REPORT
ON
THE MINERAL EXPLORATION
IN
THE SOUTHERN NURATAU AREA
THE REPUBLIC OF UZBEKISTAN

(PHASE I)

MARCH 1998

JAPAN INTERNATIONAL COOPERATION AGENCY

METAL MINING AGENCY OF JAPAN

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PREFACE

In response to the request of the Government of the Republic of Uzbekistan, the Japanese Government determined to conduct a series of survey involving geological survey, geochemical survey and other studies related to exploration of ore deposits, for the purpose of examining the potentials of mineral resources in the Southern Nuratau Area, situated some 330 km southwest of Tashkent, the Uzbek capital city, and entrusted the survey to the Japan International Cooperation Agency(JICA).

In view of the geological and mineralogical nature of the intended survey, the JICA commissioned the Metal Mining Agency of Japan(MMAJ) to execute the survey.

During the first fiscal year(Phase I) of the survey commenced in the fiscal 1997, the MMAJ organized and sent to the Republic of Uzbekistan a four-man survey team for the period from August 17, 1997 to January 23, 1998. The field survey was completed as scheduled, in close collaboration with the Uzbek government agencies concerned and the State Committee of Geology and Mineral Reserves.

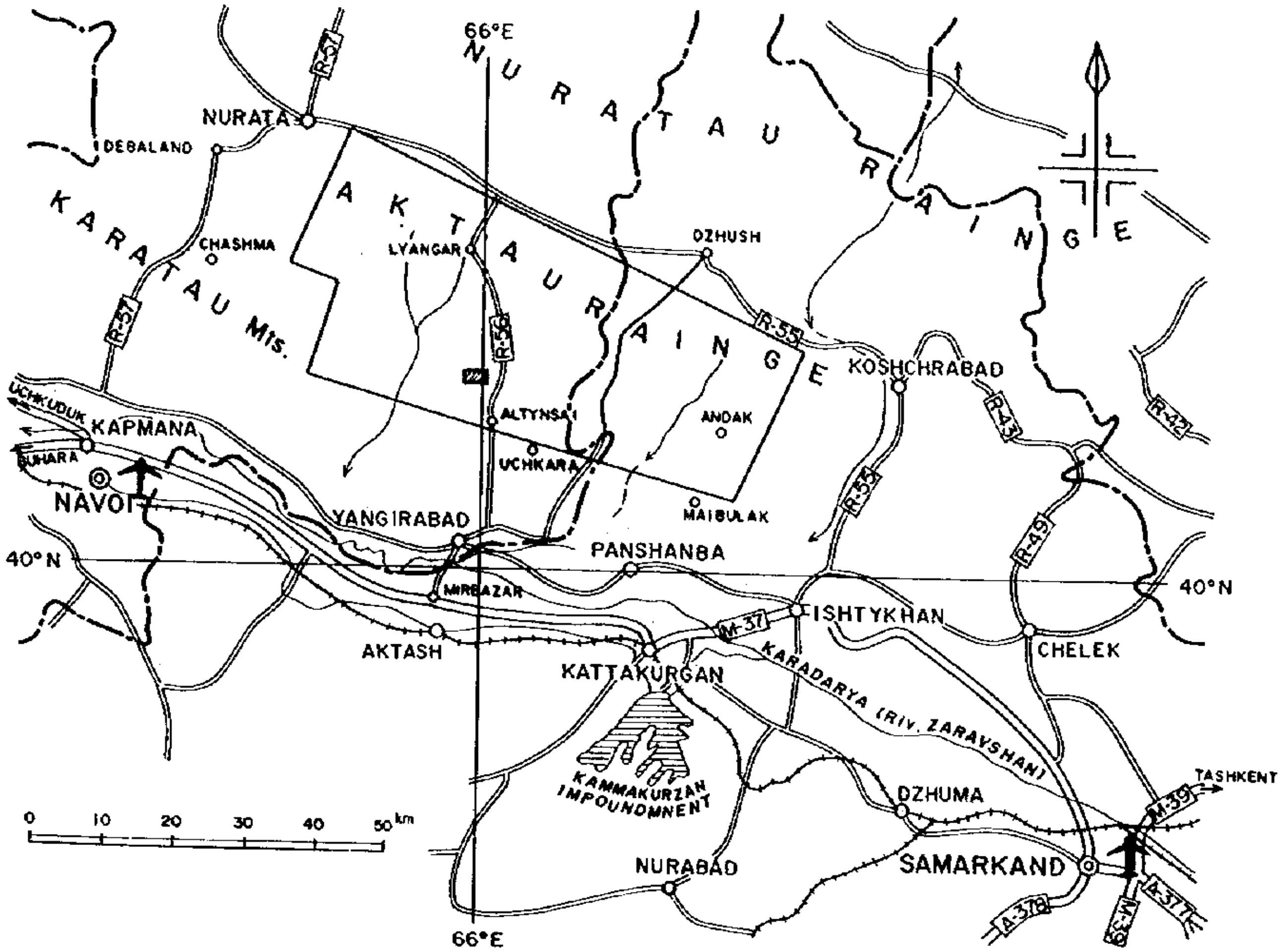
This Report summarizes the results of the Phase I survey and forms an integral part of the final survey report to be elaborated.

