The material composition of the core material of Nizhny Kenzhasai area (Almalyk ore region)

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Abstract. This study investigates the material composition of core samples obtained from the Nizhny Kenzhasai area, located within the central tectonic block of the Almalyk ore region. The primary objective is to determine the petrographic, mineralogical, and geochemical characteristics of ore-bearing rocks in relation to gold-silver mineralization. Core samples were collected from drilled wells with continuous sampling. Microscopic petrographic analysis was performed to examine the structural and textural features of the rocks, while spectral analysis was used to quantify the concentrations of major and trace elements, including Fe, Cu, Ag, As, Pb, and Zn. The results indicate elevated contents of gold and silver in altered andesitic porphyrites, metasomatic rocks, and andesitic porphyrite tuffs. Notably, chalcopyrite- and arsenopyrite-bearing zones show a high concentration of ore minerals. Two distinct gold-silver ore-bearing horizons were identified within the Akcha Formation: one located at the lower contact with Devonian-Carboniferous limestones, and the other in the middle part of the formation within pyritized and altered andesitic porphyrites. The identification of these ore horizons highlights the significant economic and geological potential of the Nizhny Kenzhasai area.

1 Introduction

The research area is located in the Akhangaran district of the Tashkent region on the northwestern slope of the Kurama Ridge. The geological structure of the area mainly consists of Devonian carbonate deposits and overlying middle Carboniferous effusives [1-3]. The area of research is located in the central tectonic block of the Almalyk ore region, bounded from the north and south by subparallel faults along which this block is lowered [2-5]. The area of the site shows widespread tectonic disturbances of north-eastern and latitudinal strike, mapped submeridional Nizhny Kenzhasai volcano -tectonic structure [6-7].

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2 Materials and methods

In the area of drilled wells, the total thickness of the studied sediments is 5859.3 m. The wells were drilled with continuous sampling. Core wells have been opened at the site:

- The tops of the carbonate stratum are D_3-C_1, composed of white, light gray, marbled, massive, fine and coarse-grained, fractured limestones; sometimes pyritized, sericitized;
- The Akcha formation - C_2ak, composed mainly of andesitic porphyrites with rare tuff layers of andesitic porphyrites, tuff sandstones, tuffoaleurolites, and metasomatites [8].

The core material was described by the laboratory of the Department of Geology of the National University of Uzbekistan named after M. Ulugbek. Analytical work on the core material was carried out by the State Enterprise "Central Laboratory" of the State Committee of Geology of the Republic of Uzbekistan by mineralogists V.F.Protsenko and E.E.Bolotskaya. The core material of 2 wells in the depth range of 30-206 m from the surface was studied.

3 Results

7 transparent petrographic sections are described in Table 1.

Table 1. Description of transparent petrographic thin sections.
Section No. 1. Nizhny Kenzhasai area, well 8, interval: **35-36.5m**

Determination of breed based on results micro-examination of thin section	**Mineral composition of the rock (volume%)**	**Rock structure**	**Texture breeds**
Andesitic (diorite?) porphyrite, intensely and very uniformly dolomitized and leucoxenized (Figures 1-7)	Main glassy chlorite-albite mass 45-50, dolomite 20-25, porphyry plagioclase (albitized) 7-10, leucoxene 7-10, sulfide 2-3	The structure is microgranular porphyritic with a uniform distribution of microclumpy new formations of dolomite and leucoxene, small nests of pyrite	The texture is generally massive with an even distribution of dolomite, leucoxene, pyrite and porphyritic plagioclase precipitates

Porphyritic plagioclase secretions are represented by single tabular-prismatic crystals up to 0.5 mm long with a thickness of no more than 0.2 mm, mostly replaced by albite with myrrous dolomite. Another type of tabular porphyritic precipitates of approximately the same size, intensively replaced by dolomite, densely combined with lumpy microcrystals of leucoxene, were most likely magnesian amphiboles or pyroxenes (no relics have been preserved).

