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EXTRACTION OF USEFUL COMPONENTS OF ORE-BEARING ROCKS OF THE "KURGAK" PLOT OF THE BLACK-SHALE FORMATION OF THE SARYJAZ AREA

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Introduction

The conducted scientific work is aimed at studying the acute problem in the field of ore minerals processing. The most energy-intensive and expensive process in the extraction and beneficiation of mineral raw materials is their destruction [1].

As it is known, the concept of innovative method (innovative technologies) is a novelty in the field of technology aimed at achieving new knowledge and solutions [2].

A group of authors [3] studied the effect of the degree of grinding on gold recovery using two-stage leaching. In the first stage the ore was subjected to bio-oxidation (active associations of acidophilic bacteria), while in the second stage gold recovery was carried out.

In the article "Evaluation of the granulometric composition of the crushed product obtained by crushing "in layer"" [4] describes the granulometric characteristics and evaluates the correspondence of the obtained parameters of the crushed product obtained as a result of industrial tests of the crusher operating "in a layer", according to the equations of Rosin-Rammler and Godin-Andreev.

Purpose of work: studying the possibility of maximum extraction of useful components from ore-bearing rocks of black shale formation of Sarydjaz area.

The relevance of scientific research is to create new highly effective methods of extracting useful components in maximum quantity from ore-bearing minerals of Saryjaz.

The choice of this research direction is determined by the need to solve the following problems:

Complexity of studying solid mineral deposits, ensuring high profitability of the modern mineral resource base of the Kyrgyz Republic, taking into account the environmental problems of the country arising from the processing of mining ores

Object of study: minerals of black shale formation of Saryjaz area.

Subject of the study: physical, physicochemical and structural characteristics of mineral samples.

To achieve the goal the following tasks were solved:

Preparatory works were carried out: sampling of rock ore samples, crushing, screening, separation.

Carrying out physical and chemical analyses of initial samples.

Determination of suitability of the proposed new method of crushing for ore minerals of black shale formation of Sarydjaz area.

Analysis, processing and generalization of the experimental data obtained.

Experimental section

1. Objects and methods of research

The object of the study is the ore-bearing rock of the black shale formation of the Saryjaz ploshad from the site "Kurghak", located above sea level 3500 meters.

For the study the samples were prepared using the following methods: crushing, screening, fractionation and magnetic separation.

Brought samples of large-sized pieces of ore-bearing rocks of black shale formation from the site "Kurgak" first crushed on a ball mill (1.5-2.0 mm), then on a non-stand crushing plant (with a 3-phase electric motor 3000 rpm 2 kW, at a pressure of 30-60 atm/cm^2), it consists of a cylindrical cup and a lid made of ceramic products, so that when crushing does not occur dust emission into the environment cup tightly closed with a lid. The crushing of the loaded sample in the amount of 20 grams is prolonged for 30-60 min.

The prepared crushed samples for spectral analysis are presented below

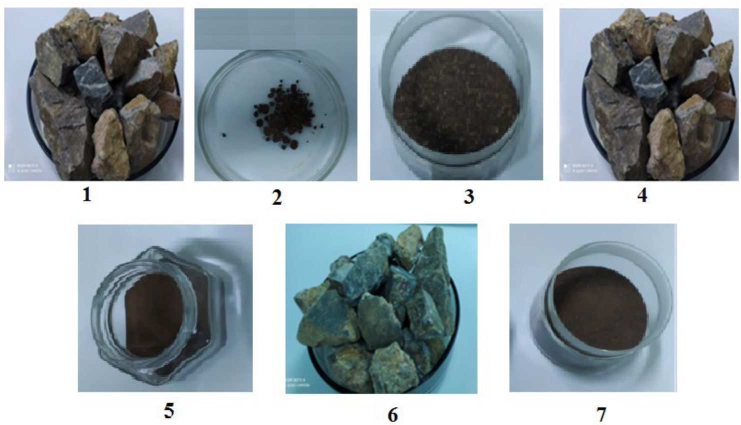

Fig. 1. Prepared for analysis of different fractions of samples: *1,4,6* - pieces of initial samples (PI (S-AS); 2-TCF (the coarsest fraction; *3*-CF (coarse fraction); *5*-FF (fine fraction); *6*-TSF (the smallest fraction)

The chemical composition of the initial sample and crushed fractions of the black shale formation from the locality "Kurgak" of Saryjaz area is presented in Tables 1 and 2.

