MINISTRY OF EDUCATION AND SCIENCE OF THE REPUBLIC OF KAZAKHSTAN

Kazakh National Research Technical University named after K.I. Satpayev

Institute of Geology, Oil and Mining

Department of Oil, Gas and Ore Geophysics

Auyesbek Alikhan

Topic: «Electrical exploration and reconnaissance by sounding method in the modification of “INFINI TEM” at the Dusembay site in the Karaganda region»

DIPLOMA WORK

Specialty 5B070600 – Geology and exploration of mineral deposits

Almaty 2020

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Kazakh National Research Technical University named after K.I. Satpayev

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Department of Oil, Gas and Ore Geophysics

ADMITTED TO DEFENCE
Head of the Department of Geophysics
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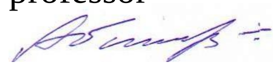 Abetov.A.E.
"_____"____________2020y.

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Done by Auyesbek Alikhan

 Scientific supervisor
Jukebayev M.Y.

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APPROVED BY
Head of the Department of Geophysics
Doctor of geological-mineralogical sciences, professor
Abetov A.E.
“_____”_______________2020y.

THE TASK
to complete the diploma work

Student: Auyesbek Alikhan

Topic: “Electrical exploration and reconnaissance by sounding method in the modification of “INFINI TEM” at the Dusembay site in the Karaganda region”

Approved by order of the Rector of the University №762–b from "27" January 2020y.

Submission deadline of the completed work "15" may 2020y.

Initial data for the diploma work: were provided by the scientific adviser

Summary of the diploma work:
a) General information about the Dusembay part
b) Electrical exploration studies
c) Results electrical exploratory works

The list of graphic material: are presented __ slides of presentation work

Recommended main literature: Bursian V.R. The theory of electromagnetic fields used in electrical exploration. L., Nedra, 1972

GRAPH
of the diploma work preparation

Section Names, list of issues under development	Submission deadline to scientific supervisor	Notes
Geological-geophysical study	8.03.20y.-29.03.20y.	
Analysis of geological and geophysical data in the area of deposit	01.04.20y-10.04.20y	
Processing of electric surveying materials	11.04.20y-30.04.20y	
Interpretation of and geophysical materials	01.05.20y-10.05.20y	

Signatures
of the consultants and standard controller for the completed diploma work with an indication of the sections of work related to them

Section names	Consultants, name, patronymic, surname (academic degree, title)	Date of signing	Signature
Geological-geophysical study	Jukebayev.M.Y		
Analysis of geological and geophysical data in the area of deposit	Jukebayev.M.Y		
Processing and interpretation of geophysical materials	Jukebayev.M.Y		
Standard controller	M.M.Aliakbar		

Scientific supervisor ____________________ Jukebayev.M.Y

The student fulfilling the task __________________ Auyesbek.A.A

Date "____"____________2020y.

ABSTRACT

to the diploma work "Electrical exploration and reconnaissance by sounding method in the modification of “INFINI TEM” at the Dusembay site in the Karaganda region."

The diploma work consists of introduction, 5 chapters, conclusion and list of used literature. This work describes the geographical location of this site, provides information on the geological and geophysical exploration of the area, describes the geological structure with the provision of information about stratigraphy and tectonics.

This site belongs to the Karsakpay field groups. The deposits of the Karsakpay group are located in the western part of the Karaganda region in the Ulytau district. The central group of the district includes deposits associated with the ore horizons of the Balbraun Formation, including Dyusembay deposits. The central part of the Karsakpay uplift within the studied area is composed of metamorphic rocks of Precambrian and loose Cenozoic deposits. Lower and middle Proterozoic, successively distinguished from bottom to top, are subdivided into a number of large local stratigraphic units-series. The measurements at the Dusembay site were carried out using the INFINI TDEM sounding technique developed by the Canadian company Abitibi Geophysics. We used the SMARTDEM24 meter and the EMIT Transmitter controller generator system. According to the technical specification, electrical exploration work was carried out with a total volume of 18 profiles, 72 linear meters. km.

Chapter 4 writes about the results of electrical exploration, and Chapter 5 talks about anomalies and recommended wells.

In conclusion, conclusions on the work performed are presented.

АННОТАЦИЯ

для дипломной работы «Электроразведка методом зондирования в модификации« INFINI TEM »на площадке Дюсембай в Карагандинской области».

Дипломная работа состоит из введения, 5 глав, заключение и списка использованных литератур.

В данной работе описывается географическое расположение данного участка, приводятся сведения о геолого-геофизической изученности района, описывается геологическое строение с предоставлением сведений о стратиграфии и тектонике.

Данный участок относится к месторождению Карсакпайской группы. Месторождения Карсакпайской группы находятся в западной части Карагандинской области в Улытауском районе. В центральную группу района входят месторождения, связанные с рудными горизонтами балбраунской свиты в том числе и месторождения Дюсембай. Центральная часть Карсакпайского поднятия в пределах изученной площади сложена метаморфическими породами докембрия и рыхлыми кайнозойскими отложениями. Последовательно снизу вверх выделяются нижний и средний протерозой, подразделяемые на ряд крупных местных стратиграфических единиц-серий.

Измерения на участке Дюсембай проводились по методике зондирования «INFINI TDEM», разработанной канадской компанией Abitibi Geophysics. В работе использовались измеритель SMARTDEM24 и генераторная система EMIT Transmitter controller. Согласно технической спецификации проведены электроразведочные работы общим объемом – 18 профилей, 72 пог. км.

В 4 главе написано о результатах электроразведочных работ, а 5 главе сказано об аномалиях и рекомендованных скважин.

В заключении представлены выводы о выполненных работах.

АҢДАТПА

«Қарағанды облысындағы Дүйсембай учаскесінде «INFINI TEM» модификациясы зондылау әдісімен электрлік барлау» тақырыбында дипломдық жумысын қорғауға.

Диссертация кіріспеден, 5 бөлімнен, қорытындыдан және пайдаланылған әдебиеттер тізімінен тұрады.

Бұл жұмыста осы учаскенің географиялық орналасуы, аумақтың геологиялық және геофизикалық зерттелуі туралы ақпарат берілген, стратиграфия мен тектоника туралы ақпарат берумен геологиялық құрылым сипатталған.

Бұл учаске Қарсақпай кен орны топтарына жатады. Қарсақпай тобының кен орындары Қарағанды облысының батыс бөлігінде, Ұлытау ауданында орналасқан. Ауданның орталық тобына Балбырауын формациясына байланысты кен орындары, оның ішінде Дүйсембай кен орны кіреді. Қарсақпай көтерілімінің орталық бөлігі зерттеліп жатқан аймаққа дейінгі метаморфтық тау жыныстарынан және кайнозойдың бос түзілімдерінен тұрады. Төменгі және ортаңғы протерозойлар төменнен жоғары қарай кезекпен бөлініп, бірқатар ірі жергілікті стратиграфиялық блоктарға бөлінеді. Дүйсембай учаскесіндегі жұмыстар канадалық Abitibi Geophysics компаниясы жасаған INFINI TDEM әдісін қолдана отырып жүргізілді. Біз SMARTDEM24 және EMIT Transmitter контроллер генератор жүйесін қолдандық. Техникалық сипаттамаға сәйкес, электрлік барлау жұмыстары 18 профильді құрайды.

4-тарауда электрлік зерттеулер нәтижелері туралы жазылған, ал 5-тарауда аномалиялармен мен ұсынылған ұңғымалар туралы айтылады.

Қорытындылай келе, орындалған жұмыстар бойынша нәтижелер келтірілген.

CONTENTS

INTRODUCTION

In the field period the field unit carried out electrical exploration works in the modification "INFINI TEM" at the site "Dusembay" in Karaganda region.

According to the technical specification the electric exploration works were carried out with total volume of 18 profiles, 72 line km.

Measurements were carried out according to "INFINI TDEM" probing method developed by Canadian company Abitibi Geophysics. SMARTDEM24 meter and EMIT Transmitter controller were used in this work.

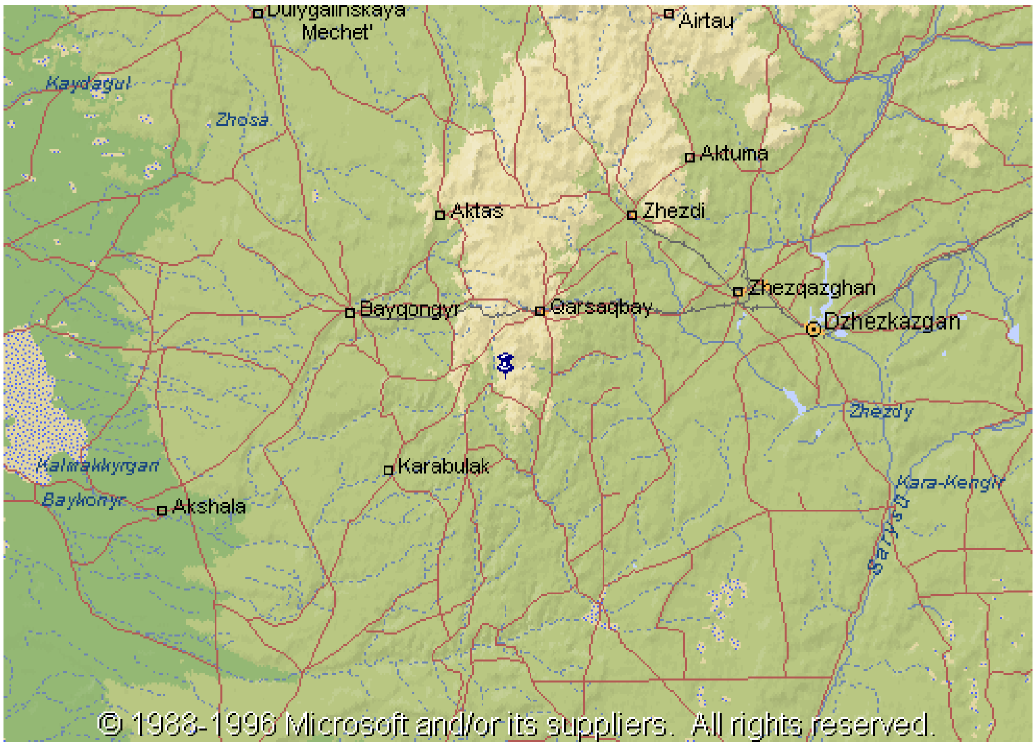
Cameral processing of field measurements was carried out, quality control was carried out, inversion models were calculated, based on the results of which specific electrical resistivity parameter sections were built.

The field work on the object was carried out in full.

1 General information about the area of work

1.1 General information

The area of the Dusembay work site belongs to the Ulytau district - the Karaganda region and is located 20 km south of the village. Karsakpay and 120 km west of the regional center of Zhezkazgan.

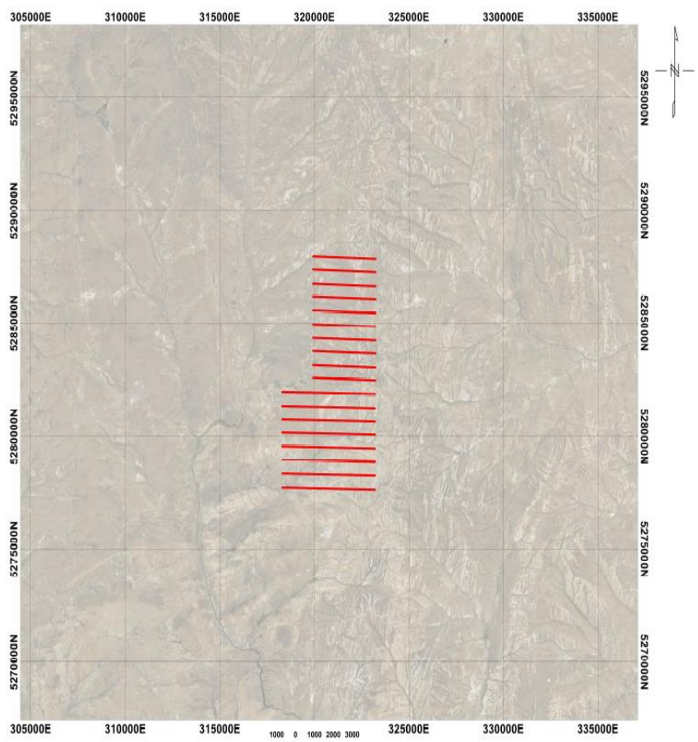


Picture 1.1 - Overview map of the work area

Table 1.1 – The coordinates of the corners of the geological allotment are given in

№	x	y
1	319941.6065	5288212.7563
2	323315.1602	5288129.6126
3	323232.0728	5277169.6565
4	318287.217	5277261.8918
5	318435.2157	5282331.6893
6	319904.3085	5282279.2228

Picture 1.2 – Map of ore development Dusembay (site 4)



Picture 1.3 – Profiles location

2 Geological structure of the Dusembay area

2.1 Stratigraphy

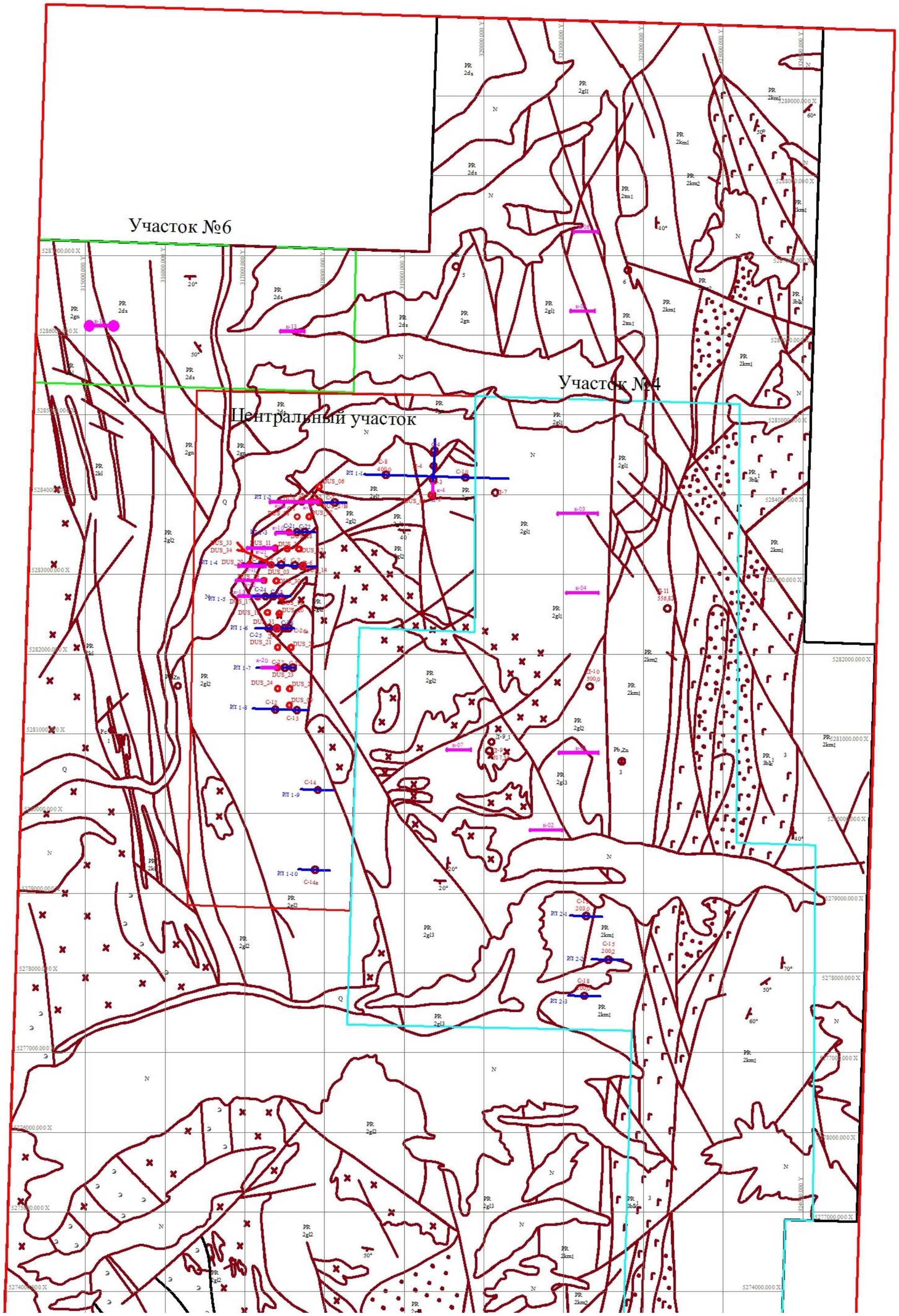
The central part of the Karsakpay uplift within the studied area is composed of metamorphic rocks of Precambrian and loose Cenozoic deposits. Lower and middle Proterozoic, successively distinguished from bottom to top, are subdivided into a number of large local stratigraphic units-series. The main unit of the local stratigraphic scale is the suite, distinguished by lithological characteristics. As part of the suite, packs are distinguished - lower local lithostratigraphic units.

