International Journal of Geology, Earth & Environmental Sciences ISSN: 2277-2081
An Open Access, Online International Journal Available at http://www.cibtech.org/jgee.htm
2024 Vol. 14, pp. 43-51/Khaliyorov et al.
Research Article

CORRELATION OF ELEMENTS IN THE GRANODIORITE PORPHYRY ROCK IN THE SHAUGAZ-KANDIR RANGE

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ABSTRACT
The article presents a schematic map of the location of copper porphyry deposits around the world. At the same time, the chemical composition of granodiorite porphyry rocks in the Almalyk mining area (Shaugaz-Qandir stream) and the general statistical parameters of distribution of chemical elements in mineral zones and rocks are presented. Based on the results of ICP-MS analysis, correlation relations of elements in the studied area were calculated and histograms were created.

Keywords: Kurama, Granodiorite *Porphyry, Almalyk, Shaugaz-Kandir, Copper, Chalcopyrite, Correlation, Pyrite, Magnetite, Bismuth, Zinc, Tellurium, Silver, Tungsten, Tin, Lead*

INTRODUCTION

The Almalyk ore region is one of Central Asia's largest mining and industrial regions. The presence here of large exploited deposits of copper, lead, and gold, which are in favorable economic conditions, was the reason for conducting a significant amount of prospecting and exploration work in the area, aimed at its detailed study and identification of new industrial facilities. Geographically, the Almalyk ore region belongs to the western part of the Kuraminsky range's northern slope and occupies the Akhangaran River's left side.

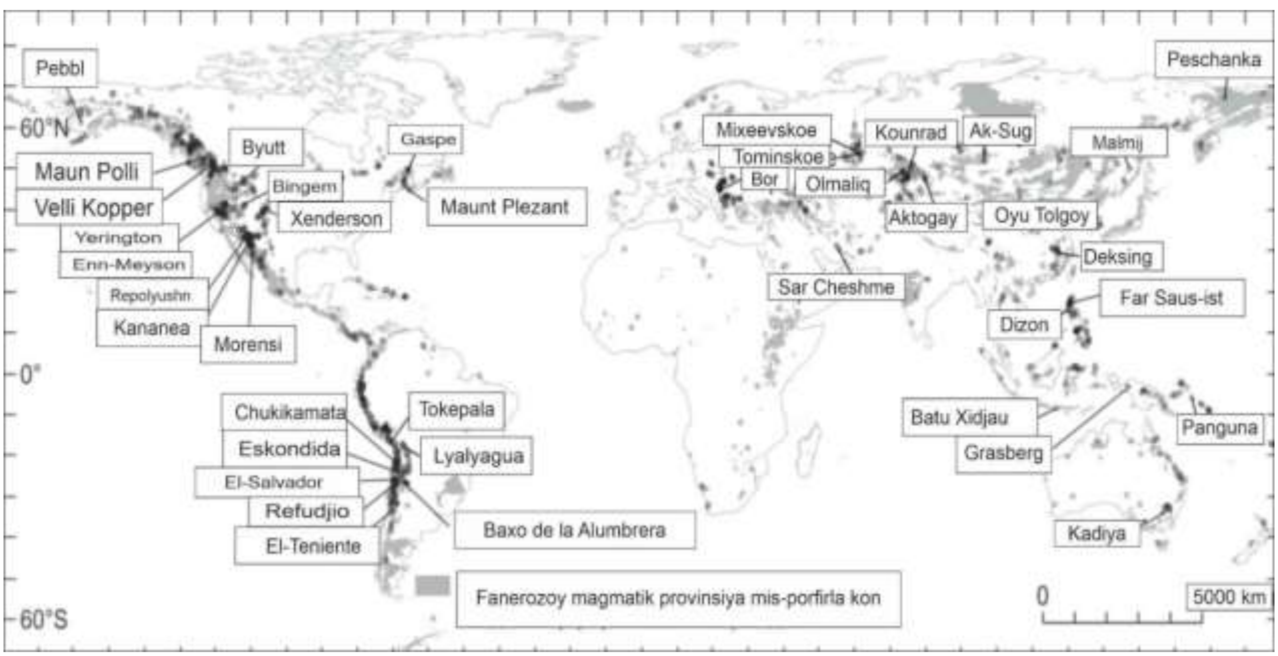

Figure 1: Geographical location of porphyry copper deposits of the world (according to Seedorff *et al.*, 2005)

