(1) False color composite image

False color composite images are made up of three bands in combination selected from seven TM bands. Composite images are as follows;

Red, Green, Blue: band 4, band 3, band 2

Red, Green, Blue: band 5, band 7, band 1

(2) Color ratio composite image

A rationing technique between bands is useful to enhance specific characteristics and also to reduce topographic effects. Spectra of clay minerals (kaolinite, illite and montmorillonite) have an absorption feature at a wavelength of approximately 2.2 micro.m that coincides with band 7 of TM. Iron oxide minerals have characteristic spectra in bands of 1, 2, 3, 4 and 7. Generally spectra of iron minerals have weak reflections in band 1, and strong reflections in band 3. It is possible to delineate areas where iron oxide minerals spread on the surface by means of rationing between bands. Composite images are as follows;

Red, Green, Blue: 5 / 7, 5 / 4, 3 / 1.

(3) Ratio image with density slice (5/7 and 4/3)

Spectra of clay minerals have weak reflectance in band 7, and strong reflectance in band 5. The ratio 5/7 therefore has high values for clay minerals, resulting in bright tones on the density slice which are assigned red and yellow colors signifying the highest ratio values. But the ratio 4/3 also has high values for vegetation; weak reflectance in band 3, and strong reflectance in band 4. After comparing both ratio images individually, it is possible to distinguish the clay dominant areas from vegetation.

3 Results of analysis

3-1 Results of Photogeological interpretation

Satellite image used for a photogeological interpretation is shown in Figure II-3-1-1.

3-1-1 Characteristics of topography and water system (Plate I-4-1-1)

The target area was classified into three topographic categories of desert, low plane and low hill. For the interpretation, the T.P.C.(1:500,000) map was referred to when necessary. The results of photogeological interpretation are as below:

(1) Desert(Du)

The desert area is located at the north-western part of the Zhaman-Aibat target area. It shows yellowish brown in color in the satellite image. (Colors described here are in the

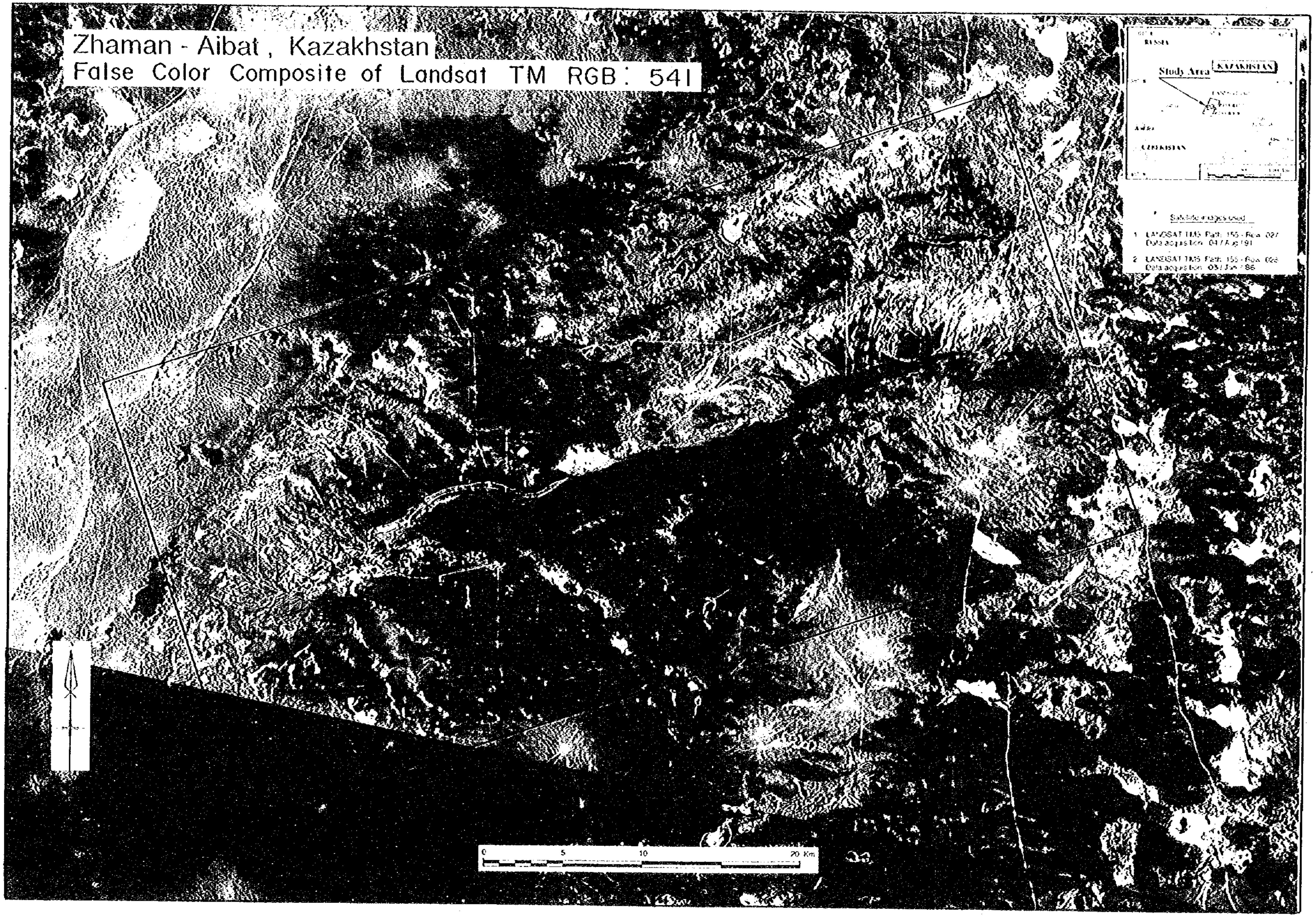


Figure II-3-1-1 False Color Composite of Landsat TM, RGB;541

satellite image formed by combination of bands 5,4 and 1, false color). In the desert, dunes developed by the effect of wind are especially distinct in the northern and southern parts in the image. In some places vegetation was detected but water course are rare.

(2) Low plane (LP)

The low plane is distributed in the area surrounding the desert. Its topographic character is similar to that of desert and at some places it is covered by sand. The vegetation is distinctive and commonly includes "praya" indicating the difference from the desert. The development of "praya" shows the concentrated region of water courses which in this case are run off channels from the hill region.

(3) Smooth hill (SH)

Smooth hill topography is spread widely and generally it corresponds to altitudes above the desert or low plane. Water courses are developed in the hilly areas but disappear at their margins where water flows into the low planes, and "praya" disappear. Smooth hills show very smooth texture in the image.

(4) Middle hill (MH)

The middle hill topography extends between the smooth hill and rough hill topography. Its altitude is also between that of the smooth and rough hills. Due to the hard resistant property of its rocks and the developing degree of the stratification it shows a rather rough texture. In geological classification they correspond to units C, D and E.

(5) Rough hill (RH)

Rough hill topography is located at the central part of the target area, and according to the highly resistant nature of the formations it shows rough texture. It is found at high altitudes and forms a watershed (water divide) with water courses flowing to north and south. Geologically, rough hill areas correspond to the unit of the axial part of the anticline structure.

3-1-2 Geology

1) Stratigraphy (Plate II-3-1-2)

By the photogeological analysis the geological classification (corresponding to stratigraphy) of the target area was distinguished as 10 geological units and subunits divided and alphabetically named in ascending order.

Referring to published geologic maps (Geologic Map of Kazakhstan, USSR., Scale 1:500,000. and others), these geological units correspond to Carboniferous, Permian, Cretaceous and Quaternary systems. The Carboniferous system described in the maps was not however distinguished in the satellite image.

The distinguished stratigraphic geological units are shown in Plate II-3-1-2 and the table I-3-1-1 the interpretation chart is listed in Table II-3-1-1. The characteristics of each geological unit are as follows:

(1) Geologic unit A

The geologic unit A is characteristically shown by the color of dark blue in the satellite image (the color is from the image of false color by band combination of 5,4 and 1. The following description is in the same image). It displays a semi-parallel pattern of water courses has rough texture, is highly resistant and has well developed stratification. It consists of the lowest geologic unit in the target area.

(2) Geologic unit B

The geologic unit B shows similar characteristics to unit A. However, it has sparse drainage, smooth texture, medium resistant rocks and the degree of stratification distinguish it from that of unit A. Unit B overlaps unit A, and it is possible to consider that it is a sub-unit of unit A.

Unit B occurs in areas surrounding unit A which are widespread in the central part by the area. Unit B is also located in the north-eastern part in an arrangement like a fenster.

(3) Geologic unit C

Unit C is characterized by its white color and arborescent drainage pattern, rough texture, medium resistant rocks and very well developed stratification. It's color varies from white to orange, hazy bluish grey and in some parts mozaik texture is observed. Unit C overlays unit B discordantly.

(4) Geologic unit D

Unit D is characterized by its color of yellow. Its inclination can be distinguished by its color, and in steeply inclined parts it often shows the topography of cuesta.

(5) Geologic unit E

Unit E shows dark blue color, rough texture, medium resistant rocks and in some places is well stratified. It's hue is similar to that of unit A but in the combined image of bands 7, 5, 4 they are clearly different from each other. Unit E is widely spread in the area.

(6) Geologic unit F

Unit F was divided into two sub-units. Lower sub-unit F1 has a characteristic bluish grey, color, flat topography, smooth texture and low resistant rocks and differs from the upper unit F2 which shows dark grey and medium resistant rocks. The color tones of both units are rather heterogeneous in all parts of the image, but other characteristic (parameter) are almost the same. These units overlap in many places discordantly.

Table II-3-1-1 List of Interpretation for the Satellite Image Analysis in the Zhaman-Aibat Area

Geologic Units		Photo Characteristics		Drainage		Rock			Cover		Remarks
		Color	Texture	Pattern	Density	Texture	Resistance	Bedding	Vegetation	Land Use	
Q	Q3	white	-	no	-	-	very low	-	no	-	
Q	Q2	light grey	aerial dune	no	-	aerial dune	very low	-	little	-	
Q	Q1	grey	aerial dune	no	-	aerial dune	very low	-	very little	-	
F	F2	dark grey	smooth	dendritic	low	smooth	moderate	poorly	no	-	
F	F1	blueish grey	even, smooth	dendritic	low	even, smooth	low	poorly	no	-	
	E	dark blue (partialy white)	rough	sub-parallel	moderate (partialy high)	rough	moderate	partialy very well	no	-	
	D	yellow	cuesta	sub-dendritic	moderate	cuesta	low	poorly	no	no	
	C	white (partialy orange)	rough	dendritic	moderate	rough	moderate	very well	no	no	
	B	blue	smooth	sub-parallel	low	smooth	moderate	commonly	no	no	
	A	dark blue	rough	sub-parallel	high	rough	high	well	no	no	

(7) Geologic unit G

Unit G is considered to correspond to Quatemary, and the results of the analysis indicate the sub-unit of Q1,Q2 and Q3. Sub-units Q1 and Q2 are different types of wind-forming strata (dune) and the unit Q3 is "praya".

2) Geologic structure

The most important geologic structure in the area is the anticlinal structure located in the central part. Its axis has a direction of east-north-east and plunges to west-south-west. Anticlinal structure is asymmetric with the south wing being more gently sloped than the north wing. The continuity of the axis in the east-northeast direction is cut and shifted by cross faults with north to south strike (direction). Another small anticlinal structure of almost parallel axis was detected to the northeast of this anticline (Plate I-4-1-1).

On the contrary faults with meridional strike were detected and they often cut the anticlinal structure described above.

Lineaments have no particular dominant direction, but in the north-west part of the area lineaments with north-east direction dominate.

Two incomplete circular structures were also detected in the western part of the area (PLate II-3-1-1).

3-2 Results of digital image processing

The Zhaman-Aibat area contains stratiform copper deposits related to weakly altered sedimentary rocks. In an attempt to identify this type of mineralization a spectral analysis was carried out with all band data. The method involved generation of color composite images and color density slice maps in order to distinguish alteration zones. The images and maps are composed of spectral or ratios of spectral bands.

3-2-1 Alteration zone.

A color ratio composite image (RGB ; 5 / 7, 5 / 4, 3 / 1) is shown as extracted alteration zones in Figure II-3-2-1. Three processed color areas are associated with the Zhaman-Aibat horst anticline; a blue area spreads as a triangle-form to the west of the horst, a reddish purple area surrounds the horst in a semicircle, and the rest of the area is yellowish green. A processed blue area corresponds to geologic units A and B, that correspond to red sandstone in Carboniferous. The blue area identifies iron oxide and iron hydroxide that coincides with the "red sandstone". According to the fact that the red sandstone contains ores, the area of blue in the image is a valid target in peripheral sedimentary rocks in the survey area. The reddish purple area corresponds to geologic unit

Q3, which is made up of Quaternary sediments surrounding the Zhaman-Aibat horst anticline. Some of the reddish parts correspond to group of lakes which expand their areas during summer. It is difficult to make a judgement on the existence of clay minerals in the reddish area (band 7/5) without sufficient ground truth information. The yellowish green area corresponds to geologic units F1, F2 and Q1, which are widely distributed in the survey area. These rocks represent weathered layers of Quaternary and of Cretaceous age. It is believed that the yellowish color reflects alteration minerals in the weathered layer mixed with clay minerals and iron oxides. The color has some variability in lightness; F1 corresponds to the dark part, and Q1 to the bright part.

In next year's study it is necessary to do a spectral analysis of rocks and to make a ground truth in geologic units.

3-2-2 Digital images and a geologic unit

Digital images are shown in Figure II-3-2-2 to II-3-2-5. These images were compared to geologic units from photographic geology. The result is shown below.

An alteration zone was extracted as a color ratio composite of blue. This distribution corresponds to geologic units A and B. A similar alteration and rock character are inferred in the geologic units C and D. Unit D shows a characteristic color of yellow in false color images (RGB; 432 and 571). But the geological horizon of C and D are younger than the ore bearing horizon of red sandstone. Next year these units must be checked by ground truth surveys.

List of digital images and geologic unit

Geologic unit	Photo, RGB 541	False, RGB 5/7, 5/4, 3/1	False, RGB 432	False, RGB 571	Pseudo, RGB 7/5	Pseudo, RGB 4/3
Q3	white	reddish-violet	white (brown)	white (brown)	very low	very low
Q2	light-gray	reddish-violet	-	-	-	-
Q1	gray	yellowish-green	-	-	-	-
F2	dark gray	yellowish-green	grayish-green	yellowish-brown	middle	middle
F1	bluish-gray	yellowish-green	grayish-green	yellowish-brown	middle	middle
E	dark blue (white)	orange	grayish-green	dark brown	high	middle
D	yellow	-	yellow	yellow	high	middle
C	white	pink (white)	grayish-brown	-	high	middle
B	blue (orange)	dark blue	grayish-yellow	dark blue	high	middle
A	dark blue	dark blue	grayish-yellow	blue	high	middle

( ) partially

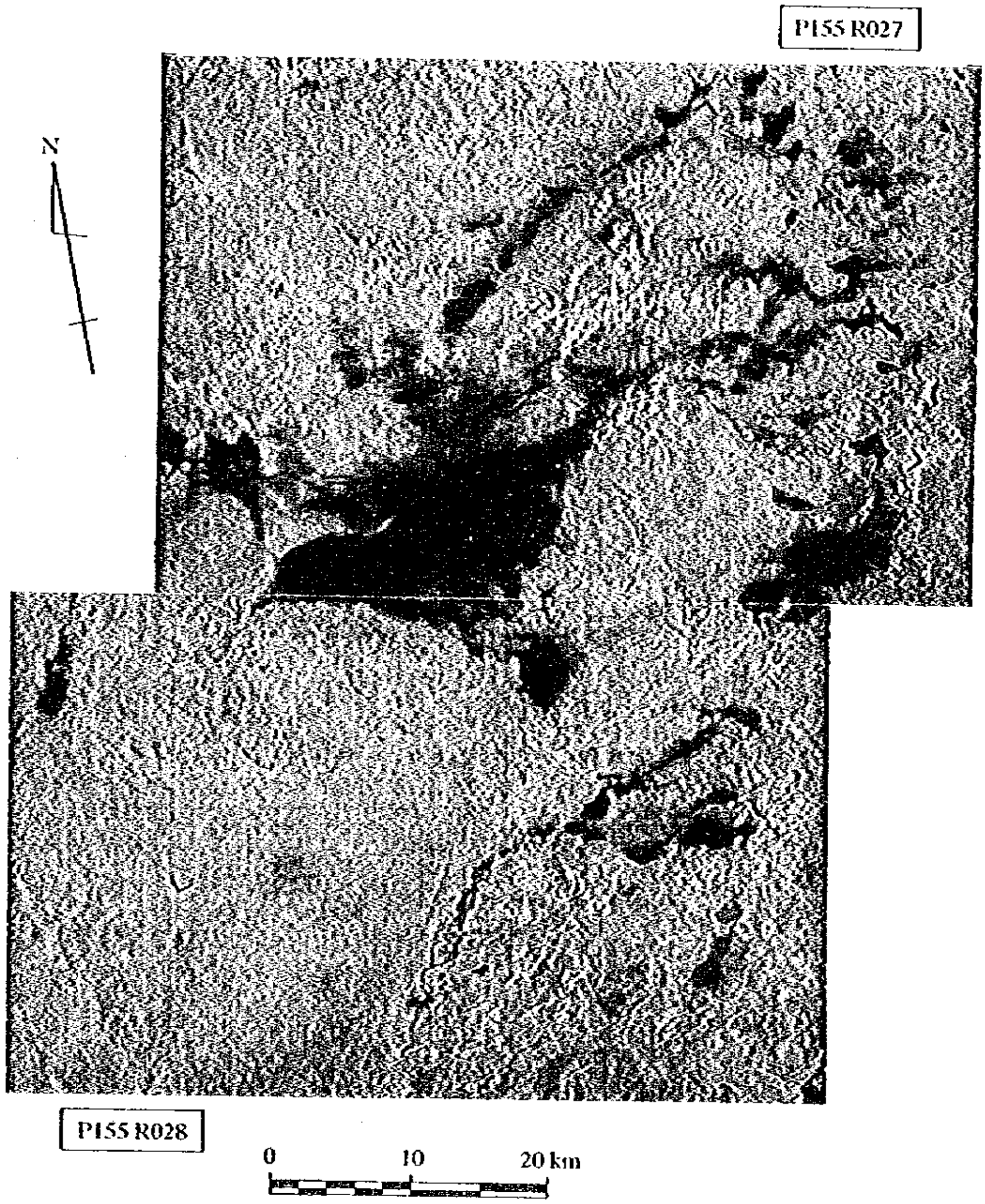


Figure II-3-2-1 Alteration Zone Extracted from the Satellite
Image in the Zhaman - Aibat Area ;
Color Ratio Composite of Landsat TM RGB : 5/7 5/4 3/1

