Chapter 5 Geology and mineralization of the detailed survey area

In this chapter, the results of surveys in Zalturbulak area, Akmola area, Arlan area,Bidaik area and Kuzultas are described.

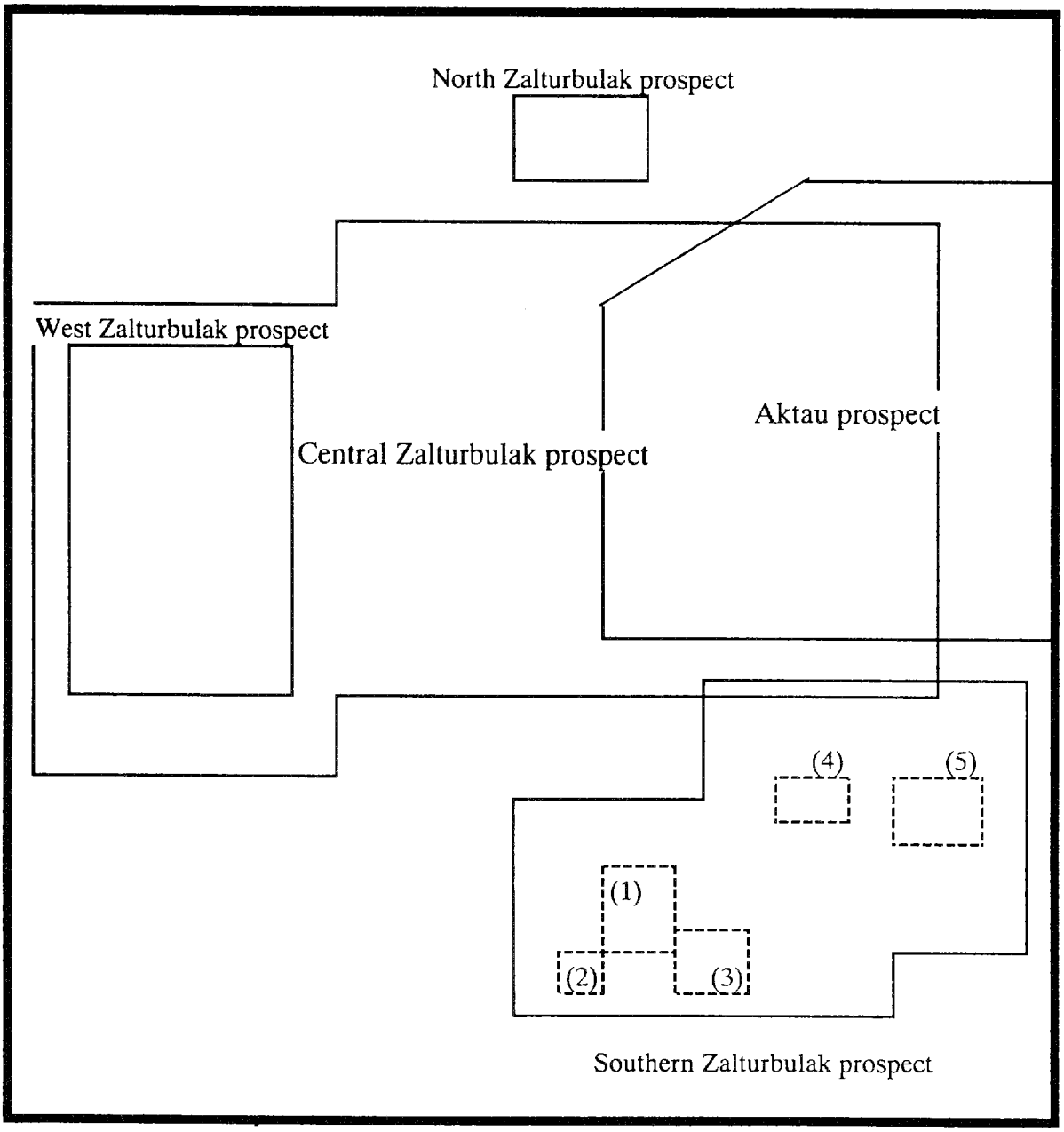
5-1 Zalturbulak area

5-1-1 Survey area and scope of work

The Zalturbulak Area is situated near the center of the Terektinsky Uplift and occupies an area of approximately 29 km^2 bounded by the latitudes of 48° 27′ 54″ and 48° 30′ 40″ N and by the longitudes of 68° 32′ 48″ and 68° 36′ 54″ E. Four sizeable areas of mineralization or mineral occurrences have been identified in the Area, namely the Southern Zalturbulak, Aktau, Western Zalturbulak and Northern Zalturbulak Prospects. In this report, the name, Central Zalturbulak Prospect is assigned to the area combining the west half of Aktau Prospect and the Western Zalturbulak Prospects for convenience of description. The Zalturbulak Prospect is further subdivided into 5 zones (Figure 5-1).

