováčekite**	$Mg(UO_2)_2(AsO_4)_2•9\text{-}12H_2O$				+
Uranospinite ?	$Ca(UO_2)_2(AsO_4)_2•10H_2O$				+
Metazeunerite	$Cu(UO_2)_2(AsO_4)_2•8H_2O$				+
	Silicates				
Coffinite*	$U[(SiO_4)_{1-x}(OH)_{4x}]$		++		
Hemimorphite**	$Zn_4[Si_2O_7](OH)_2•H_2O$				+
Kaolinite*	$Al_2[Si_2O_5](OH)_4$	+	++	++	++
Dickite**	$Al_2[Si_2O_5](OH)_4$			++	+++
Halloysite**	$Al_2[Si_2O_5](OH)_4•0\text{-}2H_2O$				++
Muscovite	$KAl_2[AlSi_3O_{10}](OH)_2$	+++			
Chlorite	$(M,Al)_6[(Si,Al)_4O_{10}](OH)_8$, where M = Mg, Fe	+++	++		
Albite	$Na[AlSi_3O_8]$	+++			
Microcline	$K[AlSi_3O_8]$	++++			

Note: I – feldspar-quartz veins, II – dolomite veins, III – essentially baritic and related to them (sulfide-calcitic, fluoritic, etc.) veins, IV – hypergene formations.

Degree of mineral distribution: ++++ – major vein and ore minerals, +++ – common minerals, ++ – minor minerals, + – rare minerals. * – minerals of the Belorechenskoye deposit, studied by the authors; ** – minerals, found for the first time at the deposit by the authors; ? – mentioned in the mineralogical literature, but diagnostics seems doubtful.

During compilation of the table, we used the following publications: Dymkov *et al.*, 1970; Zubov, Kazantsev, 1970; Melkov, Sergeeva, 1971, 1992; Annenkova *et al.*, 1972; Kazantsev, 1977, and our own data.