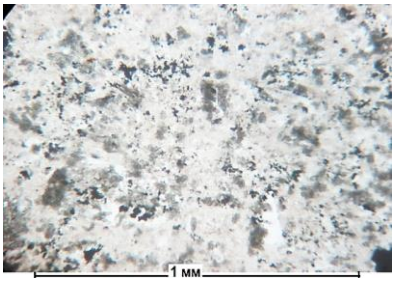

Fig. 1. Andesitic porphyrite. With one nicol

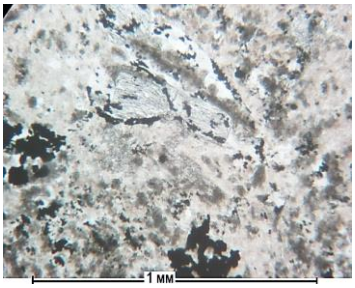

Fig. 2. Andesitic porphyrite. With one nicol

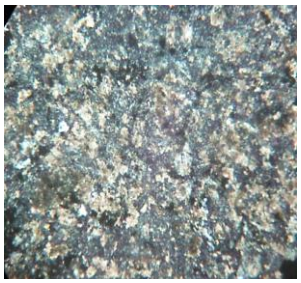

Fig. 3. View of figure 1 at two nicols

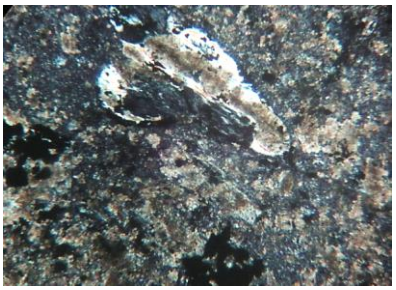

Fig. 4. View of figure 2 at two nicols

The rock is very evenly (over the thin section area) and densely saturated with micro-lumpy dolomite secretions (gray in figure 1, they are the lightest in figure 2) and almost equally densely distributed lumpy leucoxene grains (yellowish-fawn in figure 4), only sometimes clearly enriching tabular relics of former porphyritic amphibole secretions or pyroxenes.

Evenly distributed in the rock are small, irregularly shaped segregations of sulfide (black in figure 3 and figure 4), identified in a polished section as gersdorffite.

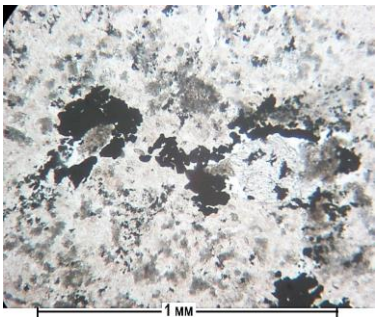

Fig. 5. Andesitic porphyrite. With one nickel. Segregations of sulfide (black), leucoxene (dark gray) and dolomite (gray)

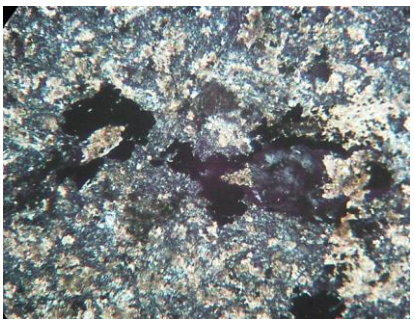

Fig. 6. View of figure 5 with two nicols

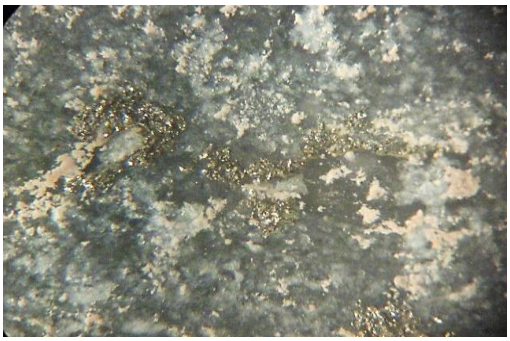

Fig. 7. View of figure 5 in oblique reflected light, the sulfide clearly does not look like pyrite and chalcopyrite.

Section No. 2 is described in Table 2.

