

CHAPTER 4 DISCUSSION

In this chapter, mineralization and geology of Erdenet Mine are discussed. Based on the drilling survey results of the Mogoin gol area and the Zuukhiin gol area, useful data and information have been compiled regarding the mineralization characteristics and geology of the explored areas.

4-1 Geological setting of Erdenet Mine

The Erdenet copper deposit is the biggest porphyry copper-molybdenum deposit in eastern Asia. Host rock is granodiorite of Selenge complex (290-240Ma). Granodiorite porphyry and syenite porphyry of Erdenet complex (250-245Ma, 250-220Ma and 205-195Ma) intruded in the Selenge complex and brought the copper mineralization of Erdenet mine. Finally, igneous activity as alkaline rock (180Ma) happened without mineralization. Erdenet mine is located in the north margin of a huge size ring structure and occurred in the structural crossing point between NW-SE distribution of granitic rock and some fault zones trending NE-SW. The center of copper deposits consists of alteration of strong silicification and greisenization. Zone alterations of quartz-sericite alteration, sericite-chlorite alteration and calcite-epidote-chlorite alteration were distributed from center to outside in the copper mineralization. Oxidized and leached zones are distributed in the ground surface and secondary enrichment zones consisting of chalcocite, bornite, covellite and oxide copper occurred underneath. Primary copper minerals consisting of chalcopyrite, bornite, pyrite and molybdenite were dispersed in the bottom of mineralization. Erdenet mine is located in the northern part of the low magnetic anomaly trending NW-SE direction and occurred in the very low magnetization zone.

Based on the results of measurement of natural remanent magnetization, K/Ar dating and Re/Os dating, the followings events were clarified:

Granodiorite (225Ma) and adakitic syenite porphyry of Erdenet complex were reversely magnetized. Very low magnetization of Selenge complex and Erdenet complex is the result of the reversely magnetized granitic rock.

The age of copper mineralization in Erdenet mine happened before intrusion of andesite dyke normally magnetized, after intrusion of granodiorite (225Ma) and at approximately same age as adakitic syenite porphyry intrusion (208Ma). Re/Os age analyzed by molybdenite is older than K/Ar age by granodiorite and syenite porphyry. This probably indicates that crystallization of molybdenite started after the incidence of magma melts (Re/Os age) or under the emplacement of granitic rocks (K/Ar age).

4-2 Mogoin gol area

White silicified altered zone with oxide copper minerals is widely distributed on the Sharchuluut Mountain in the northern part of the area. Geology consists of late Permian alkaline volcanic rocks, late Triassic to early Jurassic volcanic rock, Permian to Triassic granitic rock, Jurassic stock, dykes and Quaternary deposits. Main fault direction developed around the white silicified altered zone is NNW-SSE, NW-SE and EW. Quartz-sericite alteration is distributed in the center of northern white silicified altered zone, while sericite-chlorite alteration is distributed outside of the center, and chlorite alteration in the outer zone. The zonal alteration is same as the alteration developed in the upper part of the porphyry copper-molybdenite type ore deposits.

Results of TDIP survey indicated that high resistivity and low chargeability are found until 100m in depth from ground surface and that low resistivity and high chargeability are distributed in the deeper part. The IP anomaly zone appears to be a big size anomaly.

Drilling survey results in Phase II and Phase III programs indicated that propylitic to phyllic alteration consisting of sericite-chlorite alteration with pyrite dissemination was distributed in the western part of the area. The results also indicate that hydrothermal type acidic to phyllic alteration related to porphyry copper type mineralization was active in the central part and that phyllic alteration mainly consisting sericite-chlorite alteration was observed in the eastern part. Generally speaking, these alteration minerals appear from central and deeper parts to upper part of the porphyry copper ore deposits. The mineral assemblages show moderate temperature ($350^{\circ}\text{C} \sim 150^{\circ}\text{C}$) in genesis temperature. Pyrophyllite was detected in drilling cores of MJME-M4 and the genesis temperature is approximately 250°C and associated to pyrophyllite zone of acidic alteration zone. Homogeneous temperatures of fluid inclusion were estimated in 147°C to 165°C in MJME-M1 drill hole and 173°C to 188°C in MJME-M2 drill hole. Maximum temperature of homogeneous temperatures was 291°C . The determination of homogeneous temperatures was an impossible task because the quartz grains were very fine. Average salinities were 3.9% to 17.3% in MJME-M1 drill hole and 1.8% in MJME-M2 drill hole. Values of salinity were less than 10% and low in general. Values of CO_2 in fluid inclusion were 28.9% in maximum. Copper grades of drilling cores were very low.

