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FEATURES OF THE FORMATION OF THE CHEMICAL COMPOSITION OF GROUNDWATER IN THE ALMALYK ORE DISTRICT AND INFLUENCE IN GROUNDWATER

Abstract: The article discusses the hydrogeological conditions of the area, types and changes in the chemical composition of groundwater. Changes in the chemical composition of groundwater are also influenced by ore deposits that lie deep and do not reach the surface. As a result of all of the above processes, at a short distance from the Sarycheku, Kalmakyr, Yoshlik, Kurgashinkan and other deposits, the chemical composition of mine groundwater changes dramatically.
Key words: hydrogeological conditions of the area, groundwater of modern alluvial deposits, fissure-ground and fissure-vein water; chemical composition of groundwater, copper minerals

The Almalyk ore district, represented by porphyry copper, polymetallic and gold deposits, is located in the northern foothills of the Kurama Range on the left bank of the Akhangaran River. The main minerals are copper, molybdenum, lead, zinc, associated extractables, gold, silver, partly iron, and to these should be added cadmium, indium, rhenium, selenium, tellurium, sulfur and bismuth.

The hydrogeological conditions of the area are in close relationship with the geological structure, the nature of the relief, climatic and orohydrographic conditions. The relief of the area is shallowly hilly in the northern part and foothills with steep steep watersheds between the sai in the southern part. Elevations from north to south gradually increase (from 500-550m near the Akhangaran River and up to 1800-2000m in the southern and southeastern parts of the area). The main porphyry copper, polymetallic and gold deposits of the Almalyk ore district are located at an absolute altitude of 750-1350 m.

The history of the geological development of the region covers periods from the Lower Paleozoic to the Meso-Cenozoic and is characterized by the manifestation of all stages of geosynclinal development of the earth's crust. Sedimentary, volcanic and intrusive (dominant) formations are developed.

According to the lithological composition of water-bearing rocks, according to the conditions of accumulation and circulation, according to the depth of distribution and forms of occurrence in the fields of the Sarycheku, Kalmakyr, Yoshlik, Kurgashinkan and other areas, the following types of groundwater are distinguished:

1. Groundwater of modern alluvial deposits;
2. Fissure-ground and fissure-vein waters;

Fissure groundwater is distributed throughout the entire area of the region, forming mainly in its exposed part. The watershed surface of the region is composed mainly of effusive and intrusive rocks, broken by local and regional cracks. The relief of watersheds generally has a flat shape, which favors the penetration (infiltration) of atmospheric precipitation into the rock mass, which is the only source of nutrition for fissure groundwater [1].

Sediments containing fractured groundwater and composing porphyry copper and lead-zinc deposits of the Almalyk ore district Sarycheku, Kalmakyr, Yoshlik, Kurgashinkan and others are weakly water-rich and have movements according to the general slope of the relief in directions from southeast to northwest river valleys Akhangaran. The water content of the rocks that make up the region largely depends on the degree of their fracturing. Due to their physical and chemical properties, igneous rocks represent a medium that is sparingly soluble in water. Therefore, atmospheric precipitation penetrating into them circulates mainly within the zone of expanded fractures. In the region, the highest water permeability in igneous rocks is observed in zones of fragmentation by tectonic disturbances. It was revealed that the water flow regime is characterized by seasonal changes: an increase in flow rates in the spring (from the second half of March to the end of April) and a decrease in the summer.

According to the chemical composition, the groundwater of channel deposits is sulfate-hydrocarbonate, calcium-sodium with a mineralization of 0.3-1.0 g/l and a severity of 7-8 mEq/l.

The chemical composition of crack waters of Paleozoic effusive and intrusive rocks of the region is sulfate-hydrocarbonate-calcium-magnesium with mineralization from 0.1 to 6 g/l and hardness 4-16 mg-eq/l to 40 mg-eq/l. Significant mineralization, as well as the presence of microcomponents such as manganese, zinc, lead, copper, etc. indicate the unsuitability of these waters for economic needs [1;2].

