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Investigation of the distribution of rare elements in ores of the Gedabek deposit

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Abstract. The presented article is devoted to the study of the distribution of rare elements in the ores of the Gedabek deposit located in the Gedabek ore district. As is known, the Gedabek deposit located in the north-west of the Republic of Azerbaijan has great prospects. Precious metals such as gold, silver, and copper are extracted from the deposit. In addition, various elements are found in the ores of the deposit, including vanadium, chromium, cobalt, nickel, etc. elements. Among them, rare elements are of great importance. The article provides information about the geology of the Gedabek ore district and the Gedabek deposit and shows the mineralogical composition of the ores of the deposit. Research work was carried out to study the distribution of rare elements in the ores of the deposit. The analysis of test samples taken from the deposit was carried out. The oxide, element, and mineralogical compositions of these samples were investigated. It was found that the test samples contained high amounts of aluminum oxide, silicon oxide, silicon trioxide, potassium oxide, and iron (III) oxide among oxides, and high amounts of quartz, illite and kaolinite among minerals. In addition, it was found that they contain rare elements such as V, Pb, Ga, Se, Zr, and Rb. The test samples contained higher amounts of rare elements such as Pb, Zr, and Rb. In addition, the content of rare elements in many igneous rocks is higher than in sedimentary rocks.

Keywords: Gedabek ore region, Gedabek deposit, rare elements, magmatic, sedimentary.

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1. Introduction. In the Azerbaijani part of the Lesser Caucasus, four structural formation zones are distinguished from north to south: Lok-Karabakh, Goycha-Hekari, Miskhana-Zangezur, and Araz. The Gedabek ore region, which belongs to the Lok-Karabakh structural-formation zone, is considered the largest porphyry region in the country, being a part of the Tethys belt. The copper-porphyry deposits characteristic of the Gedabek ore region are related to Cimmerian volcanism. The main intrusive complex consists of rocks of the Atabey-Slavyanka plagiogranite and Gedabek diorite intrusion. Small dike-shaped or stock-shaped inclusions of medium and basic composition are often observed in the mentioned intrusive rocks. Small intrusions correspond to submeridional fault zones. Submeridional faults play a major role in the location and formation of copper-porphyry deposits in the mentioned area [6].

One of the promising deposits located in the Gedabek ore region is the Gedabek deposit [1, 4-8, 10, 13-16]. The main ore minerals of this deposit are pyrite, chalcopyrite and sphalerite, and non-ore minerals are quartz, barite and sericite [1]. The rocks of the early phase in the deposit are represented by gabbro and gabbrodiorites, the rocks of the late phase by diorites and quartz diorites, and rarely by granodiorites [15]. Most sulfide ores are unstable in the oxidation zone [4]. Geological, mineralogical, geochemical, isotopic and microthermometric data of the Gedabek deposit indicate that it is a high-sulfide epithermal deposit associated with a porphyry system [13]. It should be noted that all sulfide deposits located in our republic are rich in rare elements [2, 11]. Many deposits located in the Republic of Azerbaijan have great potential in terms of the richness of rare elements [3, 9, 12].

The main objective of the study is to investigate the characteristics of the distribution of rare elements in the ores of the deposit. The main issues include: providing general information about the geology of the Gedabek ore region and the Gedabek deposit, reviewing the mineralogical composition of the ores of the deposit, investigating the characteristics of the distribution of rare elements in the ores of the deposit and determining their economic significance.

2. Materials and methods. The Gedabek ore region is considered the largest porphyry-epithermal area in the country [6, 7]. The ore masses of the Gedabek deposit located in the Gedabek ore region are represented by massive, vein-rich, rich, sometimes banded and breccia-like texture types [4]. The geological map of the Gedabek ore region is shown in Figure 1.

