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Research Article

MINERALOGICAL AND GEOCHEMICAL FEATURES OF THE RARE EARTH MINERALIZATION OF THE SEVASSAY AREA (NORTHEASTERN PART OF THE KARATYUBE MOUNTAINS)

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ABSTRACT
The article discusses the mineralogical and geochemical features of rare earth mineralization in the northeastern part of the Karatyube mountains (Sevassay area). Rare earth elements are basically concentrated in accessory minerals - monazite, ortite, xenotime and in isomorphic admixtures in sphene, apatite, zircon, garnet, in rock-forming minerals - biotite, chlorite, feldspars. The relatively high content of the total amount of rare earth elements, the presence of rare earth elements in the concentrates, as well as in satellite minerals, puts the Sevassay area in the category of promising.

Key Words: *Karatyube Mountains, Sevaasay Area, Intrusive Formations, Rare Earth Mineralization, Mineralogical And Geochemical Features*

INTRODUCTION
Many of the rare metals have unique physical and chemical properties, and this makes them indispensable in a number of branches of modern industry, agriculture, and new technology. Metallurgy, mechanical engineering, electrical engineering, television and radio engineering, electronics, aviation, astronautics, medicine, chemical industry, power engineering, instrument making, enterprises producing fertilizers, biostimulants, herbicides and many other sectors of economy have become active consumers of rare elements.
Chemical elements of III group of Mendeleev's periodic system Sc, Y, La and 14 elements of the lanthanide family (Ce, Nd, Pm, Sm, Eu, Gd, Tb, Dy, Ho, Er, Tm, Yb, Lu) belong to the group of rare earth elements (Mining Encyclopedia, 1989). In a free form, rare earth elements are metals that are not resistant to oxidation, easily interact with water, releasing oxygen and form insoluble oxides. To date, more than 70 rare earth minerals are known. In most cases, they are found as impurities in other minerals. Rare earth elements are used in technology, used as alloying additives for the production of steels and alloys, as catalysts, for the production of a special kind of glass and in the military industry.
Taking into account the physicochemical characteristics and areas of industrial application of rare earth elements in recent years, the State Committee for Geology of the Republic of Uzbekistan has been gaving special attention to the study of rare earth elements. In 2017-2019 Institute of mineral resources conducted case studies aimed at studying of ore content at the Karatyube massif, where the key task was to study the mineralogical and geochemical features of rare earth mineralization in the north-eastern part of the Karatyube mountains.

MATERIALS AND METHODS
The study of the mineralogical and geochemical features of rare earth mineralization was carried out using a complex of field-geological, mineralogical-petrographic and chemical-analytical research methods.
To clarify the localization of mineralization and identify their rare earth content within the Sevassay area, 13 petrographic and 6 mineralogical sections were compiled.

The geological-structural position of the alteration zones was studied by 34 points of detailed geological observation. Linear-point samples and crushed samples were taken from petrographic, mineralogical sections and points of detailed geological observations.
Linear point samples were taken from bedrock, sampling step from 10 to 20m, sample weight depending on geological and structural conditions, types of alteration for linear point samples from 0.3-0.5 kg. up to 1.0-1.5 kg., and for crushed samples up to 10 kg.
In the course of field work, mineralized zones of granitoids of the Karatyube intrusion in the Sevassay area were studied. Mineralogical sections with a total length of 660 linear meters were compiled by mineralized zones, with the selection of various samples for further mineralogical-petrographic and chemical-analytical studies. Mineral composition of ores, their structural and textural features, and the nature of metasomatic changes have been established by description of thin sections, polished sections and mineralogical analysis of crushed sample concentrates.

RESULTS AND DISCUSSION

Fallowing intrusive formations are involved in the geological structure of eastern Karatyube (Fig. 1): medium-coarse-grained, biotite granodiorites, two-mica granites, fine-medium-grained, with areas of gneiss-like appearance. Dykes of leucocratic granites and pegmatoid formations of quartz-feldspar composition. The object of the study was the Sevassay area located in the northeastern part of the Karatyube mountains.
The geological structure of the Sevassay area is exclusively attended by magmatic formations C_3-P_1 and Quaternary formation. Magmatic formations at the site are represented by granodiorites hornblende-biotite, biotite, porphyritic Karatyube-Zirabulak Late Carboniferous adamelite-granite subcomplex (γC_3-$P_1 k$).