Porphyry copper deposits are the most important source of copper ore in currently providing more than 70% of world production. Age of the largest deposits of the world vary from the Pliocene and younger (Grasberg and Batu Hijau, Indonesia) to the Miocene (El Teniente, Chile), Eocene (Chukicamata, Chile), the times of the Laramian folding (Morenzi, USA) and the late Devonian (Uyu-Tolgoi, Mongolia). The largest deposits (ore nodes) of the world are Rio Blanco (220 million tons of Cu), El Teniente (95 million tons), Collahuasi (85 million), Chuquicamata (135 million) and Escondida (144 million) - all of Chile, as well as Grasberg (80 million), Morenzi (42 million) and Uyu-Tolgoi (39 million) (Arndt, Fonbote, 2017). For the most part, the deposits are confined to the so-called.
Most of the TEC is associated with orogenic belts Pacific Ring of Fire (west of North and South America and west coast Pacific Ocean) and the Alpine-Himalayan orogenic belt (Figure. 1). Some large ones deposits are located in the Paleozoic orogens of Central Asia and eastern North America and, to a lesser extent, in Precambrian terranes [3].
The Almalyk ore field is located in the eastern part of the Beltau-Kuraminsky volcano-plutonic belt, in the Tashkent region, on the northern slope of the Kuraminsky ridge. The area borders the Republic of Tajikistan in the west, bounded by the Akhangaran River in the north, the Kandyr and Gushsay Rivers in the east, and the Kurama Ridge in the south (Figure. 2). Sedimentary, volcanogenic, and intrusive formations are widely developed in the region.

STUDY AREA
A systematic study of the northern slopes of the Kuraminsky Range began in 1925-26 when S.F. Mashkovtsev carried out a geological survey at a scale of 1:420000. Mashkovtsev published the first data on the results of the work. Geological and prospecting works on a scale of 1:200000, carried out in 1927-29. In 1935 he completed a report on a ten-verst shooting, which by that time had covered the entire area of the eastern part of the Tashkent sheet [1].

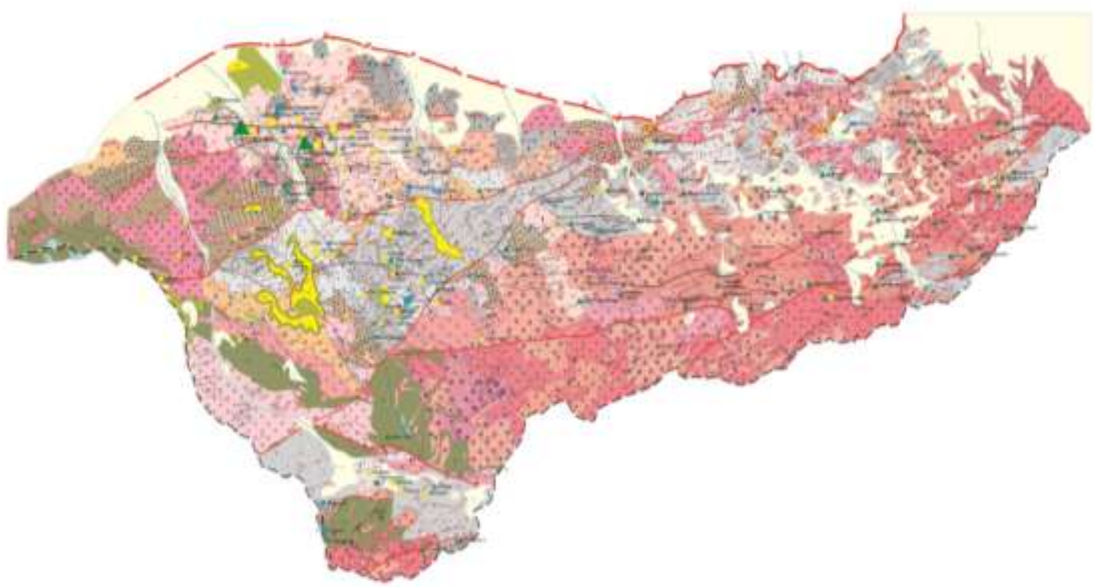

Figure 2: Geological map of Almalyk mining area (Chunixin, 2008. Scale 1:50 000)
From 1964 to 1970, within the limits of the Almalyk ore region, under the direction of I.F. Gaidamak and Yu.S. Shmanko, gravimetric surveys were carried out at scales of 1:50000 and 1:100000. In 1975, V.V. Neverov and A.A. Kulakov carried out generalizations on the study of geology, structure, and conditions for the placement of minerals in the Almalyk region. E.D. Molchanov carried out prospecting and exploration work with an assessment of the prospects for the Kyrkkyz, Yangokly ore occurrences. Promising areas for copper, polymetals, and gold have been identified.

MATERIALS AND METHODS

In the implementation of scientific work, using traditional geochemical methods, determining the material composition of samples by various analytical methods (spectral analysis, mass spectrometer ICP-MS), using the results of field and laboratory work, geological maps were created using ArcGIS software.

RESULTS AND DISCUSSION

The distribution of copper in the sedimentary rocks of the Chatkal-Kurama mountains is discussed in the works of V.I. Rekharsky (1965), D.M. Surgutanova, M.D. Troyanov (1966), L.M. and others. Ores of Kalmakyr, Dalnee (Yoshlik), Karabulak, Northwestern Balikty deposits of disseminated, vein-disseminated

