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R E P O R T

ON THE RESULTS OF GEOPHYSICAL INVESTIGATIONS CARRIED OUT IN 1973 - BEGINNING OF 1974 FOR SOLID MINERALS

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S U M M A R Y

This paper deals with the results of geophysical investigations carried out within Afghanistan in 1973 - beginning of 1974 by the Geophysical crew of the Geology and Mineral Survey Department under technical assistance of the USSR.

The investigations were carried out within eleven areas which to represent mineralized regions, as well as at mineral occurrences of copper, tin, polymetals, gold, tungsten, and chromium.

The paper presents the efficiency of geophysical survey on 1:50000 and 1:25000 scale and that of detailed geophysical investigations on 1:10,000 scale.

The report comprises four parts:

- Part one - the text comprising 100 pages, 23 tables, 19 drawings, a reference list, two textual appendices on 7 pages.

- Part two - graphical annexes, 38 pcs. on 56 sheets.

- Part three - an album of VES (Vertical Electric Sounding) curves for the areas of Čhah-i-Ab, Jarhaši, Burulaman, totalling 202 curves.

- Part four - a catalogue of geophysical investigations carried out for prospecting for solid minerals within afghanistan under technical assistance of the USSR during the period of 1971-1973, the catalogeue to include a scheme of the geophysical investigations areas on 1:2,500,000 scale.

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I N T R O D U C T I O N

Beginning with 1971 the Geophysical Crew of the Geology and Mineral Survey Department carries out systematic geophysical investigations on 1:10,000 and larger scale, the investigations being aimed at evaluation of the prospects of a number of mineral deposits and occurrences. The carried out geophysical investigations have shown their efficiency in prospecting for minerals.

The experience of the geophysical investigations carried out in Afghanistan let starting, in 1973, the implementation of complex geologo-geophysical survey on 1:50,000 - 1:25,000 scale within the known ore fields, aimed at centouring and prospecting of the areas promising for minerals, as well as at obtaining the data necessary for geological mapping.

The Project (15), 1973, envisaged the geophysical investigations within six areas:

1. Areas promising for placer gold, viz., the Čub-i-Ab, Jarbashi, and Kakča.

2. Areas promising for placer cassiterite, viz., the Western Tourmaline, the Northern Tourmaline, the Dehana.

3. The Darrah-i-Nur ore field.

4. The Qala-i-Asad ore field.

5. The Orazghan tungsten occurrence.

6. The Syah-Ghar and Nagim tin occurrences.

In the process of the investigations carrying out in 1973, it was decided to change, in some details, the plan of the geophysical investigations.

1. The electrical prospecting (VES), planned to be carried out over the Kakča and Čub-i-Ab areas, was decided to be implemented during the spring and autumn periods of 1974 due to the presence here of a continuous field of irrigation.

2. In the process of geophysical investigations implementation over the Syah-Ghar and Nagim tin occurrences it became clear that the planned volumes of investigations should be increased, as the necessity arised to carry out surveying on 1:50,000 - 1:25000 scale over the Zarkashan ore field, where the above-mentioned occurrences are located.

3. As the prospecting-evaluational investigations have resulted in discovery of new areas promising for minerals, it was decided expedient to redistribute the volumes and kinds of the planned geophysical investigations, and to carry out complex geologo-geophysical investigations over the region of Kabul caprifermus belt (the Ainak and Tagnar areas), and at the Laghar chromite occurrence instead of the electrical prospecting over the areas of Tourmaline and Dehana.

4. Due to a necessity of water-supply improving of one of the Kabul city suburbs (the Darulaman), carried out there are electrical prospecting investigations with the help of VES method.

5. During two months Soviet geophysicists have rendered technical and methodical assistance to a group of Afghan geopgysicists who carried out VES investigations.

In conformity with the above-said, the Geophysical crew plan was respectively changed.

An efficient organization of the work let carrying out the investigations the whole year round.

The geophysical observations implemented during the first quarter of 1974 appear to represent the continuation and an integral part of those carried out in 1973 over the Qala-i-Asad ore field.

The geophysical investigations were concentrated mainly over the most promising areas which represented the units of the primary importance (Fig.1 *)) and were carried out in a complex with geological investigations (geological survey, metallometric sampling, mining, etc.).

The fulfilment of the work volumes by their kinds during the period under report is illustrated by the Table 2.

In 1973, the volumes of geophysical investigations were increased compared to those of 1972 (Table 3). The increase of the work volumes (by 2.5 - 13.7 times) is characteristic mainly of the most important kinds of the investigations: magnetic prospecting, Vertical Electric Sounding (VES), Spontaneous Polarization (SP), Electrical Profiling (I P), topographical survey (laying-out of the geophysical observations grid). Side by side with the increase of the above volumes, the volume of logging was decreased due to the decrease of drilling operations by sulphide ores. From the comparison analysis of the main indices of geophysical observations of 1972 and 1973 it is seen that the average labour production per one instrument/shift, as a whole, has increased, despite the fact that the fulfilment of small-scale (1:50,000 - 1:25,000) investigations influenced upon the decrease of the labour production .

The increase of the fulfilled volumes of investigations and of the labour production are caused by the increase of the experience of the Afghan specialists and workers, by the improvement of the work organization, as well as by the introduction of new techniques (the logging station AMKS-900, impedometer IKS-50), and by the rational methods of field observations.

The Geophysical Crew consisted of the following eight Soviet specialists:

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*) Here and below the readers are reffered to the text in Russian.

Telkov V.S. - technical instructor of the Crew - up to 16 May, 1974

Kleiminov M.A. - senior engineer

Kamaev S.A. - senior engineer

Kolesnichenko V.A. - senior geologist - from 16 May, 1973

Ishaukulov L.A. - senior engineer on logging - from 13 September, 1973

Ivanov V.A. - engineer-geophysicist - from 21 July, 1973

Semionov V.S. - senior technician-geophysicist - up to 11 March, 1974

Mukhin A.A. - interpreter of Persian and technician-operator - up to 2 May, 1974.

The investigations were being carried out under the supervision of the Chief of the Crew - Mr. Rahimullo.

An individual training of the Afghan persons has resulted in obtaining by 9 persons of practical skills (one of the persons was a diploma engineer-geologist) who, under the supervision of Soviet specialists, have carried out geophysical observations working with magnetometers, at laying-out of profiles, implementation of photo-laboratory work, and as operators of generator installation (I P method).

The field observations were being carried out with the help of Soviet geophysical instruments :

- four magnetometers of M-27 type;
- nine apparatus for measuring magnetic susceptibility of IMB-2 type;
- three autocompensators of MKS-1 type;
- electrical prospecting station of VES-63 type;
- logging station of ARKS-900 type;
- impedameter of IKS-50 type for measuring of an apparent resistance of rocks (being in operation from January, 1974).

The areas where the geophysical investigations were being carried out appear to be spatially disconnected and isolated one from another, being different both by their geomorphological and geologo-geophysical features, and by the character of the planned over them investigations. Due to the latter fact, the Report deals individually with the results of the each area.

The Introduction to the Report, the chapters I and IV have been compiled by S.V. Kamaev, the chapter II and IX, as well as the conclusions to the Report, have been compiled by Kleiminov M.A.. The geological sequences and the results of metallometric sampling carried out within the Darreh-i-Nur and Zarkashan ore fields have been described by V.A.Kolesnichenko.

The majority of the graphical annexes to the Report have been drawn up by M.A.Kleiminov and V.A.Ivanov; the album of the VES curves has been prepared by S.V.Kamaev.

The present Paper is accompanied by a catalogue of the geophysical investigations carried out by the Crew during 1971 - 1973, the catalogue to include 20 cards compiled for 20 units where the geologo-geophysical investigations have been implemented. In the cards given are the main data on the implemented investigations and the results of the latters.

Table 2

Nr.	Kinds of investigations	Unit of measure	Plan of 1973	Fulfilment: Total	Fulfilment: In 1973	Fulfilment: In 1974	Percentage of plan fulfilment in 1974
	2	3	4	5	6	7	8
	Magnetic prospecting	l.km	750	916	753	163	100
		obser.point	32,000	40117	32,017	8,100	
	Magnetic susceptibility of rocks measurement	observ.point	750	760	760	-	101
	Electrical prospecting:	l.km	100	115	100	15	106
	A) I P profiling	obs.points	6000	7,306	6,366	940	
	B) Medium gradient profiling	l.km	-	12	-	12	-
		obs.points		500		500	
	C) VES & IP invest.	obs.points	200	211	209	2	104
	D) Spontaneous Polarization method	l.km	100	120	120	-	108
		obser.points	10,000	10,778	10,778		
	E) Charge method	l.km	-	15	-	15	-
		obser.points		1,540		1,540	
	Boreholes logging	l.km.b/holes	850	851	851	-	101
		logging b/holes	2,500	2, 544	2, 544		
	Geologic-prospecting routes	l.km	200	200	200	-	100
	Metallometric sampling	sample	1,600	1,700	1,700	-	106
	Ditching	cu m	330	345	345	-	104
	Channel and dotted-channel sampling	sampling	270	275	275	-	102
	Laying-out of observation grid	l.km	950	1123	961	162	101

T a b l e 3

Kinds of investigations	Unit of measure	Fulfilment 1972	Fulfilment 1973	Number of instrument/shifts 1972	Number of instrument/shifts 1973	Production per one in/shift 1972	Production per one in/shift 1973	Change of investigation volumes in 1973 year, compared to that in 19
Magnetic prospecting	1.km	208	753	122	317	1.7	2.3	Increased averagelly by 2.6 times
	obs.points	19,850	32,017			163	101	
Magnetic susceptibility of rocks measurement	obs.points	736	760	19	20	39	38	-
Electrical prospecting: a) I P profiling	1.km	82	100	108	124	0.76	0.80	Averagelly increased by 1.2 times
	obs.points	5,614	6,366			52	52	
b) median gradients profiling	- " -	20	12	32	6	0.62	2.0	Averagelly decreased by 5.4 times
		4,548	500			141	83	
c) VES (excluding VES-IP)	obs.points	15	206	4	55	3.75	3.75	Increase by 13.7 times
d) SP *)	1.km	44	120	37	73	1.2	1.6	Averagelly increased by 2.4 times
	obs.points	5,322	10,778			143	148	
e) Charge method	- " -	4	15	6	12	0.67	1.25	Increased averagelly by 2.7 times
		868	1,540			144	128	
oreholes logging	1.km b/holes	2,318	851	59	17	124	150	Decrease by 2.8 times
	1.m logging	7,332	2,544					
eying-out of observation grid	1.km	100	961	47	436	2.1	2.2	Increased by 9.6 times
	Total instrument/shifts			404	1,045			

*) As the SP observations were not carried out in 1972, in the Table presented are the data obtained in 1971.

I. AREAS PROMISING FOR PROSPECTING FOR GOLD

1. Ünh-i-Ab area

The VES electrical prospecting was being carried out with the aim of preparing the area for drilling prospecting for gold.

The task of the geophysical investigations was ascertaining the relief of the bedrock of the valleys under the cover of Quaternary rocks; the geophysical observations were being carried out by a grid of reconnaissance profiles. For this, the project envisaged 105 VES observations.

A generalized sequence of the area is the following:

1. The lowermost portion is made up of Miocene siltstones, sandstones and conglomerates, followed by poorly sorted redcoloured Pliocene conglomerates.

2. The Miocene deposits elsewhere are overlain by Quaternary rocks.

During the field season fulfilled are 68 soundings (including 3 check observations the maximum electrode spacing to amount to 1500 metres.

The sounding has been carried out over two cross-like profiles. A summary length of the profiles amounts to 5.5 linear kilometres. The observation VES points in the profiles were located at an interval of 80 metres.

The measurements have been fulfilled with the help of ERK-1 instrument, the accuracy of which is high. The declination from the average value of the main and check measured resistivities does not exceed 4%, what appears to be lower than the Instruction of electrical prospecting requires.

The VES observation points tie was done " by eye " on a map of 1:50,000 scale. A levelling traverse was layed out by the two profiles.

For the area under consideration the most characteristic are VES curves of KQ and QQ type, reflecting a moderate character of the geological sequence (the VES curves obtained for the area are given in the III-rd part of the present Report).

The right branches of the all VES curves appear to be asymptotically terminated by the apparent resistivity values of the order of 20-120 ohm.m, what to correspond to the elsewhere spread reference geoelectrical horizon, the surface of which to coinside with those of the interbedding Miocene sandstones, siltstones, and conglomerates.

According to the data obtained during the previous years (the parametric sounding and borehole logging) the values of Neogene (Miocene) deposits resistance vary between 55 and 76 ohm.m, which are in a good agreement with the obtained by us data.

The Pliocene conglomerates which to occur directly on the Miocene rocks make up a single whole geoelectrical horizon possessing a heightened resistivity of the order of 250-500 ohm.m.

The loams overlying the rubbly-pebbly formations dependently on their lithology and the degree of inundation are characterized by the resistivity values varying between 15 and 140 ohm.m and represent the upper geoelectrical horizon of relatively low resistivity. The loams, due to their shrinkage at the upper portion, are often separated to form two geoelectrical beds, of which the uppermost possesses a relatively heightened resistivity. In such cases the VES curves appear to be much more complicated.

The results of the VES curves interpretation are given in the Table on page 105(see Russian text).

Now, we shall dwell on the consideration of the long profile of the western and north-western trend. In the eastern portion of the profile, VES-5-VES+24, the surface of Miocene deposits occurs at depths of 12-15 metres and moderately plunge towards the west. Further west, the reference geoelectrical horizon sharply plunges (VES+36-VES+128 to a depth of up to 300 metres. Then the reference horizon begins slowly uplifting. In a spot of the VES+168 - VES + 184 the reference horizon sharply rises to a depth of 35-40 metres. Further west (VES +192 - VES +328) the Miocene deposits appear to occur in the depth of 15-65 metres.

Thus, according to the electrical VES prospecting, we may follow the bedrock of an ancient valley, filled in with Miocene rocks.

The smaller profile has a N-W - S- E trend (the VES +1 - VES -XVI curves).

In the southern direction the behaviour of the reference horizon appears to be the following. At a section of from VES+1 to VES -5 the Miocene rocks occur at the depth of from 14 to 20 metres. Further to the south, the reference geoelectrical horizon gradually plungs down to the depth of 280 metres (VES-IX), still further south, the horizon begins its sharp uplifting and at the section of VES-XIV - VES-XVI it occurs at the dep of 40-45 metres.

Thus, over the above-considered profile, the electrical prospecting data (VES observations) trace the bedrock of a lateral valley.

The main geological result of the electrical prospecting data interpretation is the ascertaining of the relief and the depth down to the ancient bedrock of the valleys, m asured through the quaternary deposits sequence.

2. Jorbaši area

To prepare the area for drilling for placer gold prospecting, there carried out er VES observations.

The task of the geophysical investigations within the area was an ascertaining of

the Panj valley bedrock relief under a sequence of Quaternary rocks; the observations were being carried out over a grid of individual profiles. For this aim the project envisaged 79 VES observations.

The area under consideration lies within the Panj valley flood plain, 12-14 km downstream the river from the Sunty placer gold deposit. The geological environment of the area is analogous that of the Sunty placer gold deposit area.

A generalized sequence of the deposits within the area is the following:

1. The lowermost portion of the sequence is made up of Lower Neogene rocks, represented by two strata: the lower (N_1^1) made up of interbedding siltstones, sandstones, and conglomerates, and the upper (N_1^2) showing a limited spreading and made up of poorly sorted redcoloured conglomerates.

2. The Neogene deposits are almost elsewhere overlain by Quaternary pebble beds.

3. The Quaternary pebble beds, within the first above-flood-plain terrace, are overlain by loams that are from 1 to 4-5 metres thick.

92 observations of VES method are carried out within the area (including 4 check observations), the maximum electrode spacing AB to amount to 1500 metres. Sounding observations were being carried out over three profiles a summary length of which to amount to 7.4 linear kilometres. A magnetic azimuth of the profiles is 300°. An observation grid is 1000 x 80 metres. Due to numerous water channels and branches of the Panj river presence over the area, the observation space was changed from 50 to 100 metres.

All the measurements have been obtained with the help of the ESK-1 instrument. The accuracy of the measurements exceeds that required by the Instruction. The declination from the average values of the main and check measurements amounts 3.6%. The allocation of VES observation points was done " by eye " on a map of 1:50000 scale.

The most common VES curves for the area under consideration are these of AKQ, AAK, rarely of KQ and QQ type (see part III of the Report).

The right branches of the VES curves are terminated by an apparent resistivity values of the order of 40-200 ohm.m, what corresponds to a reference geoelectrical horizon of interbedding deposits of Lower Neogene, viz., sandstones, siltstones, and conglomerates.

The Pliocene conglomerates together with Quaternary rubbly-pebbly deposits make up a single whole horizon of heightened resistivity, the magnitude of the resistivity being of the order of 300 - 1000 ohm.m.

The loams which to overlie the rubbly-pebbly deposits, within the limits of the terrace mentioned above, are characterized by the resistivity values amounting between to 25 - 65 ohm.m and represent the upper most geoelectrical horizon possessing a relative

low resistivity.

The results of the VES curves interpretation are given if the Appendix 1 and are represented by geoelectrical sections by the profiles (Appendix 2).

The 270 profile is located north of the other two profiles. Traced by the profile is the submergence of the reference horizon in the direction from the east towards the west. At a section of the VES No.8 - VES No. 144 the horizon is submerged down to a depth of 45- 90 metres. At an interval of VES 160 - VES 216 observed are maximum depths of the reference horizon occurrence which to amount to 160 metres. At an interval of VES No. 888 and VES 232 the reference horizon appears to be the most close to the day surface. The Miocene deposits almost everywhere are overlain by Pliocene conglomerates and Quaternary pebbly-rubbly formations ($Q_{II} + N_2^2$). Still upwards the column is made up of Q_{III} formations characterized by the resistivity values of from 2000 to 3000 ohm. metre.