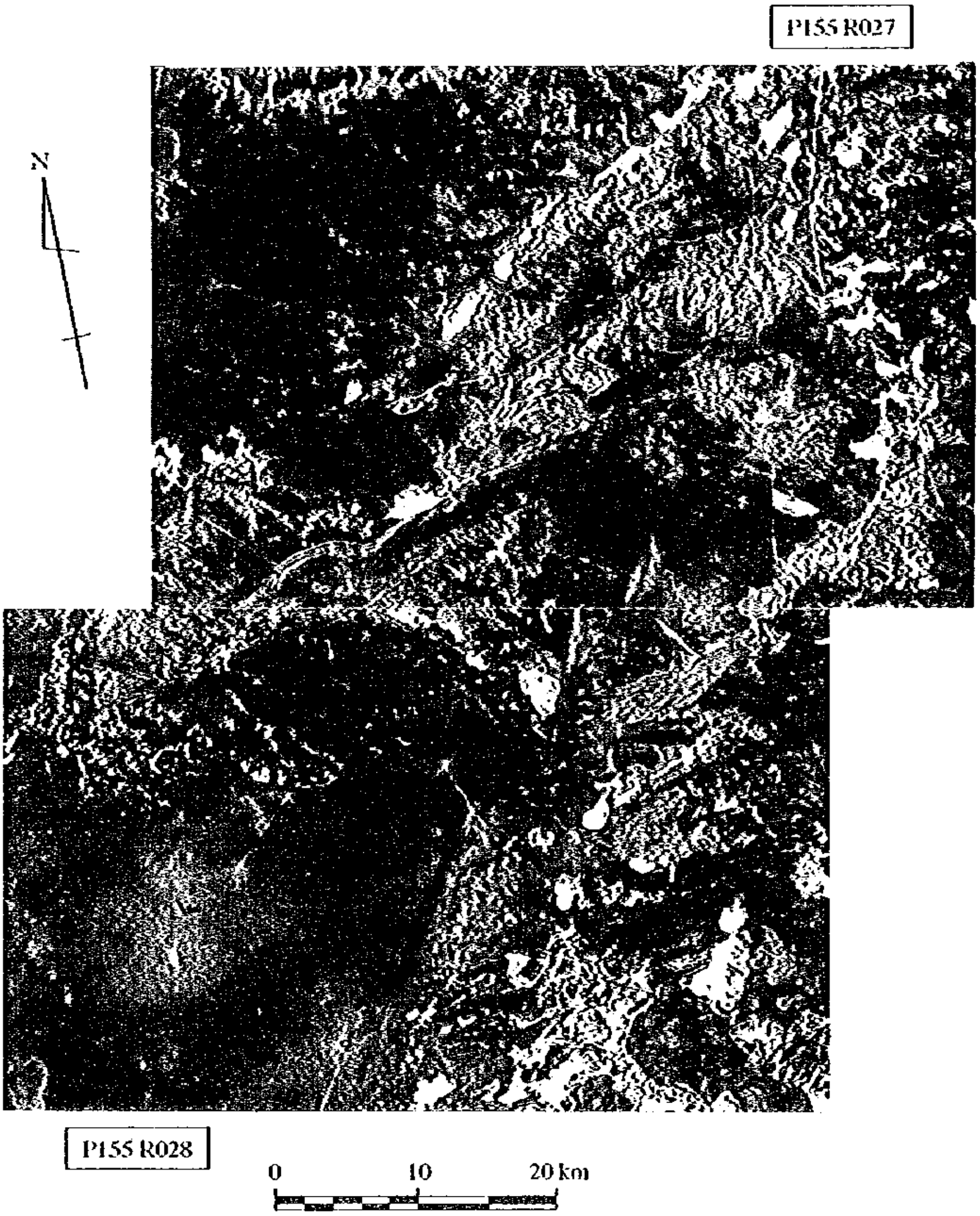


Figure II-3-2-2 False Color Composite of Landsat TM RGB : 432

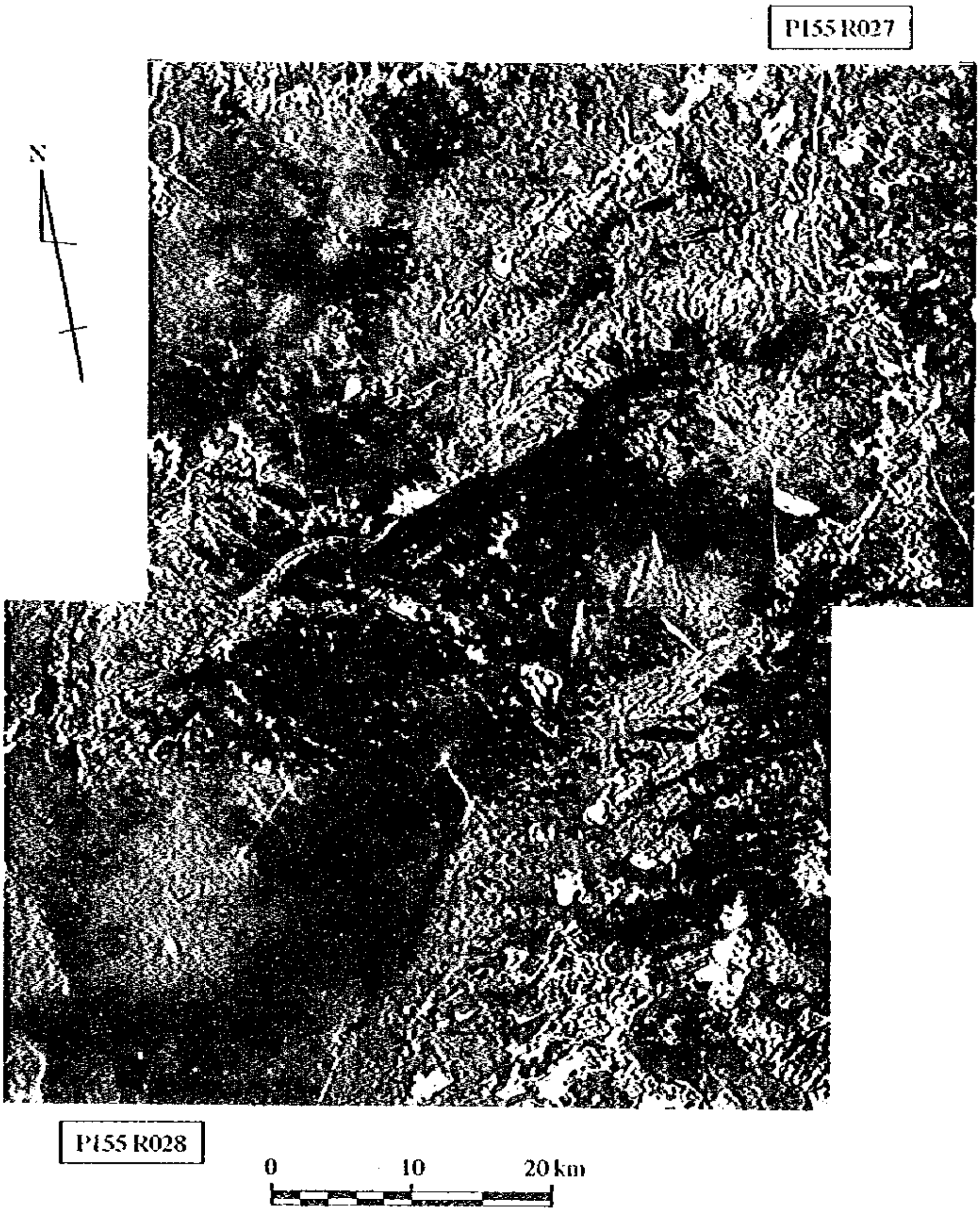


Figure II-3-2-3 False Color Composite of Landsat TM RGB : 571

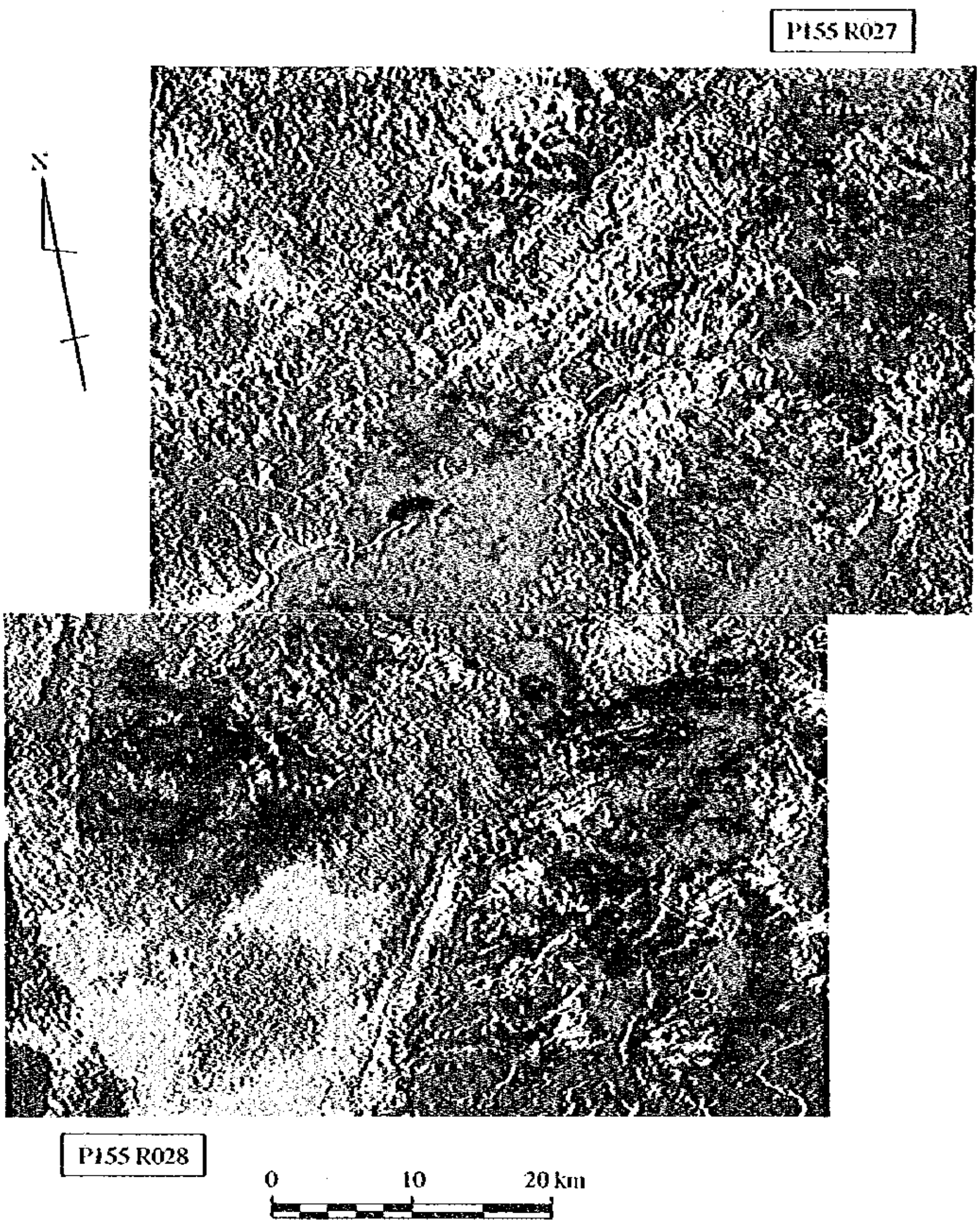


Figure II-3-2-4 Ratio 5/7 Image with Density Slice

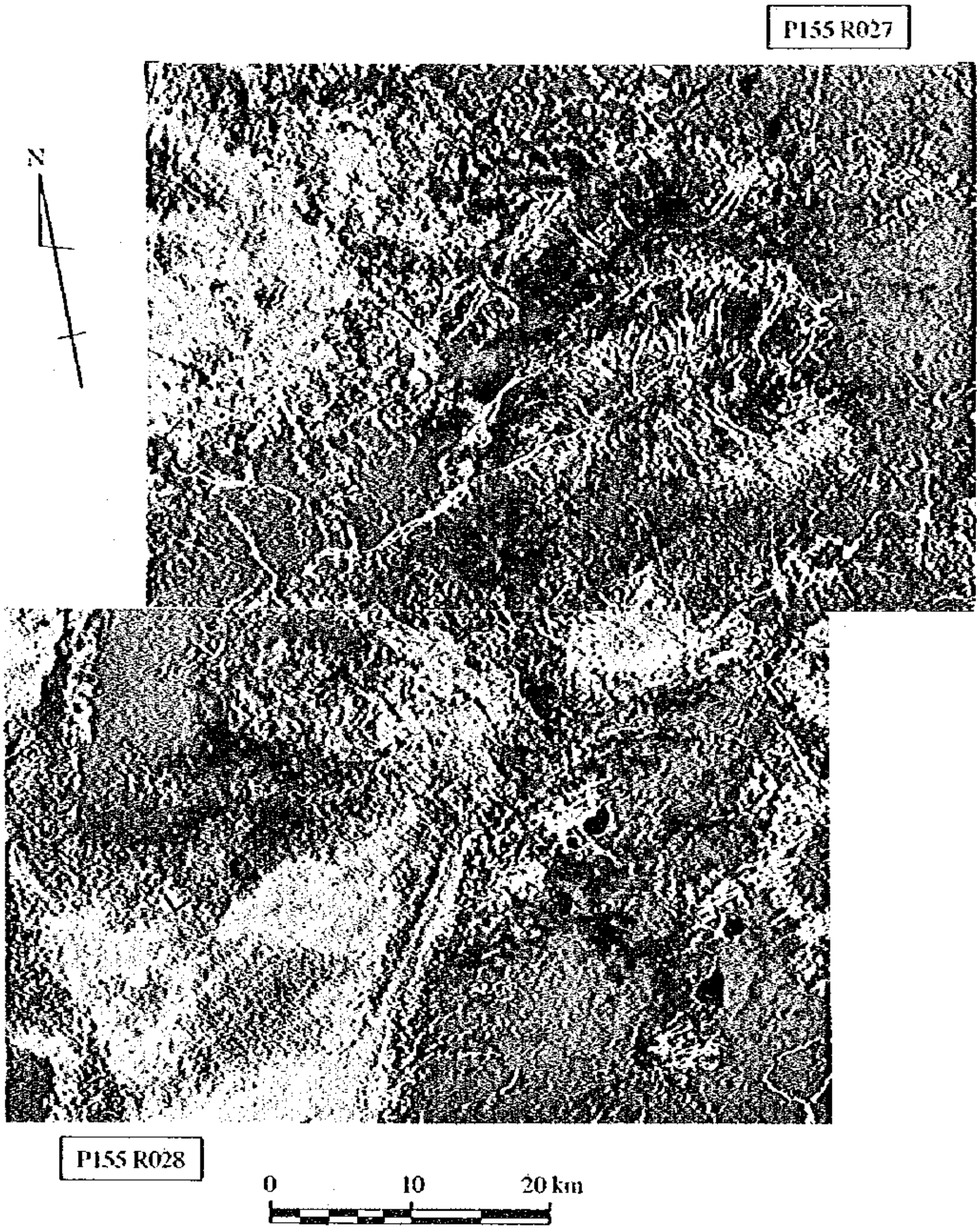


Figure II-3-2-5 Ratio 4/3 Image with Density Slice

PART III
ANALYSIS OF PREVIOUS SURVEY DATA

PART III ANALYSIS OF PREVIOUS SURVEY DATA

1 The Zhaman-Aibat area

1-1 Location, access and topography

1-1-1 Location and access

The Zhaman-Aibat area is located in the south-western part of Central Kazakhstan, approximately 180km southeast of Zhezkazgan. The geographic coordinates of the four corners of the Zhaman-Aibat survey area are (in clockwise direction) Point 1; 46°40' 10"N / 68°41' 30"E, Point 2; 46°55' 30"N / 68°34' 00"E, Point 3; 47°06' 00"N / 69°18' 40"E, Point 4; 46°50 '40"N / 69°26' 00"E (Figure I-2-1-1).

The area is accessible by driving 90km from Zhezkazgan on an all-weather road (the Kzyl-Orda road) to the junction of the Sarysu River bridge and then driving eastward for about 90km on a gravel road to reach Zhaman-Aibat area via the village of Jetykonur.

1-1-2 Topography

The survey area is located on the eastern flank of the Zhezkazgan-Sarysu depression formed during the Carboniferous age. The area may physiographycally be divided into two units reflecting underlying geology. The first unit has relatively moderate relief, low hills with relative heights 10-30m and absolute heights ranging from 300 to 320m altitude. The second unit is of high relief in the center of the area, where the Zhaman-Aibat horst anticline is formed. The relative height difference between the 2 units is approximately 60-80m. The drainage in the area is partly integrated due to the dry continental climatic condition.

1-2 Previous geological, geochemical and geophysical surveys

1-2-1 Previous geological surveys

Systematic geological works started in the 1920s. The first geological map of the Zhezkazgan-Ulsan area was made and the Taskura deposit, located 5km west of the Zhaman-Aibat deposit, was discovered at this time.

Kanysh I. Satpaev paid special attention to issues of metallogeny, stratigraphy of the Zhezkazgan Area. The works resulted in commercial estimation of the Zhezkazgan area in the 1930s and this area was recognized as one of the most important mining areas in Kazakhstan. In the 1940s several important exploration works were done by regular geological mapping methods. In 1953, the Taskura deposit was explored with drillings which confirmed the rich mineralization located close to the surface. Since 1959, the

Zhezkazgan Expedition Party has carried out exploration drilling works for copper deposits in the territory of the Zhezkazgan-Sarysu depression. During 1959-1964, the exploration parties drilled in the Zhaman-Aibat area and confirmed copper mineralization at the depth of 400-700m beneath the surface. Its thickness was estimated as 0.4-1.0m with copper grade of 1.16-1.30%.

Essential exploration for copper was carried out during 1981-1984 by the Zhezkazgan Expedition Party on the eastern flank of the Zhezkazgan-Sarysu depression. The works resulted in the detection of commercial grade copper and copper-lead mineralization at the depth of 615m-700m. Drilling statistics from 1981 to 1994 are summarized in Table III-1-2-1 and the previous geological works are shown in Plate III-1-2-1.

According to the drilling statistics, since 1981, a total of 934 holes have been drilled with a total drilling length of 619,466.3m. Of the 934 holes, a total of 808 were for exploration purposes and 126 holes were drilled with large diameter and short length for sampling. These drillings are divided into five groups on the basis of exploration stages and correlate to the following ore reserve categories. That is, drilling for over all prospecting is correlated to P_1 and P_2 categories. Drilling for detailed prospecting, preliminary estimation and preliminary survey, are correlated to C_2, C_1, A and/or B categories, respectively. Beside these, drilling for prospecting is categorized to be a kind of scout drilling in the ordinary exploration strategy.

Of the 808 holes drilled for exploration purposes, 416 have penetrated the main ore horizon 4-I and 146 holes confirmed the other mineralized horizons. Thus the total numbers of drillings which penetrated mineralized horizons amount to 562 holes.

Final core diameter of each exploration drilling is 59mm and all mineralized cores have been used for various kinds of chemical assay and metallogical testing. Only small pieces of mineralized core of each drill hole have been retained as preserved samples.

1-2-2 Previous geochemical surveys

The information on previous geochemical studies of the Zhaman-Aibat area are given in Table III-1-2-6 and the schematic map (Plate III-1-2-2). Geochemisty of the area has been systematically studied by Zhezkazgan geological expedition since 1981.

The geochemical surveys were done with the objective of discovering secondary haloes of the dispersion.

Geochemical surveys (1981 to 1984, and 1987 to 1990) have resulted in delineating mono-element and complex haloes of scattering of chemical elements, forming 4 big halo

Table III-1-2-1 Drilling Statistics in the Zhaman-Aibat Area

(TD): Technical Drilling

Year	Total Prospecting. P1, P2			Detailed Prospecting. C2			Prospecting Estimation. C1			Preliminary A and B(includ. C1)			Prospecting			T o t a l		
	Nos of drill		Total Length	Nos of drill		Total Length	Nos of drill		Total Length	Nos of drill		Total Length	Nos of drill		Total Length	Nos of drill		Total Length
		(TD)	m		(TD)	m		(TD)	m		(TD)	m		(TD)	m		(TD)	m
1981	2		1,760.0													2	0	1,760.0
1982	14		11,743.6													14	0	11,743.6
1983	19		16,110.1													19	0	16,110.1
1984				25		20,656.9										25	0	20,656.9
1985				37		30,869.7										37	0	30,869.7
1986				26		20,297.3										26	0	20,297.3
1987				2		1,667.2	26	7	21,184.9							28	7	22,852.1
1988							57		38,543.6	85	5	62,611.2				142	5	101,154.8
1989										160	81	119,231.1	3		2,465.8	163	81	121,696.9
1990										95	25	73,999.1	16		13,654.6	111	25	87,653.7
1991										94	8	68,141.3	9		8,744.5	103	8	76,885.8
1992										56		42,778.8	7		6,382.8	63	0	49,161.6
1993										49		37,905.6				49	0	37,905.6
1994										24		18,838.3	2		1,880.0	26	0	20,718.3
Subtotal	35	0	m	90	0	m	83	7	m	563	119	m	37	0	m	808	126	m
Total	35		29,613.7	90		73,491.1	90		59,728.5	682		423,505.4	37		33,127.7	934		619,466.3

areas, namely : Taskura, Zhaman-Aibat, Azat and Zhatyka.

