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Zoning of Polymetallic Rare-earth and Rare-metal Deposits in the Ak-Tyuz Ore Field (Northern Tien Shan, Kyrgyzstan)

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1 Introduction

Kyrgyzstan is a unique rare-metal province, which has significantly advanced deposits of the Ak-Tyuz ore field. The Ak-Tyuz ore deposits are located in Ak-Tyuz-Muyunkumo-Naratsky Middle terrain of Pre-Cambrian stabilization, formed by Archaean and Early-Proterozoic formations.

The gneiss, gneiss-migmatites, mica schists, marble with lenticular bodies of amphibolites and eclogites with radiogenic age of 2.8 Ga (Ak-Tyuz suite) are dated as AR. The metaeffusives turned into chlorite-epidote-actinolite schists (Kuperlisayskaya suite) with radiogenic age more than 1.6–1.7 Ga (Bakirov and Korolev, 1979) is associated with regressive metamorphism and dated as PR₁.

Metarocks of the fundament are intrusion by the magmatic formations of three tectonic magmatic cycles: Pre-Paleozoic, Caledonian and Hercynian.

The specificity of geological development of different structural zones called forth an originality of the magmatic activity. Pre-Paleozoic and Caledonian magmatic formations of island arc system took predominant development in the marginal trough. Intrusive bodies are characterized by normal granodiorite and granite composition, large sizes and mostly with a laccoliths form, stocks, etc.

During the Hercynian tectono-magmatic activation into the Middle terrain along the north-eastern Ak-Tyuz loose zone emplacement: gabbro-diorite and monzonite (phase 1), syenite-diorite (phase 2), subalkaline leucocratic granite (phase 3) and granophyres, aplite like granites and granite-porphyrries (phase 4).

From metallogenic point of view, the most significant ones are the Kuperlisaysky fissure intrusive of leucogranite with the absolute age of 260 Ma, “blind” stock-like bodies of granophyres with absolute age of 215–225 Ma. Granitic body has wedge-shaped form,

getting narrow in the north-eastern direction

All polymetallic rare-metal and rare-earth Ak-Tyuz deposits are spatially timed to the areas of subalkaline leucocratic granites and granophyres, and genetically connected to its postmagmatic activity (Kim et al., 2001, Malyukova et al., 2005, Djenchuraeva, et al., 2008).

2 Zoning in Localization of Mineralization in the Deposits of the Ak-Tyuz ore Field

In the Ak-Tyuz ore field such complex deposits as Ak-Tyuz, Kutessay-II, Kuperlisay and Kalesay beryllium deposits have important practical meaning.

The Kuperlisay REE-Th deposit is located on the western part of Ak-Tyuz ore field, where the subalkaline leucocratic granites get out directly to original ground, there are small (5x3 m) outcrops of pegmatite with oranjit, as well as albitite and greisen deposits of thorium, beryllium and rare acres. The latter are located directly in the zone of granites plunging in metamorphic rocks. Preliminary exploration held on these sites was appraised positively (Kim et al., 2001).

Thus, in the Kuperlisay the pegmatites with oranjit, albitite and greisen deposits of thorium, beryllium and rare acres have become apparent.

The Kutessay-II REE deposit is situated on the north-eastern settling of subalkaline leucocratic granites mass, in 2–2.5 km from the Kuperlisay deposit. It is a blind plutogene hydrothermal deposit localized in metasomatically transformed stock-like bodies of granophyres.

In the Kutessay-II deposit, the following zoning of ore mineralization distribution was fixed (Kim et al., 2001). Apical parts and hanging side of stock-like ore bodies set by silicified rocks of second quartzite type are characterized by predominant development of polymetallic mineralization with fluoride of rare-earth (yttrofluorite and fluorite) and malacon. A distribution of

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polymetallic mineralization inside of silicified rocks is controlled by linear structures of the north-eastern stretch (Nevsky et al., 1974).

An occurrence of polymetallic ores is sharply decreasing with the depth. It is reasoned by the fact that the zones of silicified rocks (of secondary quartzite type), which the polymetallic mineralization is genetically and spatially connected with are pinching out with the depth. In the Kutessay-II deposit, the main resources of lead are concentrated right in these rocks.

In the upper horizons of the deposit the quartz-chlorite biotite and quartz-chlorite metasomatites are widely-spread also. Mainly it is localized in the peripheral parts of stock-like ore body or on its upper horizons. Its formation took place in postmagmatic stage due to green amphibole schist and granophyres as a result of intensive pneumatolytic and hydrothermal processing.

The quartz-chlorite biotite and quartz-chlorite ores in comparison with the other metasomatic rocks contain more phosphate, carbonate and fluorinecarbonate of rare earths. Therefore these ores are the basic localizers of rare-earth mineralization which concentrate in the arched and ring-shaped zones, controlled by the appropriate structural elements. Maximum accumulation of rare-earth mineralization is observed in the marginal zones, located directly on the contact of stock-like bodies of granophyres with green amphibole or breccia schists.