Downstream the valley, one kilometre from the above-considered, loyed out is the profile No. 260. The profile also reveals the gradual plunge of the reference horizon in the direction from the east to the west. By this profile, as a whole, the reference horizon occurs lower compared to the profile No. 270. An average level of the horizon submerge amounts to some 170 metres. The greatest depth of the horizon plunge is observed at a section of from VES No.64 to VES No. 224 and amounts to 210 metres.

The single whole geoelectrical horizon of Pliocene conglomerates and Quaternary rubbly-pebbly formations over the profile under consideration appears to be well pronounced and has a constant thickness.

Further downstream the vallye is located the profile No. 250. The depth of the geoelectrical horizon plunge is a considerable one and amounts to 200-220 metres. The thickness of rocks which to overly the reference horizon is greately increased there. At an interval of VES No. 152 - VES No/160 the Miocene rocks form an uplift; the depth of the rocks submerge is to amount to 75 m.

The geophysical investigations have resulted in ascertaining of the reference horizon relief, the horizon to coinside with the Miocene rocks, and of the depth of the horizon occurrence within the area under consideration. As the obtained data suggest, the reference horizon generally plunge in the direction downstream the Panj valley, and from the east to west.

The obtained results make possible to carry out more purposeful drilling prospecting.

II. The Darrah-i-Nur ore field

The ore field is located in 90-95 km NNE of Kandahar town (Fig. 1).

The geology of the field is dominated by gently occurring dolomitic marbles of the Alamghar suite (T_3 am), followed conformably by carbonate-terrigenous formations of the Arghasu suite ($T_3 - J_2$ ar) and platy limestones of the Paynawa suite (J_{2-3} pm), the latters two suites rocks to occupy the central and eastern parts of the area under consideration. The deposits of the mentioned above suites, within the western part of the area, appear to be cut through by diorites, granodiorites of the first phase of Oligocene complex of Arghandab, and by granites and granosyenites of the complex's second phase - in the south and east of the area. Within the northern part of the area the marbled limestones of the Alamghar suite have been intruded by quartz diorites, granodiorites of the first phase of Late Cretaceous-Paleocene complex of Kurkeshan. An intensive marbleization, and the presence of stocks made up of granites at the exocontact zone of the intrusive suggest a small depth (100-300 m) of the Arghandab complex of granitoids' roof.

Vein derivaties of the complex, represented mostly by dikes of basic rocks, show a wide spreading over the field. The dikes dominantly strike in submeridional direction; they are 0.5 - 15 m thick and up to 1.5 km long. Associated within the ore field with the dikes is polymetallic mineralization (Dike No. 41, the Tokato-Khum). It is interesting to note that the dikes are concentrated mainly at the exocontact of the granitoids massif; on approching to the intrusive contact the number of the dikes is noticeably decreased and in the endocontact zone observed are only individual dike bodies.

The exocontact alterations of the country rocks are represented by skarnization, chloritization, rarely by muscovitization and serpentinization, these to be accompanied by sulphides and oxides of iron, copper, lead, and zinc. Especially widespread are skarns both at the contact of the intrusive and in the exocontact zone of it. The skarns are of variegated composition: garnetiferous, amphibolic, vesuvianic, pyroxenic, magnetitic, magnetite-ludwigitic. The skarns are from first to some metres thick and up to 120 m long. The skarn bodies that are localized at the contact of the intrusive with the Alamghar suite marbles mostly are barren, those occurring in the exocontact zone usually carry cupriferous, polymetallic, tungsten mineralization. It is not excluded that the latters appear to represent the indicators of " blind " skarn bodies confined to a contact of the roof marbles with the Arghandab complex granitoids.

A characteristic structural feature of the Darrah-i-Nur ore field is the presence in the Alamghar suite marbles of numerous zones of tectonic dislocations, some of which are healed with dike of basic rocks. The majority of the zones have a submeridional strike; [illegible] the zones strike in the northeastern and northwestern directions. The mer-

phology of the zones is complicated enough, the zones often branch out, traverse one anoter displacement of one zone by another is observed, the displacement amplitude being up to 100 m. Usually the zones carry secondary mineralization (carbonatization represented by ankerite, dolomite, rhodochrosite) often carrying an impregnation of cassiterite. The zones have the thickness varying from 1- to 3.0 metres, the extent being 2-3 kms.

Within the ore field discovered is a number of polymetallic occurrences (the Dike 41, Yakata-Khum, Darrah-i-Nur, Sakharghei), of copper and tin (Činar, Ghbarghei, Šinšahr, Ziadan), iron (Tambil). The prospecting and evaluating carried out in 1949; 1965-1966; 1968; 1971 have resulted in evaluation of the occurrences surface, and, within some of the occurrences (the Činar, Yakata-Khum, Ghbargei),the evaluation of the mineralization in the depth. A full information on the mentioned above occurrences is contained in the works of the previous investigators (Lemmon, 1950; Khasanov, 1967; Pletnikov, 1968; Efimenko, 1973).

In 1973 over the territory of the Darrah-i-Nur ore field carried out was a complex of geophysical investigations on 1:50,000 and 1:25,000, and 1:10,000 scale, accompanied by geologic prospecting routes and mining work with collection of channel samples aimed at ascertaining the areas promising for minerals. The area covered by this kind of investigation amounts to 58.3 sq.km. The fulfilled volumes of the investigations are given in the Table 4.

Table 4

Ser. Nos.	Kinds of investig.	Unit of measure	Fulfilment			
			Total	Including check observations	Percent of check observ.	Amount of instrument shifts
1	2	3	4	5	6	7
1.	Magnetic prospecting	1.km / obs.points	258	152	2.3	106
2.	Magnetic susceptibility meas.	observ.point	176	-	-	4
3.	Electrical prospecting:					
	a) Induced polarization profiling	1.km / observ.point	19.5 / 1567	204	13	31
	b) Spontaneous polarization survey	- " -	15.7 / 1224	72	6	13
4.	Metallometric sampling	sample	380	-	-	-
5.	Geologic prospecting routes	1.km	50	-	-	-

1	2	3	4	5	6	7
6.	D i t c h i n g	cu m	153	-	-	-
7.	Channel sampling	sample	58	-	-	-
8.	Laying out of observation grid	1.km	273	-	-	137
	T o t a l instrument-shifts					291

1. M a g n e t i c p r o s p e c t i n g has been carried out over an area covering 57.6 sq.km. ΔZ measurements have been implemented by 98 profiles totalling in the length of from 1.7 to 5.2 km. The azimuth of the majority of the profiles is 135-315°, viz., across the strike of the main geologic-structural elements of the region. Some of the profiles worked out within the eastern and north-eastern parts of the region under report trend at the azimuth of 45-225°. The observation grid is 250 x 50 m with thickening up to 150 - 100 x 25 m over anomalous zones and with thinning up to 500 x 50 m over the areas with moderate ΔZ field.

The mean square error of the observations amounts to $\pm$ 17.0 gammas.

The density of the observation grid and the obtained accuracy of the observations correspond to the conditions of magnetic prospecting of an intermediate accuracy on a scale of 1:25,000, as a whole for the area, and to the scale of 1:10,000 within the anomalous areas.

The magnetic prospecting was accompanied by measurements of magnetic susceptibility of the rocks making up the region under report.

The processing of the obtained results consisted of furnishing the corrections for magnetic field variation and for zero creep of the magnetometer. After the corrected values of ΔZ obtained, compiled were ΔZ graphs and map of ΔZ isolines (see Annexes 3, and 4).

The interpretation of the magnetic prospecting data consisted in ascertaining of the anomalies countours, of the dominant strike of the anomalies axes and determining the parametres of magnetic-perturbation bodies (the apparent thickness, the depth of the upper surface occurrence, etc.). The iterpretation results are shown on the Map of Geologic-Geophysical Results, Annex 8).

By the behaviour of the magnetic field, the studied area can be subdivided into two parts: the north-eastern (Profiles Nos. 252 - 400), and the south-eastern (Profiles Nos. 20 - 250).

The north-eastern part of the area is characterized by a complex ΔZ field, the

character of the field let distinguish 4 areas there: two anomalous areas possessing a sharply changeable magnetic field, both by the intensity and by signs (from the profile No. 252, points Nos. 400-588 up to the profile No. 328, points Nos. 540-605), the ΔZ values to rapidly change along the profiles from first thousand to dozens of thousand gammas, reaching the value of +32 980 gammas and 14 680 gammas; the area of comparatively moderate ΔZ field, characterized by comparatively low and moderately changing from negative values, - 80-100 gammas to positive, viz., + 100 - + 140 gammas with individual narrow negative and positive peaks up to $\pm$ 450-600 gammas; an area of quite a magnificent anomaly ΔZ of isometric shape (the anomaly No. 1, Annex 8) with the intensity of plus 760 gammas at the epicentre (profile No.346, point No. 565), complicated at its north-eastern part by narrow " peaks " of ΔZ with the magnitude of up to + 1400 gammas, the anomaly being traced along the strike for 900 m from the profile no. 338 (points Nos. 550-585) up to the profile No. 352 (points Nos. 530-580).

The south-western part of the surveyed area as a whole is characterized by quite a moderate ΔZ field, the intensity of the field being usually smoothly, in places,rapidly changing from + 200-300 gammas to minus 80-140 gammas. Against this background ascertained are several ΔZ anomalies of different extent, width and intensity at their epicentres: the anomaly II with the dimentions of 550 x 350 metres (the profile No. 240, points Nos. 520-555 - profile No. 245, points Nos. 520 - 555) and with the intensity of up to + 420 gammas against a background of $\pm$ 20-80 gammas; the anomaly III, with the dimentions of 380 x 120 m (profile No.230, points Nos. 450-462 - profile No. 235, points Nos.450-462) and intensity of up to 380 gammas against a background of $\pm$ 80 gammas, the anomaly IV with the intensity of up to 280 gammas against a background of up to $\pm$ 60 gammas, having the dimentions of the order of 380 x 150 metres (profile No.230, points Nos.232-257 - profile No. 235, points Nos. 247-257); the anomaly V with the intensity at the epicentre of + 880 gammas against a background of $\pm$ 60 - 100 gammas, possessing a complex shape in a plan (profile No.200, points Nos. 345-360 - profile No. 205, points Nos. 350-368 - profile No. 210, points Nos. 375-385 and Nos. 405-422 - profile No. 215, points Nos. 375-390, and Nos. 450-565 - profile No.220, points Nos. 375-385), the maximum extent of the anomaly being about 2000 m long and from 50 to 175 m wide; the anomaly VI having the dimentions of about 1000 x 100 m (profile No.45, points Nos. 275-285 - profile No. 60, points Nos. 345-255) with the intensity of from 320 to 620 gammas against a background of $\pm$ 90-200 gammas; the anomaly VII of small size (50-75 m x 100-150 m) with the intensity of up to + 550 gammas against a background of $\pm$ 100 gammas; the anomaly VIII with the intensity of from + 460 to 820 gammas against a background of $\pm$ 100 - 200 gammas, having the dimentions of the order of 380 x 50 m (profile No.40, points Nos. 105-110 - profile No. 45, points Nos. 115-120).

To ascertain the nature of the magnetic anomalies analysed were the results of magnetic susceptibility of the rocks measurements. The magnetic susceptibility measurements were implemented at outcrops and in ancient minings. The distribution of the magnetic susceptibility values is shown in Fig. 2 and in Table 5, compiled in accordance with the " Instruction " (7). According to the data on the magnetic susceptibility slightly magnetic ($\varkappa = 0 - 300 \times 10^6$ units of CGSM) appear to be limestones, marbled limestones, marbles, siltstones, sandstones, skarns and skarned rocks, hornfelses, porphyrites, dioritic porphyrites, granodiorite-porphyries, dikes of basic rocks and the rocks of shear zones. The mineralized limestones and marbles mostly are also slightly magnetic. However, among these rocks met also are medium-magnetic ($\varkappa = 300 \times 106 - 3000 \times 10^6$ units of CGSM) and magnetic ($\varkappa = 3000 \times 10^6 - 20000 \times 10^6$ units of CGSM), and even strongly magnetic ($\varkappa = 20000 \times 10^6 - 40\,000 \times 10^6$ and more units of CGSM) varieties. It should be noted, however, that the magnetic and strongly-magnetic varieties of the mineralized limestones and marbles are but limitedly spread over the area. The granites, granite-aplites, diorites, quartz diorites and granodiorites mostly are attributed to medium-magnetic rocks, though slightly-magnetic varieties of them are also met. The most magnetic rocks of the area appear to be magnetitic skarns; in the majority they are attributed to a group of magnetic and strongly-magnetic rocks.

Proceeding from the data on the magnetic susceptibility of the rocks spread over the area, one can assume that the anomalies I, II, III, and V are due to the presence in the depth of magnetitic skarn bodies of different size and shape; the anomalies IV and VI are connected either with more magnetic varieties of diorites and granodiorites in comparison with the surrounding rock varieties, or with magnetitic skarns occurring in the depth; the anomaly VIII is most probably caused by magnetic granodiorites and diorites; The anomalous areas of sharply changeable magnetic field within the north-eastern part of the covered by survey area correspond to bodies of magnetitic skarns of small thickness (of the order of some first metres), occurring in the depth of some first metres, or cropping out to the day surface.

The most large magnetic anomalies representing practical interest appear to be those of Nos. I and V.

To determine the parameters of the body responsible for the anomaly No.1 carried out were quantitative calculations by the ΔZ graphs over the profiles of Nos. 346 and 344 running in proximity to the anomaly's epicentres.

The results of the calculations are presented in the Table 6.

The calculations results obtained with the help of several methods suggest the thickness of the body responsible for the anomaly No.1 of the order of from 150 to 380 metres (being in the average 244 m), the body to occur in the depth of from 163 to 225 m, be-

Ser. Nos.	R o c k s	Number of measurements	$\varkappa$ average x 10^6 units of CGSM	Magnetic			
				0 – 100	100–300	300–700	1300–
1.	Limestones, marbled limestones, marbles	261	3	261/100%	–	–	–
2.	Mineralized limestones and marbles	358	–	203/57%	81/22%	18/5%	17/5%
3.	Siltstones	44	22.5	44/100%	–	–	–
4.	Sandstones	34	42	34/100%	–	–	–
5.	Skarns and skarned rocks	302	41	293/97%	9/3%	–	–
6.	Magnetitic skarns	190	–	8/4%	6/3%	6/3%	7/3.5%
7.	Hornfels	92	31	92/100%	–	–	–
8.	Granites, granite-aplites	175	–	34/20%	28/16%	67/38%	–
9.	Diorites, quartz diorites, granodiorites	149	–	8/5%	24/15%	28/20%	11/8%
10.	Porphyrites, dioritic porphyrites, granodiorite porphyries	83	144	47/57%	36/43%	–	–
11.	Basic rocks (dikes)	48	158	19/40%	29/60%	–	–
12.	Rocks of shear zones	49	61	34/69%	15/31%	–	–
				Slightly magnetic		Medium magnetic	

T a b l e 5

susceptibility of the rocks ($\varkappa \cdot 10^6$ units of CGSM)

3000	3000-7000	7000-12000	12000-20000	20000 -40000	over 4000	700-1500
-	-	-	-	-	-	-
8 / 2.5%	-	-	5 / 1%	9 / 2.5%	17 / 5%	
-	-	-	-	-	-	-
-	-	-	-	-	-	-
-	-	-	-	-	-	-
19 / 10%	19 / 10%	23 / 12%	37 / 20%	58 / 31%	7 / 3.5%	
-	-	-	-	-	-	-
-	-	-	-	-	45 / 26%	
-	-	-	-	-	76 / 52%	
-	-	-	-	-		
-	-	-	-	-	-	
-	-	-	-	-	-	

M a g n e t i c S t r o n g l y m a g n e t i c

ing in the average some 196 m, the dimentions of the body by the dip to amount to over 100 m. Along the strike the magnetic perturbation body is some 500 m long.

Table 6

Methods of calcul.	Depth of the body roof occurrence (h) in metres		Thickness (2 b), metres	
	Profile 346	Profile 344	Profile 346	Profile 344
1. Tangent method	185	185	-	-
2. Tangent method (coefficients of B.K.Fyntaitskiy)	163	209	163	300
3. Pallets of Yu.P.Tafeev	180	200	300	200
4. Characteristic points(formulas of a thick bed)	192	-	212	-
5. Pallets for ellipsoids	220	-	150	-
6. Recalculation method (pallets of V.N.Strakhov)	225	-	380	-
Average	196	244		

As it was pointed out above, the anomaly No. I at its north-eastern part is complicated by narrow ΔZ anomalies of a high intensity. These narrow anomalies correspond to a lens of magnetite occurring in marbled limestones of the Alanghor suite (T_3 am) and exposed by the ditch No.3. The lens has a steep dip (70-85°) towards the north-west and is controlled by a fault of north-eastern strike (40°). At the south-western part the lens is made up of massive, and in the east-northern part of impregnated and banded magnetitic ore. The thickness of the lens varies from 0.5 to 5.0 metres. Here it should be noted that the two channel samples (nos. 3/11, and 3/12) collected from the country skarned marbles, according to spectral analysis data, carry up to 0.3% Zn for the thickness of 2 m.

The above adduced data suggest that a number of factors, viz., comparatively large size of the magnetic perturbation body, made up of magnetitic skarns, possibly of magnetite, its confinement to a zone of a fault, and the presence of heightened contents of lead and zinc in the country rocks, point to the necessity of the anomaly confirmation by drilling.