Proterozoic. In the Precambrian section of the described area, 6 series are distinguished (Yu.A.Zaitsev), which are combined into the Lower and Middle Proterozoic.

Lower Proterozoic. It includes the Bekturgan series of crystalline schists, the Aralbaisk series of metamorphosed volcanogenic-sedimentary rocks with a predominance of dacitic , rhyolite-dacitic volcanic components and the Karsakpay iron ore series.

Bekturgan Formation (PR_1*br*). It includes porphyroblastic albite gneisses and muscovite- albite schists, actinolite amphibolites and albite-chlorito-actinolite schists with blastopsammite feldspar schists and porphyritids. No rocks of this series have been found on the work area and are not considered in more detail here.

Aralbai series (PR_1*ar*). It lies unconditionally on the Bekturgan series and according to the Karsakpai series overlaps. One Ungurshat suite ((PR_1 *un*) is traced in the series in the described region , which is in accordance with the underlying Kuzharma suite and is distinguished by the appearance in the section of green schists and porphyritoids with interbeds of marbles and ferruginous quartzites. Three bundles are distinguished in the Ungurshat suite (bottom up): a pack of porphyritoids of green schists with a thickness of 680 m with a marking horizon of ferruginous quartzites, a pack of sericite-albite schists (750 m), a pack of blastopsammite schists(350m).



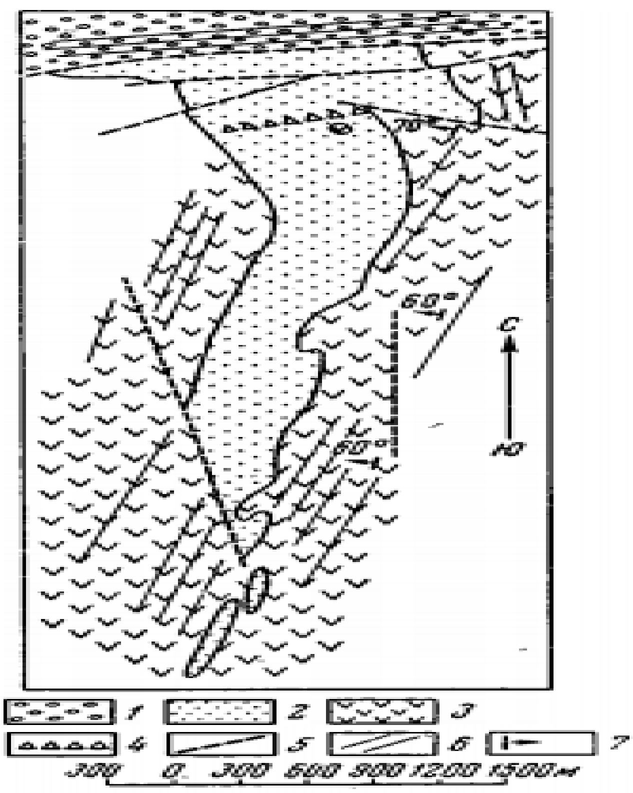
Picture 2.1 – Geological map of the Dyusembay part

The section is crowned by a horizon of marbles with a capacity of 25m. The total capacity of the Ungurshat Formation is 1800m.

The regional metamorphism of the Aralbai series corresponds to the facies of green schists. Typical rocks of the Aralbai series are metamorphosed tuffites (with volcanic material of dacite and rhyolite-dacite composition), epidote-chlorite-quartz, chlorite-quartz-albite, sericite-albite-chlorite schists. Aralbai series is a metamorphosed keratophyre formation.

Karsakpay Series (PR_1 *kr*). It is composed of porphyritoids over tuffs and lavas of basalt and andesite composition, quartz-sericite quartz-feldspar schists, phyllites, marbles, and ferruginous quartzites.

The sediments of the Karsakpai series occur according to the formations of the Aralbay series, with younger deposits the series borders on explosive faults. As part of the series, 4 suites are distinguished.



Фиг. 16. Схематическая геологическая карта района г. Каголяй:

1 — отложения среднего и верхнего девона; 2 — отложения карсакпайской свиты; 3 — отложения бурмашинской свиты; 4 — брекчированные кварциты; 5 — разломы; 6 — линии простирания; 7 — элементы залегания

Picture 2.2 – Geological map of the region Karsakpay

The Burmashinskiy suite (PR $_1$ *br*) is composed of porphyroids, green schists, quartz-sericite schists, phyllites, marbles, and ferruginous quartzites. According to it, it lies on the horizon of marbles in the roof of the Ungurshat suite of the Aralbay series. The upper boundary is drawn at the base of a powerful pack of porphyritoids of the overlying Balbraun Formation. The Burmashinsky suite is divided into two packs: the bottom - a pack of basaltic porphyroids (475 m) and the top (250m) pack of sericite schists and quartzites (iron ore with four marking horizons of marbles in $_2$, ferruginous quartzites in $_1$ and $_3$, microquartzites in $_4$).

The Balbraun Formation (PR $_1$ *bl*) is composed of porphyritic basaltic, rarely andesitic, and metamorphosed sedimentary rocks - schists and phyllites of quartz-sericite composition, marbles, quartzites, and ferruginous quartzites. A pack of basaltic porphyritoids (450-500m) stands out in the lower part of the suite. In the upper member (350 m), two marking horizons of ferruginous quartzites are established - in $_1$ and $_2$.

The lower boundary of the suite is clearly expressed everywhere and in most cases has a consonant character. The upper boundary is drawn at the base of the pack of porphyritoids beginning the Shagirlinsky suite, the contact with which is universally agreed. The total thickness of the Balbrun Suite is 750-800m.

The Shagyrly Formation (PR $_1$ *sh*) combines porphyritoids along lavas and tuffs of basaltic and andesitic composition, quartz- feldspar and quartz-sericite blastopsammite schists and marbles.

In the region, two packs are identified as part of the suite: the lower pack of andesitic and basaltic porphyritoids (up to 500 m), the upper pack of blastopsammit schists and porphyritoids (400m). The Shagyrlinsky suite according to the rocks of the Balbrunovsky suite. The border between them is drawn at the base of a pack of basaltic porphyritoids. The suite is variable in composition and does not contain marking horizons.

The Biitskiy Suite (PR$_1$ *bt*) is composed of basalt porphyritoids , porphyroids, blastopsammite schists of quartz-feldspar composition, and microgranular sericite-albite schists. The suite is divided into two packs - a pack of porphyritoids (600 m) and a pack of fine-grained sericite-albite schists and quartzites (iron ore, 350-400 m thick), with marking horizons of ferruginous quartzites, $_1$ and $_{2,}$ and quartzites $_3$. According to the Biitskaya suite, it is located on the Shagirlinsky suite.

The Karsakpay series as a whole is a sequence of powerful alternating (according to Yu.A. Zaitsev) metamorphosed volcanogenic and sedimentary rocks. Among the volcanic rocks, tuffs and lavas of basaltic and rhyolitic composition prevail; dacitic and rhyolitic volcanic rocks appearing in the upper part of the section play a smaller role. Sedimentary rocks play a subordinate role. Ferruginous quartzites, along with siliceous sediments associated with basaltic volcanism, define deposits of the Karsakpai series as a jaspilite green-shale basaltic formation.

Medium Proterozoic. It covers the metamorphic strata of the Maityubinsky anticlinorium - the Zhiydinsky, Maityubinsky and Bozdak series.

Zhiydinskiy series (PR_2 *zd*). It is composed mainly of porphyroids, blastopsammitic, essentially quartz schists and quartzites, green schists and porphyritoids are of subordinate importance. The Zhiydinsky series is divided into two suites - the Kosobin and Dyusembaysky .

The Kobosinskiy suite (PR_2 *ks*) is composed of quartz-sericite, sericite-quartz, often blastopsammite schists and quartzites, porphyritoids , green schists, porphyroids mainly in crystalline tuffs of rhyolite-dacite composition, epidote-chlorite-quartz-albite schists.

On the area of work in the zones of granitization , two upper packs (3-4 undifferentiated) stand out, composed of biotite spectacle gneisses, fine-grained leucocratic microcline-albite gneisses and various recrystallized schists with a total thickness of about 1000 m. Fields granitisation and the marginal hornfelsification associated with The Late diorites and granodiorites . In areas of the marginal hornfelsification breed Formation modified gneiss -rogoviki and amphibolite - rogoviki.

The Dyusembay suite (PR_2 *ds*) is represented by rhyolitic porphyroids formed due to crystalline tuffs, less often lavas and lithoclastic tuffs. The deposits of the Dusembay Formation occur according to the formations of the Kosobin Formation. The upper part of the suite is determined by dissenting overlap by different suites of the Maytube series. The power of the suite reaches 2500m.

The Zhiydinskiy series represents a single continuous sequence of metamorphic strata - porphyritoids, porphyroids, essentially quartz and quartz-feldspar schists at the bottom and porphyroids at the top. The role of acidic volcanics increases up the section. Deposits zhiydinskoy series intruded by granitoids zhaunkarskogo complex and broad areas subject to granitisation and hornfelsification. The metamorphism of the series corresponds to the facies of green schists. The Zhiydinsky series is considered as a leptite volcanogenic formation.

Maityubinskiy series (PR_2 *mt*). It includes porphyroids of a rhyolitic composition (according to crystalloclastic tuffs, less often lithoclastic tuffs, sometimes lavas), conglomerate schists, feldspar and quartz schists and quartzites, phyllites, green schists, marbles and ferruginous quartzites. The thicknesses of the Maytube series are separated from the underlying by a large break. The Maityuba series consists of five suites: Zhaunkar, Zhilandysay , Tumurzinsky , Koldybaishokinsky , Kumolinsky .

The Zhaunkar Formation (PR_2 *gn*) is represented by porphyroids according to the crystalline tuffs of the rhyolite composition. In virtue of the overlie quartzite, sericite -quartz, sericite, graphite, quartzite shales - marking power level of 6 to 60m. The Zhaunkar Formation, with disagreement, lies on the Dusembay , Kosobin Formations and granites of the Zhaunkar Massif. The sediment thickness of the suite is 800m.

The Zhilandysay Formation (PR_2*gl*) includes porphyroids, conglomerates, sericite-biotite-feldspar schists, quartzites and marbles. The suite contains 4 packs: a pack of conglomerates and porphyroids (800 m), a pack of porphyroids and feldspar schists (400 m), a lower pack of porphyroids (600 m) and an upper pack of porphyroids (500 m). The Zhilandysai Formation disagreeably lies on the Zhaunkar Formation of porphyroids. It is overlapped by the Tumurzinsky suite and borders on the Kumolinsky suite.

The Tumurzinsky suite (PR_2 *tm*) includes quartzite, graphite- quartzite, sericite, sericite- biite-feldspar and amphibole schists, rarely marbles. In the area, a lower pack of quartzites (Cordoban) with a thickness of 150-400 m is developed. The lower horizon of quartzites and graphite- quartzite schists are universally distinguished in the Cordoban bundle.

The Koldybaishokinsky suite (PR_2) includes conglomerate schists, sericite-biotite (chlorite) - feldspar, sericite-biotite (chlorite) - quartz schists, quartzites, marbles.

The horizons of ferruginous and graphite schists are present in two stratigraphic levels, separated in the section at a distance (120-250 m), the formation thickness is 550-600 m.

The Kumolinskaya suite (PR_2 *km*) of blastopsammite schists and porphyroids along tuffs of rhyolite composition lies with a break and disagreement on the Tumurzinsky and Zhilandinsky suites. The suite has two packs: a pack of blastopsammitic quartzites, phyllites with two marking horizons of quartzites (700-1400 m) and a pack of porphyroids (more than 400 m).

Thus, the Maytube series has a complex structure. All her retinues are separated by interruptions and disagreements. The sediments of the series have a relatively weak metamorphism of the green schist facies. One of the main rocks of the series - porphyroids, which make up more than 50% of its volume, are primarily volcanic acid formations. Features of the composition and structure of the Maytube series allow us to consider it as a volcanogenic leptite formation.

The Bozdak Formation (PR_2 *bz*) of the Middle Proterozoic is composed of conglomerates, blastopsammite schists in combination with porphyritoids and porphyroids; at the top are bundles of marbles, quartzites, sericite- quartz schists and phyllites. As part of the series, three suites are distinguished: Belkuduk, Karasai and Nadirbay. The suites are separated by interruptions in sedimentation and disagreements.

Belkuduk Formation (PR_2 *blk*) of porphyritoids and porphyroids, various blastopsammite schists and conglomerates. The suite is divided into three packs: a pack of conglomerates and porphyritoids (50-180m), a pack of porphyroids and feldspar schists (800m), a pack of porphyritoids (300m). The total capacity of the suite is 1100-1290m. A marking horizon of ferruginous quartzite schists has been identified in a pack of porphyritoids and feldspar schists. A pack of porphyritoids (PR_2 *blk*^{3}) is composed mainly of basalt porphyritoids .

The Karasai Formation is composed (PR_2 *kr*) composed of blastopsammitic chlorite-sericite- feldspar- quartz schists and porphyroids along tuffs with subordinate green schists and basalt porphyritoids . At the bottom and in the middle of the section conglomerates are present. In the west, sediments of the formation lie unconformably on the formations of the Beldukudu Formation, and in the east they have tectonic contact. The thickness of the sediment is more than 500m.

The Nadyrbaiskiy suite (PR_2 *nd*) is confined to the cores of elongated longitudinal synclines; it lies with azimuthal disagreement on the Belkuduk and Karasai suites, sharply Kumolinsky suite. The deposits of the suite are represented by blastopsammitic sericite-quartzite and carbonate schists, phyllites, marbles, quartzites. The thickness of the section of the Nadirba Formation is more than 400 m .