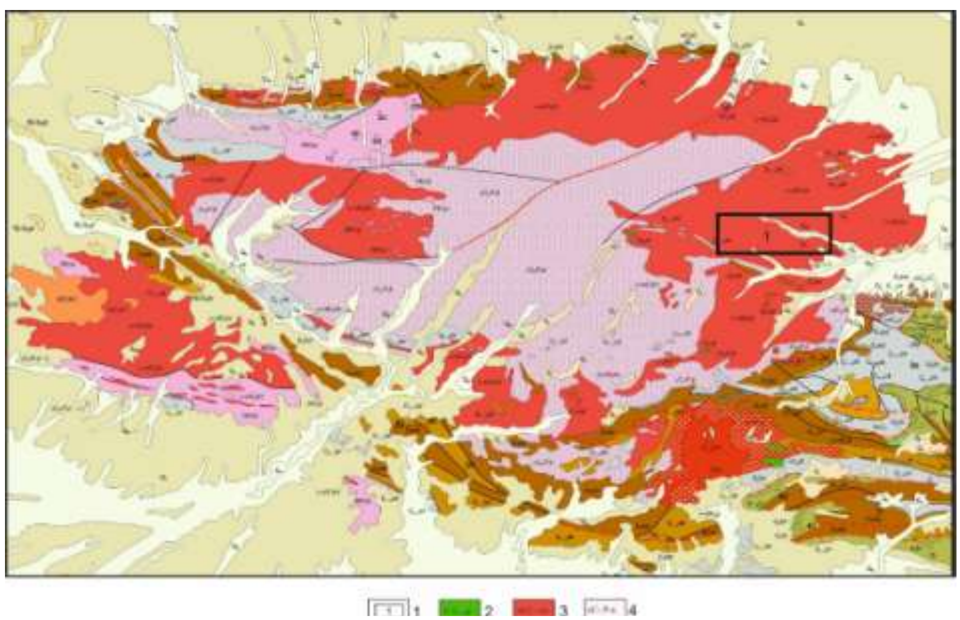

Figure 1: Overview map of the Karatyube mountains. 1 - research area 2 - gabbroids; 3 - porphyry biotite granodiorites 4 - two-mica granites

Porphyritic hornblende-biotite granodiorites are represented by coarse-grained, massive and porphyritic varieties in the area. Granodiorites are characterized by dissemination of microcline ranging in size from 2-4 cm to 5-7 cm in length with a light gray color and predominantly rectangular shape. The texture is massive, sometimes gneiss-like. Hornblende is found in granodiorites; dark brown to light reddish brown biotite predominates among the dark-colored minerals. Accessory minerals are represented by sphene, apatite, zircon, ilmenite, ortite.

Hornblende-biotite granodiorites are accompanied by dyke-like bodies of fine-grained biotite granites and tourmaline-bearing leucocratic granites, pegmatoids and quartz veins. In some places in the granodiorites schlieren segregations with a clot of biotite and dark-colored minerals with an oval shape of the accumulation, 13 cm x 15 cm in size, are visible. Biotite granites, in contrast to granodiorit, are characterized by the presence of only biotite in the composition of colored minerals and the appearance of a small amount of muscovite. The structure of the rocks is granite; the texture is massive, sometimes gneiss-like.

Biotite fine-grained granites, leucocratic granites and pegmatoids with tourmaline content compose small dike-like bodies elongated in the latitudinal and northwestern directions. They are characterized by a granite structure and traces of cataclasis are visible in the rocks.

Biotite and leucocratic granites are intensely albitized, tourmalinized; chloritization, potassium feldspar, hematitization, and ferruginization are developed. Pegmatite veins and pegmatoid bodies bearing accessory mineralization are also subject to these processes.

Element content of line-point and crushed samples taken from the granitoid formations of the Sevassay established by spectral analysis: V - 0.007-0.05%, Bi- <0.0002-0.0015%, W- <0,0003-0.0015%, Ga - 0.005-0.01%, Co - 0.0001-0.003%, Mn - 0.05-0.15%, Cu - <0.0008-0.007% , Sn - 0.0005-0.003%, Pb - 0.002-0.5%, Sb - <0.002-0.003%, Ti - 0.15-0.1%, Cr - 0.001-0.015%, Zn - 0.005-0.02%, Nb - 0.001-0.007%, Li - up to 0.01%.

Optical emission analysis (ICP-OES) in samples taken from biotite granodiorites established the following contents of rare earth elements: REE+Y 230.6-426.64 g/t, the average content for three samples is 297.9 g/t. In the crushed samples, REE+Y is up to 1209.79 g/t, at a thickness of 10 m., while the average content of 4 samples is: 525.9 g/t.

In the gravity concentrate in the crushed samples taken from the biotite granodiorites, REE+Y was found from 2263.31 to 4906.60 g/t, on average, 3584.9 g/t in two samples, the increase in rare earth elements in the gravity concentrate averaged 6.8 times.

The accompanying elements in the samples are: Nb - 15.6-24.94 g/t, Sc - 13.1-29.4 g/t, Th - 16.5-90.3 g/t, V - 3.01-4.47 g/t, Cu 10.2-31.7, Pb - 7.31-16.2 g/t, Zn - 88.8-154 g/t, Fe 38000-66344 g/t, Ti - 5100-7012 g/t, P 1200-1775 g/t, Mn - 636-1352 g/t, Cr - up to 197 g/t.

In the gravity concentrate from crushed samples, the content of accompanying elements changes as follows: Nb - 64.7 g/t, Sc - 81.1 g/t, Th - 152 g/t, V - 23.5 g/t, Cu - 56, 12, Pb - 30.62 g/t, Zn - 224 g/t, Fe 117000 g/t, Ti - 17000 g/t, P - 20100 g/t, Mn - 2450 g/t, Cr - up to 146 g/t. The increase in accompanying elements in the gravity concentrate from the crushed samples from 1.5-3 to 18 times, the largest increase is observed for P (11.3 times) and Mn - (18.1 times).

