Chapter 2 The Entire Area of the Southern Nuratau

2-1 Satellite Image Analysis

2-1-1 Purpose

The satellite image analysis was aimed to grasp the regional geological structure and distribution of lithofacies of the survey area by means of geologic interpretation using the satellite image. To extract mineralization/alteration zones, spectral analysis was conducted. Findings of the analysis were interpreted, whereby a base map was drawn for the purpose of evaluating regional potentials of the survey area.

2-1-2 Area, data and methods for analysis

Image data used for the survey are the LANDSAT TM data of Path 156 - Row 32. The coverage and data specifications of the scene are indicated in Fig. II-2-1-1.

Analysis was made on the following five items :

1) Extraction of the area to be analysed

Subscene data of 3408 x 1704 pixels(100 x 50 kms, 29.34 m/pixel), which cover the whole suvey area, were prepared.

2) Preparation of color composite images

Coefficients of correlation between bands were calculated, as well as information entropy by combination of three bands. From combinations of bands which have low correlation coefficients and high information entropy, several kinds of color composite images were produced. From these images, interpetation specialists searched on the monitor screen for the combination of bands most appropriate for geologic interpretation. As the result, it was concluded that the image, for which blue, green and red colors are assigned respectively for Bands 1, 4 and 5, best reflects topographic information and reproduces with higher fidelity changes in the tone corresponding to difference in lithofacies. Therefore, each of Bands 1, 4 and 5 was processed with the linear stretching and the edge enhancement filter, to which the blue, green and red colors were assigned, respectively, thereby producing a color composite image that was output in a scale of 1:200,000. The image produced is exhibited in II-2-1-2.

3) Geologic interpetation

Based on the 1:200,000 color composite image, the following work was conducted :

a. Geologic delineation : A geologic interpretation map in a 1:200,000 scale was drawn on a basis of photogeologic features on the image such as tone, drainage pattern, ground texture, difference in erosion resistivity and development of bedding/schistosity. The interpretation was correlated with the existing geologic map, whereby lithofacies and and geologic time of the respective geologic units were decided.

b. Lineament extraction : Continuations of linear valley topography, steep scarps and saddles appearing in the image, due presumably to geological factors, were extracted as lineaments, whereby a 1:200,000 scale lineament map was drawn. Those which have been indicated as "faults" in the existing geologic map and was extracted on the image as clear lineaments are described as "faults."

4) Elaboration of a lineament density distribution map

The total extension of lineaments per unit area was obtained from the mentioned lineament map, from which lattice data were produced and, in turn, a lineament density distribution map was drawn.

5) Mapping of alteration zones(ratioing)

An image of the alteration zone mapping was produced in compliance with the following procedures :

a. Conversion to apparent reflectance(logarithmic residuals method) : Radiance data obtained from remote sencing data are affected by atmospheric scattering and/or absorption and also by topographic factors; consequently, surface materials cannot be identified outright from the radiance data as they are. The log residuals method, while eliminating topographic factors dependent on the position of a pixel and illumination factors dependent on the wave length, pursues reflectance differentials of all pixels from an average reflectance of a subject area, in an effort to find an approximate value of the reflectance.

b. Calculation of NDVI : The NDVI(Normalized Differential Vegetation Index) is calculated in the following formula :

$$NDVI = (Band\ 4 - Band\ 3) \div (Band\ 4 + Band\ 3)$$

The higher the NDVI is, the more dense the vegetation is reckoned to be.

c. Elimination of vegetation coverage : Pixels whose NAVIs are $M + 2\sigma$ or more(DN = 169) are considered not to reflect the spectral characteristics of rocks and minerals; they were eliminated from the analysis.

d. Ratioing-1 : To select iron oxide zones, ratioing was made in the formula of (Band 2 - Band 1) ÷ (Band 2 + Band 1). Although "Band 3 ÷ Band 1" is a generally applied formula for the extraction of iron oxide zones, the ratio of Band 2 to Band 1 was used for the ratioing because iron oxide minerals of certain types are of absorption characteristics to Band 3, as well.

e. Ratioing-2 : Since many of clay minerals and carbonate minerals have absorption characteristics to Band 7 of TM, areas where these minerals occur can be detected by ratioing in the formula of (Band 5 - Band 7) ÷ (Band 5 + Band 7).

f. Principal component analysis : Principal component analysis by Bands 1, 2, 3, 4, 5 and 7 was made; the first principal component image that reflects the topographic factors(albedo) was used as a base image of the image of alteration zones.

g. Level slice : Of the ratioing-1 and -2, respectively, the accumulation frequency curves from the maximum value were drawn; and, ratioing values, at which the respective accumulation frequencies fall in with 1% and 5%, were used as the thresholds for defining the spectral anomaly areas. Results of the analysis, composed with the first principal component image, were output in a scale of 1:200,000. The image produced is exhibited in Fig. II-2-1-3.

2-1-3 Image interpretation and analysis

The geologic interpretation map drawn from the color composite image is exhibited in Fig. II-2-1-4. The area for analysis was classified into 10 units. In comparison with the existing geologic map, the areas of occurrence of intrusive rock bodies have been grasped more in detail. Especially in the northwest, the occurrence of intrusive rock bodies clearly forming the circular structure can be inferred, which are correlated with the Carboniferous granites. The Silurian unit, though classified into sub-units in the existing geologic map, is hard to segment on the image. Features of the respective units are summarized in the following paragraphs :

- Unit a : The unit extends in a narrow strip along the main drainage system in the southeastern part of the area and is interpreted as alluvium.
- Unit PP : It forms a very gentle slope, partiallly cultivated, in the southern and northern parts of the area, and is composed presumably of very soft sedimentary rocks or unconsolidated sediments. It is correlated with the Mesozoic to Quaternary sedimentary rocks(including sand and loam) in the existing geologic map.
- Unit D : It stretches in a narrow strip along the mountainside in the northwestern part. Described as Devonian in the existing geologic map, the unit is presumed to be of soft sedimentary rocks.
- Unit S-D : This unit occurs rather substantially in the northwestern part and also stretches in a narrow strip crossing the center in the WNW-ESE direction. It appears bright yellowish brown and has very high erosion resistivity and clear stratification. Presumably, it is composed of hard sedimentary rocks such as sandstone.
- Unit S : Located in the western and southern parts, the unit appears somewhat dark purplish brown and the erosion resistivity is low. It is presumed to be of soft sedimentary rocks. The existing geologic map describes it as Silurian

sandstone/conglomeratic schist.

- Unit 02 : The unit spreads out traversing the central part of the area in the WNW-ESE direction. It assumes a peculiar ultramarine color and has the erosion resistivity at an intermediate level. Stratification being somewhat conspicuous, the unit is likely to be alternation of sandstone, shale beds and others. It is correlated with the flysh type siltstone of Ordovician age in the existing geologic map.
- Unit 01 : Extending between the Unit S-D in the northwestern part, the unit appears to be ultramarine color and has somewhat high erosion resistivity. In the existing geologic map, it is decribed as siltstone/Carbonaceous siltstone of Ordovician age.
- Unit Gr_3 : Located in the southwestern part, it has a light purple color and somewhat low erosion resistivity. The lineament in the NE-SW direction is conspicuous. It is correlated with the unclassified granite in the existing geologic map.
- Unit Gr_2 : Located in the northwest, some way off from the area, the unit is treated as the same unit as the Gr_1 in the existing geologic map; however, due to the difference in tone and erosion resistivity, Gr_2 is inferred to be of different lithofacies.
- Unit Gr_1 : The unit spreads out in the north, assuming a yellowish brown color. Fine linear structures presumed to be schistosity planes are remarkable. The rock bodies occurring in the northwestern end of the area are surrounded by a clear circular structure, which is inferred to be a domical instrusive rock. In the existing geologic map, it has been described as unclassified granite.

Results of the lineament interpretation are shown in Fig. II-2-1-5. Trends in the distribution of the lineaments delineated from the area for analysis are summarized as follows :

a. The directions of NNE-SSW and ENE-WSW are conspicuous.
b. The lineament density tends to be high in the Unit Gr_1. Especially in the northwestern tip of the Gr_1 rock body, the density is very high; it is presumed that numerous fissures are distributed in the vicinity.
c. Occurrence of faults which cut the Gr_1 rock body in the NW-SE direction is inferred.

2-1-4 Alteration zone mapping

As the result of processing by ratioing, spectral anomaly areas have been extracted in the following areas:

1) Ratioing-1(anomalies suggesting iron oxide zones)

- Peripheries of the granite bodies occurring in the northeast to the central north(Unit

Gr1); especially in the northeast, high anomaly areas are found.

- The Units 01, 02 and S-D in the northwest, especially in the eastern parts of these units.
- The Unit S-D around lat. 40°20'N and long. 66°00' E and its vicinity.
- The western part of the Unit S-D.

2) Ratioing-2(anomalies suggesting argillized/carbonatized alteration zones)

- The western end of the granite bodies in the northeast to the central north(Unit Gr1).
- Along the NW-SE faults which cut the mentioned granite bodies.

An integrated interpretation map of satellite image analysis is exhibited in Fig. II-2-1-6, which indicates the distribution of intrusive rocks, faults, lineaments, spectral anomaly areas and of lineament density.

In the areas where spectral anomalies are found and lineament density is high, occurrence of mineralization is reckoned to be highly likely. Such promising area have been observed in the areas adjacent to the surrounding of the Gr1 rock bodies. For verification of the results of satellite imagery analysis, surface reconnaissance was undertaken in the region centering around the selected areas.

2-1-5 Results of ground truth

Since the bedrocks are widely exposed in the mountains and the vegetation is scarse in the survey area, the satellite image clearly reflects the geological units and lineament. Geological units in the basement interpreted from the image has well coincided with the findings of site verification. It was known that geological units are identifiable from the differences between tone of the image and surface texture, even in flatlands underlain by blanket beds.

In the ultramarine-colored area of the image(Fig. II-2-1-2), there are slate and sandstone which look gray, dark gray and black to the naked eye. The slate, more susceptible to weathering than sandstone, has changed to soil in many places, on which grass grows, whilst the sandstone is exposed as it is. The stratification of the ultramarine area on the image("O2 " in Fig. II-2-1-4) has been known to directly reflect a slight difference in the vegetation density.

In the purplish brown area of the image("S" in Fig. II-2-1-4), there are mainly brown-colored sandstone and siltstone beds, as well as light green or light reddish gray-colored, phyllitic slate beds. These beds correspond to the Lower Silurian Sartbulak Formation.

The light yellowish brown portion that appears to form a mountain on the image has been known to be a Devonian limestone bed("S-D" in Fig. II-2-1-4). In the limestone area, ultramarine-colored stripes are visible on the image, which have been known to be the partings between thin beds of dark gray-colored cherty crystalline schists and cherty conglomerates, dark gray-colored calcareous sandstone and orange-colored dolomite, etc. Limestone occurs also as roof pendant in the granite bodies in the north of the survey area("Gr_1" in Fig. II-2-1-4), assuming a light yellowish brown color.

The difference between the tone of image and the surface texture of the two types of granite bodies("Gr_1 and "Gr_3" in Fig. II-2-1-4) as interpreted in the north and south of the survey area is attributable to presence or non-presence of weathered granite, which piles up more on the Gr_1 rock body in the north than on the Gr_3 in the south.

The flatland north of the Aktau Mountains shows smooth surface texture on the image, assuming a reddish brown to yellowish brown color. In these areas, Quaternary alluvial fan sediments are widespread, which have not changed into soil. The differences in the tone of image reflect types of original rocks of the sediments; those originated mainly from gray-colored limestone assume a reddish brown color while those mainly from granite sediments look yellowish brown.

The flatland south of the Aktau Mountains shows the surface texture with many fine wrinkles on the image, assuming light reddish brown to light greenish white color. In the area, Paleogene or Neogene beds are widespread, thinly underlain by Quaternary sand and soil. Those areas where the Quaternary beds are thick or where the change into soil has advanced look light greenish white on the image, whereas those areas where the Paleogene or Neogene beds are exposed look light reddish brown.

The clear lineament with the NW-SE trend, which traverses the central part of the granite body in the north-central part of the survey area, has been known to represent a fault with a fracture zone of some 100 m in width. Since mylonitized portions are observed in the granite within the fractrure zone, the fault is considered to have been formed in the deep.

Granite occurs inside the circular structure in the northwestern part of the survey area, around which limestone, sandstone and slate form a circular ridge. These sedimentary rocks underwent contact metamorphism by granite, and quartz veins are formed; however, no mineralization is observed.

On the image, the stripes which represent the stratification structure are closed and opened, thereby indicating the folds of bedrocks. However, the precision of the image used for the survey was not high enough to extract the detailed fold structure. The image precision required for clarification of the fold structure is considered to be around 1/100,000.

In the anomalous zone extracted by image processing that suggests an iron oxide zone, limonite gossans were observed, as well as gold mineralization at a certain point(assay ore sample No. HG043; Au 2 g/t). However, that was mostly a strong shade over the steep scarp caught on the image; such shade presumably causes a ratioing value similar to that of iron oxide.

The anomaly suggesting an argillized/carbonatized alteration zone has been known to indicate the weathered granite, from which kaolinite and sericite was generated through weathering(X-ray diffractive analysis sample No. HGX38 and HGX40). Although the anomaly was not the one that accompanies the known mineralization, the method itself proved to be effective for extraction of argillized alteration zones.

