CHAPTER 3 KICHI-SANDYK DISTRICT

3-1 Method of Survey

In the Kichi-Sandyk district, geological survey with 1,409 m trenches and core drilling were performed. Length of drillings is shown on following table. Location of the drill holes and trenches are shown in Fig. II-3-1.

Table II-3-1 List of Drillings

Hole No.	Length	Direction	Inclination
MJKK-1	107.8m	N13° E	-75°
MJKK-2	100.0m	N23° E	-75°
MJKK-3	124.6m	N13° E	-75°
MJKK-4	84.0m	N13° E	-75°
MJKK-5	100.0m	–	-90°
MJKK-6	210.0m	–	-90°
MJKK-7	93.0m	–	-90°
MJKK-8	223.2m	–	-90°
MJKK-9	87.3m	–	-90°
MJKK-10	143.0m	–	-90°
Total	1,272.9m		

3-2 Geology

Geological map and geological sections are shown in Fig. II-3-2 and Fig. II-3-3 respectively.

The geology of the Kichi-Sandyk district mainly consists of crystalline limestone of Late Cambrian to Early Carboniferous (Visean) age and Permian granodiorite porphyry (Chalmansay complex) intruding into the limestone. Conglomerate of Miocene covers all of the above rocks.

Calcareous sediments are widely distributed in the northern and western parts of the district. They are mostly crystalline limestone and partially contain chert beds. Brecciated zones probably formed by thrust faulting are occasionally observed. Layered skarns occur along the contact of limestone and intrusives.

The granodiorite porphyry is leucocratic and has widely undergone hydrothermal alteration such as argillization, carbonization, chloritization and silicification. It is accompanied with vein-like skarns trending NW-SE.

The conglomerate is mainly composed of round to sub-rounded gravel of crystalline limestone, granodiorite porphyry, skarn and sandstone which are 3-10 cm in diameter. The matrix is composed of sand and clay, the former being the same materials as gravel.

3-3 Geological structure

The limestone is intruded by the granodiorite porphyry. The contact plane between the limestone and granodiorite porphyry gently dips north or west and layered skarns often occur near the contact. A part of the limestone occurs as a large xenolith captured within the granodiorite porphyry. Conglomerates of Miocene are tectonically overlain by the granodiorite porphyry and limestone with a thrust fault that gently dips SW in the eastern part of the district.

Topographic features indicate the presence of parallel faults trending NW-SE. A number of fissures and joints which have the same trends and dip steeply southward were developed in the central mineralization zone. Cu-Au bearing vein-like skarns was formed along these fractures. A number of fractured zones containing granule- or sand-size fragments with clayey materials have been detected by the second year's drilling and they are possibly part of the above-mentioned thrust fault system.

3-4 Mineralization

(1) Types of mineralization

Two types of mineralization described below are recognized in the survey district. Among them, exoskarn was the main target of this year's survey.

① Endoskarn: As mentioned above, a number of fissures and joints striking NW-SE and steeply dipping SW were formed within the granodiorite porphyry. Along these fractures near the boundary of limestone, vein-like skarns containing copper and gold, closely associated with calcite-quartz veinlets were often formed. These endoskarns occur in the central mineralization zone and below the layered skarns in the northern mineralization zone.

② Exoskarns: Layered skarns were formed in limestone at the contact with intrusives. This type of skarn occurs in the northern mineralization zone. In addition, pale green or pale brown limestone containing minor skarn minerals such as wollastonite, (weakly skarnized limestone) is widely distributed in the survey district, although they are barren.

(2) Minerals

Garnet, clinopyroxene and wollastonite are the main skarn minerals, which are accompanied with minor amounts of prehnite. Chrysocolla, malachite and minor amounts of chalcopyrite, bornite, chalcocite, covelline and electrum are identified as ore minerals. Also iron minerals of goethite, hematite and minor amount of pyrite are observed.

Bornite is frequently observed in calcite-quartz vein-lets in MJKK-10. Measurement of homogenization temperature of these veinlets suggests that the formation temperature of them are very low and bornite might be formed by the second-enrichment.

(3) Size of ore body

Width of individual vein-like skarns is on the order of 10-40 cm, and in the aggregate, they form several copper gold ore bodies with a width of a few meters to a maximum of 25 m. Deep ore bodies have a width on the order of 10-40 m. Ore bodies appear to be stockwork type as a whole, trending NW-SE, parallel to the major fracture system. The extent of the central mineralization zone as the aggregate of the above described ore bodies is presumed to be 300 m by 300 m. The downward extension of the mineralization zone is inferred to be on the order of 10-20 m and a maximum of 30 m. Mineralized part of 1.29 g/t Au was detected in the 7.0 m drill core from 90 m depth of MJKK-2, although it is not expected to extend to the surface.

Outcrop of the layered skarns extends intermittently for 2 km in the NE-SW direction along the contact of limestone and granodiorite porphyry. The layered skarns are presumed to extend to a considerable depth and their width is on the order of 10-40 m.

(4) Ore grade

Average ore grade of each major mineralized zone of drill cores in the second and the third year are shown on Table II-3-2. Fig. II-3-4 and Fig. II-3-5 shows assay and distribution of vein-like skarn mineralization in the central mineralization zone.

High grade zones were reported as 1.29 g/t Au in 7.0 m of MJKK-2, and 35.77 g/t Au in 0.30 m of MJKK-5, although other zones were very low grade less than 1 g/t Au.

On the surface in the central mineralization zone, three ore bodies of total 4,944 m^2, 1.94 g/t Au on average were calculated. However these ore bodies are inferred not to continue to a sufficient depth.

(5) Model of mineralization

From the above-described facts, the following model of mineralization of this district is proposed. Fig. II-3-6 shows the model illustration of mineralization.

