Chapter 3 General Geology

The survey area is underlain by the basement rocks consisting of Paleozoic sedimentary rocks and granitoids and blanket beds consisting of sediments of the Senonian Series of Upper Cretaceous to Quaternary Systems (Fig.I-3-1).

(1) Paleozoic Era

The sedimentary rocks that constitute the basement are classified into 13 formations of lower Cambrian to middle Carboniferous age (Fig.I-3-3). The strata of Lower Cambrian to Upper Silurian System, made of thick terrigenous sediments, mainly slate and sandstone, are widely distributed in the Karatau Mountains and Aktau Range. The strata of Upper Silurian to Middle Devonian System made of thick limestone occur in the Aktau Range in the western part of the survey area. They occur along the anticlinorium south of the same Range in the eastern part of the survey area. The Middle Carboniferous System, mainly conglomerates and coarse-grained sandstone, occurs in small blocks aligned in the WNW-ESE direction in the northwestern part of the survey area.

(2) Mesozoic Era to Quaternary System

Post-Paleozoic sediments that form the blanket beds occur with a very gentle inclination chiefly in the flatlands north of the Aktau Range and south of the Karatau. The Senonian Series of the Upper Cretaceous System and Eocene Series of the Paleogene System are composed of neritic sediments, mainly marl, siltstone, limestone, sandstone and coquinite. The Neogene System consists of molasse-type sediments, mainly semi-consolidated conglomerates, sandstone and clay, whereas the Quaternary System consists of alluvial fan sediments, terrace sediments, stream sediments, aeolian sediments, etc.

(3) Intrusive rocks

The Middle Carboniferous to Early Permian Aktau granites as well as the Early Permian Karatau granites intrude into the Paleozoic sedimentary rocks forming the main parts of the Aktau Range and Karatau Mountains, respectively. Besides the granites, igneous rocks include Silurian-Triassic lamprophyre, diorite and gabbro dikes.

(4) Geological structure

The subject area pertains to the Zarafshan-Turkestan Zone of the Southern Tien-Shan Tectonic Belt; the regional tectonic structure of the basement rocks represents the WNW-ESE trend (Fig.I-3-2). The strata are folded around a folding axis in the WNW-ESE direction and cut by fractures in similar directions, forming a narrow tectonic zone stretching in the WNW-ESE direction. Traversing the direction, fractures develop also in the NE-SW and NW-SE direction. Each formation is mainly in the fault contact to each other. Post-Paleozoic sediments occur with a very gentle inclination.

(5) Mineralization

Ore deposits and manifestations in the survey area occur along fracture zones in the WNW-ESE direction, forming the Karatau ore zone (70 km E-W and 2 km to 4 km N-S) along the northern side of the Karatau granite bodies and the Aktau ore zone (70 km E-W and 2 km to 5 km N-S) along the southern side of the Aktau granite bodies. In the Karatau ore zone, there occur gold-silver bearing quartz vein-type deposits and manifestations such as the Karamechet-Kurai manifestations and the Altynsai deposit (Fig. I-3-1). The Aktau ore zone embraces gold-silver bearing quartz vein-type manifestations such as Bitab, Bashtut, Maulyan and Taulyan. Besides, there are the iron-manganese manifestation at Akmulla, the niobium-tantalum manifestation at Sartakchi and the skarn-type tungsten-molybdenum deposit at Lyangar.