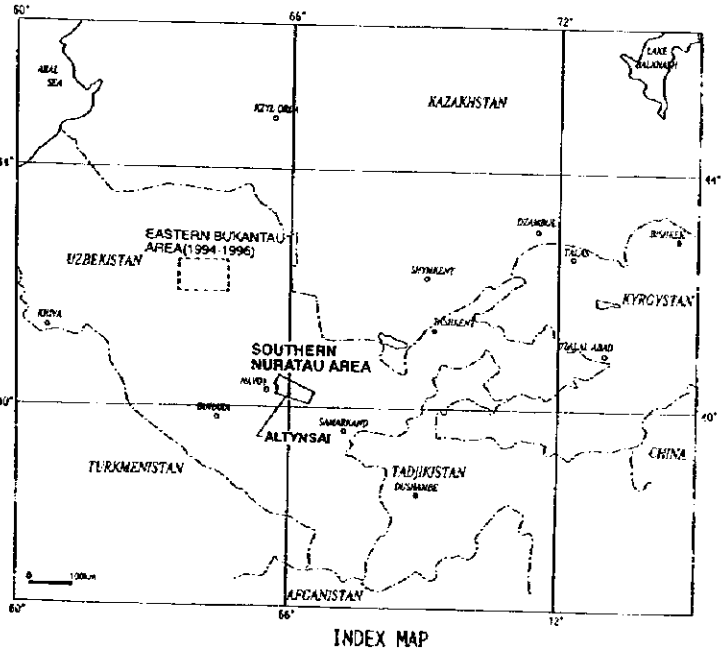
We should like to take this opportunity to express our sincere gratefulness to hte Uzbek government agencies and persons concerned for their valuable cooperation. We are also thankful to the Japanese Ministry of Foreign Affairs, the Ministry of International Trade and Industry, the Embassy of Japan in Tashkent and persons concerned who have rendered assistance and support for the survey.

March, 1998

Kimio Fujita
President
Japan International Cooperation Agency

Hiroaki Hiyama
President
Metal Mining Agency of Japan





INDEX MAP

LEGEND

(PHASE I)

The survey area for Satellite image analysis and General geological Survey (2,000 km^2)

The survey area for Detailed geological survey and Drilling Survey (5 km^2)

Fig. I -1 Location Map of the Survey Area

РЕЗЮМЕ

Настоящий отчет является сводом результатов фундаментального исследования по программе сотрудничества в освоении недровых ресурсов на первый год, которое было проведено в Нуратауском регионе Республики Узбекистан. Цель исследования заключалась в выяснении геологической обстановки и расположения рудных месторождений, и в определении общих направлений исследовательской работы в будущее, а также в оказании поддержки эксплуатацией партнерских ресурсов по совершение переоценки известных рудных месторождений и определение плана разработки. Работы по разведке на месте были проведены с августа 1997 г. по январь 1998 г.

В рамках исследования на первый год в регионе площадью 2000 км², который установлен объектом исследования была проведена расшифровка изображений, снятых с борта искусственного спутника, сбор и анализ существующих материалов и информации о недрах, а также геологическую разведку. Также, была проведена геологическая разведка в пределах 5 км² в Алтынсайском районе и разведка с разбуриванием скважин (10 скважин, общая глубина 2451 км) на Алтынсайском месторождении.

В следующем излагаем о результатах исследования на первый год по каждому из районов и рекомендации на второй год:

1) По всему Южно-Нуратаускому региону:

(1) От центральной части до южной части данного региона распространяются терригенные отложения, относящиеся к нижне-кембрийской - нижне-сулурийской системам, а в его северной части - в основном известняковые породы средне-каменноугольной системы. В этих породах наблюдается интрузия даек от силурийского до триасового периодов и гранита от каменноугольного до пермского периодов. Формация региона представляет собой растянутую в направление ЗСЗ-ВЮВ структурную полосу, формированную складками и развалами, идущими в то же направление.

(2) Снятые с борта спутника снимки, составленные на основе данных ТМ ЛАНДСАТ, четко выражают распределение геологий и структуру, и уточнено то, что они пригодны к выяснению геологии в данном регионе исследования.

(3) Уточненные и перспективные месторождения, в основном, золота распространяются вдоль зоны разломов, идущей в направление ЗСЗ-ВЮВ, и формируют Каратаускую зону минерализации (ВЗ 70 км, СЮ 2-4 км) вдоль северной стороны Каратауской гранитной породы и Актаускую зону

минерализации (ВЗ 70 км, СЮ 2-5 км) вдоль южной стороны Актауской гранитной породы.

(4) В Каратауской зоне минерализации расположены Карамечетский участок с признаками руды, Алтынсайское месторождение и другие месторождения с кварцевыми залежами, содержащими золото и серебро, а также участки с признаками полезных ископаемых. В Актауской зоне минерализации Битабский, Паштатский, Маурянский и Таурянский участки с признаками полезных ископаемых, где имеются кварцевые залежи, содержащие золото и серебро. Кроме того, в регионе находятся Акумрауский участок с признаками руды железа и марганца, Сартакучский участок с признаками ниобия и тантала и Рянгарское скарновое месторождение вольфрама и молибдена.

