Table. ***Minerals of the Mednorudyanskoe deposit***

Native Elements

Copper Cu
Gold Au
Graphite C
Sulfur S

Sulfides, Arsenosulfides and Tellurides

Pyrite FeS_2
Pyrrhotite $Fe_{1-x}S$
Chalcopyrite $CuFeS_2$
Chalcocite Cu_2S
Covellite CuS
Sphalerite ZnS
Bornite Cu_5FeS_4
Marcasite FeS_2
Cobaltite CoAsS
Hessite Ag_2Te
Galena PbS
Djurleite $Cu_{31}S_{16}$

Oxides and Hydroxides

Cuprite Cu_2O
Magnetite $Fe^{2+}Fe^{3+}{}_2O_4$
Hematite Fe_2O_3
Goethite FeOOH
Delafossite $CuFeO_2$
Tenorite CuO
Pyrolusite MnO_2
Hollandite $Ba(Mn^{4+}{}_7Mn^{2+})O_{16}$
Cryptomelane $K(Mn^{4+}7Mn^{3+})O_{16}$
Maghemite Fe_2O_3
Manganite MnOOH
Romanechite $Ba(Mn^{4+}{}_3Mn^{3+}{}_2)O_{10} \cdot H_2O$
Todorokite $MnMn^{4+}{}_3O_7 \cdot H_2O$
Thorianite ThO_2
Quartz SiO_2
Opal $SiO_2 \cdot nH_2O$
Cuprospinel $CuFe_2O_4$
Mangiroite $Na_2(Mn^{4+}{}_{15}Mn^{2+})O_{32} \cdot nH_2O$
Asbolane $CoMn_2O_4(OH)_2 \cdot nH_2O$
Boemite AlO(OH)
Gahnite $ZnAl_2O_4$
Franklinite $ZnFe_2O_4$

Carbonates

Malachite $Cu_2(CO_3)(OH)_2$
Azurite $Cu_3(CO_3)_2(OH)_2$
Calcite $CaCO_3$
Siderite $FeCO_3$
Ankerite $Ca(Fe^{2+},Mg,Mn)(CO_3)_2$
Magnesite $MgCO_3$
Rhodochrosite $MnCO_3$

Sulphates

Brochantite $Cu_4SO_4(OH)_6$
Antlerite $Cu_3SO_4(OH)_4$
Chalcanthite $CuSO_4 \cdot 5H_2O$
Barite $BaSO_4$
Gypsum $CaSO_4 \cdot 2H_2O$
Halotrichite $FeAl_2(SO_4)_4 \cdot 22H_2O$
Cyanotrichite $Cu_4Al_2SO_4(OH)_{12} \cdot 2H_2O$

Phosphates

Pseudomalachite $Cu_5(PO4)_2(OH)_4$
Reichenbachite $Cu_5(PO4)_2(OH)_4$
Turquoise $CuAl_6(PO_4)_4(OH)_8 \cdot 4H_2O$
Chalcosiderite $CuFe_6^{3+}(PO_4)_4(OH)_8 \cdot 4H_2O$
Libethenite $Cu_2(PO_4)(OH)$
Strengite $Fe^{3+}(PO_4) \cdot 2H_2O$
Wavellite $Al_3(PO_4)(OH)_3 \cdot 5H_2O$
Vivianite $Fe_3^{2+}(PO_4)_2 \cdot 8H_2O$
Cacoxenite $Fe^{3+}{}_{24}Al(PO_4)_{17}O_6(OH)_{12} \cdot 75H_2O$
Beraunite $Fe^{2+}Fe_5^{3+}(PO_4)_4(OH)_5 \cdot 4H_2O$
Fluorapatite $Ca_5(PO_4)_3F$
Sampleite $NaCaCu_5(PO_4)_4Cl \cdot 5H_2O$
Monazite –(Ce) (Ce,La)(PO_4)
Monazite –(La) (La,Ce)(PO_4)
Churchite-(Y) $(PO_4) \cdot 2H_2O$
Rabdophane-(La) (La,Nd)$(PO_4) \cdot H_2O$
Cornetite $Cu_3(PO4)(OH)_3$
Delvauxite $CaFe_4^{3+}(PO_4)_2(OH)_8 \cdot 4\text{-}6H_2O$
Dufrenite $Fe^{2+}Fe_4^{3+}(PO_4)_3(OH)_5 \cdot 2H_2O$
Planerite $Al_6(PO_4)_2(PO_3OH)_2(OH)_8 \cdot 4H_2O$