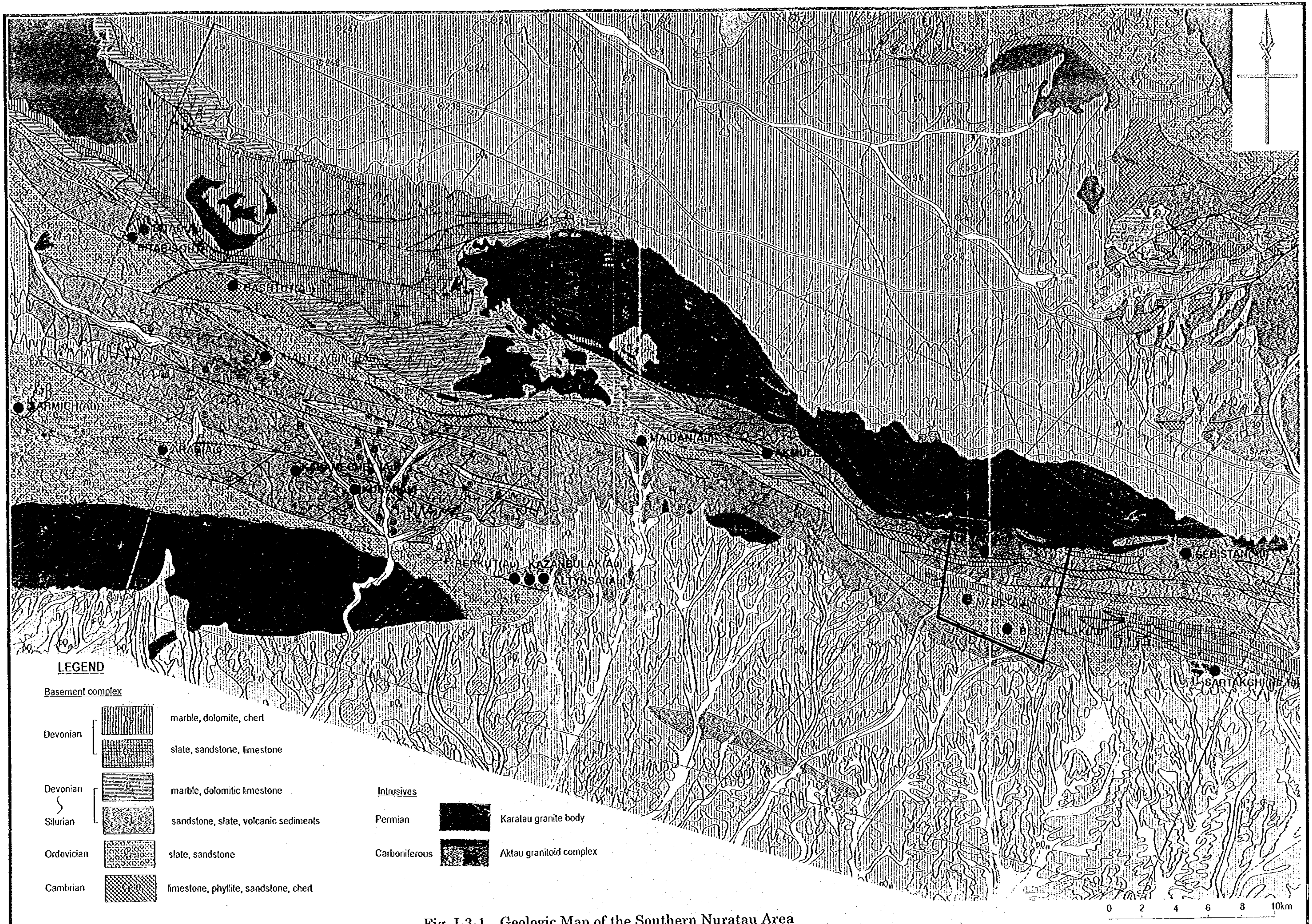


Fig. I-3-1 Geologic Map of the Southern Nuratau Area

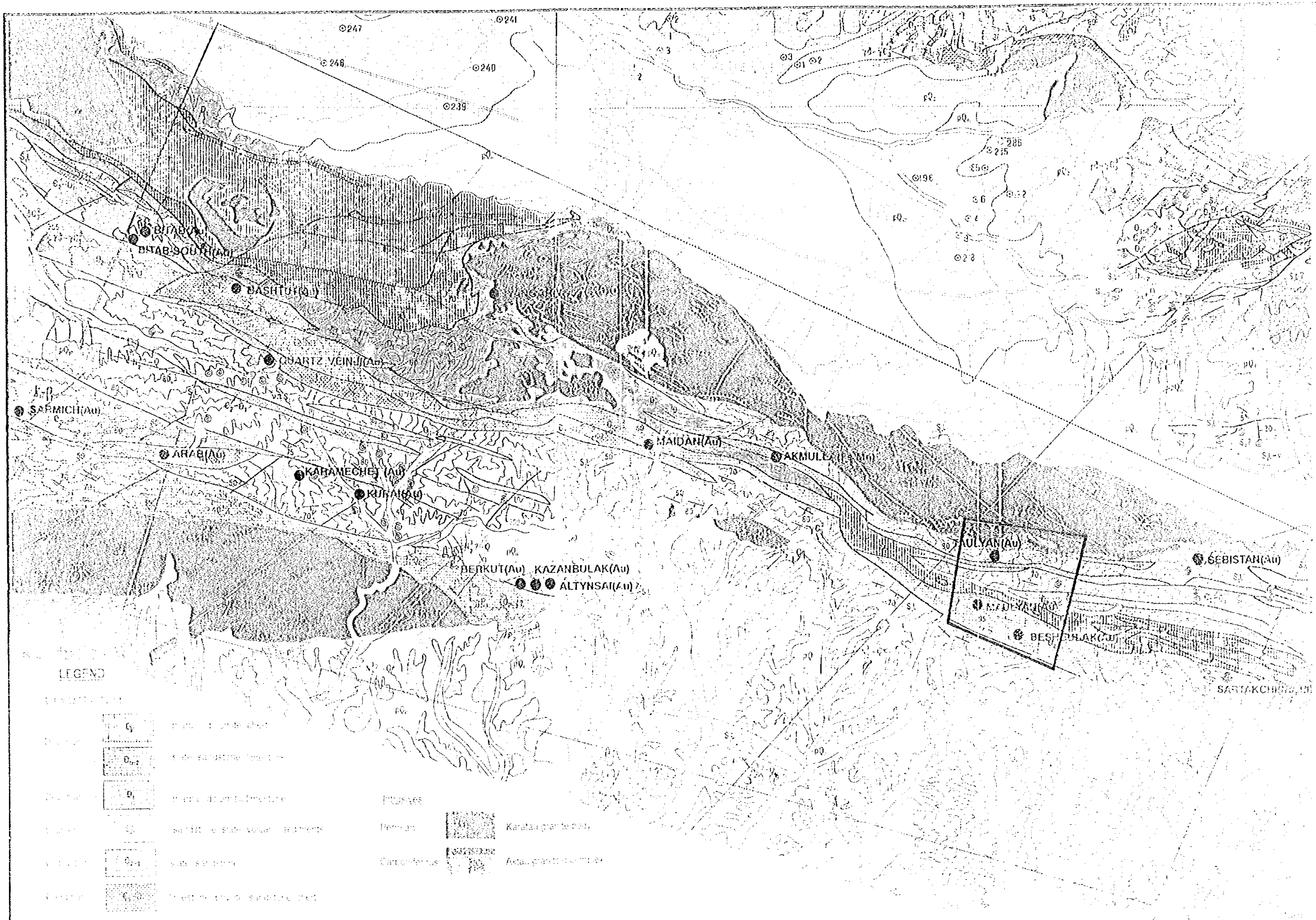


Fig. 1-3-1 Geologic Map of the Southern Nuratau Area

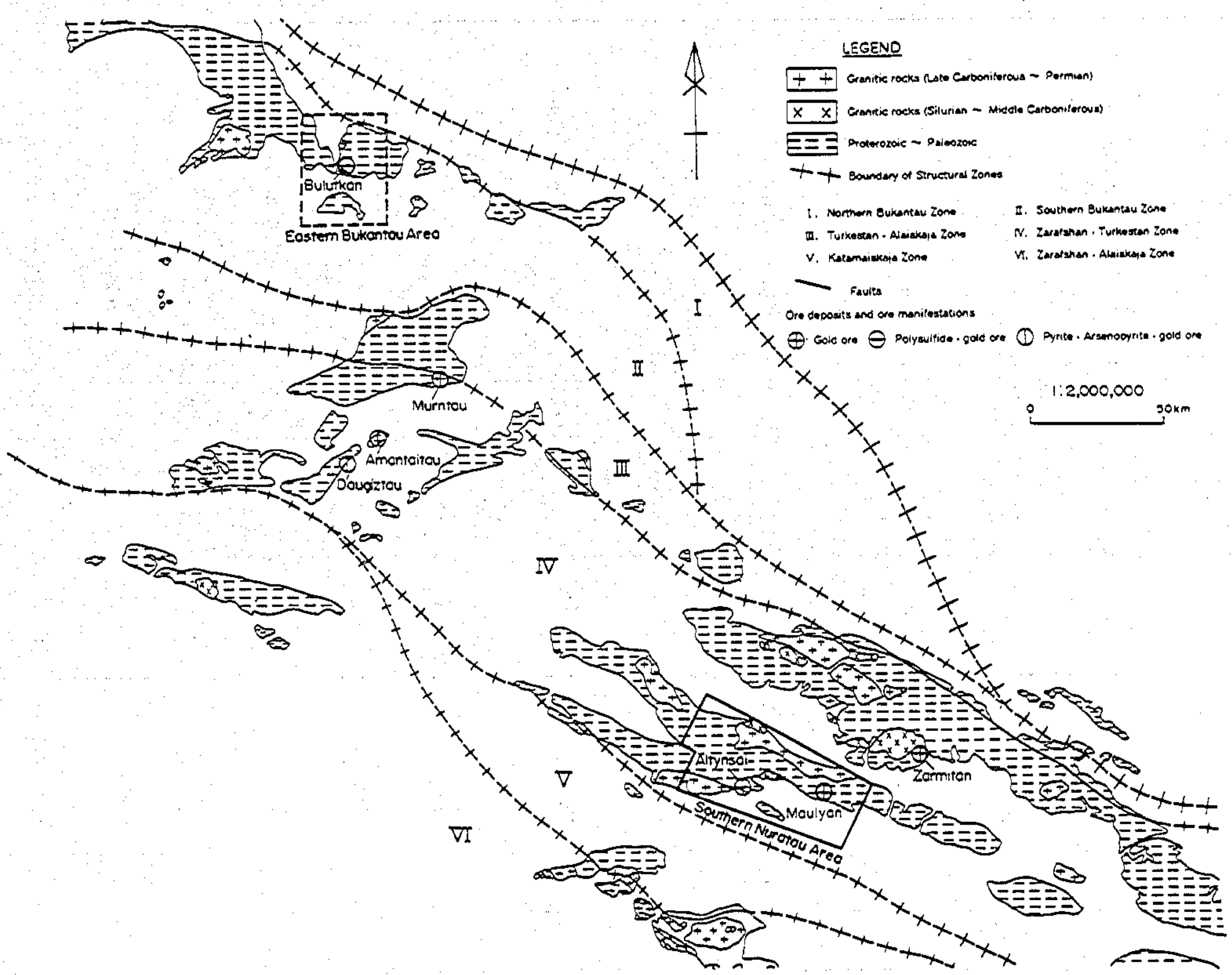


Fig. I-3-2 Structural Zones of the Western Uzbekistan

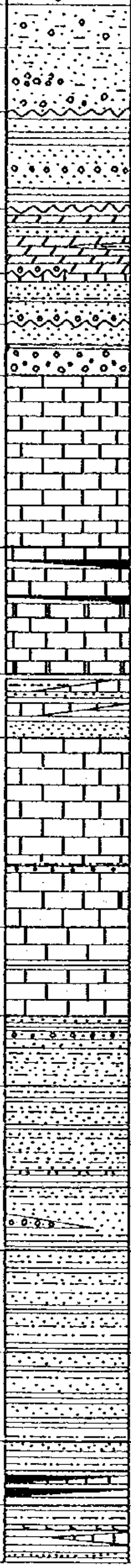
Age			Formation	Abbreviation	Geologic column	Thickness (m)	Lithology
Cenozoic	Quaternary			a			sand, gravel (present river bed sediments)
				Q		<310	sand, gravel, silt
	Tertiary	Neogene		N_2^3		<450	conglomerate, shale, sandstone, siltstone
		Paleogene		₽		310	marl, shale, sandstone, siltstone
Mesozoic	Cretaceous	Senonian		K_{2sn}		50-65	sandstone, shale, coquinite
Paleozoic	Carboniferous	middle	Bitab	$C_2?bt$		100	conglomerate, sandstone, slate
	Devonian	middle	Bakhiltau	D_2^2bh		850	limestone
			Charkhansai	D_2^1cr		620	limestone, chert, dolomite
		lower	Darasai	$D_{1-2}dr$		300	slate, siltstone, sandstone, conglomerate, limestone
			Angidan	$S_2^2?\text{-}D_1an$		1,000	limestone, dolomitic limestone, conglomerate
			Aktau	$S_2\text{-}D_2ak$		>330	limestone, slate
	Silurian	upper	Tansarai	$S_2\text{-}D_1ta$		350	siltstone, sandstone, slate, conglomerate
		lower	Tumsai	$S_1l_3^{1-2}tm$		450-500	sandstone, siltstone, slate, tuff
			Sartbulak	$S_1l_{1-2}sr$		250-300	sandstone, siltstone, slate, conglomerate
	Ordovician	upper / middle	Tusun	$O_{2-3}ts$		500	siltstone, sandstone, slate, "multicolored slate"
		lower	Karakargin	$O_1^2\text{-}O_2^1kr$		400-450	slate, siltstone, sandstone
	Cambrian	upper / middle	Shurchin	$\text{Є}_{2-3}sr$		100-300	limestone, phyllite, sandstone, chert
		lower	Kutanbulak	$\text{Є}_{1-2}kt$		150-180	slate, siltstone, limestone, metavolcanics, cherty limestone

Fig. I-3-3 Schematic Geologic Column of the Southern Nuratau Area

Chapter 4 Geography of the Survey Area

4-1 Location and Access

The survey area is situated about 330 km southwest of Tashkent, the capital, and about 100 km west-northwest of Samarkand, the ancient capital (Fig. I-1). The area spreads over the Navoi and Samarkand Regions and can be reached by car from Tashkent via Samarkand. From Tashkent to Samarkand, east of the survey area, it takes about 4.5 hours (380 km), and about 2 more hours (155 km) from Samarkand to the Altynsai deposit, where the Altynkazgan Geological Party of the Zarafshan Expedition has installed its base (Fig. I-2). The roads are paved, except for a 5 km portion near Altynsai. Maulyan district is situated 30 km east of the Altynsai district. It takes about 1 hour (45 km) by car from Altynsai deposit to the Maulyan manifestation, where the Zarmitan Expedition has been prospecting.