Table 2. Section No. 2. Nizhny Kenzhasai area, well 8, interval: **53-54.5m**

Determination of breed based on results micro-examination of thin section	**Mineral composition of the rock (volume%)**	**Rock structure**	**Texture breeds**
Andesitic (diorite?) porphyrite, weakly actinolitized and leucoxenized (Figures 8-13)	The main glassy chlorite-albite mass is 55-60, porphyry segregations of plagioclase (albitized) 25-30, actinolytic hornblende 7-10; leucoxene 1-1.5, sulfide 0.5-1	The structure is porphyritic with a uniform distribution of micro-clumpy new formations of leucoxene, small nests of sulfides	The texture is generally massive with a uniform distribution of porphyry plagioclase and actinolite pseudomorphs throughout the hornblende

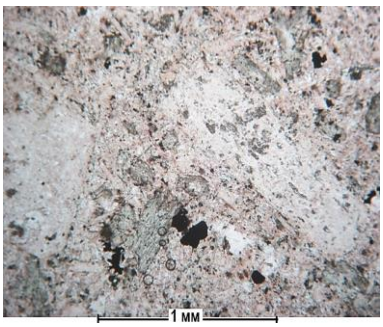

Fig. 8. Andesitic porphyrite. With one nicol

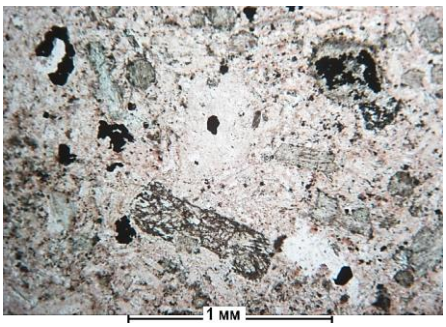

Fig. 9. Andesitic porphyrit. With one nicol

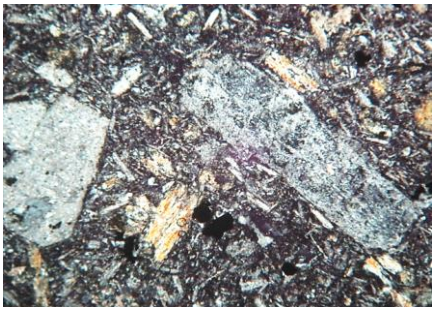

Fig. 10. Andesitic porphyrite. With two nicols

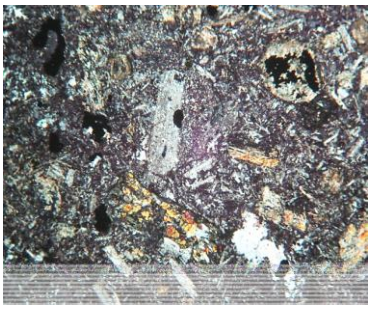

Fig. 11. Andesitic porphyrite. With two nicols

Porphyritic plagioclase secretions are only very weakly sericitized. Judging by the refractive index, they are represented by andesine. The size of their tabular-prismatic crystals ranges from 0.3 to 1.5 mm along the long axis. Their fusion with porphyritic secretions of completely actinolytic hornblende (brightly colored in m-photos 10, 11, 13) has not been revealed. The basic glassy mass of porphyrite contains up to 30-35% of finely tabular and leastlike randomly oriented plagioclase grains. Hornblende-based actinolite pseudomorphoses often contain irregularly shaped small gersdorffite nests with chalcopyrite and other ore minerals. In total, they are not more than 1.5%. Dolomitization and leukoxenization in this sample were very weak compared to the previous one.

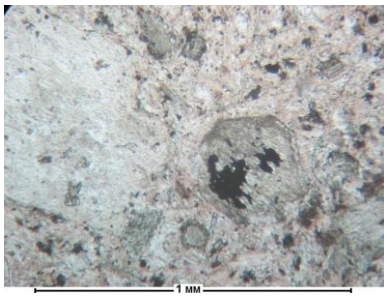

Fig. 12. Andesitic porphyrite. With one nicol

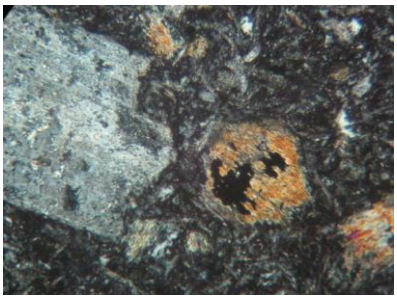

Fig. 13. Andesitic porphyrite. With two nicols. Gersdorfit in pseudomorph of actinolite after a hornblende crystal

Section No. 3 is described in Table 3.