Table 1

Chemical composition of the initial sample of black shale formation from the area of "Kurghak" of Saryjaz area

Образцы	Mn	Ni	Co	Ti	V	Cr	Mo	W	Zr	Nb
	10-2	10-3	10-3	10-1	10-2	10-3	10-3	10-2	10-2	10-3
PI (S-AS	5	20	< 0.3	3	0,5	30	0,9	0,9	5	< 1.2

PI	In	Cu	Pb	Ag	Sb	Bi	As	Zn	Cd	Sn
(S-AS)	10-3	10-3	10-3	10-4	10-2	10-3	10-2	10-2	10-2	10-3
	< 0.5	300	20	9	0,3	0,3	3	2	< 0.3	20

PI	Ge	Ga	Yb	Y	La	P	Be	Sr	Ba	Li
(S-AS)	10-3	10-3	10-3	10-3	10-2	10-1	10-4	10-2	10-2	10-3
	< 0.12	1,5	0.4	3	< 1.2	< 2	< 2	2	< 2	< 3

PI	Th	U	Au	Sc	Породообразующие элементы в %					
(S-AS)	10-2	10-1	10-3	10-3	SiO2	(S-AS)	10-2	10-1	10-3	10-3
	Pd< 1.2	< 0.5	< 0.5	< 2	>50		Pd< 1.2	< 0.5	< 0.5	< 2

Table 2

Results of spectral analysis of different fractions of the black shale formation of the Saryjaz area of the Kurghak locality

Samples	Mn	Ni	Co	Ti	V
1	10-2	10-3	10-3	10-1	10-2
PI (S-AS)	5	20	< 0.3	3	0,5
TCF(S-AS)	90	12	0.5	20	< 0.3
GF(S-AS)	50	12	0.5	4	< 0.3
CF (S-AS)	30	3	0.3	3	< 0.3
FF (S-AS)	50	0.5	0.4	15	< 0.3
MMF(S-AS)	70	9	0.4	9	< 0.3
TSF (S-AS)	30	1.5	0.3	7	< 0.3

Samples	Cr	Mo	W	Zr	Nb

1	10-3	10-3	10-2	10-2	10-3
PI (S-AS)	30	0,9	0,9	5	< 1.2
TCF(S-AS)	15	0.7	>100	7	<1.2
GF(S-AS)	15	0.5	>100	1.5	<1.2
CF (S-AS)	5	0.3	30	1.2	<1.2
FF (S-AS)	1.2	0.7	>100	7	<1.2
MMF(S-AS)	15	0.5	>100	15	<1.2
TSF (S-AS)	15	0.5	>100	15	<1.2

Samples	In	Cu	Pb	Ag	Sb
2	10-3	10-3	10-3	10-4	10-2
PI (S-AS)	< 0.5	300	20	9	0,3
TCF (S-AS)	<0.5	300	120	1.5	>100
GF(S-AS)	<0.5	200	120	1.5	30
CF (S-AS)	<0.5	300	50	0.4	20
FF (S-AS)	<0.5	200	120	1.5	>100
MMF(S-AS)	<0.5	120	120	1.5	>100
TSF (S-AS)	<0.5	150	120	1.2	>100

Samples	Bi	As	Zn	Cd	Sn
2	10-3	10-2	10-2	10-2	10-3
PI (S-AS)	0,3	3	2	< 0.3	20
TCF (S-AS)	100	12	1.5	<0.3	>1000
GF(S-AS)	70	15	1.2	<0.3	>1000
CF (S-AS)	12	15	1.5	<0.3	>1000
FF (S-AS)	50	15	1.5	<0.3	>1000
MMF(S-AS)	50	12	1.5	<0.3	>1000

Samples	Ge	Ga	Yb	Y	La	P
3	10-3	10-3	10-3	10-3	10-2	10-1
PI (S-AS)	< 0.12	1,5	0.4	3	< 1.2	< 2
TCF (S-AS)	<0.12	0.4	0.3	3	<1.2	<2
GF (S-AS)	<0.12	0.3	0.3	3	<1.2	<2
CF (S-AS)	<0.12	0.4	0.4	4	<1.2	<2
FF (S-AS)	<0.12	0.4	0.3	3	<1.2	<2
MMF (S-AS)	<0.12	0.4	0.3	3	<1.2	<2
TSF (S-AS)	<0.12	0.3	0.4	4	<1.2	<2