① As a result of intrusion of the granodiorite porphyry into the limestone, the layered skarns of 5-40 m thick were formed in the limestone along the contact plane. On the other hand, the vein-like skarns were formed along the fractures of the NW-SE system in the granodiorite porphyry, mostly within the distance of 10-20 m from the contact plane. At the same time, wollastonite was formed widely in the limestone.

② Ore solution passed along the fractures of the NW-SE system and deposited copper and gold ore in the pre-existing skarns.

③ The Kichi-Sandyk district was then tectonically deformed and divided into small blocks by thrust faults, striking N-S or NW-SE and dipping gently.

④ In the central mineralization zone, the vein-like skarns were exposed on the surface duc to intense erosion of limestone which was laying on the intrusives having a gently dipping boundary. Reconcentration of copper and gold by meteoric water led to the formation of a secondary enrichment zone characterized by green copper minerals in oxidized zones at shallow depths.

3-5 Potential for ore reserves

Taking the three years survey results into consideration, potential for ore deposit in the central and northern mineralization zones in the Kichi-Sandyk district is as follows.

1) Central mineralization zone

- Copper-gold mineralization accompanied with aggregation of vein-like skarn in granodiorite porphyry is observed (Fig. II-3-4).
- On the surface, three ore bodies of total 4,944 m^2, 1.94 g/t Au on average were calculated, adopting a cut-off grade of 1 g/t Au (Fig. II-3-5).
- Drilling survey revealed that the ore grade of the downward extension of these ore bodies were very low, 0.90 g/t Au (8K212) was the highest and most of the assays were reported as less than 0.1-0.2 g/t Au.
- As the result, following probable ore reserves (C1 or C2) are calculated.

  (Ore reserves) Area 4,944 m^2 × Depth 30 m × Specific gravity 2.6
  =385,630 t

  (Gold content) Ore reserves 385,630 t × Grade 1.94 g/t= 748 kg
- Ore gold grades are the highest on the surface and suddenly decrease underground.

2) Northern mineralization zone

- The existence of a copper-gold bearing layered skarns is expected in the area of

1.5 km by 0.7 km.

- According to the results of the drilling survey, the ore grade of the northern mineralization zone is inferred as lower than 1 g/t Au.
- Ore reserves can not be calculated, though there is the possibility of the existence of high-grade ore bodies because the previous exploration was done in a very limited area of the vast mineralization area.

3) Discussion on potential ore reserves in 1976 study

- Initially, the existence of a promising ore deposit was expected due to the 1976 Kyrghyz survey estimated potential ore reserves (C2+P1 ore reserves) of 33 tons Au with an average grade of 3.85 g/t Au in the central and the northern mineralization zones in the Kichi-Sandyk district.
- However, it was revealed that the existence of a promising ore deposit is hardly expected in both mineralization zones. The reason of this difference is studied as follows.

(1) The systematic prospecting on the Kichi-Sandyk area were carried out in 1974-1976 in USSR period and following ore reserves were expected.

zone	category	ore reserves	gold grade	gold amount
Central	C 2	3,710,700t	4.03g/tAu	15.0t Au
	P 1	4,203,400t	3.63g/tAu	15.3t Au
	Total	7,914,100t	3.82g/tAu	32.8t Au
Northern	C 2	403,400t	4.30g/tAu	1.7t Au
	P 1	201,700t	4.30g/tAu	0.7t Au
	Total	605,100t	4.30g/tAu	2.6t Au
Total	C 2	4,114,200t	4.06g/tAu	16.7t Au
	P 1	4,405,100t	3.66g/tAu	16.1t Au
	Total	8,517,000t	3.85g/tAu	32.8t Au

These ore reserves are calculated as follows.

- Assay results of 3,300 samples from trenches and pits are adopted.
- 87 ore bodies were set up.
- Ore bodies were presumed as board like shaped and extending to 200-450 m horizontally.
- Size of ore bodies were determined 0.3-4.4 m in width, and 100 m in depth

collectively.

- Waste rocks between ore bodies are not considered.

(2) The results of our three years survey are as follows.

- Downward extension is expected less than 30 m.
- Horizontal extensions are recognized less than 150 m.
- Ore gold grades are the highest on the surface and suddenly decrease underground.
- Adopting bulk mining method, waste rocks between ore bodies are difficult to separate from ore. So that the gold grade of crude ore will become very low, less than half of the ore reserves.

(3) The following points are considered as reasons for the difference in ore reserves.

- Smaller horizontal extension than 1976 study
- Smaller vertical extension than 1976 study