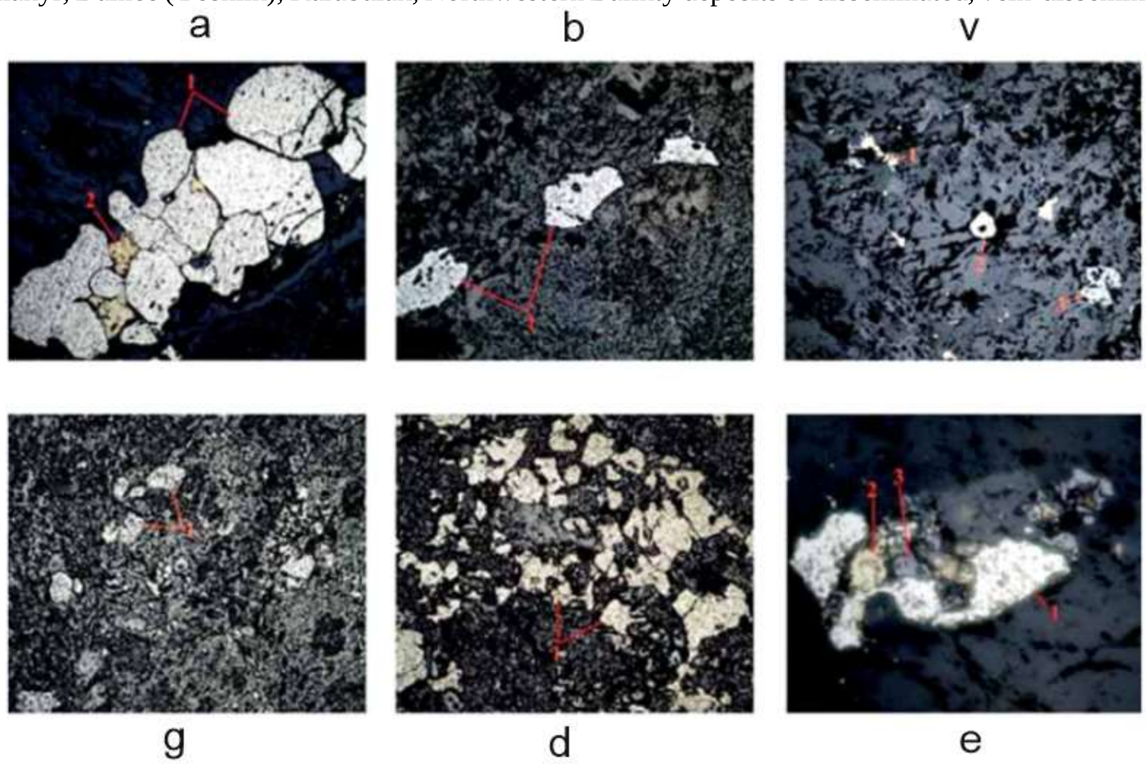

Figure 3: Microphotographs of polished sections*:* *a - polished section No. Fb-17: 1 - pyrite, 2 - chalcopyrite (magnification 100, without analyzer, veined texture of ore minerals); b - polished section No. Fb-32: 1 - iron hydroxides (magnification 100, without analyzer, veined texture of ore minerals); c - polished section No. Fb-17: 1 - chalcopyrite, 2 - pyrite, 3 - magnetite (magnification 100, without analyzer, disseminated texture of ore minerals); d — polished section No. Fb-30: 1 — magnetite (magnification 40, without analyzer, inclusions of magnetite); d — polished section No. Fb-09: 1 — pyrite (magnification 40, without analyzer, accumulation of ore minerals); e - polished section No. Fb-17: 1 - pyrite, 2 -chalcopyrite, 3 - magnetite (magnification 400, without analyzer, aggregate intergrowth of pyrite, chalcopyrite and magnetite)*

and vein type contain Cu (0.4%), Mo (0.005%), Au (0.59 g/t), Ag (2.6 g/t), which are concentrated in chalcopyrite, molybdenite, pyrite. In terms of reserves, the Almalyk deposits are super-giant and unique [9]. Researchers of porphyry copper deposits of the Almalyk mining region seem to have a commonality in their geological structure, tectonics, magmatism, material composition, and genesis of industrial mineralization.
When describing polished sections, ore minerals and their structural and textural features. The texture of ore minerals is mainly disseminated, rarely veined, disseminated - veined and nested. The veins have

significantly pyrite and chalcopyrite-pyrite composition. Sometimes sulfides are represented by oxidation products. Phenocrysts of ore minerals mainly compose individual grains and rarely form aggregative splices. The structure of the ores is fine-, medium-grained, unevenly granular, hypidiomorphic granular (Figure 3) [9].

Based on the chemical composition of the granodiorite porphyry bedrock found in the Shaugaz-Kandir stream, the correlation of the main mineral elements found in the rock was calculated (Figure 4).