It is known that the processes of formation of the chemical composition of groundwater occur in close interaction with the mineral formations of mineral deposits, reflecting the zonation of groundwater that has developed during the geological history of the area, depending on the position of the deposit within certain geographic and geotectonic regions and on the depth of occurrence mineral. In this regard, even with an insignificant content of easily soluble compounds in rocks, waters of different chemical compositions are found in mine workings at different depths. Under the influence of sulfide copper mineralization, a change in the chemical composition of groundwater occurs. Under conditions of air access, oxidation of heavy metal sulfides occurs, especially for the Kalmakyr, Sarycheku, Yoshlik copper deposits, mainly copper-chalcopyrite sulfides and iron-pyrite sulfide, and in the area of the Kurgashinkan deposit, lead-galena sulfide and zinc-sphalerite sulfide.

The oxidation of chalcopyrite, one of the main ore minerals of the Kalmakyr, Sarycheku and Yoshlik copper deposits, proceeds according to the following scheme:

$$Cu\,Fe\,S_2 - 4O_2 \rightarrow Cu\,SO_4 + Fe\,SO_4 \quad \text{Chalcopyrite}$$

Or $CuFeS_2+2Fe(SO_4)_3+2H_2O+3O_2=CuSO_4+5FeSO_4+2H_2SO_4$

According to the same schemes, the oxidation of other copper sulfides and other metals, which are common impurities in copper ores, occurs.

Pyrite oxidation occurs according to the following scheme:

$$2FeS_2 + 7O_2 + 2H_2O \rightarrow 2FeSO_4 + 2H_2SO_4 \quad \text{pyrite}$$

Ferrous sulfate is unstable under oxidizing conditions and turns into ferrous oxide sulfate:

$$4FeSO_4 + 2H_2SO_4 + O_2 \rightarrow 2Fe_2(SO_4)_3 + 2H_2O$$

During the oxidation of the main minerals of the Kurgashinkan deposit, galena and sphalerite, the following reactions occur:

$PbS + 2O_2 = PbSO_4$ Galena

$ZnS+2O_2=ZnSO_4$ Sphalerite

As a result of these processes, water is enriched with hydrogen ions (the pH of the water decreases), sulfate ions, heavy metals copper, lead and zinc, iron and metal satellites of copper as well as lead and zinc ores: zinc, lead, molybdenum. Under the influence of sulfuric acid, resulting from the oxidation of sulfides, the dissolution and destruction of interfering rocks occurs. As a result, the water is enriched with silicon and calcium. Therefore, the chemical composition of which is formed as a result of the oxidation of sulfides is the so-called “mine water”, formed as a result of intense oxidation processes during the excavation of mine workings in ore bodies, as evidenced by the given results of chemical analysis of water from quarries of the Kalmakyr and Sarycheku deposits in g/l (Table 1).

Table 1

Career (Samples)	Cu**	PH	Na*+K*	Mg*	Ca**	Fe**	Pb**	Zn**	Al***	Fe***	, SO_2	Cl’	OH’	I_2SiO_2	Sulfate residue
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
Sary-chek	5,215	1,97	0,486	0,9242	0,5111	1,557	2,245	3,466	1,528	14,25	59,17	0,001	2,705	0,253	95,87

(1)															
To the Sary-cheku deposit (2)	0,097	2,73	0,0381	0,0584	0,1245	0,028	0,066	0,051	0,014	0,011	1,021	0,006	0,115	0,0478	1,411
Kalma-kyr (3)	6,351	1,08	0,171	0,695	0,336	43,82	0,241	0,166	3,436	0,141	122,1	0,03	0,121	0,077	200,12
To the Kalma -kyr deposit (4)	0,276	2,46	0,0025	0,2636	0,2765	0,1576	0,233	0,3396	0,3145	0,886	6,552	0,008	0,125	0,156	9,672

These mine waters, moving along the drainage direction, intensively interact with the rocks; with almost all rock-forming minerals, the acidity of the groundwater decreases. As a result of all the above processes, at a short distance from the Sarycheku, Kalmakyr, Yoshlik, Kurgashinkan and other deposits, the chemical composition of mine groundwater changes dramatically. These differences consist mainly in increased (relative to other non-mine groundwater) contents of copper, lead, zinc and some other metals that are satellites of copper and other ores and sulfate ions. If in mine groundwater the copper content is measured in tens and hundreds of mg/l, then in non-mine groundwater the copper content is measured in tenths, hundredths and thousandths of mg/l.