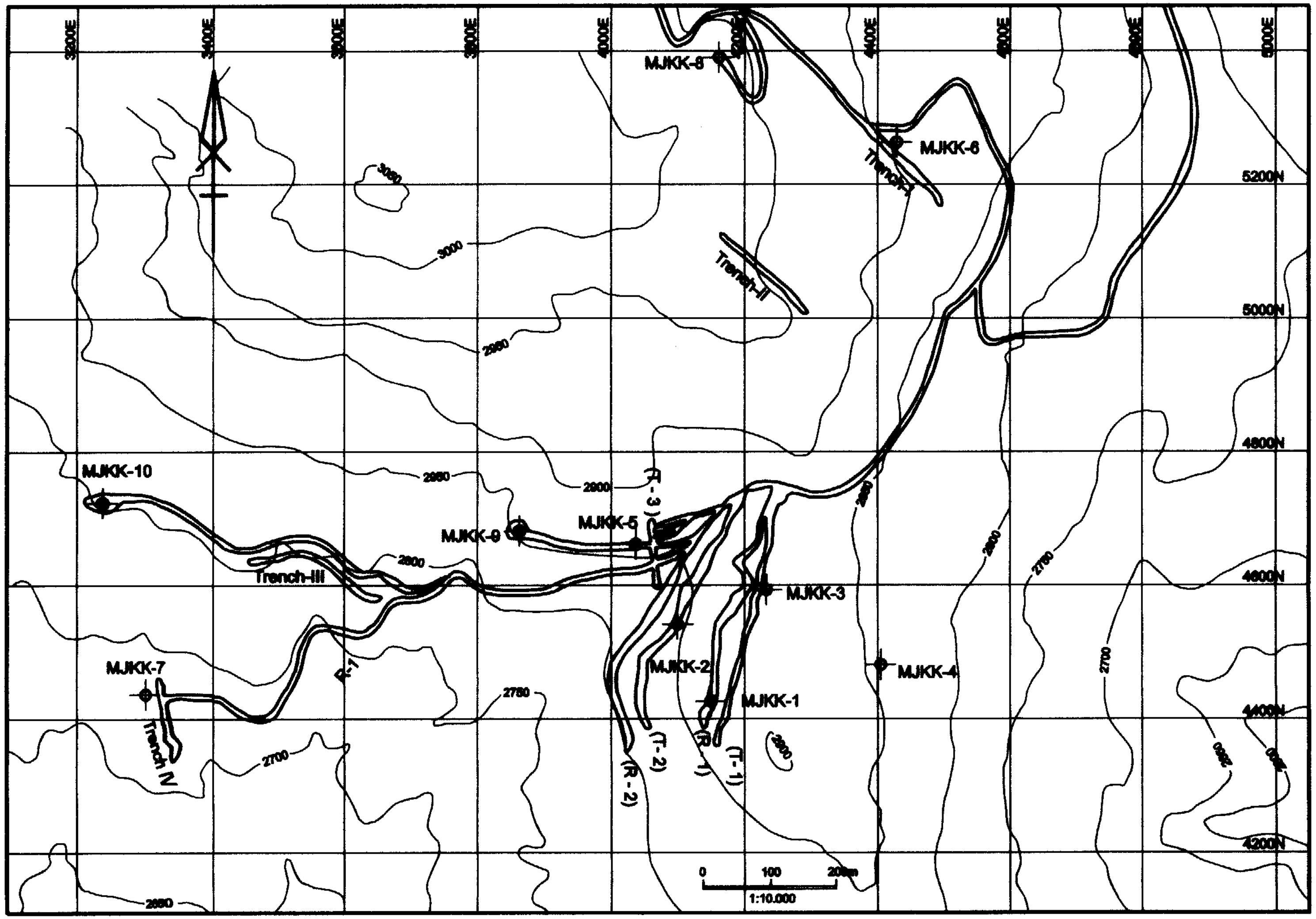


Fig. II-3-1 Location Map of Drill Holes and Trenches in the Kichi-Sandyk District