	Cu	Bi	Pb	Zn	Cd	In	As	Sb	Se	Te	Au	Ag	W	Sn	Mo	Re
Cu	1	0,67	0,38	0,21	-0,58	0,65	-0,24	-0,27	0,13	0,56	0,02	0,70	0,44	0,46	0,09	0,54
Bi	0,67	1	0,83	0,52	-0,11	0,97	-0,14	-0,27	-0,18	0,93	-0,15	0,93	0,86	0,81	0,13	-0,21
Pb	0,38	0,83	1	0,88	0,33	0,90	-0,20	-0,29	-0,27	0,92	-0,51	0,91	0,86	0,72	-0,01	-0,27
Zn	0,21	0,52	0,88	1	0,32	0,68	0,02	-0,02	-0,37	0,70	-0,61	0,75	0,62	0,42	-0,29	-0,14
Cd	-0,58	-0,11	0,33	0,32	1	-0,07	-0,46	-0,48	-0,13	0,05	-0,37	-0,07	0,11	0,02	0,04	-0,39
In	0,65	0,97	0,90	0,68	-0,07	1	-0,08	-0,19	-0,17	0,98	-0,32	0,98	0,90	0,83	0,09	-0,18
As	-0,24	-0,14	-0,20	0,02	-0,46	-0,08	1	0,98	-0,40	-0,15	0,18	-0,13	-0,16	-0,21	-0,43	-0,38
Sb	-0,27	-0,27	-0,29	-0,02	-0,48	-0,19	0,98	1	-0,23	-0,23	0,07	-0,21	-0,21	-0,24	-0,34	-0,26
Se	0,13	-0,18	-0,27	-0,37	-0,13	-0,17	-0,40	-0,23	1	-0,04	-0,45	-0,14	0,14	0,33	0,88	0,39
Te	0,56	0,93	0,92	0,70	0,05	0,98	-0,15	-0,23	-0,04	1	-0,49	0,96	0,97	0,90	0,24	-0,23
Au	0,02	-0,15	-0,51	-0,61	-0,37	-0,32	0,18	0,07	-0,45	-0,49	1	-0,39	-0,60	-0,57	-0,45	0,03
Ag	0,70	0,93	0,91	0,75	-0,07	0,98	-0,13	-0,21	-0,14	0,96	-0,39	1	0,88	0,79	0,05	-0,05
W	0,44	0,86	0,86	0,62	0,11	0,90	-0,16	-0,21	0,14	0,97	-0,60	0,88	1	0,97	0,43	-0,30
Sn	0,46	0,81	0,72	0,42	0,02	0,83	-0,21	-0,24	0,33	0,90	-0,57	0,79	0,97	1	0,62	-0,25
Mo	0,09	0,13	-0,01	-0,29	0,04	0,09	-0,43	-0,34	0,88	0,24	-0,45	0,05	0,43	0,62	1	-0,01
Re	0,54	-0,21	-0,27	-0,14	-0,39	-0,18	-0,38	-0,26	0,39	-0,23	0,03	-0,05	-0,30	-0,25	-0,01	1

Figure 4: Correlation of elements in the granodiorite porphyry rock in the Shaugaz-Kandir range

***Correlation of copper element in granodiorite porphyry*.** When calculating the correlation of elements in the granodiorite porphyry rock in the Shaugaz-Kondir valley, it was found that the copper element >4 has a very good correlation with Cu-Ag-Bi-In-Te-Re-Sn-W elements; It was found that >2 has a weak correlation with Cu-Pb-Zn elements; It was found that it has a negative correlation with Cu-Cd-Sb-As elements (Figure 5).

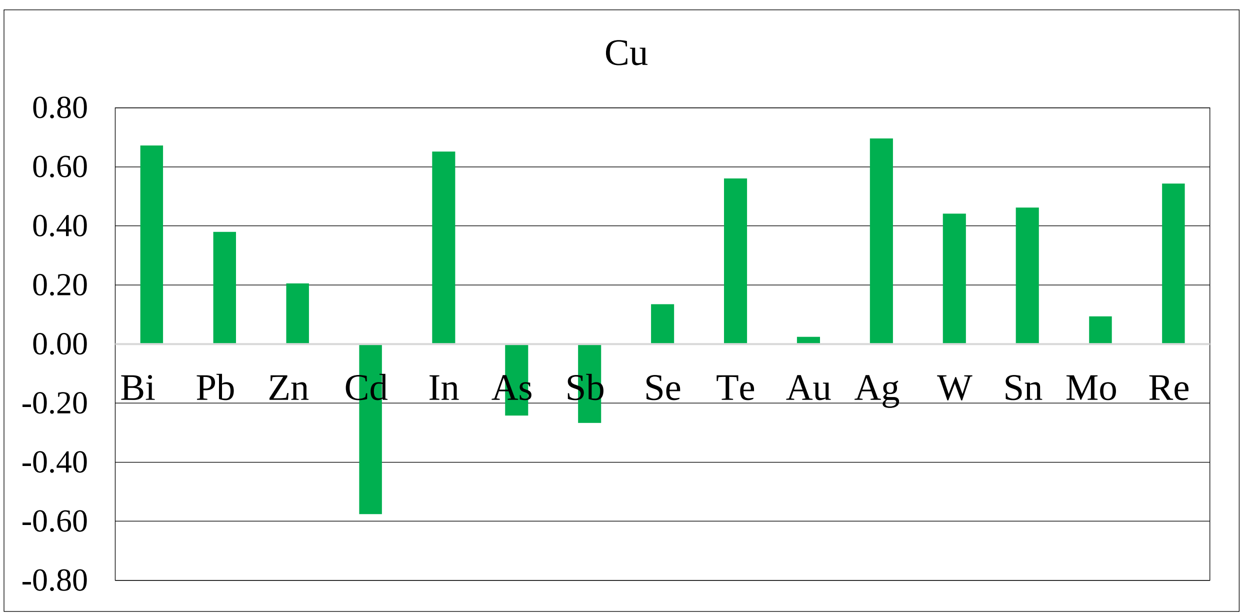

Figure 5: Correlation of elements in the granodiorite *porphyry* rock in the Shaugaz-Kandir range.