The Taskura area (Cu is up to 0.8%,Ag is up to 0.0004%, Pb is up to 0.025%,Ba is up to 8%) in its south-eastern part exactly coincides with the Taskura copper deposit, localized in the Kengir sediment. Its north-western part is probably shaped as scattering flow. The Zhaman-Aibat area (Cu is up to 0.03%, Ag is up to 0.00015%, Ba is up to 0.2%, Pb is up to 0.005%) is associated with the south-western flank of Zhaman-Aibat deposit, however it is not directly associated with deeply occurring mineralization (it is possible, that haloes were injected from underneath along the zone of sub-latitudinal faults, supposed to be located here). The Azat halo zone is confined to the central part of the Azat anticline. The set of elements of this halo is different from that of the Taskura and Zhaman-Aibat haloes (Ba is up to 5%, Sr is up to 0.02%, Pb is up to 0.01%, etc.). However it could be characterized as a zone above ore and at least one prospecting well is recommended to be drilled within the limits of this zone. The Zhatyka halo area (Ba is up to 1.5%, Mn is up to 0.6%, As is up to 0.008%) is not considered to be prospective for copper mineralization.

Table III-1-2-6 List of the Previous Geochemical Surveys in the Zhaman-Aibat Area

Index	Organization	Survey year	Scale Network (m)
1	AGPhE, Stroiteleva A.	1954	1:200, 000
2	DGPhE, Skalskii N.	1959	1:50, 000
3	DGPhE, Skalskii N.	1960	1:50, 000 500x50
4	DGPhE, Stefankevich Z.	1961	1:50, 000 500x50
5	DGRE, Schuvatov T	1981-1984	1:50, 000 500x50
6	DGRE, Scheripov A.	1987-1990	1:50, 000 500x100

DGPhE-Zhezkazgan Geophysical Exploration Expedition
DGRE-Zhezkazgan Geological Exploration Expedition
AGPhE-Atasu Geophysical Expedition

1-2-3 Previous geophysical surveys

The information on previous geophysical studies of the Zhaman-Aibat area are given in the schematic map (Plate III-1-2-2).

Geophysical studies of the area have been carried out since the 1950's. Aerial magnetic surveys have been completed here in 1955 to 1960 at the scale of 1:50,000 (Table III-1-2-2, Report 3) and 1:100,000 (Table III-1-2-2, Report 5). They have resulted in a general understanding of the magnetic field in the area, and have assisted in evaluating prospects of finding iron ore connected with ultrabasite bodies along deep seated faults.

The first ground survey was carried out by the Atasu Expedition (1954) in a small area ($6km^2$), located in the western part of the area. The survey utilized electric methods (Electrical profiling, VES, etc.) and was targetted at prospecting for underground water. However, no positive results were obtained. A 1:200,000 scale gravity survey was carried out by Zhezkazgan Geophysical Expedition in 1957 (Table III-1-2-3, Report 3). It spotted a large positive anomaly in the Zhaman-Aibat area. There were however no geological interpretations given at that time. A 1:200,000 scale gravity survey was made in the eastern part of the area in 1967 (Table III-1-2-3, Report 9), in combination with VES electric surveys, in order to account for the influence of loose formations (Table III-1-2-4,Report5).

Geophysical surveys at 1:50,000 scale were carried out by the Zhezkazgan Geophysical Expedition in 1959 to 1960 within the Zhaman-Aibat area. These surveys included gravity (Table III-1-2-3, Report 4), magnetic (Table III-1-2-2, Report 6), electric survey of VES method (Table III-1-2-4, Report 2 and 3) and geochemical surveys. This work resulted in delineating Zhaman-Aibat anticlinal structure (based on gravity and magnetic survey), and was handed over to the Zhezkazgan Geological Survey Expedition for further proving of Zhezkazgan type copper mineralization by drilling. Test drilling of that structure was carried out in 1962 to 1964. Drilling however did not fully penetrate the structure (4-drillings, 1925m). That work resulted in determining 0.4-1m intervals, by the drillings No. Y-3, Y-4 and Y-26, at the depths of 400-700m in grey sandstone within the productive rock mass, with the content of copper 0.4-1.16%. However the authors concluded a negative assessment of copper in the studied area. Between 1964 and 1974, the Zhezkazgan depression was systematically studied by seismic survey MOV(Seismic reflection), in order to study the structure of the Upper Paleozoic rock masses and to delineate prospective for oil and gas structures. The south-eastern flank of the depression has been studied by a network of lines, with the spacing of 4 to 8km and at some spots using a spacing of 2km and less. At the same time, in order to assist the interpretation of the seismic survey, a 1:50,000 gravity survey was carried out in part of the area. The results of completed seismic survey in the form of maps of isodepth of reflecting horizons have shown the increase in thickness of Carboniferous sediment in the eastern part of Zhezkazgan-Sarysu depression close to the flanks (Taskura-Tasbulack trough). A number of anticlinal structures has been delineated which are prospective for oil and gas. Seismic surveys also allowed more detailed delineation of the Zhaman-Aibat anticline structure and the depth of the bottom of sediments, productive for copper have also been estimated.

Based on analysis of both geophysical and geological data collected by the Zhezkazgan Geological Prospecting Expedition in 1980, a program of study and prospecting for copper at Zhezkazgan-Sarysu depression was formulated. The Zhaman-Aibat anticline structure was included as a first priority structure, it was first found in 1959 by geophysical survey, and later confirmed by geological studies. In compliance with that program 1:50,000 scale geophysical surveys were carried out in the area of the Zhaman-Aibat structure from 1981 to 1984 and from 1987 to 1990. Surveys included gravity (Table III-1-2-3, Report 10 and 11), magnetic (Table III-1-2-2, Report 9 and 10), electric of VES, IP and ZSB(TEM) methods (Table III-1-2-4, Report 6 and 8), geochemical and shallow scout drilling. From 1983 to 1986, and 1990 to 1992 detailed seismic MOGT(CDP) surveys (Table III-1-2-5, Report 2) were conducted in combination with electric surveys of ZSB(TEM) (Table III-1-2-5, Report 7) with line spacing of 0.8 to 2km. Results of these surveys, made it possible to compile uniform maps of geophysical and geochemical fields covering the entire described area at the scales of 1:50,000 (split in pages) and 1:100,000 (plan wiew) and to obtain valuable information on the deep structure of the territory, the structural position of the Zhaman-Aibat deposit and possible directions of further prospecting and exploration work.

Borehole logging has been widely applied in the process of prospecting with the following objectives: to classify the cross section lithologically, to select intervals of mineralization and to estimate their thickness (IP, gamma ray) and to estimate the content of minerals (Roengeno-radiometric logging).

Seismic surveys have been the principal source of useful information (Plate III-1-2-3). Results of gravity surveys and other geophysical methods (determining position of faults and structures of different importance, delineating zones with intensive hypergenic and hydrothermal alteration of rocks, etc) supported the seismic surveys in achieving these objectives.

Three large anticline structures with sub-latitudinal orientation have been found in the described territory by geophysical methods (Zhaman-Aibat, Kulen and Zhatyktau); the biggest and most interesting one from, the prospecting point of view, is the Zhaman-Aibat structure.

The Zhaman-Aibat anticline structure is shown as a structural nose in the 1:200,000 scale geological map. A number of local positive gravity anomalies with 1 to 2 mgls amplitude as well as uplifts of the R2, R2', Rs horizon depth contours, outlining positions of subsidiary anticlines (Azat, Zhaman-Aibat) have been delineated within the huge structure.

Table III-1-2-2 Previous Magnetic Survey in the Zhaman-Aibat Area

No.	Organization	year	System	Scale Network(m)	Accuracy nT
1	ZGT, Kukin G.	1952	Aeromagnitic Survey AEM-49	1:100,000	+/- 29
2	AGPhE, Stroiteleva L.	1954	Aeromagnetic Survey M-2	1:200,000 1000x200 2000x4000	+/- 10-15
3	ZGT, Zavjalova L.	1955	Aeromagnetic Survey AEM-49	1:500,000	+/- 30
4	DGPhE, Stefankovich Z.	1961	Aeromagnetic Survey M-2	1:50,000 500x100	+/- 9.7
5	KGT, Sargaskaev T	1960	Aeromagnetic S. ASGM-25, ASG-45	1:100,000	+/- 25
6	DGPhE, Skalskii N .	1960	Ground survey M-2	1:50,000 500x50	+/- 11-14
7	DGRE, Kogai S.	1976-78	Ground survey MMS-1	1:50,000 500x10	+/- 11-14
9	DGRE, Shuvatov T.	1984	Ground survey MMA-301	1:50,000 500x50	+/- 6
10	DGRE, Scheripov A .	1987-90	Ground survey MMP-203	1:50,000 500x100	+/- 3

ZGT - Western Geophysical Trust, KGT - Kazakh Geophysical Trust
DGPhE - ZHEZKAZGAN Geophysical Exploration Expedition
DGRE - ZHEZKAZGAN Geological Exploration Expedition

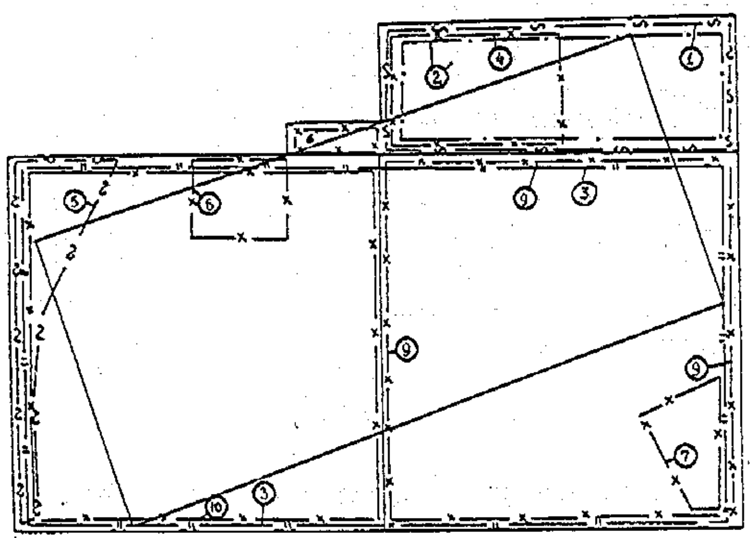


Table III-1-2-3 List of the Previous Gravity Surveys in the Zhaman-Aibat Area

No	Organization	Survey year	Grivimeter	Scale Network(km)	Accuracy (mgal)
3	DGPhE, Loskutov A.	1957	SN-3	1:200,000 4x1	+/- 0.50
4	DGPhE, Skalskii N.	1959	GAK-3M GAK-4M	1:50,000 0.5x0.5	+/- 0.21
5	DGPhE, Skalskii N.	1960	GAK-3M GAK-4M	1:50,000 0.5x0.5	+/- 0.17
6	DGPhE, Stefankevich Z.	1961	GAK-3M	1:50,000 0.5x0.25	+/- 0.10
8	DGPhE, Antonov V.	1967	GAK-PT	1:200,000 3x2	+/- 0.32
9	DGRE, Kogan E.	1973-1974	GAK-PT GR/K-2	1:50,000 1x0.5	+/- 0.16
10	DGRE, Schuvatov T.	1981-1984	GR/K-2	1:50,000 0.5x0.5	+/- 0.12
11	DGRE, Scheripov A.	1987-1990	GNU-KV GNU-KS	1:50,000 0.5x0.5	+/- 0.09

DGPhE - ZHEZKAZGAN Geophysical Exploration Expedition
DGRE - ZHEZKAZGAN Geological Exploration Expedition

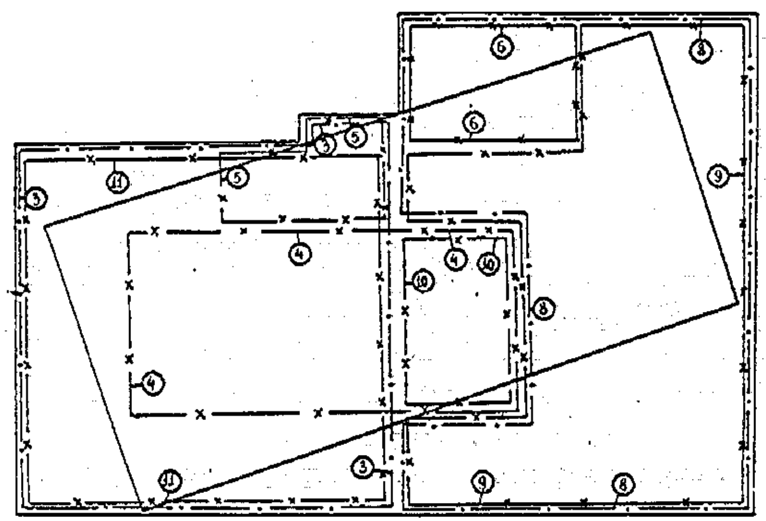


Table III-1-2-4 List of the Previous Electrical Surveys in the Zhaman-Aibat Area

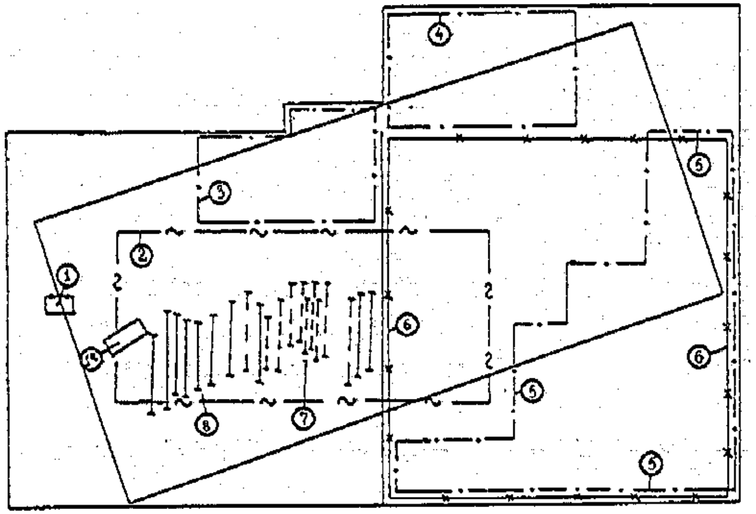
Index No.	Organization	Year	Equipment	Scale Network (km)	Accuracy (%)
1 1.a	AGPhE. Stroiteleva A	1954	EP-1	1:100.000 SP.Moving Schlum0.1x0.02 VES, IP	3-5
2	DGPhE. Skalskii N.	1959	EP-1	1:100.000 VES 2x1, 1x1, AB=1-4	max 5
3	DGPhE. Skalskii N.	1960	EP-1	1:200.000 VES.4x3, 2x1, AB=max 12	max 5
4	DGPhE. Stefankevich Z.	1961	ESK-1	1:200.000 VES.4x3	max 4.6
5	DGPhE. Antonov V.	1967	ESK-1	1:200.000 VES.space=2, AB=1-1.5	max 5
6	DGRE. Schuvatov T.	1984	AE-72 VPS-63	1:50.000 VES.1x1, 1x0.5, AB=max 1 GradientIP, a=0.05, AB=1.6	3.2
7	DGRE.Smirnova N	1986	CYCLE-2	1:50.000 TEM, line=1-2	< 5
8	DGRE.Scheripov	1988	CYCLE-2	1:50.000 TEM, space=0.5	< 5

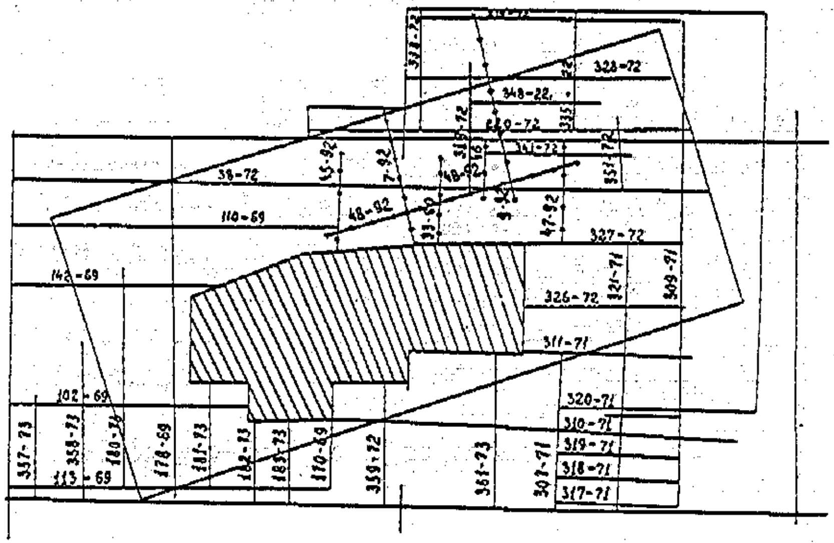
ZGT - Western Geophysical Trust, AGPhE- Atasu Geophysical experdition
DGPhE- ZHEZKAZGAN Geophysical Exploration Expedition
DGRE - ZHEZKAZGAN Geological Exploration Expedition

Table III-1-2-5 List of the Previous Seismic Surveys in the Zhaman-Aibat Area

No.	Organization	year	Instruments
1		1964-1974	MOV (The reflection method)
2		1990-1992	MOGT (Common Depth Point)

DGPhE- ZHEZKAZGAN geophysical exploration expedition
DGRE - ZHEZKAZGAN geological exploration expedition





Three more local anticline domes (western; Taskura, Central and eastern ones) are delineated within the Zhaman-Aibat anticline, associated with the Zhaman-Aibat deposit.

Based on both analysis of geophysical maps and the locations of discovered ore deposits in the Zhaman-Aibat field and separate ore boreholes to the west, it has been concluded, that ore bodies and mineralization zones are located mostly on the flanks of local anticline structures and somehow "frame" them. This finding has made it possible to locate probable positions of ore zones not yet penetrated or delineated by drilling within Zhaman-Aibat and Azat structures and to place prospecting and exploration wells accordingly.

A 1:50,000 scale magnetic map makes it possible to conclude, that characteristics of the magnetic field are determined mostly by lithological irregularities in the crystalline basement. Quite intensive positive anomalies have been delineated in the eastern flank zone of the area, that are associated with magnetite-containing sandstone of Tasukuduk Formation. The rocks of this Formation however, do not cause any considerable anomaly in the Zhaman-Aibat deposit area, because they occur at considerable depths and laboratory measurements did not show any appreciable increase in magnetic susceptibility of the samples.

Based on analysis of the electric survey of TEM(Plate III-1-2-4) data together with gravity survey data , the Kazybek area has been delineated on the south-eastern flank of the Zhaman-Aibat deposit (9km^2), where 6 wells are recommended to be drilled.

1-2-2 Current situation

In order to complete the 200m x 200m grid drilling pattern, core drilling by 4 rigs is being carried out in the Zhaman-Aibat area (January 1995). Due to the changes in economic conditions, no other geological and geophysical surveys or exploration are programmed.

1-3 Geology and mineralization

1-3-1 Geology

The Zhaman-Aibat copper deposit is located at the eastern edge of the Zhezkazgan-Sarysu depression. The stratiform copper mineralization occurs exclusively in the gray-color alluvial-deltaic sandstone facies within "Red Sandstone Formation" that ranges in age from the middle to late Carboniferous and the early Permian. The absence of igneous and intrusive activities and significant thickness of sediments are characteristics of the geology of the area.

1-3-1-1 Stratigraphy

1) Paleozoic group (Pz)

(1) Carboniferous system (C)

Sediment of Carboniferous system are widely distributed within the survey area.

Carbonate and terrigenous complex of marine sediment is included in the lower series and the complex of various accumulations of continental origin in the middle and upper series.

Serpukhov Stage (C_1s)

Detritus and pelitomorphic limestone, red sandstone and aleurolite with interlayers of grey, green-grey and dark grey sandstone and aleurolite dominate in the upper part of the rock mass. The number of terrigenous rocks decreases at lower levels where there are interlayers of pelitomorphic and organogenic clastic limestone in the horizons of calcareous aleurolite containing spherical concretions. Total thickness is approximately 750m.