Specification of Data Used

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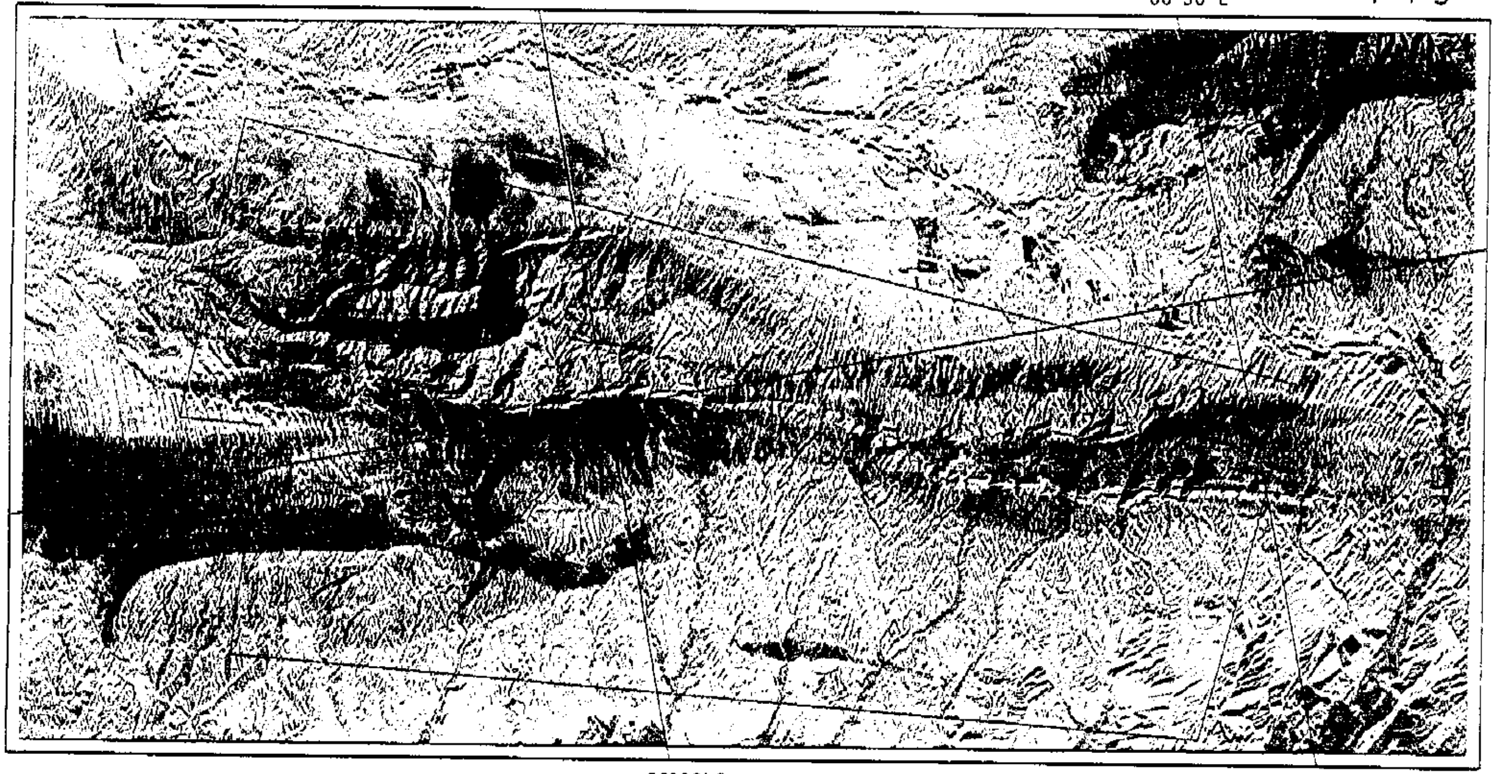
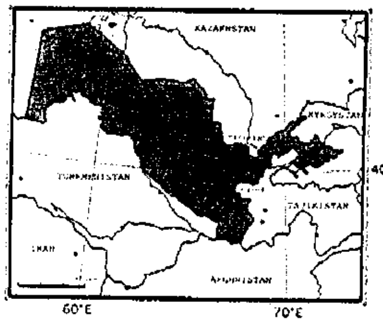
PRODUCT =97143006-01
WRS =156/032
ACQUISITION DATE =1988.09.11
SATELLITE =L4
INSTRUMENT =TM
RESAMPLING =CC
PROJECTION =UTM
USGS PROJECTION # =      9
USGS MAP ZONE =     41
EARTH ELLIPSOID =CLARKE_1866
PIXEL SIZE =28.50
PIXELS PER LINE= 6967
LINES PER IMAGE= 5965
UL 0644457.2465E 411433.6933N      646579.405     4566961.828
UR 0670404.1771E 405414.0655N      842657.513     4535850.201
LR 0664011.9907E 392419.0991N      816021.030     4367976.265
LL 0642358.8896E 394406.4960N      619942.921     4399087.892
BANDS PRESENT =1234567
SUN ELEVATION =47
SUN AZIMUTH =139
```

Fig. II-2-1-1 Ground Coverage of Satellite Data and its Specification





COLOR COMPOSITE IMAGE

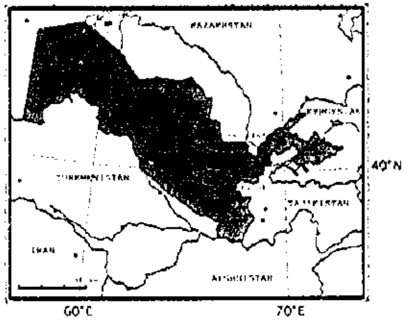
Band 1 : Blue
Band 4 : Green
Band 5 : Red

SATELLITE : LANDSAT 4
INSTRUMENT : TM
WRS : 156/032
ACQUISITION DATE : 1988.09.11
SUN ELEVATION : 47°
SUN AZIMUTH : 139°

THE SOUTHERN NURATAU AREA, REPUBLIC OF UZBEKISTAN

Japan International Cooperation Agency
Metal Mining Agency of Japan
1998
Processed by Mitsui Mineral Development Engineering Co., Ltd. (MINDECO).

Fig. II-2-1-2 LANDSAT TM Color Composite Image



0 5 10 20 30 km

RATIO IMAGE

(Band 2 - Band 1) / (Band 2 + Band 1) : 1 % of Max.
(Band 2 - Band 1) / (Band 2 + Band 1) : 5 % of Max.
(Band 5 - Band 7) / (Band 5 + Band 7) : 1 % of Max.
(Band 5 - Band 7) / (Band 5 + Band 7) : 5 % of Max.
Base Image : First Principal Component

SATELLITE : LANDSAT 4
INSTRUMENT : TM
WRS : 156/032
ACQUISITION DATE : 1988.09.11
SUN ELEVATION : 47°
SUN AZIMUTH : 139°

THE SOUTHERN NURATAU AREA, REPUBLIC OF UZBEKISTAN

Japan International Cooperation Agency
Metal Mining Agency of Japan
1998
Processed by Mitsui Mineral Development Engineering Co., Ltd. (MINDECO).

Fig. II-2-1-3 LANDSAT TM Ratio Anomaly Map

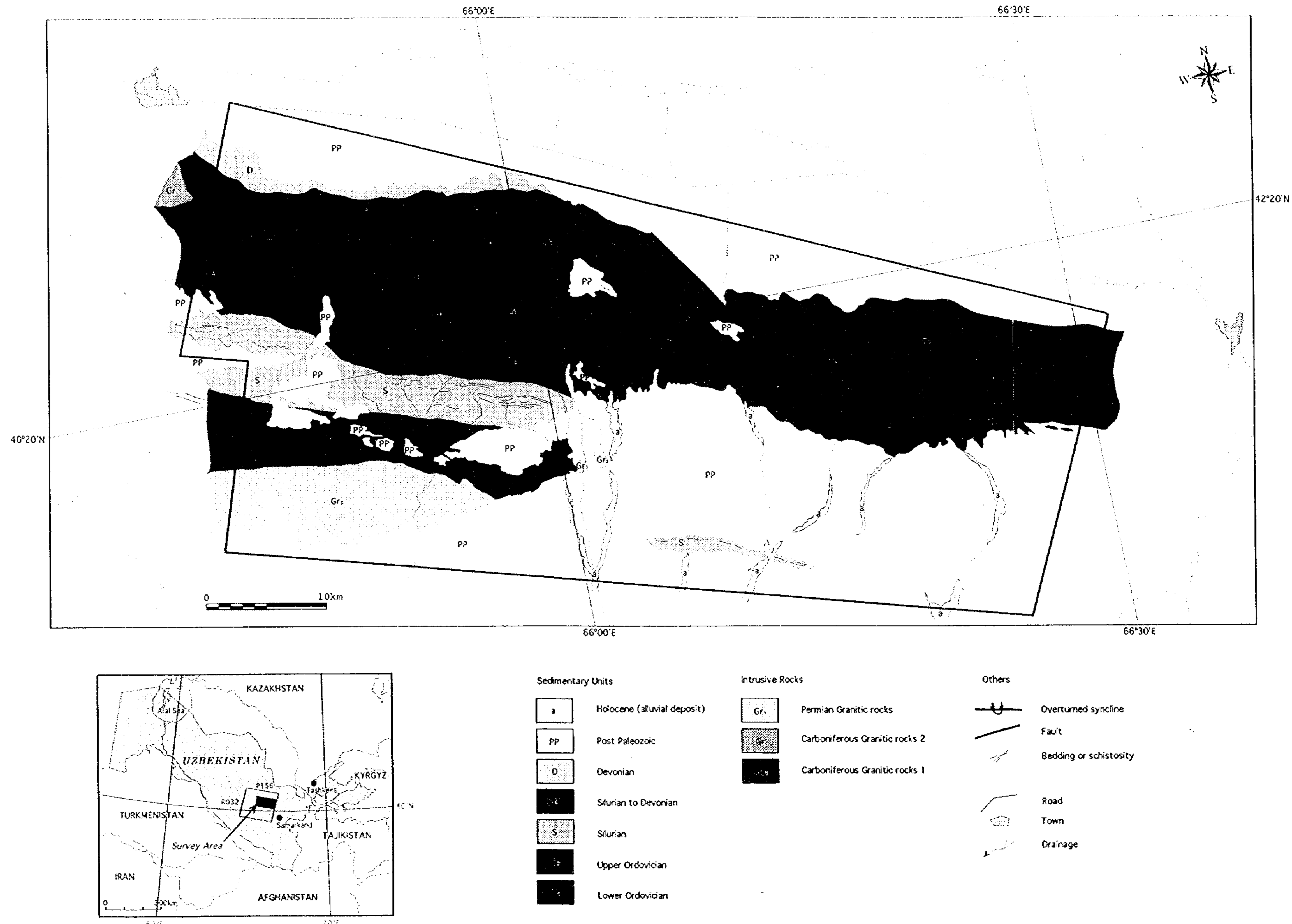
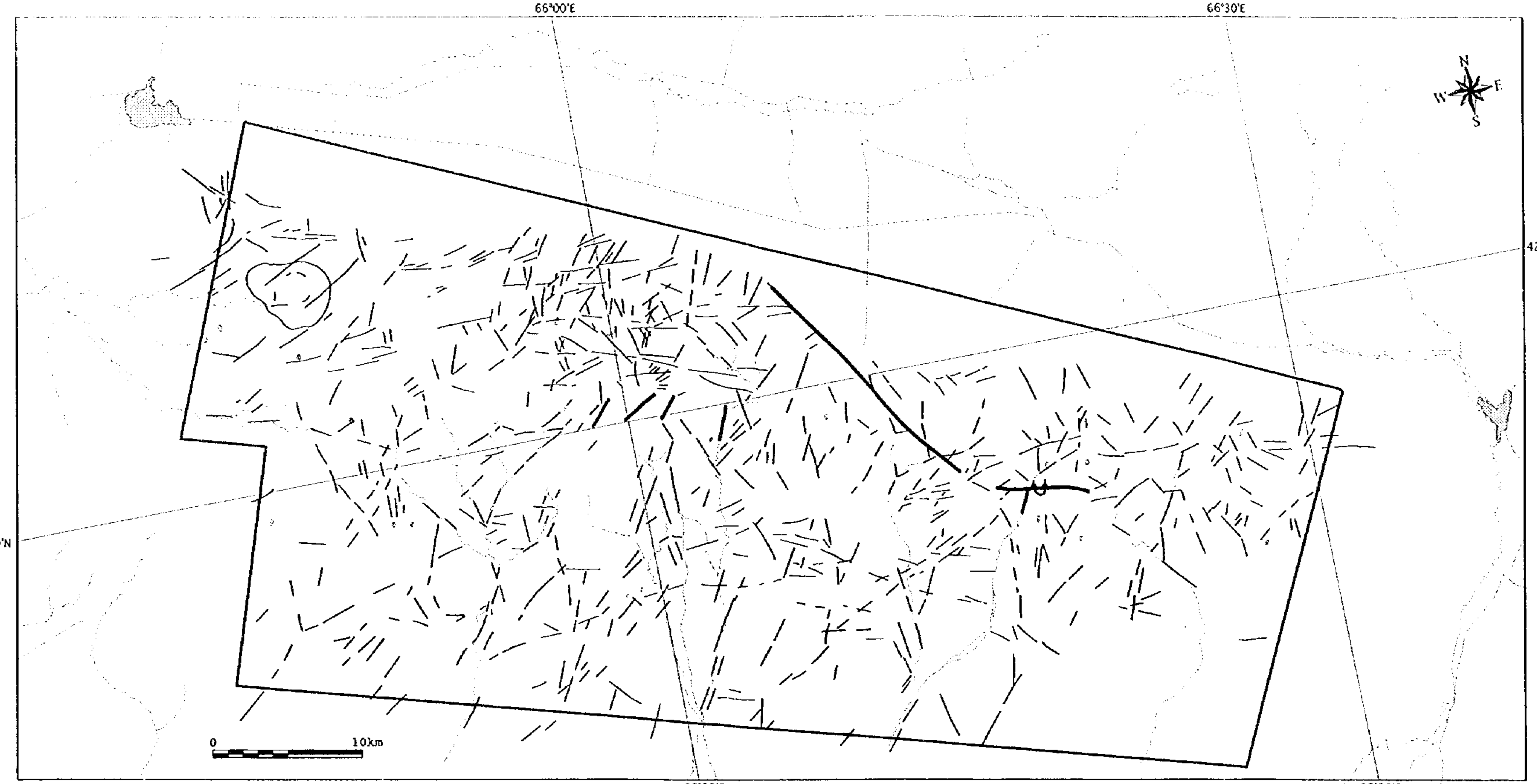
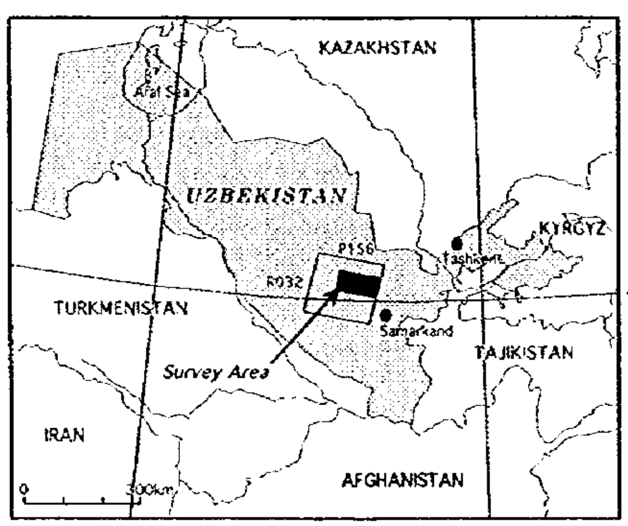


Fig. II-2-1-4 Geologic Interpretation Map of LANDSAT TM





Fault
Lineament
Overturned syncline
Road
Town
Drainage

Fig. II-2-1-5 LANDSAT TM Lineament Map

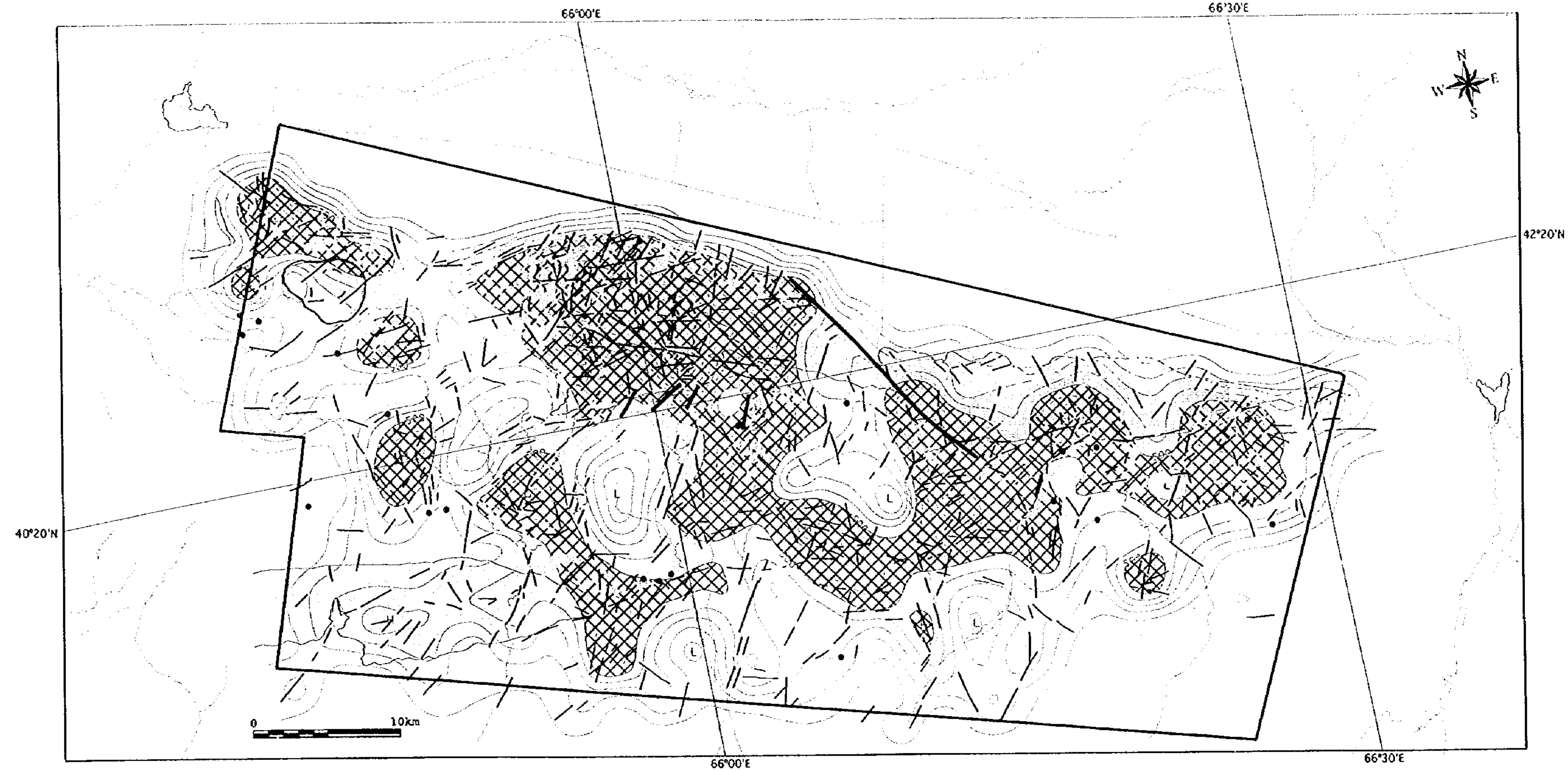


Fig. II-2-1-6 Integrated Interpretation Map of Image Analysis

2-2 General Geological Survey

2-2-1 Purpose of the survey

Purpose of the general geological survey is to clarify the relationship of geology and geological structure with mineralization in the entire area of Southern Nuratau..

2-2-2 Methods of the survey

The general geological survey in the quantities indicated in Table I-1-1 was carried out. A base camp for the survey was placed at a hotel in Milbazar,

In the reconnaissance for general survey, route mapping was conducted on the basis of the existing topography map in a 1:25,000 scale. Outcrops of particular importance were sketched on 1:100 to 1:200 scales and photographed in color. Survey findings were incorporated in the 1:50,000 geological map(PL.II-2-2-1).

Simultaneously with the geological survey, sampling of various types in the quantities indicated in Appendix 2-1 was done, as well as laboratory tests.

The laboratory tests included chemical analysis of ores, microscopic observation of thin sections of rocks and polished sections of ores, X-ray diffractive analysis and measurement of homogenization temperature of fluid inclusions. Ore samples were collected from ore deposits and manifestations for analysis. Results of the analysis are tabulated in Appendix 2-6. Major assay results are shown in Table II-2-2-1. Sampling points of the other samples for laboratory tests are indicated in PL.II-2-2-2. Results of identification of rock thin sections and the photomicrographs are exhibited in Appendices 2-2 and 2-3, respectively, while results of identification of ore polished sections and the photomicrographs are exhibited in Appendices 2-4 and 2-5. Results of the X-ray diffractive analysis are demonstrated in Appendix 2-7 and the measurements of homogenization temperature of fluid inclusions in Appendix 2-8.

2-2-3 Survey findings

1) Geology of Southern Nuratau Area

The geologic units in the survey area are described in ascending order, in the following paragraphs :

(1) Basement rocks

① Kutanbulak Formation of Lower to Middle Cambrian Systems

The formation occurs in numerous lenses surrounded by faults within a strip trending in the WNW-ESE direction, from west to east of the survey area. The lenses are 500 m wide or less. The formation lies conformably under or in fault contact with the overlying Shurchin Formation. The subject formation is composed of slate, siltstone, cherty limestone, limestone and metavolcanics. The lower portion of the formation is made up dominantly of slate and includes some banded alternations of slate with limestone or cherty limestone. In the upper portion, alternations of lutaceous limestone-siltstone and cherty slate are dominant. Thickness of the formation in the survey area is inferred to be 150 m to 180 m.

② Shurchin Formation of Middle to Upper Cambrian Systems

Similarly to the Kutanbulak Formation, the Shurchin Formation occurs in numerous lenses in strip trending in the WNW-ESE direction, from west to east of the survey area, on the south slope of the Aktau Mountains. The lenses of this formation are repeatedly exposed by faults in the Sartbulak Formation of Lower Silurian System, in the western part of the survey area. The subject formation consists of limestone, sandstone, phyllite and black chert. In the limestone beds, partings of calcareous conglomerates, 20 m to 30 m thick, are observed. Thickness of the formation in the survey area is inferred to range from 100 m to 300 m.

③ Karakargin Formation of Lower to Middle Ordovician Systems

The formation occurs chiefly in the western part of the Southern Nuratau Area, which is slightly seen in the southwestern part of the survey area. The formation lies in fault contact with the other formations, and is composed of slate, siltstone and sandstone. These strata form alternations, 20 cm to 50 cm thick. By folding and faulting, the same horizons of the formation are repeatedly exposed on the surface. The formation is inferred to be 400 m to 450 m thick.

④ Tusun Formation of Middle to Upper Ordovician Systems

The formation occurs in the south piedmont of Aktau Mountains situated in the eastern part of the survey area and also in the north side of the Karatau granite body in the western part of the survey area. The formation lies in fault contact with the other formations and consists of siltstone, sandstone and slate. Spots consisting of quartz, biotite and chlorite are observed in slate. Since "multicolored slate," characteristic of the color variety, is conformably underlain by the formation, the slate is treated as a part of the Tusun Formation in this Report. Thickness of the formation is inferred to be about 500 m.

⑤Sartbulak Formation of Lower Silurian System

In the western part of the survey area, the formation occurs in a wide belt between the Aktau and the Karatau Mountains. whilst, in the eastern part of the survey area, it occurs in a narrow belt on the south slope of the Aktau Mountains. The formation lies conformably under or in fault contact with the overlying Tumsai Formation, and lies in fault contact with the underlying formation. The Sartbulak Formation consists of slate, sandstone and siltstone, accompanied by partings of conglomerates. Laminas develop in slate and siltstone, while sanstone is massive and thick, occasionally reaching several decameters thick. Each of strata horizontally changes or are sharply bordered, forming rythmic alternations. Thickness of the formation is inferred to be 250 m to 300 m.

⑥ Tumsai Formation of Lower Silurian System

In the western part of the survey area, the formation occurs in a wide belt north of the Karatau granite whilst, in the central and eastern parts, it occurs in several bands over the whole area of Aktau Mountains. The formation and the overlying formation are in fault contact with each other. The Tumsai Formation consists of sandstone, siltstone and slate, accompanied by partings of tuff. Thickness of the formation is inferred to be about 150 m in the Karatau Mountains while the total thickness of all horizons presumably reaches 500 m.

⑦ Tansarai Formation of Upper Silurian to Lower Devonian Systems

The formation occurs in slender, lenticular rock bodies in the south piedmont of the Aktau Mountains in the western part of the survey area. The formation and the other formations lie in fault contact. The formation is made up mainly of sandy siltstone and sandstone, and includes siltstone and slate. The formation has generally undergone dolomitization. Conglomeratic horizons are observed in sandstone. Thickness of the formation is inferred to be about 350 m.

⑧ Angidan Formation of Upper Silurian to Lower Devonian Systems