The Bozdak Formation is generally characterized by a combination of predominantly basic volcanic rocks with conglomerates and other polymict clastic rocks. Among the volcanic rocks, the most typical are porphyritoids of basaltic composition with almond-stone structure and texture of ball lavas. The section of the series ends with a thickness of rhythmically alternating carbonate and finely detrital quartz rocks. The Bozdak series is a marine volcanic-terrigenous-molasses and terrigenous-carbonate formation.

Mesozoic weathering crust

Weathering crust is widely developed in Proterozoic formations. In the study area, 3 types of weathering crust were distinguished. The kaolin type is represented by variegated (white, green, yellow, red) kaolin clays and crushed stone formations that have preserved the structure of parent rocks. Of the primary minerals in the weathering zone, sericite and quartz are preserved.

The tree type bark is formed on granitoids, granite gneisses, as well as on various schists.

Woodlings are a loose rock consisting of grains of non-decolorized feldspars, quartz and dark-colored minerals.

The silicified weathering crust is developed according to the marbles of the Aralbaisk, Karsakpay and Zhiydin series. In the siliceous zone, marbles are turned into quartzites, consisting of a mosaic aggregate of quartz.

The age of the weathering crust by many researchers belongs to the Early Mesozoic (Triassic-Lower Jurassic). The thickness of the weathering crust is from 1-5 to 100m.

The Cenozoic group is represented on the area of work by Neogene and Quaternary sediments.

Miocene deposits ((N $_1$) in the region are widespread. They are represented by the thickness of greenish-gray clays of beidellite- montmorillonite composition, sometimes enriched with crushed stone and pebbles (especially at the base of the section), include crystals, intergrowths and streaks of gypsum, less often thin layers of light gray marls. The upper horizons of the stratum are usually painted in red-brown tones. Small (up to 3 mm), "grains" of iron-manganese oxides, which can form nests and clusters at the bottom of the section, are scattered throughout the thickness of the rocks.

The thickness of the Miocene deposits varies from 5 to 14 m.

The Upper Miocene-Lower Pliocene (Pavlodar suite N $_{1\text{-}2}$ *pv*) is composed of brown and red-brown, less often green clays and loams, sand, sandy loam, loam and pebble. Despite the very variegated lithological composition, the suite is easily distinguished by the variegated composition of pebbles and sands, as well as its red color.

The thickness of the Pavlodar suite is 5-15m.

The Pliocene stratum (N $_2$) supposedly composes the surface of flat-topped hills. The thickness lies on the blurred surface of the Pavlodar suite or older rocks. These deposits are represented everywhere by the thickness of pebbles and sands of essentially quartz composition, which are sometimes replaced by clusters of angular fragments in the foothill areas. These are coarse-grained accumulations of proluvial or proluvial-alluvial genesis. The thickness of the Pliocene deposits is 3-5m.

Quaternary system. Deposits are very widespread, and according to the genesis among them alluvial, deluvial and eluvial formations are distinguished.

Upper Quaternary sediments (Q $_{III}$) form the first floodplain terrace and can be traced in all modern valleys. They are represented by loam, sandy loam, poorly sorted sand with horizons of pebbles and poorly rounded gravel with a total thickness of up to 3-5 m.

Modern sediments (Q $_{IV}$) are formed by floodplain and channel sediments in all modern valleys. They are represented by loams, silty clays with plant debris, sandy loam and sand with subordinate pebble horizons. Their power is 2-3m, rarely 4-5m.

2.2 Intrusive formations

Within the study area, various granitoids and granite gneisses, as well as intrusive rocks of basic and ultrabasic compositions, are developed. The intrusive and granitized formations of the Karsakpay region are different in their structural confinement, relations with the host strata, petrographic features, contact changes, vein series, etc. Among them, the following complexes were distinguished: 1-

Middle Proterozoic granite- gneiss complex; 2-Late Proterozoic complex of amphibolized gabbro-diabases, 3- Late Ordovician complex of granitoids , an analogue of the Krykkuduks complex (Zaitsev Yu.A. 1975).

Middle Proterozoic granite- gneiss complex

Granito gneisses and gneisses genetically associated with them, as well as blastoclastic gneiss granites, are developed within the Maityubinsk anticlinorium. Granite gneisses are in close structural unity with the host folded metamorphic complexes. They fold, taking the place of stratified strata. With the enclosing shales and porphyroids granite-gneisses associated gradual transitions and array boundaries are conditional. The internal structure of the massifs is heterogeneous. In the central parts, the interbeds of gneiss are single and thin, and toward the periphery of the massifs they increase in quantity and thickness.

The Nasymbay massif of granite gneisses with an area of about 3.5 sq . Km is located on the work area. The host rocks are shales of the Zhilandysay Formation of the Maytube series. The array has a complex structure. The central core, middle and outer zones are distinguished.

The central core is composed of gray, fine-grained granite gneisses with feldspar porphyroblasts with dimensions of about 1 cm, sometimes 3 cm.

The middle zone of the massif surrounding the core is composed of fine-grained gneisses with individual blastoporphyric quartz precipitates. The outer zone is composed of fine-grained porphyroblast granite gneisses. Granite gneisses of the outer zone are surrounded by halos of biotite gneisses of spectacled texture.

Granite gneisses (both the core and the outer zones) are broken through by veins of biotite fine-grained granites with a thickness of 0.1-0.5 m.

Granite gneisses are microcline-albite porphyroblastic fine-grained light, light yellow, light pink rocks. The main minerals in them are plagioclase, potassium feldspar, quartz, biotite, accessory species are represented by zircon, apatite, magnetite, sphene and pomegranate.

Late Proterozoic complex of amphibolized gabbro-diabases (ν PR_2). Intrusive gabbro-diabases are spatially closely related to the metamorphic strata of the Karsakpay and Bozdak series (in the area of the middle pack of the Belkuduk Formation), which contain a significant amount of main effusives. Gabbro-diabases make up small hypabyssal bodies in the form of steep inter-reservoir deposits. Their maximum power is 0.5-0.7km with a length of up to 15km. They underwent a green shale metamorphism of the same type as the metamorphism of the enclosing strata. Shale and recrystallization are especially significant in the marginal parts of the bodies.

Intrusive rocks in the marginal parts are transformed into albite-chlorite-actinolite schists, similar to host shales.

Gabbro diabases are composed of albite, actinolite, epidote, and sometimes chlorite. Of the primary magmatic minerals, relicts of titanomagnetite and apatite have been preserved. Relics of brown hornblende are very rare.

Late Ordovician intrusions (δO_3). In the western part of the work area, a part of the Maityubinsk massif of granodiorites, diorites and gabbro-diorites is traced. The massif is in contact with the metamorphic schists of the Koldybaishokin Formation.

The internal structure of the massif is zonal, with more basic differences in the marginal parts. The change in the composition of granitoids from the edge of the massifs to the central one is as follows: gabbro, gabbro-diorite, diorite, quartz diorite, tonalite-granodiorite . The last two differences make up almost the entire array.

2.3 Geological formations of ancient strata

Recently, more and more researchers of the Karsakpay uplift have doubted the reality of the existence of 36 suites of a detailed stratigraphic section of the Precambrian Karsakpay, identified by geologists from Moscow State University (Filatova, Zaitsev 1971-75). The combined stratigraphic section of the Precambrian of the Karsakpay uplift by them is composed of a number of sections. Mapping Precambrian formations by these researchers was carried out by continuously describing the section with determining the sequence of sedimentation. In this case, only data from lithological-stratigraphic studies were taken into account.

When summarizing geological, geochemical and geophysical materials, the thematic party of the LHE (Suleimenov, Kogai et al. 1983) drew attention to the fact that lithological and petrographic homogeneous rocks in the stratigraphic scheme of L.I. Filatova (1971) are repeatedly repeated in various parts of the Precambrian section. Meanwhile, in rocks of similar petrographic composition related to different parts of the Precambrian section, the inheritance of geochemical and petrochemical features can be traced. An analysis of the nature of the gravitational field of the Karsakpay region shows that the maximum Δg due to the greenstone thickness (σ = 2.80-2.90 g / cm ^{3}) is traced west of their outputs. This circumstance indicates the continuation of these rocks at a depth farther to the west, which does not correspond to the ideas of Zaitsev Yu.A., L.I. Filatova (1971-1975).

In this regard, it is necessary, in brief, to dwell on the geological formations of the Precambrian strata, distinguished from other positions in topic No. 421.

Two epochs stand out in the geological development of the Precambrian folded system: the Prosthetic and Riphean-Vendian.

In the Proterozoic era, the continental crust was fragmented with the eugesynclinal (suboceanic crust) laying on it. The Riphean-Vendian era is characterized as a period of cratonization, i.e. the death of the geosynclinal and its transformation into a platform.

The evgesynclinal type is characterized by the following geological formations:

-early, flyschoid and volcanic-shale (A $_{2-3}$)

-medium: volcanic (B $_{I}$) and molassoid (B $_{2}$) -late stage of development.

The platform stage is characterized by the accumulation of highly mature sediments. The platform complex consists of deposits of carbon-terrigenous (lower Riphean), carbon-terrigenous-shale (Middle Riphean), carbon-terrigenous-siliceous (Vendian) and carbon-siliceous-shale (Cambrian) formations.

Zelenoslantsevo- spilitovaya formation composed almost exclusively basalt and diabase porphyrites, porfiritoidami and greenschists (80-95%) with occasional thin horizons tuff-sandstones, tufoalevrolitov , quartzite, glandular quartzite and marbles. It is characterized by large positive anomalies Δ g and positive linear rugged magnetic anomalies with an intensity of up to 1000 nT or more.

The green-shale- spilite formation combines the green- stone strata of the Talayryk , Saninsky , Sauntalsky and Urnek suites of the Bekturgan series; Kanym , Kugarlinsk , Ungurshat and Artashin suites of the Aralbai series; Burmashinsky , Balbraunsky , Shagirlinsky , Biitsky , Koldybaishokinsky formations of the Maytube series: Karasai formations of the Bozdak series.

The metallogenic of this formation is expressed by the manifestations and deposits of ferruginous quartzite (the Balbrun deposit, Keregetas deposit, etc.) and pyrite sulfide ores (the Vostochny Myk ore occurrence , Sarytyube).

Flyschoid formation (A $_{4}$) comprises a metamorphic formation Savinskaya , dyusensky, balginsky, artashinsky and Shan baykazhinsky formations aralbaysky series; Kankarasuisk , Aitek , and upper Talayryk formations of the Bekturgan series; the terrigenous part of the Akkiyksai , Sholak suite of the Beleutin series; biite suite of the Karsakpai series. Meta-deposits in the formation are represented by double-mica feldspar, sericite-chlorite-biotite and quartz-feldspar shales. Deposits of this formation are characterized by calm low gravimagnetic fields.

The volcanic-shale formation (A $_{2-3}$) occupies a significant part of the area of exits of the Precambrian formations of the territory. Deposits of the Kosobin , Zhiydin series are included in this formation ; Karasai and Belduku suites of the Bozdak series; Achchastastinsky , Ishan and Koskol formations of the Aralbaisk series. According to the petrochemical characteristics, the volcanics of the described formation are geosynclinal.

From a metallogenical point of view, this formation is characterized by pyrite-polymetallic mineralization (Kanym deposit, ore occurrence of Tasty , Bozai , etc.). A small deposit of copper - porphyry ores (Toygyl) is associated with plagiogranites .

An analogue of the volcanogenic (B_I) formation is the rhyolites of the Kosobin and Dusembay formations of the Zhiydin series: the Zhaunkar and Tumurzin formations of the Maytjuba series: Belkuduks , Akkiyksaysky and Altynaynurinsky formations of the Beleutinsky series. For rhyolite given formation and comagmatic it granites zhaunkarskogo complex characteristic rare- methyl - redkozemelnaya geochemical specialization (Nb , Y , Ib , Zr , etc.). The volcanic formation, together with the Zhaunkar granitoids, composes ancient volcanic-plutonic structures.

The molassoid formation (B_2) consists of conglomerates of the Beldukudu and Karasai suites of the Bozdak series, the Balbraun , Shagirlinsky and Biit suites of the Karsakpai series; Zhaunkarsky, Zhilandysaysky and Kolydybaishokinsky suite of the Maytube series. In a metallogenic relation, the formation is not of practical interest.

The Late Horogene complex (volcanogenic and molassoid formation) is a benchmark separating the underlying formations of the geosynclinal stage itself from the overlying platform Riphean-Vendian formations.

Platform complex (C) is composed of highly mature sediments. Its composition includes the Lower Riphean carbon-terrigenous, Middle Riphean carbon-terrigenous-shale, Upper Riphean carbon-terrigenous-carbonate, Vendian carbon-terrigenous-siliceous and Cambrian carbon-siliceous-shale formations.

Common features platform complex species are the same chemical composition in the presence of horizons glandular quartzite, and brown iron, carbonaceous rocks and geochemical specialization on the total Cu , Ni , Co , Cr , V , Mo .

Carbon-clastic formation is composed of quartzite, leucocratic albite gneisses oparsky , ayteksky , artashinsky , shigansky , ungurshatsky , kenteksayskoy , kuzharminskoy , Savinskaya , aschitastinsky and balginskoy suites aralbayskoy series: quartz sandstone, blastopsammitovymi quartzites, schists and quartzite conglomerates tumurzinsky suite maytyubinsky series and quartz sandstones Ushtobinsky suite of the Kokchetau series.

The lower part of the formation is represented by conglomerates with pebble of quartz, the middle — by quartzites and sandstones, the upper — by strata of brown iron ore and sericite-quartz schists.

This formation is metallogenically interesting for the concentrations of rutile and zircon in the lower part and iron equipment in the middle part of the section.

The carbon-terrigenous-shale formation is composed of carbon-quartz shales of Zhaunkar; quartz sandstones and quartzite schists of Zhilandysay , quartz sandstones and sericite- feldspar-quartz schists of Koldybaishokinsky ; quartz sandstones, carbonaceous shales of the Tatpen suite of the Maytube series. The lower part of the section of the formation is composed of light gray quartz sandstones, the upper part is represented by layers of brown (oolitic) iron ore and carbonaceous shales. The formation is characterized by a high degree of carbon and is of practical interest in relation to the search for deposits of lead and zinc.

The carbon-terrigenous-carbonate formation is represented by sediments of the Kumolinskaya suite of the Maytube series. The lower part of the formation section is composed of quartz sandstones and carbon-quartz schists containing three horizons of oolitic iron ore. The upper part of the section consists of dolomites with thin beds of quartzite schists, phyllites and marbles.

This formation is of interest in relation to prospecting for a copper deposit.

The carbon-terrigenous-siliceous formation at the bottom of the section is composed of sediments of the Zaltau Formation, and at the top - Satan, Bozigen and Baikonur Formations. According to the lithological composition, the section of the formation is similar to the section of the Koktal suite of the Cambrian. This formation in the middle of vanadienosna , and at the top - fosfatonosnyh .