The second of magnificent anomalies, i.e., the anomaly No.V, having a complex shape in a plan was described within the Ginor area (Telkov, 1972). The anomaly has been checked up by drilling which has shown that, firstly, the results of quantitative calculations obtained in 1971 with the accuracy of up to 10% coinside with the drilling data,

and secondly that for the anomaly under consideration responsible are garnet-pyroxenic skarns inriched in magnetite and sulphides occurring in the depth of the order of 110 m .

It may be assumed also that the anomalies II and III located closely enough to the No. V anomaly are caused by " blind " bodies of similar skarns.

2. E l e c t r i c a l p r o s p e c t i n g

a) Induced Polarization Profiling was carried out with the aim of discovering and tracing the areas carrying sulphide mineralization and premising for minerals. The survey on 1:50,000 scale was being carried out by the prospecting grid of 500 x 20 m along magnetic prospecting profiles (see Annex 1) in places practicable for motor transport carrying the generator and measurement installations of VPS-63 type. Over the area of 6.5 sq.km layed out are 8 profiles (from the profile No. 415 to the profile No.320, including the profile No.450) totalling in the length of from 1.3 to 3.2 km, and an individual profile No. 250 which is 4.0 km long and located at a considerable distance off the formers profiles. Supply earthing were located at the each profile, the distance between them,due to difficulties in spots choise for the electroded grounding and the station placing, amounted from 0.9 to 2.6 km. The magnitude of the resistivity varied between 50 and 250 ohms. The observations were performed with the gradient adjustement (Komarov et al., 1966, p. 160 (3)). Charging was performed by opposite sign current pulses with the intensity of the current from 1 to 5 am. The charging time was 10 sec. The ΔU_{IP} measurements were performed in every 0.5 sec after switching on the polarizing current. The registration of the observations was performed with the help of an oscilligraph with photoregistration.

The number of check points amounted to 204, viz., 13% of the total number of the measurements. The accuracy of the measurements (the mean arithmetic dispersion) for the apparent polarization (η_k) amounted to 6.0%, that for the apparent resistivity (ρ_k) - 3.7%, i.e. being within the limits of the permissible by the "Instruction" (7).

By the obtained observation results plotted are graphs of η_k, and ρ_k, and map of η_k isolines (see Annexes No.s 5 and 6).

The obtained data point to the fact that within the area under report present are anomalies of an apparent polarization of differnt intensity (from 2.5 - 3% to 4-6% observed against a background of from 1 to 3%) and shape. In the majority of places these anomalies are accompanied by diminishing of the apparent resistivities by 3-5 to 10-15 times. Within the area ascertained are both narrow, local anomalies, and anomalous zones. The correlation of the anomalies from one profile to another was performed with taking into consideration the changing character of the η_k and ρ_k graphs. The ascertained anomalous zones are located in proximity to the known mineral occurrences of Yakhato-Khum, Ziadan and Ziadan-western and due to this fact they carry the names of

the occurrences (Annex 8).

The Yakhata-Khum zone being 200-250 m wide and possessing the intensity of an apparent polarization of 4-6‰ against a background of 2.5-3.0‰ , has been traced from the profile No. 415 (points 600-625) up to the profile No.400 (points 600-620) for a distance of some 800 metres. To the anomalies of an apparent polarization corresponds the decrease of the ρk value by 10-12 times.

The Ziadan zone is characterized by the increase of the ηk values from 2.2-2.5‰ to 4.8-5.4‰ under the decrease of the ρk values from 1000-2000 ohms to 15-500 ohms. The width of the zone changes from 130 to 200 m. The zone has been traced along the strike for some 500 m from the profile No.360 (points 723-735) to the profile No.350 (points Nos. 732 - 752).

The Western Ziadan zone has been outlined by the apparent polarization values amounting from 3 to 4 ‰ against a background of 2%. The zone is 300-350 m wide and over 500 m long (the profile No.330, points 713-715 - the profile No.320, points Nos. 700-735).

Local anomalies of an apparent polarization have been ascertained over the profiles No. 450 (points Nos. 123-129), No. 415 (points Nos.780 -772), and No.320 (points Nos. 772-780). The magnitude of the apparent polarization of the above anomalies respectively amounts to 4.5% against a background of 2%, 3.5-5.5‰ against a background of 2-3‰, and 3.5% against a background of 1%.

The observations performed over the profile No.250 have also resulted in outlining of an apparent polarization anomaly, that being traced in the section between the points of 491 and 554. The anomaly is characterized by an increase of the ηk values from 2-2.5% to 3-3.5‰ with individual pulses of up to 8-10‰ . The above anomaly of an apparent polarization is found in proximity to the magnetic anomaly No.II.

Besides the above enumerated anomalies of an apparent polarization,outlined within the area with the help of IP method investigations is a zone of heightened resistivity, characterized by the ρk values varying between 15-20 and 100-150 ohms against a background of 2000-5000 ohms. The zone possesses quite clear boundaries and has been traced along its strike for a distance of about 2 km (the profile No.320, points Nos. 758-785 - profile No. 360, points Nos. 745- 795). The width of the zone varies between 190 and 570 m

The geological observations have shown that the zone of low resistivities lies in marbleizated limestones of the Alamghar suite (T_3 am) at the exocontact of the Arghandab Oligocene granitoids massif. The zone strikes in sublatitudinal direction. The zone is made up of jointed dolomitic and serpentinized marbles, traversed in places by calcite veinlets (thin sections Nos. 1/1, 1/2, 1/2-a, 2/1, 2/2). The marbles often carry leaching cavities, which seem to have been formed at the expence of Fe sulphides leaching. To study the zone of low resistivities a metallometric sampling was carried out there;

there driven are 2 ditches, too.

The metallometric sampling has been carried out by 9 profiles that are 400-550 m long, over a grid of 250 x 10 m. The samples have been collected from eluvial-talus formations over an area of spreading of the Alamghar suite carbonaceous rocks. The all samples have been subjected to a spectral analysis for the following elements: Mn, Ni, Cr, Li, Be, Sc, Mo, Sn, Cu, Pb, Zn, Bi, As, Ag. A statistic processing of the spectral analysis data was carried out in accordance with the " Instruction " (1). The results of the statistic processing are presented in the Table 7.

Table 7

Elements	Standard deviations	Percentage of the elements
Copper	C_b	0.002
	$C_b k$	0.007
	$C_b k^2$	0.021
	$C_b k^3$	0.063
Lead	C_b	0.003
	$C_b k$	0.007
	$C_b k^2$	0.018
	$C_b k^3$	0.045

Where, C_b - background content of an element
k - standard deviation

The metallometric sampling data let ascertaining two secondary dispersion haloes of copper and lead spatially gravitating towards one another, and three anomalous in content of Zn spots (Zn content being up to 0.1%). The dispersion haloes of copper and zinc, and spot anomalies of zinc are located directly in a zone of low resistivity (Annex No.8). The aureoles in a plan have an elongated shape and oriented parallel to the zone's strike; the aureoles to occupy an area of 500 x 150 m. Copper content in the aureoles amounts to 0.3%, the content of Pb being up to 0.05%. The above contents of the elements are confirmed by spectral analyses of two dotted-channel samples (Nos. 1/9, 1/14) collected from the ditch No.1 where the copper content reaches 0.5%, that of Pb - 0.3% for a thickness of

3 metres.

The above data suggest the presence inside a zone of low resistivity of local areas carrying polymetallic mineralization and indicating to the presence there of polymetallic mineralization in the depth. Here it should be noted, that next to one of the areas outlined is an anomaly of an apparent polarization.

The all above-mentioned factors point to the necessity of drilling within the zone of low resistivity of one-two boreholes aimed at a study of the mineralization in the depth. The recommended points of the boreholes location are those at the profile No. 320, point No. 776, and profile No.340, point No. 777.

The results of the IP profiling implemented within a small area of the Darrah-i-Nur ore field point to the presence in the depth of a sulphide mineralization. To clear out the prospects of the Darrah-i-Nur ore field as a whole, there should be carried out the IP investigation over the whole area practicable for the observations.

b) Spontaneous polarization method. The investigations with the help of Spontaneous Polarization technique were of an experimental character and have been implemented over 2 small areas of the Yakhata-Khum and Ziadan, covering the area of 0.7 and 0.15 sq.km respectively. The SP survey was being carried out over a grid of 100 x 10 m. Over the Yakhata-Khum area the measurements were being carried out by 6 profiles (the same profiles as for the magnetic prospecting), 1400 m long each. Within the Ziadan area the measurements were carried out by 7 profiles, these being 300 m long each (Annex 8).

The graphs of SP potential obtained for the two areas have a saw-like appearence (Annex 7). The value of the potential changes irregularly from one point to another, being between plus 40-60 and minus 140-160 mv. Against this background, over the Yakhata-Khum area, there stands out an anomaly of SP potential with the intensity of up to minus 175 mv. The anomaly 100-120 m wide and some 450 m long is confined to hydrothermally-altered limestones. Here found are ancient minings, too.

In the future, carrying out of spontaneous potential survey over the Darrah-i-Nur ore field area seems expedient as a prospecting method for mineral occurrences.

In conclusion it must be said that the geophysical investigations carried out over the Darrah-i-Nur ore field have resulted in ascertaining of magnetic anomalies, anomalies of an apparent polarization, zones of low resistivity, and of an anomaly of spontaneous potential. The magnetic anomalies are caused by " blind " bodies of magnetitic skarns of different size and morphology. The anomalies of Sp, a zone of low resistivity, and the anomaly of spontaneous potential, outlined in proximity to the known mineral occurrences, point to the presence in the depth of sulphide mineralization zones. These zones seem to be of different morphology and size, too.

The geological observations, metallometric sampling and the driven minings add the

the information helpful for the geophysical anomalies interpretation.

To give the most complete evaluation of the Darrah-i-Nur ore field prospects there should be continued geophysical investigations with the help of Spontaneous Polarization and Spontaneous Potential methods.

III. THE QALA-I-ASAD ORE FIELD

The Qala-i-Asad ore field is located in 57-60 km NNW of Kandahar town (the north-western part of the 424-P-III map sheet) and joins, in the north-west, with the Darrah-i-Nur ore field (Fig. 1).

The area of the ore field under consideration is governed by diorites and granodiorites of the first phase of the Arghandab Oligocene complex, the diorites and granodiorites being traversed by dikes of aplites, diabases, and porphyrites. In the granodiorites massif, as roof pendants occur the Alamghar suite (T_3 am) limestones that are, nearly elsewhere, have been altered to form marblized limestones and marbles. The roof pendats are of irregular shape and are oriented in the submeridional direction. Widespread over the area are Quaternary deposits.

The sedimentary-metamorphic rocks are strongly dislocated and folded into brachy-folds of NW-SE strike, the dip angles at the limbs being from 10-20 to 50-60°. The folds are complicated by NW-strike faults; north-eastern faults are less common there.

Confined to a contact of the marbles and diorites and granodiorites are numerous lenses of garnetiferous, pyroxenic, vesuvianic, epidotic skarns that are up to 5-8 m thick and up to 300-400 m long. In the skarns, the ore mineralization is represented by magnetite, galena, sphalerite, and malachite. The characteristic feature of the field is the confinement of the ore mineralization of industrial importance not to the skarns occurring directly at the contact of the igneous and sedimentary rocks, but to the tectonic zones, to deformational traps in carbonaceous rocks, and to a zone of the intrusive exocontact.

Within the Qala-i-Asad ore field located is polymetallic deposit of Bibi-Ghaukhar studied with the help of boreholes down to the depth of 80-100 m (D.Lemmon, 1950). Besides, within the field discovered are several mineral occurrences of polymetals (Khusanov R.M., 1967).

A favourable geological environment, a wide spreading of ore-bearing skarns and a considerable spreading there of Quaternary deposits, making difficult ascertaining the prospects of the ore field, have caused an organization there of prospecting geophysical investigations on 1:50,000 - 1:10,000 scale.

The main task of the geophysical investigations, similarly as within the Darrah-i-Nur ore field, was outlining within the field of areas promising for minerals. Besides,

the crew was facing a special task, viz., evaluation of the prospects of the area of the Bibi-Ghaukhar mineral deposit.

The task of the geophysical investigations was solved with the help of complex of methods, including magnetic prospecting, Induced Polarization, Electrical Profiling, and Charge Method.

The investigations were being carried out over the area of 84 sq.km in duration of two seasons: beginning from 15 May through July 10, 1973, and beginning from the middle of December through March, 1974.

The volumes of the fulfilled investigations are presented in the Table 8.

1. M a g n e t i c p r o s p e c t i n g on 1:50,000 scale is carried out over the area of 84 sq. km by 22 profiles, 8 km long each, over a grid of 500 x 50 m. The investigations on 1:10,000 scale have been implemented over an area of 19 sq.km by 48 profiles that are from 2.5 to 6.0 km long, over a grid of 100 x 25-10 m. Within the two areas the profiles were oriented in latitudinal direction.

A mean square error of the measurements amounted to $\pm$ 17.5 gammas and $\pm$ 13.9 gammas for the survey results on 1:50,000 and 1:10,000 scale respectively.

The magnetic prospecting were accompanied by magnetic susceptibility of the rocks measurements.

The processing of the measurement results and their interpretation were carried out analogous to those for the Darrah-i-Nur ore field (Section II).

The magnetic prospecting results are given in the Annexes Nos. 9, 10, 11, 12, 15.

The northern and western parts of the surveyed area (profiles Nos. 20-90 and from the profile No.100 to the profile No.200, points Nos. 100-350) are characterized by the alternating of the areas of moderate negative magnetic field with the intensity of 60-100 gammas with the sections of different-sign field of ΔZ, the value of which unevenly changes within the limits of from - 200 to + 460 gammas. Here observed are isolated narrow positive and negative anomalies of ΔZ with the intensity of plus 500-1500 gammas and minus 500-900 gammas. Within the south-eastern part of the surveyed area (from the profile No.140, points Nos.500-700, to the profile No.230, points Nos. 350-550) outlined is a profound anomaly of ΔZ of an elongated shape with the intensity of from 3500-4000 gammas, the anomalous area being about 4.5 km long. The anomalous area strikes from the north-east to the south-west (Annex 10). The character of the anomalous ΔZ field gradually changes from a clear in the south-west (the profiles Nos. 210-190) to a sharply changeable, in the north (the profiles Nos.170-140) with the extream values of up to - 1200 gammas and + 2900 gammas. Within the northern and central parts of the anomalous area, the profiles Nos. 150-180, the appearence of the ΔZ graphs, less the anomalous values, corresponds to the ΔZ field over a vertical

a vertical contact of the rocks with different magnetism or over a downthrust. The most magnetic rocks (or an uplifted block) are located east of the contact, the dominant strike of which is from SE to NE. Here it should be noted that the ascertained ΔZ anomaly is confined to a zone of contact.

Over the anomalous zone (the profiles Nos. 140-230) carried out are detailed magnetic prospecting investigations on 1:10,000 scale with the aim of obtaining additional data.

The data on the detailed survey, given in the annexes Nos. 11 and 12, let, firstly, more fully characterize the anomalous magnetic field for which several magnetic perturbation bodies are responsible (Annex 12) and determine the approximate dimentions and shape of these bodies (Annex 15), and, secondly, to more precicely ascertain the area of the alternating ΔZ field, found within the anomalous zone (Annex 12). These data, besides, let obtaining the more obvious information (the ΔZ graphs over the profiles Nos. 142-170, Annex 11) pointing to the fact that the background of the outlined ΔZ anomaly appears the ΔZ field over a vertical contact or a fault scarp.

To clear out the nature of the magnetic anomaly made use were the results of magnetic susceptibility of the rocks measurement (Fig. 3, Table 9).

According to the data of magnetic susceptibility measurement, the limestones, quarzites, skarns, and skarned rocks appear to be slightly magnetic ($\varkappa = 0-300 \times 10^6$ units of CGSM). The mineralized and ferruginized limestones, granites, granite-aplites, diorites and granodiorites mostly are also slightly-magnetic. But among the latters varieties of the rocks there are also medium-magnetic($\varkappa = 300 \times 10^6 - 3000 \times 10^6$ units of CGSM varieties. The medium-magnetic are mostly sandstones, though some of them also appear to be slightly-magnetic. A magnetic susceptibility of the hematitized limestones varies between very wide limits. The majority of the hematitized limestones is slightly-magnetic Also present are medium-magnetic and magnetic varieties ($\varkappa = 3000 \times 10^6 - 2000 \times 10^6$ units of CGSM), and even strongly magnetic hematitized limestones ($\varkappa = 20000 \times 10^6 - 40\,000 \times 10^6$ and more units of CGSM). The magnetitic ores which to occur within the area under consideration as lenses and veins appear to be strongly magnetic.

Thus, the results of magnetis susceptibility of the rocks measurement do not allow for certain ascertaining the sources of the anomalies. The ascertained ΔZ anomaly may be both caused by bodies of magnetitic ores and by strongly magnetic hematitized limestones. It is not excluded also that for the anomaly responsible are bodies of magnetitic skarns occurring in strongly-magnetic hematitized limestones.

The area of alternating magnetic field is interpreted as that with sections made up of more strongly magnetic rocks located inside those made up of less magnetic rocks, the more magnetic rocks to occur in a shallow depth, or even on the day surface (Table 9, (Fig.3).