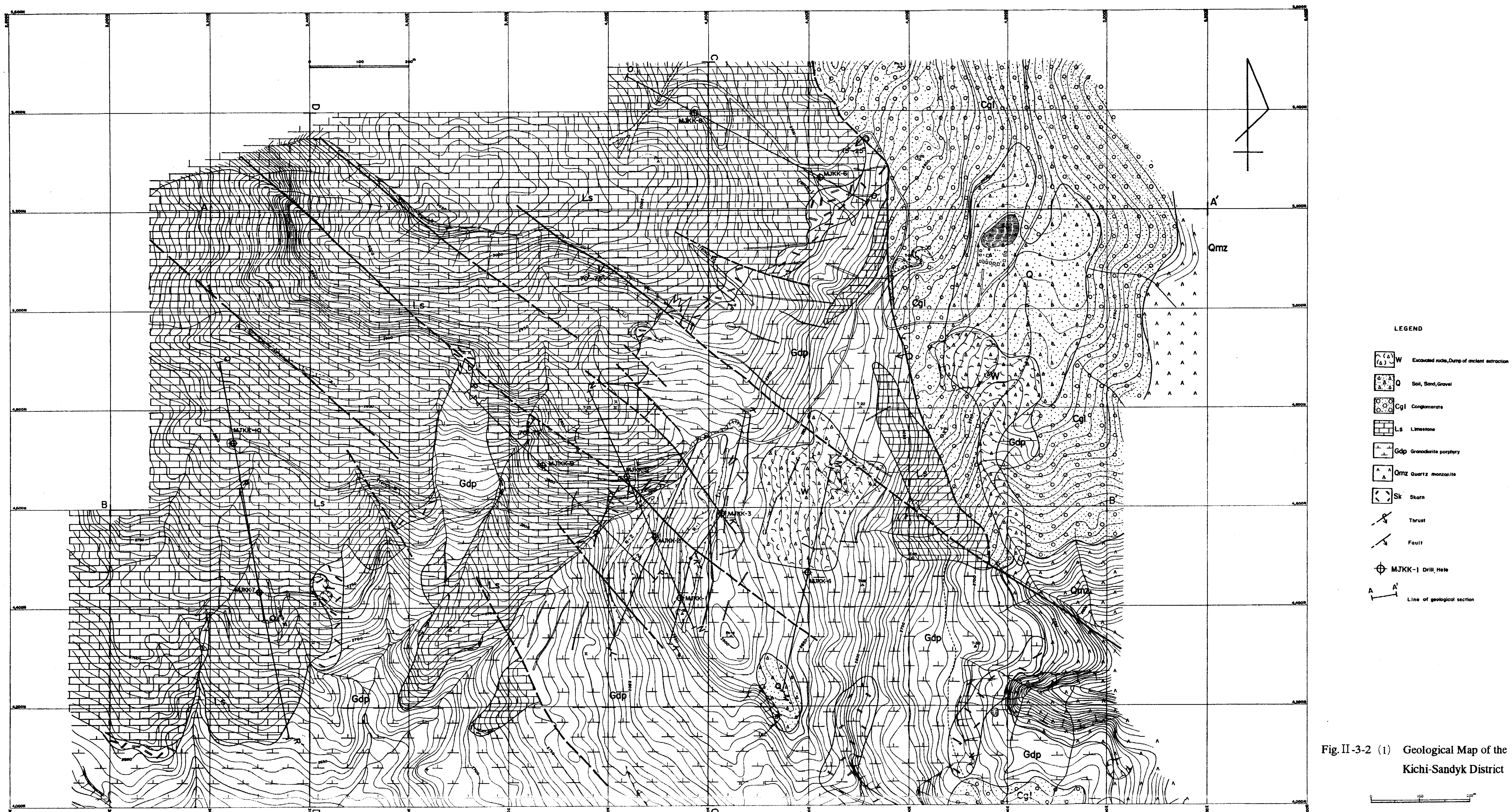
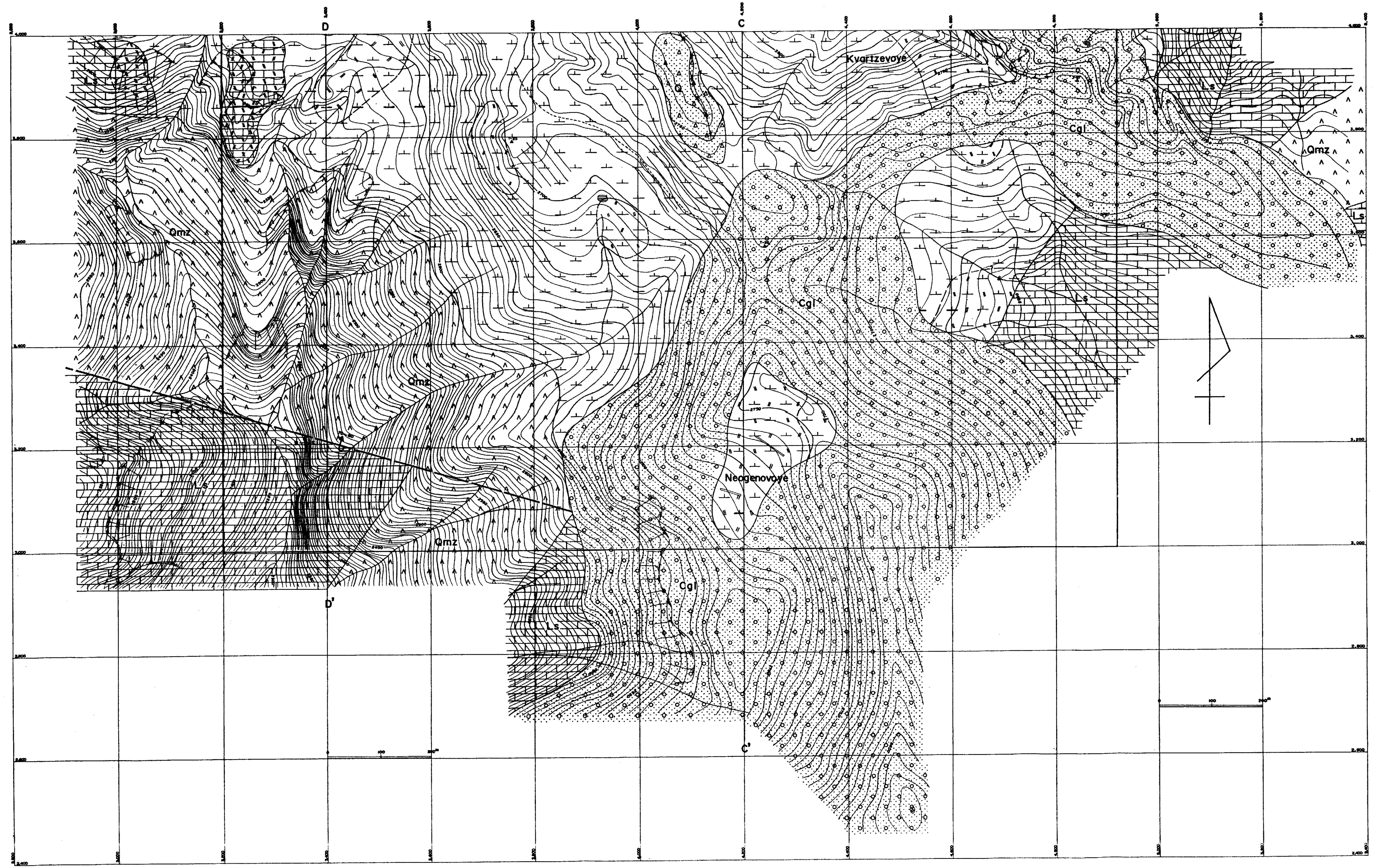