4-2 Topography and Drainage Systems

North of the survey area lies the Aktau Range consisting of mountains of 1,000-2,000 m in altitude, forming the western edge of the Southern Tien-Shan Mountains. The steep mountainous area extends in the WNW-ESE direction. The southern part of the survey area forms the foothills of the Aktau Range, has gently undulating topography between 600 m and 900 m in altitude. In the southwest, the Karatau Mountains spread in the WNW-ESE direction, whose altitude range from 600 m to 1,200 m.

During the dry summer seasons, permanent water flow can be seen only in the large streams of the area. There are many dried river beds where water flows only in the rainy seasons in winter and spring. The drainage systems represent dendritic ~ parallel patterns stretching in the NS ~ NNE - SSW directions.

4-3 Climate and Vegetation

The area has a typically continental dry climate, characterized by dry, hot summers and cold winters. The average monthly temperature drops to the lowest in January (min. -20°C) and rises to the highest in July (max. +40°C). The precipitation is high in winter and spring. The spring precipitation accounts for 30 % of the annual total of 300 mm to 350 mm.

Except large river basins, vegetation is sparse due to the desert climate; therefore, the area assumes an outlook of a rock desert. Along large rivers with constant flow, vegetation such as poplars, willows, mulberries and some fruit trees are seen, as well as shrubs. Grass and shrubs can be seen all over the area, which however wither away before August except along some streams.

Some animals inhabit the area, though small in number, such as rats, squirrels, foxes and wolves, as well as some birds and reptiles including snakes, lizards and tortoises.

Chapter 5 Conclusions and Recommendations

5-1 Conclusions

1) Whole area of the survey

(1) Geology and ore deposit

- The survey area is underlain by Lower Cambrian to Lower Silurian terrigenous sediments, Upper Silurian to Middle Carboniferous limestones, Silurian to Triassic dikes of lamprophyre, diorite, gabbro, etc. and Carboniferous to Permian granites.
- The strata are folded with an axis in the WNW-ESE direction and cut by fractures in similar directions, forming a narrow tectonic zone stretching in the WNW-ESE direction. Traversing the direction, fractures develop also in the NE-SW and NW-SE direction.
- Ore deposits and manifestations in the survey area occur along fracture zones in the WNW-ESE direction, forming the Karatau ore zone (70 km E-W and 2 km to 4 km N-S) along the northern side of the Karatau granite bodies and the Aktau ore zone (70 km E-W and 2 km to 5 km N-S) along the southern side of the Aktau granite bodies.
- In the Karatau ore zone, there occur gold-silver bearing quartz vein-type deposits and manifestations such as the Karamechet-Kurai manifestations and the Altynsai deposit.
- The Aktau ore zone embraces gold-silver bearing quartz vein-type manifestations such as Bitab, Bashtut, Maulyan and Taulyan. Besides, there are the iron-manganese manifestation at Akmulla, the niobium-tantalum manifestation at Sartakchi and the skarn-type tungsten-molybdenum deposit at Lyangar.
- Based on analysis of the existing data, the Altynsai deposit (Au) and Maulyan manifestation (Au) were extracted as promising exploration targets.

(2) Satellite image analysis

- Satellite images produced on a basis of the LANDSAT TM data clearly reflect the geological units and tectonic structure, proving to be effective for the geologic interpretation in the survey area.
- 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, about 100 m wide.
- In the anomalous zones extracted as iron oxide zones by the ratioing processing of TM data, iron oxide zones were really verified in some parts while the rest represented shaded slopes. The zones extracted as argillized, carbonatized alteration zones were not those accompanied by mineralization; however, occurrence of weathered granites including kaolinite, sericite and calcite was

verified.

2) Altynsai District

(1) Geology and ore deposit

- The Altynsai district is underlain by sediments of Ordovician-Silurian System and Late Permian to Early Triassic lamprophyre, represents a fold structure along the axis in the WNW-ESE direction. The sedimentary rocks are metamorphosed into phyllites and schists through low temperature, medium pressure-type metamorphism, and consist of biotite, muscovite, chlorite, staurolite, etc.
- The deposits in the district are gold bearing vein-type deposits consisting of quartz veins, accompanied with fracture zones of the WNW-ESE trend and those of NW-SE trend intersecting the former, and tourmaline-quartz veins which accompanied with joints with the N-S trend.

(2) Ore zone

- The district is located in the Karatau ore zone where gold manifestations occur in fractures and silicification zones in the WNW-ESE direction. The Karatau ore zone embraces ore deposits and manifestations of gold-silver bearing quartz vein type, such as the Sarmich deposit, Biran deposit (these are out of the survey area), Kurai manifestations and Altynsai deposit.
- In the Altynsai deposit, ore bodies of quartz veins such as the Nos. 1, 2, 8 ("Northwest Vein"), 9 ("Kazanbulak Vein") and 10 ("Berkut Vein") have been confirmed in hornfelsed sedimentary rocks within an area of 2.5 km in length and 500 m to 800 m in width. Tourmaline-quartz veinlet zones with the N-S trend are also developed in the areas where the ore zones occur.
- Bonanzas are located at the intersections of the WNW-ESE veins with the NW-SE fractures and tourmaline-quartz veinlets are concentrated.

(3) Size and continuity of ore deposit

- The Phase I, II and Uzbek drilling surveys, aimed at the lower extension of the bonanzas confirmed in Adit No. 4 at veins Nos. 1 and 2, discovered that the mineralization degenerates below the depth of 100 m (600 m above sea level) under the adit. This is presumably attributable to denudation of the main portions of the ore body by erosion.
- The drillhole MJSN-16 of the Phase III drilling surveys, aimed at the lower extension of the Northwest Vein (No. 8 vein) as confirmed by the Uzbek trenches, discovered the dominant mineralization (true width 0.98 m; Au 44.8 g/t) 60 m under the surface. But the drillhole MJSN-15, aimed at the lower extension (50 m) of it, only confirmed low-grade gold mineralization (true width 1.06 m; Au 1.8 g/t). From these findings, it was confirmed that gold grade considerably varies though

mineralization is continuous. The lower portion of No.8 vein remains unexplored, however, big increase of ore reserves can not be expected by further drilling because the mineralization is small in size.

- The Phase I, II and Uzbek drilling survey, aimed to examine mineralization of tourmaline-quartz veinlet zones with the N-S trend and also examine the feasibility of open pit mining, discovered low-grade gold mineralization (Au trace to 23.6 g/t) at various locations; however, the overall average of Au grade did not exceed 0.2 g/t which is insufficient for justifying open pit mining.

(4) Mineralization

- Component minerals of the quartz veins that occur in fractures zones with the WNW-ESE and NW-SE trends are pyrite, marcasite, arsenopyrite, chalcopyrite, sphalerite, goethite, lepidocrocite, galena, native bismuth, aikinite, wittichenite, scheelite, etc., while gold occurs as electrum. The tourmaline-quartz veins with the N-S trend are accompanied with pyrite, arsenopyrite, goethite, lepidocrocite, etc.
- Homogenization temperatures of fluid inclusions of quartz veins with the WNW-ESE and NW-SE trends and the tourmaline-quartz veinlets with the N-S trend generally range between 270°C and 370°C. There was no significant difference observable between them. The quartz veins and tourmaline-quartz veinlets are inferred to have been formed during the similar period of mineralization and under similar temperature ambience. No significant correlation was observed between homogenization temperature and gold grade, nor between homogenization temperature and depth at which drilling samples were taken.
- The occurrence of ore and hornfels zones and the anomalous zones of the Uzbek airborne magnetic survey mostly correspond to each other, which suggests the possible existence of concealed granites at shallow levels. The ore zones are inferred to have been formed by the mineralization originating in the intrusion of granites.
- The mineralization of the subject ore deposit represents continuity but has variable grade.