Ser. Nos.	Kinds of investigations	Unit of measure	Total	Includ. in 1974	F
1.	Magnetic prospecting	l.km	344	163	1
		observ. point	11 946	8 100	
2.	Magnetic susceptibility of rocks measurement	obs.points	63	-	
3.	Electrical prospecting:				
	a) Induced Polarization	l.km	15	15	1
		obs. points	940	940	
	b) VES-IP	obs.points	2	2	-
	c) Median gradients profiling	l.km	12	12	1
		obs.points	500	500	
	d) Charge method	l.km	15	15	2
		obs. points	1540	1540	
4.	Laying-out of an observation grid	l.km	343	162	1

Total instrument-shifts - 326

Table 8

u l f i l m e n t							
I n c l u d i n g							
ck observations			Percent of check observations		Number of instrument-shifts		
AL	1973	1974	1973	1974	TOTAL	1973	1974
3	90	283	2.3	3.5	128	47	81
	-	-	-	-	4	4	-
	-	101	-	10.7	21	-	21
	-	-	-	-	2	-	2
	-	140	-	28	6	-	6
	-	221	-	27	12	-	12
	-	-	-	-	153	73	79

The determination of the parameters (an apparent thickness and depth of the upper margin of the body occurrence) of the largest magnetic perturbation body was obtained with the help of quantitative calculations by the ΔZ graphs along the profiles No. 1 (the profile layed out across the anomaly's strike) and No. 198. The results of the quantitative calculations have been summarized in the Table 10.

Table 10

Calculation methods	Depth of the body's upper margin occurrence (H), m		Thickness of the body in metres	
	Profile 1	Profile 198	Profile 1	Profile 198
1. Tangent method with coefficients of V.K.Pyatnitskiy	77	84	220	164
2. With the help of Yu.P. Tafeev pallets	-	50	-	200
3. By characteristic points (bed's thickness formulae)	136	40	112	210
4. By the method of B.A.Andreev	100	-	175	-
5. By inverse tangent curves	95	-	260	-
6. Reculculation for the depth with the help of pallets after V.N.Strakhov	165	-	238	-
Average	100	50	200	190

The obtained calculation data point to a tabular shape of the magnetic perturbation body; the apparent thickness of the body is about 200 m. The depth of the body's upper margin occurrence is different: along the profile No.1 it amounts to some 110 - 120 m, that in proximity to the No.198 profile amounts to some 60 m.

The quantitative calculations also were performed to estimate the depth of occurrence of the eastern upthrusted block (or of magnetic rocks block) and its thickness. The latter calculations proceeded from the ΔZ graphs obtained for the profiles Nos. 170 and 200. It has been ascertained that the depth of the mentioned above block occurrence amounts to 1000-1200 m, the thickness being some 100 m.

Thus, the main result of the magnetic prospecting carried out over the Qala-i-Asad ore field is the ascertained large anomaly for which responsible are several magnetic-perturbation bodies of different dimentions and shape, the largest of which has an apparent thickness of the order of 200 m and occurs in the depth of some 60-110 m . The

T a b l e 9

susceptibility of rocks ($\varkappa \times 10^6$ units of CGSM)	300 – 700	700 – 1500	1500–3000	3000–7000	7000–12000	12000–20000	20000–40000	>40000
	–	–	–	–	–	–	–	–
	18/18%	4/4%	–	–	–	–	–	–
	6/3%	4/2%	4/6%	12/10%	18/3%	6/9%	16/9%	2/1%
	6/15%	18/57%	–	–	–	–	–	–
	–	–	–	–	–	–	–	–
	–	–	–	–	–	–	–	–
	5/8%	1/1%	–	–	–	–	–	–
	7/12%	1/2%	–	–	–	–	–	–
	–	–	–	–	–	–	22/85%	4/15%
	Medium magnetic			Magnetic			Strongly magnetic	

Ser. Nos.	R o c k s	Number of measur.	Average $\varkappa$ x 10^6 units of CGSM	Magnetic 0 - 100	Magnetic 100 - 30
1.	Limestones, marbled limestones, marbles	147	7	147/100%	-
2.	Limestones mineralized, ferruginized	99	-	59/60%	18/18%
3.	Limestones hematitized	180	-	94/55%	16/9%
4.	Sandstones	32	-	4/12%	4/12%
5.	Quartzites	53	37	49/92%	4/8%
6.	Skarns and skarned rocks	26	47	26/100%	-
7.	Granites, granite-aplites	65	-	42/65%	17/26%
8.	Diorites, grano-diorites	54	-	33/61%	13/24%
9.	Lenses of magnetite	26	4 0000	-	-
				Slightly magnetic	

area of magnetic perturbation bodies concentration is confined to a zone of major fault or to a vertical contact of rocks possessing different magnetism. The nature of the anomaly remains to be unknown.

2. Electrical prospecting.

a) Induced polarization method (I P) . Ip profiling has been implemented over the area of the ascertained magnetic anomaly with the aim of discovering zones of sulphide mineralization. The survey on 1:50,000 scale has been carried out over an area of 5.3 sq.km along 6 profiles*) (the profiles are the same as for the magnetic prospecting, being from 0.9 to 2.9 km long each, making up the grid of 500 x 20 m). The distance between the feeding earthings amounted to 3 km what let surveying three profiles under the same position of the AB line, viz., the central profile, 2.9 km long, and two lateral profiles, 2 km long each. The measurements were implemented after the gradient settled up, viz., similarly as over the Darrah-i-Nur ore field. Charging was performed by different-polar pulses of current with the intensity of from 3 to 7 am; the charge time amounted to 10 sec. The ΔU_{IP} value was measured over 0.5 sec, after switching off the polarizing current. The observations registration was performed with the help of oscillograph with photoregistration of the values.

The number of check observation points amounted to 101 what makes 10.7% of the total number of the observation points. The mean arithmetic spread for an apparent polarization amounted to 6.1%, that for an apparent resistivity - 3.9%, being, therefore, within the limits of admissible.

The obtained data suggest (Annex 13) that there are no considerable anomalies of an apparent polarization over the surveyed area. There ascertained are three inconsiderable anomalies of η_k . Over the profile No. 130, points Nos. 482-487, there stands out an anomaly of apparent polarization with the value of 4.9% against a background of 1.5-2%. The anomaly is accompanied by a decrease of apparent resistivity from 1500-3000 ohms to 300 ohms. As this anomaly lies within the area of moderate magnetic field, one may assume that it is caused by the presence of sulphide mineralization there. The second analogous anomaly of an apparent polarization has been ascertained over the profile No. 140 (points Nos.383-386), the η_k values being from 2-2.5% to 4.9 %. Similarly as in the first case, by the anomaly responsible seems an impregnation of sulphides, as here, too, the ρ_k values decrease for more than two times. Over the profile No. 150 observed

*) Due to a number of reasons, including technical ones, the IP investigations were not carried out over the whole area of the magnetic anomaly.

are " pulses " of an apparent polarization with the intensity of up to 3.5% against a background of 2-2.5% (the points Nos. 400-470). The values of apparent resistivity are decreased there from 1000-1100 ohms to 400-450 ohms. The presence here of small magnetic anomalies suggests that the third anomaly of an apparent polarization is caused by comparatively small accumulations of conductive, and at the same time, magnetic minerals.

The carried out IP investigations have resulted in ascertaining of a zone of apparent resistivity, the zone being characterized by the ρk values of from 10 to 50 ohms, against a background of 500-1000 ohms , the anomaly being located at the eastern flank of the surveyed area (profiles Nos. 160, 170, 180).

Further description of the low resistivity zone follows below.

b) Profiling by the method of median gradients was carrying out with the aim of tracing over of the above-mentioned zone of low apparent resistivity within the southern section of the surveyed area. The instruments and methods of the measurements are same as for the IP profiling. The observation profiles are same as for magnetic prospecting, being from 2 to 4 km long. The number of check points totals 140, viz., 28% of the total observation points. The accuracy of the measurements is 4%, i.e. better than the admissible.

According to the data of median gradients profiling, the values of apparent resistivity over the surveyed area moderately decrease in the direction from the north to the south from 1000-2000 ohms to 100 ohms (Annex 14). Against this background clearly stands out a zone of low resistivity characterized by ρk values of from 10-50 ohms in the north to 2-3 ohms, in the south (viz., the zone being ascertained by the decrease of the resistivity values by 30-50 times). Within the area under consideration, the zone mentioned above shows the dominant NNE strike, being traced from the profile No. 160 south for a distance exceeding 3 kms. Despite the saw-like appearance of the ρk curves, for which an electrical heterogeneity both of the rocks enclosing the zone of low resistivity, and the rocks of the zone itself, is responsible, one may assume that the western contact of the zone is steep, close to a vertical. It is interesting to note, too, that in a plan the western contact of the zone of low resistivity coincides with the eastern boundary of the anomalous area of magnetic field (Annex 15).

The location of the low resistivity zone very close to the magnetic field anomaly, and the character of apparent resistivity change over the surveyed area as a whole for certain suggest a specific geological environment of the area under consideration. However, at the present time we have no all the necessary data which could help understand the peculiarities of the area constitution.

c) Vertical Electrical Sounding (VES) was carried out to obtain additional information on a large magnetic perturbation body (VES-IP No.1), and on a zone of low resistivity (VES - IP No.2). The investigations were being carried out with the help of IP instruments making use of symmetrical vertical sounding method. The interpretation of the sounding results was performed only by the curves of apparent resistivity, making use of the VNII Geophysics pallets with the subsequent plotting of ρk curves after the obtained data.

The point VES - IP No.1 was situated over the above-mentioned magnetic perturbation body, at the point 495 of the profile 1. The maximum electrodes spread amounted 1500 m. The azimuth of the electrodes spacing amounted 25-205°, viz., the observation was carried out across the body's strike. The obtained ηk, ρk curves of the VES - Ip No.1 are presented on Fig. 4.

The curves of an apparent polarization show that the ηk values change with the depth from 0.66% to 1.0%, being, therefore, within the limits of background magnitudes. The results of the interpretation of the four-layer curve of apparent resistivity of ρk type are presented in the Table 11.

Table 11

Parameters of the bed	Nos. of beds			
	1	2	3	4
ρ Ohms	210	11	67	1.5
h,(m)	4	5	216	-

As the Table data imply, the stratum, where a large magnetic perturbation body occurs, is characterized by by low enough resistivity values, of the order of 70 ohms. The thickness of the stratum is quite a great, viz., over200 metres. Under the stratum, down to the depth o f some 225 m there occurs a patch of rocks with very low ressistivity (some 2 ohms) characteristic of conductive units.

The VES-IP No.2 point is located at the point 600 of the profile No. 210 and lies within a zone of low resistivity. The feeding electrodes spacing there was arranged along the supposed strike of the zone (the spacing azimuth being 15-195°). The maximum AB line spacing amounted 3000 m. The results of the VES - IP No.2 investigations are presented in the Fig. 5 .

The character of the apparent polarization curves behaviour implies that the ηk

value rises comparatively smoothly with the depth from 0.6 to 2.1% and does not exceed the background values.

The apparent resistivity curve is of HKQ type, characterizing five-layer stratum. The interpretation data are presented by the Table 12.

Table 12

Parameters of a layer	Numbers of layers				
	1	2	3	4	5
ρ ohms	55	30	100	24	12.5
h, metres	3	4	22	60	-

The obtained data suggest that the low resistivities zone's constitution is heterogeneous; the most conductive formations (ρ = 12.5 ohms) to begin with the depth of some 90 metres.

The plotted apparent resistivity curves by the data of the interpretation almost completely coinside with the registered in the field ρ_k curves of VES-IP No.1 and No.2. Despite this fact, the figures given in the Table 12 and 11(should be carefully regarded with as the interpretation data appear to be rightful for horizontally-bedded environment only. In the case under consideration one hardly can expect horizontally occurring beds and the error of the depth determination for certain layers may appear to be very great. Nevertheless, the results of VES-IP Nos. 1 and 2, as a whole, give some idea on the complex geological constitution of the areas under consideration.

The above-said results of the electrical prospecting have shown that within the southern part of the Qala-i-Asad ore field there are no zones of sulphide mineralization. The ascertained zone of low resistivities reflects the peculiarities of the area's geological constitution.

The Bibi-Ghaukhar deposit

The polymetallic deposit of Bibi-Ghaukhar is located im the middle part of the Qala-i-Asad ore field. Within the deposit's area, where a number of massive ore orebodies crop out, carried out are detailed geophysical investigations on 1:10,000 scale. A complex of geophysical investigations includes magnetic prospecting, electrical profiling of IP method, and charge method.

The aim of the above-said methods was contouring of the mentioned-above area and outlining of the " blind " ore bodies.

The area of the detailed geophysical investigations, covering 0.38 sq.km, lies between the profiles Nos. 130 and 140 over which the survey on 1:50,000 scale was carried out. The observation profiles were of latitudinal direction, from 0.5 to 0.9 km long, and were common for the all kinds of investigations. The distance between the profiles changed mainly from 50 to 100 metres. Only within the central part of the area, where the above-mentioned ore body occurs, the profiles were located in the distance of from 13 to 37 metres one from another. The observation space along the profiles amounted to: for the magnetic prospecting - from 5 to 12.5 metres, for the electrical prospecting - 20 metres, for the charge method observations - 10 metres.

C h a r g e m e t h o d. The observations were carried out with the help of potential method and gradient potential method, made use of the ERS-50 instrument. The observations were carried out along 8 profiles of latitudinal direction and along 2 profiles arranged perpendicularly to the formers eight, running in proximity to the charge spot (the observation points No.460,(profile No.1, and 470, profile No. 2). The profiles were 0.5 km long each. The feeding earthings were located at a spot of massive ores outcrop (the profiles Nos. 135, 74; point No. 460.5). The second feeding earthing ("earthing at infinity") was located 1800 m off the first. The charge current was 300 mam and 1 mam. An average relative difference of the potential method observations amounted 7%.

Plotted by the results of the observations are graphs of potential and potential gradient (Annex 16), and a map of potential isolines (Annex 17).

On the map of isolines one can see that the isolines outline mostly is close to a circuit, thus corresponding to a field of point earthing . Next to the earthing point only the potential isolines appear to be of an elongated shape, thus suggesting small dimensions of the ore body. The potential graphs suggest that considerable values of the potential (from 5 to 17 mv) are characteristic only for the profiles Nos. 135, 74, 136, I and II, i.e.,located off the charge spot for not more than 36 metres. Worth mentioning is the specific character of the curves change along the above-mentioned profiles:against a moderate character of the curve at its extremal portion observed is a splash. One may assume that this splash on the potential graphs is caused by the most conductive part of an ore body surrounded by less conductive ore. Besides, the potential graphs show an asymmetry of their left and right branches steepness, thus suggesting an inclined occurrence of an ore body.

According to charge method investigation data, the ore body under consideration is some 30 m long and about 5 m thick, having a moderate dip towards the southeast.

On the potential isolines map, in its northern (profile II) and western parts (profile 135, point 452) observed are bendings of the potential isolines, suggesting the presence of heightened conductivity zones there, which have no electrical connection with

the above ore body.

The magnetic prospecting has not revealed any essential features of the area's geological constitution. The ascertained magnetic field there appears to be moderate, negative with smooth change of the ΔZ value from minus 80 to minus 550 gammas. At individual points observed is smooth, too, increase of the intensity from + 30 -100 gammas. Against this background observed are two small magnetic anomalies (profile No.136, observation points Nos. 430-445, and profile No. 138, observation points Nos. 468-476), being characterized by unusual change of the intensity from plus 700-750 gammas to minus 650-800 gammas (Fig.6). For these anomalies responsible seem inconsiderable accumulations of magnetic minerals. The ΔZ field observed over the ore body appears to be even, negative.

Electrical profiling by the IP method was carried out by the technique of median gradients. The whole area has been surveyed under the location of the feeding earthings on the profile No.140, the AB line to equal to 3000 metres. In other respects, the methods of the observations was similar to that of the above described observations.

The carried out observations have resulted in obtaining, over a number of profiles, of anomalies of an apparent polarization, accompanied by diminishing of the values of apparent resistivities (Fig. 7).

P r o f i l e No.130. An anomaly η_k with the intensity of up to 4.9%, against a background of 1.5-2.0%%, has been ascertained in proximity to the observation points Nos. 482-487. The ρ_k value here diminishes by 5-10 times (from 1500-3000 to 300 ohms).

P r o f i l e No. 135. At a section of the observation points Nos. 450-466 outlined is an anomaly of an apparent polarization with the intensity of 3.5%, against a background of 2%, the anomaly being accompanied by the diminishing of apparent resistivities from 1500-3000 to 700-800 ohms.

P r o f i l e No. 135.74 . Outlined over the ore body (points Nos. 465-472) is an anomaly η_k characterized by the increase of an apparent polarization from 3.5 to 4.5% against a background of 1.5-2.5 %%. Within the anomaly, the ρ_k values decrease from 1500-1700 ohms to 500-700 ohms.

Under the location of a one of feeding groundings directly in the ore body the curves show natural maximums of η_k on both sides of the feeding electrode. The highest values of η_k at the points of the maximums (2-2.5%%) and close location of the extremums to the earthing point suggest a shallow depth of the unit occurrence.

P r o f i l e 136 . An anomaly of an apparent polarization with the intensity of up to 3%, against a background of 2%, has been outlined in the section of Nos. 456-462 profiles. The apparent resistivities there diminish from 1500-2000 to 500-1000 ohms.

P r o f i l e 140 . Over the area of detailed survey observed an anomaly of apparent polarization (observation points Nos. 442-462) with the intensity of 3.5-4.5%, against a background of some 2%. At individual points registered is the decrease of ρ_k values by not more than 2 times.

Thus, the detailed geophysical investigations carried out over the Bibi-Gheukhar area have resulted in ascertaining several inconsiderable anomalies of apparent polarization; within the limits of the anomalies ascertained is diminishing of apparent resistivity values. These facts suggest the presence here of isolated and small nests of comparatively scarce sulphide impregnation or other conductive, and at the same time, magnetic, minerals as the above-described anomalies are characterized by low values of η_k standing against quite a high background, and in the number of cases coinside with small anomalies of ΔZ. The data of profiling IP and the charge method data suggest that, firstly, a lens of massive area (30 x 5 m large) occurs in a " shirt " of the mentioned-above sulphide mineralization, and secondly, the zones of heightened conductivity, ascertained tentatively with the help of charge method investigations, also are caused by the present in the depth of small accumulations of conductive minerals. Therefore, within the area under report there could occur and discovered small ore bodies similar to the ore body under description.