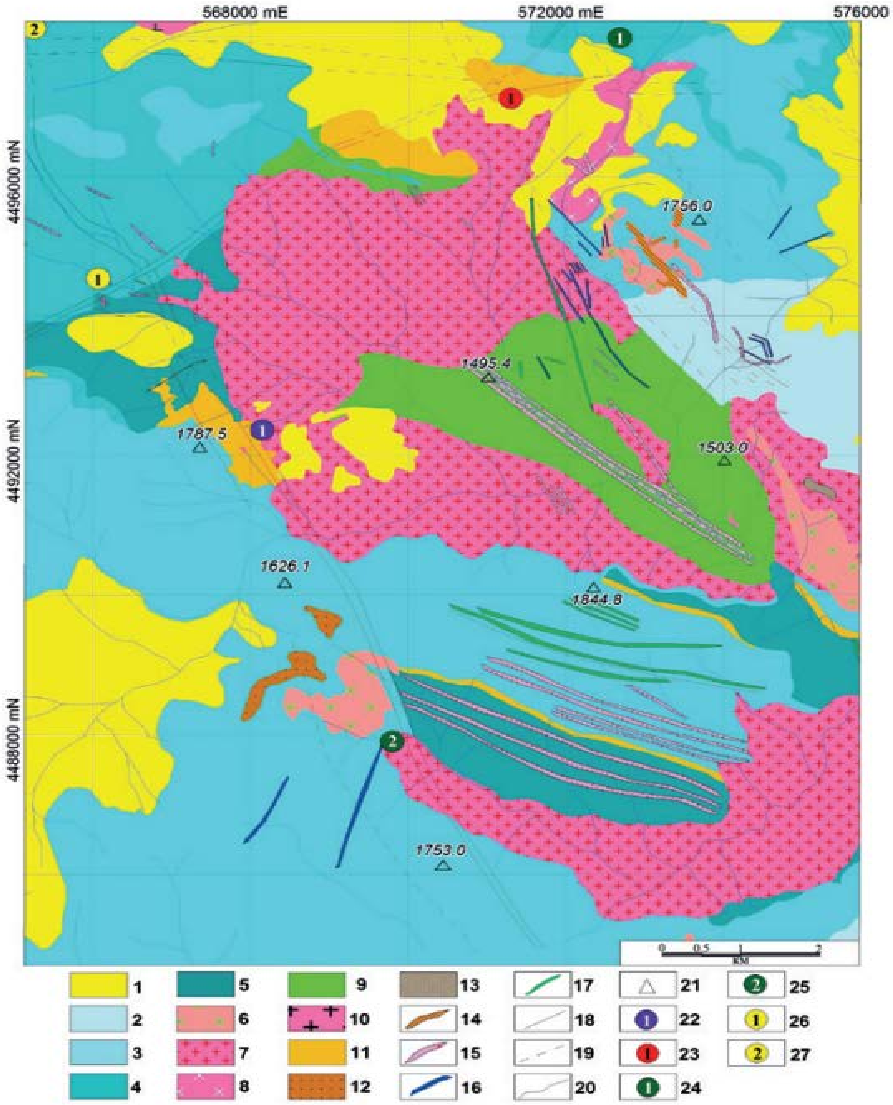

Figure 1. Geological map of the Gedabek ore district, scale 1 : 50 000 [16]

1 – quaternary eluvial-deluvial deposits; 2 – bathonian volcanic deposits: andesitic tuffs, tuff breccias, tuff conglomerates; 3 – lower cretaceous limestones of the oxfordian-kimmeridgian stage: limestones with interbeds of sandstones; 4 – upper bajocian: lavas, subvolcanic and pyroclastic facies of rhyolite-rhyodacitic rocks; 5 – lower bajocian: pyroclastic facies, tuff breccias and andesites; 6 – Garagaya-Garamurad hypabyssal subvolcanic bodies: diorite; 7 – the second phase of the Gedabek intrusion: diorites; 8 – the second phase of the Gedabek intrusion: granodiorites; 9 – the first phase of the Gedabek intrusion: gabbrodiorites, gabbro; 10 – plagiogranites; 11 – metasomatites; 12 – greisens; 13 – skarns; 14-17 – dikes: 14 – diorite, 15 – quartz-diorite, 16 – andesite, 17 – dolerite; 18 – faults; 19 – supposed faults; 20 – rivers; 21 – heights; 22 – the Gedabek deposit; 23-26 – manifestations: 23 – copper-porphyry Boyuk Galacha, 24 – copper-pyrite Pirbulag, 25 – copper-pyrite Ayatala, 26 – sulfur-pyrite Cholpan; 27 – the Ugur gold deposit

The article was prepared using analysis and synthesis methods. The object of the study is the Gedabek deposit. The composition of the test samples was investigated at the Analytical Center of the Institute of Geology and Geophysics of the Ministry of Science and Education of the Republic of Azerbaijan. The oxide, mineralogical and elemental composition of the test samples are shown in Tables 1, 2, and 3, respectively.