Correlation of bismuth element in granodiorite porphyry. When calculating the correlation of elements in the granodiorite porphyry rock in the Shaugaz-Kondir valley, it was found that bismuth element >6 has a very good correlation with Bi-In-Te-Ag-W-Pb-Sn-Cu elements; It was found that bismuth element >4 has a good correlation relationship with Bi-Zn element; it was found that the bismuth element has a weak correlation with the Bi-Mo element; It was found that it has a negative correlation with Bi-Sb-Re-As-Se-Au-Cd elements (Figure 6).

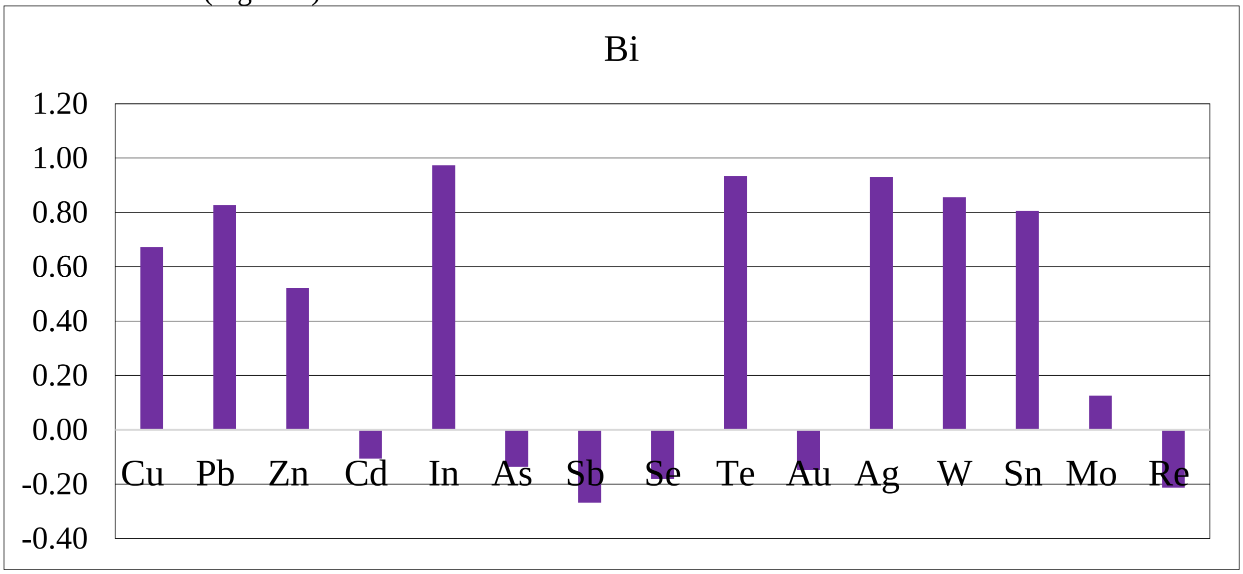

Figure 6: Correlation of elements in the granodiorite *porphyry* rock in the Shaugaz-Kandir range.

Correlation of tellurium element in granodiorite porphyry. When calculating the correlation of the elements in the granodiorite porphyry rock in the Shaugaz-Kondir valley, it was found that the tellurium element >6 has a very good correlation with the Te-Ag-W-Bi-Pb-Sn-Zn elements; it was found that the tellurium element >4 has a good correlation with the Te-Cu element; It was found that the tellurium element Te-Mo element has a weak correlation bond; It was found that the element tellurium has a negative correlation with the elements Te-Au-Sb-Re-As-Se (Figure 7).