Table 3. Section No. 3. Nizhny Kenzhasai area, well 18, interval: **204.5-206m**

Determination of breed based on results micro-examination of thin section	**Mineral composition of the rock (volume%)**	**Rock structure**	**Texture breeds**
Andesitic porphyrite tuff is crystalline-vitroclastic, practically porphyritic, moderately chloritized and leucoxenized (Figures 14-18)	The main fine silty mass is 80-85, porphyritic plagioclase crystalloclasts are 7-10; leucoxene (anatase) 3-5, sulfide (gersdorfit) 0.5-1	Structure psammo -silty fine-grained	The texture is generally massive with a uniform distribution of micro-clumpy anatase and

			gersdorfit deposits

The rock is characterized by the practical absence of plagioclase crystalloclasts, i.e., it is generally a fine-to-medium-grained tufoaleurolite. Chloritization is uniform pigmented without clearly discernible chlorite secretions. On the other hand, leucoxene (anatase, light lumps and grains in figure 18) and the much rarer lumpy gersdorffite secretions are distributed throughout the rock in secretions no larger than 0.15 (very rarely up to 0.25) mm.

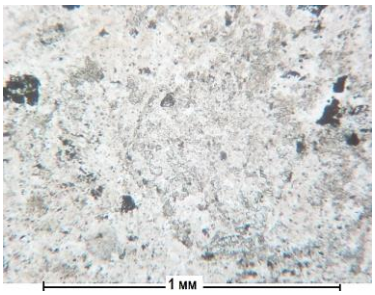

Fig. 14. Andesitic porphyrite tuff. With one nicol

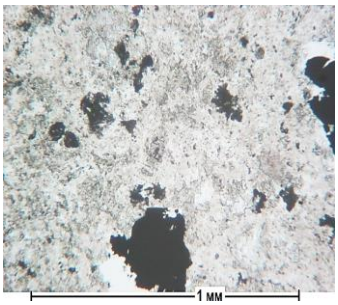

Fig. 15. Andesitic porphyrite tuff. With one nicol

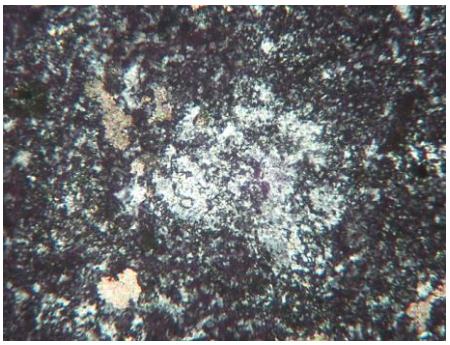

Fig. 16. Andesitic porphyrite tuff. With two nicols

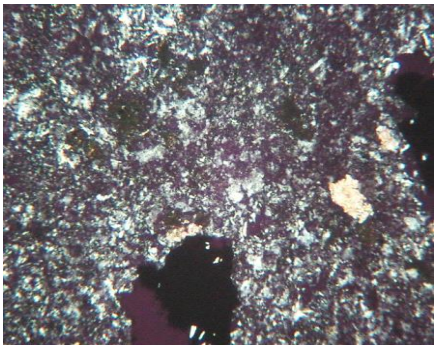

Fig. 17. Andesitic porphyrite tuff. With two nicols

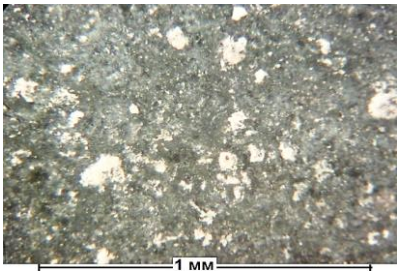

Fig. 18. Leukoxene (anatase, light lumps and grains) and much rarer lump-like discharge of gersdorfit

Description of polished sections.

Polished section No. 1 is described in Table 4.