Fig. II-3-2 (1) Geological Map of the Kichi-Sandyk District



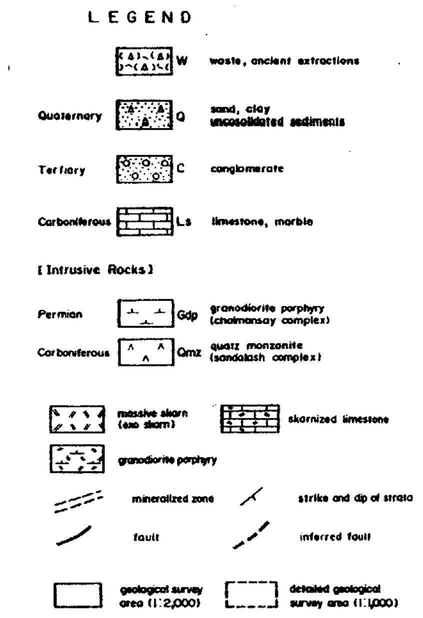


Fig. II-3-2 (2) Geological Map of the Kichi-Sandyk District

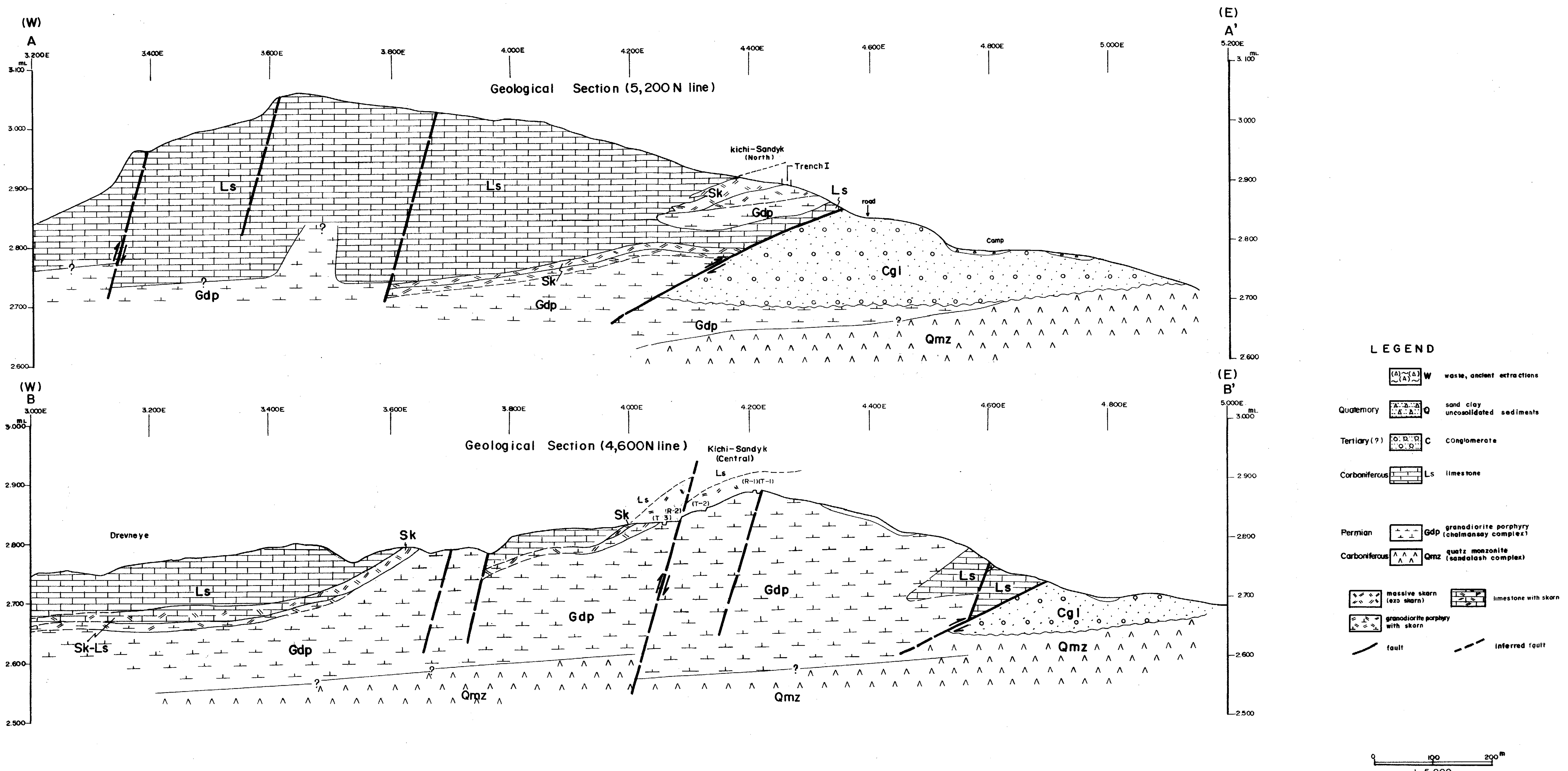


Fig. II-3-3 (1) Geological Cross Section of the Kichi-Sandyk District

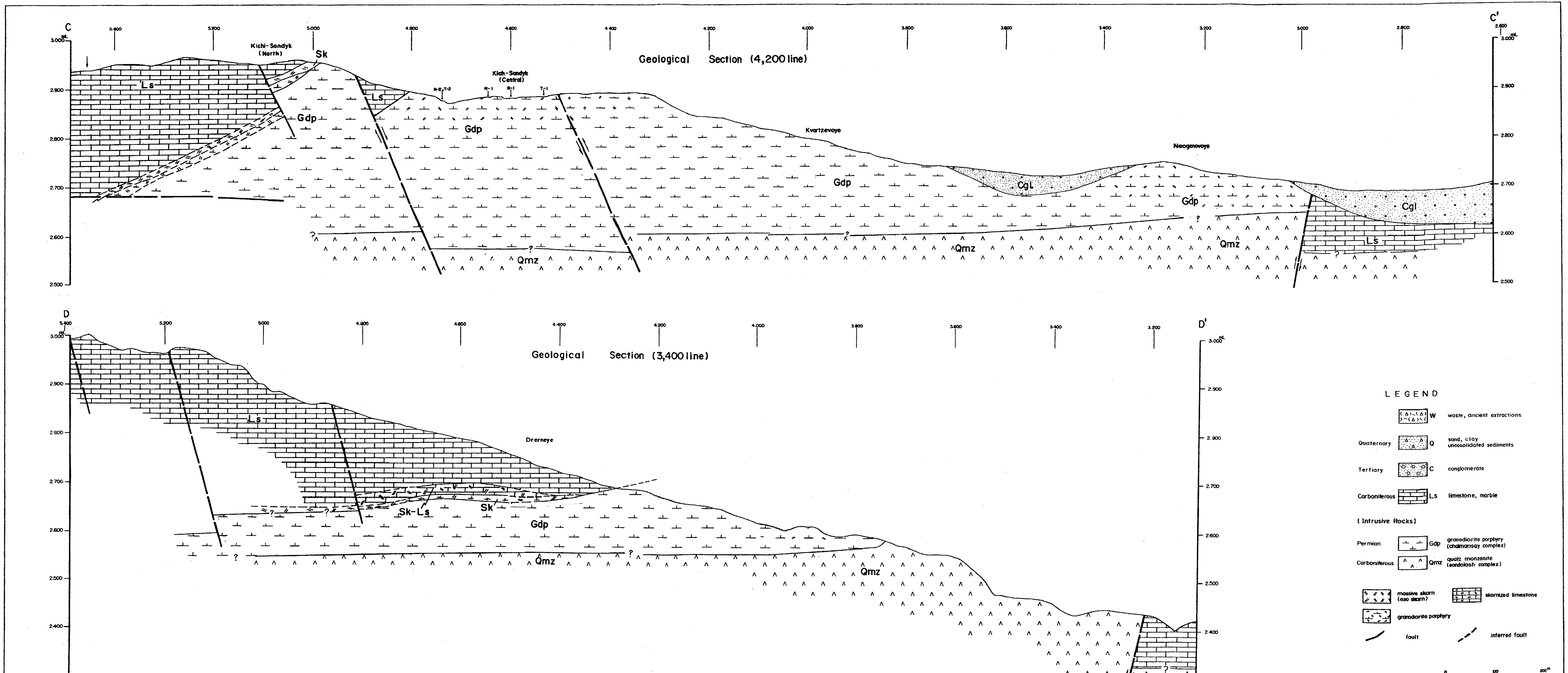


Fig. II-3-3 (2) Geological Cross Section of the Kichi-Sandyk District

Table II-3-2 Average Ore Grade of Each Major Mineralization Zone of Drill Cores (Phase II～III)

1. Vein-like skarn type

Hole No.	Depth (m)			Width (m)	Au Ave. (g/t)	Cu Ave. (%)	Reference
MJKK-1	45.0	～	46.1	1.10	0.23	0.00	
MJKK-1	93.8	～	94.8	1.00	0.20	0.03	
MJKK-1	100.6	～	102.5	1.90	0.13	0.03	
MJKK-2	7.3	～	13.2	5.90	0.27	0.04	
MJKK-2	16.8	～	23.2	6.40	0.43	0.05	
MJKK-2	73.7	～	84.2	10.50	0.17	0.02	
MJKK-2	84.2	～	91.2	7.00	1.29	0.05	max 3.47g/tAu(1.00m)