Results of mineralogical analysis of gravity concentrators from crushed samples are following: biotite, leucoxene, sphene found in electromagnetic fractions. In the heavy non-magnetic fraction, the following minerals are found: zircon 49%, apatite 49%, sphene 0.5-1%, cassiterite frequent signs, pyrite single signs.

The relatively high content of rare earth elements from 230.04-426.64 g/t to 1209.79 g/t, the presence of minerals, which contain REE in the concentrate, as well as in schlich samples, puts the Sevassay area in the category of promising. The projected area at the Sevassay area can be delineated by the content of the sum of rare earth elements 230-250 g/t and more.

The study of the contents of minerals-concentrates of rare-earth elements in schlich samples made it possible, according to their number of signs, to evaluate for five diseased systems (Table 1).

Table 1 Intensity of minerals-concentrates of rare earth mineralization on the northeastern slope of the Karatyube mountains (Paley, 1959)

Minerals	**Mineral content, g/m^3 points**				
	I	**II**	**III**	**IV**	**V**
Zircon- zr	Up to 100	100-200	200-1000	1000-2000	>2000
Apatite - ap	50-500	500-1000	1000-5000	5000-10000	>10000
Sphene – sf	50-500	500-1000	1000-5000	5000-10000	>10000
Monatsit - mz	Single grain	up to 10	10-100	100-200	>200
Ilmenit – i	50-500	500-1000	1000-5000	5000-10000	>10000
Xenotin - kn	Single grain	up to 10	10-100	100-200	>200
Ortitis – or	Single grain	up to 10	10-100	100-200	>200
Rutile – r	Single grain	up to 10	10-100	100-200	>200

Note. V points - the content of minerals in the rocks is very high - more than industrial; IV points - the content is close to industrial; II-III and especially I - low.

The group of minerals most frequently found in concentrates includes apatite, ilmenite, monazite, sphene, less often rutile, xenotime, ortite, and columbite.

Monazite - brown with a reddish tint, less often transparent, light yellow. Crystal size up to 0.5 mm is a widespread mineral, found in most concentrates, although not always in large quantities. The greatest amount of monazite is noted in the concentrates sampled along the landings. The content of monazite mainly fluctuates within the range of up to 100 g/m^3 (I-III points), and only in the Teshiktash region in some samples reaches 145-418 g/m^3 (IV-V points). Slich halos of monazite are accompanied by halos of ilmenite (I-II points), zircon (I-points), xenotime (I-points), zircon (I-points), rutile (I-III-points).

Zircon is colorless and lilac to brown, fragments of prismatic crystals, sometimes rounded. Their size is 0.2-0.4 mm.

Apatite is white, greenish, translucent, partially ferruginous, detrital with a large amount of mica inclusions. Prismatic crystals of apaptite are rare, size 0.2 to 1mm.

Rutile is dark brown with a reddish tint, acicular crystals and fragments with a ribbed surface. Cranked twins of rutile crystals are rare. Size from 0.3 to 0.5-0.8mm.

Sphene - from light brown to dark brown, tabular crystals and wedge-shaped fragments with a strong glass luster. Size 0.3-0.7mm.

Ortit is brown, black. Fragments of prismatic and lamellar crystals up to 0.4-0.6 mm.

Ilmenite is black, tabular and lamellar. Fragments with inclusions of mica. Hexagonal shapes are rare. The size is from 0.2 to 0.8 mm, less often to 1.0 mm.

Xenotime-bipyramids are yellow to brown. Size up to 0.3mm. Yttrium also belongs to the rare earth elements in terms of the close physical and chemical properties. It is mainly concentrated in rare-earth accessory minerals: monazite, ortite, and, more rarely, xenotime. Along with this, it is present in isomorphic impurities in sphene, apatite, zircon, garnet, as well as in rock-forming minerals in biotite, chlorite, and feldspars.

In monazite-bearing granites, the bulk (about 60%) of rare earth elements are contained in monazite, while the rest of them is distributed between rock-forming (biotite, chlorite, feldspars) and accessory (apatite, garnet, sphene, zircon, etc.) minerals. Mineral concentrators of rare earth elements in granites are monazite and ortite, concentrators of yttrium and elements of its group - xenotime, apatite, zircon, tantalum - niobates.

Granitoids are characterized by the presence of rare earth elements of the cerium and yttrium groups, and cerium elements in them sharply prevail (Ezhkov *et al.*, 2013).

CONCLUSION

The study of the mineralogical and geochemical features of the rare earth mineralization of the Sevassay area of the Karatyube mountains made it possible to establish:

Rare earth elements are basically concentrated in accessory minerals - monazite, ortite, xenotime and in isomorphic admixtures in sphene, apatite, zircon, garnet, in rock-forming minerals - biotite, chlorite, feldspars.

The highest contents of rare earth elements are associated with porphyritic biotite granodiorite with clots of biotite and dark colored minerals.

The high content of rare earth elements suggests that the Sevassay area is promising for the presence of industrial mineralization.

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