RESEARCH METHODS

We used ground geological and geochemical methods to assess mineralization. This article includes the results of documentation of new ledges passed in 2024 in the Amphibolite building stone quarry (Vasilinovskoe ore occurrence) and also the materials from our previous studies. All the representative samples were collected and documented with gridded data.

Microscopic studies. Ore and non-ore minerals were studied using optical microscopy methods (microscopes Nikon DS-5Mc-L2, as well as Olympus BX51, combined with multiscale structure analyzer SIAMSASM.1) accompanied by scanning electron microscopy (SEM) and X-ray microanalysis (XRMA). The study of the contents of the main components of minerals was carried out on the X-ray microanalyzer Jeol JXA-8200.

Microthermometric studies of fluid inclusions (FI) in quartz were carried out using a Linkam THMSG-600 thermocryocamera with a high-resolution 50× Olympus long-focus lens. This technique allows to record phase transformations in inclusions larger than 5 μm in size. The studies were carried out in the temperature range from –196 to +600°C, with a measurement accuracy of ±0.2° in the temperature range from +60 to –60°C and ±1.5...2°C outside this range. Pressure correction was not introduced, so the given homogenization temperatures (T_{hom}) correspond to the minimum temperature of mineral formation. The composition and concentration of solutions were studied by cryometry. According to the eutectic melting point (T_{eut}) the salt composition of solutions was determined; it was assumed that T_{eut} from –21.2 to –33.6 °C corresponds to solutions of Na-chloride composition, solutions with T_{eut} from –33.6 to –49.8 °C were interpreted as solutions of Mg-chloride composition (Spenser et al., 1990; Devis et al., 1990), and below –49.8 °C – solutions dominated by Ca (Crawford, 1981). However, the measured T_{evt} of solutions of almost all studied fluid inclusions have values lower than the T_{evt} of chemically pure systems, which is due to the presence in the solutions of small amounts of other cations – K, Fe, Si and various ore components. Therefore, the compositions of solutions considered below reflect only quantitatively prevailing in them salt component.

Pb-Pb isotopic data were obtained using the high-precision method of multicollector inductively coupled plasma mass spectrometry (MC-ICP-MS) at IGEM RAS according to the technique described in (Chernyshev et al., 2007). Sulfur sulfide isotope analysis was performed at the Center of Collective Use of Multielement and Isotope Studies of SB RAS by V.N. Reutsky. The determinations were carried out using a Delta V Advantage gas isotope mass spectrometer in the double-infusion mode. The procedure of sample preparation and mass spectrometric measurements was controlled by a set of samples of standard sulfur isotopic composition IAEA-S-1, IAEA-S-2, IAEA-S-3 and NBS-127, as well as laboratory standards. The $\delta^{34}S$ values are given relative to the VCDT standard, the reproducibility of the values is better than 0.2 ‰ (2σ).

REFERENCES

Chernyshev, I.V.; Chugaev, A.V.; Shatagin, K.N. High-precision Pb isotope analysis by multicollector ICP-mass spectrometry using $^{205}Tl/^{203}Tl$ normalization: optimization and calibration of the method for the studies of Pb isotope variations. Geochemistry International. 2007. № 11. P. 1065–1076.

Crawford M.L. Phase equilibria in aqueus fluid inclusions. Fluid inclusions: Applications to Petrology: Mineral. Association of Canada. Short Course. Handbook 6. 1981. P. 75 – 100.

Davis D.W., Lowenstein T.K., Spenser R.J. Melting behavior of fluid inclusions in laboratory-grown halite crystals in the systems NaCl-H_2O, NaCl-KCl-H_2O, NaCl-$MgCl_2$-H_2O and $CaCl_2$-NaCl-H_2O. Geochim. Cosmochim. Acta. 1990. V. 54(3). P. 591 – 601.

Spenser R.J., Moller N., Weare J.H. The prediction of mineral solubilities in mineral waters: a chemical equilibrium model for the Na-K-Ca-Mg-Cl-SO4 sistem at temperatures below 25 °C. Geochim. Cosmochim. Acta. 1990. V. 54. № 3. P. 575 – 590.