Taskuduk Formation (C_2ts)

Sediments of the Taskuduk Formation are deposited conformably on sediments of the Serpukhov Formation and are overlaid (with washout) by the rocks of the Zhezkazgan Formation. They are outcropping at the anticlinal structure (Plate III-1-3-1 and Plate III-1-3-2). The upper border at the Zhezkazgan Formation goes along the horizon of interformational conglomerate and the lower border, along the roof of limestone with fauna (Figure III-1-3-1). The Taskuduk Formation is formed by uniform red sandstone and aleurolite with interlayers of brown and grey sandstone and with one horizon of flint. It confirms the erosion or overlaying that took place in the course of sedimentation. The commercial grade copper mineralization is confined to grey-colored sediment of the Taskuduk Formation.

According to data of drilling the thickness of sediment varies widely (Figure III-1-3-2). The thickness of the Taskuduk Formation at the Zhaman-Aibat horst anticline increases from the west to the east from 70m to 600m and more. The thickness of the Formation gradually increases in the northern, southern and southeastern directions, where the thickness of the Formation reaches 1000m. The decrease and complete disappearance of grey sandstone with the increase of its thickness are characteristics of the cross section of the Taskuduk Formation

Zhezkazgan Formation ($C_{2\text{-}3}dz$)

The rocks of the Zhezkazgan Formation are widely distributed in the survey area, outcropping at the eastern flank of the depression at the core of the anticlinal structures (Plate III-1-3-1). At the area of the deposit these sediments are penetrated by drillings to the depth of 400-500m and outcrop in the eastern part of the Zhaman-Aibat horst

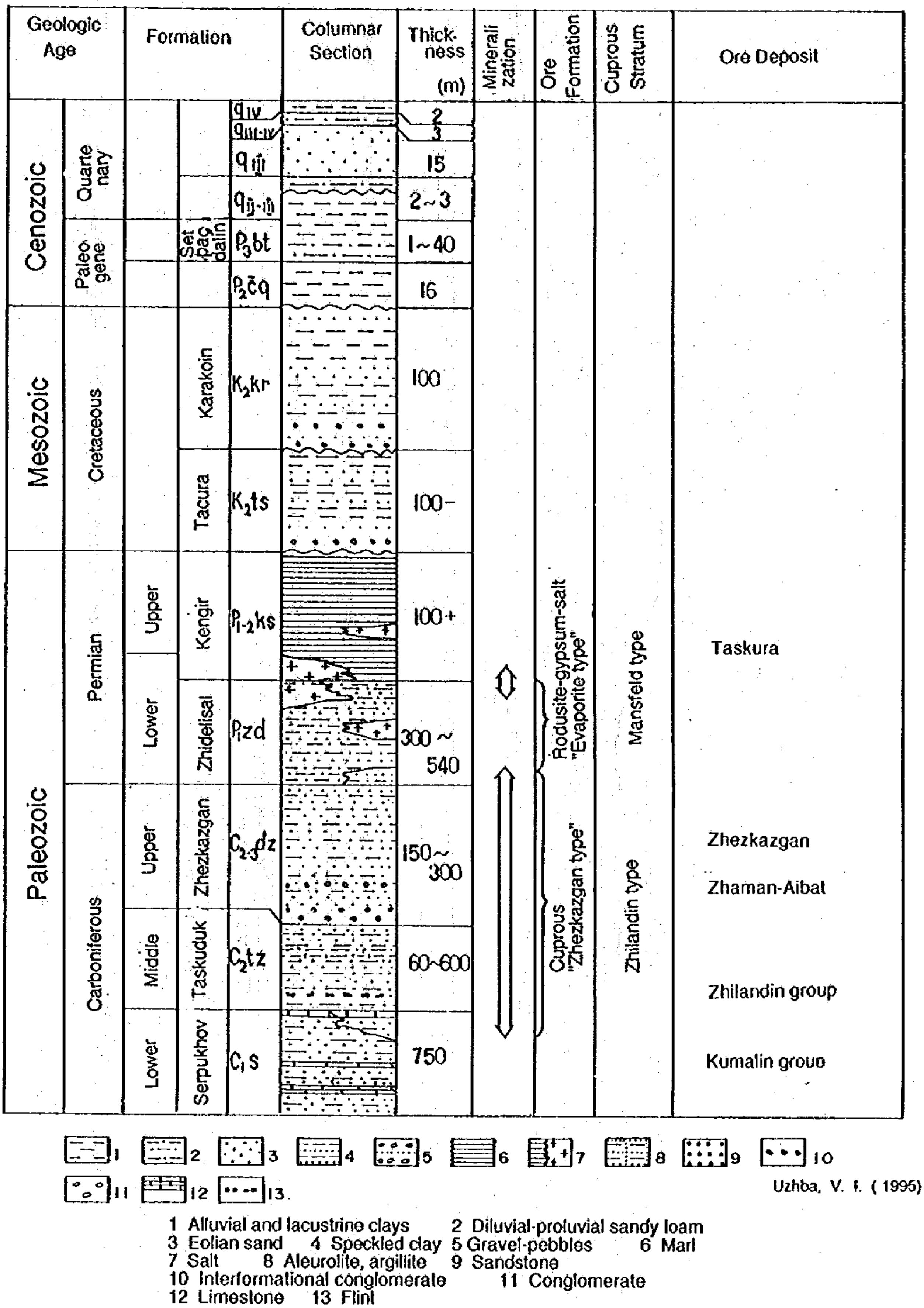
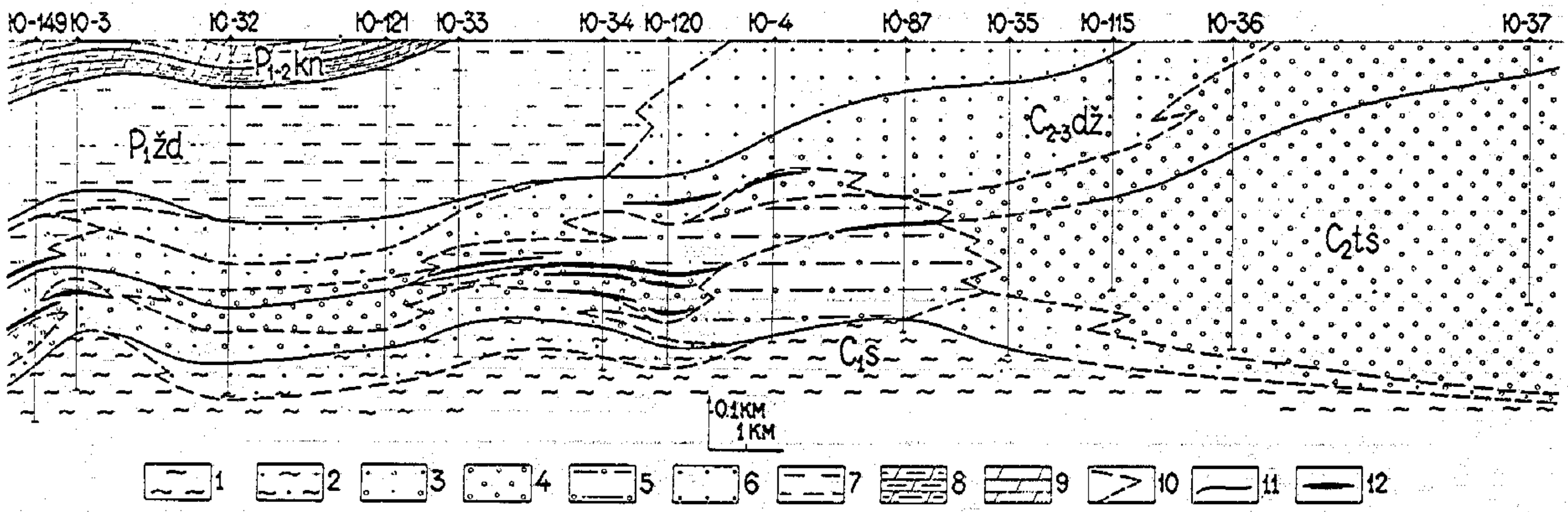


Figure III-1-3-1 Generalized Geological Columnar Section of the Zhaman-Aibat Area



1 Submarine facies zone
2 Subcontinental facies zone; Continental facies zone of lacustrine-alluvial plain:
3 Lacustrine-alluvial subzone
4 Alluvial subzone
5 Subaqueous lithofacies, continental facies zone of shallow lake and weak river streams
6 Alluvial-lacustrine subzone
7 Shallow water lacustrine subzone
8 "Transition" facies zone
9 Facies zone of lagoon-sea
10 Boundary of facies zone and subzone
11 Boundary of formation
12 Ore body

Glybovski V. O. (1988)

Figure III-1-3-2 Structure and Distribution of Mineralized Sediments of the Zhaman-Aibat Deposit Area anticline. The upper border is conventionally delineated along the roof of grey fine-grained sandstone.

Sediment of the Formation are represented by red, obliquely laminated sandstone, aleurolite and grey sandstone, rarely aleurolite with interformational conglomerate with interlayers of sedimentary breccia and interformational conglomerate (Raimundo) at the bottom (Plate III-1-3-3 and Plate III-1-3-4).

The increase of thickness of grey sandstone at the bottom of the Zhezkazgan Formation is typical for the cross section of the Formation at the Zhaman-Aibat deposit, where commercial grades of copper, lead and zinc were detected as a result of prospecting (Figure III-1-3-2).

The thickness of sediment of the Formation varies in the same directions as the thickness of the Taskuduk Formation, clearly detecting irregularity or warping and difference in the speed of sedimentation. The thickness of the Zhezkazgan Formation at the Zhaman-Aibat deposit is 150-300m.

(2) Permian system (P)

Sediment of the Zhidelisai and the Kengir Formations with terrigenous and terrigenous-carbonate compositions, respectively, are defined within the Permian system (Plate III-1-3-1).

Zhidelisai Formation (P_1zd)

The sediments of the Zhidelisai Formation are widely distributed in the area and form the core and wings of anticlinal structures (Plate III-1-3-1). They are represented by uniform rock masses of red aleurolite, argillite, sandstone, similar to rocks of the Zhezkazgan Formation. Regular decrease of grain size from the top downwards is noticed. Among properties of rocks, it is impossible to observe the presence of diffusive flakes of ferrugenous mica, veins and interlayers of gypsum and, in depressions, thick salt bearing sediment were observed in the south-western part of the survey area. The thickness of sediment is 400-550m.

Kengir Formation ($P_{1-2}kn$)

Sediment of the Kengir Formation are widely spread throughout the area. They are deposited conformably on sediment of the Zhidelisai Formation and are unconformably overlaid by Mesozoic-Cenozoic sediment. The rock mass is represented mainly by marl, limy aleurolite, sandstone with rare occurrences of oolitic limestone and argillite. Rocks are characterized by the presence of rhombic nests and veins of gypsum and calcite. The thickness of sediment exceeds 1000m.

2) Mesozoic group (Mz)

(1) Cretaceous system (K)

Taskura Fotmation (K_2ts)

Sediment of the Upper Cretaceous are deposited at the sharp unconformity angle on the washed out surface of more ancient formations and are overlapped by the Cenozoic sediment of various ages (Plate III-1-3-1). They are represented by alternation of grey and green opoka-like aleurolite, clays, inequigranular sandstone, conglomerate and marl.

The thickness of sediment does not exceed 100m.

Karakoin Formation(K_2kr)

Sediment of the Karakoin Formation are deposited unconformably on those of the Taskura Formation and are unconformably overlaid by the Cenozoic sediment (Plate III-1-3-1).

Pebble to granule size conglomerate are observed at the bottom and alternation of eolian and speckled clay correspond to the middle and the upper.

3) Cenozoic group (Kz).

(1) Paleogene system (P)

The Paleocene-Eocene sediment (P_{1-2}) overlay the Paleozoic and the Mesozoic formation of different ages and are represented by lenticular interbedded clay of various colors, aleurolite, sandstone with separate lenses of quartz-like sandstone. The thickness of sediment is 20-30m and reaches 120m in depressions.

Betpakdalin Formation. (P_3bt)

Sediment of the Betpakdalin Formation of the Oligocese age are widely distributed in the survey area and are represented by red, red-brown, brown and green clay with gypsum and manganese oxide with interlayers of aleurolite of brown color and clayey sand. The thickness of the sediment is 1-40m.

(2) Quaternary system (Q)

Quaternary system is represented by formations of various genetic types.

The composition:

①Middle-Upper-Quaternary (Q_{II-III}) eolian sand and aleurolite with admixture of gravel;

②Upper-Quaternary-Contemporary (Q_{III-IV}) proluvium-deluvium loam, clayey sand, gravel;

③Contemporary (Q_{IV}) "takyr"-salsifies clay, aleurite.

Total thickness does not exceed 10m.

1-3-1-2 Tectonic Structure

The survey area covers the zone of intersection of the Chu-Ili anticlinorium with the eastern edge of the Zhezkazgan-Sarysu depression (Plate I-3-2-1). The Chu-Ili anticlinorium is represented by a linear-stretched folded structure, subsiding to the south-west under the cover of sedimentary rocks, which form the Zhezkazgan-Sarysu depression. The border between these two structures goes along the Bekei deep fault. According to the character of folding and composition of formations, 4 stages are defined within the structure: Early Paleozoic geosyncline stage, Devonian orogenic stage, Carboniferous-Permian subplatform stage and Mesozoic-Cenozoic stage.

The early Paleozoic geosyncline structural stage is represented by sediment of the Vendian-Cambrian and the middle to upper Ordovician, which are folded into narrow linear folds in the northwestern direction. Folds are complicated by ruptured dislocations (faults). Sediment of this structural stage with sharp unconformity are overlaid by orogenic formation. Devonian orogenic structural stage includes the volcanogenic rock mass of the lower to middle Devonian. This rock mass is composed of rather large overlaid anticlinal structures. Carboniferous-Permian subplatform stage is formed by terrigenous carbonate rocks of the upper Paleozoic. These sediment are the most widely spread and they participate in the formation of the Zhezkazgan-Sarysu depression. The sub-latitudinal anticlinal structures are developed on the eastern flank of the Taskura-Tasbulak trough, which have the shape of a nose structure (Zhaman-Aibat etc.). The absence of intrusive activity and significant thickness of sediment are typical for this structural stage (Plate III-1-3-1).

Upper (Mesozoic-Cenozoic) structural stage is formed by gently pitching, mainly terrigenous rocks of marine and continental origin, classified as Jurassic, Cretacious, Paleogene and Quaternary period with a Mesozoic crust of erosion at the bottom. Sediment of Mesozoic-Cenozoic are referred to typically as platform formations.

The structure of the area is determined by faults of northwestern and sub-longitudinal strike. The faults of northwestern strike are the most ancient Caledonian ones. The Bekei deep seated fault, separating the Chu-Ili anticlinorium from the Zhezkazgan-Sarysu depression, is a typical representative of this type. Faults of sub-latitudinal strike are referred to the other type of dislocations. They have younger age, cut faults of the first direction and control and determine orientation of local folded structures. They are classified as upthrusts-overlaps and have steep dislocators.

1-3-1-3 Magmatism

Intrusive activities are known only in the eastern part of the survey area, where they are represented by the middle-Devonian subvolcanic liparite, quartz porphyry and porphyrite (Plate III-1-3-1).

1-3-2 Mineralization

1-3-2-1 Lithological properties of ore containing formations

Serpukhov Stage (C_1s)

Rocks are represented mainly by terrigenous grey and red sandstone, aleurolite, argillite, organogenic, detrital and clayey sandstone with fauna of brachiopod, pelecypod, rarely with corals (Appendix 1). The rock masses have not been studied paleontologically so the upper part of the boundary is defined conventionally based on the absence or presence of stratum of organogenic limestone.

Taskuduk Formation (C_2ts)

Sediments of the Taskuduk Formation are represented by interbedded terrigenous rocks, formed under conditions of coastal and alluvial plains. They are represented by red and grey fine-grained sandstone, aleurolite (Appendix 1). Interlayers of conglomerate with partly rounded gravels of red rock and carbonate inclusions often occur. Cement is represented by brown, rarely by fine-grained sandstone. Sediment of the Taskuduk Formation have not been age-determined paleontologically. The thickness of the formation is not constant. At the axial part at the west of the horst anticline, it decreases to 60-70m. At the east, northern wing and southern part it increases to 480-540m and more.

Zhezkazgan Formation (C_3dz)

Sediments of both the Zhezkazgan and the Taskuduk Formations are represented by rhythmical interbedding of terrigenous rocks formed under the condition of alluvial plain. There are lithological types of rocks of river bed represented by residual gravel, river sandy crust, resulting from intensive freshet at the bottom of sediments of the Zhezkazgan Formation. Such sediment in the survey area of the Zhaman-Aibat deposit is typical only for the first rhythmical sedimentation. Their total thickness is equal to dozens of metres. The upper rhythmical sedimentation, according to their internal structure, variation of thickness and composition, are similar to sediment of the Taskuduk Formation.

In general, rocks of the Zhezkazgan Formation are represented by red and grey sandstone, aleurolite, very rarely by conglomerate (Appendix 1). The lower boundary of the formation goes along the soil of grey sandstone with the interlayer of interformational ("Raimundo") conglomerate. The upper boundary is determined mostly based on lithology, according to the first occurrence of grey-colored rock stratum in the thickest part of the deposit. The thickness of sediment of the Zhezkazgan Formation in the area of the deposit is

180-240m, on the flanks it is estimated to be 300m and more.

Zhidelisai Formation (P_1zd)

Sediment of the Zhidelisai Formation are everywhere represented by obliquely laminated red aleurolite and sandstone with interlayers of brown (grey-red) fine-grained sandstone (appendix 1). The presence of gypsum and anhydrite is typical for the entire cross section and rock salt is present at the flanks of the structure (at the southern and western parts). The presence of rock salt, anhydrite and gypsum among red rocks of the Zhidelisai Formation makes it possible to include it in the evaporite complex of rocks, formed under conditions of hot climate at flood plain and lake faces. The thickness of sediment at the western flank is approximately 300m. At the northern flank it is estimated to be 540m and more.

Kengir Formation ($P_{1-2}kn$)

Sediments of the Kengir Formation are outcropping only at the western part of the structure and are penetrated by a number of prospecting drillings. They are represented by grey and dark grey marls, oolitic horizontal-layered limestone. Large amounts of gypsum at the lower part of the cross section of the formation is typical. The copper deposit in the Taskura is represented both by oxidized and sulphide ores and occurs locally in the sediment of the Kengir Formation.

1-3-2-2 Lithofacies characteristics and ore stratigraphy.

It is possible to consider that lithological composition of the Permian-Carboniferous red sediment and petrography of rocks of the Zhaman-Aibat area do not greatly differ from that of the Zhezkazgan area formations. However, lithological variations in the cross section, their relations, the nature of rhythm of sediment and character of the sediment, have some peculiarities.

The geological studies have shown that sediment of the upper part of the Taskuduk and the lower part of the Zhezkazgan Formation have distinct rhythmic structure of alluvial nature. Cyclothem of alluvial type are characterized by complete and stable composition. Elements-faces within cyclothem consequently change from coarse-grained size via sandy river bed ones to clayey flood plain ones. Lithological grain differences are characterized by large scale cross-bedding.