The Area is generally flat in relief and has a series of low hills trending in the north-south direction in its eastern part. This topographic feature is apparently related to the geology of the area; the hilly part is mainly underlain by Ordovician sedimentary and volcanic rocks, while the extensive flat plain consists of Devonian granitoids.

Rock exposures are generally poor. In part, no outcrops are located for distances of some 500m, particularly in the western part. There are a number of mineral occurrences which were prospected by drilling identified by drill casings left at hole locations and by trenching often buried under soil covers. At some of these locations, drill cores are scattered around holes and rock debris, apparently from trenches, are piled. These abandoned drill cores and rock debris were useful, making up for scarcity of outcrops, to interpret geology and mineralization of the area.



(1) Central Zalturbulak zone
(2) Southwestern Zalturbulak zone
(3) Eastern Zalturbulak zone
(4) Northern Zalturbulak zone
(5) Northeastern Zalturbulak zone

Figure 5-1 Index Map of the Zalturbulak Area

5-1-2 Geology

The relative location of Central Zalturbulak Prospect within the entire Zalturbulak Area is indicated in Figure.5-1. The regional geology of the Area is illustrated in Figure. 5-2, together with a representative cross section.

The geology of the Area principally comprises volcanic and sedimentary rocks of Ordovician age, intruded by Devonian to Carboniferous granitoids and other intrusions. Characteristics of each geologic unit are described below.

Ordovician Series

The Ordovician Series is the oldest in the Area and distributes in a north-south trending belt in the eastern part. The series comprises pyroxene andesites and sedimentary rocks which are not differentiated in the geological maps because it is virtually impossible to distinguish them into mappable units due to poor exposure and similarity of the sandstone and the andesite in their appearances on weathered outcrops.

The andesitic volcanics are composed of greenish dark gray lavas and pyroclastics. The pyroclastics are mostly fine grained tuff, lacking coarse grained fragments.

The sedimentary rocks, of clastic nature, mainly consist of siltstone and fine-grained sandstone showing grey-black to greenish dark grey colours. They are generally massive and compact, and are often hornfelsic due to thermal effect by later intrusions. It is, therefore, extremely difficult to distinguish them from andesite unless laminae are developed in places.

Granitoids

The Devonian to Carboniferous granitoids occupy a cosiderable portion of Zalturbulak Area, forming a batholithic body. The granitoids can be devided into those belonging to Karamendin Complex of Devonian to Carboniferous age and those constituting a part of middle to late Devonian Terektin Complex.

Karamendin Complex

The granitoids of the Karamandin Complex in this area include medium-grained biotite-hornblende granodiorite(hereinafter called 'granodiorite' unless otherwise quoted for its particular mineralogy) and hornblende biotite granite(hereinafter called 'granite').

The granodiorite, the most common intrusive facies of Karamendin Complex, occupy 70 % of Zalturbulak Area. It is mostly medium grained and leucocratic, and is generally uniform in its composition. The age of intrusion is determined of middle to late Carboniferous, corresponding to Variscan(Hercynian), based on the result of K-Ar