(5) На Маурянском участке с признаками полезных ископаемых отдельные частицы золота размером 2 мм в кварце, которые сочлись ювенильными. Электрумы, найденные при наблюдении полученных на Бибабском участке полированных частиц могут быть формированными в результате вторичного обогащения с учетом того факта, что они парагенизируются с пиритом (железным колчеданом) и окисями марганца в трещинах в кварце.

(6) Температура гомогенизации жидкостных включений в кварце составляет 140 град.С - 340 град. С. Эти включения подразделяются по температурам гомогенизации на группу сравнительно низких температур 140 - 170 град.С и группу высоких температур 270-340 град.С. Низкие температуры гомогенизации жидкостных включений считаются указывающими температуры гомогенизации вторичных жидкостных включений, образованных в результате попадания горячих растворов поздних периодов в трещины в кварце, судя по их генетическому состоянию. Низкие температуры показали кварц, полученный на Крайском, Себистанском и Сартакучском участках, а высокие температуры - кварц с Карамечетского, Маурянского, Таурянского и Рянгарского участков.

(7) На Маурянском участке с признаками полезных ископаемых процесс минерализации с преобразованием минералов в золото наблюдается в кварцевых жилах и зоне окремнения вдоль 10 полос зоны разломов и окремнения по направлению ЗСЗ-ВЮВ. До настоящего времени уточнено наличие 3 полос рудного тела шириной жилы 1-4 м и длиной 150 м, 200 м и 800 м, соответственно. Содержание золота варьируется в пределах 1-18 г/т. Естественное золото (частицы размером 2 мм) включается отдельным образом в свежем кварце с электрумами и, поэтому, считаются первичными. На данном участке продолжительность зоны минерализации сравнительно благородна, а содержание золота - высоко. Этот участок считается наиболее перспективным

в регионе и представляет необходимость продолжить разведку в западную и восточную стороны, а также вглубь.

2) По Артынсайскому району:

(1) Геология данного региона состоит из аспидного сланца, алеврита, песчаника, филлита ордовикского - силурского периодов и нижне-силурийских аспидного сланца, алеврита, песчаника и лампофирной дайки, которая проникла интрузией в первые породы. Месторождения в этом районе относятся к жильному - стоккцэркскому типам, которые состоят из жил кварца, ограниченных зоной трещин систем ЗСЗ-ВЮВ и СЗ-ВЮВ, и жил электрума и кварца в трещинах системы СЮ. До настоящего времени уточнено наличие более 20 зон минерализации, в т.ч. жил №1, 2, 5, 8, 9 и 10.

(2) В пределах участка длиной 2,5 и шириной 500-800 м, к которому относятся жилы №1, 2, 5, 8, 9 и 10, развиваются многочисленные трещины с образованием полос тонких жил электрума и кварца. С учетом того, что эти полосы тонких жил почти что полностью соответствует с пределами распространения зоны матричной породы из биотита, мусковита и роговика, также, исходя из результатов проведенной узбекской стороной аэромагнитной разведки, можно предполагать, что под этой полосой жил находятся стволы гранитов, расположенных по направлению ЗСЗ-ВЮВ.

(3) Кварцевые жилы, зарождающиеся в зоне трещин систем ЗСЗ-ВЮВ и СЗ-ЮВ, состоят из кварца, железного колчедана, маркадита, арсенопирита, халькопирита, сфалерита, гетита, лепидокрокита, а также из свинцового блеска, самородного висмута, айкинита, виттихенита, шеелита, рутила и электрума. Электрум, который в этот раз был уточнен в кварце, имел размер в 5-10 мкм и индивидуально суествовал с частичным парагенезисом в жилообразном расположении с халькопритом, самородным висмутом и виттихенитом. Электрум счелся первичным.

(4) В жилах электрума и кварца системы СЮ в основном содержатся кварц, электрум, железный колчедан и арсенопирит. Узбекская сторона сочла, что это является грейзеном электрума и в них содержатся вольфрамит, оловянный камень, топаз, берилл, самородное золото.

(5) Температура гомогенизации кварца составляет 250 - 350 град.С. Некоторые из рудных жил, идущих в направления ЗСЗ-ВЮВ и СЗ-ЮВ, представляют низкие температуры в пределах 110 - 200 град.С. Низкотемпературная группа, также как и район грубой разведки, является результатом воздействий вторичных жидкостных включений. Температура гомогенизации жилы элек-

трума и кварца в системе СЮ лежит в пределах 250 - 340 град. С и не представляет заметной разницы с рудными жилами, идущими в направления ЗСЗ-ВЮВ и СЗ-ЮВ.

(6) По результатам разбуривания скважин за текущий год был уточнен относительно благородный процесс минерализации (ширина 0,2-1 м, содержание золота 2-20 г/т) в жиле №5 и над жилой №1, а также здоровый процесс минерализации (ширина 1,6 м, содержание золота 15,3 г/т) под жилой №2 в скважине MJSN-8. Однако в скважинах MJSN-4, 5, 9 и 10 понизу рудного столба, уточненного в штреках жилы №1 (длина 135 м, средняя ширина 2,29 м, содержание золота 15,7 г/т) и жилы №2 (общая длина 55 м, средняя ширина 4,28 м, содержание золота 4,5 г/т) был найден только слабый процесс минерализации (содержание золота 4г/т). Причины этого, должны лежать в маломасштабном рудном теле и неравномерном содержании золота. С учетом результатов разведки в скважине MJSN-8, которые показывают благородный процесс на глубине 250 м под поверхностью грунта, уточнено, что процесс минерализации жилы №2 продолжается до довольно большой глубины.