Table 1. Oxide composition of test samples taken from the deposit

№	Conventional name of the sample	Na_2O	MgO	Al_2O_3	SiO_2	P_2O_5	SO_3	K_2O	CaO	TiO_2	Fe_2O_3	MnO	SrO	CuO	BaO	Cl^-	YTİ
1	GDB 001	0,24	0,96	18,27	68,92	0,06	0,90	5,34	1,24	0,30	1,01	0,02	0,01	0,10	0,22	0,002	2,33
2	GDB 002	0,22	0,29	16,73	56,93	0,04	9,30	4,00	0,14	0,26	4,68	0,01	0,01	0,38	0,24	0,003	6,71
3	GDB 003	0,24	0,16	7,70	79,15	0,01	2,37	3,10	0,07	0,22	4,11	0,01	0,01	0,06	0,31	0,002	2,43
4	GDB 004	0,20	1,88	16,13	72,37	0,01	0,69	4,34	0,04	0,19	1,21	0,01	0,01	0,14	0,08	0,005	2,66
5	GDB 005	0,27	5,23	14,09	45,41	0,09	7,62	2,00	2,43	0,40	13,11	0,09	0,01	0,04	0,08	0,031	9,00
6	GDB 006	0,21	0,71	14,49	65,67	0,01	4,09	3,58	1,06	0,20	3,83	0,02	0,01	0,10	0,18	0,021	5,75

Note: YTI – indicates the amount of volatile components at 950^0C.

Table 2. Elemental composition of test samples taken from the field

№	Conventional name of the sample	As	Zn	V	Pb	Cr	Ga	Se	Zr	Rb	Mo	Ni	Co
1	GDB 001	0,0003	0,0249	0,0003	0,0008	0,0153	0,0001	0,0002	0,0095	0,0075	0,0002	0,0003	0,0002
2	GDB 002	0,0002	0,0087	0,0011	0,0090	0,0142	0,0027	0,0003	0,0095	0,0049	0,0003	0,0001	0,0002
3	GDB 003	0,0010	0,0086	0,0023	0,0048	0,0136	0,0003	0,0001	0,0045	0,0040	0,0002	0,0002	0,0001
4	GDB 004	0,0026	0,0055	0,0021	0,0003	0,0063	0,0002	0,0005	0,0075	0,0002	0,0036	0,0002	0,0002
5	GDB 005	0,0002	0,0623	0,0014	0,0004	0,0096	0,0002	0,0003	0,0070	0,0038	0,0002	0,0049	0,0048
6	GDB 006	0,0029	0,0425	0,0012	0,0002	0,0009	0,0002	0,0002	0,0079	0,0040	0,0055	0,0003	0,0002

Table 3. Mineralogical composition of test samples taken from the deposit

№	Conventional name of the sample	Quartz	Feldspar	Illite	Kaolinite	Magnetite	Pyrite	Diopside	Clinochlore	Andalusite	Other impurities
1	GDB 001	50	-	30	13	-	-	5	-	-	2
2	GDB 002	40	12	12	10	-	8	-	-	16	2
3	GDB 003	62	8	10	8	-	2	-	-	8	2
4	GDB 004	50	-	33	14	1	-	-	-	-	2
5	GDB 005	30	-	26	-	-	7	-	35	-	2
6	GDB 006	55	-	20	20	-	3	-	-	-	2

3. Results and discussion. As can be seen from Table 1, the test samples contain higher amounts of aluminum oxide, silicon oxide, silicon trioxide, potassium oxide, and iron (III) oxide. As described in Table 2, rare elements vanadium (V), lead (Pb), gallium (Ga), selenium (Se), zirconium (Zr), and rubidium (Rb) were found in the test samples. In addition, according to the mineralogical composition of the test samples (Table 3), it can be noted that the studied samples contain high amounts of quartz, illite, and kaolin minerals.

The rare elements found in larger amounts in the test samples compared to others are shown in Figure 2. Also, the amounts of these rare elements found in the studies of other authors are shown in Figure 3.