The formation occurs in a belt in the southside of the Aktau granitoids complex in the central-western part of the survey area, and also on the north slope of the Aktau Mountains. The formation lies in fault contact with the other formations, and consists of crystalline limestone. By age of fossils and rock facies, the formation is divided into the lower formation and the upper. The lower formation is composed of limestone, in which laminas develop and late Silurian Neopilina exists. The upper portion, composed of massive limestone yields Favosites. At the lowest layer of the upper formation, terrigenous sedimentary beds, 16 m to 90 m thick, are observed. Thickness of the lower formation is 300 m to 350 m while that of the upper formation is approximately 700m.

⑨ Chalkhansai Formation of Middle Devonian System

In the western part of the survey area, the formation occurs in a belt on the north slope of the Aktau Mountains. The Chalkhansai Formation lies in thrust-fault contact with the underlying Angidan Formation and with the overlying Bakhiltau Formation. The Chalkhansai Formation consists of light to dark grey-colored, banded crystalline limestone. Partings of cherty limestone and dolomite are observed. The formation yields early Middle Devonian Favosites and Crinoidea.

⑩ Bakhiltau Formation of Middle Devonian System

The formation occurs on the central axis of the Aktau Mountains in the western part of the survey area. The formation lies in fault contact with the other formations, and consists of crystalline limestone. By age of fossils and rock facies, the formation is divided into the lower formation and the upper. The lower formation consists of white to dark gray-colored crystalline limestone, in which some laminas are observed and Stromatopora exists. The upper portion, consisting of massive crystalline limestone, yields Devonian coral. Thickness of the lower formation is about 510 m while that of the upper formation is about 350 m.

⑪ Aktau Formation of Upper Silurian to Middle Devonian Systems

The formation occurs in a belt in the southern edge of the Aktau Mountains in the eastern part of the survey area. It lies in fault contact with the other formations. Although the formation should be classified into limestone beds either of the mentioned Angidan, Chalkhansai or Bakhiltau Formations, it has been treated as an independent formation, due to the poor preservation of fossils which permits no correlation. The formation consists of white to dark gray-colored, banded, crystalline limestone. The rock unit resembles the Bakhiltau Formation. Thickness of the formation is 330 m or more.

⑫ Darasai Formation of Lower to Middle Devonian Systems

In the western part of the survey area, the formation occurs in a curved belt in the Aktau Mountains while, in the eastern part of the survey area, it occurs in numerous lenses in the Aktau Formation. The Darasai Formation rests conformably upon the underlying Angidan Formation. The Darasai Formation is inferred to have an unconformable relationship with the overlying Bitab Formation, in view of their locations. The Darasai Formation lies in fault conact with the other formations and is made up largely of slate, siltstone and sandstone, including partings of limestone and conglomerate. The partings of limestone yield fossils of Crinoidea, indicative of the late Silurian to Devonian times. Thickness of the formation is approximately 300 m.

⑬ Bitab Formation of Middle Carboniferous System

The formation occurs in some small blocks upon the Darasai Formation in the western part of the survey area. The Bitab Formation is thought to rest unconformably on the Darasai Formation, but lies in fault contact with the other formations. The formation is composed of slate, siltstone, sandstone, conglomerate and limestone. Conglomerate beds occurs in belts, 50 m to 100 m wide. The gravels consist mainly of limestone, and of dolomite, quartz, sandstone, hornfels and slate, but gravels of granite are unobservable. Gravels of limestone include fossils of Middle Paleozoic age before late Carboniferous time. Thickess of the formation is about 100 m.

(2) Intrusive rocks

① Silurian dikes

The dikes exist chiefly as sills in sedimentary rocks of Lower to Middle Cambrian, Ordovician and Silurian Systems They rarely cut the bedding plane at high angles. The dikes consist of gabbro, diabase, diorite, quartz diorite, quartz porphyry and granite porphyry. The sills are 0.6 m to 9 m thick and 10 m to 150 m long.

② Aktau granitoids complex of middle Carboniferous to early Permian ages

The complex constitutes main portions of the Aktau Mountains and can be divided into the three rock bodies of different stages of intrusion, ie., Darasai, Shurak and Gatchin.

(i) Darasai rock body of middle to late Carboniferous age

The rock body intrudes into Devonian sedimentary rocks and, in turn, is intruded by the late Carboniferous Shulak rock body. The Darasai rock body has been dated as 295-322 Ma in absolute age. The lithofacies are mainly quartz diorite and granodiorite, and some tonalite and granodiorite porphyry.

(ii) Shurak rock body of late Carboniferous age

The rock body intrudes into the Darasai rock body and, in turn, is intruded by the late Carboniferous to early Permian Gatchin rock body. From rock body occurring in the Northern Nuratau Mountains, which are correlated with the subejct rock body, 260-286 Ma has been determined by K-Ar method. The rock body is chiefly of adamellite and granodiorite.

(iii) Gatchin rock body of late Carboniferous to early Permian ages

The rock body intrudes into the Shulak rock body in the form of gently inclined plate in thicknesess up to several decameters. The absolute age of 265-268 Ma has been determined. The rock body is chiefly of leucocratic, fine to medium-grained granite and include muscovite and garnet.

③ Karatau rock body of early Permian age

In the survey area, the rock body composes the main portion of the Karatau

Mountains and intrude into the Tusun Formation of Middle to Upper Ordovician Systems. The absolute age of the rock body has been determined to be 270-274 Ma. The rock body chiefly comprises biotite granite and include amphibole-biotite granite.

(3) Blanket strata

① Senonian Series of Createceous Period

In the survey area, the strata occur mainly in the south piedmont of the Karatau Mountains. The basement rocks and the overlying Paleogene have an unconformable relationship. The strata is composed chiefly of neritic sandstone, shale and siltstone and include coquinite. Thickness of the strata is approximately 100 m.

② Eocene Series of Paleogene Period

The strata occur from the south piedmont of the Karatau Mountains to the mountain edge in the extreme east. The strata has an unconformable relationship with the underlying Cretaceous System and also with the overlying Neogene System. The strata are mainly of marl in the lower portion, whilst the upper portion is mainly of green clay beds of montmorillonite and includes siltstone, conglomerates, limestone and coquinite. Thickness of the strata in the survey area is 50 m to 60 m.

③ Pliocene Series of Neogene Period

The strata are widespread in the flat area in the southern part of the survey area and have an unconformable relationship with the underlying Paleogene System and also with the overlying Quaternary System. The strata are of molasse-type sediments composed of siltstone, conglomerates, sandstone and shale. Thickness of the strata is up to 450 m.

④ Quaternary System

The strata, widespread in the flat area in the southern part of the survey area, are composed of terrace sediments, alluvial fan sediments, colluvial soil, aeolian loam and stream sediments.

2) Ore deposits and manifestations

In the survey area, there are about 20 known ore deposits and manifestations of gold, silver tungsten-molybdenum, iron-manganese, tantalum-niobium, copper, tin, etc.(Fig. 1-3-1, Table II-1-1) The ore deposits in the area can be classified in the following categories:

① Gold-silver bearing quartz vein : Karamechet, Kurai, Berkut, Kazanbulak, Altynsai, Bitab, Bashtut, Maidan, Maulyan, Taulyan, Beshbulak, Sebistan

② Tungsten-molybdenum bearing skarn : Lyangar

③ Tungsten-copper bearing skarn and copper bearing quartz vein : Takhku

④ Tantalum-niobium pneumatolytic deposit : Sartakchi
⑤ Tin placer deposit : Sulukyz, Tulyasai
⑥ Iron-manganese hydroxide deposit : Akmulla

Exploration is still ongoing only at the Berkut, Kazanbulak and Altynsai deposits and Maulyan manifestation in the Altynsai District.

1. Gold

1) Kurai-Karamechet manifestation

The manifestation, discovered in 1953, is located at the Kuraisai stream 3 km north of the Karatau intrusive rock body.