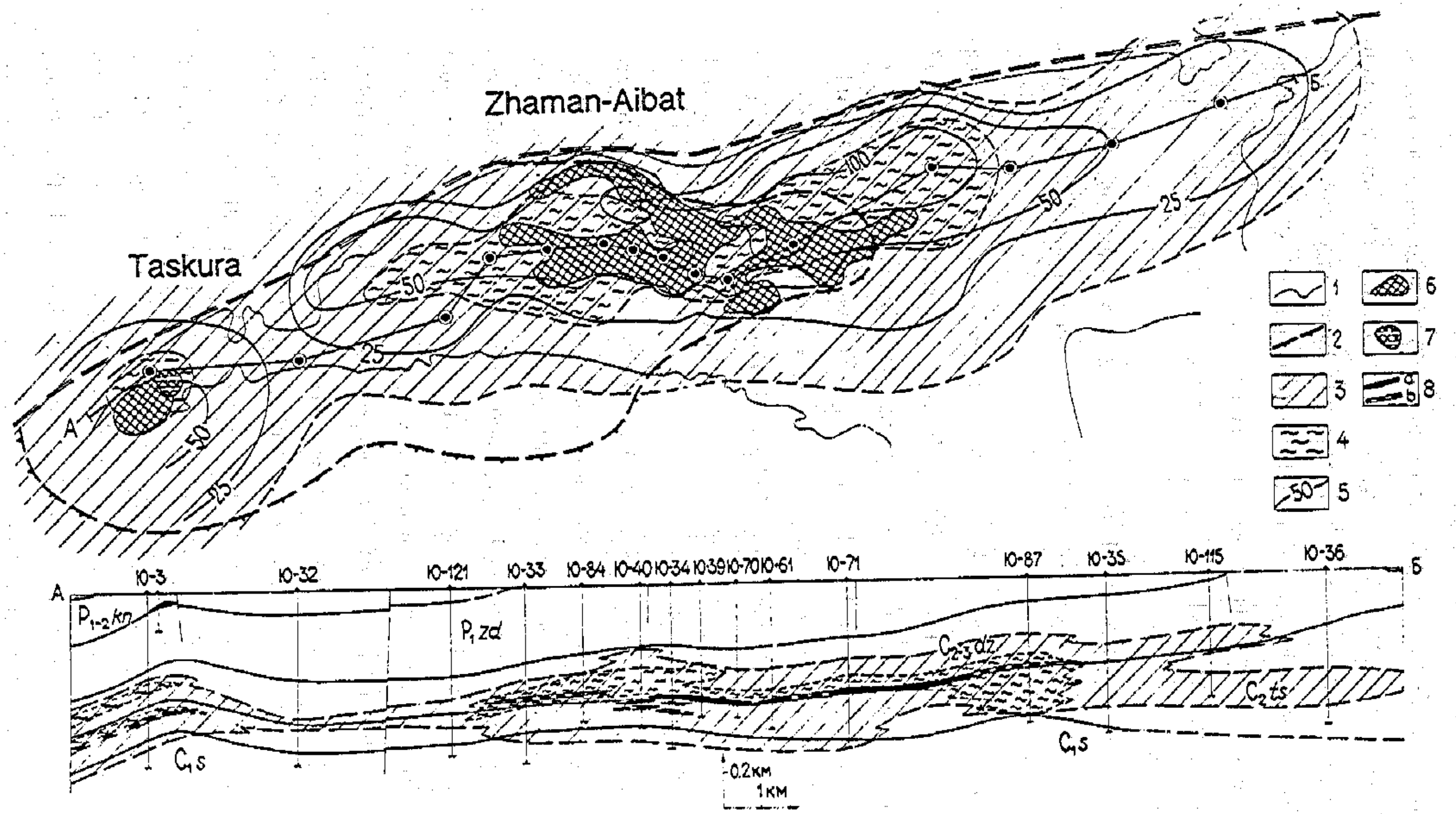
The majority of sediments at faces zone of a lacustrine-alluvial plain have been accumulated under conditions of subaeration. Climatic conditions of sedimentation are characterized by high aridity. Rocks with high carbonate content are characterized by significant predominance of oxidized iron over ferrous iron, explaining the red color of rocks. Sandstone is often grey in color. The total iron content in grey sandstone (2%) is half of that in their red colored analogues (4%) and clayey variations (4 and more %). Green rim of greying is observed at contacts of grey sandstone and red aleuro-argillite, confirming the secondary character of grey color of sandstone.

Subaqueous lithofacies are spatially linked to lacustrine-alluvial faces subzone and are developed within cross sections of both the Zhezkazgan and the Taskuduk Formations (Figure III-1-3-2). They form comparatively large and compound-formed lenses in the central part of the area. At the eastern flank the lense has maximum vertical range and directly adjoins grey sediments of the Serpukhov Formation. To the west it shifts upwards along the cross section, covering only the lower part of the Zhezkazgan Formation. The plan view of the lense of subaqueous lithofacies shows that it is stretched along the axis of the Zhaman-Aibat horst anticline.

Lacustrine faces, represented by aleurolite and argillite with horizontally wavy and cross-wavy-laminated or massive structures, predominate in the cross section of the Zhidelisai Formation. Thin interlayers of gypsum and its inclusions are rather typical for the rock mass. Partings and inclusions of rock salt (the western flank of the Zhaman-Aibat area) are rarely described. Thin partings of unsorted coarse-grained sandstone and interformational gravelite are very seldom. The color of rocks is exclusively red sometimes with bright shades. The color of rocks and homogeneous sediment of sulphides and salt indicate arid climatic conditions during Permian age with sharp predominance of evaporation. The sediment of the Zhidelisai Formation are referred to as faces zone of shallow lakes (with sulphate sedimentation) and weak river streams. The boundary of that faces zone and the lacustrine-alluvial subzone is rather unclear and characterizes the gradual change of landscape at the territory.

Thus, the faces composition of red-colored sediment of the Zhaman-Aibat area is characterized by a relatively wide set of faces types of sediment of continental and subcontinental faces complexes and is in general similar to the composition of formations of the area of the same age. Unlike the Zhezkazgan ore field, only a part of the cross section of sediment of the Taskuduk and Zhezkazgan Formations has distinct and cyclic rhythm of alluvial character.

Grey-colored rocks of two genetic types of color are developed in the rock mass of red-colored sediment. Grey sandstone of epigenetic color occur at both subzones of the faces zone of the lacustrine-alluvial plain (Figure III-1-3-3). Grey-green and dark-colored aleuro-argillite and sandstone with syngenetic color are developed more locally and are linked to lacustrine-alluvial faces subzones. Fragments of grey rocks probably of both types of colors are described in the Serpukhov subcontinental sediment



Glybovski V. O. (1988)

1 Boundary of outcrop of cuprous red coloured formation
2 Epicentre of con-sedimentation
3 Distributed area of epigenetic grey coloured rocks
4 Distributed area of syngenetic grey coloured rocks
5 Isopac line of grey sandstone
6 General outline of assumed-commercial mineralization of the Zhezkazgan type
7 The outline of assumed-commercial mineralization of the Mansf eld type
8 Ore body (a: high grade, b: low grade)

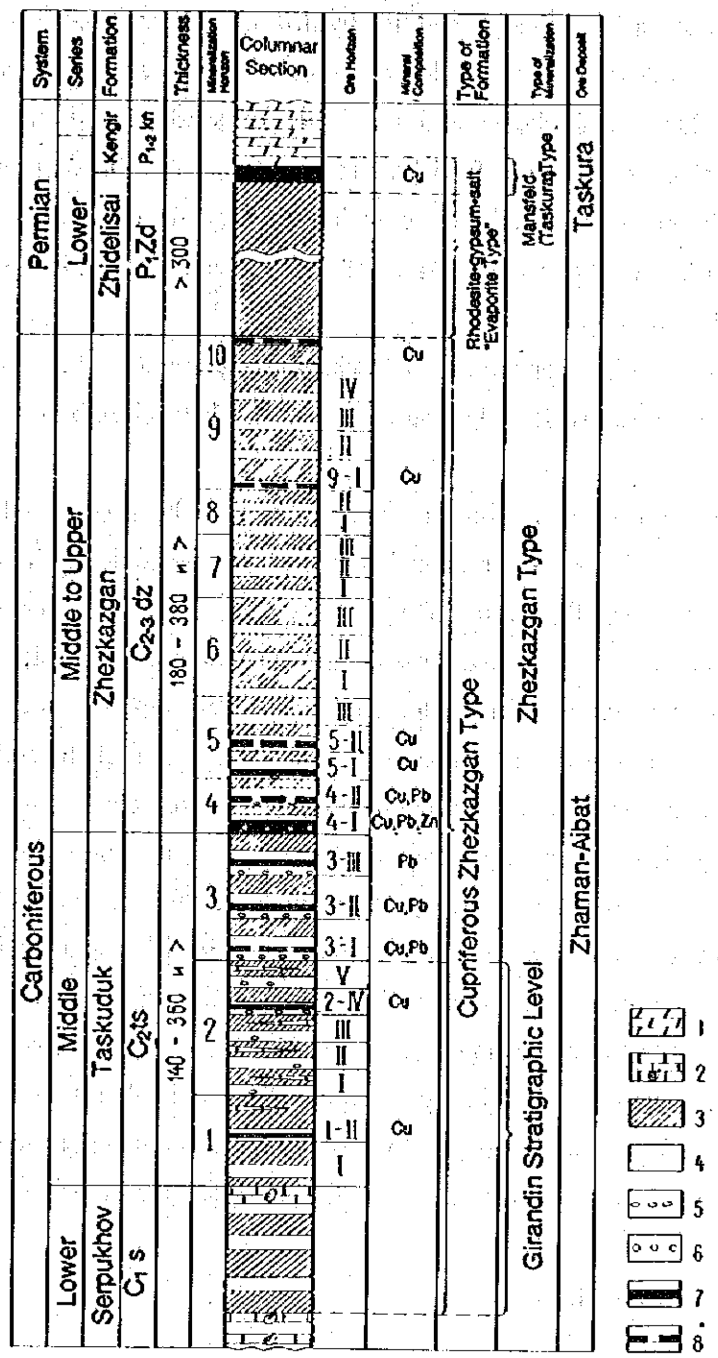
Figure III-1-3-3 Schematic Geological Cross-Section of the Zhaman-Aibat Ore Deposit Area as well. In general, grey rocks form a large and compound constituted multi-colored lens, its boundaries are clearly delineated only at the eastern and southern flanks.

Copper mineralization is localized in interlayers of grey-colored sandstone, gravelstone and conglomerate, rarely aleuro-sandstone, aleuro-argillite. Commercial grade mineralization is concentrated in coarse-grained differences, which as a rule have secondary grey color and are composed of lower elements-faces of cyclothem (rhythms) of alluvial character. Fine-grained primary grey subaqueous lithofacies contain poor ores. In general mineralization covers practically the whole cross section of the lens of multicolored rocks forming a polystage structure.

As recognized in the Zhezkazgan ore field, the cross section of productive sediments within the ore field of the Zhaman-Aibat deposit has been preliminarily divided into ore-bearing horizons.

The availability of reliable horizon markers such as organogenic limestone of the Serpukhov stage, conglomerate and gravel of Raimundo type and relative persistence of interlayers of grey sandstone makes such division appropriate. The internal structure of ore-bearing horizons is shown in Figure III-1-3-4. In compliance with this, the Taskuduk Formation contains 3 horizons and the Zhezkazgan Formation 7 horizons. Each horizon is subdivided into bands. A band corresponds to cyclothem (rhythm) and usually consists of two strata. The lower grey, sandy stratum often with conglomerate (conglomerate-breccia) or gravel at the foot, the upper stratum is red aleuroargillite.

The first ore-bearing horizon in the cross section of the Taskuduk Formation is located at the subzone of lacustrine-alluvial faces. Its structure is characterized by unclear cycles, lack of thickness and relatively poor persistence of sandy strata. Two bands are conventionally defined in it. The second ore-bearing horizon is linked to alluvial faces subzone. Five bands are defined within its composition. In general, the second ore-bearing horizon is characterized by the presence of interformational conglomerate at the foot of bands and the presence of thin interlayers of limestone without signs of fauna (slightly silicified) at its roof. The upper boundary of the second horizon goes along the roof of the last band with limestone. The third ore-bearing horizon is located at the alluvial faces subzone and is characterized by a clear cyclic structure. Three bands with rather stable and thick grey strata at the foot are defined in it. Two bands are defined in the composition of the forth horizon. The stratum of grey sandstones, including conglomerate (or gravel) of the Raimundo type, is at the foot of the lower band. The boundary between the Taskuduk and the Zhezkazgan Formations is outlined along the sediment of this band. Both bands, according to their structure, are typical alluvial cyclothem. The fifth ore-bearing horizon is



Glybovski V. O. (1988)

1 - Marl ; 2 - Limestone ; 3 - Red Aleuro-Argillite ; 4 - Grey Sandstone ; 5 - Intra Formation Conglomerate ; 6 - "Raimundo" Conglomerate and Gravelite ; 7 - Assumed Commercial Grade Mineralization ; 8 - Assumed Low Grade Mineralization.

Figure III-1-3-4 Generalized Stratigraphic Column of Cupriferous Sediments of the Zhaman-Aibat Deposit Area included in alluvial facies subzone and is divided into three bands. 6, 7, 8, 9 and 10 ore-bearing horizons cover lacustrine-alluvial subzone and are characterized by very unclear cycles (rhythm), lack of thickness and instability of sandstone strata. Thus, productive sediment of the Zhaman-Aibat ore field (the Taskuduk and the Zhezkazgan Formations) are dissected into 10 ore-bearing horizons, containing 28 bands combining 56 strata (Figure III-1-3-4). It must be noted that the structure of bands to some extent is "generalized".

1-3-2-1 Mineral composition

The mineral composition of the ores is comparatively simple. The bulk of the copper is concentrated in the three widely distributed minerals, chalcocite, bornite and chalcopyrite (appendix 2).

A vertical zonation in distribution of these minerals has been observed in the deposit. In upper horizons of the deposit, the principal role is played by chalcopyrite, but deeper down, bornite predominates, and finally in the lower horizons, chalcocite predominates. The lead mineralization consists of galena, and the zinc mineralization, of sphalerite.

Silver is present in the ores in the form of independent minerals including native silver or is involved in the form of isomorphous additives in the lattice of the sulfides.

The most widely distributed ore types in the deposit are segregated type. Ore minerals replace the matrix of sandstone and conglomerate and less frequently the feldspars. The ore fabric is often banded being defined by the features of the country rocks. In the weakly mineralized rocks, ore minerals are concentrated mainly in the coarse grained seams. In the richest ore, when ore minerals comprise a significant portion of the volume of the rocks, the fabric of the ores shows the massive state. In the conglomerates, mineralization is concentrated in the matrix. The vein type of mineralization is also noticed in the ore, which is widely distributed, but appears to be small in value. The mineral composition of the vein ores is, in general, the same as that of the banded and segregated ores.

1-4 Ore reserve estimation

1-4-1. Drill data

Extensive drilling exploration is being carried out in the Zhaman-Aibat copper deposits by Zhezkazgangeologiya as aforementioned. The total amount of drilling has reached 934 holes with a total length of 619,466.3 m. The drilling work which has been completed to date is summarized in Table III-1-2-1.

The drill holes are generally located on a 200m x 200m (category C1) or a 400m x 400m (category C2) grid basis. On some of the grid lines, holes are spaced at 100m to provide more detailed information. In addition to the exploratory drill holes, some holes have been drilled to collect samples for metallurgical testing. Locations of all the drill holes are indicated in Figure III-1-4-1, together with outlines of individual ore bodies.

Core samples are first semi-quantitatively analyzed for major elements such as Cu, Pb, Zn and Ag. According to the results of the semi-quantitative analysis, samples are selected for quantitative analysis at the laboratory of Zhezkazgangeologiya. Unit core lengths for the analysis range from 0.5m to 1.0m in general. Composite samples are prepared combining several pulverized samples and are analyzed for minor elements such as Re, Os, Cd, P, Sb, V, Hg and Se, as well as total and sulphide sulphur. The analytical data are recorded on hand written chemical analysis data sheets labelled with drill hole numbers, depth of samples and other particulars.

The Japanese Survey Team started preparing a computer data base with spread-sheet software for the ore reserve estimation of the Zhaman-Aibat deposits. Due to time limitation, however, only the data-base of the copper results for the Eastern Orebody was completed in the first year's operation. The data-base includes approximately 2,862 analytical data from 305 drill holes.

The hand written data sheets are often incomplete, duplicated or confused in their formats. Therefore, it is necessary to review all the data sheets and to reassemble them in a systematic manner, before data-base entry. The data-base, once completed, should be carefully managed and progressively up-dated.

1-4-2 Verification of analytical data.

In order to confirm validity of the analytical data, some of the pulverized samples were selected and re-analyzed in a Japanese laboratory. The selected 50 samples are listed in Table III-1-4-2 and the analytical results are shown in Table III-1-4-3. Comparing the analytical results obtained by the Zhezkazgangeologiya laboratory with those by the Japanese laboratory, the former is significantly higher in copper contents, with an average difference of +7.6% (excluding 2 samples which indicated extraordinary differences). Of all the compared samples, 16 (32%) indicated that the results of the Zhezkazgangeologiya laboratory are positively biased by more than 10% in comparison with those of the Japanese laboratory. Further, 5 (10%) of the results obtained by the Zhezkazgangeologiya were more than 20% higher than those by the Japanese laboratory. The discrepancy between the two laboratories is so significant that a thorough verification will be required for the existing analytical data. No correction has been made for the existing analytical data in the ore reserve estimation in this year's study.

Table III-1-4-2 Samples for Check Analysis of Ore from the Zhaman-Aibat Copper Deposit

Ser. No.	Sample No.	Line No.	Drill No.	Sampling Depth (m) From	To
1	30262	191	268	605.7	606.3
2	30264	191	268	607.3	607.9
3	30265	191	268	607.9	608.9
4	30266	191	268	608.9	610.0
5	30267	191	268	610.0	610.75
6	30268	191	268	610.75	611.7
7	30270	191	268	612.2	612.7
8	30271	191	268	612.7	613.4
9	6042	195	117	613.7	614.7
10	6043	195	117	614.7	615.7
11	6044	195	117	615.7	616.3
12	5735	195	117	616.3	616.9
13	5736	195	117	616.9	617.6
14	5737	195	117	617.6	618.3
15	109478	207	535	561.6	562.2
16	109480	207	535	562.7	563.2
17	109809	207	535	563.2	563.7
18	109510	207	535	563.7	564.45
19	109511	207	535	564.45	564.95
20	109513	207	535	565.5	566.0
21	109517	207	535	567.95	568.8
22	109518	207	535	568.8	569.4
23	109519	207	535	569.4	569.9
24	109520	207	535	569.9	570.4
25	109523	207	535	571.5	572.1
26	109524	207	535	572.1	572.6
27	109525	207	535	572.6	573.1
28	111038	213	553	549.5	550.1
29	111039	213	553	550.1	550.6
30	111041	213	553	551.6	552.65
31	111044	213	553	554.15	555.05
32	111046	213	553	555.95	556.8
33	111047	213	553	556.8	557.4
34	111048	213	553	557.4	558.05
35	111495	219	561	527.4	527.9
36	111496	219	561	527.9	528.6
37	111497	219	561	528.7	529.1
38	111498	219	561	529.1	529.9
39	111499	219	561	529.9	530.65
40	111500	219	561	530.65	531.35
41	111501	219	561	531.35	531.85
42	111502	219	561	531.85	532.5
43	111503	219	561	532.5	533.3
44	111504	219	561	533.3	534.15
45	111505	219	561	534.15	534.95
46	111506	219	561	534.95	535.85
47	111507	219	561	535.85	536.35
48	111508	219	561	536.35	536.85
49	111509	219	561	536.85	537.35
50	111510	219	561	537.35	537.85

Table Ⅲ -1-4-3 Result of Check Analysis of Ore Samples from the Zhaman-Aibat Copper Deposit

No.	Spl. No.	"JAPAN"	"Zhez."	Ratio(%)	Note
1	30262	0.25	0.16	64.00	
2	30264	2.09	2.34	111.96	
3	30265	4.82	5.16	107.05	
4	30266	3.20	3.44	107.50	
5	30267	2.62	2.78	106.11	
6	30268	5.16	5.46	105.81	
7	30270	0.23	0.32	139.13	
8	30271	0.50	0.50	100.00	
9	6012	0.63	0.55	87.30	
10	6043	1.56	1.62	103.85	
11	6044	0.01	0.01	100.00	
12	5735	0.56	4.14	739.29	Abnormal
13	5736	4.28	4.50	105.14	
14	5737	8.99	9.65	107.34	
15	109478	0.35	0.39	111.43	
16	109480	0.37	0.40	108.11	
17	109809	6.24	6.70	107.37	
18	109510	0.43	0.46	106.98	
19	109511	2.43	2.48	102.06	
20	109513	0.39	0.42	107.69	
21	109517	5.49	5.67	103.28	
22	109518	5.28	5.38	101.89	
23	109519	3.72	3.91	105.11	
24	109520	1.62	1.75	108.02	
25	109523	0.19	0.21	110.53	
26	109524	0.34	0.38	111.76	
27	109525	0.24	0.27	112.50	
28	111038	7.04	7.68	109.09	
29	111039	0.46	0.51	110.87	
30	111041	1.56	1.87	119.87	
31	111044	0.59	0.61	103.39	
32	111046	0.09	0.12	133.33	
33	111047	0.96	1.05	109.38	
34	111048	0.92	0.98	106.52	
35	111495	4.42	4.95	111.99	
36	111496	0.78	0.87	111.54	
37	111497	0.07	3.72	5314.29	Abnormal
38	111498	0.64	0.56	87.50	
39	111499	0.07	0.08	114.29	
40	111500	0.15	0.17	113.33	
41	111501	2.88	2.99	103.82	
42	111502	1.43	1.46	102.10	
43	111503	2.49	2.64	106.02	
44	111504	2.24	2.09	93.30	
45	111505	12.10	13.00	107.44	
46	111506	6.24	6.73	107.85	
47	111507	6.32	6.85	108.39	
48	111508	1.43	1.52	106.29	
49	111509	3.81	5.91	155.12	
50	111510	4.02	4.11	102.24	
Average		2.54	2.74	107.62	

"JAPAN": Japanese Laboratory
"Zhez.": Zhezkazgangeologiya Laboratory

1-4-3 Result of ore reserve estimation

The Zhaman-Aibat ore deposits are categorized into four types of ores according to their relative differences in major ore mineral contents. They are 1) copper ore comprising mainly chalcocite and bornite with minor chalcopyrite, 2) complex ores, mainly chalcocite, bornite, galena and sphalerite with minor chalcopyrite, 3) lead-zinc ores, mainly galena, sphalerite, chalcocite and bornite, and 4) silver ores, mainly chalcocite, bornite and native silver, with minor chalcopyrite. The cut-off grades of these ore types are set at 0.4% Cu for the copper ores, 0.8%Pb+Zn and 0.3%Cu for the complex ores, 1.10%Pb+Zn for the lead-zinc ores and 5g/t for the silver ores.

