ISOTOPE GEOCHEMISTRY OF GOLD ORE DEPOSITS OF THE UKRAINIAN CARPATHIANS

V. ZAGNITKO and A. PARFENOVA

Institute of Geochemistry, Mineralogy and Ore Formation, NAS of Ukraine, Kiev; Ukraine; igmof@mail.kar.net

Abstract

In the theses are considered isotope-geochemical of features of gold ore-bearing deposits of the Ukrainian Carpathians. Two in principle of various sources are distinguished on these deposits for ore-forming fluids. First is volcanogenic a source of ore-forming fluids with impurity of meteoric waters (Beregov group); second is essential metamorphogene a source with mobilization of components from enclosing primary-sedimentary rocks (Sauliak group).

Key words: stable isotope, gold ore deposit, genesis, Ukrainian Carpathians.

Isotopic methods are included now not only to theoretic investigation but also to solving tasks of prospect in concrete regions. The gold-ore deposits are almost always polymetal ones, therefore is a possibility of complex isotopic investigation of them. Intensive application of isotopic methods to ore geochemistry is determine absolutely new approaches of role and sources of water in hydrothermal ore formations. It is, in particular, shown in the most of publications, that there is a strong influence of meteoric waters on forming hydrothermal ores. Only for two from 40 ore deposits of American continent there is no reason to assume mixing of hydrothermal fluids with meteoric waters. Participation of meteoric waters has been marked in processes of orogeny on the others ore deposits more or less intensive.

The similar conclusions have been made also for the some gold ore bearing deposits of the Ukraine, for the Carpathians ones, in particular. Thus, according to some data, isotopic compositions of hydrogen and oxygen from inclusions of gold-bearing quarts veins show a presence of meteoric water in the inclusions. Our data on isotopic composition of oxygen, carbon and sulphur in ore bodies and country rocks have shown, however, that the water has no relation to ore formation. Metamorphogene water and $C0_2$ were here the main ore-forming components have being mobilized from country rocks.

The several gold-bearing manifestations are known in Carpathians and Transcarpathian area, two from which - Muzhiev and Saulyak were detail explored. The Muzhiev deposit is ready for operation. This deposit is located in Miocene volcanic structures; it is related with volcanic products, which have acidic composition. The volcanic structures of the region and mineralization related with it are one from links of the Intra-Carpathian volcanic belt, accompanied by deposits of gold, silver, polymetals, barite, alunite and kaolins.

The vertical primary zoning is typical for all deposits, including for Muzhiev deposit. The gold ores with silver are located on a surface; they are replaced by gold-silver-plumbum-zinc ores with considerable impurity of a copper on depth. The composite sulfide gold-polymetal ores are a dominant type of ores on the Muzhiev deposit.

The results of isotopic researches of this deposit suggest:

1. The isotope composition of strontium in polymetal ores [1, 2] indicates that the source of ores′ matter is mixed crust-mantle; that is characteristic feature of the modern polymetal deposits (Weig-Eilend, New Zealand).

2. A hybrid character of magmatic rocks, related with polymetal deposits, is confirmed [1] by the isotope ratio of strontium in magmatic rocks of this ore field ($^{87}Sr/^{86}Sr$ = from 0.704 up to 0.708)

3. The isotope ratios of oxygen and carbon in carbonates (from 15.5 up to 17.9‰, SMOW and from +1.5 to -9.8‰, PDB accordingly) specifies a heterogeneous source of the carbonate substance in minerals from ore zones: abyssal and sedimentary-metamorphized components are presented both [2].

4. The isotope composition of quartz from gold-bearing vein of gold ($\delta^{18}O$ range from -5.2 to +13.7‰) also reflects a multiphase and polyvariant character of a mineralization. Along with the abyssal sources of oxygen, in particular on final stages of ore process were present also surface, meteoric waters; their calculated isotope composition variate from +6.2 to -15‰ [2, 3].

5. The values $\delta^{34}S$ for sulphides of Beregov ore region are close to the meteoritic standard, and for sulphates from auric barites are a little displaced in the party of positive values (from -0.2 to +9.6‰) while in non-metalliferous sites they are +22.8‰.