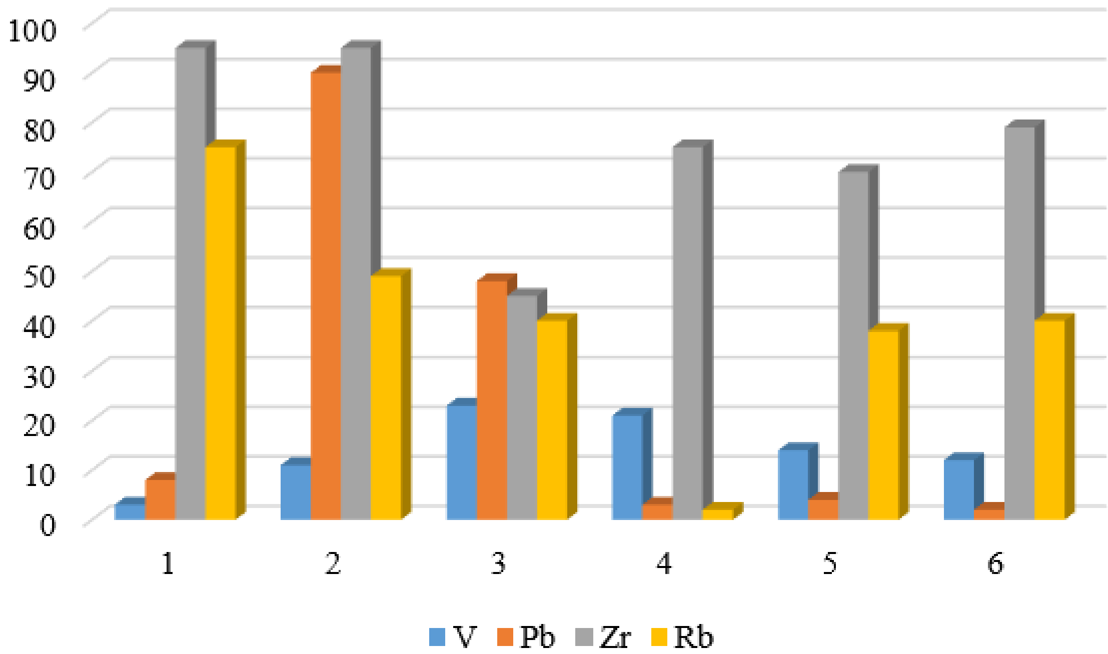

Figure 2. Rare elements found in relatively large quantities in test samples

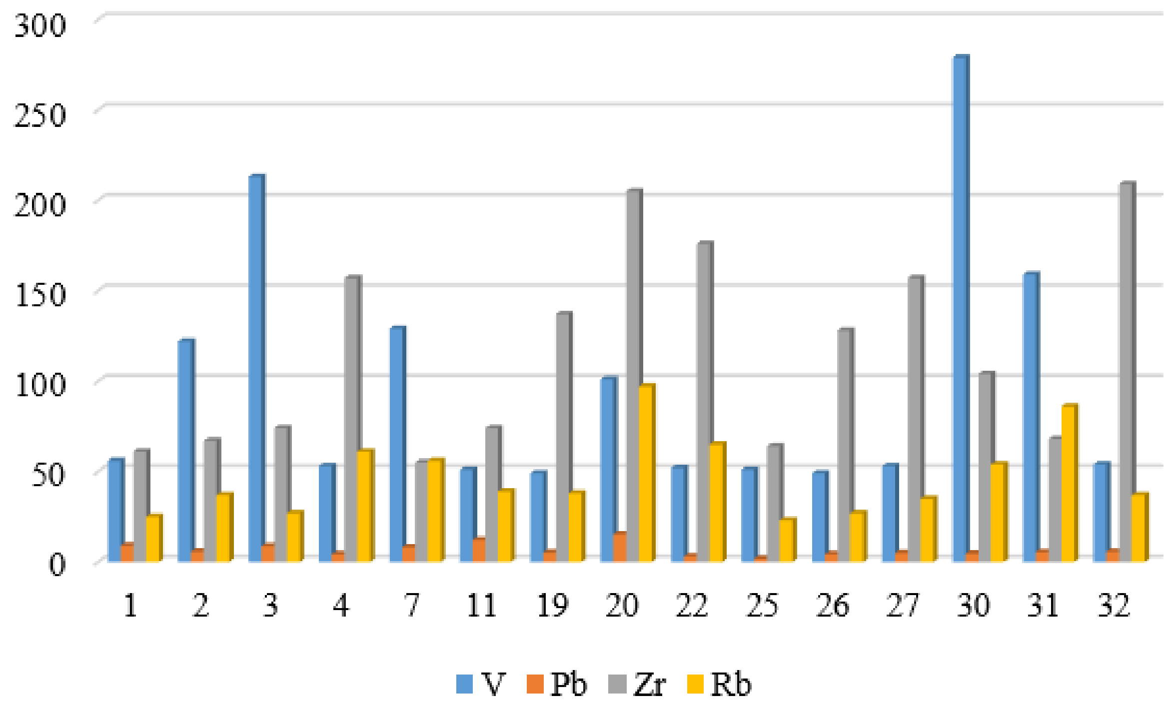

Figure 3. Amounts of V, Pb, Zr, and Rb elements reported in test samples in other studies [16]

It should be noted that other studies have found rare-earth elements in the test samples. The amounts of these elements are shown in Figure 4.

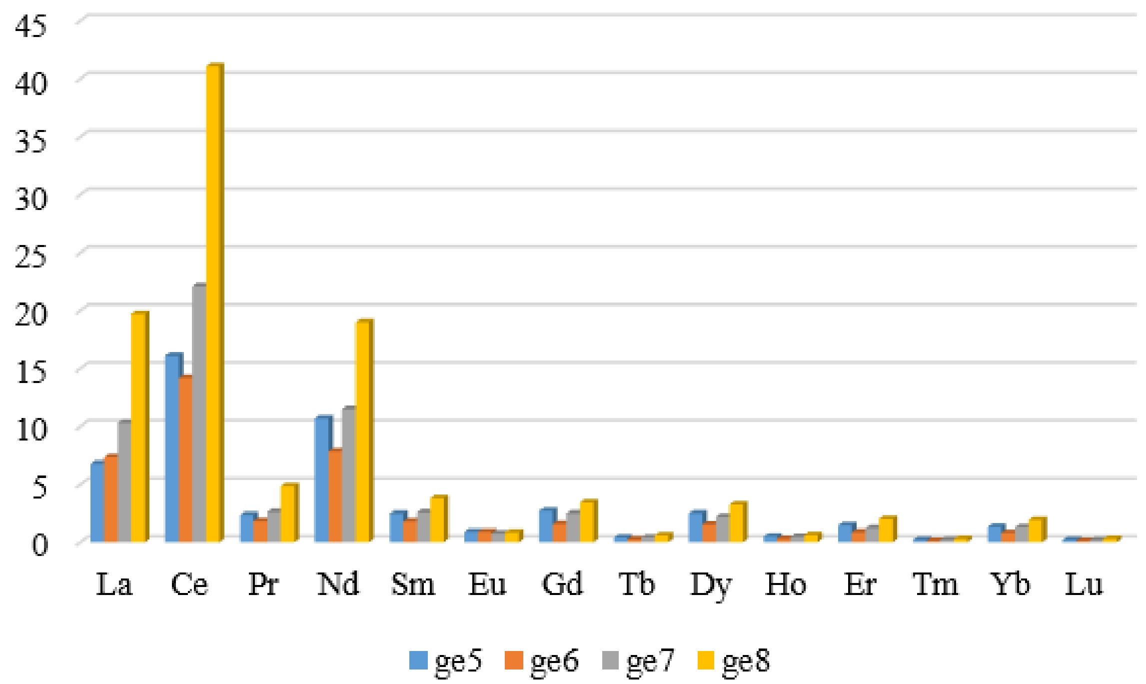

Figure 4. Rare-earth elements found in the test samples [16]

4. Conclusion. 1. Based on the results of the test samples, it can be noted that the amount of rare elements varies in a wide range. The amount of Pb, Zr, and Rb elements indicated among the rare elements in the test samples is higher. It is more expedient to conduct research to obtain accurate results. 2. The conducted research shows that the amount of rare elements in the minerals included in the composition of magmatic and sedimentary rocks of the Gedabek deposit differs significantly from each other. Thus, the amount of rare elements in most rocks of magmatic origin is much higher than their amount in sedimentary rocks.

Conflict of interest

The author declare that they have no conflict of interest in relation to this research.

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