Table 4. Section No. 1. Nizhny Kenzhasai area, well 8, interval: **77-78.5m**

Determination of breed based on results micro-examination of thin section	Mineral composition of the rock (volume%)	Rock structure	Texture breeds
Porphyrite with impregnation and veining of gersdorffite (Figure 19)	Gersdorfit 2-2.5	Allotriomorphic-irregular-grained , corrosive, cataclastic	Disseminated, vein-disseminated

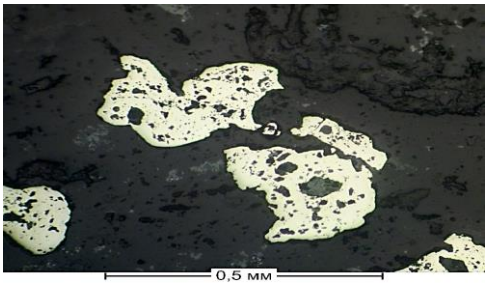

Fig. 19. Gersdorfit deposits in porphyrite.

Gersdorffite forms irregularly distributed grain deposits with diameters up to 0.5 mm along cracks in the rock, occasionally forming thin veins.

The shape of the gersdorffite precipitates is irregular polygonal. The borders are corroded, twisted, or smoothed. The internal structure is heterogeneous, often cavernous, and numerous inclusions of non-metallic minerals are found (Figure 19). The size of gersdorffite secretions ranges from thousandths of a mm to 1.3 mm.

Unlike the first two samples, there is no uniform interspersing of gersdorffite micrograins.

Polished section No. 2 is described in Table 5.

Table 5. Section No. 2. Nizhny Kenzhasai area, well 8, interval: **180.5-182m**

Determination of breed based on results micro-examination of thin section	Mineral composition of the rock (volume%)	Rock structure	Texture breeds
Tuff of andesitic porphyrites with banded dissemination of gersdorfite (Figures 20-22)	Gersdorfit 2-3	Allotriomorphic-irregular-grained, corrosive, cataclastic	Interspersed

Most often, gersdorffite forms a thin (less than 0.025 mm), abundant inclusions, forming an accumulation in a band along the central part of the plate (Figure 20). In another band, characterized by the presence of larger grains of plagioclase and hornblende, larger grains up to 0.5 mm in size are common, also folded into small clusters (Figures 21 and 22).

The shape of the grains is irregular, polygonal, amoeboid, rounded. The internal structure is heterogeneous, inclusions of non-metallic minerals are often found. Many grains are cavernous. Some grains are cataclysmic, often the fragments are dragged apart for a short distance, and the cracks of the cataclysm are filled with non-metallic minerals.such secretions usually have a hypodiomorphic appearance.

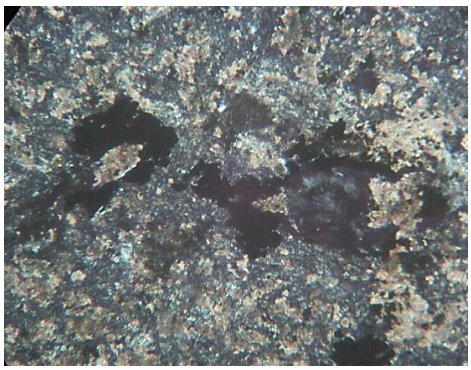

Fig. 20. Tuff of andesitic porphyrites. Fine impregnation of gersdorffite.

Fig. 21. Tuff of andesitic porphyrites. Amoeboid discharge of gersdorfit.

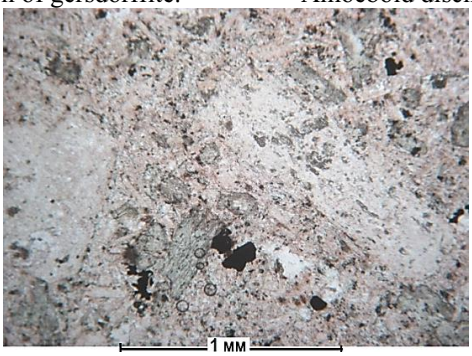

Fig. 22. Tuff of andesitic porphyrites. Cataclased gersdorfit.

Polished section No. 3 is described in Table 6.

Table 6. Section No. 3. Nizhny Kenzhasai area, well 18, interval: **30.5-32m**

Determination of breed based on results micro-examination of thin section	**Mineral composition of the rock (volume%)**	**Rock structure**	**Texture breeds**
Porphyrite with abundant dissemination of magnetite and rare pyrite grains (Figures 23-25)	Titanomagnetite 5-7, pyrite 0.1	Hypidiomorphic uneven-grained	Interspersed

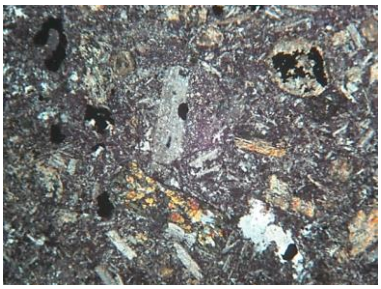

Fig. 23. Porphyrite. Magnetite deposits.