The manifestation area is composed of middle Cambrian to lower Ordovician slate and sandstone, into which dikes of upper Carboniferous granite porphyry and Silurian dioritic porphyrite intrude(Figs. II-2-2-1 thru -3). The beds are folded by WNW-ESE isoclinal folding and cut by fractures with the same trend which contain gold mineralization and also by fractures with the ENE-WSW trend. Gold mineralization occurs in these WNW-ESE and ENE-WSW fractures, forming two ore zones: the northern ore zone(Karamechet manifestation) occurring in the former fractures and the southern ore zone(Kurai manifestation in a narrow sense) in the latter.

The northern ore zone is situated in the northern part of the subject area, extending more than 7 km in the WNW-ESE direction. The ore zone, composed of fracture zones of silicified slate and siltstone containing quartz veins-veinlets, dips 65° to 80° northward. In the zone, sulfide minerals such as pyrite, arsenopyrite, marcasite, chalcopyrite, galena, etc., in addition to quartz, are recognized, which account for 10% or less in quantity. Under microscope, scheelite, goethite and lepidochrocite were identified. Between 1963 and 83, the northern ore zone was prospected with extensive trenching. Although ore showings grading Au 1.0-2.5 g/t were found everywhere, those grading Au 5 g/t or more over a width of 1 m to 1.3 m were limited to several locations only; as a whole, the zone proved to be of low grade.

At a cutoff of Au 1 g/t, about 10 ore bodies, 50 m to 700 m long, 0.7 m to 11 m in average width, grading Au 1.1-2.4 g/t and Ag 0.0-28.5 g/t were extracted in the northern ore zone.

The assay of slime samples of non-core drilling executed at various locations for prospecting of lower portions of the zone indicated Au 0.1-1.5 g/t, rarely 2 g/t. At the non-core drillhole Nos. 13 and 14 near the Trenches K-12 and K-13 which showed the best grades of the zone, three veins, 5-6 m long, grading Au 2-5.6 g/t, were found(Fig. II-2-2-3). The drilling results indicate that the veins are of poor continuity and low grade.

The southern ore zone, located 2.5 km southeast of the northern ore zone, occur in a fracture zone in slate, siltstone and sandstone, characterized by quartz veins and intensive iron oxide. The ore zone extends in the direction of ENE-WSW, dipping 60° – 75° northward. Thicknesses of quartz veins reach 5 m to 10 m (Max. 30 m) in the central part. The highest gold grade was located by the trenching in the western part of the ore zone where the quartz veins decline in width and iron oxide is abundant. The ore body was 200 m long, 1.74 m in average width, averaging Au 8.0 g/t and Ag 7.0 g/t. (Fig. II-2-2-1) The east and west extensions of the ore body, already prospected by trenching, are lower in grade, leaving little potentials for future development of the ore body.

2) Bitab manifestation

The manifestation is located in the south piedmont of the Aktau Mountains in the northwest edge of the survey area.

The Aktau Ore Zone spreads out some 70 km in extension and 2 km to 5 km in width, along the south piedmont of Aktau Mountains, embracing gold manifestations such as Bashtut, Maidan, Taulyan and Maulyan.

The Bitab manifestation was discovered by the 1972-73 survey, together with the Bashtut manifestation and investigated by trenching, a 10-m prospecting shaft and a tunnel since 1974. The manifestation area is composed of slate, siltstone and sandstone of the Jivachisai Formation of middle Cambrian age, and diorite porphyrite and diabase dikes intrude into them.(Figs. II-2-2-4 thru 6) The beds strike E-W to NW-SE and dips 20° to 80° north or southward. The directions of the intrusion of dikes are NW-SE and NE-SW, which conform with the directions of the fractures. There are brecciated, silicified fractures in the NW-SE direction, which is intersected by younger fractures in the NE-SW direction. Gold manifestations usually occur either at intensive portion of NE-SW fractures or at intersections of NW-SE fractures with NE-SW fractures.

Mineralizaed portion of NW-SE fracture zones are usually 1 m to 10 m wide while some of them reach 3 km long. Fracture zones are filled with crushed rocks and quartz veins, which, at intersections with NW-SE fracture zones, are accompanied by quartz veins and silicified veins containing gold, silver, lead and arsenic.

Widths of the quartz veins do not exceed 20 m while gold and silver grade sometimes exceeds 100 g/t. Component minerals are pyrite, sphalerite, malachite, goethite, lepidochrocite, manganese minerals, chlorite and quartz containing native gold. Gold exists in cracks of quartz vein and wall rocks and its grain sizes vary from very fine grain to 1.5 - 2 mm.

Near intersections of NE-SW fractures with NW-SE fractures, prospecting by a 10-m shaft and a 12-m tunnel had been carried out, while, in 1992, clearing was done along the veins in the NE-SW direction. By the prospecting shaft and tunnel, low-grade gold mineralization(Au 1 g/t or less) was confirmed. A quartz vein found by the clearing was accompanied by high-grade gold(1 m wide; several decagrams/t); the vein was 37 m long, 10.5 m in average width, grading Au 4.1 g/t and Ag 1.8 g/t. However, the drilling SKB-1[a] aimed at 40m below the ore body merely caught low-grade mineralization(core length 4.0 m, Au 0.4 g/t), suggesting the ore body being small in size.

3) Bashtut manifestation

Discovered in 1972, the manifestation is situated in the piedmont south of the Aktau Mountains and 7 km east-southeast of the Bitab manifestation. Geological survey and trenching survey were conducted by the Sarmich Geological Party since 1974.

The manifestation area is composed of middle Cambrian to lower Ordovician sandstone, sandy slate, slate and calcareous slate. (Figs. II-2-2-4 thru -7) There are two fracture zones in the WNW-ESE direction, in which brecciation of sanstone and slate is intensive, as well as oxidation of iron sulfide. In the breccia zone, host rocks are substantially silicified/albitized, while quartz veins-veinlets containing sulfide minerals are accompanied by mineralization.

The northern ore zone varies from 1-2 m to 7-8 m in width. Gold grade is as low as 1 g/t or less.

The southern ore zone extends 120m to 130 m south of the northern ore zone. The southern ore zone was traced by trenching over 2 km in extension. The breccia zones have, in addition to quartz, substantial dissemination with pyrite and arsenopyrite. Quantity of sulfide minerals reach 5% to 10% where concentrated. On the surface, iron sulfide is oxidized and converted into goethite and lepidochrocite. The breccia zones vary in width from 1 m to 20 m. Gold grade is generally 1 g/t or less, the maximum being several g/t. The drilling SKB-4[a] aimed at some 80 m beneath a bonanza(1.0 m wide; Au 50.0 g/t) confirmed at Trench K-2575 caught only low-grade mineralization(core length 2.25 m; Au 1.64 g/t). The ore body presumably has poor continuity and ununiform grade distribution.

4) "Quartz Vein II" manifestation

The manifestation is located 6 km north of the Karamechet manifestation. In the fracture zone of several hundred meters in sandy slate of the Jivachisai Formation of middle Cambrian age, low-grade gold mineralization is recognized. The manifestation has so far remained unprospected.

5) Maulyan-Beshbulak manifestation

Located between the Dzhazmansai Stream on the west and the Sebistansai Stream on the east, in the south piedmont of the Aktau Mountains, the manifestation, was discovered in 1965 and prospecting started in the same year.

The manifestation is bordered on the north by crystalline limestone of the Devonian Aktau Formation, whilst the southern part is covered by Quaternary sediments. The altitude being 850 m to 1.100 m, the undulation is deeply dissected mainly by the north-south streams. The manifestation area is composed mainly of slate, siltstone and sandstone of the Badamchalinskaya Formation of Orldovician age, rarely accompanied by carbonaceous slate and limestone. (Figs II-2-2-8 and -9) The schistosity strikes WNW-ESE and dips 80° to 85° northward or is perpendicular. To the north of the area, the Silurian Nakrutskaya Formation extends, composed mainly of slate, siltstone and sandstone. Contacts of these two Formations are in fracture zones. About 10 of fracture zones/silicified zones, 1 m to 20-30 m wide, with the WNW-ESE trend, which cut the both Formations, have been confirmed by trenching. Along the tectonic zone, quartz veins, 0.5 m to 1 m wide and 5 m to 30 m long, occur. Gold is related mianly with quartz veins, sometimes accompanied by silicified sandstone or slate. Quartz veins are milky white-colored, often crushed and contain iron oxide(goethite, lepidocrocite) and sulfide minerals such as pyrite, arsenopyrite, pyrrhotite and chalcopyrite. Native gold contained in quartz is 0.1 mm to 2.0 mm in size. The highest grades confirmed in trenches are Au 17.8 g/t and Ag 8.6 g/t at K-3(vein width 2.4 m) and Au 11.0 g/t and Ag 1.4 g/t at K-7(vein width 4.2 m). Three ore bodies, 1 m to 4 m in vein width and 150 m, 200 m and 800 m in respective extension, have so far been confirmed. Gold grade varies from 1 g/t to 18 g/t. In the manifestation, trenching survey has still been conducted by the Uzbek side, and drilling survey is scheduled for 1998. In the manifestation, ore zones represent relatively good continuity and high grade of gold. Ore potentials are left in the east and west extensions. This manifestation is considered to be the most promising in the entire general survey area.