Changes in the chemical composition of groundwater occur not only under the influence of ore bodies, but also during the dissolution of ore minerals during deposit development. H_2SiO_2

Changes in the chemical composition of groundwater are also influenced by ore deposits that lie deep and do not reach the surface. In this case, the main importance is the diffusion movement of copper sulfate ions and other heavy metals in groundwater from places of their higher concentration to lower ones.

The results of the study show that as groundwater moves away from ore bodies, their chemical composition outside the deposit gradually becomes indistinguishable from the surrounding waters, since the content of copper, satellite metals of copper ores and sulfate ion decreases. (Table 1).

It should be noted that this trend does not always occur, i.e. reducing the content of copper, satellite metals of copper ores, sulfate ion. In some cases, the content of these components directly near ore bodies is lower than at some distance from them.

This is explained by the fact that the content of mineralization components depends not only on the concentration of these compounds in the rock, but also on the intensity of their transition from rock to water and the amount of water passing through the rock, i.e. on the speed of movement of groundwater [1]

In Fig. 1. The distribution of copper in groundwater confined to fissures in igneous rocks of the Sarycheku deposit is shown.

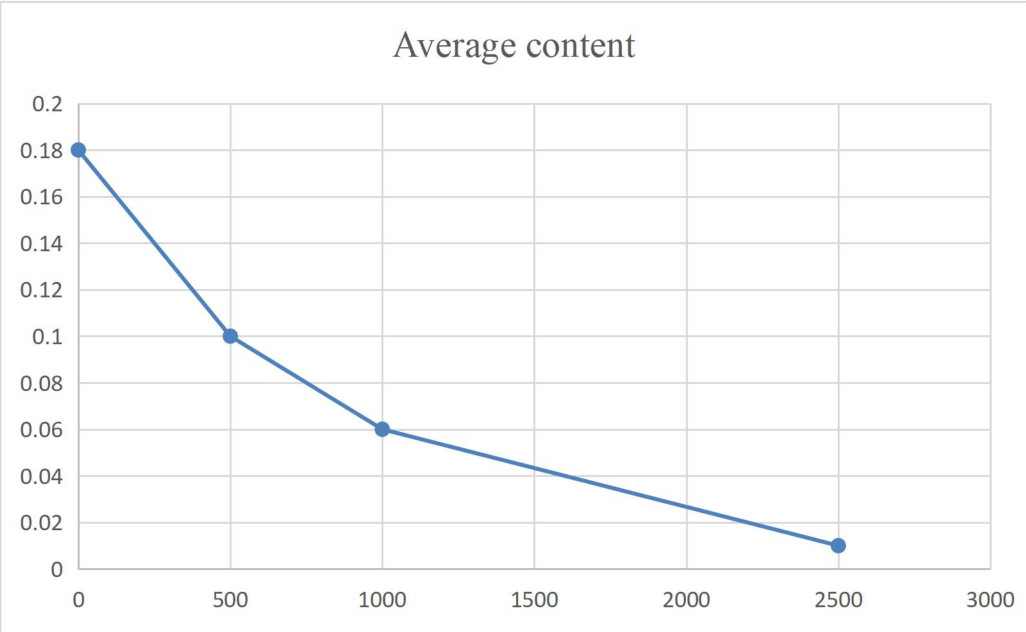

Fig. 1. Changes in copper content in groundwater depending on the distance to the Sarycheku deposit.

An analysis of the available materials on the copper content in groundwater allows us to outline the following characteristic features of halos of increased copper content in the groundwater of the Kalmakyr, Sarycheku and Yoshlik deposits. Under conditions of difficult groundwater flow, the copper content increases. High mineralization reduces the copper content. The highest copper content in groundwater is formed during interaction with disseminated mineralization located near the surface.

The distance from deposits where relatively high levels of copper and other metals are found in groundwater varies depending on geological and hydrogeological conditions. In the conditions of the Almalyk ore region, which is characteristic of highly dissected mountains, this distance usually does not exceed 500 m (Fig. 1; 2; 3).