The delovetsky suite is ore-bearing for Sauliak (Rahov massif) deposit, it is typical spilite-keratophyre formation. The ore zones appears zoning here. The carbonaceous manganese ores are related with spilite–diabase, locally converted in silicates. In upper part of a section massive, massive - impregnated pyrite, in main, copper pyrite ores are observed which related with andesite magmatism. The distribution of gold in ore formation has the following order of magnitudes (g/t): manganese - 0.3-1.0; copper pyrite - up to 3.0; pyrite-polymetallic - 10 and it is more; quartz (Sauliak) type - 50 up to 1000; arsenious type - 10. The ore bodies have complicated morphology, dipping is low to a southwest.

On structural signature in the ore-bearing sequences is determined massive quartz, white-gray or dairy color, sometimes transparent, performing lenses, veinlet and veins in shales. Comb quartz is found on sites of steep bends of quartz lenses. The practical interest

represents spotty ore quartz related by gradual transitions with black quartzites. Majority of quartzes have a broad band of values $\delta^{18}O$.

It is possible to select three types of metasomatites on mineral composition in ore rock mass: carbonate-quartz (I), sulfide-quartz (II) quartz (III). The high values ($\delta^{18}O$ = 16‰) are characteristic of the first type of rocks, the quartzes of the second type have easier isotope composition of oxygen, $\delta^{18}O$ = 12.3‰, mineralization of the third type contains quartz with a broad band of values $\delta^{18}O$ - from 8.7 up to 15.4‰ (average value is 12.4‰). The difference of barren quartz differs from low ore-bearing and ore-bearing is the very low contents of a heavy oxygen isotope, $\delta^{18}O$ = 8‰. The magnification of the contents of an isotope ^{18}O in quartz in zones enriched with scattered organic substance is observed. As a rule, such quartz has high factor of intensity of luminescence and increased contents ore component.

The result of isotope researches carbonates of ore sequences show a broad ranges of $\delta^{18}O$ (9.7-17.2‰) and $\delta^{13}C$ (-15.3÷1.2‰) and lower contents of heavy isotopes, than in marbles. On data G.P.Mamchur etc. [4], F.I.Zhukov and D.O.Lesnoj [5], the isotope composition of carbon in carbonates varies in limits from -13.7 up to +1.5‰.

In shales of quartz-carbonate-sericitic composition, which contain mineralization, the significances $\delta^{18}O$ and $\delta^{13}C$ in carbonatic component differ from such in marbles by lower contents of heavy isotopes of oxygen and carbon.

Carbonate in black quartzites represented siderite and dolomite. They are distributed layerwise along micaceous interlayer, enriched by organic ($\delta^{13}C$ = -19.2‰). These carbonate are close on isotope composition of carbon to dolomite from near ore-bearing listvenite. Ore-bearing and near ore-bearing of formation were formed in different geological situation, that is confirmed by different isotope composition of their oxygen.

References

Danilovich L.G. Petrogenesis of abyssal formations of Carpathians on datas of isotope composition of strontium // Geol. j. – 1977, **37**, issue. 4. – P. 67-80.

Koptyuh Yu.M., Kulibaba V.M. To a problem of genesis of gold mineralization of Beregov of ore region of Transcarpathian // Of a Problem of gold ore-bearing of depths of Ukraine. –Kyiv, 1997. – P. 211-220.

Shcherbak M.P., Bartnicki E.N., Lugova I.P. Isotope geology of Ukraine. - Kyiv, 1987. - P. 246.

Mamchur G.P. et all. $\delta^{13}C$ value of carbonate of crystalline rocks of the Carpathians, which are containing ore-bearing manifestations of gold // In collection: Geology and geochemistry of combustible minerals. - Lviv, 1978. - Issue. 51. - P. 30-37.

Zhukov F.I., Lesnoj D.A. Isotopes of sulphur and carbon in stratiform deposits folded of areas. -Kyiv: Nauk. dumka, 1982. - 159 p.