Within the Qalai-Asad ore field, as a whole, the geophysical investigations have resulted in discovering a large anomaly of magnetic origin, and a zone of low resistivity possessing a considerable extent.

The ΔZ anomaly, for which several magnetic perturbation ore bodies, different in size and shape and occurring in the depth of from 60 to 100 metres are responsible, stands against a background of either a major fault, or of a contact of some strata. The zone of low resistivities stands against a background of natural change of apparent resistivities ascertained in the southern part of the ore field under description. A close relationship of the above-mentioned anomalous areas undoubtedly suggests specific phenomena of the Qalai-Asad ore field's southern part. The above data altogether suggest to a necessity of drilling work over the area under description, aimed at ascertaining the nature of the anomalies. Over the area should be drilled at least two boreholes down to the depth of 200-300 m each. The recommended spots of the boreholes drilling are in the profile No. 208, observation point No.508 (the borehole should be drilled down to the depth of 300 m), and in the profile No. 210, observation point No.587 (the borehole is to be drilled down to the depth of some 200 m), Annex 15.

IV. THE ZARKASHAN*) ORE FIELD

In the geological respect, the ore field under consideration is made up of the Alamghar suite (T_3 am) carbonaceous deposits, of the Gulyakhel suite (K_{1-2} gh) carbonate-terrigenous formations, and of intrusive rocks, too.

Within the ore field under consideration the most old are the Alamghar suite rocks that are represented by grey-coloured massive limestones, over some areas being marbleizated and dolomitized. The Alamghar suite rocks are characterized by a high facies persistence over the whole area of their spreading.

The Alamghar suite's rocks are overlain, without an apparent unconformity, and with conglomerates at the basement, by carbonate-terrigenous formations of the Gulyakhel suite. The Gulyakhel suite is made up of quartzous and calcareous sandstones, bituminous and organogene-detrital limestones which irregularly interbed one with another and carry lenses and interbeds of quartzous gritstones and conglomerates. Characteristic of the suite's rocks are quite a sharp facies changeability, moderate occurrence (10-15°), the presence of numerous moderately-occurring dykes of graniteids, a profound hornfelsnization in proximity to the Zarkashan intrusive.

The Zarkashan intrusive appears to be of complex composition, being made up of two phases rocks: 1) gabbro-diorites and granodiorites; 2) leucocratic granites, adamellites, granodiorites, granosyenites, monzonites. The rocks of the two phases are cut through by dykes of aplites, granite-aplites, granodiorite-porphyries, syenite-porphyries, diorite-porphyries, diabasic porphyrites. The dykes are 0.5-15.0 m thick and 100-1000 m long. The contacts of the intrusive with the country rocks are usually curved, steep. At the exocontact of the intrusive observed are numerous apophyses, and dykes of graniteids.

The exocontact alterations of the country rocks are pronounced in hornfelsnization, serpentinization, dolomitization, marbleization of the limestones. At the contact with the carbonaceous rocks developed are calcareous and magnesial skarns, with which associated is gold-polymetallic mineralization.

In the structural respect, the Zarkashan ore filed lies within the Arghandab structural-facies zone of Early Alpine folding. Widely spread here are folds and faults of northeastern, northwestern and sublatitudinal strike.

From 1966 through 1973, within the ore field carried out are prospecting-surveying, revisory-estimation and exploration, resulting in discovery of a number of mineral occur-

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*) In a number of works this field is reffered to as the Nagur ore field.

rences of tin (Syahghar, Maghn, Karezta), polymetals (Mirzaka, Basharghar), and gold (Zarkashan, Dinamite, Baba-i-Kushtah). The all above mineral occurrences have been in details studied by new (12, 13).

The geophysical investigations carried out in 1973 over the Zarkashan ore field, firstly appeared to represent the continuation of the 1972 investigations, carried out over the Syahghar and Maghn stanniferous mineral occurrences, and were aimed at evaluation of these areas prospects in the depth. Consequently, these geophysical investigations turned to be complex geologo-geophysical areal investigations on 1:50,000-1:25,000 scale, aimed at a discovery and contouring of areas promising for minerals.

A complex of geologo-geophysical investigations included magnetic prospecting, accompanied by magnetic susceptibility of the rocks measurements, electrical prospecting (VES profiling), metallometric sampling, geological prospecting routes, and mining, accompanied by channel sampling.

The fulfilled volumes of the investigations are presented in the Table 13.

Table 13

Ser. Nos.	Kinds of investigations	Unit of measure	Fulfilment: Total	Including: check observ.	% of check observations	Amount of instr/sh.
1	2	3	4	5	6	7
1.	Magnetic prospecting	1.km / obs.point	60 / 1206	40	3.3	18
2.	Magnetic susceptibility of rocks measurements	obs.points	145	-	-	5
3.	Electrical prospecting:					
	a) IP method profiling	1.km / obs.points	74.5 / 4492	677	16	86
	b) VES-IP	obs.points	3	-	-	3
4.	Metallometric sampling	sample	925	-	-	-
5.	Geological prospecting routes	1.km	50	-	-	-
6.	Trenching	cu m.	154	-	-	-
7.	Channel and dotted-channel sampling	sample	147	-	-	-
8.	Laying-out of obs.grid	1.km	101	-	-	-
	Total instrument shifts					112

1. M a g n e t i c p r o s p e c t i n g is carried out over the field aimed at ascertaining the peculiarities of the field's geological constitution. The area covered by the survey amounts to 28 sq.kms. ΔZ measurements have been performed over 15 profiles, 4 km long each. The profiles azimuth is 120-300°. The observation grid is 500 x x 50 metres.

The mean square error of the observations amounted to $\pm$ 8.5 gammas. The density of the observation grid and the obtained accuracy of the observations correspond to the conditions of a survey of high accuracy of a scale of 1:50,000.

The magnetic prospecting was accompanied by magnetic susceptibility of the rocks measurements.

The processing of the ΔZ results consisted in introducing of corrections for a magnetic field variation and for a zero creep of a magnetometer. Plotted by the corrected values of ΔZ are plan-graphs of ΔZ. Also compiled is a map of ΔZ isolines (Annexes Nos. 18 and 19).

The interpretation of magnetic prospecting data consisted in determining of magnetic anomalies contours. The interpretation data are reflected in a map of geologo-geophysical results (Annex 22).

The ΔZ field of the area under consideration, for the exception of its north-eastern corner, appears to be very smooth, moderately changing both from the north to the south and from the east to the west from minus 100-150 gammas to plus 100-150 gammas, showing rare positive and negative " spikes" of ΔZ graphs reaching the values of from plus 190-210 gammas to minus 200-300 gammas.

Against this background stand out two anomalous zones of ΔZ values.

The first zone, being elongated from the profile No.20 (observation points Nos.360-500) to the profile No.35 (observation points Nos. 460-500) is characterized by mainly changeable magnetic field, the intensity of the field to vary sharply from one observation point to another within the limits of plus 2500 to minus 3100 gammas.

The second zone consists of two clear positive ΔZ anomalies with the values of + 850 and 750 gammas, the zone being outlined over the observation points Nos. 325-355 and Nos. 425-440 of the profile No.30.

The two anomalous ΔZ zones are caused by the presence of diorite-made stocks and by the located next to them (lenses of magnetite and skarns with magnetite, as the results of magnetic susceptibility of the rocks measurements show that the mentioned rocks are most magnetic among the rest rocks cropping out within the region under report (Fig.8, Table 14).

In conclusion it should be said that the magnetic prospecting has not provided with new

data on the geological constitution of the surveyed area.

2. E l e c t r i c a l p r o s p e c t i n g .

a) Induced polarization profiling on 1:25,000 scale was carrying out with the aim of discovering and contouring sulphide mineralization zones promising for mineral deposits. Detailed investigations on 1:10,000 scale were aimed at estimation of the prospects of the mineralization in the depth (the Syahghar and Maghm tin occurrences).

The observations on 1:25,000 scale has been carried out over an area of 15.5 sq.km along 19 profiles that were from 0.8 to 4.9 km long. The profiles were azimuthed at 120-300°, and 15-195°. The observation grid was 200-300 x 20 m thick.

The detailed investigations area amounted in total to 1.53 sq.km (the Syahghar area - 1.2 sq.km, the Maghm area - 0.33 sq.km). Over the Syahghar area investigated are 10 profiles of a close to meridional strike, each being from 1.0 to 2.6 km long. Over the Maghm area, the observations were performed along 4 profiles that were from 0.8 to 1.3 km long. Within the areas of the detailed observations the observation grid was 100 x 20 m thick.

Over the whole area of the electrical prospecting investigations the spacing of the feeding electrodes (A B) amounted to 3 km, what allowed, firstly, the carry out the all measurements over the all profiles of the Maghm area without a change of the feeding electrodes position, and secondly, to work out the Syahghar area under two only positions of the current A B line. Such an arrangement of the electrodes, thirdly, allowed carrying out observations over three profiles remoted one off the other for 500 m , viz., over the central, up to 2.9 km long, and two lateral, up to 2.0 km long each. The magnitude of the earthing resistivity changed between 80 and 200 ohms.

The observations were carrying out with the help of a gradient set up. The charging was performed by different-polar current pulses, with the current intensity of from 3 to 5 amp; the duration of the charging amounted to 10 sec. The ΔU_{IP} value was recorded 0.5 sec after a switching off of the polarizing current. The observations record was oscillographic, with photoregistration.

The accuracy of the measurements (a mean arithmetic spread) amounted to : for the apparent polarization - 6%; for the apparent resistivity - 2.4%. The observations results for the Zarkushan ore field are presented in the Annexes Nos. 20, 21, 22, and in Figs. 9, 10, 11.

The I P profiling has resulted in outlining of a large area of apparent polarization anomalies covering a considerable part of the electrical profiling area. The area comprises several anomalies of apparent polarization, differing one from another for their dimentions and intensity. For a more convenient consideration we have called the areas as " Central", Northwestern", " Northern ", "Northeastern", and " Southwes-

Ser. Nos.	R o c k s	Number of observ.	$\varkappa$ Average x x 10^6 units of CGSM	Mag 0-100	100-1
1.	Limestones; limestones hematitized, marbled, arenaceous and brecciated	437	0.7	437 / 100%	
2.	Conglomerates, ferruginized conglomerates	118	1.5	118 / 100%	
3.	Oritstones	75	0.0	75 / 100%	
4.	Sandstones; sandstones hematitized and carbonatized	214	1.4	214 / 100%	
5.	Limestones and skarns with magnetite	24	–	2 / 8.5%	
6.	Hornfels	181	20	181 / 100%	–
7.	Quartzites, quartzous rocks	67	2.0	67 / 100%	–
8.	Skarns and skarned rocks	125	24	125 / 100%	–
9.	Diorites	73	3000	–	–
10.	Diorites finegrained (dykes)	58	151	23 / 40%	35 / 60%

Slightly magneti

T a b l e 14

...etic susceptibility $\varkappa \times 10^6$ units of CGSM						
...0	300-700	700-1500	1500-3000	3000-7000	7000-12000	12000 - 20 000
	-	-	-	-	-	-
	-	-	-	-	-	-
	-	-	-	-	-	-
	-	-	-	-	-	-
	5 / 21%	9 / 37%	4 / 17%	-	1 / 4%	3 / 12.5%
	-	-	-	-	-	-
	-	-	-	-	-	-
	-	-	-	-	-	-
	-	-	44 / 60%	29 / 40%	-	-
	-	-	-	-	-	-

Strongly magnetic M a g n e t i c

term", viz., following their arrangement inside the anomalous area. Besides, there are several local anomalies outlined beyond the contour of the anomalous area, but in a close proximity to the latter. One of the anomalies is confined to the Bashurghor polymetals occurrence.

The " Central " anomaly has been traced from the north-east towards the south-west, from the profile No. 65 up to that of No. 90 for a distance of more than 2.5 kms. The width of the anomalous area varies between 900 m and 2.0 kms. The anomaly being located within the Alanghar suite deposits spreading is characterized by a monotonous increase of an apparent polarization values from 0.6-1.0 ‰ to 2.5 -3.0‰, followed further along by monotonous, too, decrease of the values up to the background ones (0.6-1.0‰). The anomaly is complicated by isolated local anomalies with the intensity of up to 3.5-4.5‰; the anomalies involve small areas of the order of from 100 x 30 to 200 x 70 m.

The values of apparent resistivity over the whole " Central " anomaly generally are decreased up to 500-100 ohms, compared with non-anomalous areas where the ρ_k values vary from 2500-3000 ohms to 5000 -8000 ohms, in places even to 10 000 - 20 000 ohms. Minor η_k anomalies are accompanied by diminishing of ρ_k values from 200 to 500 ohms, in some places - up to 20-50 ohms.

The " North-western " anomaly is also localized within the Alanghar suite rocks, and by the character resembles the " Central " anomaly. For the anomaly characteristic is also moderate rise of the η_k curves (Annex 20) from 0.6 -1.0‰ to 2.5 - 3.0 ‰ with the subsequent their fall up to 0.6 - 1.0‰. Against this background stand out individual local anomalies with the intensity of from 3.5 to 8-10‰, accompanied by a decrease of apparent resistivity values from 2500-5000 ohms to 150-200 ohms. The minor (local)anomalies are from 80 x 40 to 170-180 x 70 m large. The " North-western anomaly as a whole occupies an area of some 800 x 300 metres. The anomaly has been traced from the profile No.55 up to that of No.63.

In the map of geologo-geophysical investigations results (Annex 22) the"Central" and " North-western" anomalies are shown by a vertical shading.

The " Northern " anomaly appears to be considerable by both the intensity of apparent polarization values and by the dimentions (the area occupied by the anomaly is some 3 sq.km), the anomaly being traced from the NE (profile No. 55, observation points Nos. 312-323) towards the SW (profile No. 76, observation points Nos. 362-384) for a distance of about 2.5 km, the width of the anomaly being from 2.1 km in the north to 800 m in the south.

The anomaly confined mainly to the Gulyakhel suite deposits is clearly enough seen in the η_k graphs (Annex 20) by a sharp increase of apparent polarization values from 5 to 10‰, against a background of from 0.6 to 2-3‰, being well correlated from

one profile to another. The η_k curves at their central part have a complex appearance: observed here is alternation of several (from 3 to 5-7 and even more) maximums (minor anomalies of apparent polarization) with the values of η_k from 16-18 to 22 - 27%. One may assume that such a shape of the η_k graphs is caused by a superposition of a series of local anomalies, for which responsible are formations occurring at a shallow depth, on a wide-scale regional anomaly, for which responsible is an abyssal unit. To this also point the structure of the " Northern " anomaly in a plan (Annex 21). A number of apparent polarization isolines form a moderate contour which to involve the whole area of the anomaly spreading, and to correspond a regional η_k anomaly. Inside this contour observed are " spots " of minor anomalies caused by shallow-occurring units. The minor anomalies are of small dimentions; the anomalies are traced over no more than 2-3 profiles. The correlation of the minor anomalies from one profile to another was carried out taking into account the character of the η_k and ρ_k curves.

Characteristic of the " Northern " anomaly, as a whole, are apparent resistivity values of from 1500 to 2500 ohms against a background ρ_k values of from 5000 to 8000 ohms (Annex 20). The minor anomalies in the majority of places are accompanied by diminishing of apparent resistivity values up to 100-300 ohms, and even to 20-60 ohms, against a background of 1500-2500 ohms.

The " Northeastern " anomaly is located 500 m east of the " Northern" anomaly and is characterized also by a high intensity of an apparent polarization; the " Northeastern " anomaly to occupy smaller area compared with that of the " Northern " anomaly. The " Northeastern " anomaly is distinguished for a very sharp rise of an apparent polarization values from 8-18% against a background of from 1 to 2.5-3.0%. Simultaneously with the apparent polarization increase observed also a sharp decrease of apparent resistivity values from 2500-5000 to 30-100 ohms. The anomaly under consideration has been traced from the north to the west, from the profile No.63 up to the profile No.70, being some 750 m long and some 300 m wide. Here it should be noted that the " Northeastern " anomaly is confined to a zone of contact between the Alanghar and Gulyakhel suites rocks.

The " S o u t h e a s t e r n " a n o m a l y in a plan mainly coincides with the area of Gulyakhel suite rocks spreading. The anomaly, similarly to the two above-described, is characterized by a sharp increase of η_k values up to 15-18%, being accompanied by diminishing of an apparent resistivity values from 3000-5000 ohms to 150 ohms.

Due to difficult for practicability conditions of the relief, the anomaly remains to be uncontoured and has been traced along two profiles only, viz., along the profiles

Nos. 85 and 90.

The above-described " Northern ", "Northeastern", and " Southeastern " anomalies are shown in the map of geologo-geophysical investigations by an oblique shading.

As it has been pointed out above, the IP investigations have resulted in discovery of several minor anomalies of apparent polarization located beyond the limits of the area dominated by anomalous values of η_k. Two of the anomalies are described below.

The " Bashorghor " anomaly is ascertained over the same by name polymetallic occurrence, the anomaly being from 130 to 220 m wide and over 500 m long (the profile No.120, observation points Nos. 255-277 - profile No.115, observation points Nos. 273-286).

The anomaly under description has been ascertained by an increase of apparent polarization from 0.5 to 4-4.5 % with simultaneous decrease of apparent resistivity values from 1500-2500 to 400-1000 ohms.