В следующем приводим рекомендации на следующий год:

1) По Маурянскому району:

В результате изучения существующих материалов и геологической разведки, проведенных в текущем году, было выяснено, что данный участок с признаками полезных ископаемых имеет сравнительно благородную продолжительность зоны минерализации с высоким содержанием золота. Для того, чтобы уточнить состояние минерализации на глубинах рудного тела, найденного узбекской стороной в ходе траншейной разведки, рекомендуется провести разведку с разбуриванием скважин. Кроме того, на расстоянии 3 км в юго-восточную сторону от конца участка находится Бешбулакский участок, а на расстоянии 3 км в северо-восточную сторону - Таурянский. Рекомендуется в район исследования включить эти участки и провести георазведку.

2) Артынсайский район

(1) В текущем году в результате разведки с разбуриванием был найден благородный процесс минерализации на глубине 250 м под поверхностью грунта, а также была выяснена продолжительность процесса вниз. Для уточнения процесса минерализации в зоне западнее жилы №2 и под ней рекомендуется продолжить разведку с разбуриванием.

(2) С учетом того, что ещё не уточнена вертикальную продолжительность рудного столба (общая длина 135 м, средняя ширина 2,29 м, содержание золота 15,7 г/т) жилы №1, уточненной в шахтной разведке, рекомендуется провести разведку с разбуриванием.

(3) На глубинах под жилами №5, 6, 7, 11 и 12 южной зоны минерализации проведена только частичная разведка, однако возможно, что эти разломы на северном склоне достигают до глубин, зарождая там основное рудное тело, а также, что жилы №1 и 2 являются ветвящимися жилами такого рудного тела. Для уточнения процесса минерализации на глубинах рекомендуется провести разведку с разбуриванием.

(4) В результате разведки с разбуриванием, проведенной в текущем году, определено, что в полосе электрумо-кварцевых тонких жил системы СЮ имеет место содержание золота 0,3-1,0 г/т, а также 2-5 г/т в некоторых местах. На том участке, где содержание золота составляет более 1-1,5 г/т, возможно создать открытую карьеру. Рекомендуется провести разведку с разбуриванием под поверхностной полосой сосредоточения тонких жил.

Summary

This Report summarises results of the survey in Phase I (FY1997, the first fiscal year) implemented in the Southern Nuratau Area of the Republic of Uzbekistan, under the Technical Cooperation for the Mineral Exploration. The survey was intended to clarify geological conditions and occurrence of ore deposits in the subject area, to provide guiding principles for future exploration, to revalue the known ore deposits and also to draw mining plans, thereby assisting the host country in developing its mineral resources. The field survey was executed from August, 1997 through January, 1998.

During the Phase I survey, satellite image analysis, collection and analysis of existing geological data, and geological reconnaissance were executed, which covered the entire survey area of 2,000 km^2. In addition, detailed geological survey was carried out in the Altynsai District, as well as drilling survey (10 holes totaling 2,451.1 m) of the Altynsai deposit.

The survey findings of Phase I and recommendations for Phase II are summarized as follows:

1) The Entire Area of the Southern Nuratau

(1) The survey area is underlain by Lower Cambrian to Lower Silurian terrigenous sediments in the central to southern part, while in the northern part, mainly by Upper Silurian to Middle Carboniferous limestones. The rocks are intruded by Silurian to Triassic dikes and Carboniferous to Permian granites. 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 E-W direction.

(2) The satellite image produced on a basis of the LANDSAT TM data clearly reflects the geological units and tectonic structure, proving to be effective for the geologic interpretation in the survey area.

(3) Ore deposits and manifestations mainly of gold in the survey area occur along fracture zones in the WNW-ESE direction, forming the Karatau ore zone (70 km east to west and 2 km to 4 km from north to south) along the northern side of the Karatau granite bodies 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.

(4) 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 in

the detailed survey area. 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.

(5) At the Maulyan manifestation, independent gold grains, 2 mm in diameter, were observed in quartz, which was determined to be primary gold. Electrum confirmed by observation of polished section from the Bitab manifestation is associated with pyrite and manganese oxide in cracks of quartz, which has possibly be generated by the secondary enrichment.

(6) Homogenization temperature of fuild inclusions of quartz ranges between 140℃ and 340℃, which is divided into a relatively low temperature group (140℃ to 170℃) and a high temperature group (270℃ to 340℃). In view of the mode of occurrence, the low temperature group is inferred to indicate that of secondary fluid inclusions originated in hydrothermal solution of a later stage which was trapped in the cracks of quartz. Quartz of Kurai, Sebistan and Sartakchi fall within the low temperature group whilst the high temperature group includes Karamechet, Maulyan, Taulyan and Lyangar.