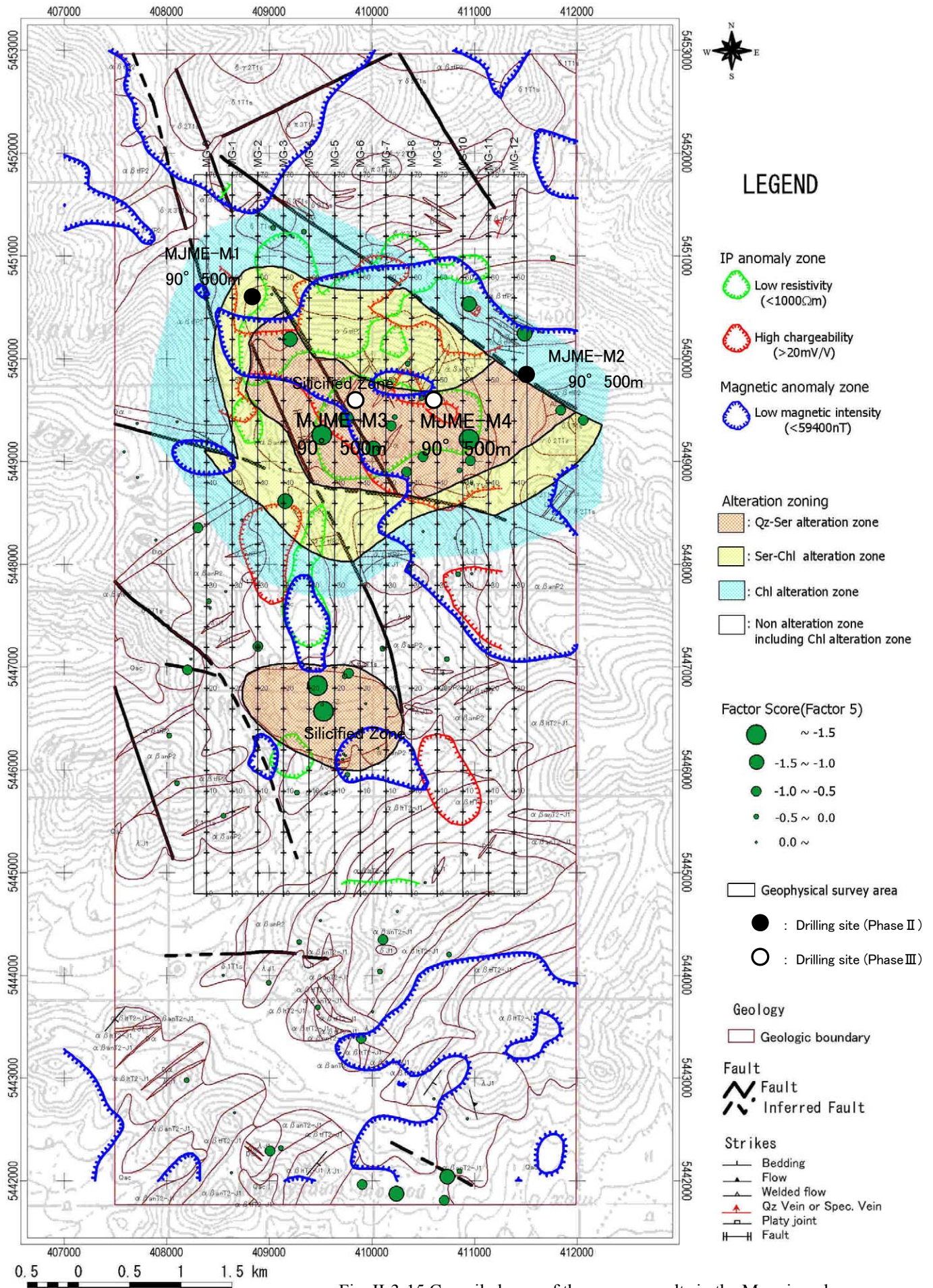


Fig. II-3-15 Compiled map of the survey results in the Mogoin gol area

4-3 Zuukhiin gol area

The mineralized zone in the area was discovered by a project of mineral cooperation between Czechoslovakia and Mongolia. During the detailed survey, drilling survey with more than 20 drill holes was conducted. Ore grades estimated were Cu 0.11 to Cu 0.17% and Mo 0.003 to Mo 0.007% in the mineralized zone.