The second anomaly of apparent polarization has been ascertained over the profile No. 85, observation points Nos. 326-329. The anomaly is characterised by an increase of η_k values up to 5.5% against a background values of about 1%, the values of apparent resistivity over the section diminish from 10 000 ohms to 2-8 ohms. The measurements carried out over the profiles Nos. 84 and 86, located 100 m off the profile No. 85, have shown that here, too, the ρ_k values sharply decrease from 10 000 - 20 000 ohms to 600-1000 ohms. However, the η_k anomalies over the profiles Nos. 84 and 86 are absent. Here it should be noted that the magnetic prospecting over the profiles No.85 have resulted in ascertaining of two inconsiderable ΔZ anomalies with the intensity of some 100 gammas. These anomalies have been traced over the section of the profile limited by the observation points Nos. 312 and 325.

The detailed electrical prospecting carried out over the Sychghor and Maghm tin occurrences have not revealed any considerable concentrations of sulphides. Over the two areas the values of apparent polarization do not exceed 1.5%, these to correspond to a natural background of the areas (Annex 20, sheets VI and VII). The recorded in some places diminishing of the apparent resistivity values from 6000-12 000 ohms to 2000-3000 ohms (Sychghor area) and up to 200-1000 ohms (Maghm area) seems to have been caused by faults. However, next to the area of detailed geological exploration (Sychghor) ascertained is an anomaly of apparent polarization, viz., the " Northwestern " anomaly, described above.

In conclusion we shall dwell on the results of IP observations carried out over the profile No.85 which runs over the Zarkoshan deposit area (Annex 20). At a section of the observation points Nos. 588-636, i.e., over a zone of skarns carrying a sulphide mineralization, a number of minor anomalies of apparent polarization with the intensity of up to 3-5%, against a background of 1-1.5% have been ascertained. To the η_k anom-

lies confined is diminishing of the ρ_k values from 2500 to 300-350 ohms.

b) Vertical Electrical Sounding IP was carrying out with the aim of obtaining data on a deep structure of the " Northern " apparent polarization anomaly. The observations were performed with the help of VPS-63 station, making use of symmetrical vertical soundings method. The observation VES-IP points were located within the contour of the mentioned above anomaly. The A B line was oriented along the strike of the anomaly and along the slopes . The maximum length of the A B line amounted to 2000 metres.

The interpretation of the apparent resistivity VES-IP curves was carried out with the help of VNIIGeophysics pallets with the subsequent graphical plotting of ρ_k graphs. The interpretation of the apparent polarization curves of VES-IP was of a qualitative character due to the absence in the Geophysical crew of an album of theoretical pallets of η_k. The depth of the units occurrence responsible for the apparent polarization anomalies was determined by curves beds points characteristic of η_k VES-IP curves (Komarov V.N., et al., 1966, page 170). The point VES-IP No.1 is found over the observation point 330.5 of the profile No.63. The A B azimuth was 20°. The obtained η_k and ρ_k VES-IP No.1 curves are presented in Fig.9.

The apparent resistivity curve is of KHKN type characterizing a 6-layer stratum. The interpretation results are presented in the Table 15.

Table 15

Parameters of a layer	Numbers of layers					
	1	2	3	4	5	6
ρ, ohms	65	34	420	1280	1220	29 000
h, metres	3	2	25	90	110	-

The bend points of the apparent polarization curve suggest the depth of occurrence of the upper margin of a unit responsible for the η_k anomaly of the order of 40 metres.

The Table 15 shows that, firstly, the loose deposits over the VES-IP No.1 observation point are some 5 m thick, and the unaltered limestones of the Alamghar suite occur in the depth of some 240 m. The obtained results do not give the idea on what kind of rocks occur in the section of from 5 to 240 m. One may only infer that an anomalous unit could be both represented by the Gulyakhel and Alamghar suites rocks.

The VES-IP No.2 point is located in 100 m NW of the No.280 observation point of the profile No. 63. The A B line here was oriented at 40°.

The η_k and ρ_k VES-IP No.2 curves are presented in Fig. 10. The apparent resistivity curve has not been interpreted due to a considerable its distortion.

The apparent polarization curve suggests that the unit responsible for the anomaly occurs at a great enough depth, the upper contact of the unit to occur in the depth of some 15 metres from the day surface.

The VES-IP No.3 point lies in 50 m NW of the observation point No. 420, of the profile No.63. The feeding electrodes spacing azimuth is 30°. The obtained sounding curves (η_k and ρ_k) are presented in Fig. 11.

The curve of apparent resistivities suggest a multilayer structure of a stratum. The curve was interpreted as 7-layer, of KHKN type. The interpretation results are presented in Table 16.

Table 16

Parameters of a layer	Numbers of layers						
	1	2	3	4	5	6	7
ρ, ohms	950	110	477	174	7200	6300	40 000
h, metres	2.0	12.0	18.0	22.0	345	122	-

From the Table 16 it is seen that the most conductive formations occur in the depth of between 2.0 to 54 metres. Then, down to the depth of some 520 metres there occurs a stratum possessing the resistivity characteristic of mineralized limestones of the Alaughar suite. Unaltered limestones occur in the depth which to exceed 520 m. At the same time, the apparent polarization curve suggests the presence of a unit, responsible for the IP anomaly, the unit to occur in the depth from 15 to 150 m. Thus, this unit may be represented by both the rocks of the Gulyakhal suite and by the upper portion of the Alaughar suite sequence.

Check curves of VES plotted by graphical method after the interpretation of the VES -IP Nos. 1 and 3, as a whole, appear to be in good agreement with the field observation curves. However, the interpretation results may be taken as evaluation ones as they have been obtained proceeding from a horizontal-bedded environment. But as a matter of fact, the rocks over the area appear to have an inclined occurrence.

The results of vertical sounding IP, as a whole, suggest that for the " Northern " anomaly responsible is the whole stratum of the Gulyakhal suite and the near-contact part of the Alaughar suite deposits.

In order to find out the nature of the apparent polarization of the " Northern "

and " Northeastern " anomalies, located close to one another, and being of the same character, carried out is a complex of geological investigations which included geologo-prospecting routes, metallometric sampling, geochemical (dotted-channel) layer-by-layer sampling accompanied by collection of specimens for preparing thin sections, ditching with channel sampling.

The geological observations have shown that the two above-mentioned anomalies gravitate mainly to carbonate-terrigenous deposits of the Gulyakhel suite (E_{1-2} gh), and partly, towards the Alanghar suite's (T_3 sm) carbonaceous formations (Annex 22).

The metallometric sampling was carried out over geophysical profiles by the sampling grid of 200-300 x 25 m. The samples were collected from eluvial-talus formations within the area of carbonate-terrigenous rocks spreading (the Alanghar and Gulyakhel suites). The all samples were subjected to a spectral analyses for the following elements: Mn, Ni, Cr, Li, Be, Mo, Sn, Cu, Pb, Zn, Bi, As, Ag, Au, A statistical processing of the spectral analysis data was carried out in conformity with the " Instruction " (11). The results of the statistical processing are presented in Table 17.

Table 17

Elements	Standard deviations	Percentage of an element
Tin	C_b	0.0006
	$C_b k$	0.002
	$C_b k^2$	0.007
	$C_b k^3$	0.023
Copper	C_b	0.0014
	$C_b k$	0.004
	$C_b k^2$	0.012
	$C_b k^3$	0.036
Lead	C_b	0.0012
	$C_b k$	0.0075
	$C_b k^2$	0.045
	$C_b k^3$	0.27

Where, C_b - background content of an element

k - a standard deviation from the background content

The metallometric sampling data let outlining within the " Northern " anomaly secondary dispersion halos of Sn, Cu, Pb, the dispersion halos being disconnected one from another. Besides, between the anomalies " Northern " and " Northeastern " outlined, beyond the limits of the formers, is a complex Cu-Pb-Zn aureole. The all above-mentioned aureoles have an elongated in north-eastern direction shape and small dimentions (500 x x 300 m). Anomalous concentrations of the components within the aureole's contours amount to: for tin - 0.006%, for copper - up to 0.01%, for lead - up to 0.5% (Annex 22).

The discovered secondary aureoles gravitate towards sublatitudinal fractures traced in carbonate-terrigeneous deposits of the Gulyakhel suite, also to a contact of the latter with the underlying Alunghar suite rocks.

Of an undoubtful interest is a complex secondary dispersion halo characterized by high anomalous concentrations of lead (up to 0.5%) and zinc (up to 0.3%). The source of the components appears a zone of silicification and carbonatization with brown-coloured ochreous oxidized sulphides confined to a contact of the Alunghar and Gulyakhel suites. The zone has been stripped by a ditch No.7. According to chemical analysis results, the contents of lead and zinc in the zone amount to respectively 0.18 and 0.23% for an average thickness of 14 metres. Here it should be noted that confined to analogous shear zones of carbonatized and silicified rocks,occurring at the contact of the Alunghar and Gulyakhel suites,are auriferous-polymetallic ore bodies of the Mirzaka and Basharghar mineral occurrences.

The ditches Nos. 4, 5, and 6 have stripped a tectonic contact of the Alunghar and Gulyakhel suites to which gravitates a contour of the " Northern " anomaly of apparent polarization. Here, at a contact, occur strongly sheared, carbonatized, and ferruginized both the Alunghar suite's marbled limestones, and the Gulyakhel suite's carbonate-terrigeneous deposits. The fractured and altered rocks here are up to 10-12 m thick. The spectral analysis data have shown that the channel samples collected in the ditches carry heightened concentrations of copper, lead, and zinc. By the No. 4 ditch the copper and lead contents amount to 0.1% for a thickness of 1.0 and 4.0 m; b y the ditch no.5 the contents of copper and zinc amount to 0.1% for a thickness of 1.0 m; by the ditch No.6 the contents of Cu and Zn amount to 0.1% for a thickness of 1.0 m.

The geochemical (dotted-channel) layer-by-layer sampling has not given any positive results.

A petrographical study of the collected specimens has shown that in a number of places over the area under consideration observed are thin impregnations of pyrite, evenly spread over the area of thin sections, and amounting to from 2-3 to 5% of their volumes. Besides, in the thin sections observed a small amount of coaly matter. This latter fact should be kept in mind as the practice of IP investigations has shown that the presence of both an impregnation of pyrite and graphite may cause anomalies of an apparent polari-

zation. At the same time, the results of I P profiling over the profiles Nos. 120 and 123 (the observation points No.s 300-350) point to an absence of anomalies over the hornfelsnizated rocks that also carry an impregnation of pyrite.

The geological investigations have given a number of additional results on the anomalies " Northern " and " Northeastern ". However, the nature of these anomalies remains to be unknown as yet.

The main results of the geophysical investigations carried out over the territory of the Zarkashan ore field appear to be the following:

1. The ascertained magnetic anomalies correspond to the areas of spreading of the Zarkashan complex first phase diorites and located next to them skarns with magnetite and magnetitic bodies.

2. Outlined over the area are three anomalies of an apparent polarization of a high intensity and of considerable dimentions, the contours of the anomalies to coinside mainly with the areas of spreading of carbonate-terrigeneous deposits of the Gulyakhel suite, and partly involving the rocks of the Alamghar suite.

Of the greatest importance appear, undoubtedly, the anomalies of I P, as the obtained geologo-geophysical results suggest, firstly, that for the apparent polarization anomalies responsible appears to be not only the whole stratum of the Gulyakhel suite, but the contacting with it portion of the Alamghar suite calcareous stratum, and secondly, that the secondary dispersion aureoles of tin, copper, lead , and zinc are found within the contour of one of the η k anomalies. As the geological constitution of the area of I P anomalies and the Mirzaka, Basharghar, Baba-i-Kushta mineral occurrences appears to be similar, and so as the nature of the mentioned-above anomalies remains to be unknown, it is expedient to drill over the area several boreholes down to the depth of from 200 to 500 m aimed at clearing out the bodies responsible for the apparent polarization anomal-ies.

The recommended spots of the boreholes drilling are the following (Annex 22):

1. Profile No.65, observation point No. 539
2. Profile No.68, observation point No. 519
3. Profile No.70, observation point No. 519
4. Profile No. 28, observation point No. 225
5. Profile No. 63, observation point No. 394
6. Profile No. 63, observation point No. 438

fluxgate

V. THE GRUZGHAN TUNGSTEN DEPOSIT

The deposit lies approximately in 270 km NE of Kandahar town (Fig. 1).

The geology of the area is governed by sedimentary formations of the Arghana suite ($T_3 - J_2$ ar),represented by limestones, marls, siltstones, and sandstones, and of the Paynewa suite (J_{2-3} pa), represented by mainly limestones. The deposits of the two suites are cut through by stock-like bodies of diorites of Late Cretaceous-Early Paleogene complex of Barkashen, and by a massif of amphibole-biotitic granites, granodiorites of Oligocene complex of Arghandab. The exocontact alterations of the country rocks are pronounced in hornfelsization of the terrigenous rocks and in metamorphism, and skarnization of the carbonaceous rocks.

In the tectonic respect, the area under consideration is confined to the south-eastern limb of an anticline,where the beds dip at the angles of 35-40°. The south-eastern limb of the fold is complicated by a series of steep fractures of north-eastern and sublatitudinal strike. By the fractures the blocks of rocks are displaced for some hundreds of metres.

Known within the area are numerous lenticular bodies of garnetiferous, amphibole-pyroxene-garnetiferous skarns that are from first to 50 m thick and up to first hundreds of metres long. The mineralization in the skarns is represented by scheelite, scyringite, chalcopyrite, hematite, magnetite, malachite, and azurite. The skarns have been in details studied in the process of geological survey (Davgal, 1971) and prospecting revisory estimation (Efimenko, 1974). Industrial concentration of the tungsten has been ascertained by the above investigations.

The aim of the geophysical investigations was mapping under the sedimentary cover of the contact of limestones and granitoids, obtaining of data on dip angles of the contact, and ascertaining of zones promising for a discovery of a rich copper-tungsten mineralization.

The facing task was solved with the help of magnetic prospecting investigations, carried out in a complex with measurements of magnetic susceptibility of therrocks, and with the help of electrical prospecting, making use of spontaneous polarization method, and with the help of metallometric sampling.

The volumes of the investigations carried out by the Geophysical crew over the Gruzghan area are presented by the following below Table 18.

Table 18

Ser. Nos.	Kinds of investigations	Unit of measure	Fulfilment			
			TOTAL	including		
				Check observations	Check obser. percentage	Number of instrum./shift
1.	Magnetic prospecting	1.km / observ.point	102 / 4583	291	6.3	52
2.	Magnetic susceptibility of rocks measurem.	observ.point	250	-	-	6
3.	Spontaneous polarization electrical prospecting	1.km / observ.point	10.3 / 584	112	11.0	8
4.	Metallometric sampling	sample	395	-	-	-
5.	Dotted-channel sampling	sample	15	-	-	-
6.	Geological prospecting routes	1.km	70	-	-	-
7.	Laying-out of observation grid	1.km	105	-	-	21
	Total instrument-shifts					117

1. Magnetic prospecting was the main kind of the geophysical investigations carried out over the deposit's area, and over the areas of industrial tungsten concentrations (the detailed investigations on 1:10,000 scale).

The survey on 1:50,000 scale was carried out over an area of 34 sq.km along 19 profiles, each being from 2.0 to 7.0 km long; the observation grid was 500 x 50 m. The detailed investigations have been carried out over an area of 3.0 sq.km, along 31 profiles, each being 1.0 km long; the observation grid was 100 x 10 m. In the both kinds of the investigations the profiles were oriented at the azimuth of 165-345°.

The mean square error of the observations of the investigations on 1:50,000 and 1:10,000 scale amounted to ± 9.8 gammas, thus corresponding to the conditions of a high accuracy survey.

The magnetic prospecting was accompanied by measurements of magnetic susceptibility of the rocks making up the area under consideration.

The processing of the measurement results and the interpretation of the magnetic prospecting data was carried out similarly to that of the Zarkashan ore field.

The investigations results (plans of the graphs and maps of isolines ΔZ) are given in the Annexes Nos. 23-26.

Over the area of the magnetic survey on 1:50,000 scale, the magnetic field appears to be strongly differentiated. Observed here are sections of comparatively moderate magnetic field, the sections of alternating magnetic field, and zones of positive and negative ΔZ anomalies (Annex 24).

The data of magnetic susceptibility of the rocks measurements (Table 19; Fig.12) give the notion on the distribution of the rocks varieties over the area under consideration. For example, the slightly magnetic ($\varkappa = 0 - 300 \times 10^6$ units of CGSM) are limestones, arenaceous limestones, mineralized and marbled limestones, marbles, epidote-garnetiferous and garnetiferous skarns, hornfelses, and the rocks of shear zones. Mostly slightly-magnetic also are siltstones and graultaids, though medium-magnetic varieties of them ($\varkappa = 300 \times 10^6 - 3000 \times 10^6$ units of CGSM) met as well. The diorites and granodiorites mainly are attributed to medium-magnetic rocks. The skarned rocks carrying hematite, magnetite and malachite appear to be both slightly-magnetic and medium-magnetic depending on magnetite content. Due to the above reason, among the skarns with hematite, magnetite, and malachite ascertained are slightly-magnetic, medium-magnetic, and even magnetic ($\varkappa = 3000 \times 10^6 - 20\,000 \times 10^6$ units of CGSM) varieties. The greatest magnetic susceptibility is characteristic of magnetitic skarns which mostly are magnetic, and rarely - strongly-magnetic ($\varkappa = 20\,000 \times 10^6 - 40\,000 \times 10^6$ and more units of CGSM) .

Therefore, within the region under consideration the positive anomalies may be caused by both magnetitic skarns and by the most magnetic varieties of diorites, skarns, and skarned rocks.