(7) In the Maulyan manifestation, gold mineralization accompanies quartz veins and silicified veins along about 10 of fracture or silicified zones in the WNW-ESE direction. Three ore bodies, 1 m to 4 m wide and 150 m, 200 m and 800 m long, have been ascertained up to now. Their gold grade varies from 1 g/t to 18 g/t. The manifestation has relatively good continuity of mineralization zones and high gold grade. The east and west extensions and the lower portion of the ore bodies are worthy of exploration; the Maulyan manifestation is considered to be most promising of all in the general survey area.

2) Altynsai District

(1) The area is underlain by the Ordovician-Silurian slate, siltstone, sandstone and phyllite, as well as lower Silurian slate, siltstone and sandstone, intruded by lamprophyre dikes during late Permian to early Triassic times in the vicinity of the No.10 vein ("Berkut Vein") in the west. Ore deposits in the District are either gold-bearing quartz veins controlled by fracture zones with the WNW-ESE and NW-SE trends, or vein-type deposits composed of tourmaline-quartz veins which accompanies joints with the N-S trend. More than 20 ore zones have been ascertained, which include the veins Nos. 1, 2, 5, 8, 9 and 10.

(2) In an area, 2.5 km long and 500 m to 800 m wide, that embraces the veins Nos. 1, 2, 5, 8 and 10, inumerable joints with the N-S trend develop, forming tourmaline-quartz veinlet zones. In view of the fact that the veinlet zones almost conincide with the areas of occurrence of biotite-muscovite hornfels as the host rocks and of the Uzbek airborne magnetic survey findings, it is inferred that granite stocks extist aligned in the WNW-ESE direction beneath the veinlet zones.

(3) Component minerals of the quartz veins that occur in fractures zones 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, rutile and electrum. Electrum, 5-10 μm in grain size, observed in polished sections in the subject survey occurs in quartz, associated with chalcopyrite, native bismuth and wittichenite in a vein-like alignment but exists independently, which was determined to be primary electrum.

(4) The tourmaline-quartz veins with the N-S trend are composed mainly of quartz, tourmaline, pyrite, arsenopyrite. The Uzbek study indicates inclusion of wolframite, cassiterite, topaz, beryl and native gold. The veins are considered to be tourmaline greisen-type.

(5) Homogenization temperature of fluid inclusions of quartz is generally 250℃ to 350℃, while some of the veins in the WNW-ESE and NW-SE direction showed the low teperature from 110℃ to 200℃. The low homogenization temperature of fluid inclusions is inferred to indicate that of secondary fluid inclusions, as well as in the general survey area. Homogenization temperature of tourmaline-quartz veins with the N-S trend being 250℃ to 340℃, which makes no significant difference from that of the veins with WNW-ESE and NW-SE directions.

(6) The Phase I drilling survey discovered relatively rich mineralization (true width 0.2 m to 1 m; Au 2 g/t to 20 g/t) on the hanging side of No.1 vein and in No.5 vein, while dominant mineralization (true width 1.6 m; Au 15.3 g/t) was confirmed by the drilling MJSN-8 in the lower portion of No.2 vein. The MJSN-4, -5, 9 and -10, aimed at portions beneath the bonanzas confirmed by the drift at No. 1 vein (extension 135 m; average width 2.29 m; Au 15.7 g/t) and the drift at No. 2 vein (extension 55 m, average width 4.28 m; Au 4.5 g/t), however, only encountered low-grade mineralization (Au 4 g/t or less). This is due presumably to the ore bodies being small in size and ununiform in grade distribution. The MJSN-8 captured good mineralization 250 m under the surface, which confirmed that the mineralization of No.2 vein continuous fairly into the deep.

Recommendations for Phase II are summed up in the following paragraphs:

1) Maulyan District

The analysis of existing data and geological surveys conducted during Phase I indicated that the Maulyan manifestation has relatively good continuity of mineralization zones and high gold grade. It is advisable to execute drilling survey, in order to clarify mineralization in the deep portions of the ore bodies confirmed by the Uzbek trenching survey. It is also advisable to execute detailed geological survey in the Maulyan district, including adjacent ore manifestations such as Taulyan and Beshbulak.

2) Altynsai District

(1) The Phase I drilling survey caught good mineralization 250 m under the surface, which indicates continuation of the mineralization into the deep; it is advisable to continue the drilling survey to verify mineralization in the western extension and deeper portion of the No. 2 vein.

(2) As the downward extension of the bonanza of the No.1 vein (extension 135 m; average width 2.29 m; Au 15.7 g/t), which was discovered at the drift, remains to be investigated; it is advisable to explore the portion by drilling survey.

(3) The lower portions of the veins Nos. 5, 6, 7, 11, 12, etc. in the southern ore zone remain almost unexplored, except the portions surveyed by drilling in Phase I. It is likely that the fractures dipping north continue to the deep as far as granite body, bearing major ore bodies and that the No.1 and No. 2 veins are its branch veins. In order to verify mineralization in the deep, it is advisable to carry out drilling survey.

(4) As the result of the Phase I drilling, gold grades in the tourmaline-quartz veinlet zones with the N-S trend were 0.3 g/t to 1 g/t, partially 2 g/t to 5 g/t. Zones where veinlets concentrate in stockworks and gold grades 1 - 1.5 g/t or higher can posssibly be open-pitted. It is advisable to explore the lower portions of the veinlet concentration zones by drilling survey.

