The temperature conditions of epigenetic mineralization formation in Ratno Beds within Rafalivka area (Volhyn, Ukraine)

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The Ratno Beds, a part of Upper Proterozoic flood basalts formations, is, located in the Volhyn (Ukraine) (Shymlyanskyy, 2006, Bialowolska *et al.*, 2002, Derevska, *et al.*, 2008). The Ratno Beds within Rafalivka ore-bearing area consists of one to four basalt flows which are interbedded by tuffs, tuffbreccias and lavobreccias. Mineralogical and petrographic study of volcanic rocks and their postmagmatic alterations show that basalts differ in their rock-forming minerals quantity and secondary alterations, structural and textural parameters, the presence of amygdaloids, veins and voids. Epigenetic mineralization in the Ratno Beds is represented by palagonite, chlorite, zeolite, analcime, opal, chalcedony, iron hydroxide, carbonates, quartz, barite, wairakite, iron- and copper sulphides etc. Native metals are represented by native copper (main ore mineral), silver, iron, nickel etc (Rudenko *et al.*, 2013).

At the beginning of the 21st century, more than 200 boreholes were drilled within Rafalivka area (Chartoryisk fracture zone) and comprehensive geological and geophysical exploration with the goal to find native metals were conducted. Being highly explored this area was relevant for detailed studies and for clarifying thermobarogeochemical conditions of secondary mineral formation. About 50 mineral samples (quartz, calcite, analcime) from the Ratno Beds were selected and analysed by gas-liquid inclusions (GLI) homogenization method. These minerals were taken from the amygdaloids, veinlets, breccias cement and so on.

Earlier, the temperature of epigenetic mineralization formation and the sequence of mineral-forming processes in the volcanic section of the Rafalivka area were determined as result of thermobarogeochemical research. It was shown that the maximum temperature of the epigenetic mineralization was 335°C (from wairakite and quartz). This high temperature was resulted, presumably, by some additional heat source which appeared after the cooling of the basalt flow and the formation of an autometasomatic mineralization at temperature 100-50°C. The most favourable temperature for the native copper formation is 175-125°C.

Our additional studies within a chosen polygon displayed, that epigenetic minerals were formed at low temperatures between 150-100°C (Fig. 1). It should be noted, that wairakite, which was recorded in other wells in the western part of Rafalivka area, was not found among the newly formed minerals. Since wairakite is the high-temperature hydrothermal analogue of analcime, it forms at 175-400°C. This fact may also confirm low-temperature nature of the epigenetic mineralisation within the research area.

Taking into account our data and the results of previous studies (Derevska *et al.*, 2001), we constructed a contour diagram which shows the maximum temperature distribution of homogenization GLI of quartz and analcime for Rafalivka area (Fig. 1).

Two temperature-zones of epigenetic mineralization formation are determined in Rafalivka area within the Chartorysk fracture zone. The first one (150-335°C) is a high temperature zone, which is indicated by wairakite (200-335°C) and quartz (150-300°C). Analcime, chlorite, zeolite, native copper, silver, iron etc, are also abundant in this zone. The second zone is of low-temperature (125-100°C). It is allocated between the major lineament of the Chartoryisk fracture zone (near Polytsi quarry). The temperatures were estimated by quartz and analcime. In this case, the mineral association is represented by quartz, barite, opal, chalcedony, calcite, native silver, iron and copper sulphides. The distribution zones of the low-temperature mineralization confined elevated concentrations of gold.

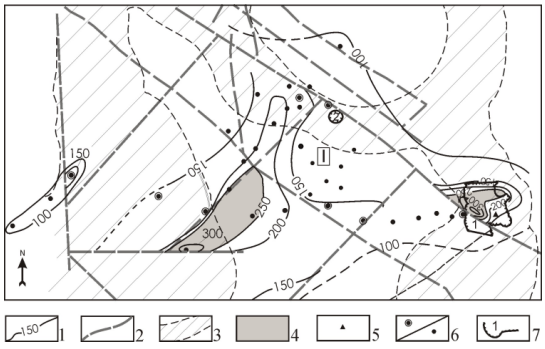

Fig. 1.: Scheme of temperature maximum values variability of gas-liquid inclusions homogenization in quartz, wairakite and analcime (modified after Derevska *et al.*, 2001). 1 - isolines of homogenization temperature maximum values; 2 - faults, 3 – magma-controlling zones; 4 –homogenization temperature values over 250°C; 5 - place of copper nuggets discovery; 6 - drillholes, which copper content > 0.1% (a) and other drillholes (b), 7 - quarries: 1 - Rafalivka quarry and 2 – Polytsi quarry. I – study area.

Thus, in the east Rafalivka area within the Chartorysk fracture zone the high-temperature processes of mineral formation were not revealed. That is shown by the absence of wairakite and a significantly lower temperature of the mineral (analcime, quartz, opal, chalcedony, etc.) formation. These data may indicate the distance of the research area from the additional heat source, which existed in the central Rafalivka area during the epigenetic mineralization of the Upper Proterozoic Ratno Beds.

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