A comparative analysis of ΔZ graphs and the data of geological observations has shown that over an area, governed by limestones and marbles, the magnetic field is moderate with the intensity smoothly changing from minus 150 to plus 150-200 gammas. Over the granitoids ascertained is an alternating magnetic field characterized by chaotically changing ΔZ value from one point to another from minus 150-200 gammas to plus 500-550 gammas, pointing to a heterogeneity of the magnetic features of the rocks. Positive magnetic anomalies with the ΔZ values of from 200 to 500-550 gammas are quite surely ascertained by the character of ΔZ curves, the anomalies being caused either by the magnetitic skarns, or by skarns and skarned rocks carrying a considerable concentration of magnetite. To zones of faults correspond clear negative ΔZ anomalies with the intensity of from - 150 to - 350 gammas that are well correlated from one profile to another (Annex 23).

Over the northern and southern parts of the area covered by 1:50,000 scale survey ascertained are two zones of faulting. The northern zone is traced over the profile 90

Ser. Nos.	R o c k s	Number of observ.	$\varkappa$ Average x 10^6 units of CGSM	Magneti			
				0-100	100-300	300-700	700-
1.	Limestones, hematitized limestones, marbled limestones, marbles, limestones at the contact	1088	3.5	1088 / 100%	-	-	-
2.	Arenaceous limestones	38	150	30 / 70%	8 / 21%	-	-
3.	Siltstones	142	-	68 / 48%	50 / 35%	22 / 15.5%	2 / 1.
4.	Skarned rocks with hematite, magnetite, and with malachite	29	-	12 / 43%	4 / 13%	9 / 31%	1 / 10
5.	Epidote-garnetiferous, garnetiferous skarns	576	50	528 / 92%	48 / 8%	-	-
6.	Skarns with hematite, magnetite and malachite	38	-	-	4 / 11%	7 / 18%	1 / 3
7.	Magnetitic skarns	62	-	-	-	-	-
8.	Hornfelses	411	20	409 / 99%	2 / 1%	-	-
9.	Granites	63	-	22 / 35%	16 / 26%	17 / 26%	1 / 1
10.	Diorites, granodiorites	439	-	9 / 2%	59 / 14%	89 / 21%	1 / 4
11.	Rocks in shear zones	248	6	248 / 100%	-	-	-
				Slightly-magnetic		Medium-mag	

T a b l e 19

gnetic susceptibility of the rocks $\Delta\Omega \times 10^6$ units of CGSM

700-1500	1500-3000	3000-7000	7000-12 000	12 000 - 20000	20 000 - 40 000	Over 40 000 %
-	-	-	-	-	-	-
-	-	-	-	-	-	-
2 / 1.5%	-	-	-	-	-	-
3 / 10%	1 / 3%	-	-	-	-	-
-	-	-	-	-	-	-
12 / 32%	10 / 26%	5 / 13%	-	-	-	-
-	-	-	26 / 42%	17 / 27%	8 / 13%	11 / 18%
-	-	-	-	-	-	-
8 / 13%	-	-	-	-	-	-
193 / 45%	80 / 18%	-	-	-	-	-
-	-	-	-	-	-	-
-magnetic		M a g n e t i c			S t r o n g l y - m a g n e t i c	

up to the profile No.45 and is over 4.5 km long. The southern zone being over 8 km long, has been traced in sublatitudinal direction from the profile No. 120 up to the profile No. 45. In proximity to the profile No.45 the two zones join a more vast isolated zone, to what points out a negative ΔZ field over the whole length of the profiles Nos. 30-40 (Annexes Nos. 23, 24, 28).

The contact of limestones and granitoids appears to be confined to the southern zone of a tectonic fracture. As the ΔZ graphs over the mentioned-above zone appear to have a similar behaviour of the left and right branches, one may infer that the dip angles of the zone are steep enough. Therefore, one may suggest that the contact of the limestones and granitoids, too, has a steep dipping.

Over the area of detailed investigations the character of magnetic field generally appears to be regular. Side by side with a strip of clear negative ΔZ anomalies with the intensity of from - 100 to - 500 gammas, which to correspond to a zone of tectonic fracture, observed is a number of not less clear positive magnetic anomalies characterizing by an increase of ΔZ values up to + 550 gammas (Annex 26).

One of the positive anomalies of ΔZ has been ascertained against a background of negative values of the field, i.e., over a tectonic fracture zone (profile No.76, observation points Nos. 631-635 - profile No. 70, observation points Nos. 625-636). This anomaly is 700 x 100 m large; for the anomaly responsible are both diorites and skarns with magnetite (Annex 28). The ΔZ anomaly traced over the section off from the profile No. 77 (observation points Nos. 564 - 578) to the profile No. 75 (observation points Nos.562 - 570) is 250 x 200 m large; the anomaly being confined to a stock of diorites which partly crop out to the day surface. West of this anomaly ascertained are three more ΔZ anomalies (profile No. 70, observation points Nos. 561-569 - profile No.69, observation points Nos. 562-572; profile No. 67, observation points Nos. 577-592 - profile No. 64, observation points Nos. 570-590; profile No. 62, observation points Nos. 577-584 - profile No. 57, observation points Nos. 562 - 574), the anomalies to have an analogous to the above character and comparatively small dimentions (from 220 x 100 m to 560 x 220 m). One may assume that these anomalies, too, have been caused by the presence of diorite stock.

The behaviour of the ΔZ curves suggests that the contacts of the magnetic perturbation bodies (stocks of diorites, or bodies of skarns with magnetite, or both kinds of bodies in assembly) with the country rocks are steep. A shear zone appears to have a steep dip, too.

2. E l e c t r i c a l p r o s p e c t i n g b y s p o n t a n e o u s p o l a r i z a t i o n (SP) m e t h o d was of experimental character and was being carried out within limited area, viz., directly over the area of tungsten mineralization. The

spontaneous polarization field measurements have been performed over 10 profiles (the detailed magnetic survey), over an observation grid of 100 x 10 metres.

An average absolute error of the observations amounted to ± 4.12 mv, i.e., being within the limits of an admissible. The observation results have shown that the value of spontaneous polarization potential over the whole area irregularly changes from one observation point to another from – 40 to 90 mv (Δmax 27).

Further carrying out of the SP observations was stopped due to the fact that no positive results were obtained at the initial stage of the investigations.

3. M e t a l l o m e t r i c s a m p l i n g has been carried out over the eastern part of the mineral occurrence with the aim of ascertaining secondary aureoles of tungsten and copper. The metallometric samples were collected over a grid of 250 x x 10 m, the sampled area being located within that covered by magnetic prospecting profiles of Nos. 90-120. The technique of the samples collection and of the obtained results processing was the same as for the Darrah-i-Nur ore field (see Section II). According to a spectral analysis data, no secondary aureoles of tungsten and copper are present within the area under consideration.

Therefore, the principal results of the geophysical investigations obtained over the Ozrughan mineral occurrence are the following:

1. Traced under Quaternary deposits are several shear zones.

2. Ascertained are several positive magnetic anomalies; for the anomalies responsible appear to be either bodies of magnetitic skarns, or stocks made up of diorites, skarns inriched in magnetite, or the all mentioned-above formations taken together.

3. The contacts of the magnetic perturbation bodies with the country rocks appear to be steep enough in all the directions.

4. Shear zones, traced over the area, appear to have, too, steep contacts.

VI. THE DARULAMAN AREA

VES Electrical Prospecting was being carried out there aimed at prospecting for ground waters.

The Darulaman area lies within the southern part of the Kabul city. Here, the Kabul valley is from 4.2 to 4.5 kilometres wide. The depth of erosion by the valley, filled in with alluvial deposits, amounts to 110 metres. A schematic section of the rocks that to fill in the valley appears to be the following (adown):

- loams, occurring in an interval of from 0 to 45 metres;
- sands with gravel, occurring in an interval of from 0 to 30 metres;

- conglomerates with clayey cement in the upper portion, and with calcareous cement - at the lower portion - the interval of 10-60 m;

- clay with pebbles - the interval of 60 - 110 m.

The loamy rocks possess a frequently interbedding appearance. The conglomerates and the underlying them clay appear to be persistent in the composition and thickness. A water-bearing horizon, that is confined to a stratum of sands and conglomerates, appears to be of pressure type. The rocks which are to underly the horizon are represented by Neogene clay.

Carried out over the area are 45 VES observations, the maximum space of the A B line being 1500 metres. The Vertical Electrical Soundings have been carried out over three profiles, totalling in the length of 2.5 l.km. The observation spacing was 50 metres.

The observations were carried out with the help of ESK-1 apparatus. The accuracy of the observations appears to be higher compared to that required by the " Instruction ". The deviation from the average basic values, according to the check observation data, amounts to 3%. The allocation of the VES observation points was performed " by eye " on a map on 1:10,000 scale.

According to the VES data, and the drilling results obtained during the previous years over the adjacent areas (Slipko V et al - " Report on the ground waters reserves estimation of the Kabul basin), the reference geoelectrical horizon appears to be represented by Neogene clays, the resistivity values of which do not exceed 500-900 ohm.m, the clays with pebbles to have the resistivity values of the order of 60-110 ohms.m. The upper portion of the column, made up of different loams, possesses the resistivity of 20-150 ohms.m.

It is seen, therefore, that the above-described geologe-geophysical section is well enough differentiated by the resistivity of the rocks, what appears to be a good factor for carrying out there of electrical prospecting.

For the area the most characteristic are VES curves of NK, QQ, and AK type, corresponding the lithological section of the area.

The right branches of the VES curves are terminated by the ρ_k values amounting to 14 - 36 ohms.m, and, thus, corresponding to a reference geoelectrical horizon of Neogene clay.

The interpretation results are presented in the Appendix No.1 *) and in the geoelectrical sections by the profiles (Annex 29).

A magnetic azimuth of the I-I profile is meridional. Over the southern portion of the profile (VES - No. 9 - No. 12) the Neogene clay surface occurs in the depth of 40 metres, with inconsiderable variations from one observation point to another. In the northern direction, the reference horizon plunges, and in proximity to the VES No.15 it occurs in the

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*) See Russian text.

depth of 190 m. Then, next to the above VES, the horizon sharply rises, and at the next observation point the horizon occurs in the depth of 56 metres.

Thus, according to the electrical profiling VES data, over the area mapped is a basin (or a scour) of an ancient water-channel. The basin is 120-150 m wide, and is filled in with the formations having the resistivity values of some 350 ohms.m. By the analogy with the results obtained during the previous years one may assume that the basin is filled in with indurated conglomerates or sands (the latters being characterized by the highest values of resistivity). To check up the above results, it is necessary to drill a borehole at the VES No.13.

The Neogene clay and conglomerates are overlain by a monotonous, well persistent in the thickness, stratum of loams, the loams to show the resistivity values of up to 150 ohms.m.

The II-II profile lies west of the I-I profile, being oriented perpendicularly to the latter and has a common point of VES No.9 of the profile I-I.

The reference horizon of the Neogene clay has shown the resistivity values of from 9 to 20 ohms.m. The horizon occurs in the depth of 12 m over the western part of the area, and in the depth of 42 metres, over the eastern part of the area. A maximum occurrence depth of the horizon at the observation point VES No.3 amounts to 60 metres.

The Neogene clay is overlain by monotonous loamy formations possessing the resistivity of up to 120 ohms.m.

The III-III profile has a latitudinal strike and is oriented perpendicularly to the profile I-I, the common observation point of the profiles appears to be that of VES No.9.

The Neogene clay horizon is well traced from one observation point to another. At the VES No.8 - VES No.11 observation points observed is inconsiderable submerge of the horizon in the direction from the west to east (from 4 metres in the west to 18 metres in the east). Further to the east, the horizon plunges down to the depth of 64 metres (Ves No.14), then begins it uprising again. At the interval of VES No.11 - VES No. 15 there mapped is a basin. According to the resistivity values, the deposits filling in the basin appear to be the following:

- interval of 6-18 metres - different kind of loams;
- interval of 12-42 metres - conglomerates
- interval of 17-64 metres - clay with pebbles, boulders, pebble-round-stones.

The alluvial deposits rest on the Neogene clays.

For the loams characteristic are the resistivity values of 20-140 ohm.m, for the conglomerates - 700-800 ohm.m; the deposits composed of clay with pebbles, boulders, and cobble-round-stones posses the resistivity values of from 60 to 80 ohms.m.

According to the data obtained during the previous years, the water-bearing sands

and conglomerates are ascertained by the resistivity values of 350-800 ohms.m. To check up this assumption, a hydrogeological borehole should be drilled at the VES No.14 point.

The geophysical investigations carried out at the Darulaman have resulted in ascertaining of two areas of indudated conglomerates spreading. To check up the areas necessary is drilling of two prospecting boreholes at the VES No.13, the profile No.III, and at VES No.14, the III-III profile.

Taking into consideration the fact that at the III-III profile the depth of the water-bearing conglomerates occurring is not a great, it was desided to drill the first borehole at the VES No. 14 point during a winter period of 1973-1974. The drilling operations were carried out by the Ministry of Agriculture.

According to an oral communication, the borehole in the depth of 16 metres has pierced through conglomerates and sands, the rocks in the depth of 22-23 metres appear to be water-bearing. The discharge of the water amounts to 20 litres per sec. The water is of good quality.

VII. THE LOGHAR CHROMITE OCCURRENCE

The occurrence lies in 45 km south of Kabul city (Fig. 13) within the limits of Kabul structural-formational zone, and is confined to a massif of ultrabasites, tentatively attributed to Early Cretaceous age (the Loghar complex rocks). The intrusive body has an elongated in latitudinal direction shape. The contacts of the body with the country rocks are concealed under Neogene (Intubund series) deposits and under Quaternary rocks. The massif is built up of two phases rocks: 1) dunites, peridotites; 2) pyroxenites (beyond the limits of the occurrence area). The two phases rocks are cut through by Late Cretaceous (?) dikes of diabases, diabasic porphyrites, microgabbroids, gabbro-diabases, the dikes are from 1 to 5 m thick and up to 2 km long. The post-magmatic alterations in the ultrabasites are widely spread being represented by zones of an intensive serpentinization and slight talcatization.

Known over the area by the present time are over 20 lenticular ore bodies having the extent of from 2 to 80 m and being from 0.5 to 20-25 m wide.

The task of the geophysical observations over the area was determination of the depth of pinching out of the known ore bodies and prospecting for " blind " ore bodies.

The task was solved with the help of magnetic prospecting, carried out in a complex with magnetic susceptibility of the rocks measurements. As an experimental was carrying out of observations with the help of Spontaneous Polarization method.

The Table 20 gives the volumes of the carried out investigations.

Table 20

Ser. Nos.	Kinds of investigations	Unit of measure	Fulfilment TOTAL	Including: Check obser.	% of check observation	Number of instrument/shifts
1.	Magnetic prospecting	1.km / obs.point	67.5 / 7413	380	5.1	47
2.	Measurement of magnetic susceptibility	obs.points	50	-	-	-
3.	Electrical prospecting (SP)	1.km / observ.point	2 / 200	10	5	1
4.	Laying-out of observation grid	1.km	68	-	-	32
	Total instrument/shifts					81

The magnetic prospecting was carried out over the area of the occurrence covering 6.0 sq.km. The observations were carried out along 2 1 profiles, each being 3 km long (Fig. 13), the azimuth of the profiles was 150-330°, the observation grid was 100 x 10 metres.

A mean square error of the observations amounted to ± 18.0 gammas. The density of the observation grid, and the obtained accuracy of the observations correspond to the conditions of a survey on 1:10,000 scale.

The magnetic field over the surveyed area appears to be a non-uniform one. Observed over the profiles is the Δ Z which irregularly changes from one observation point to another from + 220 to - 400 gammas. Against this background ascertained is a considerable number of magnetic anomalies, both isolated and correlated from one profile to another (Annex 30). The Δ Z anomalies appear to have a sharply sign-changing character, their intensity to vary rapidly between plus 1500-3000 gammas to minus 1000-1200, in places to minus 5000 gammas. Only one of the mentioned-above Δ Z anomalies has been ascertained over an outcrop of chromitic ore body.

The magnetic susceptibility of the rocks data (Fig. 14) suggest that the most magnetic within the area are serpentinites and zones of serpentinization. The rest formations, the chromitic ores including, are practically non-differentiated by the mag-

netic susceptibility, being slightly-magnetic.

Therefore, the ascertained anomalies appear to be mainly caused by the zones of serpentinization. Thus, the magnetic prospecting carried out over the Loghar mineral occurrence has not resulted in any positive data.

Electrical prospecting by spontaneous potential method (SP) was of an experimental character. The observations with the space of 10 m were carried out along one profile running over the largest chromite body. As the observations have shown, the values of the natural field potential irregularly vary between - 40 to + 130 mv. The mentioned-above ore body was not recognized in the potential graphs.

Over the Loghar chromite deposit, as a whole, no positive results have been obtained from the geophysical observations.

VIII. CUPRIFEROUS OCCURRENCES

In 1973 geophysical observations were being carried out over two copper occurrences, viz., Ainak and Taghar, located approximately in 40 km south of Kabul city.

The geology of the areas is governed by carbonate-schisty formations of the Leikhwar suite (V-O? lh), representing a part of the Kabul metamorphic series section. The Leikhwar suite's deposits are represented by marbles, quartzites, phyllite-like, graphitic, garnet-micaceous schists and metamorphosed calcareous sandstones. In many places, the suite's rocks are cut through by Early Paleozoic (?) intrusions of amphibolites, being at the same time, in some areas, overlain by the Lataband series (N_{1-2} lt) loose deposits. The cupriferous mineralization is confined mainly to beds of marbles, quartzites; less commonly the mineralization is ascertained in the phyllite-like schists. As a rule, the mineralized zones are steep (60-80°). The mineralized zones are from dozens of metres to first hundreds of metres thick, and some kilometres long. For the mineralized zones characteristic is an irregular spreading of the copper mineralization.

The aim of the geophysical investigations was the evaluation of the Ainak and Taghar mineral occurrences in the depth, and tracing of the ore zones under Quaternary and Neogene deposits.