Samples	Be	Sr	Ba	Li	Ta
3	10-4	10-2	10-2	10-3	10-1
PI (S-AS)	< 2	2	< 2	< 3	< 1.2
TCF (S-	<2	5	2	<3	<1.2

AS)					
GF (S-AS)	<2	2	2	<3	<1.2
CF (S-AS)	<2	2	3	<3	<1.2
FF (S-AS)	<2	3	3	<3	<1.2
MMF (S-AS)	<2	3	3	<3	<1.2
TSF (S-AS)	<2	3	2	<3	<1.2

Samples	Be	Sr	Ba	Li
3	10-4	10-2	10-2	10-3
PI (S-AS)	< 2	2	< 2	< 3
TCF (S-AS)	<2	5	2	<3
GF (S-AS)	<2	2	2	<3
CF (S-AS)	<2	2	3	<3
FF (S-AS)	<2	3	3	<3
MMF (S-AS)	<2	3	3	<3
TSF (S-AS)	<2	3	2	<3

Samples	Rock-forming elements in %						
4	SiO_2	Al_2O_3	MgO	Fe_2O_3	CaO	Na_2O	K_2O
PI (S-AS)	>50	12	1.2	>12	1.2	1.5	0.4
TCF (S-AS)	50	12	1.5	9	3	0.4	1.5
GF(S-AS)	40	1.5	0.9	>12	1.2	0.4	2
CF (S-AS)	50	12	2	9	4	0.9	0.3
FF (S-AS)	40	9	0.9	>12	2	0.4	1.5
MMF(S-AS)	40	9	0.9	>12	2	0.4	1.5
	40	12	1.5	7	4	0.9	1.2

As can be seen from the table there is an increase in the quantitative content of a number of elements Mn, Ti, W, Pb, Sb, Sn, Au, Zr, Co, Bi, As, especially Mn from 5-90 g/t, W from 0.9->100, Pb from 20-120, Sb from 0.3->100, Sn from 20->1000 and Au from <0.5-5 g/t.

At the same time, the amount of some elements remains unchanged as in the original sample V, Nb, In, Cd, Th, U, Sc, Ge, Y, La, Ta, and some have a slight decrease (Cr, Ga, Ag, Zn).

The microstructure of the initial (PI) and fragmented particles (CF, TSF) and their local composition were studied by means of scanning electron microscope (SEM)

Microstructure of initial samples (PI)

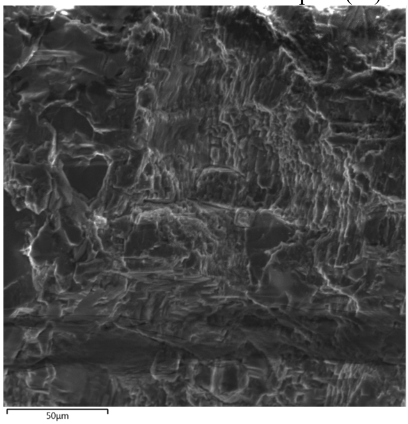

Fig. 2. Image of PI 3, St. 1 (surface area 200 µm)

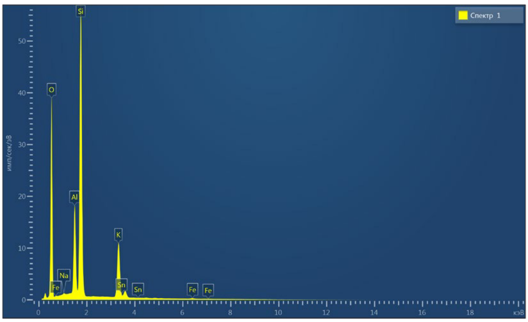

Fig. 3. Spectrum of PI 3, st.1

Table 3

Elemental composition of PI 3, st.1

Result type	Weight %
Spectrum name	Spectrum 1
O	58.82
Na	0.15
Al	7.42
Si	25.05
K	7.96
Fe	0.28
Sn	0.31
Summa	100.00

Statistics	O	Na	Al	Si	K	Fe	Sn
Max	58.82	0.15	7.42	25.05	7.96	0.28	0.31
Min	58.82	0.15	7.42	25.05	7.96	0.28	0.31
averaging	58.82	0.15	7.42	25.05	7.96	0.28	0.31
Standard deviation	0.00	0.00	0.00	0.00	0.00	0.00	0.00