(5) Ore reserves

- At the cutoff grade of 2.0 g/t (Au), the total ore reserves of No.1, No.2 and No.8 veins combined are 423,000 t, grading 9.6 g/t Au, or approximately 4.0 t of Au in terms of metal content. While those of No.1, No.2 and No.8 veins are 109,000 t, grading 10.3 g/t Au (1.1 t of Au content), 239,000 t, grading 6.9 g/t Au (1.7 t of Au content) and 75,000 t, grading 17.0 g/t Au (1.3 t of Au content), respectively.

3) Maulyan District

(1) Geology

- The Maulyan district is underlain by Paleozoic sedimentary rocks such as limestone, slate and sandstone, intruded by granites and dikes of lamprophyre, etc. The sedimentary rocks are metamorphosed into phyllites and schists through low temperature, medium pressure-type metamorphism, consist of biotite, muscovite, chlorite, staurolite, etc.
- These strata are folded along an axis in the WNW-ESE direction and divided in blocks by faults in the WNW-ESE, NE-SW and NW-SE directions.

(2) Ore Zone

- The district forms a part of the Aktau ore zone where gold manifestations occur in fractures and silicification zones in the WNW-ESE direction. Gold manifestations have been confirmed at Maulyan, Beshbulak, Taulyan and Shur.
- Geochemical survey did not find a clear continuity between the scattered Au anomalies. The Au anomalies are spotted around the known gold manifestations -- in the southern part of the Maulyan manifestation, vicinity of the Taulyan manifestation and southern part of the Shur manifestation.

(3) Size and continuity of ore manifestation

- The extent of the Maulyan manifestation on the surface is 1 m to 4 m wide and 1,000 m long (No.1 ore body), 400 m long (No.2 ore body) and 200 m long (No.3 ore body). The gold grade varies from 1 g/t to 33.4 g/t.
- Two drillholes of the Phase II drilling survey and six Uzbek drillholes independently confirmed the continuity of the No.1, No.2 and No.3 ore bodies between 16m and 135 m under the surface. They, however, only confirmed low-grade gold mineralization (true width 0.2-1.8 m; Au 1.6-8 g/t). From these findings, the near-surface mineralization is inferred to be dominant.
- Twenty drillholes of the Phase III drilling survey were aimed to examine mineralization of shallow portion of the No.1, No.2 and No.3 ore bodies, between 10 m and 15 m under the surface, and also examine the feasibility of open pit mining. Among the thirteen drillholes, aimed to examine mineralization of lower portion of the No.1 ore body, four drillholes discovered low-grade gold mineralization (true width 0.4-1.9 m; Au 1.7-5.8 g/t). Among the seven drillholes, aimed to examine mineralization of the No.2 ore body, three drillholes confirmed weak gold mineralization (true width 0.4-1.1 m; Au 1.8-9.6 g/t). However, analyses of ore samples collected from another thirteen drillholes did not indicate Au grade higher than 1.0 g/t.
- The Phase II geological survey and Uzbek trenching survey indicate that the Beshbulak, Taulyan and Shur manifestations have low Au grades.

(4) Mineralization

- Samples collected from gold-bearing quartz veins at the Maulyan manifestation are accompanied by ore minerals such as pyrite, goethite, lepidocrocite, arsenopyrite, chalcopyrite and sphalerite, while gold occurs as electrum.
- Homogenization temperatures of fluid inclusions at the ore zone mostly fall within the range of 250°C-350°C. The homogenization temperatures of quartz samples grading Au 1.2-2.0 g/t were 221°C-281°C, higher than the general temperature range of gold occurrence, 100°C-250°C. No significant correlation was observed between homogenization temperature and depth at which drilling samples were taken.
- In light of the occurrence of the Aktau granites, characteristics of the surrounding manifestations, drilling results and homogenization temperatures, gold-bearing quartz veins at the subject manifestation are inferred to have been formed under high temperature ambience, which is considered to lack the conditions required for a high-grade, large-scale gold concentration zone.

(5) Ore reserves

- At the cutoff grade of 1.0 g/t (Au), the tentative estimation of the total ore reserves of No.1, No.2 and No.3 ore bodies indicated 252,000 t, grading 4.2 g/t Au, or approximately 1.1 t of Au in terms of metal content. While those of No.1, No.2 and No.3 ore bodies are 149,000 t, grading 3.8 g/t Au (0.6 t of Au content), 87,000 t, grading 5.0 g/t Au (0.4 t of Au content) and 16,000 t, grading 4.2 g/t Au (0.07 t of Au content), respectively.

5-2 Recommendations

1) Altynsai Deposit

(1) Ore reserves estimates of No.1, No.2 and No.8 veins added up to 423,000 t, grading 9.6 g/t Au, or approximately 4.0 t of Au in terms of metal content. The lower portion of No.8 vein remains unexplored, except the shallow portions surveyed by the Phase III and Uzbek drilling surveys. In order to verify the deep mineralization, it is advisable to continue the drilling survey by the Uzbek side.

(2) All the ore bodies of No.1, No.2 and No.8 veins are small in size, however, have dominant mineralization (Au grade higher than 10 g/t) in the upper portions. There is the possibility that the Altynsai deposit could be developed as a small-scale mine by tunnel mining, though it depends on the results of future drilling and tunneling surveys by the Uzbek side.

2) Maulyan Manifestation

(1) Tentative calculation indicated that the total ore reserves of No.1, No.2 and No.3 ore bodies combined are 252,000 t, grading 4.2 g/t Au, or approximately 1.1 t of Au in terms of metal content. A certain increase in ore reserves by further exploration may be anticipated but a significant improvement in Au grade is unlikely.

(2) All the ore bodies in the subject manifestation are small in size and have variable and low1 overall grade (Au grade less than 5 g/t). At present, there is little possibility that the Maulyan manifestation could be developed as a large-scale deposit. For developing the manifestation as a small-scale mine, discovery of considerably high grade ore is necessary by the future drilling and tunneling surveys by the Uzbek side.

PART II SPECIFIC INFORMATION

2) Maulyan Manifestation

(1) Tentative calculation indicated that the total ore reserves of No.1, No.2 and No.3 ore bodies combined are 252,000 t, grading 4.2 g/t Au, or approximately 1.1 t of Au in terms of metal content. A certain increase in ore reserves by further exploration may be anticipated but a significant improvement in Au grade is unlikely.

(2) All the ore bodies in the subject manifestation are small in size and have variable and lowl overall grade (Au grade less than 5 g/t). At present, there is little possibility that the Maulyan manifestation could be developed as a large-scale deposit. For developing the manifestation as a small-scale mine, discovery of considerably high grade ore is necessary by the future drilling and tunneling surveys by the Uzbek side.

PART II SPECIFIC INFORMATION

Chapter 1 Satellite Image Analysis

1-1 Methods of Analysis

Using the LANDSAT data and selecting the best band combination fit for geologic interpretation, a false color image of the subject area was produced on a scale of 1:200,000 for interpretation of the geologic units and structure. Based on the interpretation, a geologic interpretation map and lineament analysis map, both on a scale of 1:200,000 were drawn. Spectral analysis, including ratioing and decorrelation stretching, was made so that a 1:200,000 image, most appropriate for the extraction of alteration zones, was produced. From the spectral analysis image, alteration zones were extracted and mapped on a 1:200,000 scale.

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-1-1. The interpretation work was conducted in the following procedures:

1) Photogeological interpretation

(1) Extraction of the area to be analyzed

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

(2) Preparation of color composite images

After several trial productions of color composite images, 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 the difference in lithofacies (Fig.II-1-2).

(3) Geologic interpretation

From the false color composite image, geological units and lineaments were interpreted.

2) Extraction of alteration zones

As the result of processing by ratioing, spectral anomaly areas (possible alteration zones) have been extracted.

(1) Ratioing-1:

To select iron oxide zones, ratioing was made using the formula of (Band 2 - Band 1) ÷ (Band 2 + Band 1).

(2) Ratioing-2:

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

(3) 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 alteration zones.

(4) Level slice:

For both ratioing-1 and -2, the accumulation frequency curves from the maximum value were drawn; and, ratioing values, at which the respective accumulation frequencies fall within 1% and 5%, were used as the thresholds for defining the spectral anomaly areas. Results of the analysis were composed with the first principal component image (Fig.II-1-3).

3) Geological survey

To complement the results of photogeological interpretation and extraction of possible alteration zones, the geological survey was conducted.

4) Synthetic analysis

Geological information obtained through LANDSAT data image analysis, geological survey and compilation of existing data were integrated to analyze the relationship of mineralization with geologic unit and structure.