Block A of the horizon 4-I of the Eastern orebody was selected for the ore reserve estimation in this year's study because its size and grade are superior to other parts of the Zhaman-Aibat ore deposits. The ore reserve estimation was carried out with the following procedure;

Step 1. A 3m or longer section in each drill hole with an average grade equal to or greater than the cut-off 0.4%Cu forms a unit ore section. The average grade of the unit ore section is a length weighted average of the grades of the analytical units.

Step 2. A 4m, or shorter, section with an average grade lower than the cut-off is incorporated with the immediately upper and lower unit ore sections forming a part of a single unit ore section. The average grade is re-estimated, taking account of the average grade and the length of the low grade section. Where the re-estimated average grade is lower than the cut-off, either of the upper or lower unit ore section is adopted in the process of Step 3.

Step 3. The unit ore sections in individual drill holes are stratigraphically correlated, taking account of their chemical, mineralogical and other characteristics, and are differentiated into specific ore horizons.

Step 4. The unit ore sections correlated to ore horizon 4-I are selected to outline block A. The average grade and length of horizon 4-I ore section in each hole are principally applied to the polygon formed by the perpendicular bisectors of the lines joining the hole to neighbouring holes.

The lateral limit of block A is defined by lines connecting (1) the midpoints between pairs of the drill holes spanning the ore boundary or (2) points 100m outside the outermost hole where no drill hole exists beyond this hole.

The shapes of the peripheral polygons are overridden by the limit of the block as defined above.

Step 5. The volume of each polygon is estimated by multiplying the length of the ore section (thickness) by the area of the polygon measured on the ore block plan. The tonnage is estimated by multiplying the volume by the specific gravity 2.6 g/cm³ (2.60 t/m³).

Step 6. The average grade of block A is estimated by averaging all polygon grades weighted by their tonnage. The sum of polygon tonnage gives the total tonnage of block A.

The above procedure is principally the same as that of the Zhezkazgangeologiya except for the use of a polygon method for the tonnage and average grade estimation of the entire block A. The Zhezkazgangeologiya estimate the total tonnage by multiplying the arithmetic mean of thickness (lengths) of the ore sections in individual holes by the total area of block A which has been measured on a map using a planimeter. The average grade is a thickness-weighted mean of the average grades of the ore sections. Therefore, each hole is considered to represent the same area regardless of the pattern of drill hole distribution.

In the course of this year's study, specific gravity measurements were made for some selected copper ore samples. The results of the measurements have led to the following correlation between the ore specific gravity and the copper content in percent;

S.G.= 2.63+0.016xCu+0.0002xCuxCu (Cu in %)

According to this equation, the average specific gravity of the copper ore is estimated at approximately 2.66. However, the specific gravity of 2.60, which is the same figure used by the Zhezkazgangeologiya, has been adopted by the Japanese Survey Team for the ore reserve estimation.

The results of the ore reserve estimation of block A of the Eastern ore body obtained by the Japanese Survey Team are shown in Table III-1-4-1, together with the ore reserves of the same block as of January 10,1994 for comparison. The difference between the two reserves is reasonably small, with slightly greater tonnage (47.7 million t versus 46.4 million t) and higher average grade (1.84%Cu versus 1.80%Cu) obtained by the Japanese Survey Team.

Table III-1-4-1 Summary Table of Ore Reserve Estimation on Block-A Orebody of the Zhaman-Aibat Copper Deposit

ITEM		TEAM/Calc.	Japanese Survey Team (1995)	Zhezkazgangeologiya (1994)	Note
Category of Estimation			Geological Ore Reserve (Not Mining Reserve)	Geological Ore Reserve (Not Mining Reserve)	
Calculation Method			Polygon Method	Section Method	
No. of Drills			217	217	
No. penetrate Ore			115	115	
Outline of Estimation					Ratio(%)
Area		(sq.m)	3,365,326	3,447,426	97.6
Dimension of Dep.	Leng. (ENE)	(m)	4,500	4,500	
	Width(WNW)	(m)	1,500(max)- 500	1,500(max)- 500	
Ore Horizon	Min.	(m)	493.50	493.50	
	Max.	(m)	632.20	632.20	
Average Thickness		(m)	5.45	5.18	105.2
Volume		(cub.m)	18,346,112	17,857,668	102.7
Ore Density			2.600	2.600	100.0
Ore Weight		(t)	47,699,892	46,429,900	102.7
Ore Grade	Cu	(%)	1.84	1.80	102.1
	Ag	(g/t)	9.19	8.87	103.7
Metal Amount	Cu	(t)	876,883	835,700	104.9
	Ag	(kg)	438,545	411,800	106.5
Condition of Calculation	1) Ore body boundary delineated by Zhezkazgangeologiya was adopted. It is the bisector of pairs of neighouring dills in which one of the pair penetrated the ore body and the other did not.				
	2) Gaps inside border and polygon are assigned to nearest polygons.				
	3) Cut-off grade is 0.4%Cu. Interlayer is less than 4 m.				
Results of Estimation	1) Both results have mainly similar values.				
	2) Differences of values are related to those of thickness and area. The difference of average thickness depends on the gap between siple mean and block area weighted mean.				

2 The Samarsky area

2-1 Location, access and topography

2-1-1 Location and access

The Samarsky survey area is located in the Telmansky district of the Karaganda region 35km to the north of Karaganda, and 10km to the north of Termitau. Geographic coordinates of the corners of the Samarsky survey are (in clockwise direction) Point 1; 50° 11'25"N/72° 52'45"E, Point 2; 50° 16'45"N/73° 00'00"E, Point 3; 50° 09'38"N/73° 10'50"E, Point 4; 50° 04'18"N/ 732'47"E (Figure I-2-1-2).

The area is accessesible from Karaganda by: the Karaganda-Temirtau-Tselinograd all-weather road (Route 36) for approximately 30km; route 194 toward the town of Akutau from the junction 5km north of Temirtau for approximately 5km; a paved road heading to the southeast to the Samarsky Sanatorium on the north shore of a water reservoir (approx. 5km); a gravel road from the Sanatorium heading to north (approx. 5km).

The nearest railway stations are the Akutau station, 10km to the north-east of the area, and the Tokarevka station, 15km to the east of the area.

2-1-2 Topography

The topography of the Samarsky survey area belongs to "stage of old age" classification and it is characterized by low hills. Hill and valley form of relief prevails in the area. The altitude varies from 500m to 600m. The relief is complicated by shallow seasonal river beds of small nameless rivers, run-off dells and small artificial water storage areas and open pits (quarries). The highest elevation in the area of the deposit is 594.2m and the lowest point is 489.3m.

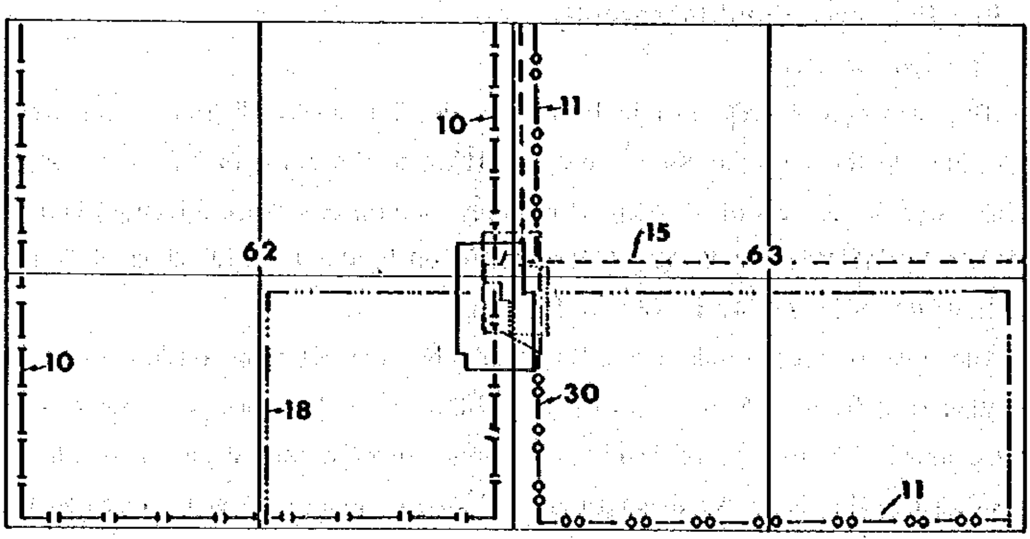
2-2 Previous geological, geochemical and geophysical surveys

2-2-1 Previous geological surveys (Figure III-2-2-1)

The first recorded prospecting in the "Sarymsak" area dates to 1935, when the prospecting for tourmalized secondary quartzite of Sarymsak mountain was carried out. The main target of this work was raw boron minerals.

Gold mineralization was first detected in 1953 and was named "Nurin deposit". At the same time some small elongated zones with malachite and azurite were revealed among light colored (secondary quartzite) rocks.

In 1954 the Sarymsak area was studied again as a possible deposit of raw boron materials. A number of trenches and exploring shafts were driven and a geological map at



Legend

10 MSU (Moscow State University) Konfel O.M. 1:200,000. 1959

11 MSU Mozarovich O.A. 1:200,000 1959

15 CKGA, CKPhE Bydrin V.P. 1:200,000 1967

18 CKGA, Aksamentova N.V. 1: 50,000 1956-1957

30 Contour of work by P.I. Khomchenko 1: 10,000 1960

Contour of work by Opravhat V.A. 1: 10,000 1965

Area covered by works of X.K. Ismailova 1: 10,000

Contour coveredby work of Samarsky Party 1: 10,000 1994

scale 1:500,000

0 10 20 30 40 50km

Figure III-2-2-1 Compiled Index Map of Previous Geological Surveys in the Samarsky Area the scale 1:2,000 was compiled with general characteristics of secondary quartzites.

From 1956 to 1959 the area became the object of systematic investigations under the name "Nurin deposit" as a representative of tourmaline formation. Attention was drawn to the possible connection between tourmalinized rocks and gold and copper mineralization and a drilling survey for gold and copper was carried out (4 boreholes). Copper dispersion haloes (0.1-0.4% in epicentres) and molybdenum haloes (0.02%) associated with secondary quartzite were found in the vicinity of the Sarymsak hill but could not confirm any ore deposit.

Geological studies of this territory at the scale of 1:200,000 were completed by 1959. At the same time a large-scale geological survey began and a geological map at the scale 1:50,000 was prepared during the period from 1956 to 1958. These works resulted in an understanding of the stratigraphy, tectonic and metallogenic zoning with the recommendation to conduct detailed prospecting for copper-porphyric deposits in secondary quartzites.

As the Sarymsak secondary quartzite massive was considered to be very prospective from the standpoint of copper-porphyric type deposits, a geological survey has carried out in 1962 together with geophysical surveys at the scale of 1:10,000, covering the area of 15.75km². To explore the revealed anomalous zones and geochemical haloes, shallow drilling and exploratory workings were carried out (shafts 8.5m, trenches 35m³, boreholes 770m)

During 1966-1972 the Samarsky ore field including areas (ore occurrences) Samarsky Severny, Zapadny, Tsentralny and Yuzhny was studied and the following surveys were carried out: gravity (22.1km²), sampling and analysis for gold (6km), trenches (5,204.3m³), shafts (163.8 m.) and boreholes (2,398.5m). The results have confirmed, that the area is prospective for gold and copper-porphyric mineralization. Certain recommendations on conducting further exploratory work were made.

After summarizing all past data by the Karagandageologiya (Karaganda Expedition), in 1989, the area was again targetted for intensive exploration drilling. To complete the geologic map of the central Samarsky copper deposit and surrounding area, mapping drillings (shallow drillings penetrating sediment cover to the bed rock) were carried out.

Since 1990 exploration drilling has delineated the ore body of the "Central" Samarsky copper deposit and the "Western" Samarsky gold-polymetallic deposit.

A total of 76 exploration holes have been drilled.

2-2-2 Previous geochemical surveys (Figure III-2-2-2)

From the beginning of the systematic prospecting of ores in the Samarsky area in the 1950's, geochemical survey methods were adopted and played an important role in outlining the target area. Since 1957, lithological and geochemical prospecting of secondary haloes have been carried out in the area. Over 30,000 samples have been taken. Sampling has been carried in a network of 100m x 20m or 100m x 25m.

Spectral analysis makes it possible to determine the following contents of 23 elements: Mo, Ag, Pb, Cu, Co, Bi, Sn, Cd, Ge, V, Be, Sr, Ni, Sb, W, Li, Ti, Mn, As, B, Zn, Ba and Au. This work has resulted in compiling maps of secondary haloes of 13 elements which express the influence of mineralization in the area : Cu, Mo, Sn, W, Ag, Bi, Au, Ba, B, Ge, Pb, Zn and As. They characterize geochemical properties of geological structure of the area and make it possible to evaluate its prospects.

At the Central and Northern parts of the area copper haloes outline an intrusive massive, hosting copper molybdenum deposit. Series of small linear haloes are associated with zones of gold and polymetallic mineralization. A halo with an intensity of 0.01-0.1% outlines the Central ore field of impregnated copper ore. It has ring shape. Richer and closer to surface zones of copper mineralization are outlined within it by the most intensive anomalies from 0.03 to 0.1%.

Haloes of W(0.003-0.03%), Sn(0.0002-0.0005%) and Mo(0.0003-0.01%) are morphologically close to each other, have ring shape, apparently determined by morphology of a younger intrusion, breaking through monzodiorite.

Summarized halo of Cu, Mo, W and Sn is outlines the area of copper mineralization. Tourmalinization zones mapped by B(boron) haloes are also interesting from the standpoint of gold. Au(gold) halo is morphologically close to the projection of ore zone to the surface and is well correlated with copper.

Haloes of Ag, Pb, Zn, As and Bi are located at the flanks of the Cu halo and characterize zones of hydrothermally altered volcanicas, with zones of polymetallic mineralization.

Vertical geochemical zonation of the primary haloes has been analyzed on the Line 34 at the cross-section of 11 exploration drillings. Haloes of Cu, Mo, Sn, W, B, Ge, Sr, Ni, Bi, Co, Pb and Zn have been studied there.

Cross-sections clearly define morphology of mineralization zones, which has inherited the anticline structure of the ore field. The ore zone is arc-shaped with its Western limb dipping steeply more than the Eastern one.

Axial zonation of the ore body has been studied at the Western limb. The following

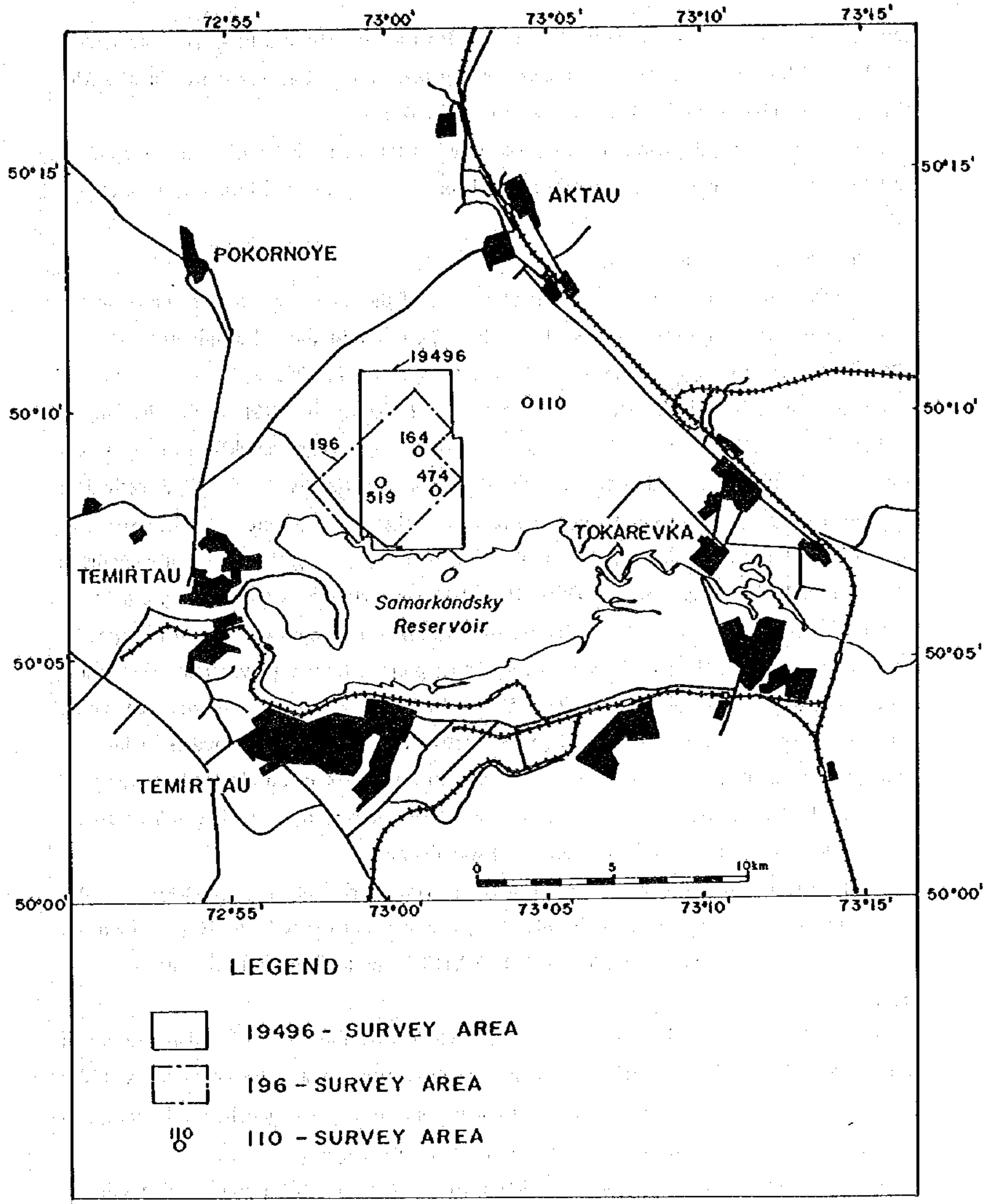


Figure III-2-2-2 Compiled Index Map of Previous Geochemical Surveys in the Samarsky Area above-ore elements are clearly defined here: Ge, Bo and Sn. The ore body is characterized by haloes of Mo, Au and Pb. Lower parts of ore body are characterized by Zn and Mo; below-ore, low-productive levels are characteristic for Bi and Cr.

The geochemical interpretation map is compiled in Plate III-2-2-1 with secondary haloes and taking into account zonation have been used for compiling mineralization in the area.