First phase survey indicated that copper values of mineralized zone were more than Cu 0.10%. The promising zone was expanded along WNW-ESE direction, about 2km in extension and 200m in width. The geology of the area consists of early Triassic volcanic rocks, Triassic to Jurassic volcanic rocks, Jurassic volcanic rocks and Permian to Triassic granitic rocks. Granitic rocks belonging to Selenge complex are mainly distributed in the area and consist of diorite, granodiorite, granite and granitic syenite porphyry. Andesitic porphyry dykes intruded in the granitic rocks. Main fault directions are NE-SW, NW-ESE and EW. Alterations related to mineralization consist of sericite-chlorite alteration and chlorite alteration.

Mineralized zone in the area was reconfirmed by geological survey of Phase III. Green altered andesite with copper grade of Cu 1.48% was detected in the granodiorite with copper mineralized zones. Drilling survey was conducted in the anomalous zone to clarify the soil geochemical anomaly of more than Cu 100ppm and the high IP anomaly of high chargeability/ low resistivity detected in the area.

Drilling survey of phase III indicated that copper mineralization was observed in the granodiorite with copper values of Cu 0.784% in maximum and 0.039% (MJME-Z3, 496.30m in core length) to Cu 0.120% (MJME-Z2, 494.65m in core length). Alteration in the mineralized zone mainly consists of phyllic alteration to propylitic alteration. Pyrophyllite showing 250°C in genesis temperature was detected in the drilling cores. It is inferred that genesis temperature of the mineralization may be more than 300°C because secondary biotite also observed in the drilling cores. Alteration probably indicated that hydrothermal fluids of high temperature are partly transported in the granodiorite forming phyllic alteration to propylitic alteration as a whole. The hydrothermal fluid probably was neutrality to acidity. Mineralization in the area consists mainly of chalcopyrite mineralization including pyrite and probably a porphyry copper type mineralization.

Average homogeneous temperature by fluid inclusions in quartz vein shows 160°C to 267°C. Homogeneous temperatures at 428m in MJME-Z2 drill hole indicated relatively high values from 231°C to 312°C in range. Salinities of three drill holes were 1.21% to 12.00% in average. The salinities were 12.00% at 263m in MJME-Z1 drill hole and 10.10% at 428m in MJME-Z2 drill hole. According to these results, the homogeneous temperatures and salinities show tendency to increase towards the direction of MJME-Z2 drilling site.

Isotope values of oxygen and hydrogen are marked under the distribution range of Climax ore deposit shown in isotope figure of porphyry copper deposits. Since isotope values of

oxygen and hydrogen estimated by temperature correction were marked in the central range of epithermal deposits in the western part of Nevada, primary magma water is received the influence of meteoric mater which is approximately $\delta D = -150\text{‰}$ and resulted probably from highland water.

The above confirms that the mineralization in the Zuukhiin gol area is porphyry copper type mineralization. To further clarify these results, the extension of the mineralization toward the southwestern part of the drilling sites can be investigated by detailed exploration works.