6) Taulyan manifestation

The manifestation, situated in the Central Aktau Mountains, 4 km north of the Maulyan manifestation, occurs near the contacts of Aktau granitoids body with the Buratbulakskaya Formation in the south. Prospecting started in the area in 1965, with trenching survey. The Buratbulakskaya Formation is composed of alternation of sandstone and slate, intensively crushed and silicified. Dikes of granodiorite, 1 m to 3-4 m wide and of diabase porphyrite, 10 m to 12 m wide and 250 m in extension, intrude into the sedimentary rocks. A lenticular swarm of quartz veins-veinlets, about 1 m wide, almost in parallel with the NW-SE fracture zone is observed. Quartz is milky white-colored, crushed and accompanied by iron oxide. Gold mineralization is accompanied by quartz veins, while sedimentary rocks and granodiorite as the host rock also contains gold though in minute quantity. Extension of the mineralization zone reaches several meters to 200-250 m and rarely 500 m. Most of the 1,919 pieces of trenching samples represented

Au 1 g/t or less while four pieces showed Au 1 g/t to 4 g/t(width 1 m).

7) Sebistan manifestation

The manifestation was prospected in 1967, together with Taulyan. Trenching survey traced over 2.5 km in the E-W direction a intensively silicified/mylonitized fracture zone, 20 m to 150 m wide. The fracture zone corresponds to the contacts of thermally metamorphosed slate(hornfels) near the contacts of granite bodies in the north with the carbonatized slate in the south. Diabase and aplite dikes, 1 m to 50 m thick, intrude into the fracture zone. At intersections of E-W fracture zone with NE-SW fracture zone, mylonitized and silicified slate zones increase their widths up to150 m. Most of the 1,200 pieces of samples collected from the manifestation by the Uzbek side graded Au 0.1 g/t or less while six samples showed Au 1-2 g/t.

2. Tungsten and molybdenum

1) Lyangar deposit

The Lyangar deposit, discovered in 1928 as a molybdenum deposit, is situated in the central part of the Aktau Range, at the flank of Mt. Takhku, the highest peak of the Range. After a tungsten deposit was discovered sometime later, Lyangar was prospected and developed as a tungsten-molybdenum deposit until 1980.

Silurian to Devonian crystalline limestone and the Aktau granitoids body that intruded in Carboniferous time are widespread around the ore deposit. By the post-magmatic activity, various ore deposits are formed within crystalline limestone near the contacts and granitoids body. The molybdenum and scheelite deposit, the mainstay of these deposits, occur in skarns.

Mineralization occurs in pyroxene skarns and garnet-pyroxene skarns, 1 m to 40 m thick and max. 3 km long. In the skarns, the WO_3 grades 0.25% to 0.6%, averaging 0.36%, while Mo grades 0.007%, accompanied by gold and copper.

Skarn of fine grains and coarse grains exists; the former is fine-grained garnet skarn and garnet-pyroxene skarn, which was formed during the early stage of skarn formation and is accompanied by little mineralization, whereas the latter represents those which were altered/recrystallized with ore solution at a later stage of quartz-sulfide minerals, and are accompanied by scheelite mineralization.

Concentration of scheelite is recoginzed not only in skarn-type ore bodies but in granites, limestones and also in quartz veins in skarns which contain calcite and sulfide minerals.

The main tungsten mineral is scheelite, accompanied by tungstenite. Molybdenum minerals are mainly molybdenite and powellite that is oxide mineral.

Besides, the skarn ore bodies are accompanied by chalcopyrite, pyrite, marcasite, arsenopyrite, native gold, native bismuth and tetradymite.

3. Copper

1) Takhku manifestation

The manifestation is located near the Lyangar deposit. Ore bodies occur in the vicinity of contacts of granite bodies and limestone; in quartz veins, skarns and also in brecciated slate, chalcopyrite is recognized. Copper grade varies between 0.1% and 11.3%. Drilling indicated that the ore bodies are 0.6 m to 9 m thick. The manifestation has not been evaluated as yet.

4. Tantalum and niobium

1) Sartakchi manifestation

The manifestation is located in albitized and greizenized biotite-granite stocks that intrude into lower Cambrian slate. Niobium and tantalum are yielded as columbite. Nb in granite bodies averages 0.06% to 0.031% while Ta averages 0.01% to 0.003%. The manifestation has been investigated by surface prospecting and is considered to be unworthy of further prospecting due to its small size and low grade.

5. Tin

1) Sulukyz and Tulyasai manifestations

The manifestations are located on the left bank of the Kuraisai stream at the eastern edge of the Karatau granite body. They are pneumatolytic type manifestations, where fine-grained cassiterite, scheelite and a small quantity of monazite are recognized in greizenized fracture zones. Tin contents are from trace to 0.02%, frequently reaching 0.1%.

In 1950, the cassiterite placer deposit in Sulukyz and Tulyasai were investigated. The placer deposit is 20 m wide, 1 km or less in extension and 1 m to 2 m thick. Cassiterite contents are 3 to 1,250 g/m^3, averaging 400 g/m^3. 105 prospecting pitting executed in 1950 indicated 12.7 tons of cassiterite reserves.

6. Iron and manganese

1) Akmulla manifestation

The manifestation is located in the southeastern part of the Aktau Range, 18 km to 20 km east of the Lyangar deposit. It was discovered in 1938 and prospected in 1959. The ore bodies occur in a fracture zone extending some 3 km in the WNW-ESE direction between crystalline limestone and Silurian phyllitic slate at the northside. The limestone along the fracture is dolomitized and leached, where caves filled with manganese oxide such as pyrolusite, psilomelane, manganiferous siderite and iron hydroxide are formed.

Manganese contents amount to max. 24%. The ore bodies are 10 m wide or less and 1,300 m to 1,400 m long. Along the fracture zone, ancient stopes are still existing, which were excavated up to the depth of 50m. While the lower portion of the ore deposit remain unexplored, mineralization seen on the surface represents an oxidized portion of the ore body (manganiferous siderite or polymetallic sulfide ore body) existing in the deep. The iron grade in the iron hats varies from 7% to 44%, while manganese grade ranges from 0.1% to 8 %.

2-3 Summary and Considerations

The survey area pertains to the Southern Tien-Shan Tectonic Zone, underlain by Lower Cambrian to Lower Silurian terrigenous sediments in the south while, in the north, mainly by Upper Silurian to Middle Carboniferous limestones. These rocks are intruded by Silurian to Triassic dikes and Carboniferous to Permian granites. The regional tectonic direction of the basment rocks is WNW-ESE, which is intersected by fractures that develop in the NE-SW direction. The geologic structure is inferred to have been fromed by the early Paleozoic Caledonian orogeny and the late Paleozoic Hercynian orogeny.

Ore deposits and manifestations mainly of gold extend along the fracture zones in the WNW-ESE direction, forming the Karatau ore zone (70 km east to west and 2 km to 4 km north to south) along the northern side of the Karatau granite bodies (270-274 Ma) and the Aktau ore zone (70 km east to west and 2 km to 5 km north to south) along the southern side of the Aktau granite bodies (295-322 Ma, 260-286 Ma, 265-268 Ma). The two ore zones, aligned in parallel along the respective granite bodies, are inferred to have been formed by mineralization accompanying activity of the granites.

In the area where the blanket beds occur, some 12 km southeast of the Altynsai District, which corresponds to an extension of the Karatau ore zone, Silurian basement rocks are exposed, protruding insularly. In the iron oxide zone extracted from the satellite image, a gold manifestation (sample No. HG043) was confirmed. Although covered by the blanket beds from near the Altynsai District to the east, the Karatau ore zone can be inferred to continue in the basement rocks.

Thanks to broad exposure of the basement rocks in the mountains and scanty vegetation in the survey area, the satellite image clearly reflects the geological units and lineaments. The geological occurrence interpreted from the image satisfactorily coincides with the results of the site verification. The difference in tone and surface texture between the two types of interpreted granite bodies located in the north and south of the survey area has proved to be attributable to difference in the degree of surface weathering.