Silicates

Albite $NaAlSi_3O_8$
Oligoclase (Na,Ca)$AlSi_3O_8$
Orthoclase $KAlSi_3O_8$
Augite (Ca,Na)(Mg,Fe,Al)$(Si,Al)_2O_6$
Diopside $CaMg(Si_2O_6)$
Epidote $Ca_2Al_2Fe(SiO_4)(Si_2O_7)O(OH)$
Zoisite $Ca_2Al_3(SiO_4)(Si_2O_7)O(OH)$
Andradite $Ca_3Fe_2(SiO_4)_3$
Grossular $Ca_3Al_2(SiO_4)_3$
Tremolite $Ca_2(Mg,Fe^{2+})_5(Si_8O_{22}(OH)_2$
Plancheite $Cu_8Si_8O_{22}(OH)_4 \cdot H_2O$
Shattuckite $Cu_5(SiO_3)_4(OH)_2$
Titanite $CaTiSiO_4O$
Chrysocolla $(Cu,Al)_2H_2Si_2O_5(OH)_4 \cdot nH_2O$
Prehnite $Ca_2Al(AlSi_3O_{10})(OH)_2$
Clinochlore $(Mg,Fe)_5Al(Si_3Al)O_{10}(OH)_8$
Chamosite $Fe_5Al(Si_3Al)O_{10}(OH)_8$
Hisingerite $Fe_4(Si_4O_{10})(OH)_8 \cdot 4H_2O$
Muscovite $KAl_2(Si_3Al)O_{10}(OH,F)_2$
Kaolinite $Al_2Si_2O_5(OH)_4$
Talc $Mg_3Si_4O_{10}(OH)_2$
Nontronite $Na_{0.3}Fe_2^{3+}(Si,Al)_4O_{10}(OH)_2 \cdot nH_2O$
Nacrite $Al_2Si_2O_5(OH)_4$
Halloysite $Al_2Si_2O_5(OH)_4 \cdot 2H_2O$
Hemimorphite $Zn_4Si_2O_7(OH)_2 \cdot H_2O$
Allophane $Al_2O_3 \cdot SiO_2 \cdot H_2O$

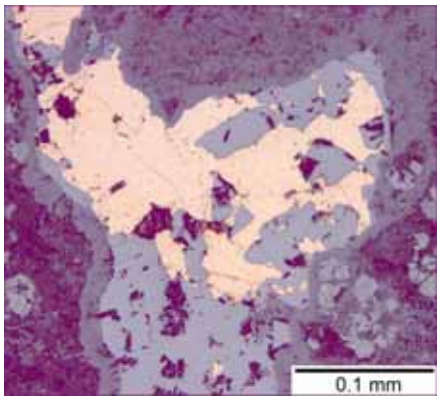
Vanadates and Arsenates

Volborthite $Cu_3V_2O_7(OH)_2 \cdot 2H_2O$
Chalcophyllite $Cu_{18}Al_2(AsO_4)_3(SO_4)_3(OH)_{27} \cdot 33H_2O$
Olivenite $Cu_2(AsO_4)(OH)$
Clinoclase $Cu_3(AsO_4)(OH)_3$
Cornwallite $Cu_5(AsO_4)_2(OH)_4 \cdot H_2O$

Chlorides

Atacamite $Cu_2Cl(OH)_3$

Note. The minerals, whose identification is not reliable, are *italicized*; the minerals identified by the authors at the deposit for the first time are **bolded** including those, whose identification is not reliable by the opinion of the scientific editor, are ***bold italicized***.



