

**PHYSICAL AND CHEMICAL CONDITIONS OF FORMATION
OF THE TASH-YAR ZINC-MASSIVE SULFIDE DEPOSIT, SOUTHERN URALS**

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The Tash-Yar zinc-massive sulfide deposit is located in the eastern part of the Uchalinsk ore area, which lies in the northern part of the Magnitogorsk volcanogenic trough. The deposit is in the northern exocontact of the largest Akhunovsk granite massif (P₁) [1], surrounded by zone of the contact-metamorphic alteration – cordierite–plagioclase–amphibole–quartz hornfels [2,3] The ores of the Tash-Yar deposit are represented by series of steep zones of vein-disseminated sulfide mineralization at a distance of 250-900 m from granite massif.

The ores are hosted by basalt–rhyolite volcanogenic–sedimentary complex, belonging to the Karalytash suite (D_{2gV1}): dacites and rhyodacites, basalts, their tuffs.

Lens-shaped ore bodies are distinguished in altered felsic volcanites, volcanogenic–sedimentary rocks and partly basalts. The richest ores are located in sericite–quartz and quartz–sericite metasomatic halos, whereas chlorite occurs in outward zones, biotite – at a depth and on SE flank of the deposit. There are several lens of vein-disseminated ores, steeply dipping in NW direction, stretching till 400m with thickness up to 50m [Fig. 1A]. The ores of the deposit contain not so much sulfides. The major ore minerals are pyrite and sphalerite (occurring in equal quantities), secondary – chalcopyrite and rare – bornite, chalcocite, pyrrhotite, magnetite and altaite.

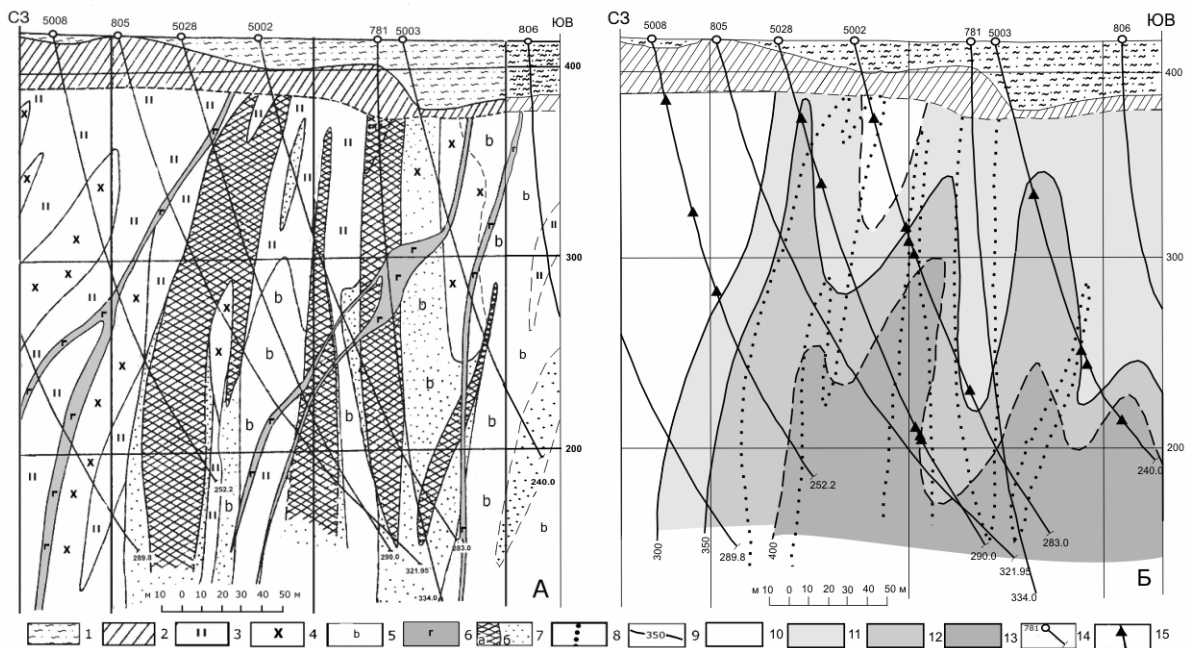


Fig.1. Cross-sections of the central part of the Tash-Yar deposit: A – geological, B – scheme of palaeotemperatute zonation.