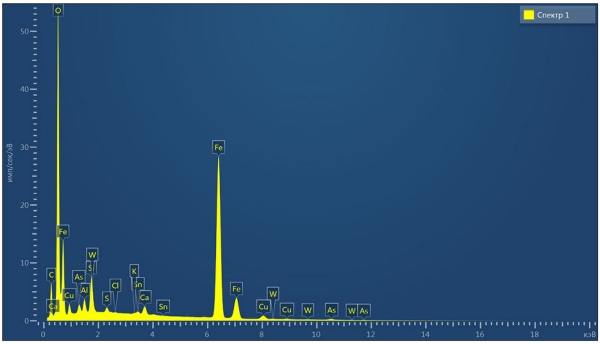

Fig. 4. Spectrum of GBF 2, st.1

Table 4

Elemental composition of CF 2, st.1

Result type	Weight %

Spectrum name	Spectrum 1
C	14.37
O	40.27
Al	0.86
Si	1.80
S	0.28
Cl	0.05
K	0.09
Ca	0.57
Fe	37.80
Cu	1.53
As	1.12
Sn	0.59
W	0.67
sum	100.00

Statistics	C	O	Al	Si	S	Cl	K	Ca	Fe	Cu	As	Sn	W
Max	14.37	40.27	0.86	1.80	0.28	0.05	0.09	0.57	37.80	1.53	1.12	0.59	0.67
Min	14.37	40.27	0.86	1.80	0.28	0.05	0.09	0.57	37.80	1.53	1.12	0.59	0.67
averaging	14.37	40.27	0.86	1.80	0.28	0.05	0.09	0.57	37.80	1.53	1.12	0.59	0.67
Standard deviation	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00

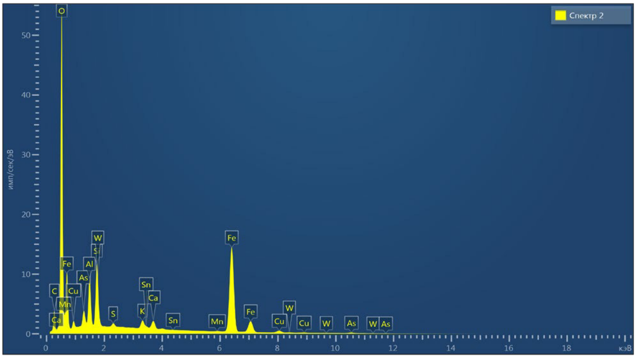

Fig. 5. Spectrum of CF 2, st. 2

Table 5

Elemental composition of CF 2, st.2

Result type	Weight %
Spectrum name	Spectrum 2
C	10.81
O	50.28
Al	3.62
Si	4.17
S	0.24
K	0.74
Ca	0.70
Mn	0.10
Fe	24.73
Cu	1.05
As	2.36
Sn	0.66
W	0.54
sum	100.00

Microstructure of the smallest fraction (TSF)

Statistics	C	O	Al	Si	S	K	Ca	Mn	Fe	Cu
Max	10.81	50.28	3.62	4.17	0.24	0.74	0.70	0.10	24.73	1.05
Min	10.81	50.28	3.62	4.17	0.24	0.74	0.70	0.10	24.73	1.05
averaging	10.81	50.28	3.62	4.17	0.24	0.74	0.70	0.10	24.73	1.05
Standard deviation	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00

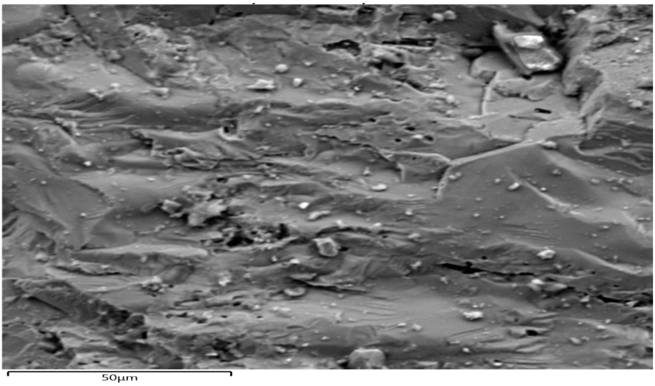

Fig. 6. Image of TSF 1, st.1. (surface of main particles zone 150 µm)