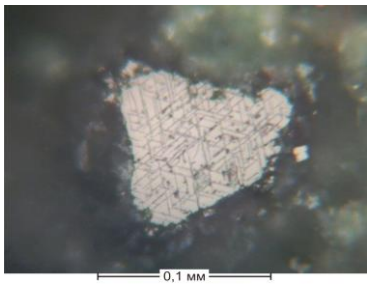

Fig. 24. Porphyrite. Magnetite grain with ilmenite plates.

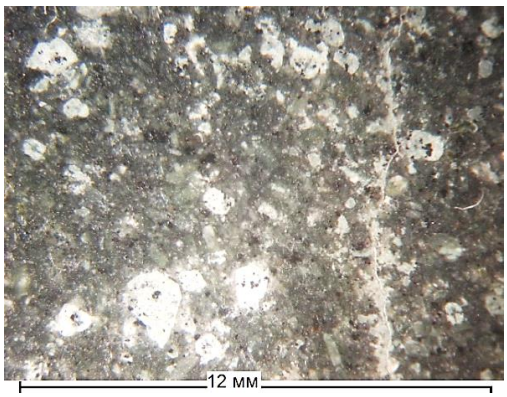

Fig. 25. Porphyrite. View of a polished section under a binocular

The discharge of ore minerals in the thin section is evenly distributed, often forming small granular accumulations. The main ore mineral in the shelf is titanomagnetite. The shape of the grains is irregular polygonal, often square and triangular in cross section, occasionally hexagonal grains. The borders are sharply curved or jagged. The internal structure is heterogeneous, cavernous, and inclusions of non-metallic minerals are often found. The size ranges from thousandths of mm to 0.1 mm. In almost all grains of magnetite, the structures of the decomposition of a solid solution are found - plates, less often drops of ilmenite (Figure 24). In figure 24, the network made up by Ilmenite is clearly visible. Pyrite in the shelf is found in rare polygonal and rounded grains, less than 0.002 mm in size.

Polished section No. 4 is described in Table 7.

Table 7. Section No. 4. Nizhny Kenzhasai area, well 18, interval: **116-117.5m**

Determination of breed based on results micro-examination of thin section	**Mineral composition of the rock (volume%)**	**Rock structure**	**Texture breeds**
Porphyrite with abundant dissemination of magnetite and rare pyrite grains (Figure 26)	Titanomagnetite 5-7, pyrite 0.1	Hypidiomorphic uneven-grained	Interspersed

Titanomagnetite grains are not very evenly distributed over the area of the section, forming small granular clusters.

The shape of magnetite grains is often irregular, polygonal, and square sections are often found. The boundaries are always sharply sinuous or jagged. The internal structure is not homogeneous, cavernous, inclusions of nonmetallic minerals are not uncommon. Some magnetite grains show disintegration structures that form ilmenite droplets and platelets. The size of magnetite grains is from thousandths of mm to 0.1 mm.

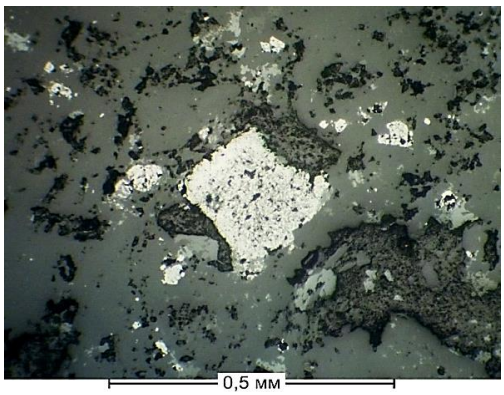

Fig. 26. Porphyrite. Magnetite deposits.