1 – Quaternary deposit; 2 – crust of weathering; 3 – sericite-quartz and quartz-sericite metasomatites; 4 – chlorite-sericite-quartz, quartz-chlorite-sericite and chlorite-quartz-sericite metasomatites; 5 – biotite-chlorite-quartz, biotite-chlorite-sericite-quartz, biotite-sericite-quartz-chlorite and biotite-quartz-sericite-chlorite metasomatites; 6 – gabbro-diabase; 7 – vein and disseminated ores: a) rich and balance ore; b) outbalance ore; 8 – boundaries of the ore bodies [on fig. B]; 9-13 – isolines (9) and fields of palaeotemperature (10-13): 10 – <300°C; 11 – 300-350°C; 12 – 350-400°C; 13 – 400-450°C; 14 – drill holes and their depth; 15 – points of samples, where T_{hom} were defined

The temperature of contact metamorphism of the hosted volcanites of the deposit reached to 700°C and decreased then till 550-500°C by the data of garnet–biotite and garnet–cordierite thermometry [4].

Fluid inclusions (FI) studies in quartz from vein and disseminated ores have been carried out for samples, collected in three main cross-sections of the Tash-Yar deposit. FI were investigated in quartz

of quartz-sulfide veins and disseminated ore spots in metasomatites. The most common are two-phase FI. CO₂ – bearing FI are found out in quartz from quartz-sphalerite (\pm chalcopyrite, pyrite) veins.

Thermometric analyses (n=150) have shown that formation of vein-disseminated sulfide mineralization took place at $t=440-205^{\circ}\text{C}$. Two intervals of homogenization temperatures (T_{hom}) – $420-320^{\circ}\text{C}$ and $300-205^{\circ}\text{C}$ are distinguished [Fig.2]. An increase of palaeotemperature in SE direction and with a depth was established [Fig.1B]. 300°C isotherm divides areas of distribution of zinc vein-disseminated ores (NW lower temperature field – $300-200^{\circ}\text{C}$) and copper-zinc ores (temperatures $380-280^{\circ}\text{C}$ are prevail). Higher T_{hom} is established in quartz from veins in comparison with disseminated sulfide mineralization. T_{hom} FI in quartz-pyrite veins are lower – $200-290^{\circ}\text{C}$. Homogenization of FI in quartz from quartz-sulfide veins with highest T_{hom} (up to 440°C) takes place in liquid phase as well as gas phase at the same temperatures. CO₂ bearing FI occurrence confirms heterogeneity of fluids.

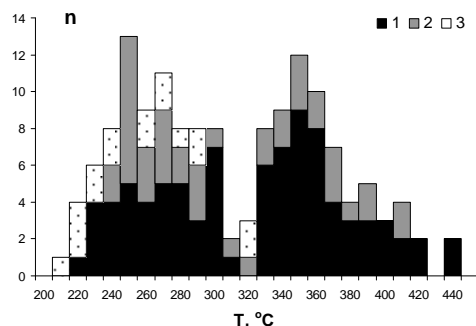


Fig.2. Homogenization temperature distribution for fluid inclusions in quartz of vein-disseminated ores of the Tash-Yar deposit. 1,2 - zinc sulfide ores: 1 – vein, 2 – disseminated; 3 –quartz-pyrite veins

The highly dense ($0.79-0.65 \text{ g/sm}^3$) carbonic acid ($T_{\text{melt CO}_2} = -56.6^{\circ}\text{C}$) was founded in FI under freezing. Homogenization of CO₂ takes place at $18-17.5^{\circ}\text{C}$ in the liquid phase. Calculated salinities for CO₂- bearing FI are 3.1–6.1 wt. % Na equiv., pressure – 1.6–0.7 kbar. CO₂ concentration in fluids reached 31 wt. %.

The results of an investigation confirm hypothesis about the Tash-Yar deposit as a product of re-generation more early formed sulfide lodes. The deposit has been formed in result of superposition of two close in time periods of remobilization on synvolcanic sulfide ores: synintrusive and followed dynamometamorphic (P_{1-2}). Intrusion of granite was accompanied by recrystallization and redeposition of sulfides in thermal field of the intrusion, redistribution of nonferrous metals (till the ore concentration of Zn) and formation of lateral zonation: $\text{Cu} \rightarrow \text{Zn, Pb, Ag}$, stretched over hundreds meters from the massif and corresponding to palaeotemperature zonation.

Metamorphic nature of fluids, formed productive quartz-sulfide association is confirmed by estimated high pressure of minerogenesis. Thermobarogeochemical investigations carried out show that formation of productive sulfide vein-disseminated took place at temperature of $440-205^{\circ}\text{C}$, $P=1.6-0.7$ kbar, salinities of solution 6.1–3.1 wt.% in conditions of fluid heterogeneity. Ore forming fluids of the Tash-Yar are characterized by higher temperatures and pressure in comparison with massive sulfide deposits of the Urals type [6-7].

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