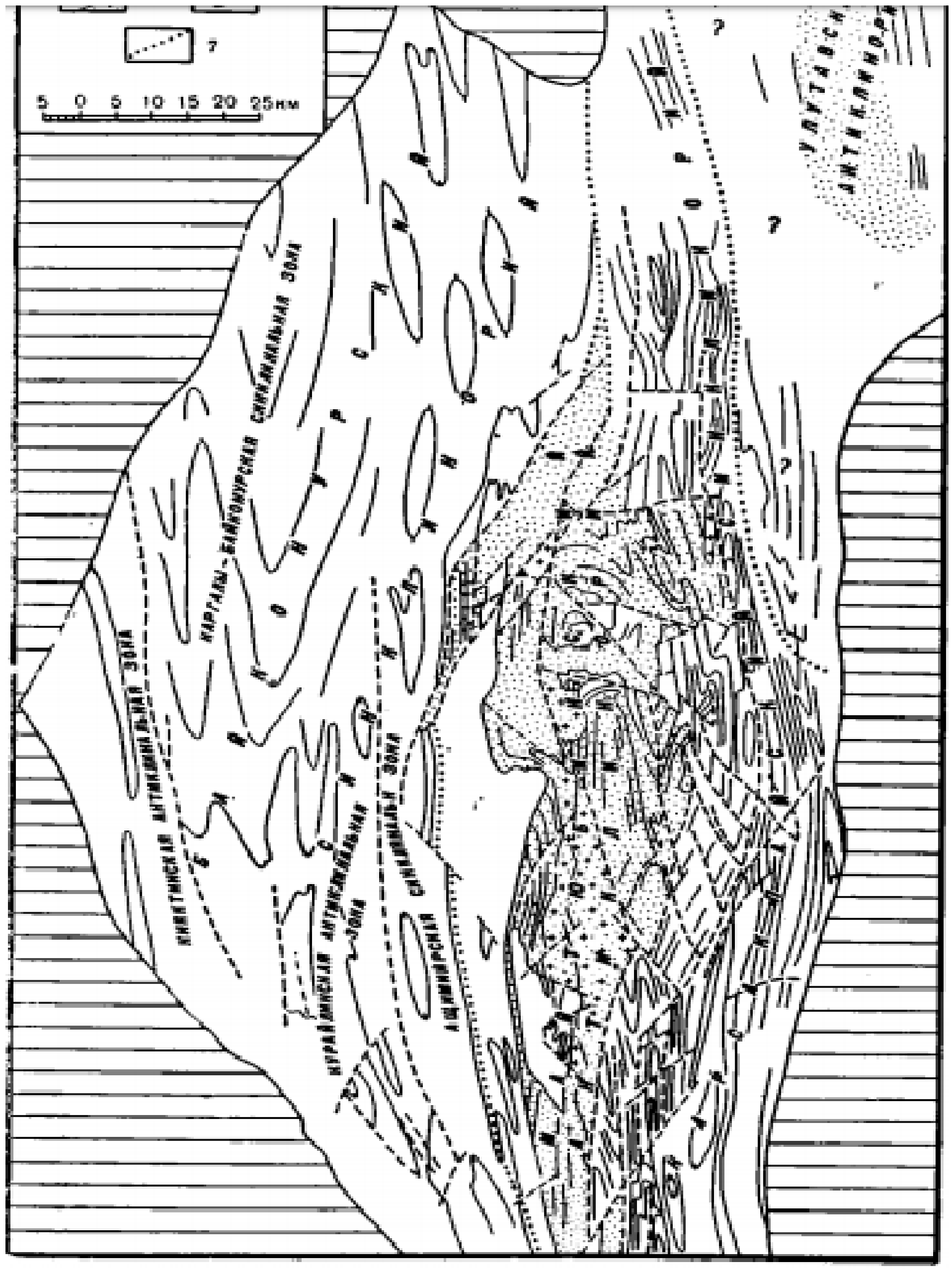
The carbon-siliceous-clay formation is composed of rocks of the Koktal Formation, identical to the rocks of the Zaltau Formation. The formation is characterized by vanadium in the lower parts of the section and bariton in the upper.

Thus, the considered variant of the stratigraphic section of the Precambrian Karsakpaya allows to sharply increase prospects for the search for deposits of ferrous, non-ferrous, rare and polymetals in the region. This fact is confirmed by the identification of the Dyusembay polymetal deposit in the area predicted in topic No. 421, the polymetallogenic zone.

2.4 Tectonics

The structural and tectonic structure of the Karsakpay region is very complex. The most detailed is described by Yu.A. Zaitsev(1975).

The area of the Dusembay site is located at the junction of the core and the eastern wing of the Maityubinsk anticlinorium. Below we dwell on the description of these structures.



Picture 2.3 – Tectonic structure of the Maytube anticlinorium

The structural elements of the region distinguished within the Caledonian basement are distinguished by the nature of folding, composed of various folded complexes, characterized by intrusive complexes of different ages, composing arrays of various shapes and conditions of implementation. When isolating tectonic (blocks) inside the folded Caledonian basement, gravimetric materials were used very widely.

Structurally, the Maytube anticlinorium is very heterogeneous . By the nature of folding, its core, western and eastern wings are separated.

Three extended zones with a common north-north-western strike are distinguished in the core of the Maytube anticlinorium: from the south-west Zhiydinsky Altuayskaya; Central Maytyubinsk (gneiss belt) and from the northeast - Nasymbay-Koktyubinsk . The area of the Dyusembay site covers only part of the Nasymbay-Koktyubinsk zone.

This zone is located to the north-east and east of the Central Maytobe gneiss belt. The zone is characterized by the development of direct brachioscopic folds and simple linear folds, sometimes complicated by disharmonious and explosive small folding.

One of the largest structures is the Dusembay anticline, extending in the meridional direction for 20 km.

The core of the anticline is composed of rocks of the Kosobin and Dusembay formations and granite gneisses. The eastern wing and southern pericline are formed by the rocks of the Zhaunkar , Zhilandysay and Tumurzinsky suites, and to the west of the wing are the rocks of the Zhaunkar and Koldybaishokin suites. The anticline has a simple structure of the core and east wing. The hinge plunges south at angles of 20-30 °. On the east wing, tilt angles reach 40 °. The east wing is complicated by a series of small northwest and meridional faults. Further to the east, as we approach the Kyzyshek fault, small linear folds of meridional strike appear with a length of 4-5 km and a width of up to 1 km with angles of incidence of 50-60 ° on the wings.

The southern part of the Dusembay anticline is characterized by a zone of small longitudinal brachiskladoks whose length does not exceed 4 km. These folds are composed of rocks of the Zhilandysay Formation. The angles of incidence on the wings vary widely (20-70 °). Some folds are distinctly fracturing. All of them are breached by numerous small bodies of late Ordovician diorites, which are apophyses of the Maityubinsky massif. The data of gravity and magnetic exploration allowed us to identify the deep contours of their distribution (up to a depth of the granite roof of about 500 m). This zone of small folds is elongated by 4-6 km in length and is limited from the east by the Kyzymshek gap.

To the south of it is a separate field granite -gneysov and gneiss on the right bank of river Dyusembay dome-shaped folds of the Nasymbay anticline type are developed here , in the core of which there is a granite- gneiss massif. The crease is about 4km long and 2km wide. The angles of incidence on the wings and pereklinami are 50-70 °. Two synclines with a wingspan of up to 0.7 km and incidence angles of 60-80 ° are located southwest of the Nasymbay anticline. All these folds are straight, only at the Kyzymshek rupture is a steep (up to 50 °) monocline composed of porphyroids of the Zhilandinskaya Formation.

This zone to the west is limited by the outcrops of the granitoids of the Maityube massif, and from the east by the Kyzymsheksky fault. As indicated above, at the base of the zone under consideration along its entire length there is a deep hidden part of the Maytube massif, which is established by gravimagnetic fields and confirmed by geological data.

The eastern wing of the Maityubinsky anticlinorium is composed of rocks of the upper suites of the Maytyubinsky series (mainly the Kumolinsky suite) and overlapping them disagreeingly with the Bozdak series. It is characterized by narrow linear folds of submeridian strike. These folds are morphologically similar to the folds of the Karsakpay synclinorium. Nevertheless, Yu.A. Zaitsev (1975) separately singled out the eastern wing of anticlinorium.

The eastern wing of the Maityubinsk anticlinorium along the Kyzysheksk longitudinal fault borders on the west with the core, and in the east - with the Karsakpaysky synclinorium along the Karsakpaysky fault. It represents a zone that is sharply distinguishable in structural style from adjacent structural zones. The strata composing it are plunging to the east, being crumpled into numerous longitude linear folds. For all these folds, a close morphology and a single structural plan. From nucleus folds anticlinorium they differ in length (up to 15-20 km at the maximum width of 1-2 km), the layers steep angles of incidence on the wings (40 ° to 60 °, sometimes to the vertical) and priostrennymi locks. These folds are complicated on the wings by smaller folds of various orders, sometimes by curling . The most intense folded faults near the Karsakpay fault.

Among the largest folds that form the eastern wing of the Maityubinsk anticlinorium , there is a system of synclines elongated longitudinally along the Karsakpay fault and made by various suites of the Bozdak series.

The anticlines separating them are reduced. They are trimmed by long longitudinal discontinuous violations. Individual anticlinal folds are almost completely destroyed. Therefore, here, two adjacent synclines come into contact along the gaps.

The largest synclinal folds that stand out in the eastern wing of the anticlinorium within the study area are Karasai , Baizhan, and Seitskaya .

The Karasai and Baizhan synclines, respectively 16x3 and 16x2 km in size, have a similar structure. They are torn apart by diagonal discontinuities of the northwestern strike (the Bastyubinsky shift and smaller ones), along which a certain shift of the fold axes occurs. To the west of the Baizhan synclinal there is a narrow and long, circumferentially torn off from the west and anticline tilted to the west in essence, which is a continuation to the south of the Koktyuba anticline. Even to the west, directly adjacent to the Kyzyshekskoye Fault, a narrow, overturned to the west, syncline (a continuation of the Belkuduk syncline), performed by the Belkuduk suite of the Bozdak series, can be traced .

The western wings of the Karasai and Baizhan synclines are saturated with stratum bodies of the Late Proterozoic gabbro (on the Dyusembay site they are widespread in the southeastern part), which form arrays of a phacolite type that are complex in structure.

The Seit synclinal located to the south was made by a pack of conglomerates, porphyroids, porphyritoids, and feldspar schists of the lower Belkuduk Formation. Unlike the northern synclines, it is most closely located to the Karsakpay fault.

Discontinuous violations are widespread on the eastern wing of the Maityubinsk anticlinorium. Gaps are decrypted and mapped on the terrain according to the displacement of different horizons and packs, and are also recorded according to geophysical data. Among longitude faults, the largest are Kyzysheksky and Karsakpaysky with displacement amplitudes of more than 1 km and 4-5 km, respectively. According to the interpretation of gravimetric anomalies, they have eastern dip incidence at angles of 60-85 °.

Gaps in diagonal systems (northwest and northeast) are predominantly vertical. The amplitudes of displacements along them range from several tens to hundreds of meters.

Of these faults, the most significant in the area is the Bastyubinsky fault-shift of north-western strike, characterized by a steep fall to the northeast (60-80 °) and a horizontal amplitude of about 3 km. Along the fault slip, the granitoids of the North Sarysai massif are transformed into cataclastic gneiss granites. The width of the gneiss granite zone is from 0.5 to 1.5 km.

Intrusions are not characteristic of the eastern wing of the Maityubinsk anticlinorium . On the surface are removed only array sredneproterozoyskih granite -gneysov near mountain Kumdyadyr and small arrays Late Ordovician granitoids on the right bank of the river .B eleuty .

The next large structure of the region is the Karsakpay synclinorium , bordering the eastern wing of the Maityubinsk anticlinorium along the Karsakpay fault.

Different-aged folded complexes take part in its structure. Within its limits, the Karelian folded complex, composed of basalt-dacitic and jespilite formations (corresponding to the Aralbay and Karsakpai series), is most widespread .

In the largest synclinal folds, there are younger folded complexes composed of volcanic-shale molassoid and shale-carbonate formations belonging to the Grenville folded complex. In stratigraphic terms, these formations correspond to the Bozdak series. The Karsakpay synclinorium is represented by a series of linear, often overturned folds elongated in the submeridional direction. The width of these folds usually ranges from tens of meters to 1.5km, rarely 3-4km. Their length reaches tens of kilometers. Large folds are often complicated by smaller ones , and disharmonious folds of flow and lamellae are widely developed in shale complexes . Here, overturned folds are often observed, the slope of the axial surfaces of which varies in cross sections of the synclinorium. At the eastern border, the axial surfaces of the folds fall to the west at angles of 80-45 °, as they approach the

Karsakpay gap, the inclination angles decrease and the folds become either straight or inclined to the east at angles of 70-80 °.

According to the peculiarities of the structure, the Karsakpay synclinorium is divided into three sections, alternating in the longitudinal direction: North, Central, South.

The central section covers the narrowest part of the synclinorium, adjacent from the south and north to the village. Karsakpay. Here, the section of the Karsakpay series is not complete, and folding is the most intense. On this site, the synclinorium is composed of the Aralbaisk and Karsakpai series. In a small area north of the village. Karsakpay also developed rocks of the Bozdak series and the bottoms of the Beleutinsky.

The base structure of the central section is made up of narrow, often isoclinic and tilted folds, the length of which is in the range of 1-20 km. Their width usually does not exceed hundreds of meters, sometimes reaching up to 1.5km. The largest fold of this type is the Baizhan synclinal. The core of the fold is composed of slates and marbles, and the wings are porphyritoids of the Balbrun suite. Throughout, it is composed of stratum bodies and rods of gabbro-diabases and is complicated by numerous steep faults of the north-western direction.

Discontinuous violations within the sites are developed widely. The largest of them belong to the longitudinal system. Karsakpay fracture controlling outputs to the surface greenschist strata uplift is steep, shifter falls east at angles 50-80 °.

Within the synclinorium, steep faults of the northwest and northeast directions play an important role, the former often having a noticeable shear component.

The tectonic structure of the Karsakpay uplift can also be considered from a different point of view - this was undertaken on the topic No. 421 of the Zhezkazgan GRE (Suleimenov, Kogai et al. 1980-83).

The nature of the gravimagnetic field, taking into account the results of the formation analysis and data from the NHS, allows us to represent the territory under consideration as consisting of large blocks of the earth's crust bounded by deep faults. These large blocks are divided by tectonic disturbances of higher orders into a number of small horsts and grabens.

As mentioned above, the studied areas are located within the eastern part of the Maityubinsky and western parts of the Karsakpay blocks.

The Maityubinsky block is separated from the Baikonursky Zhaltausky deep fault from the west, and from the east through the Kyzysheksky deep fault it borders on the Karsakpaysky block. It is composed of folded complexes of the Late Horogenic and platform stages.

Within the central part of the Maityubinsk block, three extended zones of north-north-western strike are distinguished, characterized by the development of large simple linear folds. The central part is characterized by narrow linear, often isoclinic folds in gneisses and granitized complexes.

Within the block are the Late Ordovician granitoids of the Maityubinsky massif, subalkaline granites of the Aktassky granite and granite gneisses of the Zhaunkarsky and syenites of the Karsakpay massifs.

The volcanogenic formation (B_1) and the granitoids of the Zhaunkar complex comagmatic with it form the Maityubinsk volcanoplutonic structure in the central part of the block . Platform complex (C) is developed east and west of the structure, composing narrow grabens of meridional strike. The molassoid formation (B_2) also composes narrow grabens.

The western wing of the Maityubinskaya volcanic- plutonic structure is composed of rocks of the platform complex performing graben synclines and, very rarely, the geosynclinal complex (A_{2-3}), which compose a horst anticline.