MJKK-3	17.2	～	18.2	1.00	0.10	0.03	
MJKK-3	28.8	～	30.8	2.00	0.50	0.06	
MJKK-3	47.9	～	54.2	6.30	0.41	0.02	
MJKK-3	87.5	～	89.0	1.50	0.13	0.01	
MJKK-3	95.5	～	97.7	2.20	0.23	0.00	
MJKK-3	99.9	～	102.0	2.10	0.10	0.00	
MJKK-3	110.8	～	112.8	2.00	0.17	0.00	
MJKK-4	39.5	～	42.6	3.10	0.19	0.01	
MJKK-5	25.2	～	33.1	7.90	0.24	0.13	
MJKK-5	35.9	～	36.2	0.30	35.77	2.76	
MJKK-5	36.2	～	38.2	2.00	0.44	0.07	
MJKK-9	49.5	～	49.7	0.20	0.62	0.07	
MJKK-9	58.1	～	58.5	0.40	0.06	0.05	
MJKK-10	130.0	～	141.0	11.00	0.13	0.02	

2. Layered skarn type

Hole No.	Depth (m)			Width (m)	Au Ave. (g/t)	Cu Ave. (%)	
MJKK-6	22.8	～	23.8	1.00	0.11	0.01	
MJKK-6	35.7	～	37.8	2.10	0.18	0.02	
MJKK-6	65.4	～	66.0	0.60	0.12	0.04	
MJKK-7	28.4	～	30.4	2.00	0.16	0.01	
MJKK-8	173.3	～	175.7	2.40	0.10	0.06	
MJKK-10	95.0	～	100.0	5.00	<0.03	0.14	
MJKK-10	105.0	～	116.0	11.00	0.10	0.02	
MJKK-10	122.0	～	130.0	8.00	0.06	0.01	