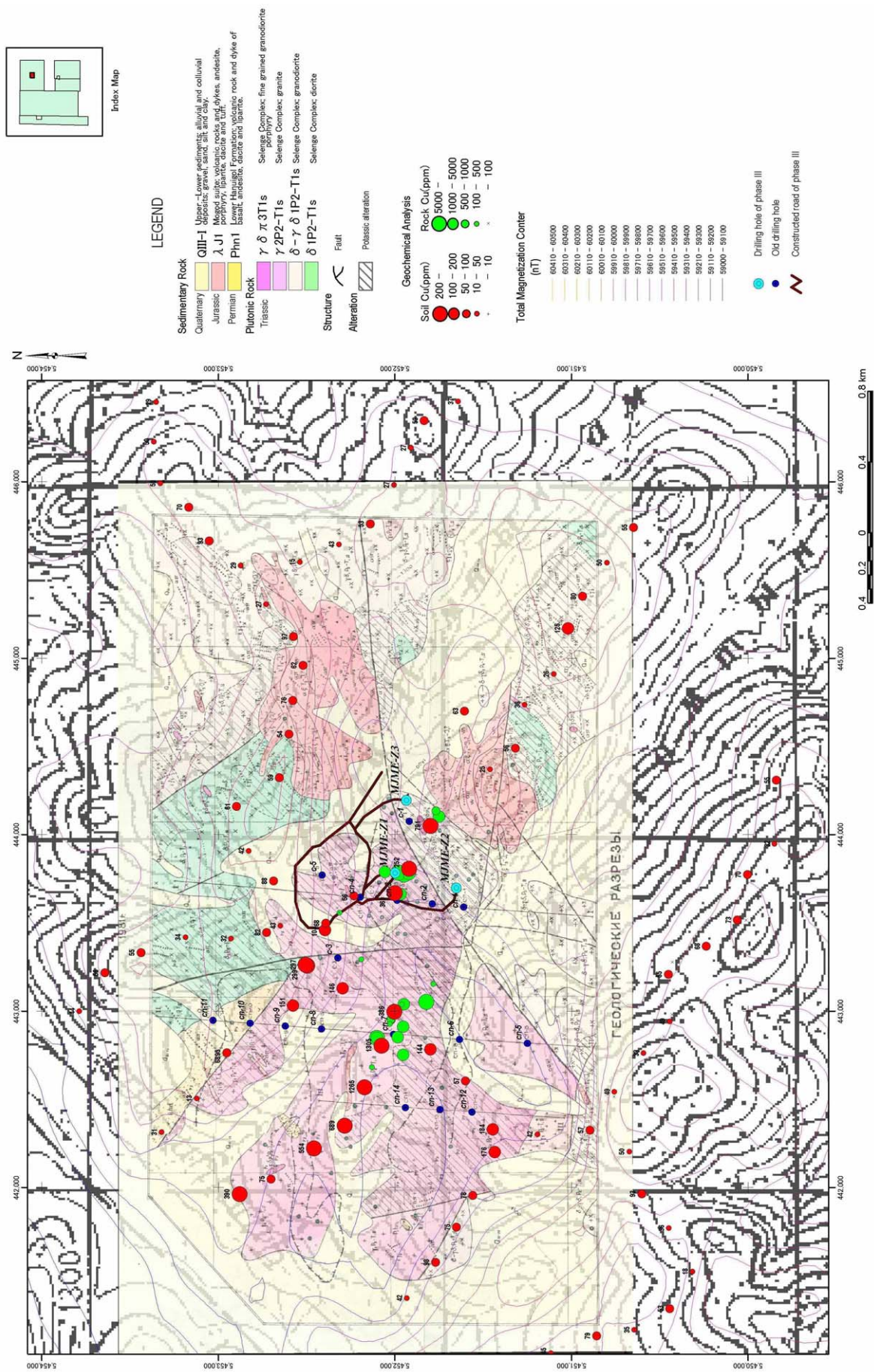


Fig. II-4-2 Compiled map of geological survey results in the Zuuhiin gol area

4-4 Khujiriin gol area

Data compilation, geological survey and airborne geophysical survey in Phase I as well as geological survey and TDIP geophysical survey in Phase III have been conducted in this area. Compiled map of geological survey results in the Khujiriin gol area is shown in Fig. II-4-3.

The geological survey results of Phase I indicated that copper mineralization as malachite and chalcopyrite and high rock geochemical anomalous zone of copper, lead and zinc were confirmed in the area. The geological survey carried out in Phase III indicated that high soil geochemical anomalies of copper with more than Cu 200ppm were concentrated in the central part of the area. The TDIP geophysical survey detected very high resistivity anomalies in an area where quartz veins including chalcopyrite, malachite and azurite are distributed along east west trending.