In the gravitational field, the Maityubinskaya volcanic- plutonic structure is characterized by a region of reduced gravity with individual local anomalies Δg . The magnetic field of the structure is lowered with separate sections of a mosaic character. The general reduced nature of the gravimagnetic field is due to the predominance of non-magnetic, with a low density of granites, granite gneisses, rhyolites and porphyroids that make up this structure. The platform also complex clearly indicated a reduced gravitational field, negative anomalies TU and low values of p.

The Karsakpay block is formed by the Karelian and Grenville folded complexes. The block structures are developed within the block: horst-anticline and graben-syncline. The kernels of horst anticlines are composed of rocks of green shale- spilite formations, and the graben-synclinal is made of rocks of volcanic-shale, flyschoid and carbon-terrigenous formations.

3 Electrical exploration studies

3.1 Equipment and method of electric exploration works

Hardware TDEM-ARMIT

The TDEM hardware complex can be divided into two components:

1 Generator Station

2 Measuring complex

The generating station is a set of equipment for supplying current to the loop, the measuring complex is equipment for sensing.

The complex consists of the following:

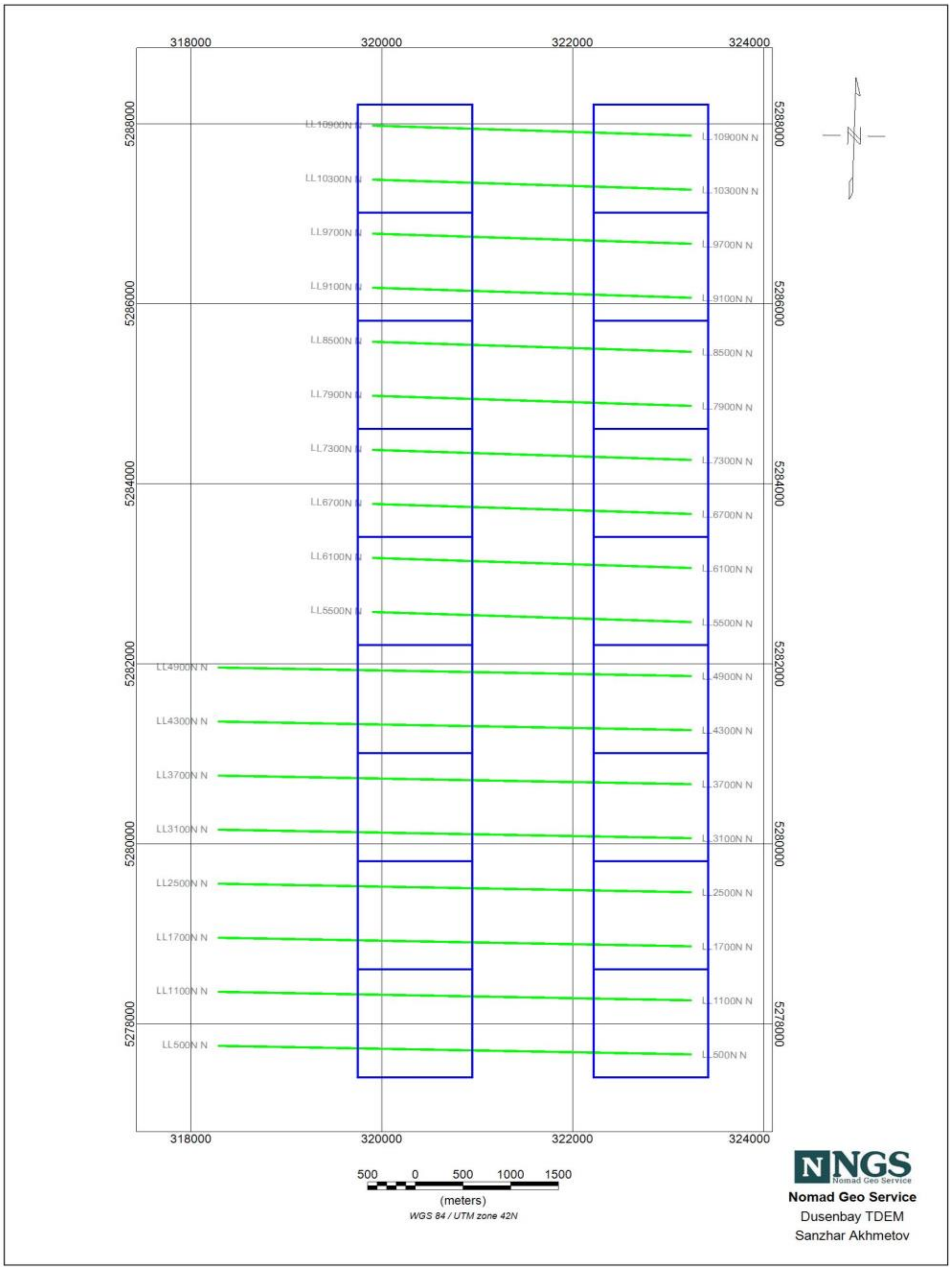
Generator station		
1	Generator	
2	EMIT Transmitter controller	
3	DuraTank	
4	Transmitter	
Measuring complex		

5	SMARTDEM24	
6	Armit	

Arrangement pattern

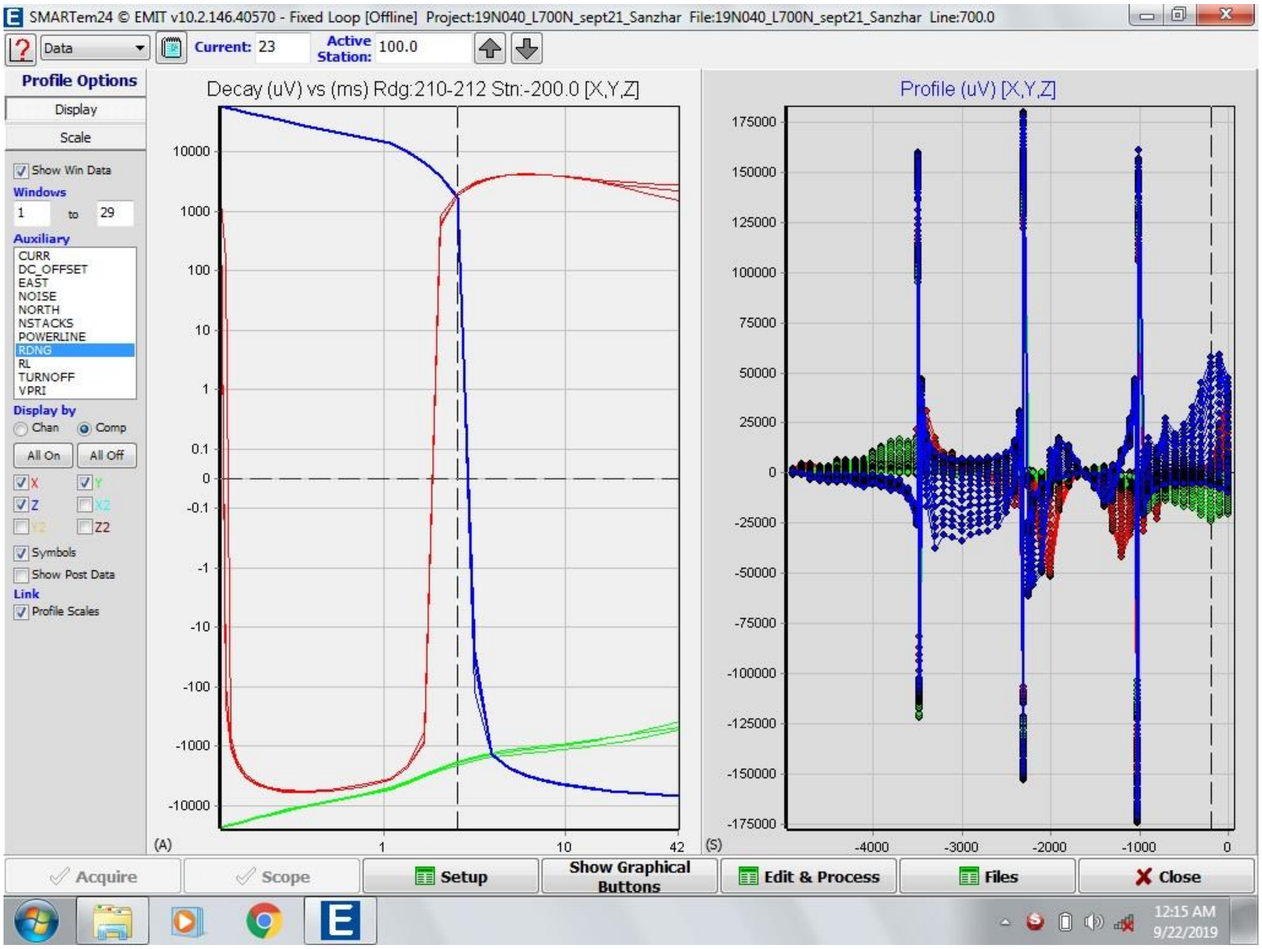
Studies are profiled electromagnetic sensing, wherein the electromagnetic field excitation source is a loop , through which passes an alternating current and changes of this field is recorded by inductive sensors.

Below are the TDEM arrangements in the Dusembay section, where the sounding profiles are shown in green and the supply loops are shown in blue. In this project, two loops were used for one profile.

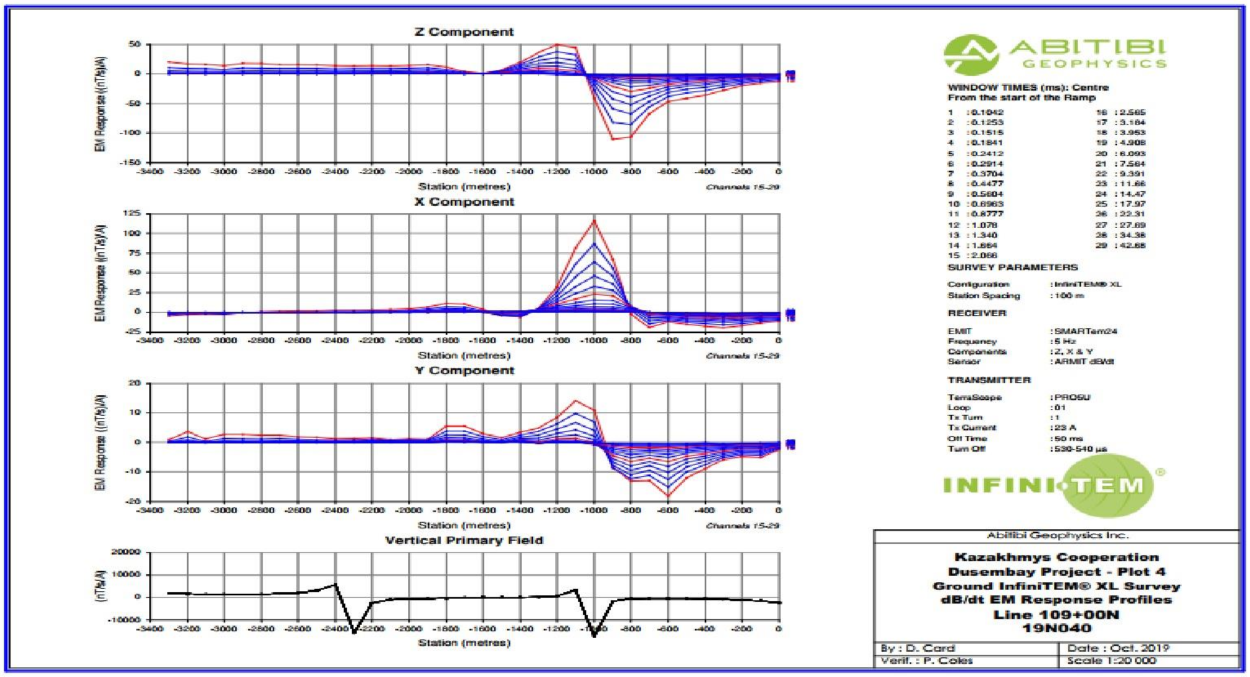


Picture 3.1 – the scheme of mining site

The following is an example of a measurement. The curves on the X Y Z channels are shown on the left, the general graph for the entire profile on the right



Picture 3.3 – Interactive TDEM Data Measurement



Picture 3.4 - TDEM Preliminary Profile Results.

Processing and interpretation of the ES data was carried out in the Maxwell system.

Maxwell is a 32-bit Windows application for processing EM data.

Maxwell is designed to handle all forms of EM geophysical data: time, frequency, ground, airborne, dB /dt and B-field.

In Maxwell possible to conduct automatical processing data sets to calculate the inversion with manual 1D - modeling. The application creates professional high-quality presentations of plans, profiles, spectra and visualizations of models and has an interface for transferring files to other software.

3.2 TDEM survey srecifications

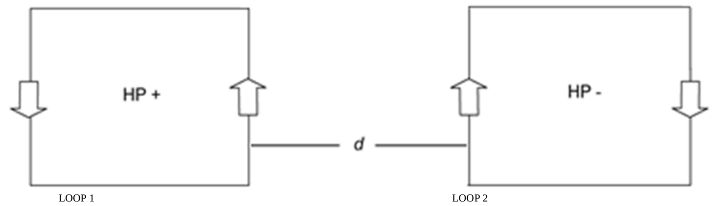
Table 5 - Hinge Specifications

- SHOOTING TYPE — **TDEM** (**Time Domain** Electromagnetic Survey)
  Hinge configuration: Infini TDEM R XL
  SHOOTING INTERVALS: 50M & 100M
- MEASURING — VERTICAL Z AND HORIZONTAL X AND Y B FIELDS AND PARTIAL DERIVATIVES WITH RESPECT TO TIME (∂B / ∂t) OF THE SECONDARY EM FIELD.
- COMMON VOLUME OF THE WORK — **18 lines – 72.2l-км**

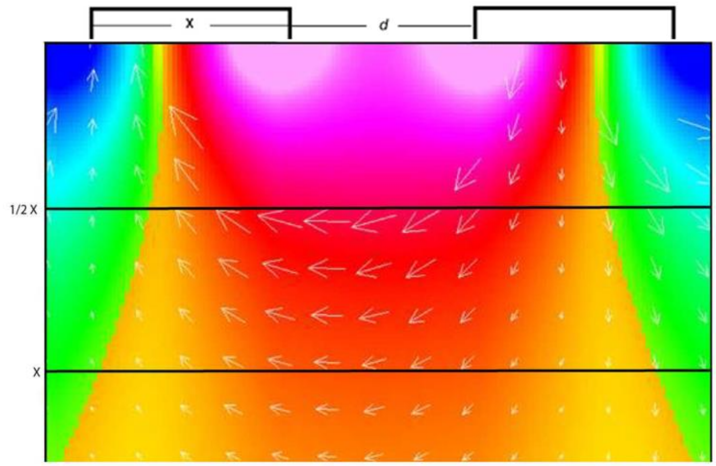
Loops #	Shooting lines	Dimensions	Data collections	Frequency(Hz)	Current A)	Ramp (мкs)
Loop 1	L 109+00N	3600x1200 м	September from 7 to 21, 2019	5	23	540
	L 103+00N				23	530
Loop 2	L 97+00N				23	510
	L 91+00N				23	510
Loop 3	L 85+00N				23	530
	L 79+00N				23	530
Loop 4	L 73+00N				23	520
	L 67+00N				23	520
Loop 5	L 61+00N				23	500
	L 55+00N				23	500
Loop 6	L 49+00N				23	520
	L 43+00N				23	520
Loop 7	L 37+00N				23	520
	L 31+00N				23	520
Loop 8	L 25+00N				23	520
	L 19+00N				23	520
Loop 9	L 13+00N				23	520
	L 7+00N				23	520