The clear lineament with the NW-SE trend, which traverses the central part of the granite body in the north-central part of the survey area, has proved to represent a fault with a fracture zone of some 100 m in width. Since mylonitized portions are observed in the granite within the fractrure zone, the fault is considered to have been formed in the deep. In the anomalous zone extracted by image processing that suggests an iron oxide zone, limonite gossans are observed, as well as gold mineralization at a certain point (sample No. HG043; Au 2 g/t). However, that was mostly a strong shade over the steep scarp facing northwest caught on the image; such shade presumably causes a ratioing value similar to that of iron oxide. The anomaly suggesting an argillized, carbonatized alteration zone indicates the weathered granite, from which kaolinite was generated through weathering (X-ray diffractive analysis sample No. HGX38 and HGX40).

Component minerals of the gold-bearing quartz veins in the general survey area are quartz, pyrite, goethite and lepidochrocite, accompanied by small quantities of marcasite, arsenopyrite, chalcopyrite, sphalerite, galena, pyrrhotite, scheelite and electrum.

It was in the Maulyan and Bitab manifestations that gold was macroscopically or microscopically observed, where gold occurs as electrum, accompanying quartz veins. In Maulyan, independent gold grains, 2 mm in dia., are observed in quartz, which are considered to be primary gold. Electrum confirmed by observation of polished sections from the Bitab manifestation is associated with pyrite and manganese oxide in cracks of quartz, which has possibly occurred by secondary enrichment.

The samples analysed during the subject survey are distinctly divided to those in which gold is associated with silver in relatively good correlation and those which do not contain silver (Figs. I-4-1 thru -3). The former are from Bitab and Kurai (especially from Bitab) while the latter are mainly from Maidan and Bashtut and also from Maulyan and Taulyan. Samples of Beshbulak are of relatively high silver contents without gold. The samples analysed during the survey show no correlation between gold and arsenic.

Homegenization temperature of fluid inclusions of quartz from repsective ore deposits and manifestations range between 140°C to 340°C, which can be classified into the relatively low temperature group (140°C to 170°C) and the high temperature group (270°C to 340°C) (Appendix 2-8). In the general survey area, quartz of Kurai, Sebistan and Sartakchi showed low temperatures, while quartz of Karamechet, Maulyan, Taulyan and Lyangar falls within the high temperature group.

Among the gold deposits and manifestations in the general survey area, those which have rather extensive mineralization zones are Kurai-Karamechet, Bitab-Bashtut and Maulyan, of which Maulyan is considered most promising. In the manifestation, some 10 of fracture-silicification zones in the WNW-ESE direction, 1 m to 20-30 m wide, have been confirmed by the Uzbek trenching. Quartz veins and silicified veins along these fracture zones are accompanied by gold mineralization. The highest grades obtained at the trenches K-3 and K-7 are Au 17.8 g/t, Ag 8.6 g/t (vein width 2.4 m) and Au 11.0 g/t, Ag 1.4 g/t (vein width 4.2 m), respectively. Three ore bodies, 1 m to 4 m wide and 150 m, 200 m and 800 m long, have been confirmed. Their gold grades vary from 1 g/t to 18 g/t.

The manifestation is still under trenching survey by the Uzbek side and drilling is scheduled for 1998. The manifestation has relatively good continuity of mineralization zones and high grade of gold. The east and west extensions and the lower portion have potentials worthy of exploration.

Table II-1-1 List of Ore Deposits and Ore Manifestations in the Survey Area (1)

Ore deposit / manifestation	Location, elevation and infrastructure	Geology and mineralization	Size and grade				Prospecting	Ore reserves				Exploration right
			Length (m)	Width (m)	Au grade (g/t)	Ag grade (g/t)		Category	Reserves (thou.t)	Grade (g/t)	Metal (t)	
1. Bitab ore manifestation	Located in southern Nuratau Range (Aktau), 1km SE of village of Yukary-Bubak. Located at 75km from Railway station Kermine.	Zone of silicification, brecciation in sandstones and slates of L.- M. Cambrian-L.Silurian. Oxidized zone develops in the surface. Mineral ;Pyrite,sphalerite, arsenopyrite,malachite, gold	37	10.5	4.1	1.8	1974 ; Trenching, shaft sinking, & sampling 1992 ; Clearing, drilling(1) & sampling					Goskomgeology (Samarkandgeology)
2. Bashtut ore manifestation	Located in southern Nuratau Range (Aktau), 30km SE of regional center of Nurata.	Quartz veins in quartz sandstones of M. Cambrian-L.Ordovician. Two ore zone. Mineral ;Pyrite, goethite, lepidochrocite, arsenopyrite,	Ore zone ; 2,000	1-20	1-4.2 (average 0.6)		1974-1976 ; Trenching, shaft sinking, drilling & sampling					Goskomgeology (Samarkandgeology)
3.Kurai-Karamechet, ore manifestations	Located in southern Nuratau Range (Karatau), 15-16 km SW of Lyangar mine. Located at 15 km west of Altynsai. It takes about one hour by car.	Zone of crushing with quartz veins in slates of L.Silurian. 11 ore bodies. Mineral ; Gold, pyrite, arsenopyrite, galena, sphalerite, chalcopyrite, marcasite	Kurai; 200 Karamechet; 50-700 (10 orebodies)	1.74 0.7-11	8.0 1.1-2.4	7.0 0-28.5	1963-1970 ; Trenching & sampling 1974-1976 ; Trenching & sampling 1977-1983 ; Trenching, drilling (sludge = 51, core = 2), geochemical prospecting(rock)	P	1,125	Au = 8 g/t Ag = 7 g/t	Au = 9 t Ag = 11 t	Goskomgeology (Samarkandgeology)
4. Maidan ore manifestation	Located in southern Nuratau Range (Karatau), 10km SE of Lyangar mine. Located at 30km north of regional center Khatyrchi.	Zone of crushing and silicification in sandstones, and slates of M. Cambrian to L. Silurian. Oxidized pyrite develops in the surface.	Ore zone ; 1,000	1-5	0.09-1		1965 ; Trenching & sampling					Goskomgeology (Samarkandgeology)
5. Tashkuduk placer	Located in southern Nuratau Range (Karatau), 8km south of Gordijak village, 22km NW of regional center Khatyrchi.	Placer of river-bed type. Gold is fine and pellitized.	Ore zone ; 1,000		Au 1 g/m^3 (max.5g/m^3)		1950-1955 ; Shaft sinking & sampling (9)					Goskomgeology (Samarkandgeology)
6.Taulyan ore manifestation	Located in southern Nuratau Range (Aktau), 1km SW of Taulyan village, 30km SE of Lyangar mine.	Zone of crushing with quartz veins in slates and sandstones of L. Silurian. Limonite develops in the surface. Gold is in limonitized quartz.	Ore zone ; few meters-200~500	0.1-2.0	max. 4		1965-1966 ; Trenching (16), sampling (96), sampling from shaft (370) 1970-1972 ; Trenching (19), Electric prospecting					Goskomgeology (Samarkandgeology)

Table II-1-1 List of Ore Deposits and Ore Manifestations in the Survey Area (2)

Ore deposit / manifestation	Location, elevation and infrastructure	Geology and mineralization	Size and grade				Prospecting	Ore reserves				Exploration right
			Length (m)	Width (m)	Au grade (g/t)	Ag grade (g/t)		Category	Reserves (thou.t)	Grade (g/t)	Metal (t)	
7.Sebistan ore manifestation	Located in southern Nuratau Range (Aktau), 40km east of Altynsai .	Zone of silicification and limonitization in slates of L. Silurian.	Ore zone ; 2,500	20-150	0.1-2		1970-1972 ; Trenching (17), sampling (1,200) 1985-1989 ; Trenching, sampling (2,000), geochemical prospecting (rock) 1970-1972 ; Electric prospecting					Goskomgeology (Samarkandgeology)
8.Maulyan ore manifestation	Located in southern Nuratau Range (Aktau), left bank of Maulyan stream, 25km east of Altynsai.	Zone of crushing with silicification, graphitization and limonitization in slates and sandstones of M.Ordovician-L. Silurian. Mineral:Pyrite, pyrrhotite, arsenopyrite, chalcopyrite.	3 ore bodies ; 150-800	1-4	0.1-18	0.1-47	1965 ; Trenching (13) 1970-1972 ; Trenching (6), electric prospecting 1985-1989 ; Trenching (25) & sampling Under prospecting	P		Au = 5-6.6 Ag = 2.6-3.5	Au = 3.9 Ag = 0.95	Goskomgeology (Samarkandgeology)
9.Beshbulak ore manifestation	Located in southern Nuratau Range (Aktau), 3km SE of Maulyan , 35-40km to regional center Khatyrchi.	Three mineralization zones with quartz veins and veinlets in slates and sandstones of M.Ordovician-L. Silurian. Mineral ; Pyrite, arsenopyrite	Ore vein ; 15-30	0.5-1.0	2.0-2.5		1966 ; Trenching (2) & sampling 1970-1972 ; Trenching, sampling & electric prospecting					Goskomgeology (Samarkandgeology)
10.Berkut ore manifestation	Located in southern Nuratau Range (Karatau), 15-16km south of Lyangar mine, 2km west of Altynsai .	Zone of crushing with mineralization in sandstone and slates of M.Ordovician - L. Silurian. Stockwork quartz and quartz-tourmaline veins. Tungusten mineralization (scheelite) is accompanied by a lamprophyre dyke. Mineral ; Pyrite, arsenopyrite	Zone of crushing ; 1,000	0.1-1.5	0.1-27.8	10.6 (max.)	1954-1958 ; Trenching (44), shaft (2), drilling (1) & sampling (205) 1968-1971 ; Trenching, sampling & electric prospecting 1974-1976 ; Detailed survey of the above 1995 ; Trenching (several) & sampling					Goskomgeology (Samarkandgeology)