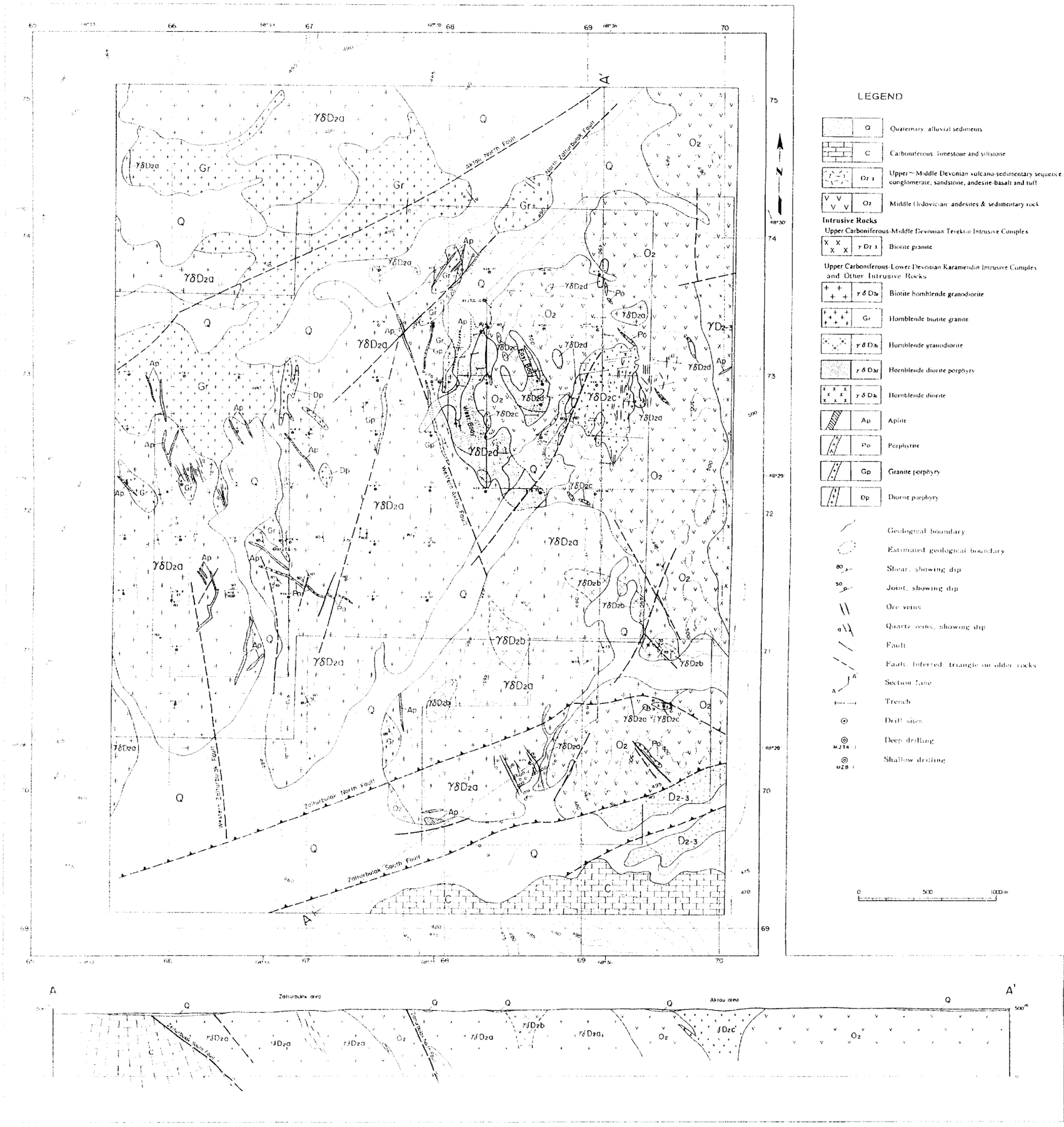


Figure 5-2 Geological Map of the Zalturbulak Area

age determination indicating 328±16 Ma and 297±15 Ma for two samples collected in West Zalturbulak. The result of whole rock chemical analysis of two granodiorite samples indicates that contents of SiO_2, Na_2O and K_2O range from 64.5 to 65.6 %, from 3.2 to 3.5 % and from 3.2 to 3.53 % respectively. This range of chemical composition is plotted in the granodiorite domain of calc-alkaline rock series in the Si_2O-Na_2O+K_2O diagram as defined by Science Academy of the former USSR(Serykh, 1996).