CONTENTS

PART I GENERALITIES

PART II PARTICULARS

PART III CONCLUSIONS AND RECOMMENDATIONS

LIST OF FIGURES

LIST OF TABLES

LIST OF PLATES

APPENDICES

PART I GENERALITIES

Chapter 1 Introduction

1-1 Antecedents of the Survey

The subject survey of mineral resources in the Southern Nuratau Area of the Republic of Uzbekistan was conducted by the Japanese Government to comply with the request of the Uzbek Government, in conformity to the Scope of Work agreed to between the two governments on June 14, 1997.

The survey was intended to clarify the geological conditions and mineral resources in the mentioned area, to provide the guiding principles for future exploration and to revaluate the known ore deposits, thereby assisting development of the mineral industry of the host country. It was also aimed to promote technology transfer to the host nation's organizations concerned through the collaborative survey.

1-2 Outline of the Phase I Survey

1-2-1 Survey area

The Southern Nuratau Area is located some 330 km southwest of Tashkent, the capital of the Reublic, and some 100km west-northwest of Samarkand, the ancient capital(Fig. I-1). Topographically, the area consists of the northern moutainous zone(alt. 1,000 - 2,000 m above sea level) and the southern hilly zone(alt. 600 - 900 m).

1-2-2 Purpose of the survey

During the Phase I survey, satellite image analysis, collection and analysis of existing geological data, and general geological survey were executed, which covered the entire survey area of 2,000 km^2. In addition, detailed geological survey was performed in the Altynsai District (5 km^2), as well as drilling survey of the Altynsai deposit (10 holes totaling 2,451.1 m).

The following were purposes of the survey:

1) To conduct photogeologic interpretation of a satellite image for clarification of geologic structure and lithofacies of the whole area; to extract alteration zones accompanying mineralization from a spectral analysis image; and, to draw a base map of the survey area for evaluation of regional potentials.
2) To outline ore deposits and manifestations and grasp occurrence of the deposits, by means of collection, sorting and analysis of existing geological data and information, in quest of exploration themes.
3) To conduct regional reconnaissance, as well as detailed geological survey of the Altynsai District, in order to grasp relationship of geology and geologic structure to mineralization in the district.
4) To execute drilling survey at the Altynsai District, collect samples and confirm ore

reserves, thereby ascertaining and describing stratigraphy and occurrence of the ore deposit.

1-2-3 Methods of the survey

1) Satellite image analysis

Using the LANDSAT data and selecting the band combination best fit for geologic interpretation, a false color image of the suject area was produced on a scale of 1:200,000 for interpretation of the geologic units and geologic structure. Based on the interpretation, a geologic interpretation map and a lineament analysis map, both in 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.

The data processing and analysis work were carried out in Japan.

2) Analysis of existing data

Existing data and information on the geology and ore deposits were collected at the State Committee of Geology and Mineral Reserves in Tashkent, the Samarkandgeology in Samarkand and at the Zarafshan Expedition.

3) Geological survey

General survey and detailed survey of the Altynsai District, in the quantities indicated in Table I-1-1 were conducted. The base camp for the survey was placed at a hotel in Milbazar.

The general survey included elaboration of a route map utilizing the existing 1:25,000 topography map. Outcrops of particular importance were sketched on 1:100 - 1: 200 scale and photographed in color. Survey findings were incorporated in the 1:50,000 geological map.

In the detailed geological survey, a route map was elaborated on a basis of a 1:2,500 topography map that was enlarged from the 1:5,000 map furnished by the Altynkazgan Geological Party. Outcrops of particular importance were sketched on a 1:100 - 1:200 scale and photographed in color. Survey findings were incorporated in the geological maps(1:2,500 and 1:10,000).

Simultaneously with the geological survey, sampling of various types in the quantities indicated in Appendix 2-1 was carried out.

4) Drilling survey

Drilling survey in the Altynsai District, in the quantities indicated in Table I-1-1 were conducted. The drilling work was undertaken by an appointed local drilling contractor.

After core identification and phtographing, the split cores were collected, of which various types of sampling, in the quantities indicated in Appendix 2-1, and laboratory tests were made. Results of core identification are indicated in the geologic core logs (Appendix 1).

1-2-4 Organization of the survey team

1) Planning and negotiation

Japan		Uzbekistan	
Name	Entity	Name	Entity
Takafumi Tsujimoto (Leader)	MMAJ	A.Abdurakhmanov	SCG
Taro Kamiya (Survey Planning)	JICA	A.L.Ogarkov	〃
Satoshi Yamaguchi (Geology)	MMAJ	G.E.Kamagurov	〃
		A.T.Zakirov	〃

2) Survey team

Japan		Uzbekistan	
Name	Entity	Name	Entity
Katsuji Fukumoto (Leader)	MINDECO	A.Abdurakhmanov (Coodinator)	SCG
Haruo Harada (Geologist)	〃	G.E.Kamagurov (Coodinator)	〃
Kiyohisa Shibata (Geologist)	〃	A.T.Zakirov (Coodinator)	〃
Tsutomu Aoyama (Drilling Engineer)	〃	A.L.Ogarkov (Geologist)	〃
		N.E.Kozarez (Geologist)	〃
		Xamidoraev (Geologist)	SKG
		V.A.Shebchenko (Geologist)	AG
		Lev.A.Sim (Geophysist)	SCG
		N.Akhmedov (Coodinator)	SKG
		M.B.Karimov (Coodinator)	ZE
		Zalyotov (Drilling Engineer)	SKG
		Abdumutalov (Drilling Engineer)	ZE