Table II-1-1 List of Ore Deposits and Ore Manifestations in the Survey Area (3)

Ore deposit / manifestation	Location, elevation and infrastructure	Geology and mineralization	Size and grade: Length (m)	Width (m)	Au grade (g/t)	Ag grade (g/t)	Prospecting	Ore reserves: Category	Reserves (thou.t)	Grade (g/t)	Metal (t)	Exploration right
11.Altynsai (Altynkazgan) ore deposit	Located in southern Nuratau Range (Karatau), 18km south of Lyangar mine. Elevation ; 625-875m Located at 105km WNW of Samarkand, 140km along the road. It takes 2hrs. and 15min. by car from Samarkand.	Zone of crushing with quartz veins and veinlets bearing gold and silver. Country rocks are metamorphosed slates and sandstones of M.Ordovician-L. Silurian. There are 20 ore zones. Mineral ; Gold, pyrite, arsenopyrite, scorodite, sphalerite, galena, chalcopyrite, wittichenite, native bismuth.	No.1 vein ; 400+ 135(tunnel) No.2 vein ; 600+ 55(tunnel) No.5 vein ; 400+ No.6 vein ; 30+ No.8 vein; 600+	1-7 (2.29) 1-4 (4.28) 1.2-2 0.5-3.5 0.5-3.5	4-23 (15.7) 6-13 (4.5) 1-16.4 1-10 1-17.7	3-14 (5.7) 3-7 (2.1) tr-8.6 tr tr-26.6	1952-1960 ; Trenching & shaft shinking (20m) 1953-1954 & 1958-1959 ; Addit (3 addits, 2,333m), drilling (4), Trenching (1,810m) sampling (572) & shaft (2.4m) 1968-1970 ; Trenching, sampling & electric prospecting 1970-1972 ; Trenching, drilling (4 holes, 872.8m), sampling, electric & magnetic prospecting 1974-1976 ; Detailed survey of the above Since 1995 ; Trenching, drilling, addit & shaft sinking					Goskomgeology (Samarkandgeology)
12.Kazanbulak ore manifestation	Located in southern Nuratau Range (Karatau), 1km west of Altynsai, 15km south of Lyangar mine.	Zone of crushing and silicification. There are many veins and veinlets in sandstones and slates of M.Ordovician-L. Silurian. Mineral ; Au, galena, scorodite, scheelite	Ore zone ; 300+	1.5-5	0.1-217.8	1-34.6	1955 ; Sampling 1968-1971 ; Trenching, sampling & electric prospecting 1974-1976 ; Detailed survey of above trenches Since 1995 ; Clearing & channel sampling					Goskomgeology (Samarkandgeology)
13.Lyangar ore deposit	Located in southern Nuratau Range (Aktau), near Lyangar village, NNE slopes of Mt. Takhku (2,003m). Located at 18km north of Altynsai.	Garnet-pyroxene skarns with impregnations of scheelite at the contact between the Carboniferous Aktau granitoids and the Silurian-Devonian crystalline limestone. Mineral ; scheelite, molybdenite, powellite, chalcopyrite, pyrite, marcasite, pyrrhotite.	Ore zone ; max.3,000 Ore body ; 20-500	1-40 0.2-12	WO_3 = 0.25- 0.6% Cu = max.2.68% Mo = 0.007%		1935-1959 ; Exploration tunnel (14,190m), drilling (53,974m), trenching (22,093 m^3), sampling (28,089) 1946-1980 ; Mining	C1 C2			WO_3 =1,119 WO_3 =3,273	Republican Organizati-on "Special Alloy"

Table II-2-2-1 Major Assey Results in the General Survey Area

Sample No.	Local grid (X-Y)	Name of ore manifestation	Au (g/t)	Ag (g/t)	As (%)	W (%)	Remarks
HG041	50 - 69	Maidan	2.2	<1	0.02	<0.001	phyllite with quartz veinlets
HG042	49 - 69	Maidan	6	<1	0.03	<0.001	quartz vein
HG043	53 - 52	(unnamed)	2	<1	0.03	<0.001	spectral anomaly(Fe) point, SE of Altynsai, quartz vein
HG079	35 - 78	Bashtut	2.8	<1	0.03	<0.001	silicified rock
HG080	35 - 78	Bashtut	4.2	<1	0.08	<0.001	silicified rock
HG082	35 - 78	Bashtut	2.2	<1	0.05	<0.001	silicified rock
HG098	29 - 80	Bitab-South	2.6	<1	0.5	0.003	silicified dike
HG106	30 - 80	Bitab	2.4	<1	0.04	0.001	quartz vein
HG107	30 - 80	Bitab	2.2	<1	0.08	<0.001	schist with quartz veinlets
HG108	30 - 80	Bitab	15.03	5.6	0.05	<0.001	silicified rock and quartz vein
HG109	30 - 80	Bitab	8.8	11.4	0.02	<0.001	quartz vein

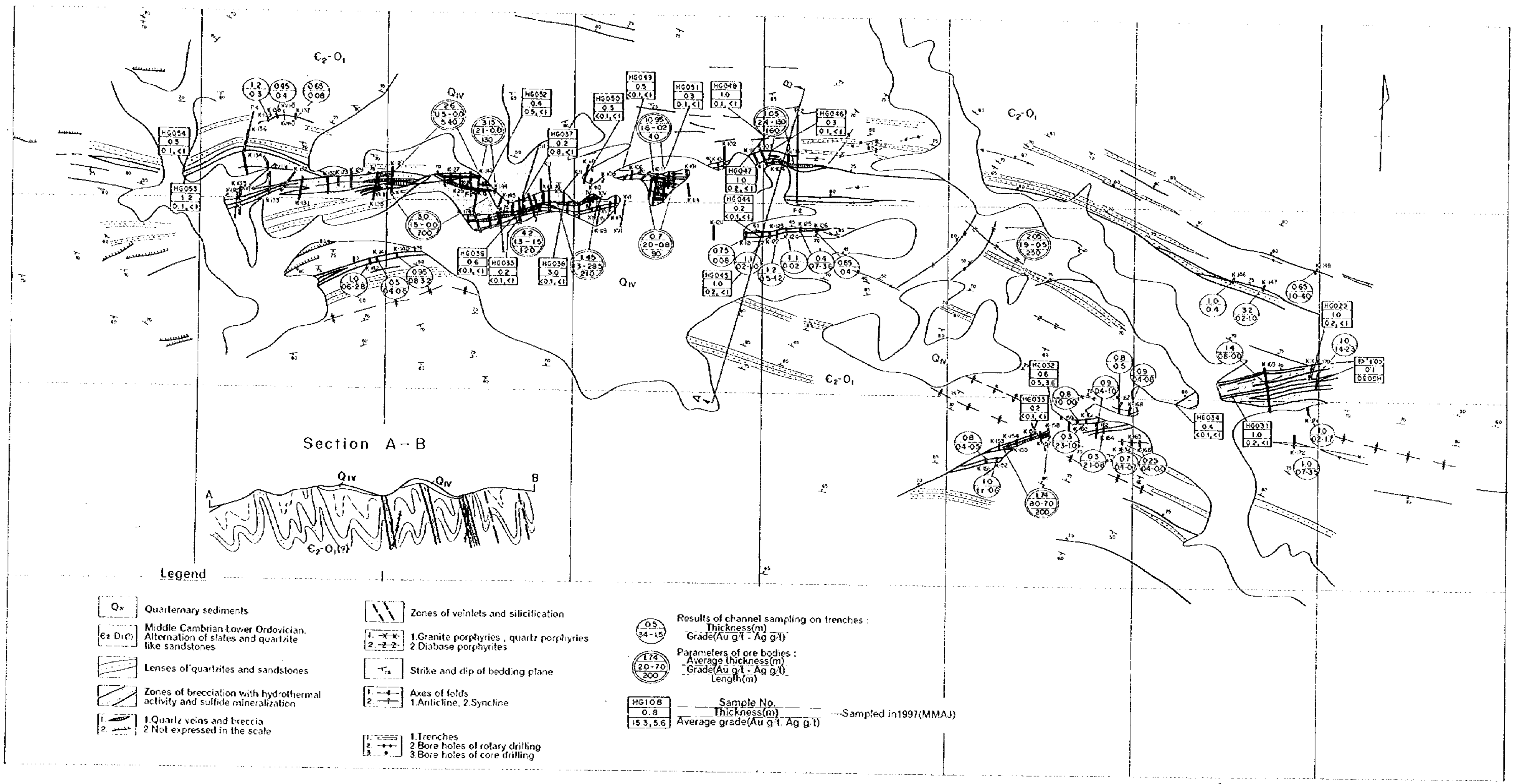
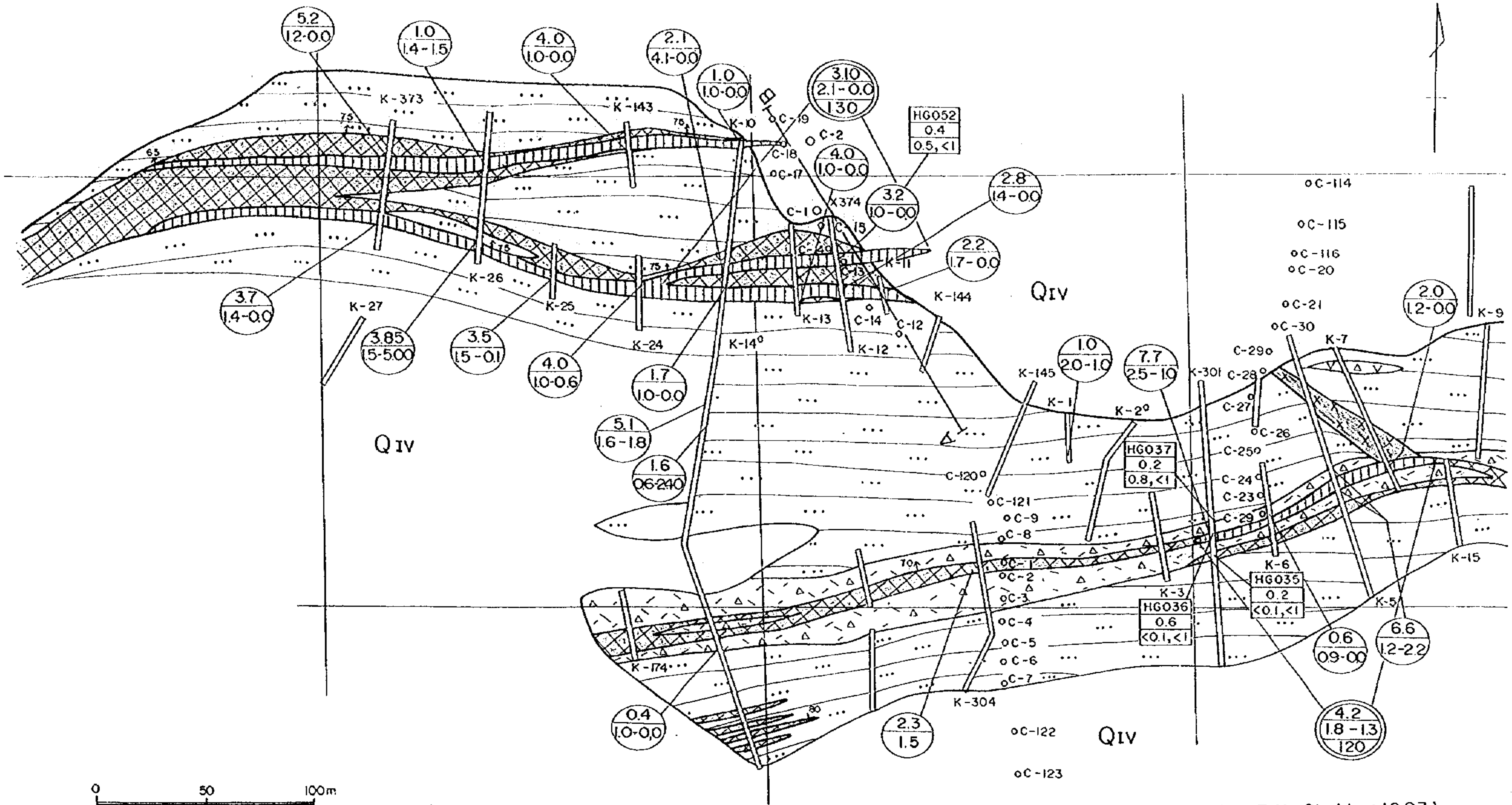


Fig. II-2-2-1 Geologic Map of Kurai and Karamechet Ore Manifestations

(after EN. Shubin; 1981)



Legend

Q IV	Quarternary sediments		Ore bodies
1. 2.	Middle Cambrian-Lower Ordovician 1.Sandstones, 2.Slates	K-128	Trench and its No.
	Dikes (Diorites , dioritic porphyrites)	1. oC-11 oC-12 2. oC-2	1.Rotary drilling and its No. 2.Core drilling and its No.
	Fractures	1.2 / 2.4-1.8	Thickness(m) / Grade (Au g/t - Ag g/t)
	Zones of brecciation and jointing	4.2 / 1.8-1.3 / 115	Parameteres of ore bodies : Thickness(m) / Grade (Au g/t - Ag g/t) / Length(m)
	Breccia of slate-quartz composition	HG108 / 0.8 / 15.3, 5.6	Sample No. / Thickness(m) / Average grade(Au g/t, Ag g/t) ----Sampled in1997(MMAJ)

Fig. II-2-2-2 Geologic Map of Karamechet Ore Manifestation

Section A - B

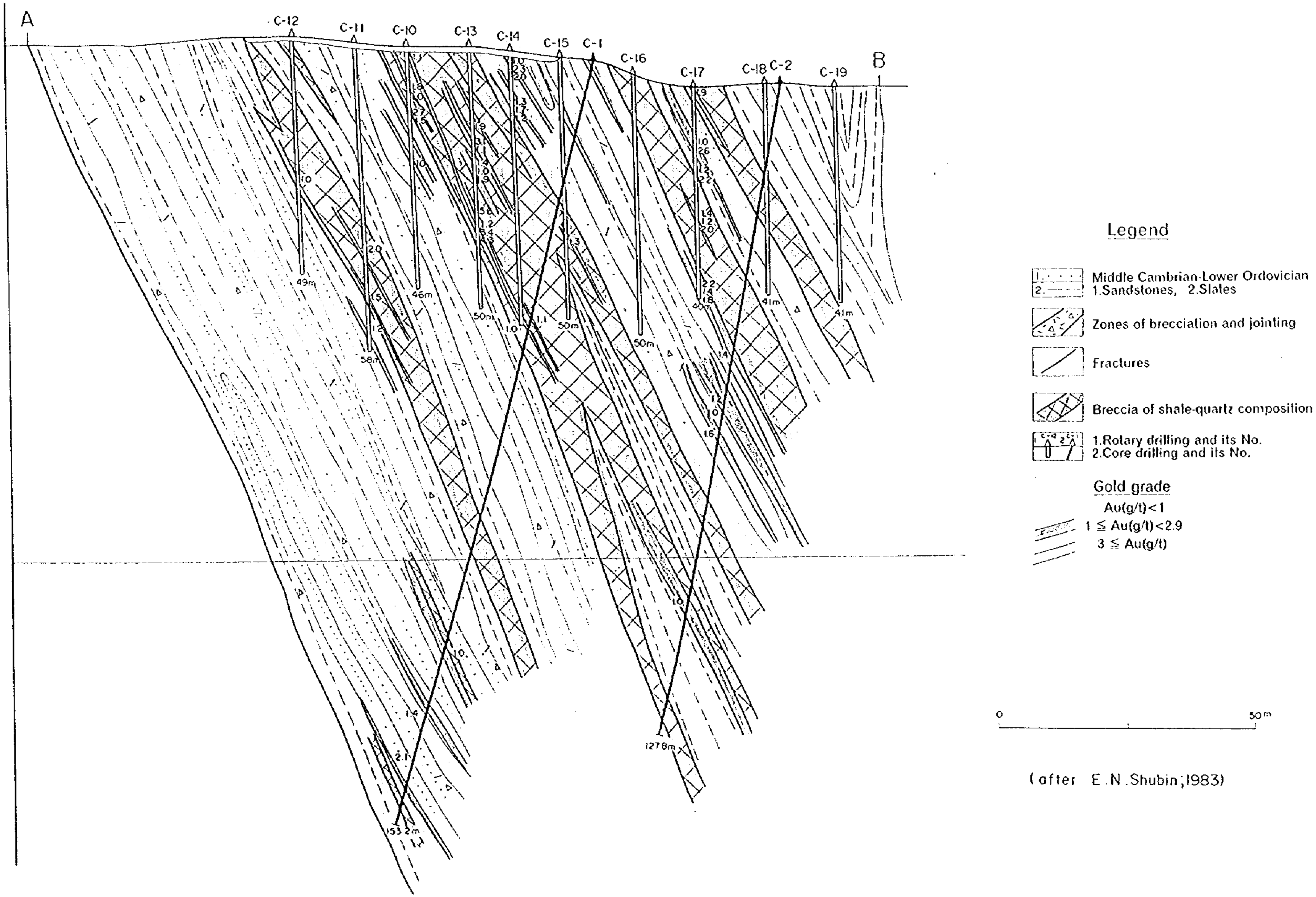


Fig. II-2-2-3 Geologic Cross Section of Karamechet Ore Manifestation

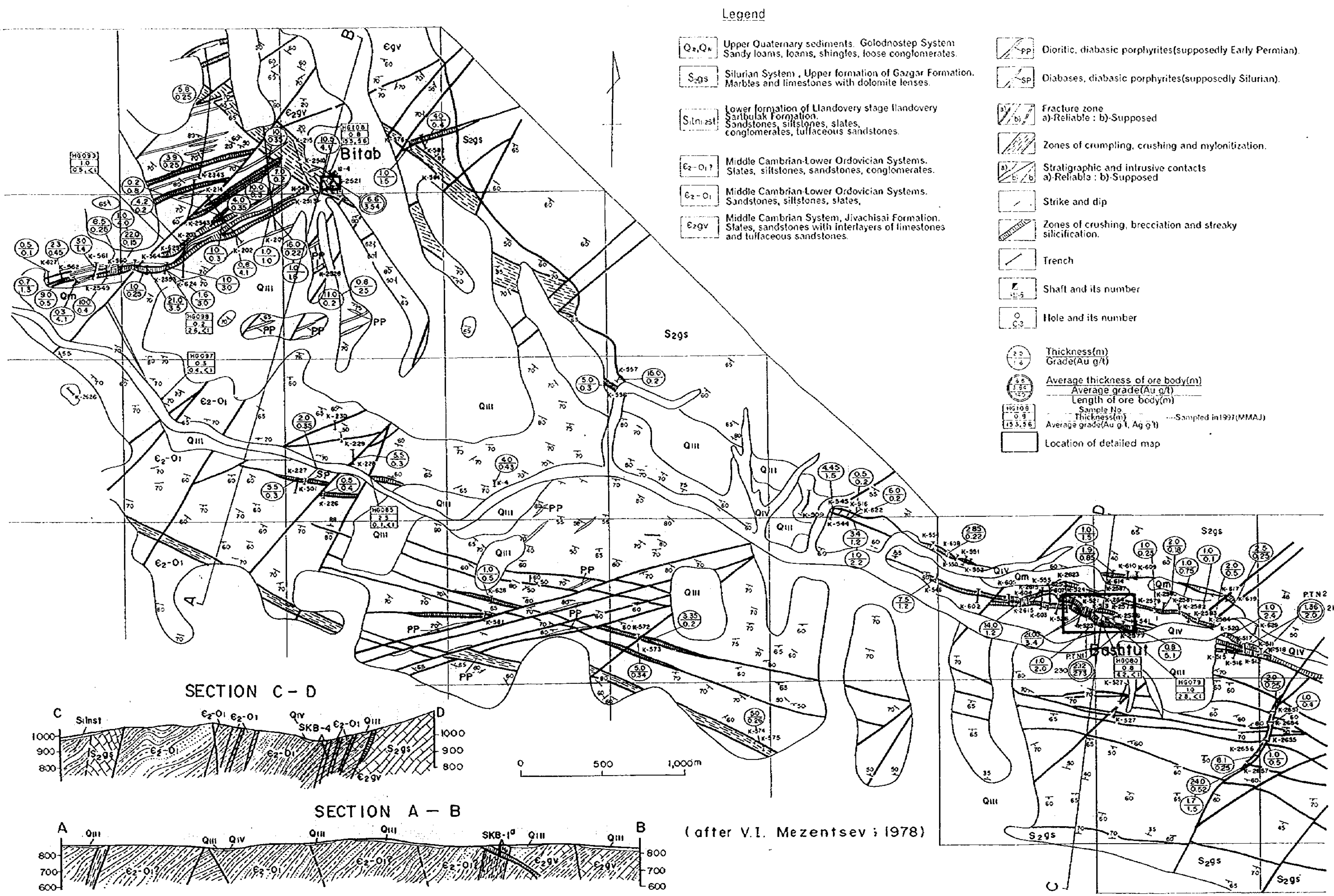


Fig. II-2-2-4 Geologic Map and Cross Sections of Bitab and Bashtut Ore Manifestations

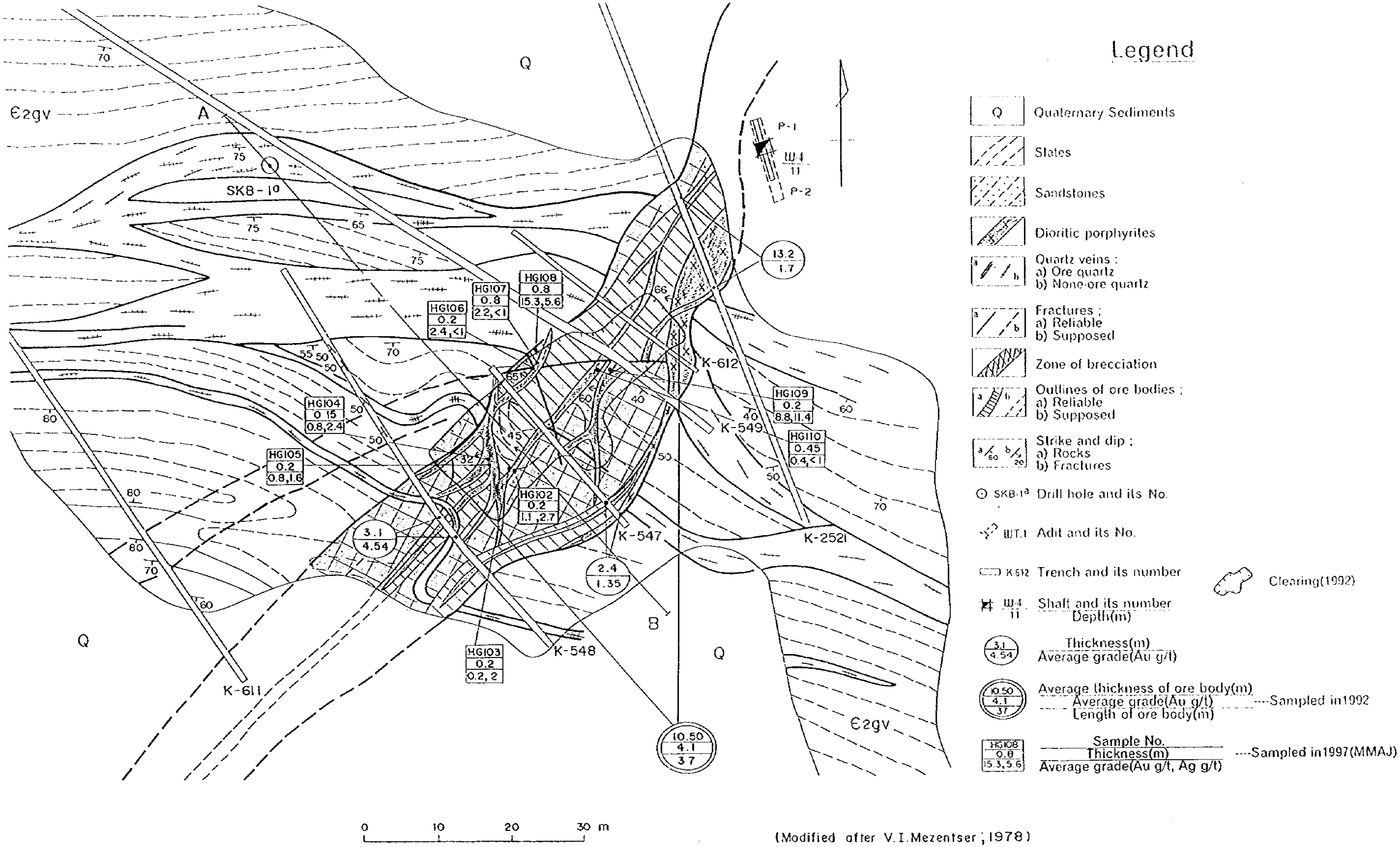


Fig. II-2-2-5 Geologic Map of Bitab Ore Manifestation

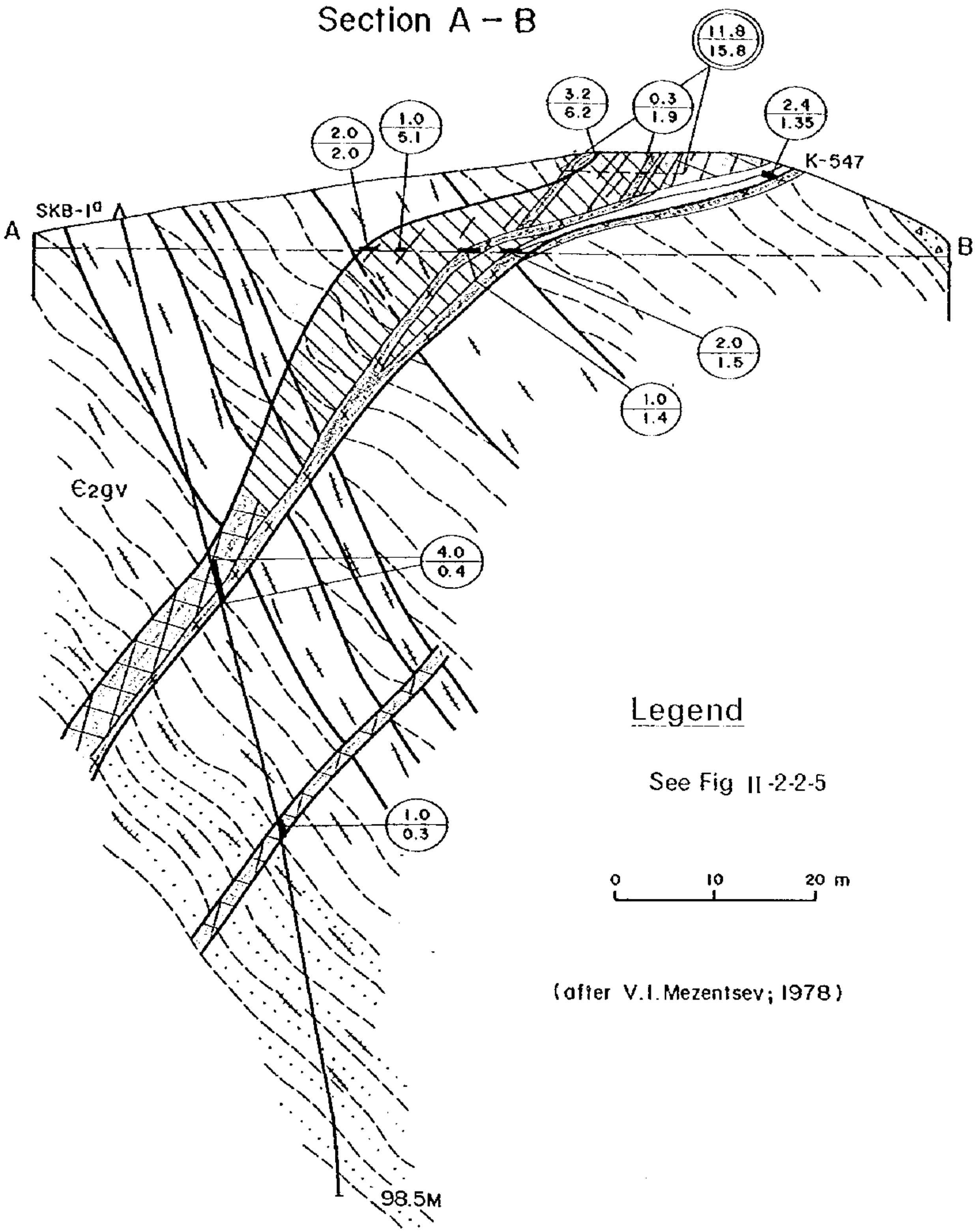


Fig. II-2-2-6 Geologic Cross Section of Bitab Ore Manifestation

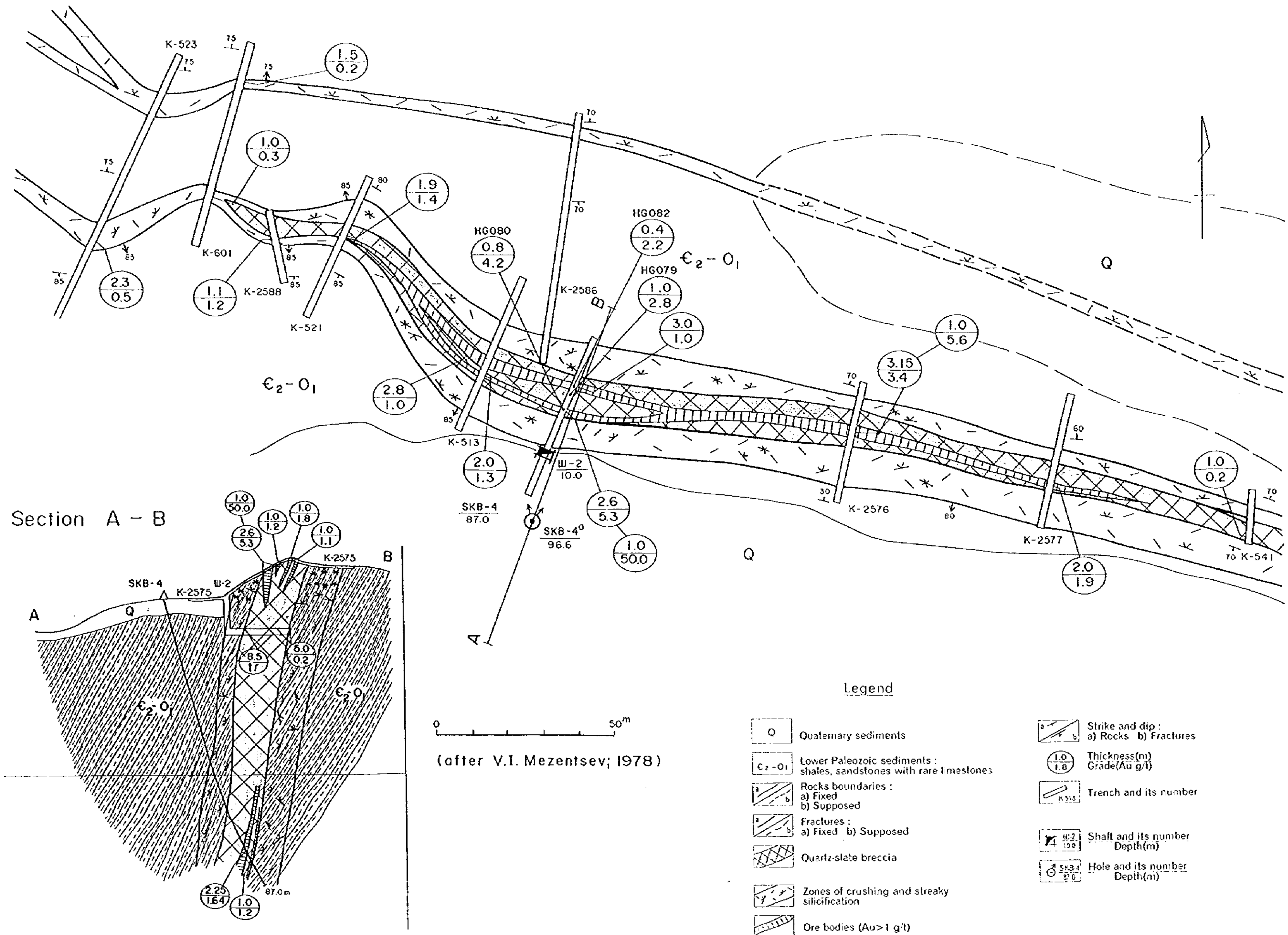
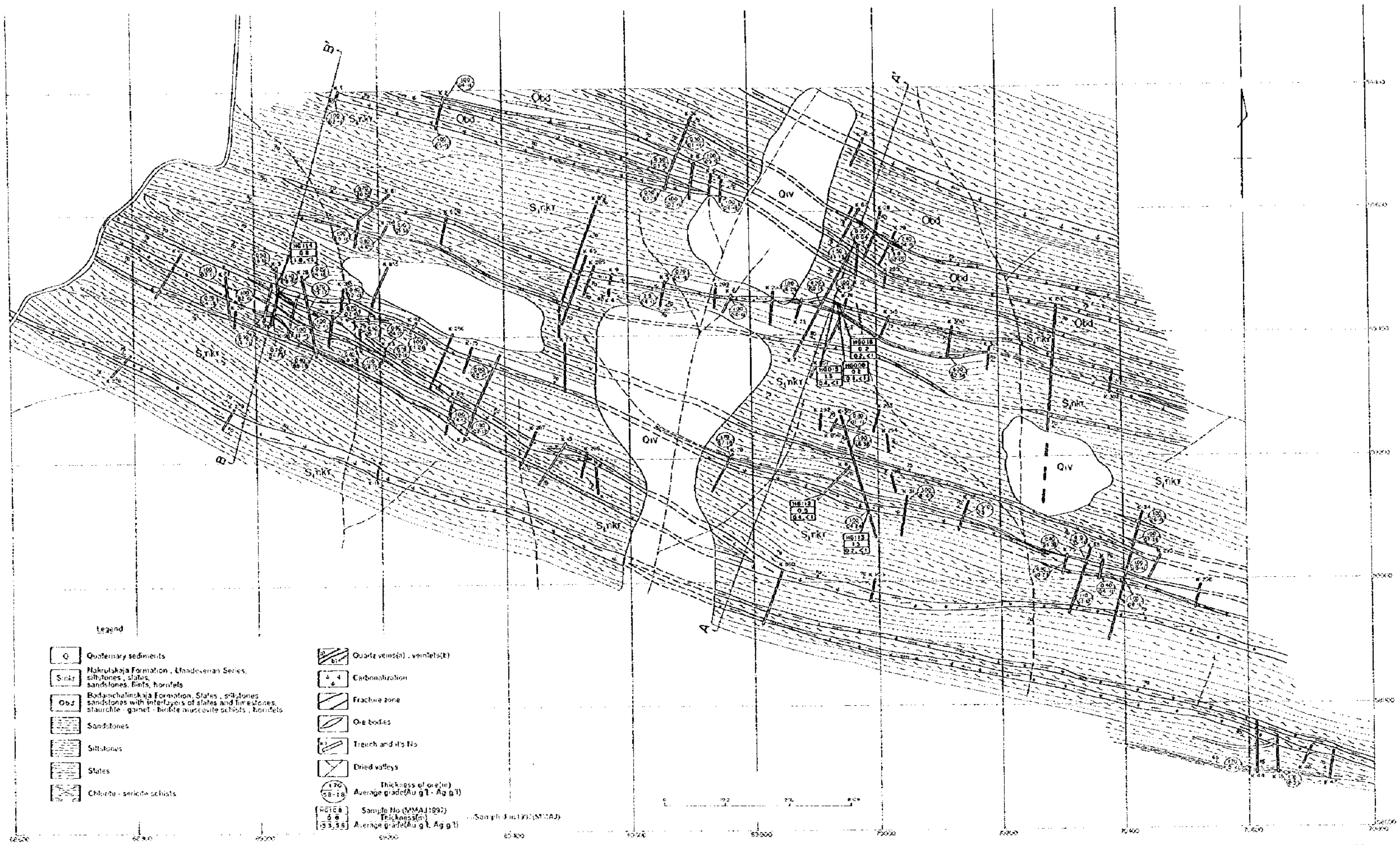
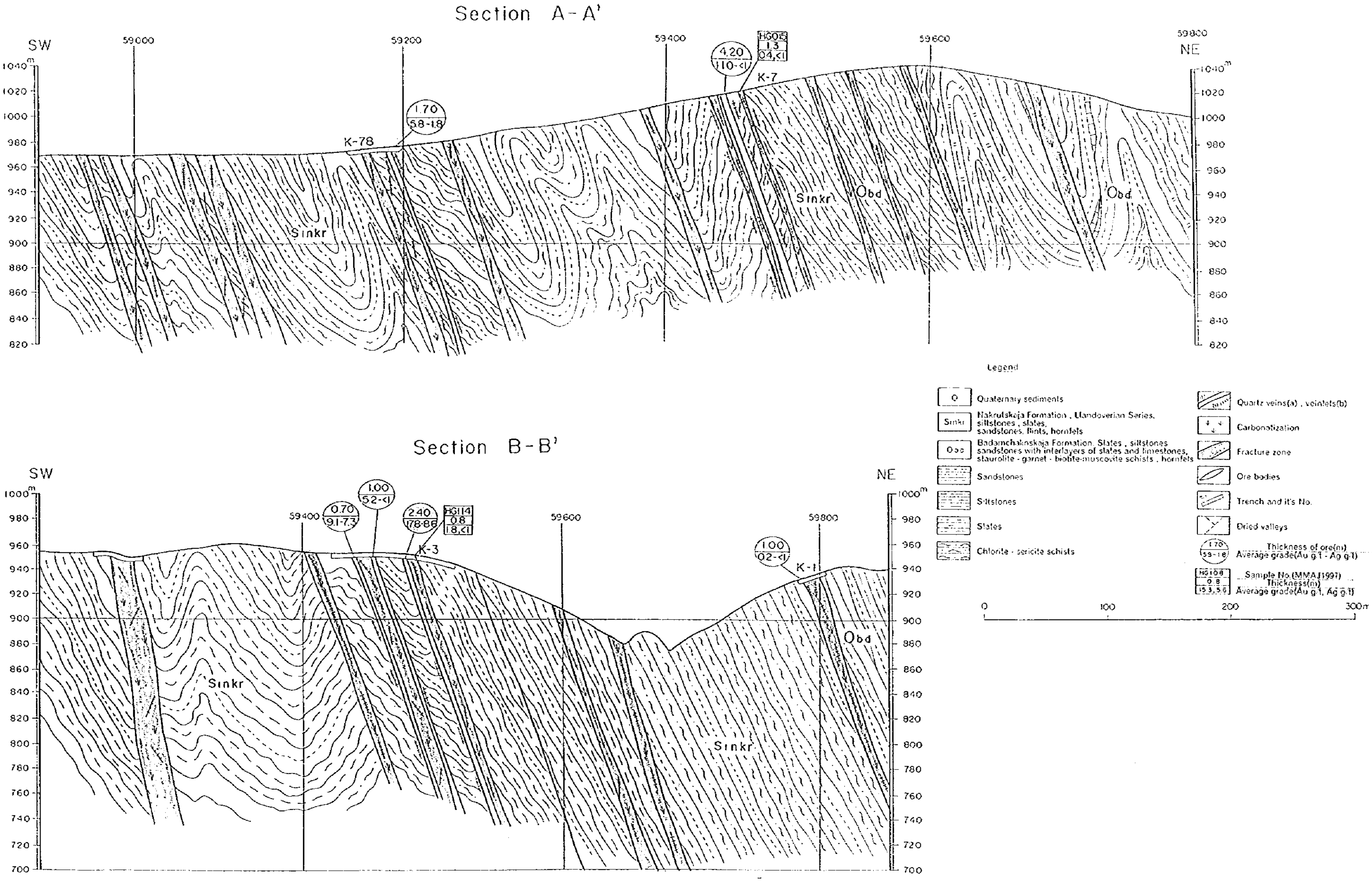


Fig. II-2-2-7 Geologic Map and Cross Section of Bashtut Ore Manifestation



(after Zoloton Expedition, 1997)

Fig. II-2-2-8 Geologic Map of Maulyan Ore Manifestation



(after Zarmitan Expedition; 1997)

Fig. II-2-2-9 Geologic Cross Sections of Maulyan Ore Manifestation

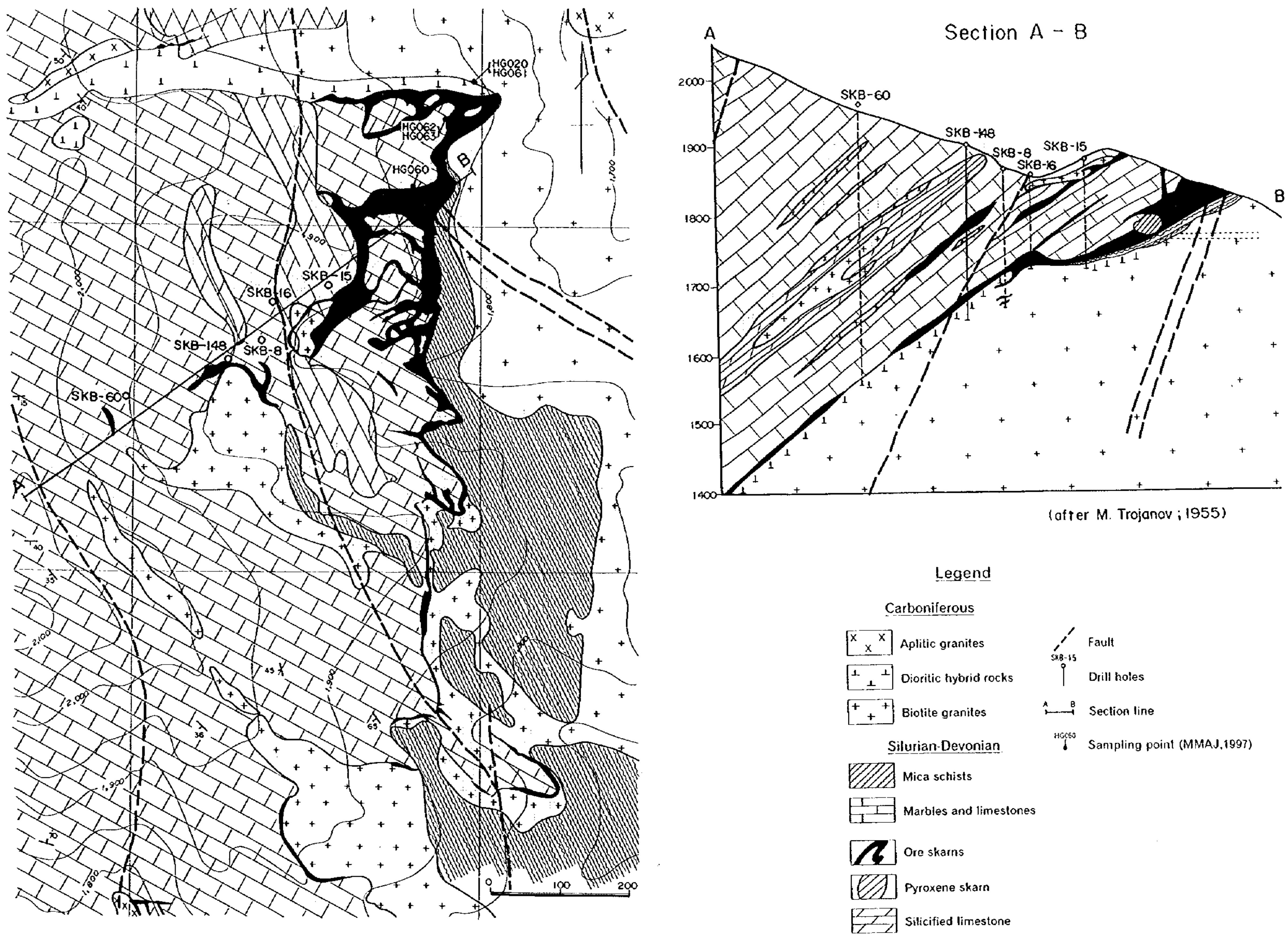


Fig. II-2-2-10　Geologic Map and Cross Section of Lyangar Tungsten Mine

Chapter 3 Altynsai District

3-1 Detailed Geological Survey

3-1-1 Purpose of the survey

Purpose of the detailed geological survey is to clarify relationship of geology and geologic structure with mineralization in the Altynsai District.

3-1-2 Methods of the survey

Detailed geological survey in the quantities indicated in Table I-1-1 was carried out in the Altynsai District. A base camp for the survey was placed at a hotel in Milbazar.

In the reconnaissance for the survey, route mapping was conducted on the basis of a topographic map in a 1:2,500 scale, which was enlarged from the one in a 1:5,000 scale furnished by the Altynkazgan Geological Party. Outcrops of particular importance were sketched on 1:100 to 1:200 scales and photographed in color. Survey findings were incorporated in the geological maps in scales of 1:2,500 and 1:10,000 (PL. II-3-1-1 and Fig. II-3-1-1).

Simultaneously with the geological survey, sampling of various types in the quantities indicated in Appendix 2-1 was done, as well as laboratory tests.

The laboratory tests included chemical analysis of ores, microscopic observation of thin sections of rocks and polished sections of ores, X-ray diffractive analysis and measurement of homogenization temperature of fluid inclusions. Ore samples were collected from trenches and tunnels for analysis. Results of the analysis are tabulated in Appendix 2-6. Sampling points of the other samples for laboratory tests are indicated in PLs. II-3-1-4 and -5. Results of identification of rock thin sections and the photomicrographs are exhibited in Appendices 2-2 and 2-3, respectively, while results of identification of ore polished sections and the photomicrographs are exhibited in Appendices 2-4 and 2-5. Results of the X-ray diffractive analysis are demonstrated in Appendix 2-7 and the measurements of homogenization temperature of fluid inclusions in Appendix 2-8.

3-1-3 Survey findings

1) Outline of geology and ore deposits in Altynsai District

The Altynsai District is located in a hilly zone (alt. 650 m to 850 m) in the extreme east of the Karatau Mountains, some 105 km west-northwest of Samarkand. The District is accessible from Samarkand by car in about 2 hours (road distance 155 km). Geologically, the Altynsai District pertains to the Karatau ore zone, together with the Sarmich deposit and the Kurai and Karamechet manifestations, to the west.

The area is underlain by the Ordovician-Silurian slate, siltstone, sandstone and phyllite, as well as lower-Silurian slate, siltstone and sandstone. Lamprophyre dikes that intruded during late Permian to early Triassic times occur in the vicinity of the No.10 vein ("Berkut Vein") in the west.

Sedimentary rocks and metamorphic rocks in the District are folded in anticline and syncline with the WNW-ESE trend. There are many fracture zones with the WNW-ESE and NW-SE trends and numerous joints with the N-S trend. Ore deposits in the District are either gold-bearing quartz veins controlled by fracture zones with the WNW-ESE and NW-SE trends, or tourmaline-quartz veins accompanying joints with the N-S trend. Among ore deposits in the District, the best known is the Altynsai deposit.