2-2-3 Previous geophysical surveys

The information on previous geophysical studies of the Samarsky area are given in the list of previous geophysical surveys (Table III-2-2-2) and in the schematic map (Figure III-2-2-3). Systematic study of the Samarsky ore field started in 1960 with a combination of geological and geophysical surveys at a scale of 1:50,000. In 1961 while checking a geochemical anomaly an area, 0.5km x 1.6km in size, was selected for detailed geophysical survey. An electrical potential anomaly with 50mV was obtained by the electrical method of SP (Plate III-2-2-3). Based on the positive results of that work, an area of 15.75km^2 was covered by a 1:10,000 scale survey in 1962. The following geological-geophysical methods have been applied: magnetic survey (Plate III-2-2-1) and metallometric surveys in a network of 100m x 20m (15.75km^2), IP, SP electric surveys (7km^2). The area has been regarded as prospective for gold and silver as well as for copper-porphyritic and polymetallic ores and it was recommended for detailed study. The "Samarsky Zapadny" section was surveyed within its limits and was subsequently defined as prospective for polymetals. Anomalies of Induced Polarization with intensity 6 to 8% were detected in the course of an electric survey by IP method at the background value of 2%. A band of mineralized rocks with width of 100m, stretching for 400m in the north-west direction was delineated.

The quality of geophysical and geochemical surveys carried out in 1961-1962 does not correspond to current requirements. Besides that, anomalies at Lines 16 to 20 cast doubt on the accuracy of the surveys. According to V.P. VYDRIN the total prospective area is 40km^2.

Since 1966 the Samarsky ore field has been studied by the Alexandrovskaya group of CGPE (Central Geophysical Expedition). A gravity survey in a network 200m x 100m (22.1km^2), magnetic survey in a network 100m x 20m (7km^2) and geochemical surveys in a networks of 100m x 20m and 100m x 100m (6km^2) were applied.

Based on the prospecting results obtained from 1965 to 1972 (Grankin and others), Thematic party (1989) recommended further prospecting work in this area. The Samarsky area was considered to be prospective for gold and polymetals. which justified further prospecting at the scale 1:10,000 in this area.

Table III-2-2-2 List of the previous geophysical survey in the Samarsky area

(after BOOK1, 1992)

Report	Year	Author	Method , scale	Network, spacing
148	1960	Khomchenko P. I. Zinchenko O. V. CKSD, CGPE	Ms - 1:100, 000 1:10, 000 Gch- 1:50, 000 1:25, 000 Es - 1:25, 000	500x100m 1, 000x100m 1, 000x50, 500x50m 100x20m 500x50m 250x50m
161	1961	Pak V. P. Kaz	Ms - 1:100, 000	height 40m
164	1961	Khomchenko P. I. Vydrin V. P. CKSD, CGPE	Ms - 1:10, 000 Gch- 1:10, 000 Es(VES)- Es(IP) -	100x20 100x20 distance 2, 000m pitch 500m 200x200m 400x200m 100x20m
196	1962	Khomchenko P. I. Belousov A. I. CKSD, CGPE	Ms - 1:10, 000(15. 75) Gch- 1:10, 000 Es - 1:10, 000 (7) (SP, IP)	100x20m 100x20m 200x40m
494	1965 - 1972	Opravhat V. A. Pacholyuk V. P. CKTSD, CGPE	Gr - 1:25, 000 (22. 1) Ms - 1:10, 000 (4) Gch- 1:10, 000 (6)	200x100m 100x20m 100x20m, 100x100m
950	1983	Mageramova E. A. CKTSD, KSPE Geophysical party	Ms - 1:10, 000 Es - 1:10, 000 (SP)- --	100x25 m 200x50m pitch 25 m

Gr:Gravity, Es:Electric, Ms:Metallometric, Gch:Geochemical

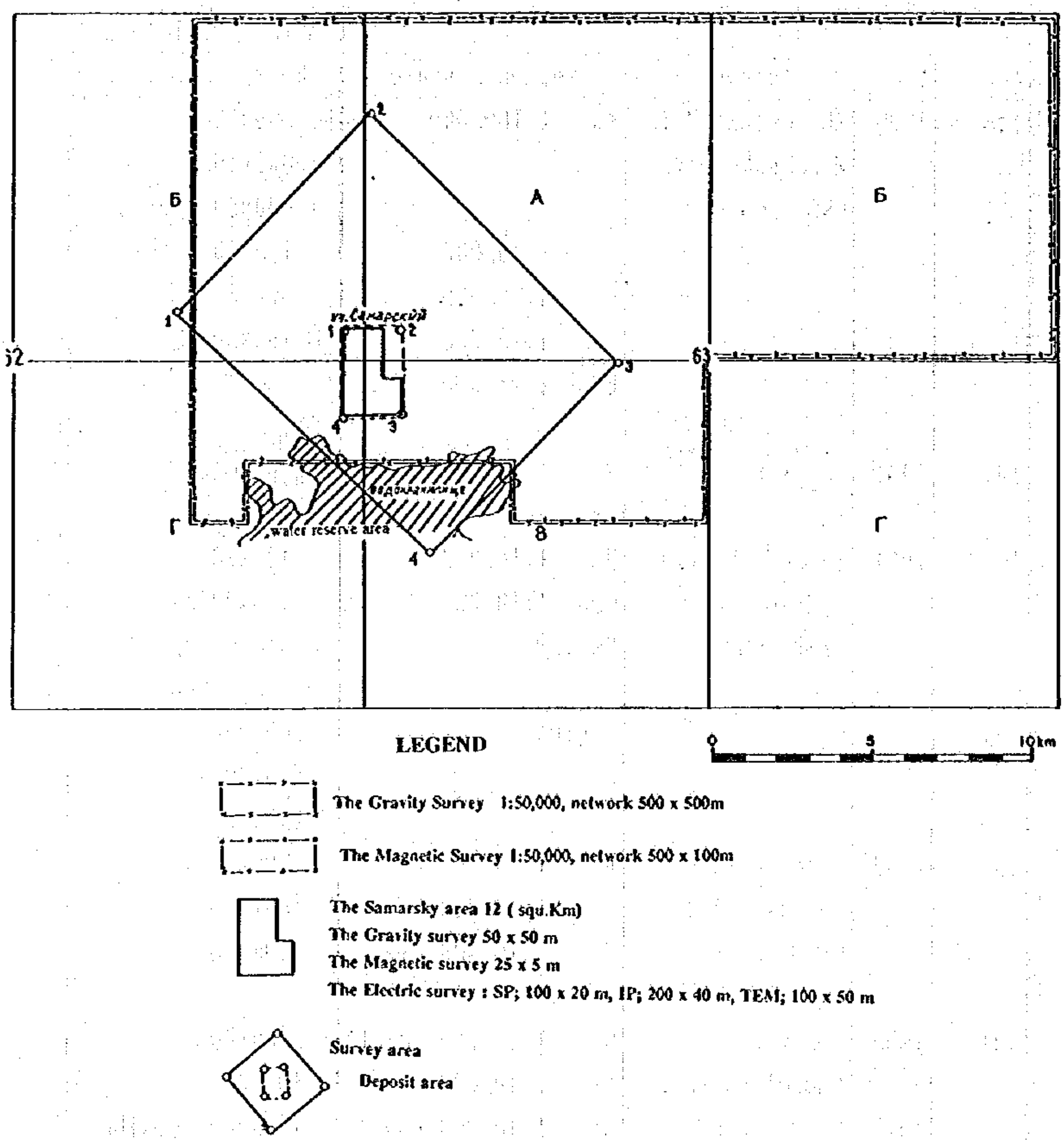


Figure III-2-2-3 Compiled Index Map of Previous Geophysical Surveys in the Samarsky Area

Geophysical analysis utilized data obtained by the Batembai party and the gravity map at the scale of 1:10,000 from the report of the Rybinskaia geophysical party.

Data from the gravity survey of 1972 carried out on the Samarsky deposit area show the complicated gravity field. Most probably it is connected with the wide development, in the area, of various genesis of magmatic rocks and their intensive hydrothermal alteration down to more than 500m. The southern part of the anticlinal Tulkulin volcano plutonic circular structure on the gravity map is clearly marked by a considerable increase of the gravity field and in the northern part, by lower values. The border between them coincides with a zone of steep gradient on which the Sarymsak-Tulkulin fault is mapped. According to the data of the magnetic survey at the scale of 1:10,000 (Plate III-2-2-2) the studied area is clearly divided into two different parts according to the nature of the structure of the magnetic field. The region of positive magnetic field is formed with metasomatically changed granitoids and volcanic rocks of the Zharsor Formation. In plan it coincides with the central part of the Tulkulin structure and has mainly longitudinal orientation of changes of the magnetic field. The region of negative magnetic field encircles the outcrops of conglomerate-sandstone mass of the Kagyr Formation on the sides of this structure. The region of positive magnetic field has a complicated structure expressed with a large number of anomalies of various amplitude, strikes and dimensions.

The magnetic anomalies can be conventionally divided into 4 parts:

- the zone of small intrusives and dikes of the basic rocks
- the outcrops of monzodiorite containing copper porphyric bodies
- the area of development of gold polymetal mineralization in the western area
- the outcrops of volcanic rocks of Zharsor Formation (south-eastern part).

(1) The anomalies of intrusives and dikes

The anomaly zone located within Line 28 (stations 200 to 350) is a series of small anomalies. Spatially the described zone coincides with the area of development of andesite-basalt and monzodiorite containing a large number of small intrusives and dikes of subalkaline gabbro-diorite and dolerite of the Late Permian Manybay complex. It ought to be noted that singling out volcanogenic and intrusive formations according to magnetic survey data is quite complicated here because of widely expressed processes of metasomatism.

(2) The anomalies of monzodiorite

An anomalous zone of magnetic field forms to the of north the first zone and occupies the central part of Lines 28 to 50 (stations 200 to 380). It is characterized by a pair of high (500 to 1,000 nT) and low anomalies (200 to 300 nT). Spatially the zone coincides with outcrops of the Tulkulin small intrusive of altered monzodiorite of the first and second phases of Kukkudukutubin complex containing bodies of copper porphyric ores. According to the drilling data, the intrusive on the depth increases significantly. Dipping of its roof in the south-eastern direction at the angle of 30 deg is observed.

It should be noted that within ore bodies granitoid and volcanic rocks of Devonian are everywhere changed metasomatically to facies of beresite*[1] and propylite and in less changed shape are preserved only in small areas. Within this zone outcrops of beresite and beresitized quartz monzodiorite of the second phase of intrusion form a broken half-ring, which in the western part coincides in plan with the most intensive half-ring magnetic anomaly. According to results of determination of physical properties of less changed samples of quartz monzodiorite they have average magnetic susceptibilities as high as 1,631x10e-5 SI.

However, the drilling determined that sometimes ore and ore containing beresite developed in monzodiorite of the first stage of intrusion have high magnetic susceptibility. In borehole No58 in samples taken from subore-and supraore-beresite, high magnetic susceptibility of these rocks (3,000 to 5,500 x 10e-5SI) was measured. Similar high magnetic ore beresite were intersected in boreholes No 48 and 49 at the depth of 100m to 312m, where the average magnetic susceptibility varies from 308 to 3,182 x 10e-5SI reaching maximum values of 6,000 to 9,000 x 10e-5 SI. Taking into account all this data and the complex geological structure it can be concluded that the described half-ring magnetic anomaly is most probably conditioned with not only quartz monzodiorite of the second phase but also with ore containing and hematite and magnetite containing beresite developed mainly in monzodiorite of the first phase of Kukkudukutubin complex. This zone of the magnetic field is characterized by the presence of secondary areas of dispersion of molybdenum, copper, gold, silver. Calculated anomaly grades appear to be equal and the strike of secondary areas agrees with the strike of primary structures.

According to data from the report of the Dalnenskaia geophysical party (1962), which carried out the electric survey works in this area(Plate III-2-2-3), the Samarsky copper porphyry mineralization is marked with IP anomalies with intensity 6 to 10% on a background of 3%.

---

*[1]Beresite: An aplitic hypabyssal rock altered to a material resembling greisen, containing quartz and often pyrite. Beresite was originally described as being predominantly feldspar, was later determined to be free of feldspar, and was still later described as a quartz porphyry (Johannsen, 1939, p.243)

In the south-western part of the area a positive magnetic anomaly is defined in Lines 12 to 26 (stations 16 to 220). This large anomaly is isometric in plan and is stretched in longitudinal direction with intensities up to 900-1,000nT. It corresponds to the zone where the Tulkulin fault adjoins small intrusions of quartz monzodiorite of Early Permian Vishnev complex and hornfels.

(3) The anomaly of Au-polymetal mineralization

The anomalous zone covers the north-western part of the study area. In a gravity map the area of the relative gravity represents a decrease of values of gravity force, associated with the massive of granitoids located at depth. The character of the magnetic field within this zone is marked by relatively decreased values (from -50 to +100nT). Spatially it coincides with the area of development of sandstone of the Konyrskaia Formation and metasomatically changed tuffites, tuffoconglomerate breccia and large-fragmental tuff andesite of the Upper Zharsor Subformation. Magnetic anomalies of small dimension are conditioned with small unexposed dike-like bodies of quartz monzodiorite of Early Permian. Small exposures of these rocks are marked in many places within this zone and they were identified in many exploration wells. Within Lines 52 to 57 (stations 150 to 120) weakly positive or negative anomalies correlate with anomalous zones of supposed polarization associated with hydrothermal activity. Three maximums of intensity of 7 to 8% confined to tourmaline-serisite-quartz sulphide zones are defined within this anomalous zone. Secondary areas of dispersion of lead, zinc, gold and, more seldom copper, are confined to tourmaline-sericite-quartz metasomatically altered rock. According to drilling data all large bodies of gold-polymetal ores and zones of mineralization are localized within this zone.

(4) The anomalies of the south-eastern part

The south-eastern part of the area, (Lines 0 to 30), is characterized by a magnetic field of small intensity 100 to 300nT. In plan this zone coincides with outcrops of volcanic rocks of the Zharsor Formation. Spatially it coincides with the area of development of Middle Devonian terrigenous rocks of the Konyr Formation.

2-2-4 Current situation

In the Samarsky survey area (including the "Central,Cu" and the "North-west,Au") exploration drilling of 32,156.2m in total has been completed. Each drillhole was approximately 600m deep for copper exploration and 300m deep for gold exploration (Table III-2-2-1). Since the autumn of 1994 an additional three drillings were commenced by deepening old drillholes or by new drilling at the eastern limb of the "Samarsky Central Cu deposit". They will be completed in the summer 1995 and are aimed at checking the deeper

Table III-2-2-1 Drilling Statistics in the Samarsky Area

Area. Type / Year	Samarsky Ore Field			Samarsky Copper Area			Samarsky Gold Area			Annual Total	
	Kind of Drill	No. of Holes	Total Length	Kind of Drill	No. of Holes	Total Length	Kind of Drill	No. of Holes	Total Length	No. of Holes	Total Length
1989	Mapping Drill	548	17.913	-	-	-	-	-	-		17.913.0
1990	-	-		Core Drill	21	8.006	Core * Drill	19	2.829.2		10.835.2
1991	-	-		-	-	-	-	-	-		0.0
1992	-	-		-	-	-	Core Drill	11	2.251		-
1993	Mapping Drill	47	795	Core Drill	25	19.970				('92-93)	2.251.0
1994							-	-	-	('93-94)	20.765.0
Mapping		595	18.708							595	18.708.0
Exploration					46	27.976		30	5.080.2	76	33.056.2
Total										671	51.764.2

* Core Drill : for Exploration

geologic structure and confirming the mineralization at lower levels.

No geophysical surveys are programmed in the deposit area except for borehole logging accompanying drilling. In May 1995 a report on the geophysical data will be presented for the region surrounding the Samarsky deposit by the Central R.G.E as "Result of regional geophysical work of 1:50,000". This report may identify interesting regions for further exploration.

2-3 Geology and mineralization

2-3-1 Geology

2-3-1-1 Stratigraphy

The Samarsky area is located at the marginal Devonian volcanic belt at the junction of large caledonide structures, Erementay-Nyazsky anticlinorium, Semizbugin and Shokshan synclinoria (Plate I-3-2-2).

The structural position of the area results in wide development of volcanic, intrusive and volcanogenic-sedimentary formations of Devonian age.

The stratified divisions of sedimentary formations and intrusive formations have been defined as described below:

1) Sedimentary formation

(1) Devonian system(D)

Devonian system deposits are widely spread through the territory of the area. They compose basically the wings of a Tulkulin ring volcanic-plutonic structure and are divided into Early-Devonian Zharsor tuffogeneous volcanogenic and Middle-Devonian Konyr volcanogenic sedimentary Formations. The former is subdivided in turn into Lower and Upper Subformations.

① Early-Devonian Zharsor Formation

According to petrochemical and lithologic data the Formation is divided into Lower(D_1zr_1) and Upper(D_1zr_2) Subformations mainly composed of volcanics of basalt, andesite and dacite compositions respectively.

Lower Subformation

The Lower Subformation of Zharsor Formation (D_1zr_1) is most widely spread in the South-Western and North-Eastern parts of the Samarsky ore field. The Subformation discordantly overlaps the Silurian and Ordovician deposits and it is concordantly overlapped by the rocks of the Upper Subformation within the area. The thickness of the Lower Subformation is not less than 545m.

The formation is mainly composed of agglomerate tuff. Lower Subformation volcanics in the Zapadny area are metasomatically altered to fully-manifested beresite with abundant pyrite.

Upper Subformation

The Upper Subformation of Zharsor Formation (D_1zr_2) is concordantly overlapped by volcanogenic-sedimentary deposits of the Middle Devonian Konyr Formation. The described deposits are most widely developed in the South-Eastern and North-Western parts of the site dipping at angles of 20-30°. It constitutes limbs of the Tulkulin volcano-plutonic structure.

It is composed of coarse-fragmental pyroclastic tuff and sometimes lava of andesitic dacite and andesite. The thickness of the Upper Subformation is more than 510m.

Subvolcanic formations

Subvolcanic formations of the Early Devonian ($\alpha \beta \pi D_1$) related to the volcanism of Zharsor time are widely spread at the Lower Subformation. It is mainly composed of leucocratic basaltic, andesitic basaltic rocks.

② Middle Devonian Konyr Formation (D_2kn)

Deposits of this Formation in the Zhivet stage widely occur in Northern and Western parts of the Samarsky area. Konyr Formation with washout and angular unconformity overlaps the volcanic rocks of lower and upper members of the Zharsor Formation and it is in turn overlapped by Neogene clay. The formation is composed mainly of red-colored tuffaceous inequigranular sandstone, conglomerate. The incomplete thickness of the formation is less than 250m.

(2) Neogene system

The deposits of Neogene age are represented by Kalbaman ($N_1^{2-3}kl$), middle to late Miocene and Pavlodar(N_1^3-N_2^1pv) late Miocene-early Pliocene formations composed mainly of clay and formations of redeposited disintegrated weathering crust with lenses of sand and pebble.

① Middle-late Miocene. Kalkaman Formation ($N_1^{2-3}kl$).

The deposits occurring widely in the area overlap the rocks of Paleozoic and they are overlapped by the formations of Pavlodar series. The Kalkaman Formation is composed mainly of lacustrine, alluvial-lacustrine and diluvial-proluvial grey-green fat clay and redeposited weathering crust. The thickness of the Formation varies from a few meters up to 50m.

② Late Miocene-Early Paleocene. Pavlodar Formation (N_1^3-N_2^1pv)

The deposits of this formation have wider areal occurrence in comparison with those of the Kalkaman Formation. The largest areas in which their bedrocks are found are in the northern and north-eastern parts of the site. They overlap the Kalkaman Formation and Paleozoic rocks and they are covered by Quaternary formations. The formation is composed mainly by red-brown, more rarely by speckled, washed lacustrine, lacustrine-alluvial sandy clays. The formation thickness varies from a few meters up to 22 and 35m.

(3) Quaternary system(Q)

The lower layer in the Quaternary system is Lacustrine-alluvial deposits (la Q_I) that occur most often in the western part of the area. They are represented by lacustrine-alluvial and alluvial brownish-beige loam, clay and polymictic fine-middle grained sand. The thickness of the rock mass is less than 5m.

Middle-Upper layers are Proluvial-diluvial deposits (pd $Q_{II\text{-}III}$). They are represented by carbonaceous sandy loam with the debris. The thickness of these deposits does not usually exceed 1-2m.