A complex of geophysical observations, including magnetic prospecting, and magnetic susceptibility of the rocks measurements, electrical prospecting, and profiling of IP, were carried out over the areas.

The volume of the carried out observations within the Ainak and Taghar areas is shown in the Table 21.

Ser. No.	Kinds of investigations	Unit of measure	TOTAL	Aimak	Tagbar	[illegible]
1.	Magnetic prospecting	1.km	84.5	72	12.5	
		obs.point	8275	7012	1263	
2.	Magnetic susceptibility measurement	obs.point	76	76	-	
3.	Electrical prospecting:					
	a) I P profiling	1.km	6	6	-	
		obs. points	347	347		
	b) Spontaneous Polarization	1.km	96	88.5	5.5	
		obs.points	8370	7952	370	
4.	Geological prospecting routes *)	1.km	30	-	-	
5.	Ditching *)	cu m	38	-	-	
6.	Channel sampling	sample	55	-	-	
7.	Laying-out of observation grid	1.km	107.5	92	15.5	

Total instrument-shifts - 162

*) The volumes of geological observations carried out by the Geophysical crew. The results of these investigations are not given in the present chapter, but there.

Table 21

l f i l m e n t					
c l u d i n g					
a b s e r v.	Percent of check observations		Number of instrument/shifts		
ghar	Ainak	Taghar	Total	Ainak	Taghar
26	3.5	2.0	47	39	8
-	-	-	2	2	-
-	12	-	7	7	-
97	7.7	25.6	51	45	6
-	-	-	-	-	-
-	-	-	-	-	-
-	-	-	-	-	-
-	-	-	55	43	12

the copper occurrence of Khurd-Kabul.

The investigations are being carried

B. The Aimak area.

Due to the peculiarities of the geological constitution of the Aimak area, the geophysical investigations were being carried out there by profiles oriented in different directions. A part of the profiles was layed out by the azimuth of 10-190°, the other part - by the azimuth of 100-280°. For a more convenient consideration of the geophysical data the area with the submeridional orientation of the observation profiles was called by us as the Aimak-I, that with the sublatitudinal orientation of the profiles - the Aimak-II .

Magnetic prospecting was carried out over the area of 3.5 sq.km, along 76 profiles from 0.3 to 10 km long. The observation grid mostly was 50 x 10 m large with thinning out up to 50 x 20 m over a comparatively tranquil magnetic field.

A mean square error of the observations amounted to ± 11.0 gammas.

The density of the observation grid and the obtained accuracy of the observations are in good agreement with the requirements of a survey on 1:5000 scale.

Over the western part of the Aimak-I area (from the profile No. 15 to the profile No.34) recorded is a changeable magnetic field, both by the sign and by the intensity. Here the ΔZ values chaotically vary from - 1200 to + 3500 gammas. In the eastern direction, beginning with the profile No.35, the area of varying magnetic field gradually transits into a clear negative ΔZ anomaly with the intensity of up to minus 1800 gammas. This anomaly fades out in proximity to the profile No. 45. Further east of the No.45 profile, the magnetic field appears to be tranquil, smoothly changing in the direction from the north to south along the profiles, the values being from plus 200-250 gammas to minus 200-300 gammas.

Within the southern part of the Aimak-II area (profile No.190 - profile No. 120) observed is a tranquil magnetic field which is smoothly changing from the west to the east from + 120 to minus 190 gammas. In the northern direction from the profile No.120 to the profile No. 35 the character of the ΔZ field changing appears to be the same, but recorded here are increased positive values of ΔZ up to + 1000 gammas (Annex 31).

The results of the magnetic susceptibility of the rocks measurements (Fig. 15) suggest that for the ΔZ anomalies responsible are magnetic (dark-coloured) varieties of the amphibolites, as the light-coloured amphibolites and the other rocks of the area appear to be slightly-magnetic ($\varkappa$ = 0-300 x 10^{6} units of CGSM).

The whole aggregate of the magnetic survey on 1:5000 scale data, obtained for the Aimak area, appears to reflect the only some fragments of the general constitution of the magnetic field (Annex 32).

Electrical prospecting (the natural field method) was carried

out over the area of 3.3 sq.km along 69 magnetic prospecting profiles, from 0.3 to 1.6 km long. The observation grid was 50 x 10 metres.

A mean absolute error of the observations amounted to ± 2.94 mv.

Over the Aimak-I and Aimak-II areas distinguished is a clear zone of negative SP field anomalies characterized by considerable values of the potential reaching up to minus 550-650 mv (the Aimak-I) and minus 650-750 mv (the Aimak-II). The anomalies rapidly fade out on approaching Quaternary and Neogene deposits (Annex 33).

The anomalous zones of the two areas comprize several local SP anomalies (Annex 34). For example, over the Aimak-I area distinguished are three SP anomalies; ascertained over the Aimak-II area are five SP anomalies, four of which being considered as a single one anomaly of a considerable extent.

Over the Aimak-I area the SP anomalies are characterized by comparatively small dimentions. The first anomaly, being some 270 x 120 m large, has been traced from the profile No.36 (observation points Nos. 161 - 175) up to the profile No.33 (observation points Nos. 172-184). The second anomaly, from 100 to 275 m wide, has been traced for about 300 metres from the profile No.30 (observation points Nos.180-211) up to the profile No. 25 (observation points Nos. 186-199). The third anomaly, being over 275 x 35 m large, and traced from the profile No.24, observation points Nos. 225-226 up to the profile No. 21, observation points Nos. 210-217; the anomaly has not been contoured in the east.

The former two above-described anomalies are confined to zones of cupriferous mineralization (Fig.16). A supposed depth of the units, responsible for the anomalies, amounts to from 35 to 55 metres. The third anomaly coincides spatially with a stratum of argillaceous-coaly slates which seem to be responsible for the anomaly.

As it has been pointed out above, one of the SP anomalies,ascertained over the Aimak-II area, has a considerable size, viz., up to 1400 x 40-200 metres, the anomaly being confined to a zone of cupriferous mineralization spreading (Fig. 17). The bodies responsible for the anomaly occur in the depth of from 30 to 100 metres, the greatest depth being ascertained over the central part of the anomaly (the section of the Nos. 130-145 profiles). The second S P anomaly, some 250 x 200 m large (the profile No.30, observation points Nos. 43 -61 - the profile No. 60, observation points Nos. 38-50) has been outlined over an area of amphibolites spreading. The nature of the anomaly remains to be unknown as yet.

Of interest appears to be the fact that the S P anomalies, though being located next to the ore zones, appear to be displaced towards the zones uprise, and are not completely located within the cupriferous mineralization zones. This phenomenon can be explained only by the fact that in the depth, under the ore zones, there o c c u r

rocks carrying either cupriferous or sulphide mineralization. This assumption can be checked up only with the help of drilling operations.

The results of S P observations in an aggregate suggest that the S P anomalies are confined mainly to zones carrying a cupriferous mineralization; in places observed are S P anomalies over the argillaceous-cosly slates. Therefore, this method of investigations, undoubtedly, should be used in prospecting for copper occurrences over the whole Lagbar-Kobul region.

E l e c t r i c a l I P p r o f i l i n g was carried out in small volume, aimed at ascertaining the possibility of the method use for tracing out the ore-bearing zones of the Ainak area under Neogene deposits. The carried out observations have shown that the Ainak-I and Ainak-II zones of cupriferous mineralization are clearly distinguished for the anomalous values of an apparent polarization, which to reach 6-10%%, against a background η_k values of 1.5 - 2.0%% (Annex 35). The obtained results suggest that the mineralized zones can be traced under Quaternary of Neogene deposits with the help of the method.

2. T h e T e g h a r a r e a .

The geological environment of the area, the aims and volumes of the geophysical observations are presented above.

T h e m a g n e t i c p r o s p e c t i n g on 1:10,000 scale has been carried out over an area of 1.1 sq.km, along 11 profiles, each being from 1.0 to 1.5 kms long. The azimuth of the profiles was 160-340°. The observation grid amounted to 100 x 10 m (Fig. 18).

A mean square error of the observations amounted to ± 12.7 gammas, thus corresponding to observations of medium accuracy.

The recorded ΔZ field over the copper-bearing marbles appears to be tranquil, almost unchangeable in the intensity along the profile. From one profile to another, the ΔZ values smoothly change from + 200 gammas to + 400 gammas. To the garnetiferous, garnet-biotitic schists with hematite, and in places with magnetite, corresponds a sharply changeable character of the magnetic field. Here, the ΔZ values chaotically vary from one observation point to another from - 1200 to + 1800 gammas (Annex 36).

T h e S P o b s e r v a t i o n s have been carried out along 4 magnetic prospecting profiles, each being from 0.8 to 1.5 km long. The observations spacing was 10-20 metres.

Over the mineralized marbles the value of potential irregularly varied along the profiles from - 80 to + 100 mv.

Along the two profiles over the phyllite-like schists with copper minerals impregnation outlined is S P anomaly with the intensity of up to minus 400 mv (Fig.19).

The S P observations will be continued over the Tagber area.

IX. BOREHOLE LOGGING

Borehole logging has been carried out over the " Vostok " copper-staniferous occurrence and over the lead-zinc occurrence of Spira.

The aim of the logging carried out over the two areas was ascertaining, in the boreholes, of zones inriched in sulphide mineralization and determining the occurrence depth and thickness of the ore intervals.

The facing task was fulfilled with the help of a complex of methods of electrical logging, including a method of apparent resistivity measurement (AR), S P observations, method of electrode potentials (EP), and a method of sliding contacts (SC).

The apparent resistivity measurements were carried out with the help of a gradient-probe of AI, GMO.1N type.

The AR, SP, EP, and SC diagrams were recorded in a depth scale of 1:200 (the " Vostok " area) and on 1:100 scale (the Spira area).

The fulfillment of the observations is illustrated in the Table 22.

Table 22

Unit of measure	Fulfilment							
	TOTAL	"Vostok" area	Spira area	% of check observations		Number of instrument/shifts		
				"Vostok"	Spira	Total	"Vostok"	Spira
1.m b/holes	851	544	307	10	10	18	12	6
1.m logging	2,544	1,784	760					

1. The " Vostok " area. The electrical logging was being carried out in the boreholes Nos. 8, 9, 10, 12. The logging results are presented in the Annex 37. In all the logged boreholes the AR, Sp, EP, and SC diagrams reveal anomalies corresponding to mineralized intervals. The characteristic of the anomalies is presented in the Table No. 23.

Table 23

	Methods			
	A E	S P	EP	S C
	Decrease of ρ k values	Decrease or increase of SP potential	Electrode potential increase	Current intensity increase
Borehole No.8	Up to 100 ohms against a background of 8,000-10,000 ohms	Decrease up to - 210 mv, and increase up to +310 mv	Up to + 460 mv	By 2 - 2.5 times
Borehole No.9	From some 1,000 ohms to 0-20 ohms	Increase up to + + 120 - + 180 mv	-	-
Borehole No.10	From 5,000-10,000 ohms to 120-160 ohms	Increase up to + + 30 - + 50 mv	Up to + 250 mv	By 3-5 times
Borehole No.11	Up to 1,000-1,500 ohms against a background of 10,000-20,000 ohms	Increase up to + + 75 mv	Up to + 280 mv	By 3-6 times

The logging diagrams show that the above-mentioned anomalies are clearly correlated with one another. The logging diagrams let determining the depth of sulphidized rocks occurrence.

Borehole No.8 can be logged down to the depth of 120 m. The recorded diagram suggests an intensive sulphide impregnation in the intervals of 26 - 35.5m ; 40-43.5 m; 46.5-52.8 metres; 54.2 - 59.0 m; 82-83 m. A poor sulphide mineralization is distinguished at the intervals of 20.5 - 24.0 m; 64.5 - 68.0 m; 72 - 72.5 m, and at 109.5 m.

The borehole No.9. Logging observations have been performed down to the depth of 120 m. The rocks carrying sulphides impregnations occur in the depth of 38-54 m, and 102 - 117 m.

Borehole No.10. A poor sulphide mineralization has been ascertained at the intervals of 52.5m; 72 - 76.5 m; 82.5 - 84.5 m; 95 - 98 m; 114 - 115 m ;.a more rich sulphide mineralization has been ascertained in the depth of 100.7 - 103 m, and 115 - 125 m.

The results of electrical boreholes logging were also made use of for compiling geological sections by the boreholes logged.

2. The Spira area . Logging was carried out by the boreholes Nos. 1, 2, 4, and 5. The logging data are presented in the Annex No. 38.

Borehole No.1. A mineralized zone has been ascertained in an interval of 38.5 - 46.0 metres, and at 49.7 metres by the data showing the increase of electrode potentials from 30 to 185 mv, also by the data of an apparent resistivity fall down from 500 to 25 ohms.

Borehole No.2. At an interval of 70.6 - 73.6 m ascertained in an apparent resistivity anomaly (a decrease of ρk values to 25 ohms, against a general background of 400 ohms). Also ascertained here are S P anomalies, anomalies of electrode potential (by an increase of electrode potential values up to + 135 mv), and of an anomaly revealed by a sliding contact method (an increase of a current intensity approximately by 1.5 times), the anomalies to correspond to a mineralized zone.

Borehole No.4. The character of the AR, SP, and SC curves correspond to a contact between mudstones and metasomatic rocks. Here, too, at the contact zone, in the depth of 64.5 - 66.0 m, ascertained is a sulphide mineralization by an electrode potential anomaly, that having the intensity of up to 20 mv.

Borehole No.5. The AR and S P data let determining the occurrence depth of a contact between mudstones and metasomatically-altered rocks.

The logging results were also made use for compiling geological sections by the boreholes.

Thus, the data of logging carried out over the " Vostok " and Spira areas helped ascertaining the occurrence depth and thickness of the mineralized zones pierced through by boreholes.

C O N C L U S I O N S

The geophysical investigations carried out in 1973 - beginning of 1974 appear to be an important constituent part of a complex of geological prospecting and exploration implemented in Afghanistan with the aim of looking for solid minerals.

In 1973, side by side with detailed geophysical investigations on 1:10,000 - 1:5,000 scale, for the first time carried out were areal investigations on 1:50,000 - 1:25,000 scale.

The geophysical investigations were being carried out both within different ore-bearing regions, and over individual mineral occurrences of copper, tin, polymetals, gold, tungsten, and chromium, which required evaluation of their prospects and mineralization in the depth.

A complex of geophysical and geological observations was being carried out so as to solve the problems of discovery and contouring areas promising for minerals, tracing the ore-bearing and ore-controlling structures, determining the dimentions of the occurrences, and the occurrence depth of both the ore bodies and ore zones, and obtaining the data for geological mapping.

The principal results of the geophysical observations obtained in 1973 - I-st quarter of 1974 are the following:

<u>The Čah-i-ab and Jarhoski areas</u>. A Vertical Electrical Sounding carried out over the areas has resulted in ascertaining the relief of the burried Panj valley and its tributaries, the ascertained relief to help more purposfull prospecting for placer gold with the help of drilling operations.

<u>The Darreh-i-Nur ore field</u>. The magnetic prospecting have resulted over the field in discovery of several ΔZ anomalies corresponding to bodies of magnetitic skarns of different size and occurring in the depth of from 100 to 200 metres. The magnetitic skarn may carry either a sulphide or lead-and-zinc mineralization. The I P profiling has resulted in ascertaining a sulphide mineralization in the depth over several known polymetallic occurrences, also of a zone of low resistivities, within which outlined are secondary aureoles of copper, lead and zinc minerals, the aureoles being characterized by high concentrations of the minerals. It is not excluded that in the depth there occur ore bodies too. A complete evaluation of the prospects of the ore field is possible after completion there of the IP investigations.

<u>The Qala-i-Asad ore field</u>. The magnetic prospecting carried out over the field helped ascertaining a large enough zone of ΔZ anomalies, corresponding to several magnetic per

turbation bodies of different size and morphology, the bodies to occur in the depth of from 60 to 100 m. The I P observations suggest that no valuable concentrations of sulphide minerals occur over the Qala-i-Asad ore field. The Electrical Prefiling has revealed a long enough strip of low resistivities.

The data of magnetic prospecting and electrical prefiling suggest that the revealed anomalies, the nature of which has not been as yet ascertained, stand out against a background of some specific peculiarities of deep geological constitution of the ore field. A check up of the anomalies with the help of drilling may provide with new additional data on the geological constitution and prospects of the Qala-i-Asad ore field.

The Zarkashan ore field. The I P observations have resulted in ascertaining the anomalies of apparent polarization with high enough intensity, the anomalies possessing considerable dimentions, viz., from 0.3 x 0.8 to 1.5 x 2.0 km. Within the contours of the largest IP anomaly outlined are secondary aureoles of copper, lead, zinc, and tin minerals with quite a high concentrations of the latters. The area of the anomalies localization, the nature of the anomalies being not cleared out yet, appears to have similar features of the geological constitution with that of the known polymetallic occurrences. A possibility of mineralized zones discovery is not excluded in the area.

The Grazzhan tungsten occurrence . The magnetic prospecting has surely enough traced zones of tectonic dislocations and shearing. Ascertained here are steep dip angles of the contact between limestones and granitoids.

The Barulamas area. The electrical prospecting (VES) has outlined an area of indudated conglomerates spreading. A hydrogeological borehole drilled at the area gives an inflow of good quality water with an industrial discharge.

The Aymak area. The electrical prospecting helped contouring several S P anomalies located in a close proximity to zones of cupriferous mineralization. The electrical prospecting data suggest that the S P method may be used as a prospecting method all over the whole Loghar-Kabul cupriferous mineralization region.

Thus, the carried out geophysical observations have resulted in great many data on the geological constitution of the studied units, and helped much more thrustworthyly judge on the prospects of individual areas and large enough regions, and more purpusfully carry out drilling and mining operations, what finally enhances the efficiency of the geological exploration.

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