At that in the Northern stock-like body (level 2353 m) parts with maximum concentration of rare-earth minerals are concentrated in the central and the north-eastern parts of it in the upper horizons of Central stock-like ore body, the most concentrated rare-earth zones are located in the southern and eastern peripheral parts of tubular breccia bodies of schists.

Different zones, composed by the minerals of rare-earth stage are getting wider and flatter with the depth. It is explained by the fact that by the depth the areas of the quartz-chlorite biotite and quartz-sericitic metasomatites, with which rare-earth mineralization are connected spatially and genetically, increase significantly.

The most powerful zone (up to 60 m) of the sericitic rocks edges with Central body of granophyres on the middle-ore level, where on the areas of sericite development, the main mass of cyrtolite, columbite (niobite), ferritorite and tinstone is located. And in the zones of biotite and chlorite there are monazite, ytrobastnasite, yttoparisite and molybdenite.

In close association with aggregate of muscovite it is possible to see fluorite, cyrtolite, tantaloniobates, tinstone, ferritorite, silicates of rare-earth (tscheffkinite, cerite) and rarely fluorinecarbonates of rare-earth. The average content of rare-earth sum in the quartz-muscovite

metasomatites is 0.169% and ZrO_2 0.61%. Generally, the ores of lower ore zone are perspective for extraction of zirconium and hafnium and at the same time of tantaloniobates, tin, thorium and rare-earth mineralization.

In the deposit, the following vertical (from up to down) and horizontal (from the center of stock-like ore body to the periphery) zoning in ore mineralization disposal is fixed:

- in the above-ore zone – beryllium mineralization;
- in the upper-ore zone – polymetallic mineralization with peach (ytrofluorite, fluocerite) of rare-earth and malacon, and also phosphate, carbonate and fluorinecarbonate rare-earth mineralization with molybdenum;
- in the middle-ore zone – thorium-rare-earth with tinstone;
- in the lower-ore zone – thorium-zirconium with tantaloniobates and silicates of rare-earth.

There are 4 stages of ore mineralization in the deposit: beryllium; polymetallic; rare-earth; columbium-thorium-zirconium.

Temperature mode of formation is shaking from 200°C up to 400°C.

The Kalesay Be deposit is located in 800 m to the north-east from the deposit Kutessay-II, in the above-ore zone and localized in the linear feldspar stockworks with phenacites and fluorites, lying down in the green amphibole schists of Kuperlisay suite.

The beryllium mineralization is controlled by the slim (first mm – 2.5 cm) albite-fluorite-phenacite veins. System of veins composes in the schists of linear stockworks zone.

In the deposit among the beryllium minerals besides phenacite, representing the main ore value, there are also genthelvine, gelbbertrandite, bavenite, baverite, beryl and mialarite.

Concentration of beryllium mineralization in the above-ore zone is explained by that it is connected with high migration ability of beryl in the form of volatile complex compounds with peach ($Na [BeF_3]$, etc.) (Ginzburg et al., 1974).

The Ak-Tyuz Pb-Zn-REE deposit is located in 5 km to the north-east from the Kuperlisay deposit and represents blind granophyric stock, exposed by the excavation in the depth 33 m. from the daylight. An apical part of the stock was completely composed by the silicified rocks of second quartzite type, where were rich polymetallic ore with average presence of lead at about 17%. In the contact of granophyres with the breccia green amphibole schists low-power (3–5 m.) zone of the quartz-chlorite biotite and quartz-chlorite metasomatites is noted. The silicified rocks of the deposit are started to lens out gradually in the 4th

horizon, and the number of quart-chlorite metasomatites is started to grow sharply with an industrial content of rare-earth, molybdenite and tinstone.

3 Conclusions

The zoning in the location of different genetic types of ore deposits, spatially connected to the subalkaline leucocratic granites is observed in the Ak-Tyuz ore field:

In the Kuperlisay, where granites comes out to the daylight, the pegmatites with oranjit, albitite deposits of thorium, beryllium and greisen deposits with REE are localized.

In Kutessay-II, located in 350-400 m from the leucocratic granites, the high-temperature plutogene deposits of niobium-thorium-zirconium, rare-earth and polymetallic mineralization had been forming in the granophyres. In its lower-ore zone greisen formations with tantalum-niobium and ferritorite-tinstone-cyrtolite mineralization with silicates of rare-earth.

In the remote from the granites ore deposits, the lower and middle temperature hydrothermal ore bodies with polymetallic and gold-ore mineralization are predominantly formed.

The beryllium mineralization is localized in the above-ore zone.

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