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

1-2 Image Interpretation and Analysis

1) Geological unit

The geologic interpretation map drawn from the color composite image is exhibited in Fig. II-1-4. The area for analysis was classified into 10 units.

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

In comparison with the existing geologic map, the areas of occurrence of granite 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.

2) Geological structure

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

① The directions of NNE-SSW and ENE-WSW are conspicuous.

② The lineament density tends to be high in the Unit Gr1 (Aktau granites). Especially in the northwestern tip of the Gr1 rock body, the density is very high; it is presumed that numerous fissures are distributed in the vicinity.

③ Occurrence of faults which cut the Gr1 rock body in the NW-SE direction is inferred.

The clear lineament with the NW-SE trend, which traverses the central part of the Gr1 granitic 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 fracture 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.

On the image, the stripes that represent the stratification structure are closed and opened, thereby indicating the folds of basement rocks. However, the precision of the image used for the survey was not high enough to extract the detailed fold structure.

3) Alteration zone

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. 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. 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. 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 has been observed in the areas adjacent to the surrounding of the Gr1 rock bodies (Fig.II-1-6).

Specification of Data Used

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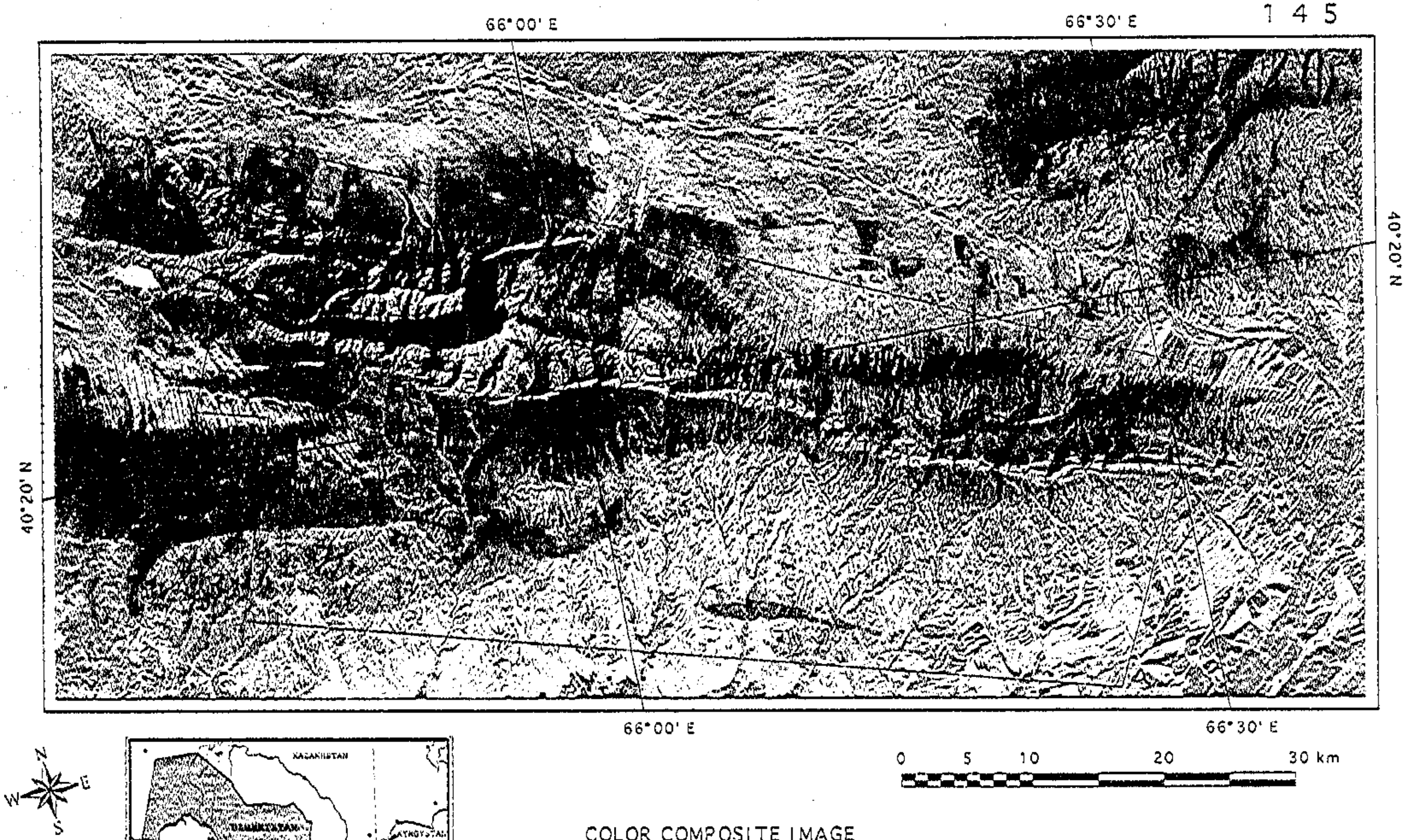
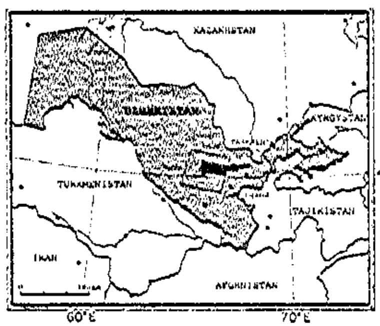
Fig. II-1-1 Ground Coverage of Satellite Data and its Specification