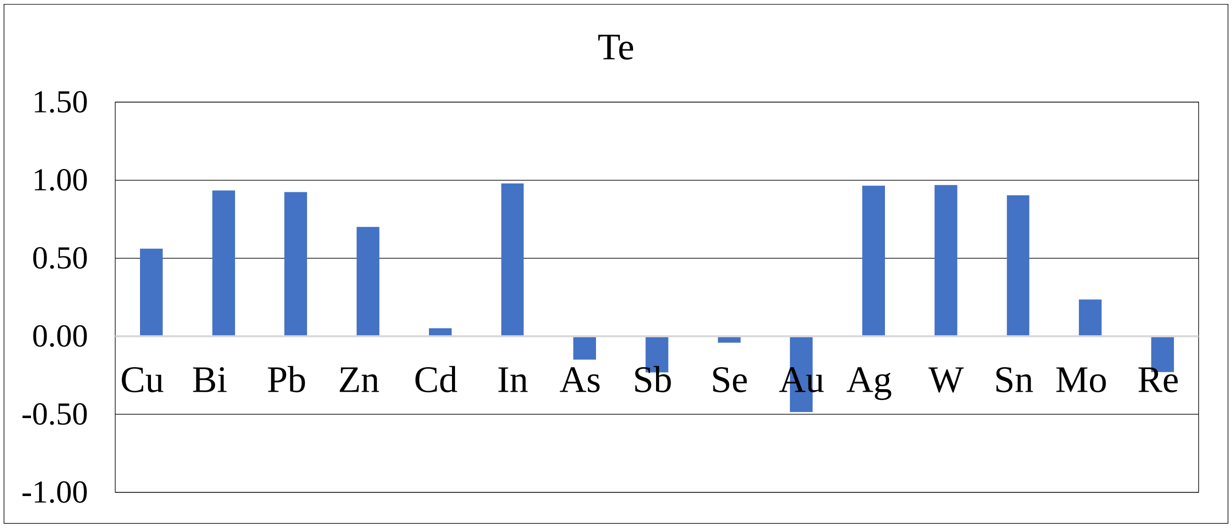

Figure 7: Correlation of elements in the granodiorite *porphyry* rock in the Shaugaz-Kandir range.

Correlation of silver element in granodiorite porphyry. When calculating the correlation of the elements in the granodiorite porphyry rock in the Shaugaz-Kondir stream, it was found that the silver element >6 has a very good correlation with the Ag-In-Te-Bi-Pb-W-Sn-Zn-Cu elements; It was found that the silver element has a negative correlation with the Ag-Au-Sb-Se-As-Cd elements (Figure 8).

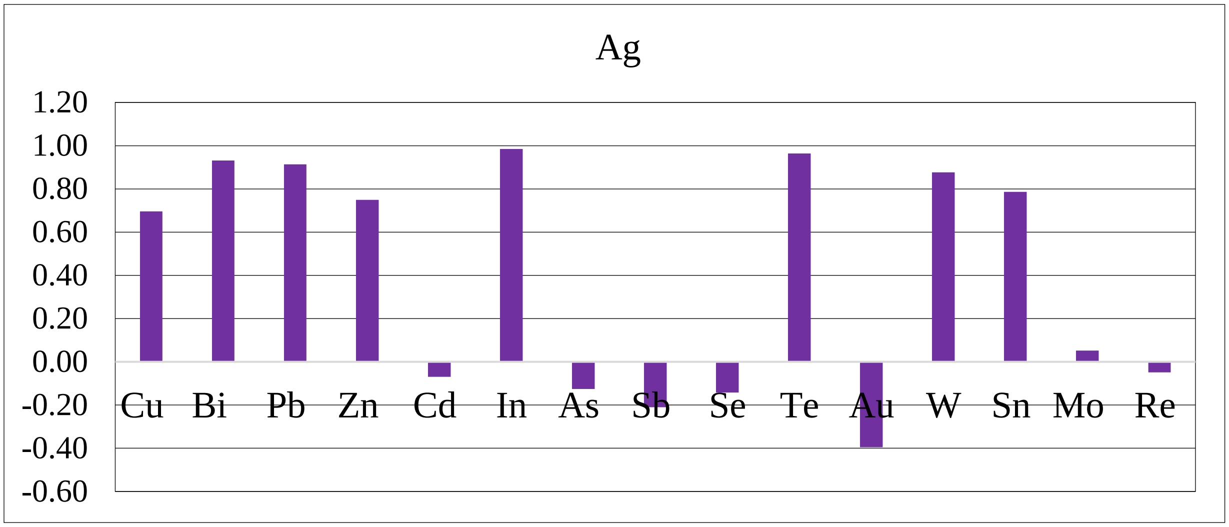

Figure 8: Correlation of elements in the granodiorite *porphyry* rock in the Shaugaz-Kandir range.

Correlation of tungsten element in granodiorite porphyry. When calculating the correlation of elements in the granodiorite porphyry rock in the Shaugaz-Kondir stream, it was found that tungsten element >6 has a very good correlation with W-Te-Sn-Ag-Bi-Pb-Zn elements; it was found that tungsten element >4 has a good correlation with W-Cu-Mo elements; It was found that tungsten element has a weak correlation with W-Se-Cd elements; It was found that tungsten element has a negative correlation with W-Au-Re-Sb-As elements (Figure 9).