- CONFIGURATION OF INFINITEMR XL

A: Configuration InfiniTEM® XL - map



B: Configuration InfiniTEM® XL - section



Picture 3.5 - InfiniTEM Loop Configuration

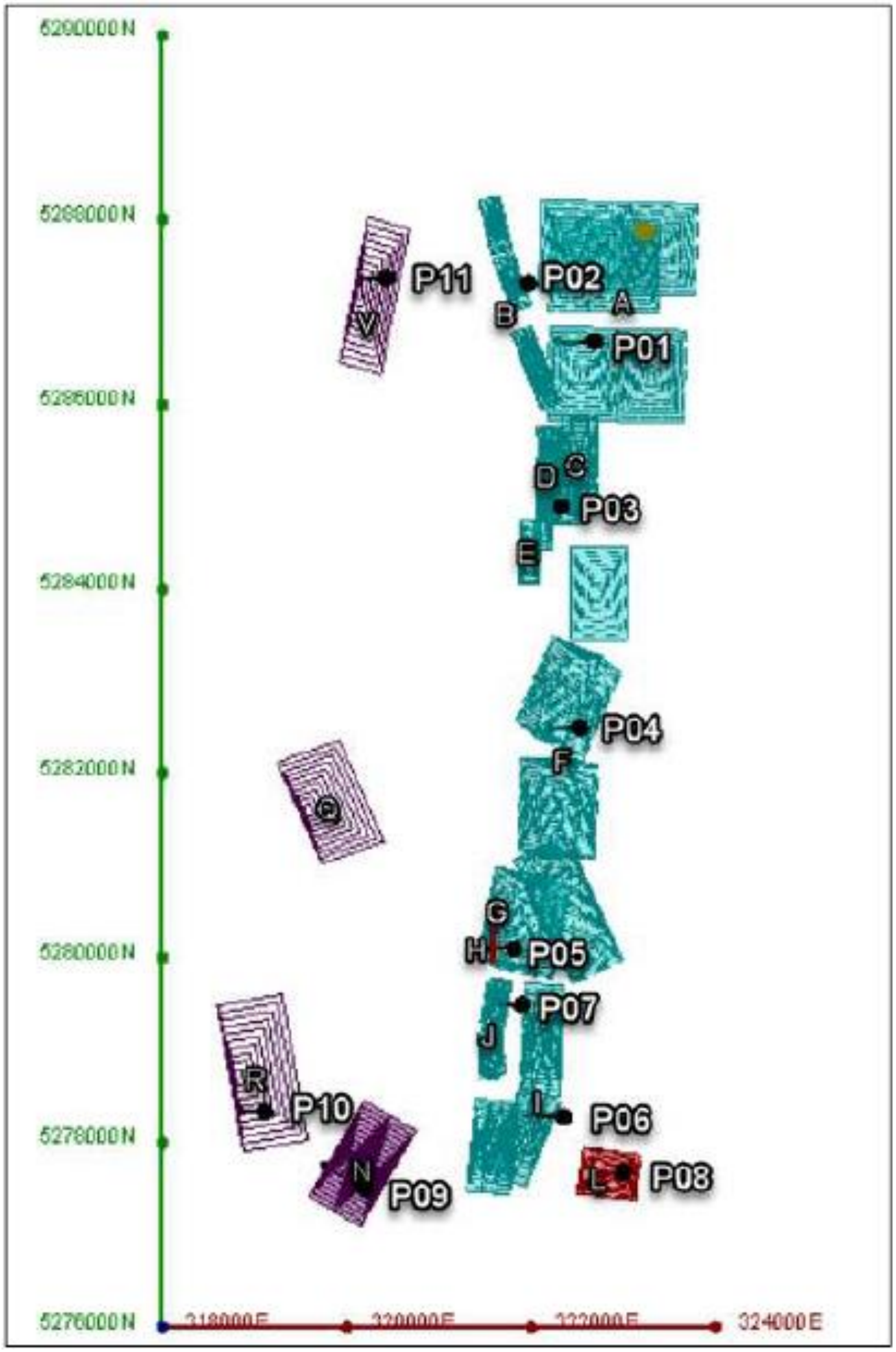
4 Results electric exploratory works

Time Domain Electromagnetic Surveying (TDEM) has revealed many large conductive bodies throughout the survey area. The interpretation identified 22 axes of conductors, named from A to V, which are shown on the map of the Geophysical interpretation (Fig. 4.2). The survey was carried out on lines located at a distance of 600 m from each other, in order to minimize costs over a large survey area. The large distance between the survey lines means that the determination of the axes of the conductors is the best estimate in this case. In order to correctly correlate stratigraphy from one line to another, it is necessary to significantly reduce the interval between the lines.

By configuration of Infini TDEM ® XL has worked on the site is correct, and very high peak values were observed throughout the survey. Simulations showed very large conductor anomalies. With this size, the simulation may lose some accuracy, especially in terms of immersion, depth and power of the conductor.

On the geological situation is, the site was not previously known, so at the moment modeling suggests steep declines. As geological understanding develops, modeling can be revised with new geological information.

The study was aimed at the resistivity minima found by the previous Z TEM study. If any V TEM data was collected at the site, then integrating the Z TEM, V TEM, and Infini TDEM XL data along with a more detailed description of the geological target model can be very useful.



Picture 4.1 – Map of all simulated plates and recommended wells

Picture 4.2 – Map of interpretation

Geological objective of the project "Dusembay " is the search for lead-zinc - sulfide of mineralization timed of the various breeds of graphite metasedimentation formations. Both sulfides and graphite formations can affect conductors with a wide range of conductivity. In the case of ore sulfides, galena can be moderate or highly conductive sulfide, while sphalerite itself is usually not conductive. Given the size and length of stratigraphic conductors deposited on the card, it is likely that they are largely represent formational conductors, which can be the aforementioned graphitized metasedimentic layers. If the ores themselves are more conductive than formation conductors (it is especially likely if pyrrhotite is a significant concomitant mineral), then the studied areas with high conductivity or smaller simulated anomalies can narrow the exploration focus. It is assumed that mineralization occurs upon contact with meta-sedimentary units, in an area where smaller conductors are correlated and appear near larger conductors.

Research Areas

Simulation Maxwell plates were used to create models, direction n us x on the solution geological problems. As discussed above, values of such high amplitude require modeling a powerful plate to reproduce the model. The powerful plate method is less reliable than the classic thin plate method, and often the powerful plate will be much thicker than the real geology they seek to model. This complicates yet recommendations of wells for drilling, since the choice of location within a powerful plate requires some guesswork, and determining the best place for anomalies may often be found on one of the edges of plates of powerful, but not in the center. This is simply the effect of the math used in simulation software.

To solve the problem of precision modeling of powerful plates, an advanced modeling method was used, which allows better focus on priority conduction zones. The technique is based on the fundamental principles of TDEM:

1. The half-width anomaly (size along the line) is matched for the target at a given distance.
2. The shape of the anomaly gives geometric information about the orientation of the conductor.
3. The anomaly of the half-width and shape does not change if the amplitude value is scaled.

Using the above principles, we can perform a thin-plate model for most conductive anomalies by scaling the amplitude of the anomalies down until amplitudes that can be matched to thin-plate models are achieved. Then, drilling recommendations are given that could cross both thin plates and thick models of plates.

Modeling was performed for all the “strong” and “moderate conductors in this survey, as defined in the table below. Weak conductors are generally more complex and less accurate for modeling, so they were excluded at this time. However, if a specific weak conductor of interest for exploration, modeling can be undertaken before drilling.

The simulated anomalies showed various signs, including:

- Very large, very powerful and strong conductivity.

Anomalies A and F

- Large, powerful and strong conductivity.

Anomalies B - E , G , I and J

- Moderate size, moderate power and very strong conductivity.

Anomaly H

- Deep and strong conductivity producing a uniquely wide anomaly

Anomaly L

- Low to moderate power and moderate conductivity.

Anomalies of N, R, Q and V

A set of eleven proposed boreholes was transmitted, the purpose of which is to select an appropriate range of simulated geophysical features above (and conductivity ratings A, B, D, F, H, I, J, L, N, R, V).

Table 1 – Recommended wells

Recommended wells ID	Objective	Well coordinates WGS84 / UTM зона 42N			Tilt angle (°)	Azimut (°)	Depth(м)	Estimated intersection (м)
		East(м)	North (м)	Weight (м)				
P01	A	322 685	5 286 680	540	60	270	800	650
P02	B	321 970	5 287 310	545	60	270	400	300
P03	D	322 330	5 284 895	535	60	270	250	150
P04	F	322 530	5 282 495	535	60	270	650	550
P05	H	321 805	5 280 100	535	60	270	500	400
P06	I	322 350	5 278 285	535	60	270	750	600
P07	J	321 900	5 279 490	535	60	270	650	550
P08	L	323 000	5 277 680	530	80	270	1100	900
P09	N	320 200	5 277 500	515	50	300	800	650
P10	R	319 115	5 278 335	510	60	270	500	400
P11	V	320 425	5 287 360	535	60	270	550	450

* Planned wells do not account for deviation. The geologists planning these wells should adjust the parameters to reflect the expected deviation. The goal is to be as close as possible to the drilling location where the planned wells intersect the model plate. The plate model was sent to 3D DXF files on a DVD.

Table 2 – Description of the Anomaly InfiniTDEMR XL project Duysembay

<table>
<tr><th rowspan="2">Anomalies</th><th rowspan="2">Plate models</th><th colspan="2">Grid coordinates</th><th colspan="2">CoordinatesUTM WGS84 / UTM зона 42N</th><th rowspan="2">Modeled Depth To Top (м)</th><th rowspan="2">Conductivity: Weak, Medium, Strong</th><th rowspan="2">Notes</th></tr>
<tr><th>Line</th><th>Place</th><th>East</th><th>North</th></tr>
<tr><td rowspan="4">A</td><td rowspan="4">A1
A2
A3</td><td>L 109+00N</td><td>10+00W</td><td>322 233</td><td>5 287 902</td><td rowspan="4">160-280</td><td rowspan="4">Strong</td><td rowspan="4">Anomaly A indicates the presence of a large, strong conductor in the Notrho-eastern part of the survey grid. This may be due to one source or several conducting horizons at a depth in the immediate vicinity of each other.</td></tr>
<tr><td>L 103+00N</td><td>9+00W</td><td>322 333</td><td>5 287 299</td></tr>
<tr><td>L 97+00N</td><td>10+50W</td><td>322 182</td><td>5 286 704</td></tr>
<tr><td>L 91+00N</td><td>9+50W</td><td>322 282</td><td>5 286 101</td></tr>
<tr><td rowspan="3">B</td><td rowspan="3">B1
B2
B3
B4</td><td>L 109+00N</td><td>17+00W</td><td>321 533</td><td>5 287 925</td><td rowspan="3">350-395</td><td rowspan="3">Strong</td><td rowspan="3">Anomaly B includes the conductive signs observed in the three survey lines. The anomalies seem smaller and closer to the surface than the anomaly A. It is difficult to be sure whether there is really continuity between the conductors of anomaly B through the lines, because of the wide interval between the lines. The anomaly must be traced, it is important to do this near the survey lines.</td></tr>
<tr><td>L 103+00N</td><td>14+00W</td><td>321 833</td><td>5 287 315</td></tr>
<tr><td>L 97+00N</td><td>12+00W</td><td>322 032</td><td>5 286 709</td></tr>
<tr><td rowspan="2">C</td><td rowspan="2">C1
C2</td><td>L 85+00N</td><td>9+50W</td><td>322 282</td><td>5 285 501</td><td rowspan="2">505</td><td rowspan="2">Strong</td><td rowspan="4">Anomalies C and D are apparently located approximately along the trend from conductor A of the horizon. The TDEM anomaly forms along the lines L 79 + 00N and L 85 + 00N have a sharper shape, which suggests the presence of two separate anomalies located closer to the surface. It is likely that these two anomalies are the same ones that produce the anomaly deeper further to Notrh. When two conductors differ in depth, their sensitivity merges and creates an anomaly that looks like a single source, such as anomaly A.</td></tr>
<tr><td>L 79+00N</td><td>9+00W</td><td>322 331</td><td>5 284 899</td></tr>
<tr><td rowspan="2">D</td><td rowspan="2">D1
D2</td><td>L 85+00N</td><td>10+00W</td><td>322 232</td><td>5 285 503</td><td rowspan="2">475</td><td rowspan="2">Strong</td></tr>
<tr><td>L 79+00N</td><td>10+50W</td><td>322 181</td><td>5 284 904</td></tr>
</table>

Аномалии	Plate Models	Grid Coordinates		Coordinates UTM WGS84 / UTM зона 42N		Modeled depth to the top (м)	Conductivity: weak, medium, strong	Примечания
		Line	Place	East	Notrh			
E	E1	L 73+00N	11+00W	322 131	5 284 306	275	Strong	Anomaly E is a strong conductor that sits approximately along the strike from anomalies of C and D trends. E has a much smaller amplitude, so this trend will be better focused on the anomalies of C and D.
F	F1 F2 F3 F4	L 73+00N	6+00W	322 631	5 284 289	360-220	Strong	A strong, extensive conductive trend, identified as anomaly F, runs 3 kilometers along the line L 73 + 00 Nt oL 31 + 00 N. This conductor appears just at the end of trend C, D and E. It is possible that this the conductor is a biased continuation of the trend of C, D and E, which has been biased by the deformation of geological stratigraphy. If structural control is a key factor for mineralization within the formation conductors in this area, then the north end of anomaly F and the south end of anomalies C, D may be of interest for further observation.
		L 67+00N	7+00W	322 531	5 283 693			
		L 61+00N	9+00W	322 330	5 283 099			
		L 55+00N	9+50W	322 280	5 282 501			
		L 49+00N	9+50W	322 253	5 281 888			
		L 43+00N	10+50W	322 153	5 281 290			
		L 37+00N	11+00W	322 103	5 280 690			
		L 31+00N	10+50W	322 154	5 280 090			
G	G1	L 37+00N	13+00W	321 903	5 280 693	355	Strong	Anomalies G, H, I, and J indicate the presence of a more complex, finer conductive structure in the southern part of the anomalous trend F. It is possible that they are all part of the same common geological source as trend F. However, K and H are located much further west than others, so it is most likely that they are associated with different geology.
H	H1	L 31+00N	16+00W	321 604	5 280 100	295	Very Strong	
I	I1 I2	L 25+00N	11+00W	322 104	5 279 490	460-215	Strong	
		L 19+00N	13+00W	321 905	5 278 894			
		L 13+00N	10+50W	322 155	5 278 289			
		L 7+00N	13+00W	321 906	5 277 693			

Аномалии	Plate Models	Grid Coordinates		Coordinates UTM WGS84 / UTM зона 42N		Modeled depth to the top (м)	Conductivity: Weak, medium, Strong	Примечания
		Line	Place	East	Notrh			
J	J1 J2 J3	L 25+00N	16+00W	321 604	5 279 499	470-265	Strong	
		L 19+00N	17+00W	321 505	5 278 901			
		L 13+00N	18+00W	321 405	5 278 303			
		L 7+00N	18+00W	321 406	5 277 703			
K	N/A	L 109+00N	26+00W	320 634	5 287 955	N/A	Moderate	One line, a moderate conductor was detected at L 109 + 00N.
L	L1	L 7+00N	6+00W	322 605	5 277 680	230	Strong	Anomaly L is the only anomaly that shows a large width and some complexity only along the line L7 + 00N. The source extends east of horizon J and can be explained by several geological patterns, including a conductor running parallel to the survey line, a powerful sequence of folded conducting horizons starting on this line, or one very large / large massive conducting body. A large plastic body of 550 × 500 × 800 m in size was used for modeling. Since this anomaly appears only in the southern part of the region, further determination can be achieved by directing the study to the south.