1 4 5





Japan International Cooperation Agency
Metal Mining Agency of Japan
1998

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

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

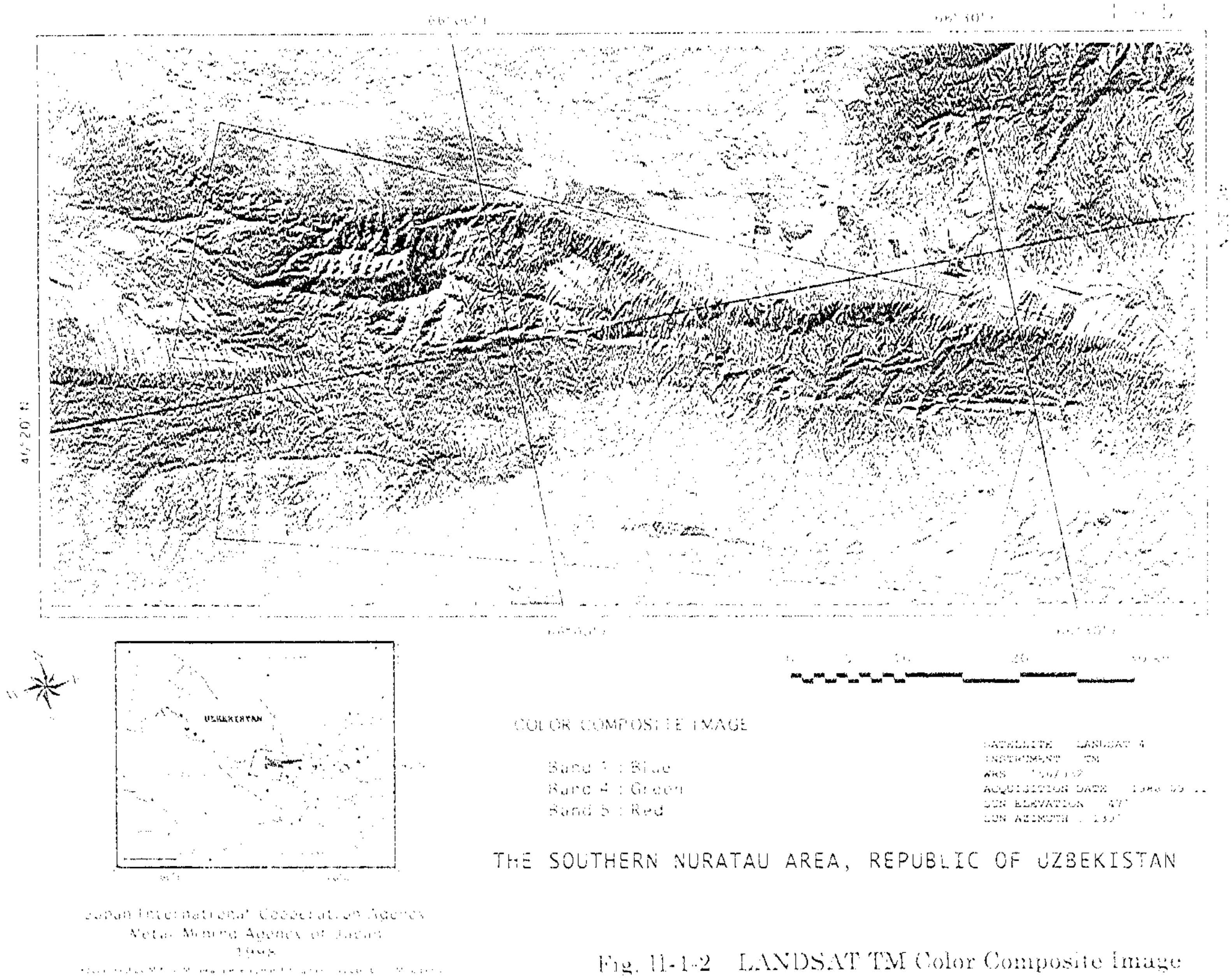
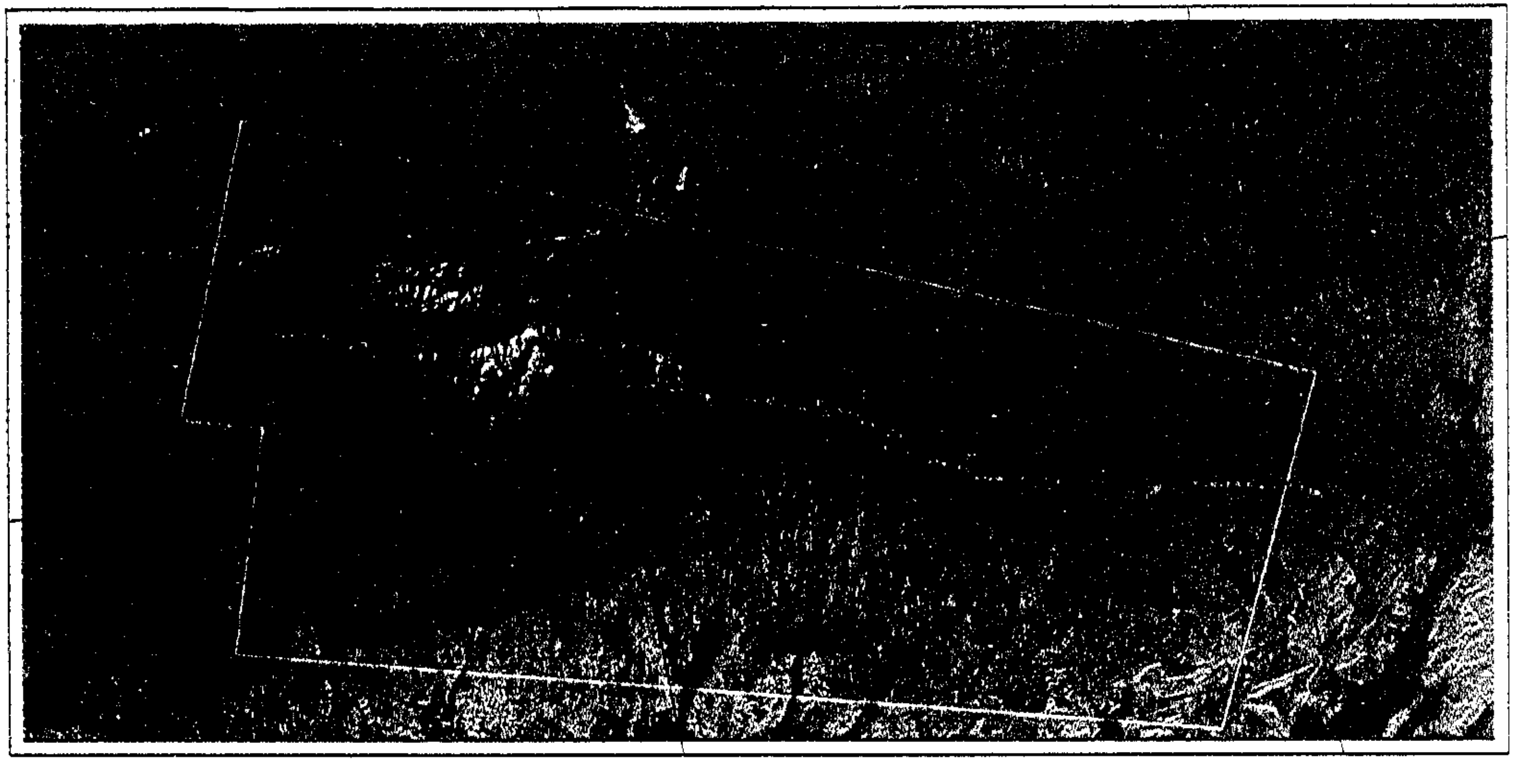
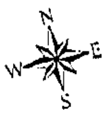
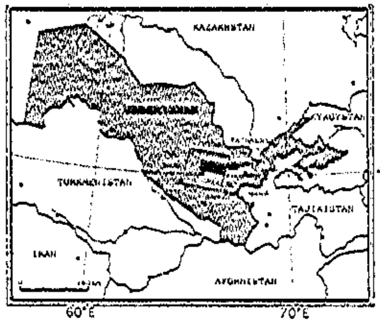


Fig. II-1-2 LANDSAT TM Color Composite Image







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-1-3 LANDSAT TM Ratio Anomaly Map