Spectral analysis was also carried out on the core material. Spectral analysis identified the following chemical elements (Table 8): Si, Al, Ca, Na, K, Fe, Mg, P, Mn, V, Ti, Cr, Ag, Cu, Pb, Zn, As, Bi, Ni, Co, Mo, Sn, Be, Li, Zr, Ga.

Contents of B, Pt, Pd, Os, Tr, W, Hg, Ta, Nb, Re, Ce, La, Se, Te, Gd, In, Tl, Ge, U, Th is below the sensitivity of determination by spectral analysis.

Table 8. Results of spectral analysis of rocks from the Nizhny Kenzhesai area (content in % and n•10 $^{-3}$ %)

Name of elements	No. wells						
	CH-8	CH-8	CH-8	CH-8	CH-18	CH-18	CH-18
	Interval testing						
	35.0-36.5	53.0-54.5	77.0-78.5	180.5-182.0	30.5-32	116.0-117.5	204.5-206
	Geological rock names						
	Andesitic porphyrite			Andesite tuff porphyrite	Andesitic porphyrite		Andesite tuff porphyrite
Si	>3	>3	>3	>3	>3	>3	>3
Al	>3	>3	>3	>3	>3	>3	>3
Ca	0.5	0.5	0.6	1	1	2	0.6
Na	3	3	3	>3	>3	0.3	>3
K	3	3	3	1	>3	2	>3
Fe	3	3	>3	>3	>3	>3	>3
Mg	>3	>3	>3	3	>3	>3	1
P	40	40	40	100	300	40	40
Ba	30	30	40	30	40	-	40
Sr	10	10	10	10	10	-	10
B	-	-	-	-	-	-	-
Mn	60	60	60	40	100	100	60

V	20	20	30	20	30	30	20
Ti	300	300	300	300	300	300	200
Cr	1	1	1	2	4	6	2
Pt	-	-	-	-	-	-	-
Pd	-	-	-	-	-	-	-
Os	-	-	-	-	-	-	-
Jr	-	-	-	-	-	-	-
Au	-	-	-	-	-	-	-
Ag	-	-	0.02	-	0.04	-	-
Cu	2	2	10	2	6	8	1
Pb	1	1	4	0.4	1	2	1
Zn	1	1	3	-	1	2	3
As	-	-	-	2	4	2	-
Bl	0.1	0.1	0.1	-	0.3	0.1	0.1
Ni	1	1	1	1	2	1	1
Co	1	1	1	3	1	1	0.2
Sb	-	-	-	-	-	-	-
Hg	-	-	-	-	-	-	-
Mo	0.1	0.1	0.1	-	0.3	0.4	-
W	-	-	-	-	-	-	-
Sn	0.1	0.1	0.2	-	0.2	0.1	-
Be	-	-	0.1	0.3	0.2	0.1	0.2
Ta	-	-	-	-	-	-	-
Nb	-	-	-	-	-	-	-
Li	4	4	4	10	-	3	1
Ce	-	-	-	-	-	-	-
La	-	-	-	-	-	-	-
Y	-	-	-	-	-	-	-
Gd	-	-	-	-	-	-	-
Sb	-	-	-	-	-	-	-
Zr	2	2	4	4	4	6	4
Hf	-	-	-	-	-	-	-
Re	-	-	-	-	-	-	-
Sc	-	-	-	-	-	-	-
Te	-	-	-	-	-	-	-
Cd	-	-	-	-	-	-	-
Sn	-	-	-	-	-	-	-
Tl	-	-	-	-	-	-	-

Ga	2	2	1	2	1	1	1
Ge	-	-	-	-	-	-	-
U	-	-	-	-	-	-	-
Tn	-	-	-	-	-	-	-

4 Conclusion

Based on the results of analytical studies on core material, the following conclusions can be drawn:

- increased gold and silver contents were noted in altered andesitic porphyrites, metasomatites, andesitic porphyrite tuffs;

- horizons with silver content from 1.1 g/t to 4.3 g/t are noted, the thickness of such horizons ranges from 1.5 m to 12.5m;

- two gold-silver ore-bearing horizons are established at the Nizhny Kenzhesai area:

1) the first is noted in the lower part of the Akcha formation near the contact with limestones D_3-S_1 ;

2) the second is established in the middle part of the Akcha Formation in altered, pyritized andesitic porphyrites containing chalcopyrite and arsenopyrite as inclusions.

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