A large mass of the granite is located in the northern part of the area. It is mostly medium grained leucocratic with pinkish tint, accompanying fine grained facies in places. The granite also occurs as a stock branching south-southeastward off the northern main body in West Zalturbulak and as a small intrusion within the granodiorite body in Aktau. A sample of the granite collected in West Zalturbulak indicates K-Ar ages(whole rock) of 295±15 Ma, which is also correlated to Variscan. The whole rock analysis of a sample indicates the contents of SiO_2, Na_2O and K_2O at 70.6 %, 2.7 % and 3.5 % respectively, falling in the granite domain of calc-alkaline rock series in the Si_2O-Na_2O+K_2O diagram. Judging from its K-Ar age, mineralogy and chemical composition, it appears reasonable to assume that the granite has been differentiated from the granodiorite forming an extensive batholith in the general area.

Terektin Complex

Distribution of Terektin Complex is limited in the eastern margin of the Area. The rocks are essentially medium grained, leucocratic, with pinkish tint, biotite granite. They are mostly massive, though schistosity is locally developed.

Other Intrusions

Other inrusions than described above include hornblende diorite porphyry, pyroxene-hornblende diorite, aplite, porphyrite and granite porphyry. Of these, hornblende diorite porphyry(hereinafter 'diorite porphyry') and pyroxene-hornblende diorite(hereinafter diorite) are important in terms of mineralization of the Area. It may be reasonably assumed that these two intrusions are genetically related to each other because of the similarity in their compositions and the proximity in their locations of emplacement.

Two oval-shaped intrusive bodies of the diorite porphyry distribute near the contact between the Ordovician volcano-sedimentary rocks and Karamendin Complex, trending in the NNW-SSE direction with long axes ranging from 600 to 1300m and widths of some 300m. A number of small stocks are also located within the volcano-sedimentary rock distributing area. Intrusions of the diorite porphyry invariably form hornfelsic contact aureoles around them. The rocks are fine grained, compact and contain about 20 volume % of plagioclase phenocrysts with sizes less than 1mm within fine grained,

holocrystalline matrices. They contain an insignificant amount of mafic minerals, commonly comprising hornblende, occasionally accompanied by pyroxene and/or biotite. A sample of the diorite porphyry indicates a K-Ar age of 373±11 Ma, late Devonian age, which is correlated to the last stage of Caledonian orogeny. The whole rock analysis of a sample presents the contents of SiO_2, Na_2O and K_2O at 63.4 %, 2.2 % and 3.6 % respectively. The composition is plotted at the boundary between the granodiorite and quartz diorite domains of calc-alkaline rock series in the Si_2O-Na_2O+K_2O diagram.

A sizable intrusion of the diorite is located in association with the Aktau mineralization and elongates in the N-S direction with its long and short axes of 800m and 400m respectively. A few small bodies also distribute around diorite porphyry intrusions. The diorite intersected by the drill hole, MJTA-4, is of the same kind, although subjected to a different degree of alteration. The diorite is invariably black, fine grained, compact and holocrystalline.

As aforementioned, the diorite porphyry and the diorite are closely related to each other in their genesis. Therefore, they are grouped in the same intrusive unit for the purpose of discussing the related mineralization and alteration in this report.

Aplite is fine grained, compact rocks and mainly distributes in the northern part of the Area, forming dikes several meter wide. The aplite dikes occur within or closely associated with hornblende-biotite granite, which suggests that these two types of intrusions are closely related to each other in genesis.

Two granite porphyry dikes, some 400m long, are located along NNW-SSE and N-S running faults in the western part of Aktau. The rocks are pinkish light gray in color and contain a minor amount of feldspar phenocrysts with grain sizes up to 2 mm in matrices comprising fine grained feldspars and quartz.

Occurrences of porphyrite are limited to the eastern part of the Area and insignificant in terms of mineralization and alteration.

5-1-3 Gravity anomalies and magnetic anomalies

(1) Gravity anomalies

An old gravity map (Kazimir et al,1969) is shown in Figure 5-3. The method of analysis is unknown. From the attached figure and the shape of the contours, the thin contour lines seem to be long wavelength component of Bouger anomaly map by applying a Row-pass filter. The thick line is the result of removal of the long-length wave component by filtering.

The contours of the long wave length gravity anomaly map generally show a N-S trend. The eastern area is highly anomalous and the strength of the anomaly decreases to west. This general trend correlates with the geology, the distribution of Ordovician volcanics corresponding to areas of high gravity.

Residual anomalies of more than 0.6 mgal are distributed in patches of the Northeastern Zalturbulak zone and Aktau prospect. The anomaly in Aktau prospect coincides with area of diorite. This is noteworthy fact as the diorite of Aktau is a host rock of gold mineralization.