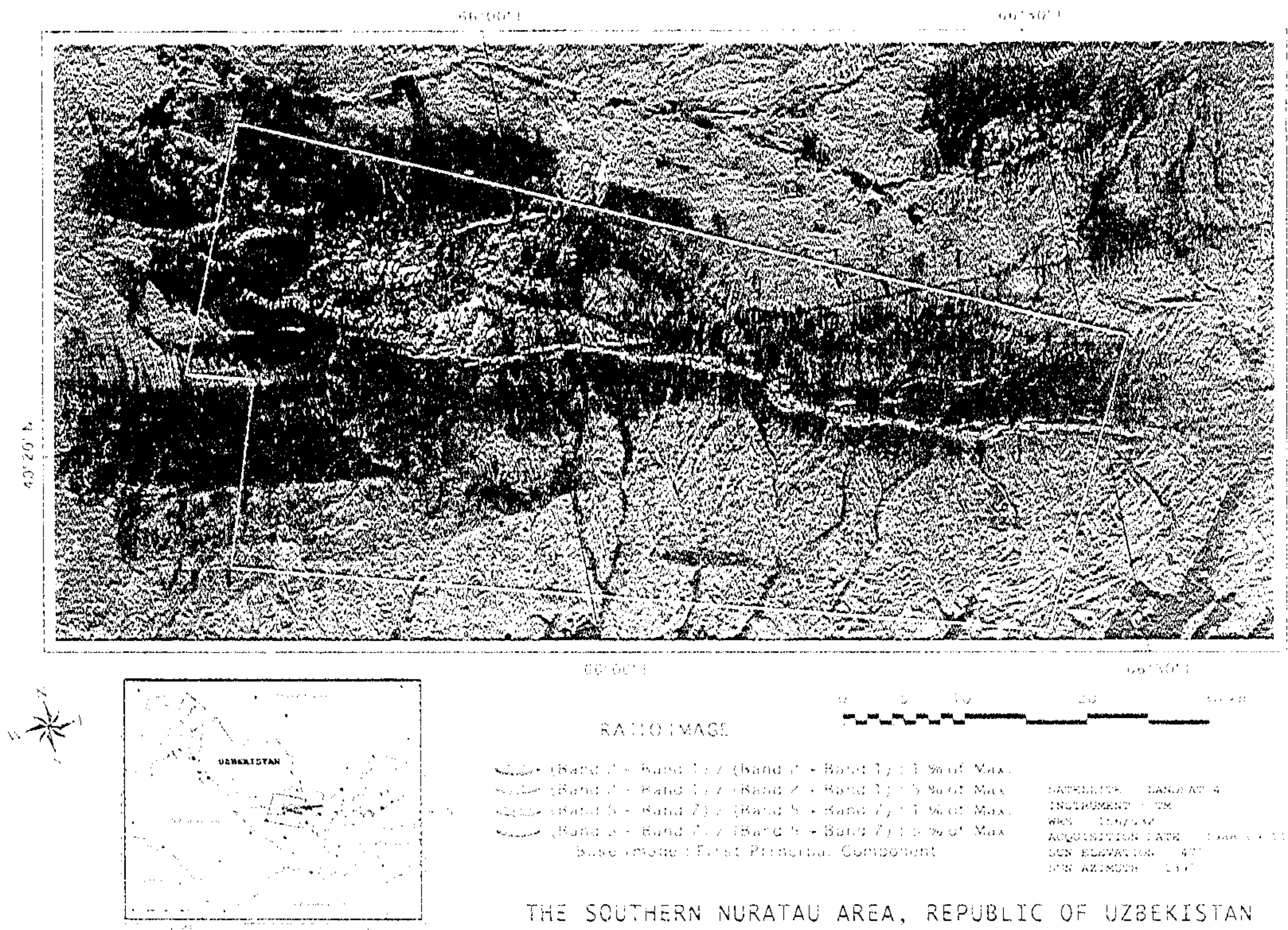
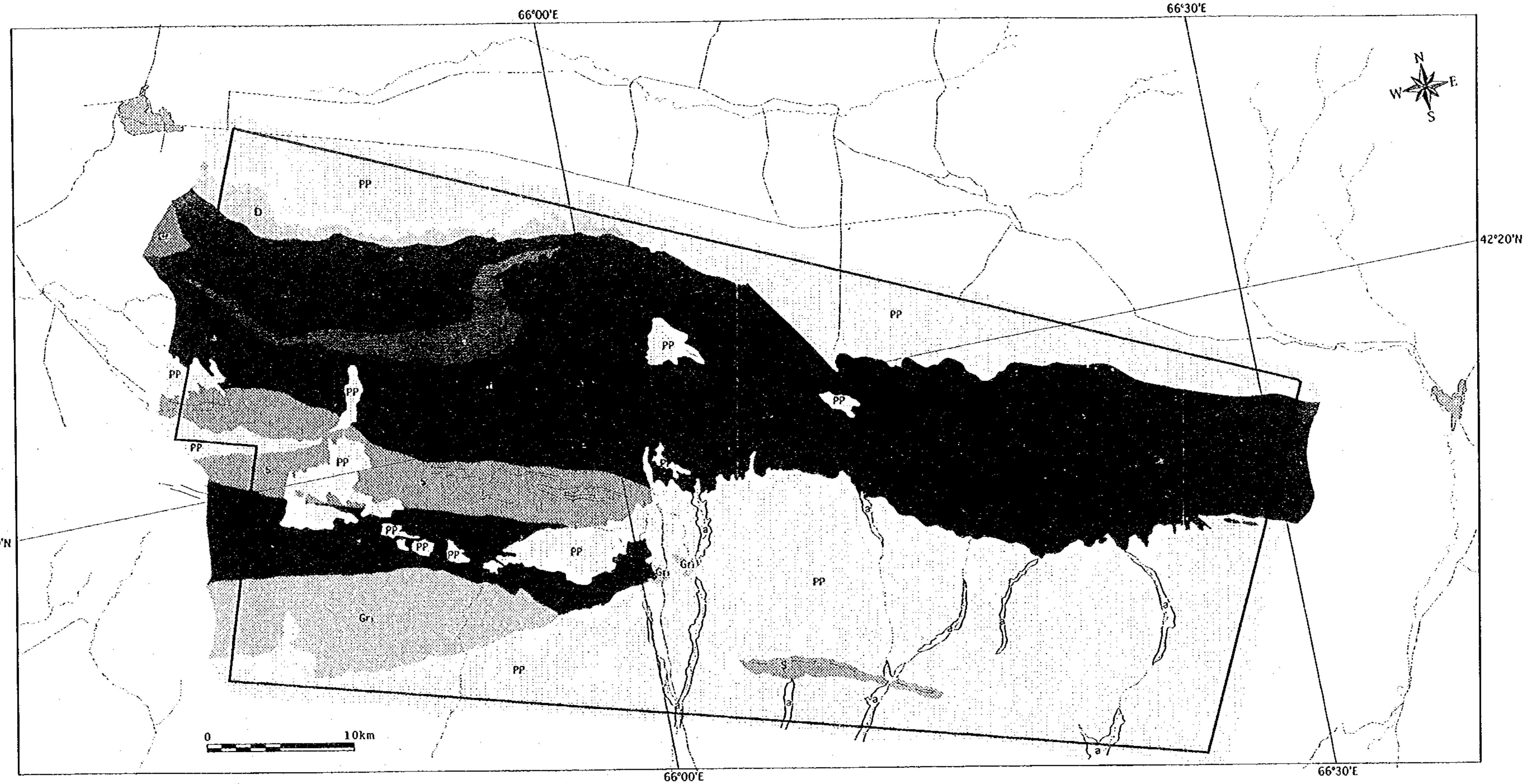
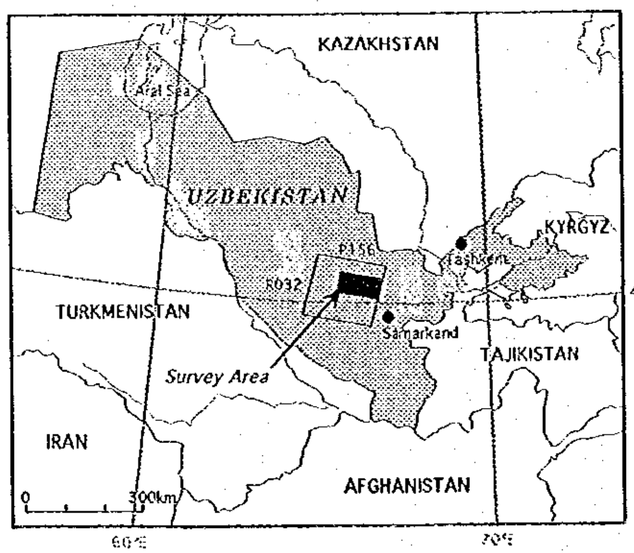


Fig. II-1-3 LANDSAT TM Ratio Anomaly Map





Sedimentary Units

- a — Holocene (alluvial deposit)
- PP — Post Paleozoic
- D — Devonian
- Silurian to Devonian
- Silurian
- Upper Ordovician
- Lower Ordovician

Intrusive Rocks

- Gr1 — Permian Granitic rocks
- Carboniferous Granitic rocks 2
- Carboniferous Granitic rocks 1