66. **Copper** intergrown with **cuprite** (grey) in porous limonite, polished section in reflected-light. Photo: V.A. Popov.

(Yekaterinburg) and *"Museum of Nature"* Department of *"Gornozavodkoi Ural"* Reserve Museum (Nizhniy Tagil) were also studied.

The minerals have been briefly described, photographed and diagnosed by us at the laboratories of the Institute of Mineralogy, Urals Branch, the Russian Academy of Sciences (Miass), the Institute of Geology and Geochemistry, Urals Branch, the Russian Academy of Sciences, and at the Geological Faculty of Lomonosov Moscow State University, using X-ray diffraction, the electron microprobe, bulk chemistry, and infrared and Raman spectroscopy. This has expanded List of Mineral Species (Table) up to 103 mineral species (Popova *et al.*, 2015). Twenty one out of the 103 species have been identified based on our findings (including 8 minerals which diagnostics is under Editor's question). Others have been included based on literature sources. Pyroxene, feldspar and chlorite diagnostics were clarified.

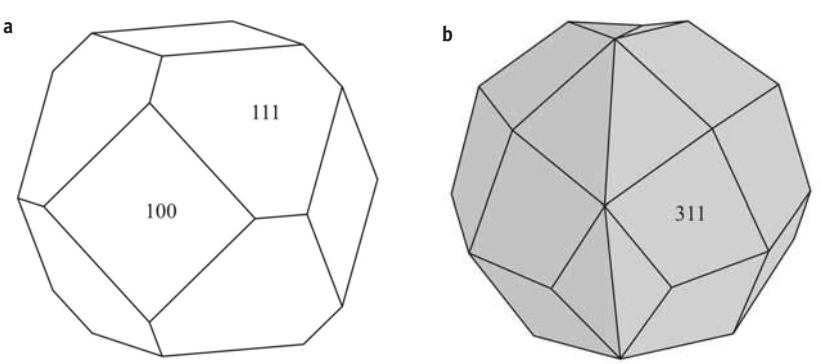
Forty-three minerals are primary, 64 are supergene, with four (hematite, calcite, siderite and quartz) manifesting themselves both within primary ores and the supergene zone.

Native Elements

Copper. It is possible that native copper was first encountered at the Mednorudyanskoe deposit by the Mednaya pit miners in 1722. However no documentary proof was found. The first mention of local native copper appeared in the first third of the 19th century (Engelgardt, 1829, Menge, 1830). As part of Alexander von Humboldt's expedition in 1829, Gustav Rose collected samples of various Nizhniy Tagil ores which he consequently received as a gift.

He later published sketches of crystals and Mednorudyanskoe copper twins (Rose, 1842). The most typical crystals were cuboctahedron, tetragonal trisctahedrons and the variations thereof, as well as twins {111} *(Fig. 67)*. There are recorded finds of native copper in the form of skeletal crystals and branching aggregates *(Figs. 68, 70)* in the Severnaya shaft dumps (on pyrite-magnetite aggregates: Soloviev, 1953) as well as within the contemporary quarry amongst clay-limonite masses. A dendritic layer of native copper (15 cm in size) is exhibited in the Urals Geological Museum of the Urals State Mining University in Yekaterinburg (Ponomarev, Erokhin, 2006).

Copper is most widespread in the southern part of the deposit (Soloviev, 1953) as small drusy aggregates, crusts, separate crystals and veins with cuprite in bog iron ore geodes, in intergrowth with cuprite *(Fig. 66)* and in fine-grained tenorite



67. **Copper,** (a) crystal and (b) twin by {111}. *After* G. Rose, 1842, twin plane is vertical. Drawing: V.A. Popov.