3) Field inspection

Masaomi Kurihara MMAJ

JICA :	Japan International Cooperation Agency
MMAJ :	Metal Mining Agency of Japan
SCG :	State Committee of Geology and Mineral Reseves
SKG :	Samarkandgeology
ZE :	Zarafshan Expedition
AG:	Altynkazgan Geological Party
MINDECO :	Mitsui Mineral Development Engineering Co., Ltd.

1-2-5 Period of the survey

	1997					1998	
	Aug.	Sept.	Oct.	Nov.	Dec.	Jan.	Feb.
Planning, Preparation	—16						
Field survey	17—	—	—	—	—	—23	
Tests and analysis				—	—	—	—15
Compilation of report					—	—	—

Table I-1-1 Outline of the Survey

Items	Quantity			
Satellite image analysis	Analyzed area ; 2,000 km^2			
Geological survey (general survey area)	Survey area ; 2,000 km^2 Length of route ; 584 km			
(detailed survey area)	Survey area ; 5 km^2 Length of route ; 22 km			
Drilling survey (Altynsai deposit)	Hole No.	Length	Dip	Direction
	MJSN-1	190.0m	-75°	N 10° E
	MJSN-2	160.1m	-75°	S 10° W
	MJSN-3	341.4m	-75°	N 10° E
	MJSN-4	320.0m	-75°	N 10° E
	MJSN-5	320.0m	-75°	N 10° E
	MJSN-6	173.0m	-75°	N 10° E
	MJSN-7	191.1m	-75°	N 10° E
	MJSN-8	335.5m	-80°	N 10° E
	MJSN-9	200.0m	-75°	N 10° E
	MJSN-10	220.0m		
	Total 10 holes	Total length 2,451.1m		

Chapter 2 Geography of the Survey Area

2-1 Location and Access

The survey area is situated about 330 km southwest of Tashkent, the capital city, and about 100 km west-northwest of Samarkand, the ancient capital. The area spreads over the Navoi Region and the Samarkand Region and can be reached by car from Tashkent via Samarkand. From Tashkent to Samrkand, east of the survey area, it takes about 4.5 hours(380 km), and about 2.0 more hours(155 km) from Samarkand to the Altynsai deposit, where the Altynkazgan Geological Party of the Zarafshan Expedition has installed its base.(Fig. 1-1) The roads are paved, except for some 5 km near Altynsai.

2-2 Topography and Drainage Systems

In the north of the survey area, lie the Aktau Range consisting of ranges of 1,000 - 2,000 m in altitude, which forms the western edge of the Southern Tien-Shan Mountains. The steep mountain country extends in the WNW-ESE direction. Southern part of the survey area, which corresponds to the foothills of the Aktau Range, has gently undulating topography between 600 m and 900m in altitude. In the southwest, the Karatau Mountains spread in the WNW-ESE direction, whose altitute ranges from 600 m to 1,200 m.

During the dry summer seansons, permanent water flow can be seen only in large streams in the area, while 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 direction.

2-3 Climate and Vegetation

The area has a typically continental dry climate, characterized by dry hot summer and cold winter. The average monthly temperature drops to the lowest in January(min. –20℃) and rises to the highest in July(max. +40℃).

The precipitation is high in winter and spring. The annual total precipitation ranges from 300 mm to 350 mm. The spring precipitaion accounts for 30% of the annual total.

Excepting in large river basins, vegetation is scanty due to the desert climate; therefore, the area assumes an outlook of rock desert.

Along large rivers with constant stream, vegetations such as poplar, willow, mulberry and some fruit trees are seen, as well as shrubs. Grass and shrubs can be seen all over the area, which however wither away until July except along some streams. The area is inhabited by some animals, though small in number, such as rats, squirrels, foxes and wolves, as well as some birds and reptiles including snakes, lizards and tortoises.

Chapter 3 General Geology

The survey area is underlain by the basement rocks consisting of Paleozoic sedimentary rocks and granitoids and by the blanket beds consisting of sediments of the Senonian Stage of Upper Cretaceous to Quaternary Systems (Fig. I-3-1 and PL. II-2-2-1). The subject area pertains to the Zarafshan-Turkestan Zone of the Southern Tien-Shan Geological Tectonic Zone; the regional tectonic structure of the basement rocks represents the WNW-ESE trend (Fig. I-3-2).

The sedimentary rocks which constitute the basement are classified into 13 formations of lower Cambrian to middle Carboniferous ages(Fig. I-3-3) and these formations lie mainly in fault contact with each other. These formations occur in belts with the WNW-ESE trend along the extension of the Aktau Range and the Karatau Mountains, accompanied by remarkable folding. The middle Carboniferous-early Permian Aktau granitoids, as well as the early Permian Karatau granite, intrude into the sedimentary rocks, forming the main bodies of the Aktau Range and of the Karatau Mountains, respectively. Igneous rocks include, besides the granitoids, Silurian-Triassic lamprophyre, diorite and gabbro dikes.