Others

- Overturned syncline
- Fault
- Bedding or schistosity
- Road
- Town
- Drainage

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

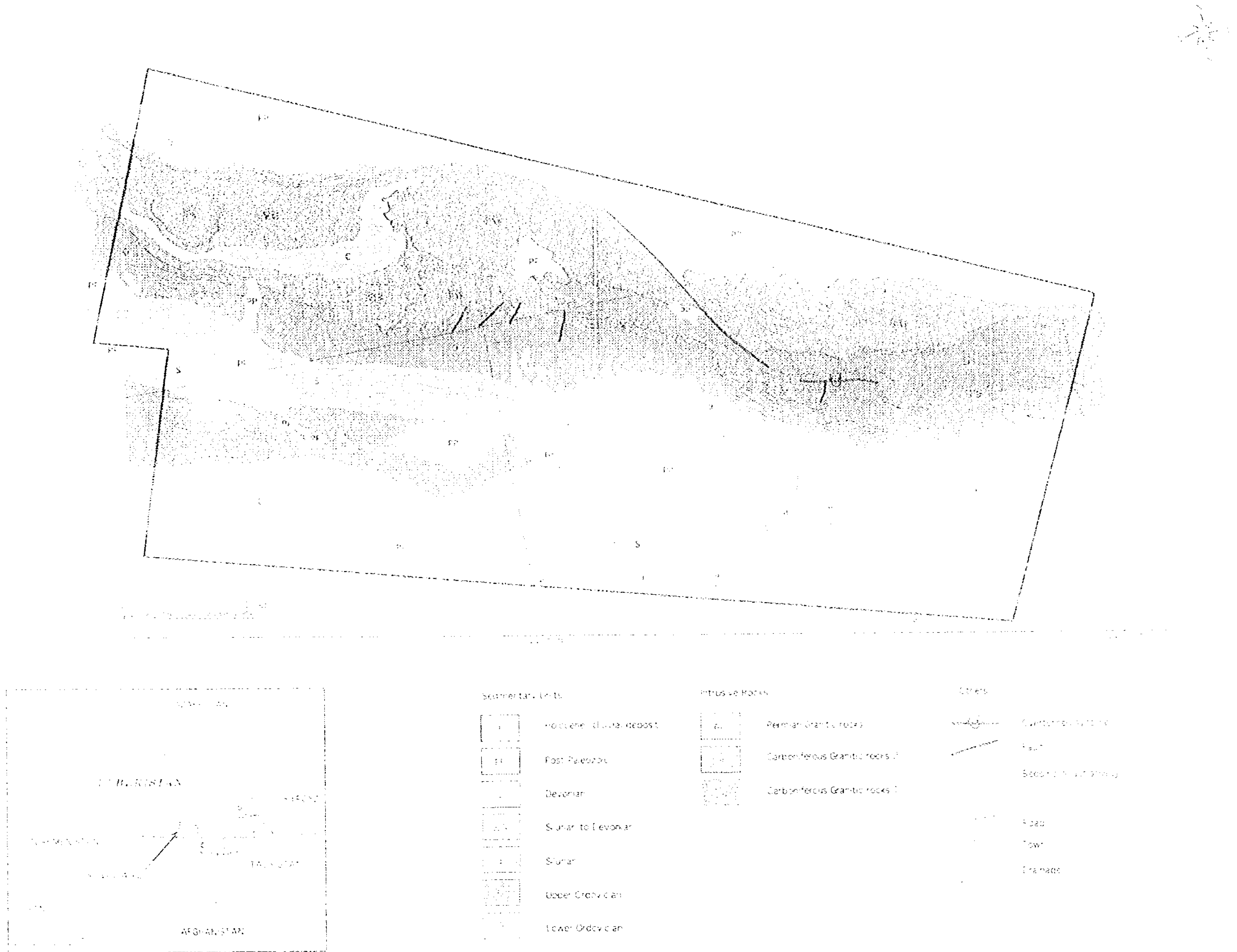


Fig. II-1-4 Geologic Interpretation Map

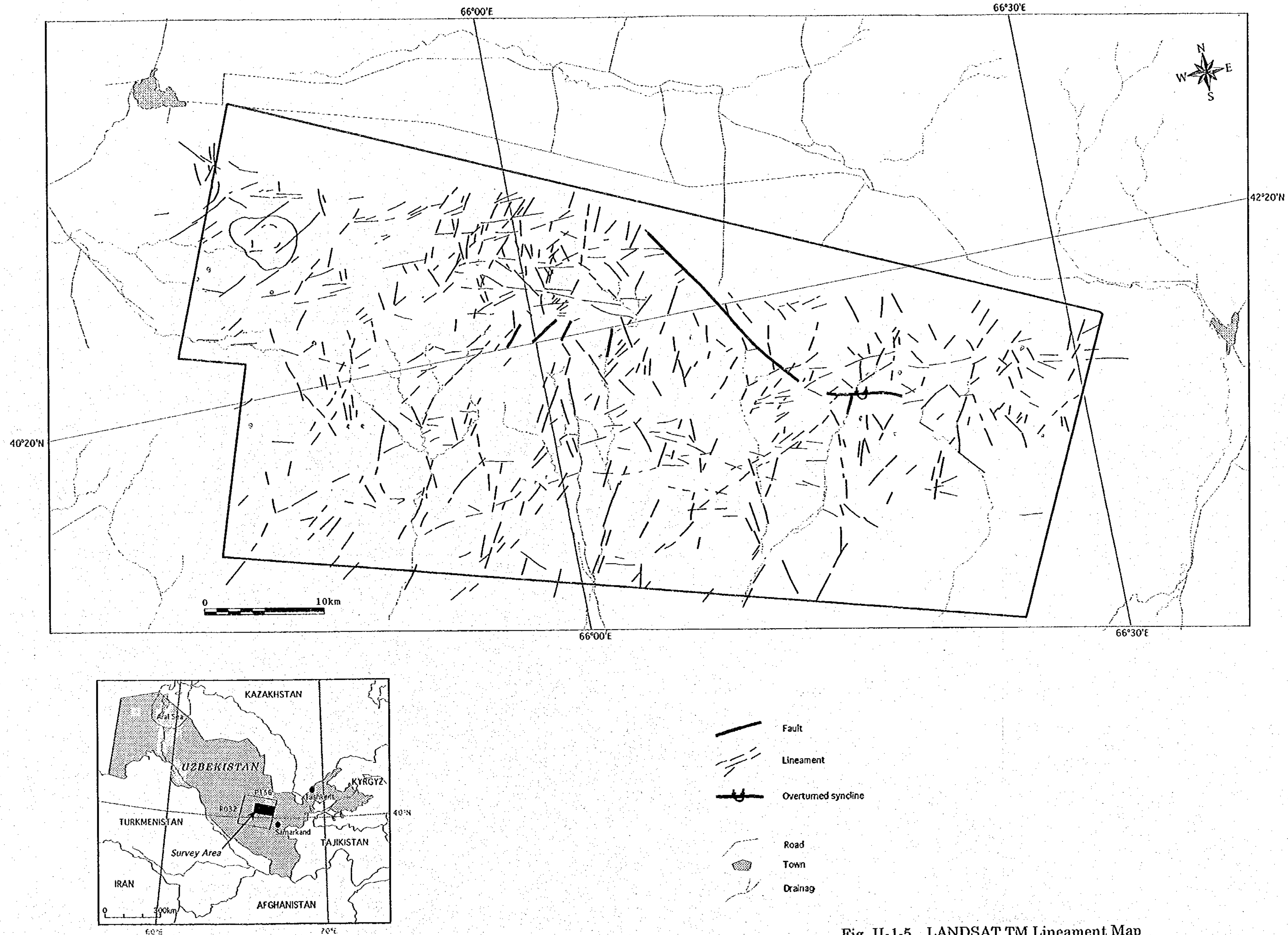
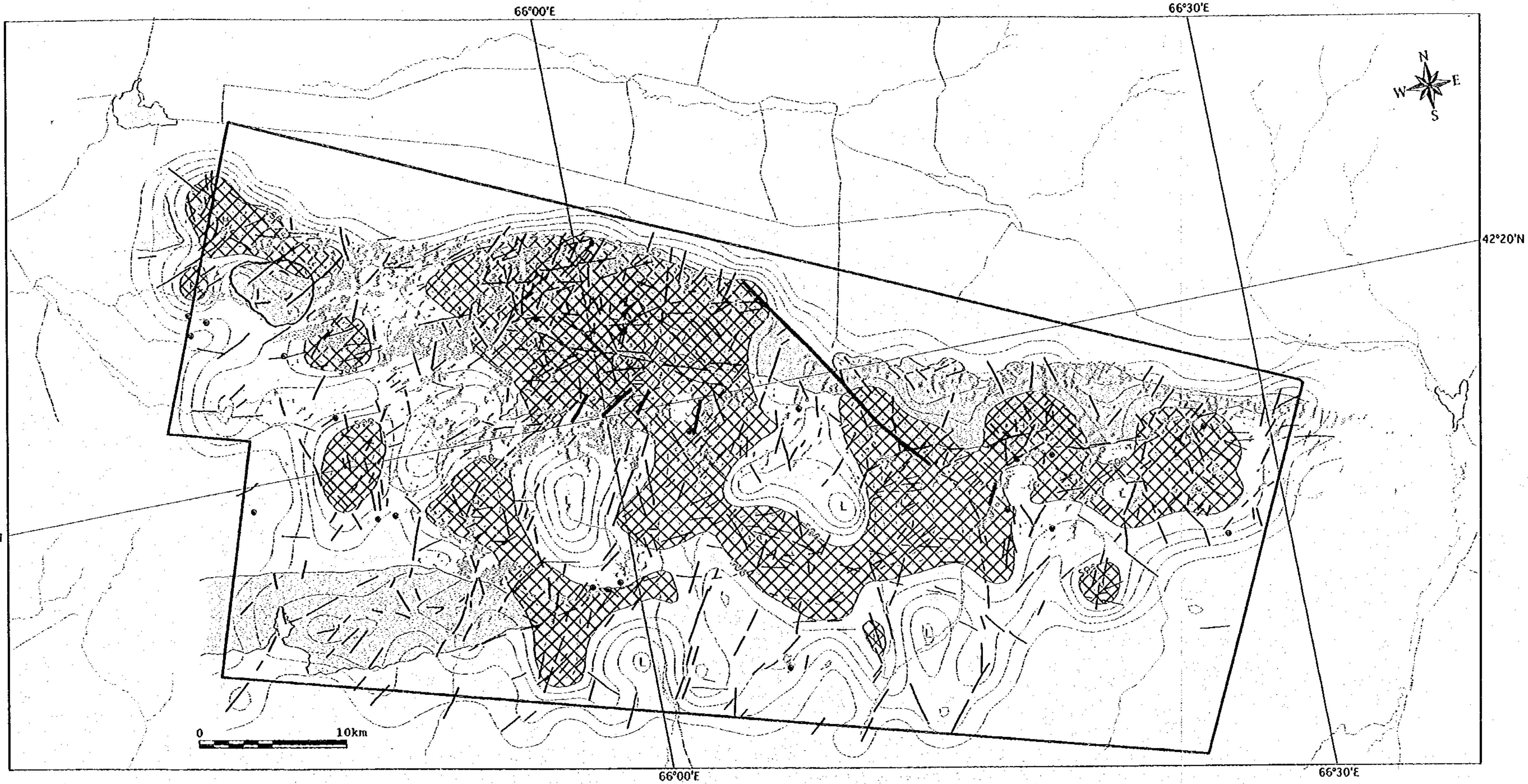


Fig. II-1-5 LANDSAT TM Lineament Map



Granitic intrusive rocks

Fault

Lineament

Lineament density (m/km²)

Spectral Anomaly by band2 / band1 (second order)

High lineament density (≥500 m/km²)

Known ore deposit/showing

Road

Town

Drainage

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