Аномалии	Plate Models	Grid Coordinates		Coordinates UTM WGS84 / UTM зона 42N		Modeled depth to the top (м)	Conductivity: Weak, medium, Strong	Notes
		Line	place	East	Notrh			
M	N/A	L 7+00N	0+00W	323 205	5 277 669	N/A	Increasing	The increasing sensitivity of the average time was found in the eastern part of L 7 + 00N and near the edge of the model of conductor L. This may be associated with a separate conductor or may be associated with the edge of a large plate-like body, perhaps this leads to conductor L. As this anomaly increases , the shape of the anomaly shortens at the end of the line, so accurate modeling is not possible.
N	N1	L 25+00N	30+00W	320 204	5 279 525	325	Weak	Previously, an anomaly was detected in the southern part of the grid only 25 + 00 N to L 7 + 00 N. The anomaly is most noticeable on L 7 + 00E, and modeling suggests that it can propagate further south.
		L 19+00N	29+00W	320 305	5 278 924			
		L 13+00N	31+00W	320 105	5 278 327			
		L 7+00N	34+50W	319 756	5 277 734			
O	N/A	L 31+00N	22+00W	321 004	5 280 111	N/A	Weak	A subtle anomaly is the alleged presence of a weakly conducting body near the center of the studied region on the lines L 19 + 00N - L 31 + 00N.
		L 25+00N	23+50W	320 854	5 279 513			
		L 19+00N	24+00W	320 805	5 278 914			
P	N/A	L 19+00N	40+00W	319 205	5 278 944	N/A	Weak	A thin anomaly suggests the presence of a weakly conducting body in the southwest of the study area.
		L 13+00N	40+00W	319 205	5 278 343			
		L 7+00N	42+00W	319 006	5 277 748			
Q	Q1	L 49+00N	38+00W	319 403	5 281 940	465-70	Moderate	A moderate conductor was found in the western part of L 49 + 00 N to L 37 + 00 N.
		L 43+00N	36+00W	319 603	5 281 338			
		L 37+00N	37+00W	319 503	5 280 739			

Аномали и	Plate Models	Grid Coordinates		Coordinates UTM WGS84 / UTM зона 42N		Modeled depth to the top (м)	Conductivity: Weak, medium, Strong	Notes
		line	place	east	Notrh			
R	R1	L 25+00N	47+00W	318 505	5 279 557	N/A	Moderate	A moderate conductor is visible in the southwestern corner of the grid, west of the anomaly P at L 25 + 00 Nt oL 7 + 00 N.
		L 19+00N	45+00W	318 705	5 278 953			
		L 13+00N	44+00W	318 806	5 278 351			
		L 7+00N	48+00W	318 406	5 277 759			
S	N/A	L 73+00N	33+00W	319 932	5 284 378	N/A	Incresing	A buildup was found in the westernmost places L 73 + 00N to L 55 + 00N. This conductor can represent the Northern magnitude of the Q anomaly. Since sensitivity decreases at the end of the line, an extended study will be required to model this anomaly.
		L 67+00N	33+00W	319 932	5 283 779			
		L 61+00N	33+00W	319 932	5 283 178			
		L 55+00N	33+00W	319 931	5 282 579			
T	N/A	L 85+00N	20+00W	321 232	5 285 536	N/A	Weak	A weak but well-defined susceptibility is observed east of the S anomaly at L 85 + 00N to L 55 + 00N. An anomaly is best observed at L 67 + 00N, where the shape suggests that the source may be closest to the surface. Perhaps exposure in this area.
		L 79+00N	21+00W	321 132	5 284 939			
		L 73+00N	24+00W	320 832	5 284 348			
		L 67+00N	23+50W	320 882	5 283 747			
		L 61+00N	25+00W	320 731	5 283 151			
		L 55+00N	25+00W	320 731	5 282 552			
U	N/A	L 103+00N	23+00W	320 933	5 287 345	N/A	Weak	An anomaly was found in the northern part of the grid at L 103 + 00N to L 97 + 00N.
		L 97+00N	23+50W	320 883	5 286 748			
V	V1	L 103+00N	31+00W	320 134	5 287 372	N/A	Moderate	A moderate conductor was detected at L 103 + 00N.

The interpretation is a geophysical assessment of the Duisembay project, based solely on the data presented in the report. Geologists who are familiar with this area can better appreciate the geological significance of anomalous geophysical features. In addition, as time comes and information is provided by subsequent intelligence programs, the identified objects can be reevaluated. Integrating this data with other geophysical data in the area would be very useful.

5 Interpretation of geophysical anomalies

The tectonic position and general features of the rare-earth type of deposits

From the characteristics of rare-earth deposits it can be seen that they have quite serious differences in the mineral composition, morphology of ore deposits, the composition of the host strata and, finally, in the set of components suitable for industrial extraction to be unambiguously assigned to a single type of industrial deposits. Deposits of this type, localized with volcanic and sedimentary strata of middle Proterozoic. In all of these objects are often (but not permanently) contained in elevated, rarely industrial, amounts of rare earth and / or uranium minerals, copper sulfides, sometimes gold. All deposits of the class in question are confined to the host rocks of the early to middle Proterozoic. They are localized in areas of the continental crust that bear signs of initial, undeveloped rifting during the initial ore formation. Ore areas and individual deposits are located along large weakened zones in the continental crust in the form of regional faults and crushing zones. Ore formation can be stretched in time, but it is beginning usually synchronously with the accumulation of the enclosing strata or immediately follows it. Many deposits occur inside or directly above acid volcanic strata. Others are confined to sedimentary prisms, which are believed to have accumulated in aulacogens or along rifting continental margins. This position indicates that mineralization of the type under consideration is probably related in general terms to the extension of the crust following the initial stabilization of the earth's crust at the end of the early Proterozoic. Mineralogical, geochemical, and isotopic data indirectly indicate the relationship of these types of ore formation and ore- bearing rocks with the processes of carbonatite formation and mantle sources of rare earths.

The geology of the Dyusembay site fits into the model of the formation of the Middle Proterozoic rifting continental margins:

- in the range in vulkanoplutogenic (magmatic second) arcs and widespread calc-alkaline medium and lava acid composition, and in the nucleus arc ridge located granodiorite and granite intrusion. Copper-molybdenum-porphyry and tintungsten deposits are associated with them.

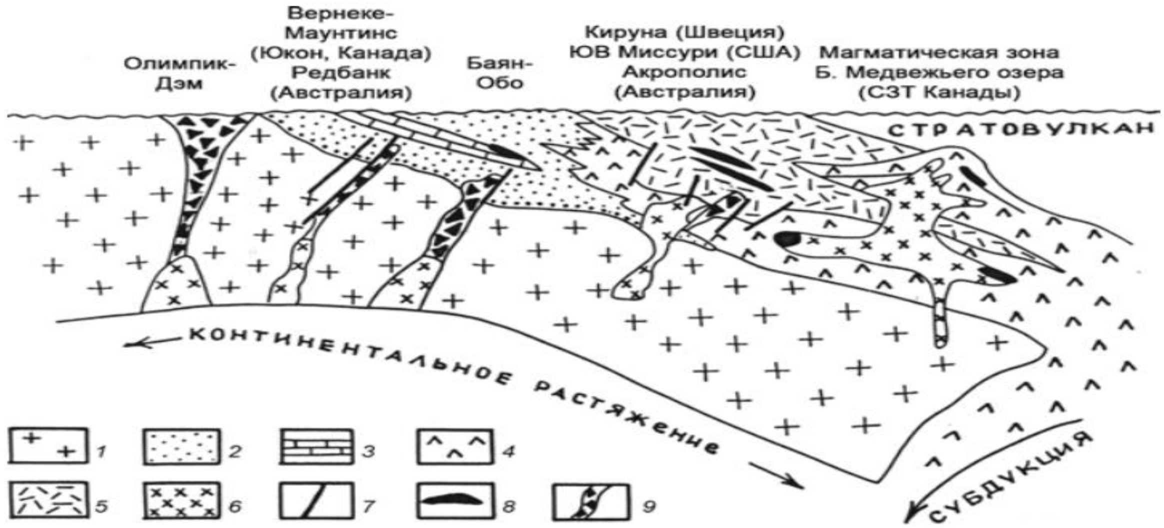


Рис. 9. Схематическое отображение тектонической позиции и обстановок формирования среднепротерозойских железоокисных (с медью, ураном, редкими землями, золотом) месторождений. По М. Хитцману и др. [11]

1 – гранитный фундамент; *2* – терригенные осадки; *3* – карбонатные породы; *4* – вулканиты среднего состава; *5* – кислые вулканиты; *6* – интрузии среднего состава; *7* – разломы; *8*, *9* – морфологические типы железоокисного (с медью, редкими землями, ураном, золотом) оруденения: пластовое (линзовидное) типа стратабаунд (*8*), в брекчиях, трубообразное (*9*)

Picture 5.1 – Model for the formation of Proterozoic deposit

Description and comparison of conductivity anomalies

Anomalies with high conductivity values (indicated by symbols from A to J) are concentrated in the eastern part of the site and have a meridional strike, crossing the site area from north to south.

The anomalies located in the eastern part of the site, according to the location on the geological map, are associated with tectonic disturbances of the meridional strike, breaking through the rocks of the Kumolinskiy suite (PR_2 *km*), consisting of blastopsammits schists and porphyroids along tuffs of rhyolite composition.

The northern part of the conduction anomalies (from A to E) are new areas of study (from profile 10900 to profile 7900).

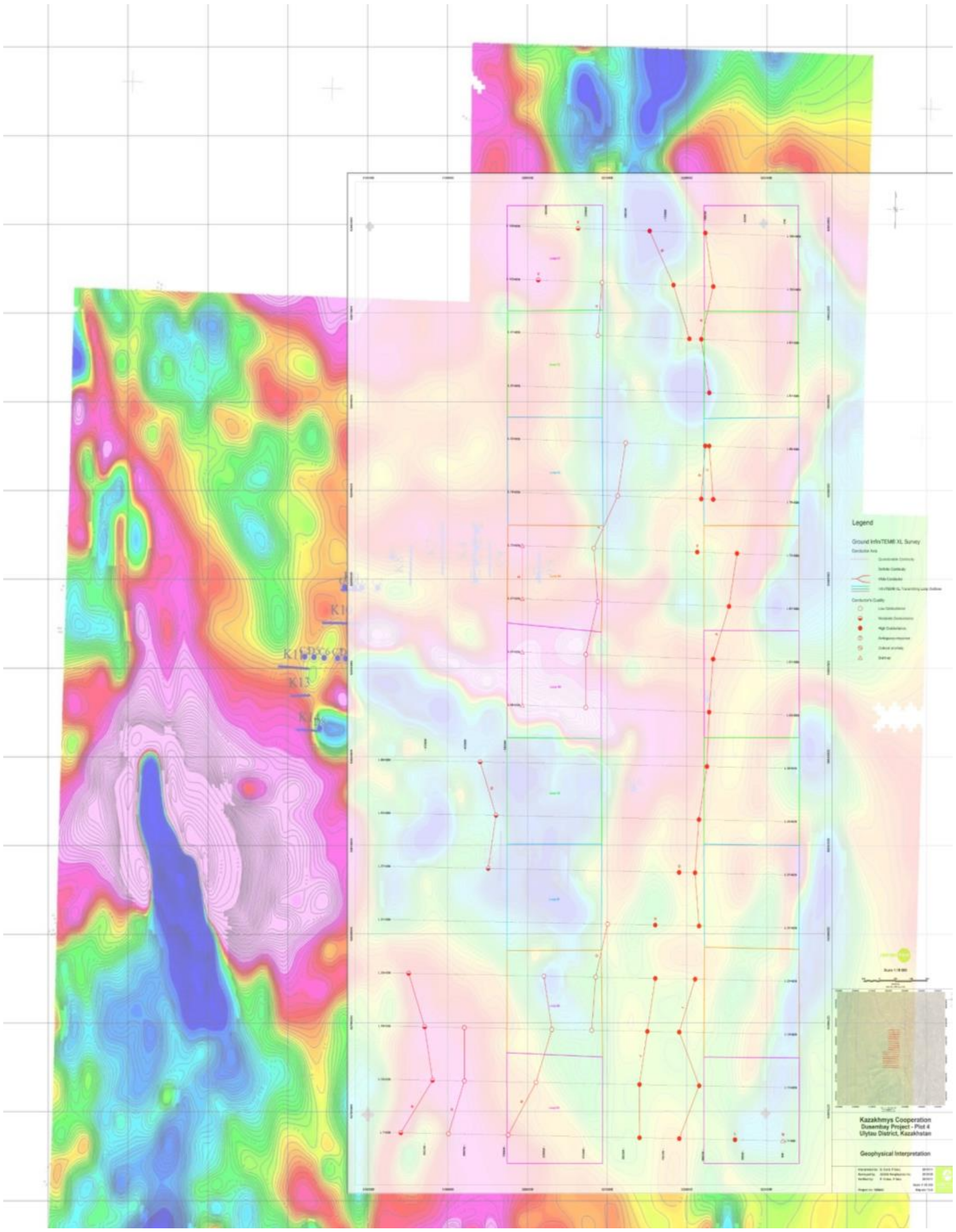
Anomalies of the F line (eastern part of profiles 7300–3100) are more studied by previous works. Part of the anomaly between profiles 6100 and 5500 can be identified (by core) from well D-11 (556 m), i.e. determine the composition of the rocks that cause high conductivity and, possibly, conduct laboratory studies to determine physical properties (resistivity).

The anomaly indicated by the letter G (eastern part of profile 3700) spatially coincides with the Pb- Zn ore occurrence indicated on the geological map.

The rocks that create the high conductivity of the abnormal line J (profiles 2500-700) can be identified by the complex of previous mining operations. Intensive drilling was carried out in the anomaly area - wells S-13 (200m), S-15 (200m) and S-18 (200). Here, according to previous work, lines of geological sections RL-2.1, RL-2.2 and RL-2.3 were built. Anomalies in the mean conductivity indicated by the letters P and Q are located in the southwestern part of the site (profiles 700–2500 (P) and profiles 300–4900 (Q)), are associated with zones of tectonic disturbances and intrusive bodies of diorites breaking through the Middle Proterozoic rocks Zhilandysay Formation (PR_2 *gl*) (conglomerates, sericite-biotite-feldspar schists, quartzites and marbles). The composition of the rocks, having average conductivity values, can be determined by the core of the D-9 well (517 m), drilled earlier at the exploration stage.