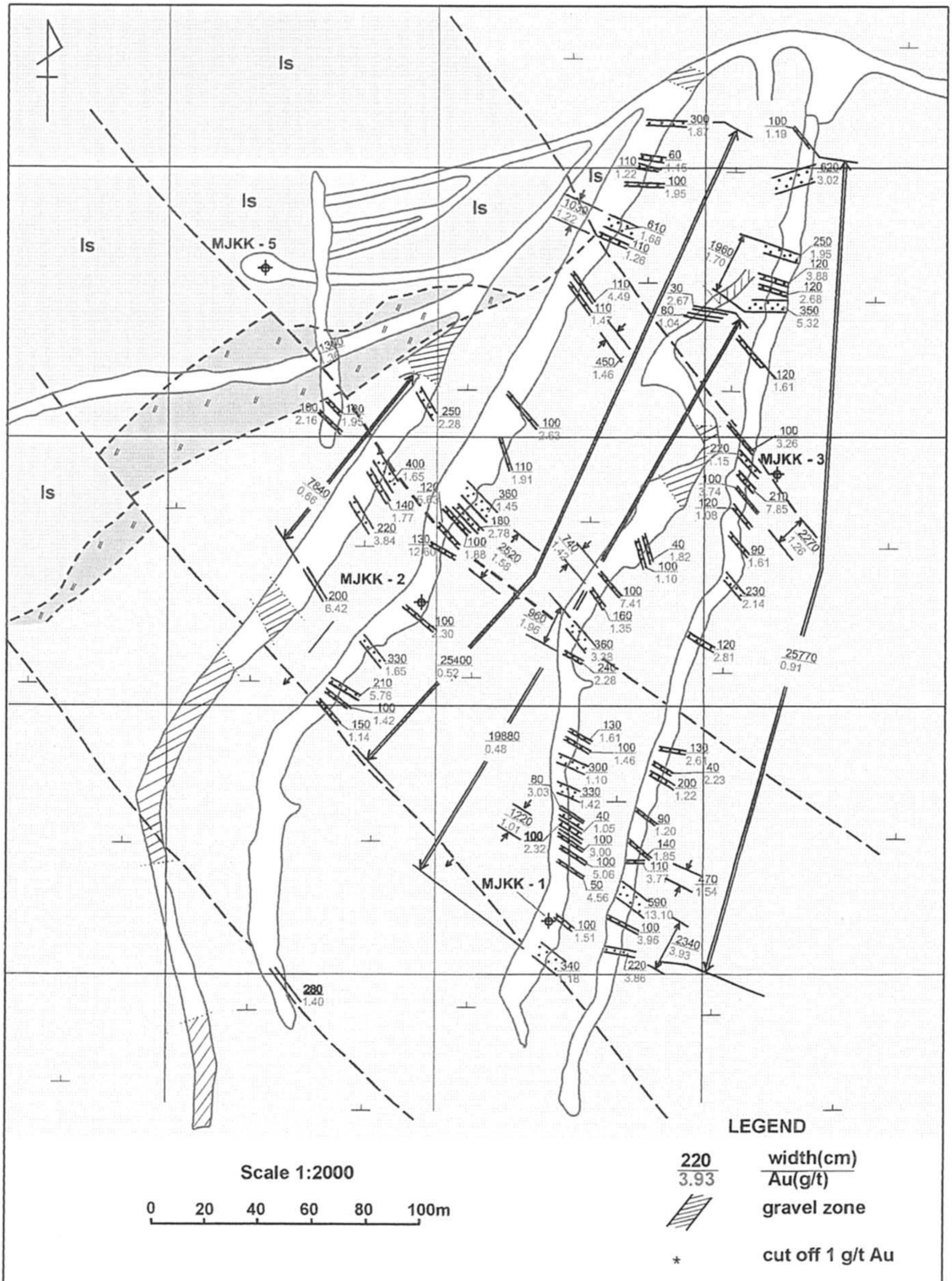


Fig. II-3-4 Gold Assay Map in the Kichi-Sandyk Central Mineralization Zone

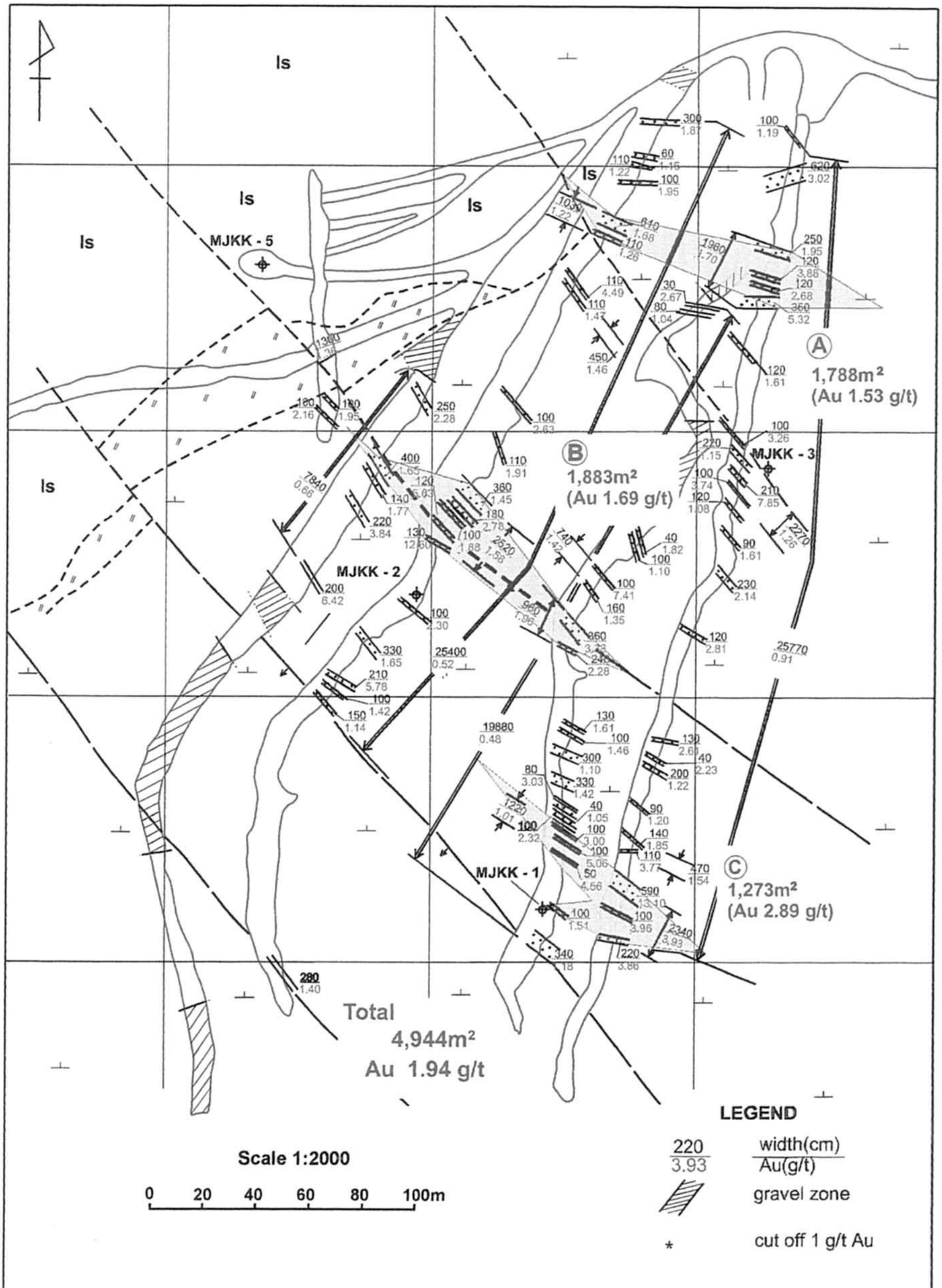