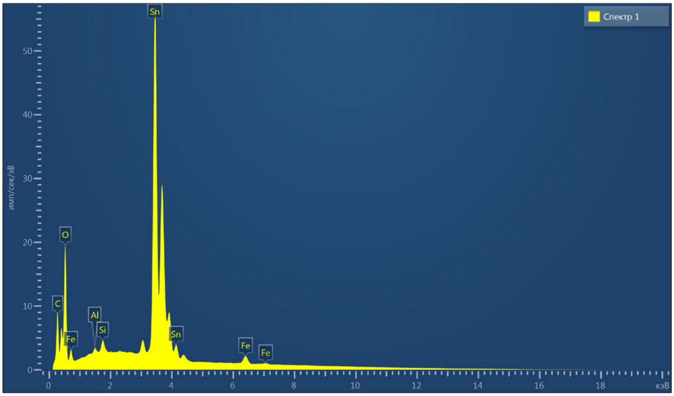

Fig. 7. Spectrum of THF 1, st.1

Table 6

Elemental composition of the THF 1, st. 1.

Result type	Weight%
Spectrum name	spectrum 1
C	6.57
O	33.03
Al	0.26
Si	0.46
Fe	1.49
Sn	58.19
sum	100.00

Statistics	C	O	Al	Si	Fe	Sn
Max	6.57	33.03	0.26	0.46	1.49	58.19
Min	6.57	33.03	0.26	0.46	1.49	58.19
averaging	6.57	33.03	0.26	0.46	1.49	58.19
Standard deviation	0.00	0.00	0.00	0.00	0.00	0.00

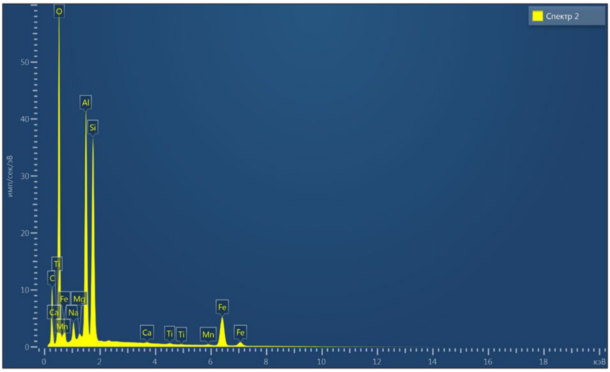

Fig. 8. Spectrum of THF 1, st..2

Table 7

Elemental composition of THF 1, st 2

Result type	Weight %
Spectrum name	spectrum 2
C	21.84
O	50.86
Na	1.36
Mg	0.21
Al	10.01
Si	9.23
Ca	0.06
Ti	0.09
Mn	0.13
Fe	6.21
sum	100.00

Statistics	C	O	Na	Mg	Al	Si	Ca	Ti	Mn	Fe
Max	21.84	50.86	1.36	0.21	10.01	9.23	0.06	0.09	0.13	6.21
Min	21.84	50.86	1.36	0.21	10.01	9.23	0.06	0.09	0.13	6.21
averaging	21.84	50.86	1.36	0.21	10.01	9.23	0.06	0.09	0.13	6.21
Standard deviation	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00

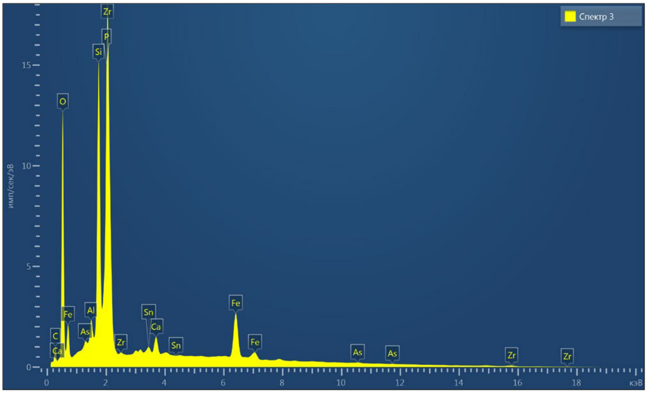

Fig. 9. Spectrum of THF 3, st.3

Table 8

Elemental composition THF 3, st.3

Result type	Weight %

Spectrum name	Spectrum 3
C	7.59
O	43.15
Al	0.81
Si	9.52
P	1.42
Ca	1.04
Fe	7.91
As	0.38
Zr	27.15
Sn	1.05
sum	100.00