Discovered in 1938, the Altynsai deposit was investigated between 1952 and 76 by geological survey, electric prospecting, magnetic prospecting, two prospecting tunnels, drilling survey (eight holes) and extensive trenching survey. The prospecting was later suspended to reinforce exploration of the Sarmich deposit to the west but was resumed in 1995. Currently, trenching, drilling and tunneling surveys are ongoing. More than 20 ore zones have so far been ascertained, which include the veins Nos. 1, 2, 5, 8 ("Northwest Vein"), 9 ("Kazanbulak Vein") and 10 ("Berkut Vein").

(1) Northern ore zone

Major veins such as Nos. 1, 2 and 8 are located in this ore zone. Structure that controls mineralization is a fracture zone with the WNW-ESE trend, dipping 45° to 70° southward, 15 m to 40 m wide and 500 m to 1,000 m long. Inside the fracture zone, host rocks are intensively crushed, limonitized and silicified, accompanied by quartz veins. Extension of the Nos. 1 and 2 echelon veins reaches 1,300 m, along which ancient stopes excavated up to an approximate depth of 30 m remain over 470 m. Although gold grades of the surface level of the No.1 and No.2 veins are unclear because of the ancient mining of bonanzas, the following grades have been obtained at a drift of +698.89 m level, 25 m to 35 m underground:

No.1 vein: Extension 135m; average width 2.29m; Au 15.7 g/t, Ag 5.7 g/t

No.2 vein: Extension 55m; average width 4.28m; Au 4.5 g/t, Ag 2.1 g/t

Ancient stopes remain in a surfacial portion of the No. 8 vein, as well. The vein is 0.5 m to 3.5 m wide, grading 0.1 g/t to 10 g/t, while a sample taken from a bonanza indicates Au 17.7 g/t (width 2.7m). The vein has been prospected by the Uzbek side up to some 100 m under the surface with drilling at four holes, a 25 m exploration shaft, a 35 m prospecting drive (Fig. II-3-2-9). So far, no dominant mineralization has been found, except at the drillhole C-25 where Au 6.2 g/t (width 1.31m) was confirmed.

(2) Southern ore zone

In parallel with the southern side of the No. 1 and No. 2 veins, veins with the WNW-ESE trend including Nos. 5, 7, 11 and 12 have been found. These veins occur in anticlinorium. The fractured-silicified zones including these veins are up to 40 m wide and 300 m to 700 m long, dipping 35° to 70° -80° northward. Mineralization accompanies a quartz vein, 0.5 m to 3 m wide, which is accompanied by oxidized sulfide minerals. Gold concentrates in intersections of fracture zones trending in different directions. In trenches, gold grades are mostly 0.1- 0,9 g/t, rarely 1-10 g/t or more. At a trench excavated by the Uzbek side, mineralization of the No.12 vein grading 8.9 g/t (width 1.5m) has been confirmed. As for the lower portion of the southern ore zone, no exploration has been executed excepting the drilling MJSN-2 aimed at the No.11 vein, which was executed during the subject survey.

(3) No. 9 vein ("Kazanbulak Vein")

The vein is located 1 km west of the No.2 vein of Altynsai deposits. Gold mineralization occurs in a fracture zone trending in the NW-SE direction which cuts sandy slate (Fig. II-3-1-3). The ore zone is 5 m wide, 300 m long and dips northeast. The gold mineralization accompanies a lenticular quartz vein, up to 1.5 m wide and 15 m long, existing in a fracture zone. Its gold grade varies markedly between 0.1 g/t and 217.8 g/t (usually 2-7 g/t). The Uzbek drilling C-43 aimed at the level 50 m beneath a bonanza of the vein (Au 217.8 g/t, 1.0 m wide) only caught low-grade mineralization, 2.7 m wide, grading 0.6 g/t. The ore body is presumed to be small in size and widely variable in grade.

(4) No.10 vein ("Berkut Vein")

This vein is located 1 km west of the Kazanbulak Vein. Ore zones in echelon trending in the WNW-ESE direction spreads over an area, 200 m wide and 1 km long. Between 1956 and 58, prospecting that included 44 trenches, two exploration shafts, a prospecting tunnel and drilling at one hole was carried out. The initial objective of prospecting was tungsten, of which two types of ore body exist.

The first type occurs in two lamprophyre dikes with the NW-SE trend, 270 m long and 6 m wide. WO_3 grade of the dikes varies from 0.01% to 0.95% (0.25% in average). Gold grade is 0.1- 2.6 g/t (0.6 g/t in average), while a sample collected from the fracture zone indicated 19.6 g/t. The ore body is too low in grade and too small in size to be mined.

The second type ore bodies are stockwork quartz veins and tourmaline-quartz veins with the N-S trend, disseminated with sulfide minerals. Some 400 of quartz veins, 0.01 m to 0.2 m thick, have been confirmed. Gold grade ranges bewteen 0.1 g/t and 27.8 g/t(usually 0.3-1.5 g/t). A highest grade of silver is 10.6 g/t while WO3 grades 0.02% to

0.15%(max. 2.25%). The vein is not prospected at present.

(5) Tourmaline-quartz veins with the N-S trend

Numerous joints trending in the N-S direction and dipping 45° to 80° westward develop in an area, 500 m to 800 m wide, which embraces the Nos, 1, 2, 5, 8 and 10 veins. Tourmaline-quartz veinlets, 0.1 cm to 25 cm wide, occur in the joints (Figs. II-3-3-1 and -2). The veinlet zone almost coincides with the biotite-muscovite hornfels zone. From the anomalies (20-60 gamma) of the Uzbek airborne magnetic survey, it has been inferred that granite stocks are aligned in the WNW-ESE direction under the veinlet zone. The veinlet zone is considered to be tourmaline greisen formed by pneumatolysis of granites concealed on relatively shallow levels. Gold grade of the veinlets is generally 1 g/t or lower, rarely amounting to several g/t.

Component minerals in quartz veins occurring in fracture zone with the WNW-ESE and NW-SE trends are mainly quartz, pyrite, marcasite, arsenopyrite, chalcopyrite, sphalerite, goethite and lepidochrocite, accompanied by galena, native bismuth, aikinite, wittichenite, scheelite, tourmaline, rutile and electrum. Electrum identified in the polished sections is 5-10 μm in grain size and occurs in quartz, associated with chalcopyrite and native bismuth in vein-like alignment but is independently existing without contact with these minerals.

In the tourmaline-quartz veins accompanying the joints with the N-S trend, main component minerals are quartz, tourmaline, pyrite and arsenopyrite. The Uzbek study indicates that wolframite, cassiterite, topaz, beryl and native gold are included, it was not verified in the subject survey.

Table II-3-1-1 Major Assey Results in the Detailed Survey Area(surface)

Sample No.	Local grid (X-Y)	Name of ore vein	Au (g/t)	Ag (g/t)	As (%)	W (%)	Remarks
SD078	754.26 - 461.04	No.2	5.4	5.3	< 0.01	0.001	N80° W90° ?,W=0.6m,ss+qv,limo
SD067	754.33 - 461.06	No.2a	2	9.4	0.01	0.002	N80° W50° S,W=1.8m,ss+network qv,limo
SD068	754.32 - 461.06	No.2a	2	3.4	0.02	0.002	N80° W50° S,W=0.8m,ss+qv,limo
SD070	754.32 - 461.06	No.2a	2	3.2	0.01	0.001	N80° W50° S,W=1.0m,qv+limo
SD023	755.37 - 460.54	No.6	3.6	< 1	0.02	0.002	No.3 trench,N80° W,W=2.0m,ss+qv,limo,silic(MS)
SD024	755.37 - 460.54	No.6	7.2	1.6	0.02	0.002	No.3 trench,N80° W,W=1.0m,ss+qv,limo,silic(S)
SD030	755.35 - 460.54	No.6	4	< 1	0.06	0.002	W=2.0m,shear,silic zone(MN)
SD101	755.03 - 460.48	No.7	4	4.4	0.01	0.004	N70° W,W=1.2m,ss+qv
SD045	754.00 - 461.45	No.8	3.8	8	0.03	0.001	E-W90° ,W=1.1m,sl+limo
SD051	754.42 - 461.33	No.8	3.6	4	0.03	0.002	K-40,N60° W?,W=0.6m,network qv
SD052	754.25 - 461.42	No.8	35.3	8	0.08	< 0.001	K-117,W=0.6m,shear zone
SD053	754.25 - 461.42	No.8	3.6	4	0.05	< 0.001	K-117,W=0.5m,shear zone
SD016	755.30 - 460.22	No.11	2	4.4	0.02	< 0.001	D trench,N75° W80° N,W=1.5m,silic zone(M)
HD003	753.43 - 461.02	Kazanbulak	2.4	< 1	0.05	0.002	N53° W,65° N,W=0.3m,qv
HD006	753.41 - 461.03	Kazanbulak	4.4	< 1	0.03	0.001	N40° W86° N,W=0.75m,qv
HD014	753.58 - 460.90	Kazanbulak	6	< 1	0.04	0.004	W=0.8m,shear qv(0.3m)+sheared rock(0.5m)
SD098	754.88 - 460.54		11.8	4	0.02	0.003	N10° W60° NW,W=0.05m,qv
SD099	754.88 - 460.54		3.2	2	0.01	0.08	N30° W60° NW,W=0.05m,qv
SD143	755.36 460.98		3.4	< 1	0.3	0.001	K-65,W=1.1m,network qv+limo

Table II-3-1-1 Major Assey Results in the Detailed Survey Area(underground)

Sample No.	Local grid (X-Y)		Name of ore vein	Au (g/t)	Ag (g/t)	As (%)	W (%)	Remarks
SD147	54.69	60.94	No.1	6.9	< 1	0.02	0.002	L-61,W=0.4m,sulfide v
SD148	54.69	60.94	No.1	8.2	12.8	0.03	0.002	L-61,W=0.6m,qv
SD149	54.69	60.95	No.1	69.6	34.6	0.03	0.001	L-61,W=1.0m,qv
SD150	54.69	60.95	No.1	14.2	10	0.05	0.002	L-61,W=1.0m,qv
SD151	54.69	60.95	No.1	4.8	3.2	0.06	0.003	L-61,W=1.0m,qv
SD156	54.69	60.95	No.1	2	< 1	0.07	0.003	L-61,W=1.0m,ss with py
SD157	54.69	60.95	No.1	23.3	3.2	0.06	0.003	L-61,W=1.0m,ss
SD158	54.68	60.95	No.1	2.8	2	0.07	0.003	P-2,W=1.0m,qv
SD159	54.68	60.95	No.1	2.4	3.2	0.08	0.003	P-2,W=1.0m,qv+sulfide v
SD165	54.67	60.94	No.1	435.2	52	0.09	0.003	P-4,W=1.0m,silic ss(hanginng wall)
SD167	54.71	60.95	No.1	3.6	7.6	0.03	0.003	20m west of P-4,W=1.0m,ss
SD168	54.71	60.95	No.1	33.4	22.6	0.06	0.003	20m west of P-4,W=1.0m,qv+sulfide v
SD169	54.71	60.95	No.1	2.2	5	0.05	0.001	20m west of P-4,W=1.0m,qv
SD189	54.70	61.00	No.2	2.4	< 1	0.1	0.001	N60° E40° S,W=1.0m,shear zone+limo