The zones of weak conductivity (O and N) are located in the south of the site (the middle part of the profiles 700 and 3100) and accumulate in the area bounded by tectonic rocks. In this zone, in 2019, the Customer of ER works scheduled mining operations (K-02).

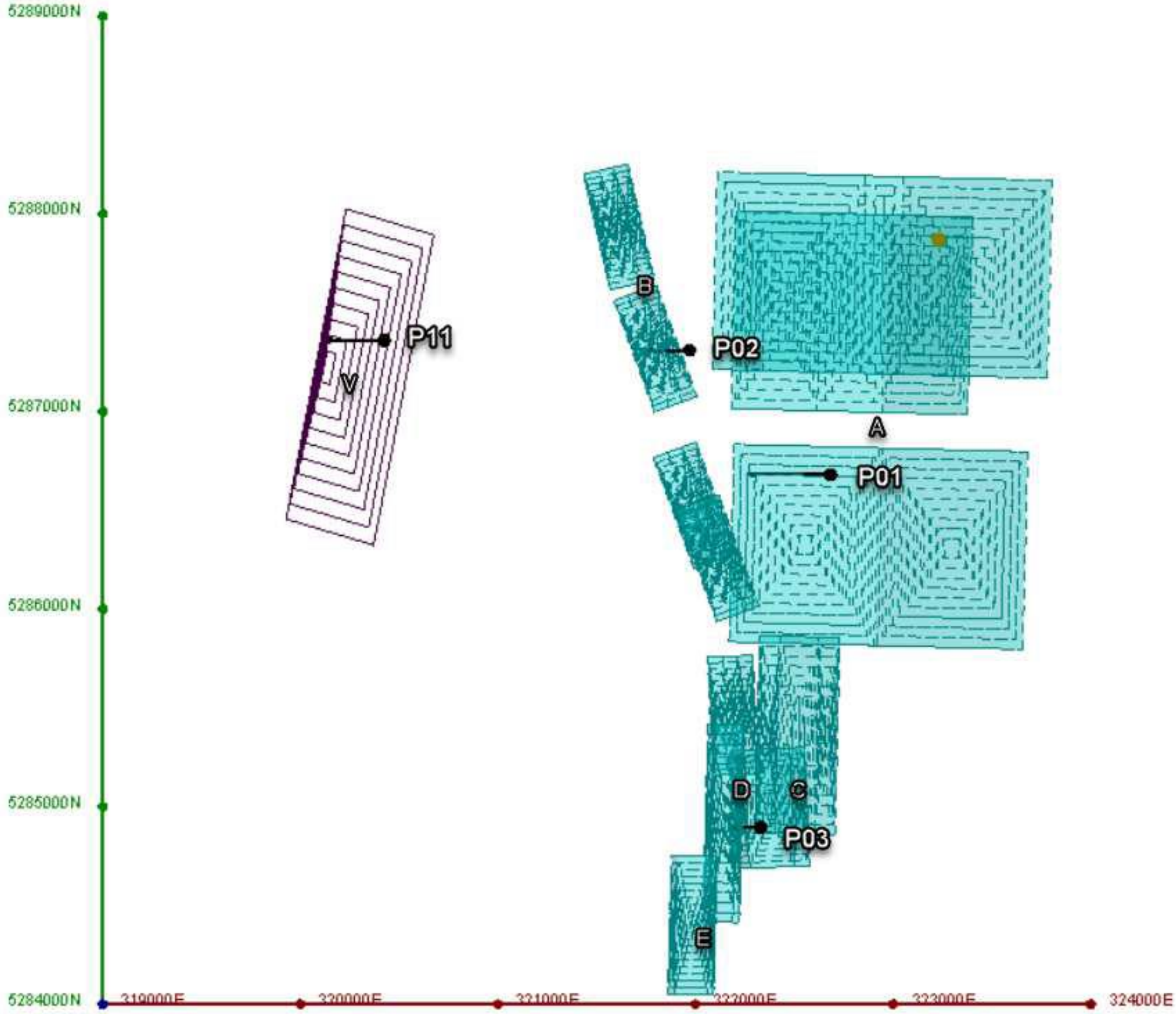
Zones of anomalous conductivity values found in the eastern part of the site are described in a magnetic field by areas of gradient values, apparently more related to the tectonics of the area (discontinuous disturbances, thrust structures), and to a lesser extent with geological boundaries. The anomalous conduction zones of the central and western parts of the site spatially follow the contours of geological boundaries (average MP values) or are located in the region of intrusive formations (MP maxima).



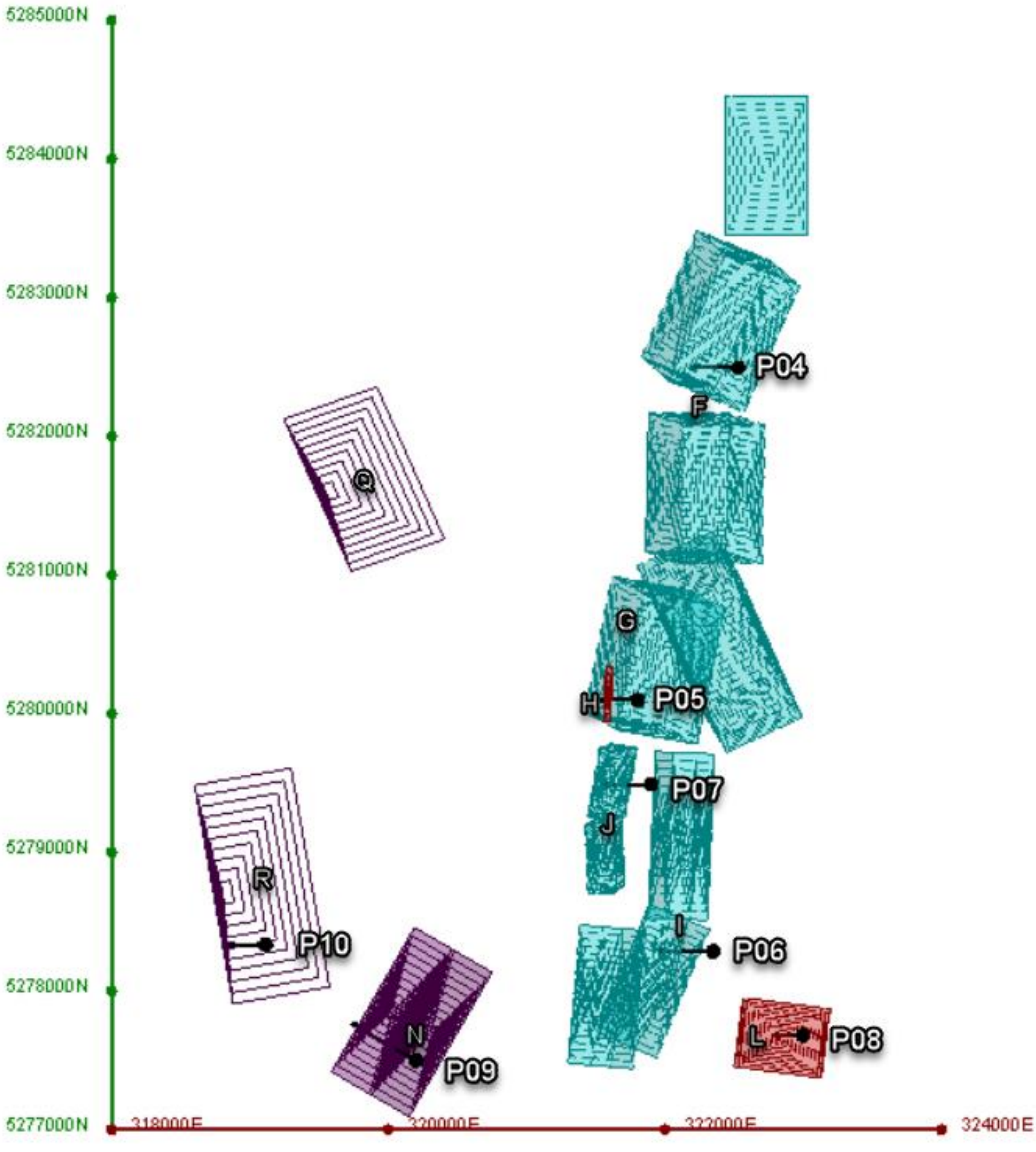
Picture 5.2 – Conductivity anomalies on a magnetic field map

Picture 5.3 – Conduction anomalies on the geology map of the work site

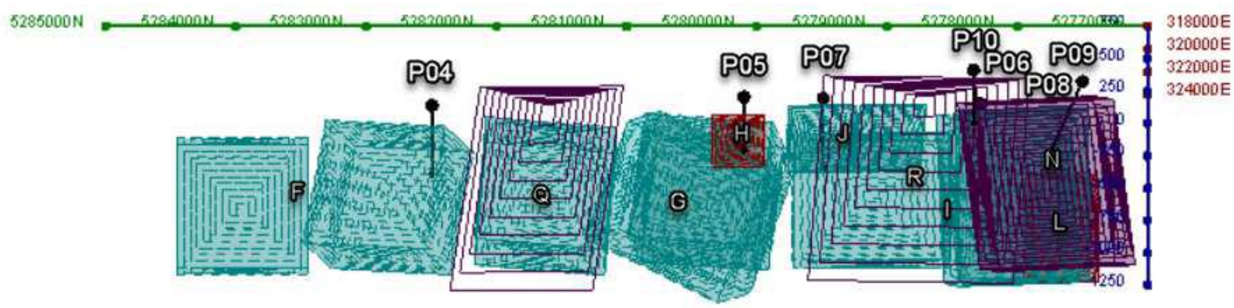
APPENDIX A



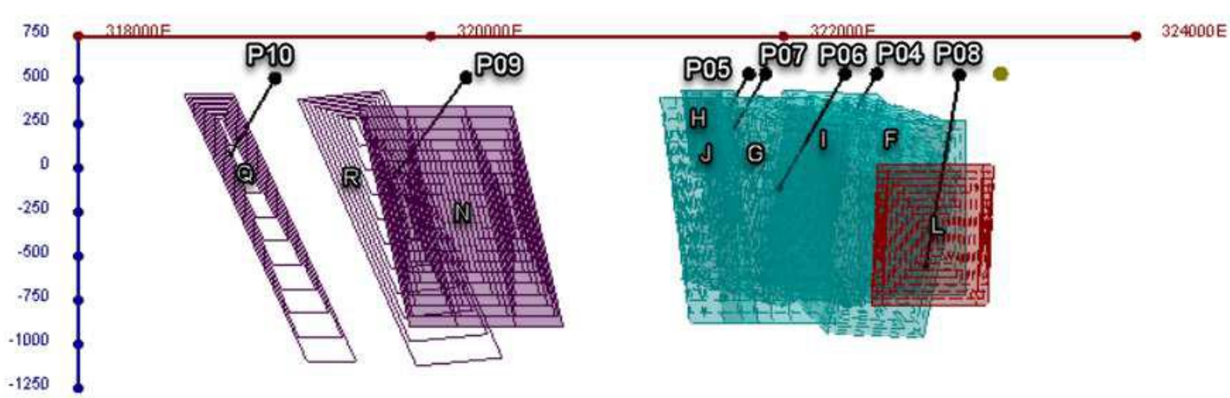
Picture 1 – Map of plates and wells for anomalies A, B, C, D, E and V.



Picture 2 – Map of all simulated plates and recommended wells



Picture 3 – West view of plates and recommended wells



Picture 4 – View from the south of all simulated plates and wells

Table 3 – Simulated plate parameters

Plate name	X	Y	Z	Depth to top (м)	Tilt angle (°)	Tilt Direction(°)	Rotation (°)	Lenth (м)	Depth size(м)	Conductivity	Power (м)
A1	322 570	5 287 700	180	-363.39	72.5	91.49	0	1000	2500	180	900
A2	322 575	5 287 505	250	-291.47	80	91.49	0	1000	2500	150	750
A3	322 550	5 286 325	300	-237.62	72.5	91.49	0	1000	2500	105	700
B1	321 575	5 287 925	415	-128.03	82.5	77	0	600	600	450	150
B2	321 760	5 287 305	415	-127.7	82.5	70	0	600	600	450	150
B3	321 960	5 286 510	440	-102.35	82.5	70	0	600	600	450	150
B4	322 075	5 286 245	450	-91.25	82.5	70	0	600	600	450	150
C1	322 365	5 285 365	450	-87.49	72.5	91.49	0	1000	1000	250	100
C2	322 415	5 284 995	410	-125.07	82.5	267.5	0	600	600	300	300

Plate name	X	Y	Z	Depth to top (м)	Tilt angle (°)	Tilt Direction(°)	Rotation (°)	Lenth (м)	Depth size(м)	Conductivity	Power(м)
D1	322 150	5 285 460	450	-89.3	82.5	87.5	0	600	600	450	150
D2	322 160	5 284 915	465	-72.34	87.5	271.49	0	1000	800	300	150
E1	322 000	5 284 400	390	-147.58	87.5	271.49	0	700	700	200	200
F1	322 735	5 283 950	275	-256.84	90	90	0	1000	1000	300	600
F2	322 505	5 282 740	295	-238.05	75	292.5	-5	1000	1000	300	600
F3	322 420	5 281 580	295	-238.56	75	270	-5	1000	1000	300	600
F4	322 495	5 280 355	200	-332.34	87.5	245	-22.5	1200	1000	300	600
G1	322 045	5 280 320	295	-239.97	75	280	-5	1000	1000	300	600
H1	321 590	5 280 140	380	-151.78	90	272.5	0	400	400	30000	50

Plate name	X	Y	Z	Depth to top (м)	Tilt angle (°)	Tilt Direction(°)	Rotation (°)	Lenth (м)	Depth size(м)	Conductivity	Poweer(м)
I1	322 185	5 279 115	260	-274.37	82.5	272.5	0	1200	1000	450	300
I2	321 835	5 278 105	405	-127.18	82.5	112.5	0	1000	1300	300	300
J1	321 585	5 279 490	445	-86.34	82.5	100	5	500	500	1000	200
J2	321 535	5 278 955	445	-85.07	82.5	87.5	5	500	500	1000	200
J3	321 495	5 277 965	405	-124.12	82.5	95	0	1000	1300	300	300
L1	322 865	5 277 660	20	-509.03	87.5	277.5	0	500	800	300	600
N1	320 025	5 277 860	350	-166	75	120	0	1200	1300	6	300
Q1	319 490	5 281 575	415	-101.79	65	65	-2.5	1200	1674.8	10	-
R1	318 740	5 278 695	420	-86.67	65	80	0	1600	1674.8	25.049	-
V1	320 080	5 287 240	465	-65.95	67.5	100	-2.5	1600	1200	15	-

CONCLUSION

Field experimental work on the facility was completed in full, provided for by the Agreement with the highest possible quality, as far as real field conditions allowed. Field studies and field office processing were carried out under the methodological guidance of a representative of the company Abitibi Geophysics LTD.

According to the results of the work were performed:

1. Field work in a profile version by sounding method according to the Infini TDEM technology on 18 profiles;
2. Field office processing, analysis of the quality of the measured values and interpretation;
3. An interpretation map is constructed where abnormal conduction zones are marked.
4. Recommendations on drilling operations are given ;
5. A database of measured, processed and inversion data based on the results of the ER was created;

Based on the results of the work, design drilling was recommended in order to clarify the nature of the identified electrical prospecting anomalies.

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