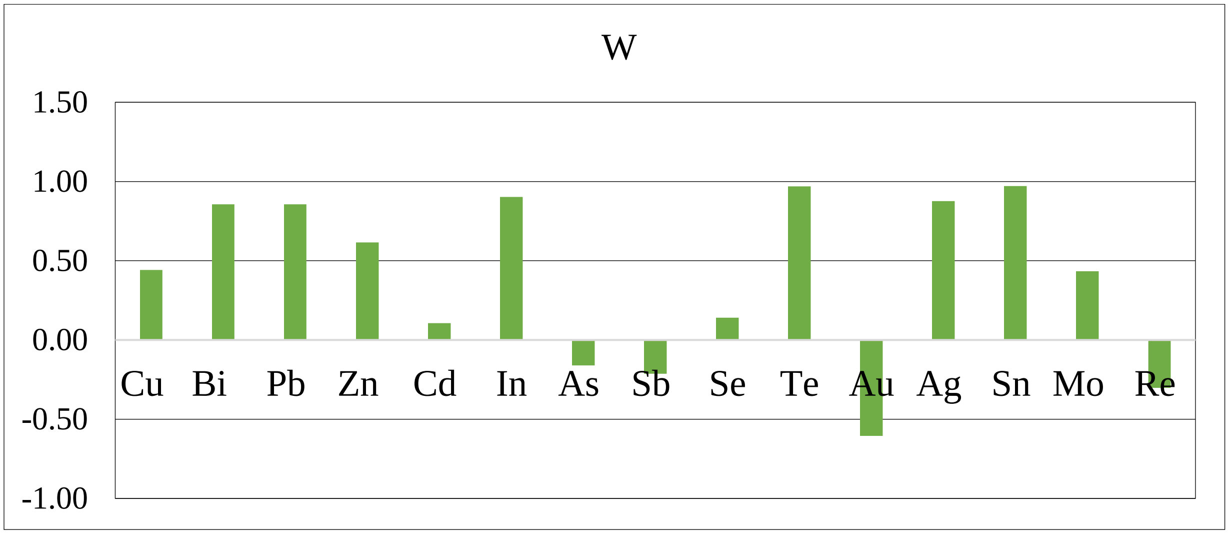

Figure 9: Correlation of elements in the granodiorite *porphyry* rock in the Shaugaz-Kandir range.

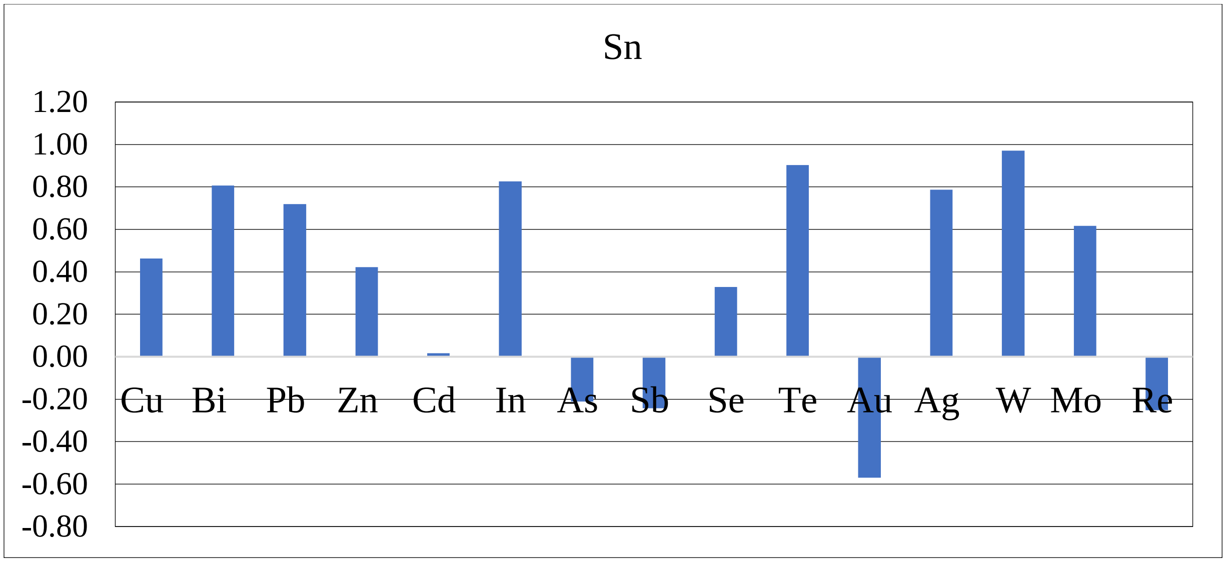

Figure 10: Correlation of elements in the granodiorite *porphyry* rock in the Shaugaz-Kandir range.

Correlation of tin element in granodiorite porphyry. When calculating the correlation of elements in the granodiorite porphyry rock in the Shaugaz-Kondir stream, it was found that the tin element >6 has a very good correlation with Sn-W-Te-In-Bi-Ag-Pb elements; It was found that tin element >4 has a good correlation with Sn-Cu-Mo-Zn elements; it was found that the tin element has a weak correlation with the Sn-Se element; It was found that tin element has a negative correlation with Sn-Au-Re-Sb-As elements (Figure 10).