Recent layer is Proluvial (pQ_{IV}) and lacustrine (LQ_{IV}) deposits composed of proluvial loams, sandy loams and sands occur most widely in this layer. The thickness of such deposits is not more than 1m.

The weathering crust has two types buried weathering crust is up to 6.5m in thickness and occurs in the Zharsor and Konyr Formations. Redeposited weathering crust varies from 5m up to 20-30m compose the deepest parts of Neogene deposit sections which overlap with wash-out the rocks of Paleozoic.

2) Intrusive formations

Intrusive formations in the Samarsky area are strongly variable depending on the time of their intrusion, petrochemical properties and structural position. All of them are closely connected with Devonian volcanism, which resulted in the formation of ore containing Tulkulin volcanic-plutonic structure and with Permian stage of Epicaledonian tectonic-magmatic activation. The following complexes have been conventionally defined.

(1) Early Devonian Karamendin complex

Early Devonian Karamendin complex of quartz-diorite($q\delta_1D_1km$), associated with the first phase of intrusion and granodiorite porphyry($\gamma\delta\pi_2D_1km$) of the second phase of intrusion constitute the Tulkulin intrusion, which is outcropping in the central part of the volcanic-plutonic structure in the Samarsky area.

Both major phases are accompanied by sub-phase intrusive activities.

The former sub-phase is composed of the associated metasomatic formations of medium-fine grained ($q\delta_1$), microdiorite and quartz-diorite-porphyry of exocontact facies ($\mu q\delta_1$), beresite (br_1), potassium feldspar facies (kL_1), propylite(p_1) and secondary quartzite(vk_1).

The latter sub-phase, continuing to the second phase formed associated intrusives and dikes that coincide in places. They are composed by quartz-diorite-porphyry biotite-plagioclase-like ($q\delta\pi_2^2$), eruptive breccia of granodiorite-porphyry ($\gamma\delta\pi_2^3$), beresite (br_2) and potassium feldspar facies (kl_2).

This complex is most widely spread within the Devonian volcanic belt and is closely connected with Devonian volcanics.

During all of these activities some parts of the intrusive bodies were brecciated and formed so-called breccia pipes in the central part of the massive. The breccia pipes include many kinds of clastic fragments of early stages and hosting rocks of Early Devonian Formations. These breccia pipes played an important role in the hydrothermal alteration and copper-porphyritic and gold polymetallic mineralization in the second phase intrusion of the complex (Figure III-2-3-1).

Plan view of Tulkulin massive shows that it has an oval shape, and is apparently represented by a stock-shaped body, 6x3km in size. At the Western part of the area the intrusion is cut off by the Western-Tulkulin upthrust-overlap.

Almost everywhere rocks of this complex are almost completely altered by metasomatism to beresite.

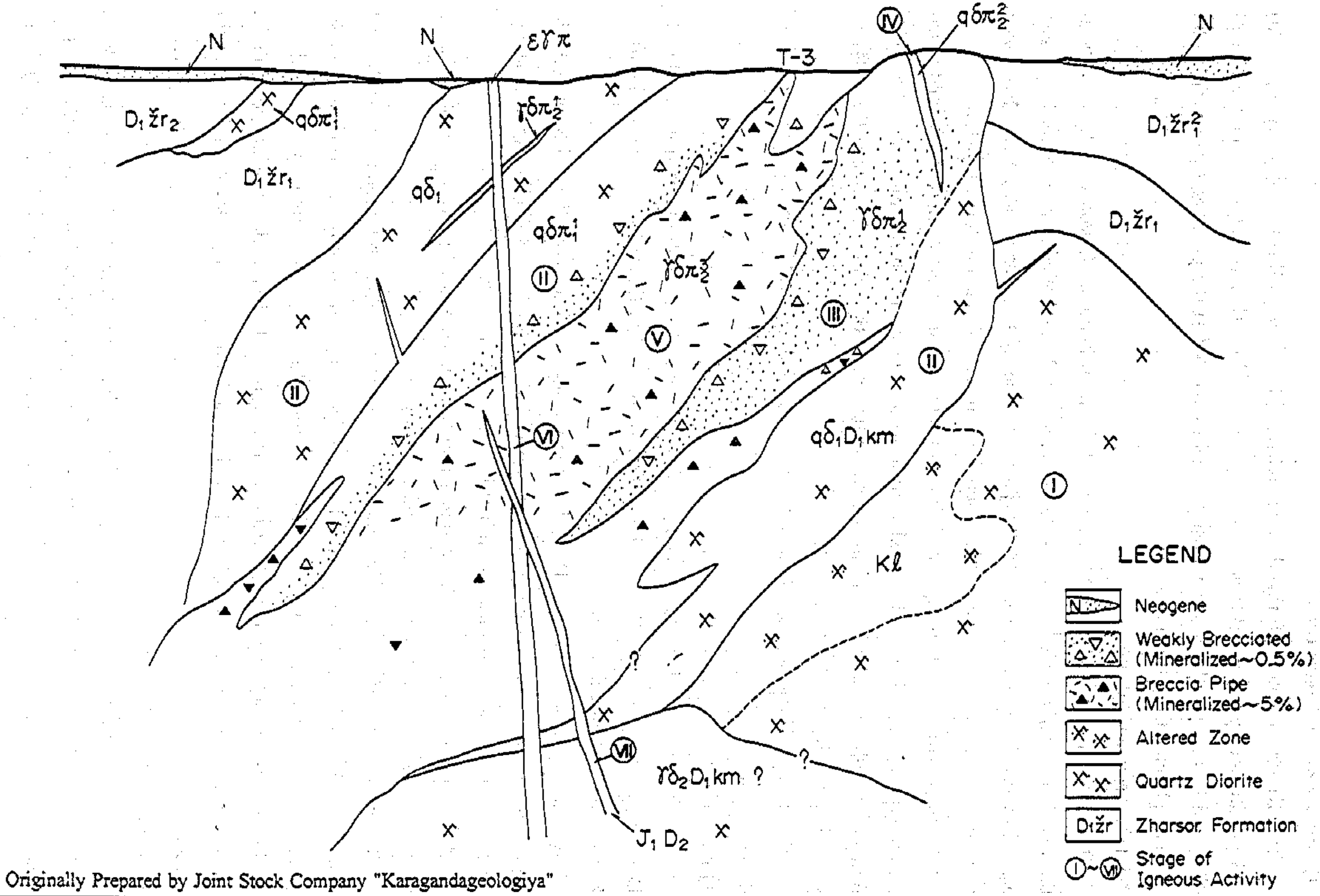
(2) Lower Permian Vishnev complex of quartz monzodiorite ($q\mu\delta P_1v$)

Lower Permian Vishnev complex of quartz monzodiorite ($q\mu\delta P_1v$), less frequently monzodiorite ($\mu\delta P_1v$) and granodiorite ($\gamma\delta P_1v$) has been conventionally defined within the Samarsky complex. This complex consists of minor intrusions and dikes, mostly located in peripheral parts of Tulkulin volcanic-plutonic structure and zones of faults. Most of them are partly or completely overlaid by Neogene clays or are not uncovered by erosion at the sandstone of the Konyr Formation.

The most widely spread rocks are represented in the complex by quartz monzodiorite, constituting the majority of dikes and intrusive bodies.

(3) Upper Permian Manybay complex

The complex of sub-alkaline dolerite ($\varepsilon\beta P_2mn$), gabbro ($\varepsilon\nu P_2mn$) and gabbro-diorite ($\varepsilon\nu\delta P_2mn$) has been conventionally defined in the surveyed territory. This complex includes groups of dikes and minor intrusions, located mostly at axial parts of the Tulkulin volcanic-plutonic structure. Most often granitoids of this complex occur in the Southern part of the territory.



Originally Prepared by Joint Stock Company "Karagandageologiya"

Figure III-2-3-1 Schematic Cross-Section of the Samarsky Copper-Molybdenum Deposit Area

(4) Upper Permian Koitas complex

The Koitas complex of rhyodacite-porphyry ($\lambda \zeta \pi_2$kt), rhyolite-porphyry ($\lambda \pi_2$kt) and granite-porphyry ($\gamma \pi_2$kt) is defined conventionally. This complex includes group of dikes and less frequently, minor intrusions, mainly located at the peripheral part of Tulkulin volcanic-plutonic ring structure.

2-3-1-2 Tectonic structure

The territory of the Samarsky area is located within marginal Devonian volcanic belt, at the junction of large Caledonian structures-Erementay-Nyaz anticlinorium, Semizbugin and Shokshan synclinorium, adjacent to the junction zone of Caledonian and Early Hercynian structures of Central Kazakhstan, thus determining its complicated tectonic structure.

There are two structural stages and five structural and intrusive complexes defined based on the type of prevailing folding and fault tectonics are on the magmatic and sedimentary formations within the area. The main structural element of the Samarsky area is the Tulkulin volcanic-plutonic ring structure.

The first and the second structural stages are defined within the orogenic stage of development.

1) First structural stage

The first structural stage is composed of continental andesitic basalt-dacite Lower Devonian formation of Zharsor Formation and Early Devonian orogenic intrusive Karamendin complex of diorites.

By the beginning of Lower Devonian age the area had undergone significant tectonic restructuring by Caledonian tectonic movement and the Tulkulin ore-containing volcanic-plutonic ring structure with minor intrusions was formed.

Above-intrusion roof of Tulkulin minor intrusions is composed of volcanics of andesitic basalt-dacite formation in the Western and Eastern part.

The central part of the volcanic-plutonic structure is complicated by numerous faults and minor intrusive and dike bodies of the Permian age. These are mostly granodiorite of Early Devonian Karamendin complex. They form the Tulkulin intrusion, containing gold-polymetallic and copper-porphyritic mineralization. It has a dome structure with its nucleus composed of hydrothermally altered granodiorite of Early Devonian Karamendin complex.

2) Second structural stage

The second structural stage is composed of continental-marine Middle Devonian molasse rock associated with the Konyr Formation, constituting overlaying Samarkand syncline. The syncline forms the structure of the Northern, Western and Eastern limbs of the Tulkulin volcanic-plutonic structure.

3) Stage of developing Epicaledonian activity

Epicaledonian activity is represented by minor bodies and dikes of alkaline and acidic composition of Early and Late Permian Vishnev, Manybay and Koitas complexes. The described folding and intrusive complexes are complicated by numerous faults, that are characterized as having important tectonic and ore-determining roles.

4) Faults

Faults are widely spread and play an important role in the geology of the area, determining prevalence of small blocks in its structure.

The major faults are the Tulkulin, West-and East-Tulkulin, Sarymsak-Tulkulin and Sarymsak faults.

The largest fault is the Tulkulin deep seated fault which is assumed to have a steep Western dip (60-85°), meridional strike and is stretching from the South to the North through all the Western part of the territory of the area. In the Western part of the area it limits placement of mostly copper-porphyritic mineralization of the Samarsky deposit, and its outlining tectonic cracks are responsible for placement of gold-polymetallic mineralization.

The East-Tulkulin fault, which has a North-Eastern direction, is located in the South-Eastern part of the area, upthrusting with dislocation, directed to the East at the angle of 70°. The fault outlines outcrops of the Tulkulin intrusion and the Eastern flank of a copper-porphyritic body to the West of the Samarsky area.

The Sarymsak-Tulkulin fault is located in the Central part of the area.
It has a steep, almost vertical dip and is outlined by dike-like bodies of granodiorite of Early Permian age and coincides with outcrops of granodiorite of the second intrusion phase of the Karamendin complex.

Other numerous smaller faults can be divided into two groups of tectonic cracks with North-Eastern (younger age) and North-Western strike.

2-3-2 Mineralization and alteration

2-3-2-1 Mineralization

Ore deposits and occurrences, located within the Samarsky survey area are included in copper-molybdenum-gold formation and are closely associated with Devonian volcanism, that has resulted in formation of ore-containing Tulkulin volcanic-plutonic structure.

The structural position of the Samarsky survey area resulted in development of two types of mineralization: copper-porphyritic and gold polymetallic.

1) Porphyry copper type mineralization

Two comparatively large bodies of copper-porphyritic ore occur in the Samarsky survey area. They are located in the Northern part (No.1 body) and in the central part (No.2 body) of the area. Both ore bodies are composed of metasomatic altered rocks of quartz diorite, granodiorite of the Early Devonian.

Ore body No.2 is the object of geological ore reserve estimates in this year. It is located at the above-intrusion zone of Tulkulin massive. The massive is composed of hydrothermally altered rocks of beresite-sericite composition. The ore body was delineated based on the cut-off grade of copper of 0.2%; it has an isometric shape with irregular borders and a size of 500mx400m. It is cut by faults, having North-Eastern (Sarymsak-Tulkulin, Sarymsak) and meridional directions (Tulkulin).

Ore body No.2 is shaped like a cone and is located in the upper parts of the intrusive massive. The bottom of this cone is close to oval shaped, with the size 2,000m x 1500m. The vertical range of mineralization is over 500m.

Ore body No.1 has a similar character to No.2. The shape is like a cylinder with a slightly stretched oval cross section approximately 400m x 250m in plan view.

Their major sulphide ores are veinlet-impregnated and impregnated-veinlet types.

2) Gold-polymetallic type mineralization

This type of ore has been found in the "Western" section and its Southern extension. Ore mineralized zones are associated with the Zharsor Formation of Lower Devonian.

Gold ore mineralization is developed at the zone of crushing and hydrothermal alteration (sericite-beresite metasomatic alteration). Ore and ore mineralized zones do not have clear geological borders. They have been delineated by sampling and are represented by accumulations of gold-polymetallic quartz, quartz-carbonate, quartz-sulphide, sulphide veinlets. The mineralized zones have conformable orientations with surrounding crushed zone of North-Eastern strike with the inclination of 35-55°.

Analysis of spatial distribution and structure of ore bodies shows, that all of them have zonal structures. The outer zone contains poor polymetallic and gold mineralization, inner parts contain commercial mineralization (over 3 g/t Au).

Four gold ore bodies have been discovered in a north to south line in the North-Western Dumkorin section. In the two northern bodies gold prevails over lead and zinc and in the southern bodies lead and zinc prevail over gold.

3) Gold-bearing crusts of weathering.

Gold-bearing crusts of weathering are widely developed within the Dumkorin tectonic block (Zapadny-"Western" section) and are localized in Neogene sediments. They have an average thickness of 20m and average content of gold of 0.2 g/t Au.

2-3-2-2 Mineral composition

Based on the results of microscopic observation and others, general characteristics of selected ores has been studied for mineral composition in the Samarsky ore deposits area. Two main types of ore have been defined here: copper ore and lead-zinc ore with gold. Their characteristics are as follows:

1) Copper ore

According to the assemblage of copper minerals, copper ores are classified into chalcopyrite ore and chalcopyrite-molybdenite ore. Chalcopyrite mineralization is being regularly replaced at depth by chalcopyrite-molybdenite mineralization. Chalcopyrite ores are basically composed of chalcopyrite, pyrite and accessory sphalerite, rutile and magnetite. Molybdenite-chalcopyrite ores are mostly composed of accessory molybdenite, pyrite and rutile. Hosting rocks of these ores have spotted textures.

2) Polymetallic ore

Polymetallic ore is composed of lead, zinc and in some cases gold is also present. Their mineral composition is basically sphalerite, galena, pyrite, chalcopyrite and, as a minor minerals, chalcocite, tetrahedrite, native gold, magnetite and rutile are also present in some cases. The dominant texture is "impregnated" with some veinlet-like and veinlet/jointing textures also apparent. Gold is found in the veinlet type texture ore.

2-3-2-3 Alteration (Figure III-2-3-2)

Intrusives and hosting volcanogenic rocks are affected by intensive hydrothermal alteration. Distribution of hydrothermally-altered rocks is in the form of concentric zones. Silicified rocks are located in the center. Moving outward, they are replaced by vast zones of quartz-sericite composition, transforming into sericite, which is then replaced by quartz-tourmaline and tourmaline. Flanks of the area are mostly occupied by propylite. Hosting rocks of copper-porphyritic deposits are generally altered with various intensity to beresite. In general, mineralized zones of gold are also associated with sericite-beresite metasomatic rocks. Gold ore mineralization is developed at the zone of crushing and hydrothermal alteration containing fine impregnation of pyrite. The secondary alterations in the rocks of the Konyr Formation were expressed by recrystallization of cement and they are presented mainly by the processes of chloritization, carbonization and silicification.

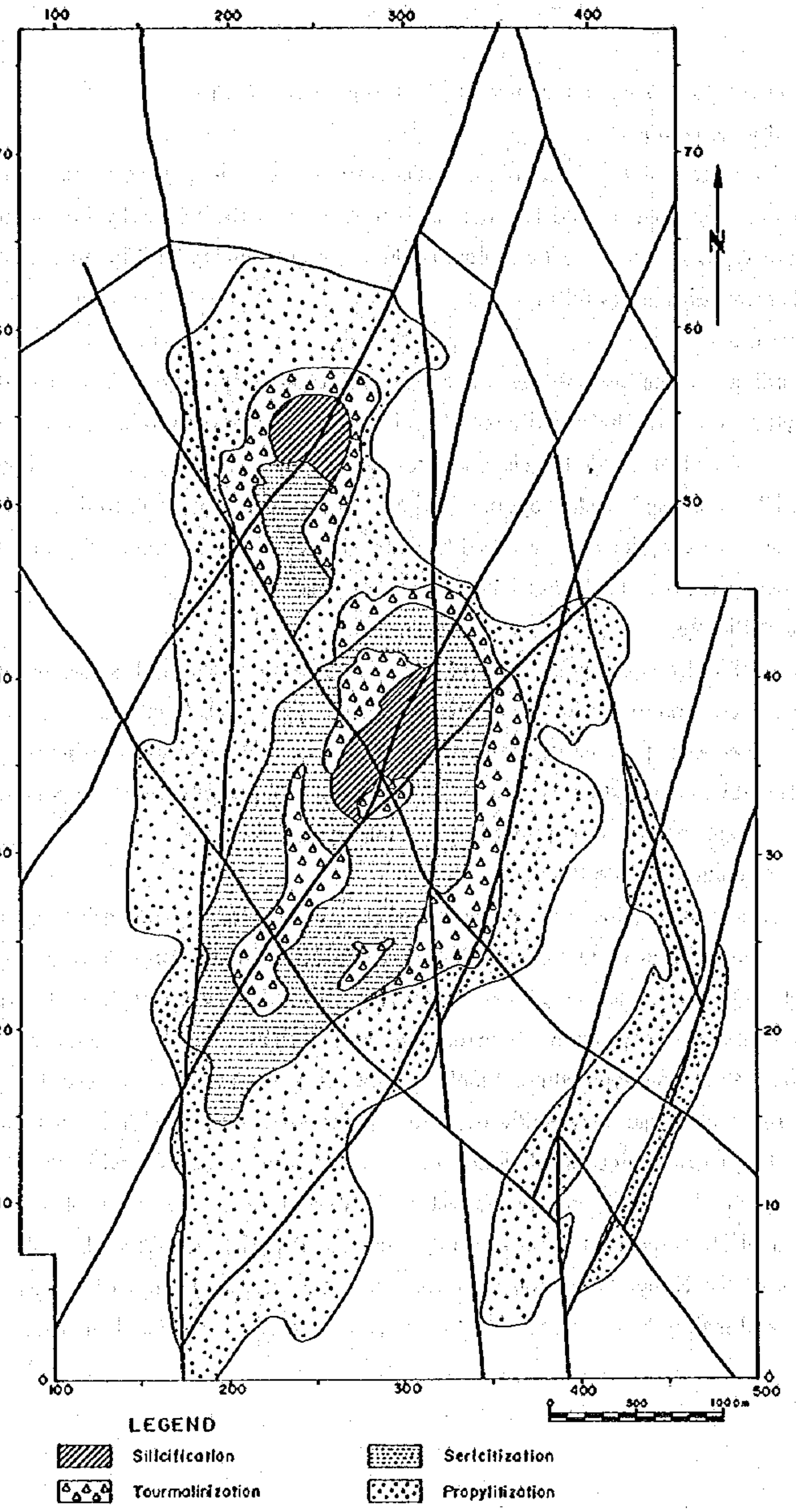


Figure III-2-3-2 Generalized Alteration Map
of the Samarsky Copper-Molybdenum Deposit Area
Originally Prepared by Alexander V. Pokusaev (1955)