Statistics	C	O	Al	Si	P	Ca	Fe	As	Zr	Sn
Max	7.59	43.15	0.81	9.52	1.42	1.04	7.91	0.38	27.15	1.05
Min	7.59	43.15	0.81	9.52	1.42	1.04	7.91	0.38	27.15	1.05
averaging	7.59	43.15	0.81	9.52	1.42	1.04	7.91	0.38	27.15	1.05
Standard deviation	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00

When studying the spectra and elemental composition of the initial samples of PI 3 in both sites *1* and *2*, an overestimation of Si and O followed by AI, K, C, Fe is observed;

In CF 2 sample in both sites *1* and *2* also observed overestimation of O and Fe followed by elements for study *1* - C, Si, Cu, As, AI, W, Sn, Ca for study *2* - Si, AI, As, Cu, Ca, Sn, W;

All the THF samples overestimated the amount of oxygen (O) except THF 1, study *1* - Sn, O, C, Si, AI, Fe; SMF 1, study *2* - O, C, AI, Si, Fe, Na, Mg, Mn, Ti; THF 3, study *3* - O, Zr, Si, Fe, C, P, Sn, Ca, AI, As.

Images of initial sample (PI) particles are presented below in Fig. 10, 11:

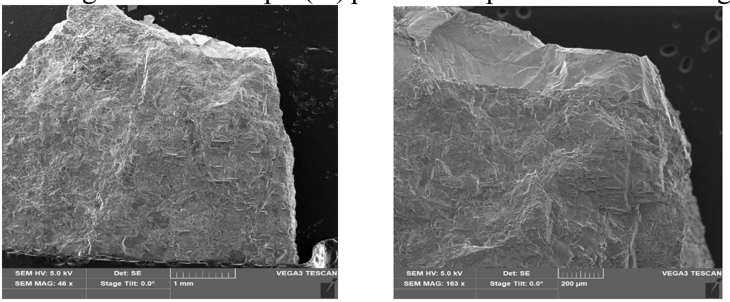

Fig. 10. Morphological structure of large particles of PI 5×5 mm

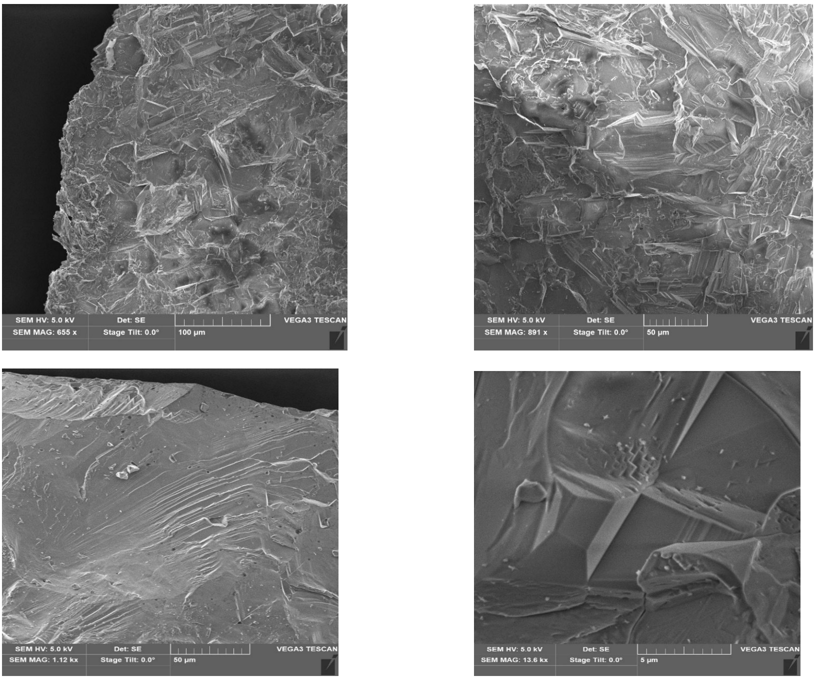

Fig. 11. Image of the surface of large particles of PI 5×5 mm

Thus, when studying the morphological structure of the material of large particles containing ore of 5X5 mm size, large fracture, step structure and quasi-skid facets are observed on the surface of the material.