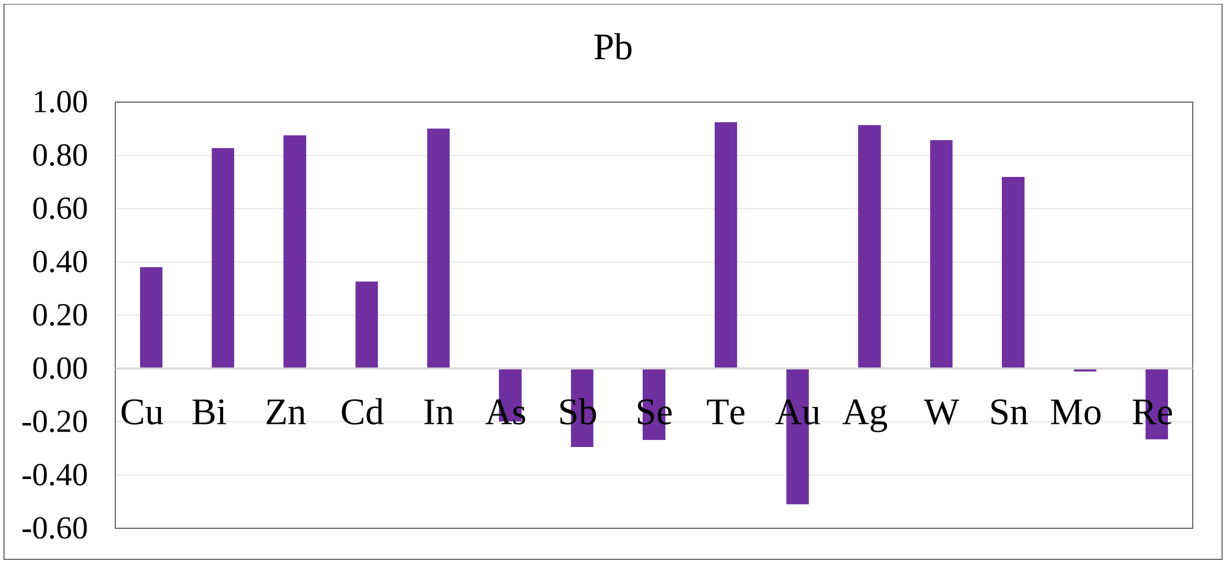

Figure 11: Correlation of elements in the granodiorite *porphyry* rock in the Shaugaz-Kandir range.

Correlation of lead element in granodiorite porphyry. When calculating the correlation of elements in the granodiorite porphyry rock in the Shaugaz-Kondir valley, it was found that the lead element >6 has a very good correlation with the Pb- Te-In-Ag-W-Zn-Bi-Sn elements; it was found that the lead element >2 has a weak correlation with the Pb-Cu-Cd element; it was found that the lead element has a negative correlation with the Pb-Au-Re-Sb-Se-As elements (Figure 11).

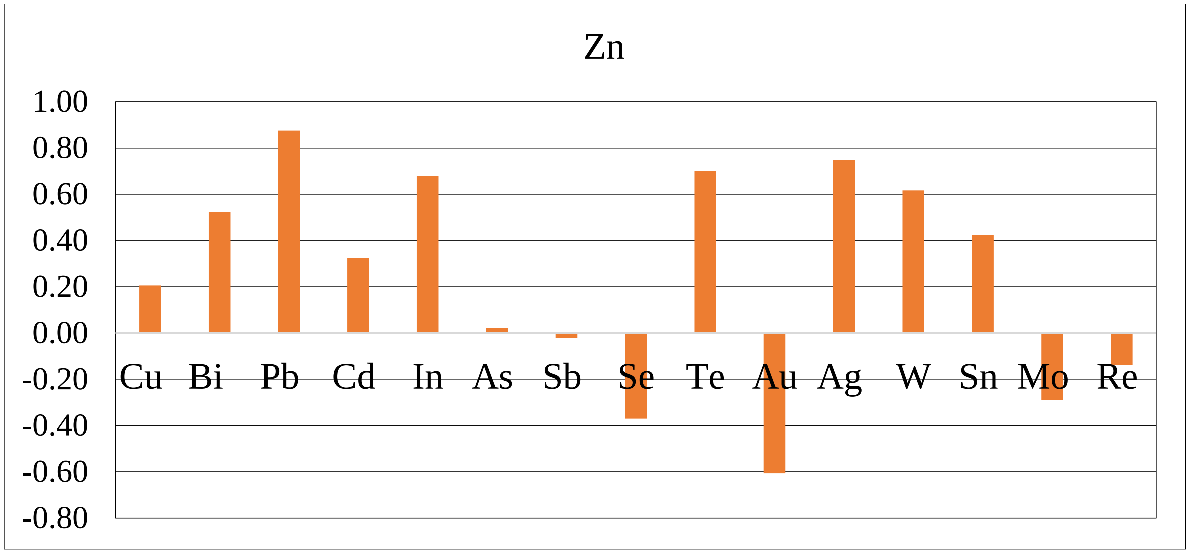

Figure 12: Correlation of elements in the granodiorite *porphyry* rock in the Shaugaz-Kandir range.

Correlation of zinc element in granodiorite porphyry. When calculating the correlation of elements in the granodiorite porphyry rock in the Shaugaz-Kondir stream, it was found that zinc element >6 has a very good correlation with Zn-Pb-Ag-Te-In-W elements; It was found that zinc element >2-4 has a good correlation relationship with Zn-Bi-Sn-Cd-Cu elements; it was found that the zinc element has a weak correlation with the Zn-As element; It was found that the zinc element has a negative correlation with the Zn-Au-Mo-Re-Sb elements (Figure 12).

CONCLUSION

The correlation of elements in the granodiorite porphyry rock in the Shaugaz-Kandir range was calculated. It was found that Cu-Bi-Te-Ag-W-Sn-Pb-Zn have a good correlation with the main elements. It indicates the presence of chalcopyrite, pyrite, sphalerite, molybdenite, bismuthine minerals in the area. It can be seen that the main ore minerals are related to hydrothermal processes in the area.

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