It is expected that the extension of copper mineralization toward southwest can be clarified by utilizing for future exploration studies, a detailed TDIP geophysical survey and a detailed soil geochemical survey.

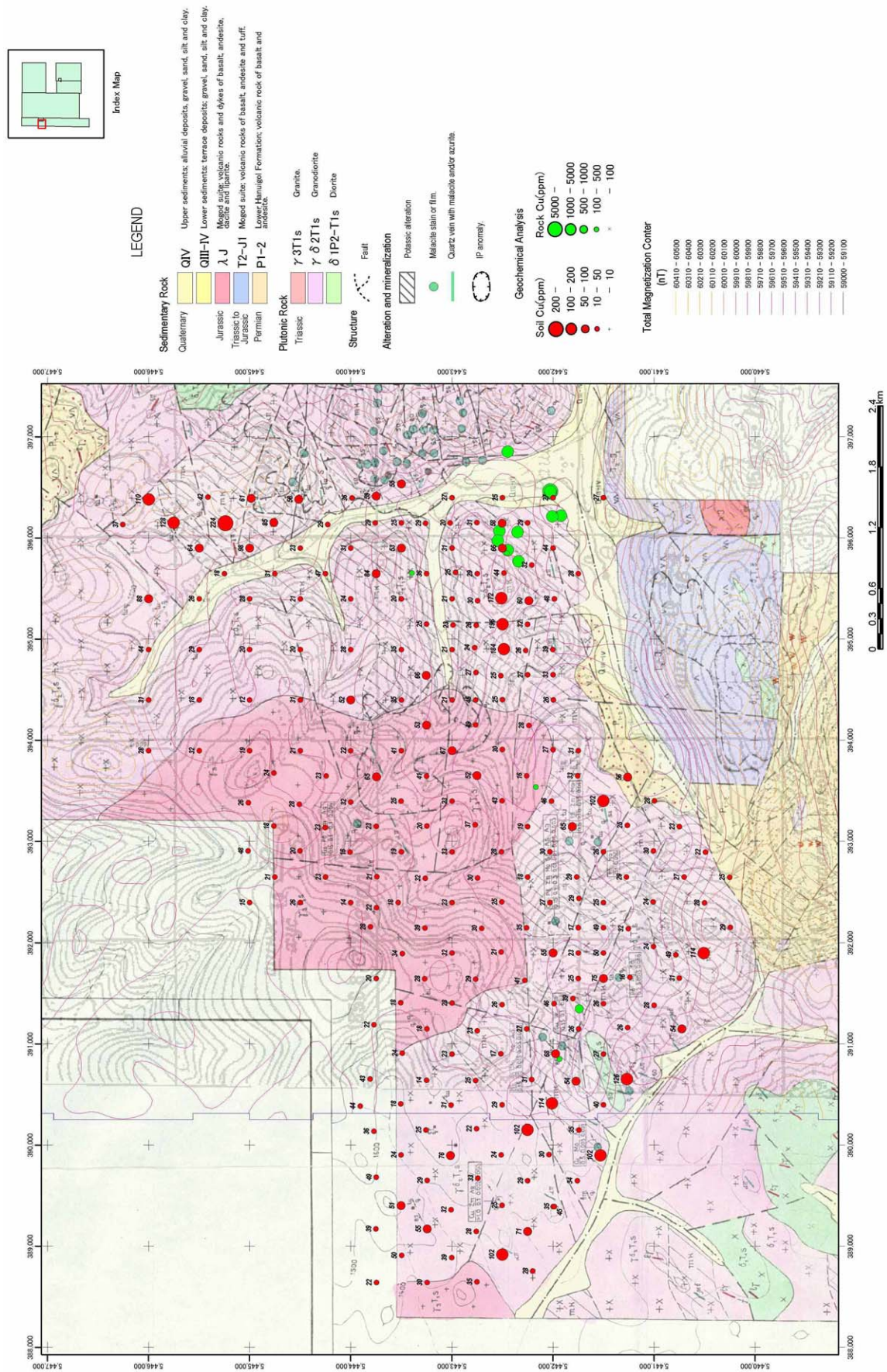


Fig. II-4-3 Compiled map of geological survey results in the Khujiirin gol area