Next, we present images of the coarse fraction (CF) with an indication of their size established through SEM, Fig. 12.

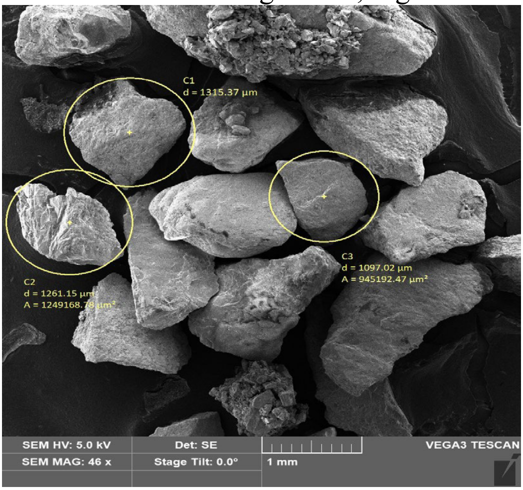

Fig. 12. CF sample (powdered Ø particles 1-1.5 µm)

The studied CF material is a coarse powder of oval shape,particle diameter size = from 1mm to 1.5 mm, there are inclusions of particles of the same material of about 50 microns.

According to morphology the surface of particles represents: stone-like structure, brittle and quasi-brittle fracture.

Further the sizes of the smallest fractions (THF) were determined by SEM, which are presented in the following images, Fig. 13-14.

The studied THF material is a powder with crystalline particles, which the average value of the diameter of the main particles was 167,7 µm, the cross-sectional area of the crystalline particles from 879, 65 μm^2 to 2664.51 μm^2.

The morphological structure of the surface of basic particles is stone-like structure, quasi brittle fracture, and the surface of crystalline particles: flat with small chips at an angle, presumably a single crystal or polycrystal.

In publications of scientists in the field of geology and mining, "black shales" are considered as a new promising and unconventional source of noble and rare-metal raw materials.

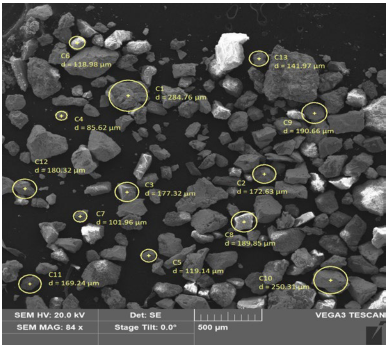

Fig. 13. diemeter of the main particles THF (av.) (Ø 167,7 µm)

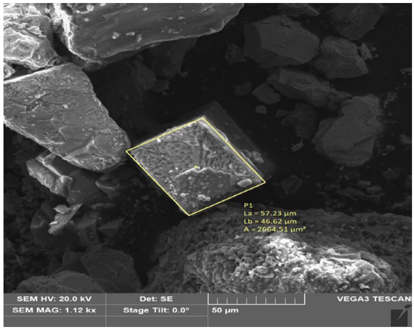

Fig. 14. Powder with crystalline THF particles (Ø 167.7 µm)

Conclusion

1. Ore-bearing rock of the Kurghak section of the Saryjaz area has the highest openability in relation to the non-standard crushing plant;

2. There is an increase in the quantitative content of a number of elements - Mn, Ti, W, Pb, Sb, Sn, Au, Zr, Co, Bi, As, especially Mn from 5-90 g/t, W from 0.9->100, Pb from 20-120, Sb from 0.3->100, Sn from 20>1000 and Au from <0.5-5 g/t ;

References

1. **Portnov V.S., Yurov V.M., Tursunbaeva A.K.** et al. Issues of optimization of the process of crushing of refractory ores. Fundamental Research. №9, 2012.

2. Source: Innovative technologies. Modern innovative technologies. - https://kstu.kg/ innovative -technologies/.

In our country innovation activity is supported in every possible way, this is confirmed by the Law "On innovation activity" adopted in the Kyrgyz Republic on November 26, 1999, № 128.

Law "On innovation activity" from November 26, 1999 № 128.

3. **Kanaev A.T., Baimyrzaev, K.M., Semenchenko G.V**. and others. Influence of the degree of grinding of ore of Bolshevik deposit on the gold recovery. 2017.