Fig. II-3-5 Map of Ore Bodies in the Kichi-Sandyk Central Mineralization Zone

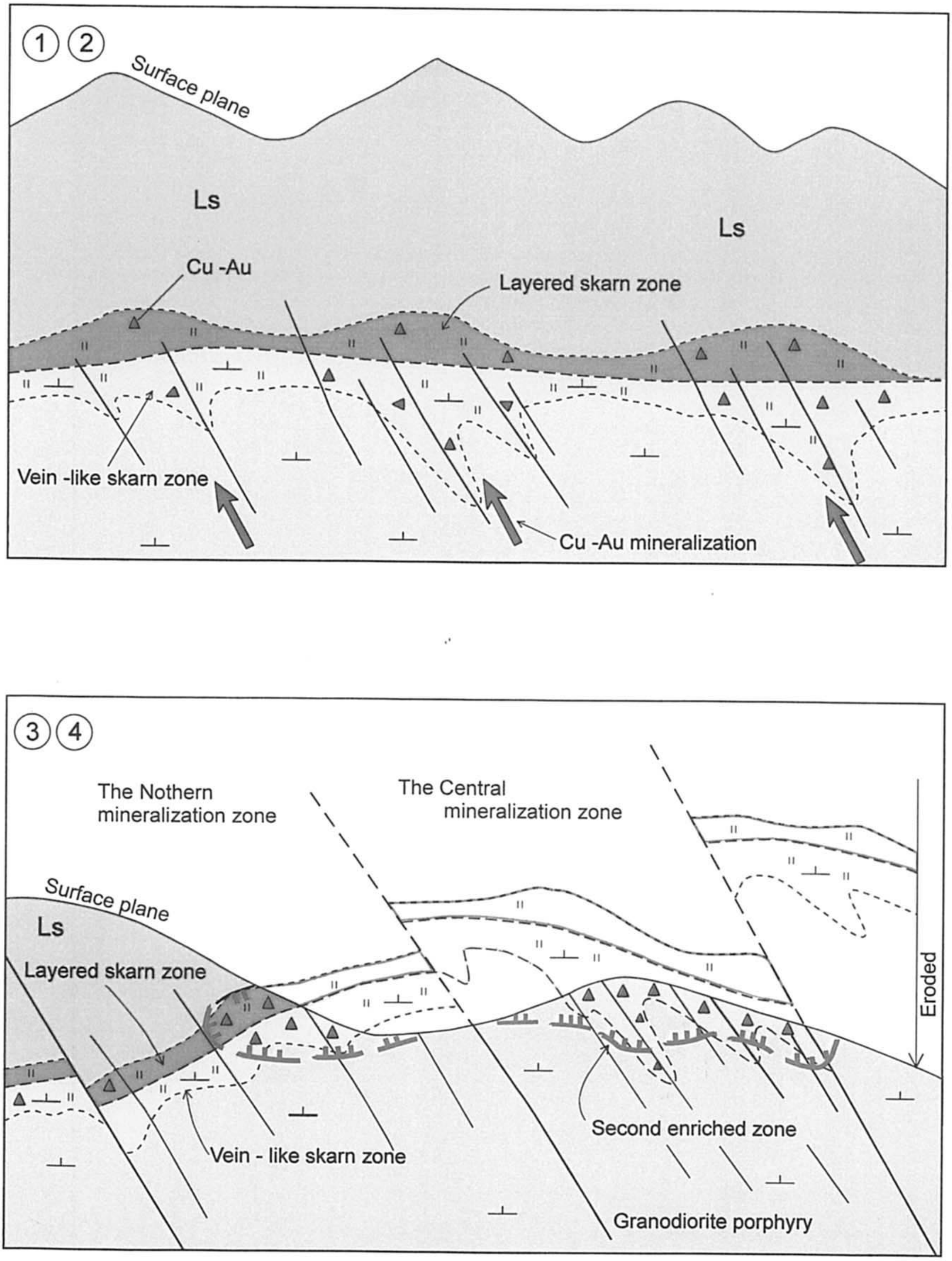


Fig. II-3-6 Model of the Mineralization of the Kichi-Sandyk District