(2) Magnetic anomalies

A large positive magnetic anomaly occurs in the center of the area (Figure 5-4, Kazimir et al,1969). Surrounding it are negative magnetic anomalies showing strong linear trends. The Zalturbulak prospect is an isolated area of highly positive magnetics trending ENE-SWS. This area is bordered by linear negative anomalies with the same trend. The linear negative anomalies, which coincide with the zone of steep gravity gradient, may reflect faults. The existence of Zalturbulak North fault, Zalturbulak South and Aktau North fault were estimated by both the geological observation in the field and these geophysical phenomena.

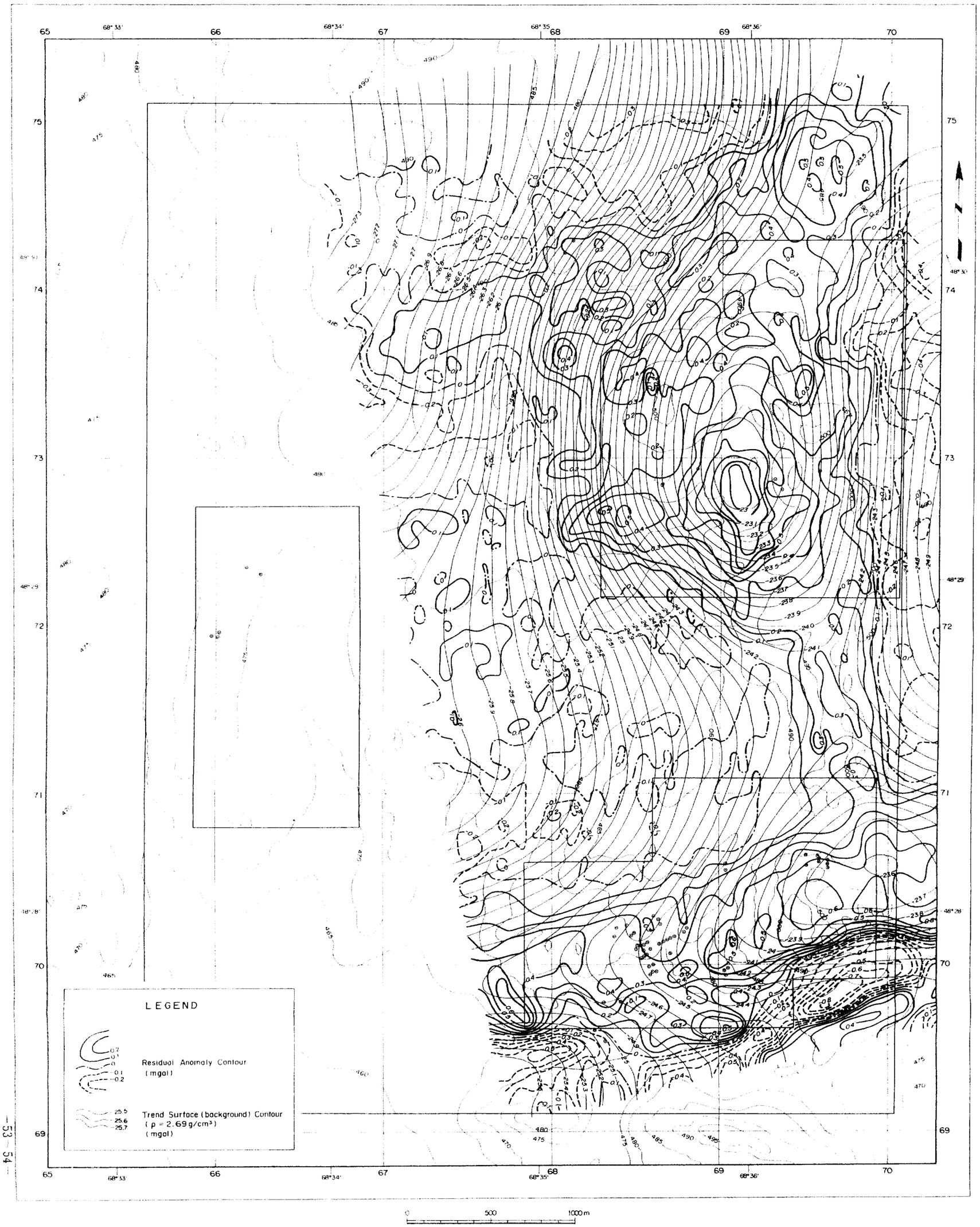


Figure 5-3 Gravity Anomaly Map

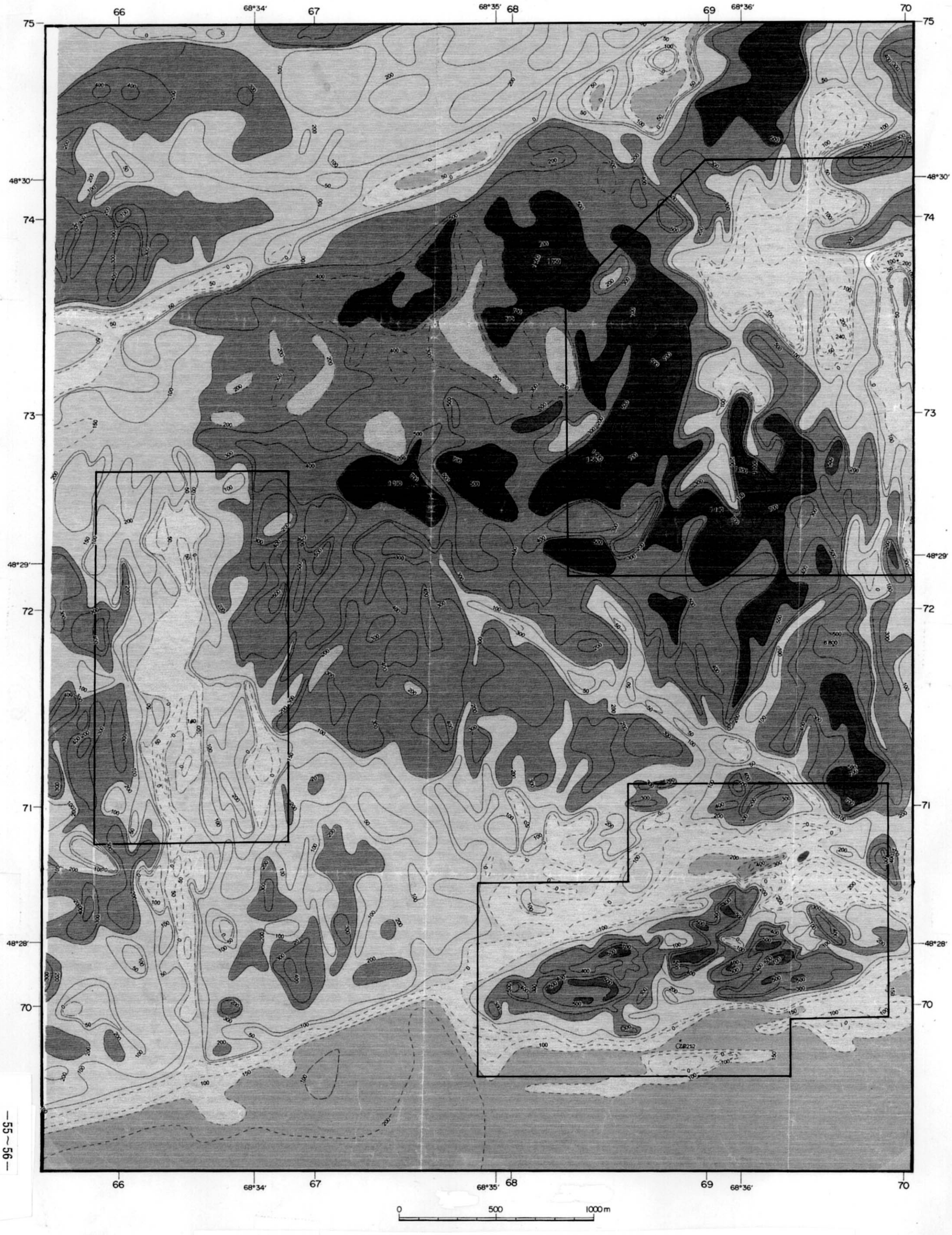


Figure 5-4 Magnetic Anomaly Map in Z component of the Zalturbulak Area