Average content

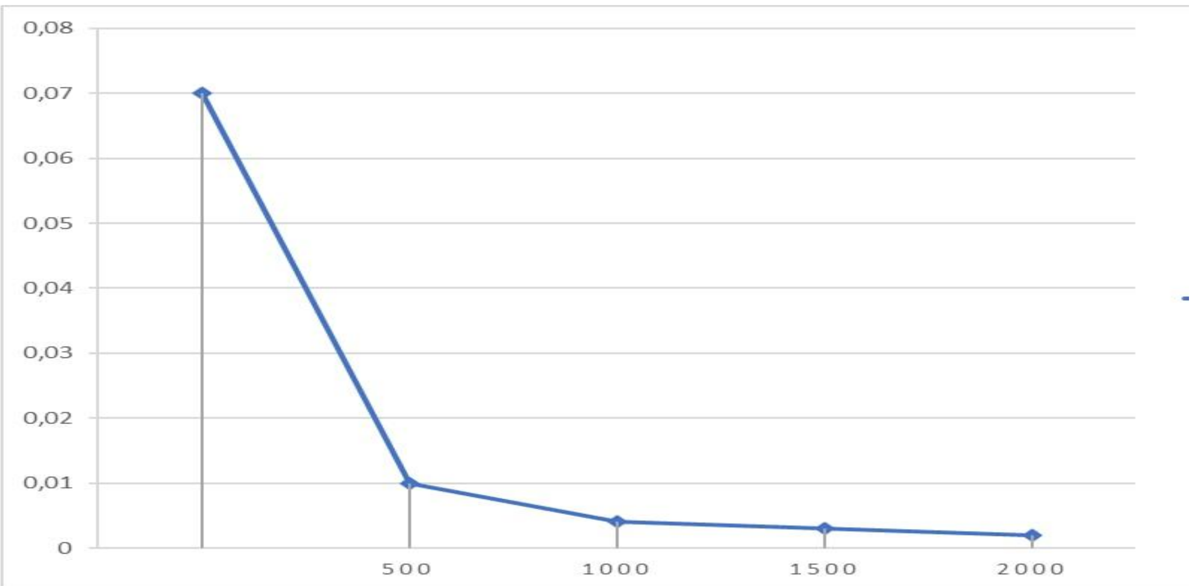

Fig.2. Changes in copper content in groundwater depending on the distance to the Kalmokyr deposit.

The main copper minerals in the area studied during the formation of the chemical composition of groundwater are chalcopyrite, bornite, and less commonly chalcocite; pyrite is also widespread.

Average content

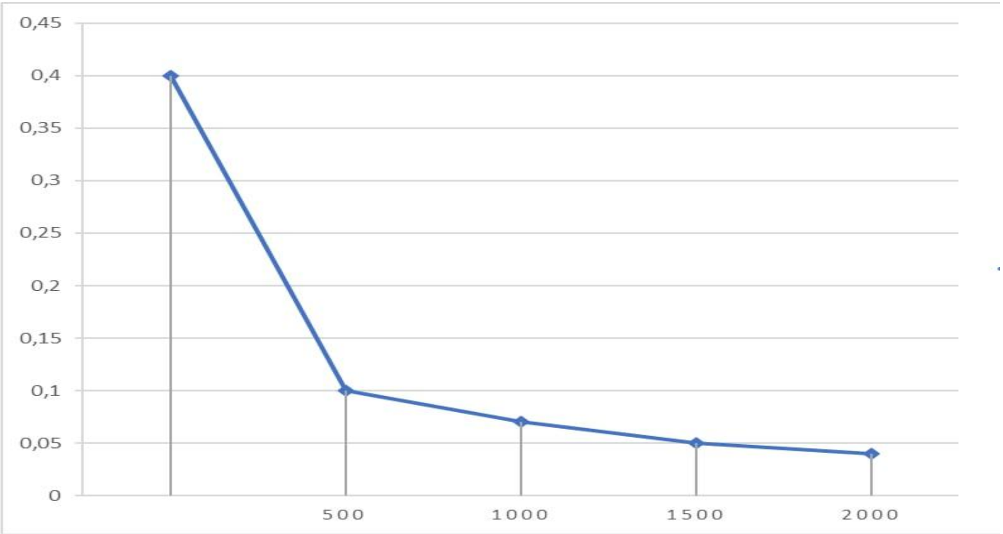

Fig.3. Changes in zinc content in groundwater depending on the distance to the Kurgashinkan deposit.

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