The lower Cambrian to upper Silurian beds, composed of thick terrigenous sediments, mainly slate and sandstone, are widespread in the Karatau Mountains and also in the Aktau Range east of the survey area. The upper Silurian to middle Devonian beds are mainly of thick limestone. In the west of the survey area, they occur in the Aktau Mountains while, in the east of the area, along the anticlinorium south of the Aktau Mountains. The middle Carboniferous beds, mainly of conglomerates and coarse-grained sandstone, occur in small blocks aligned in the WNW-ESE direction, in the northwest of the survey area.

Sediments which form the blanket beds occur with very gentle inclination chiefly in the flatlands north of the Aktau Mountains and south of the Karatau Mountains. The Senonian Stage of Upper Cretaceous System and the Eocene Series of the Paleogene System are composed of neritic sediments, mainly marl, siltstone, limestone, sandstone and coquinite. The Neogene Series 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.

Ore deposits and manifestations in the area are mainly gold-silver vein type, originated in Silurian to Triassic dikes and Carboniferous to Permian granites.

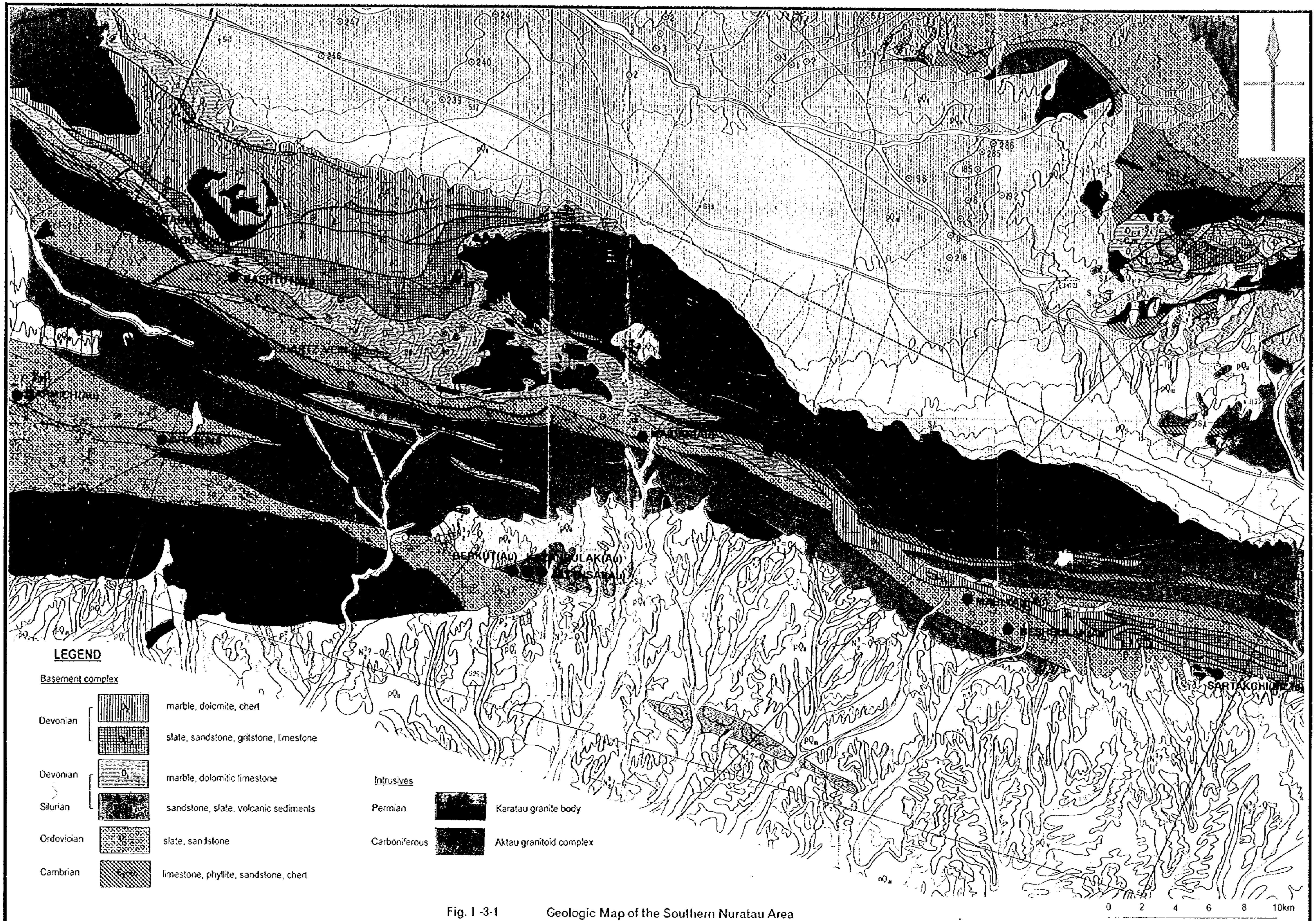


Fig. I -3-1 Geologic Map of the Southern Nuratau Area

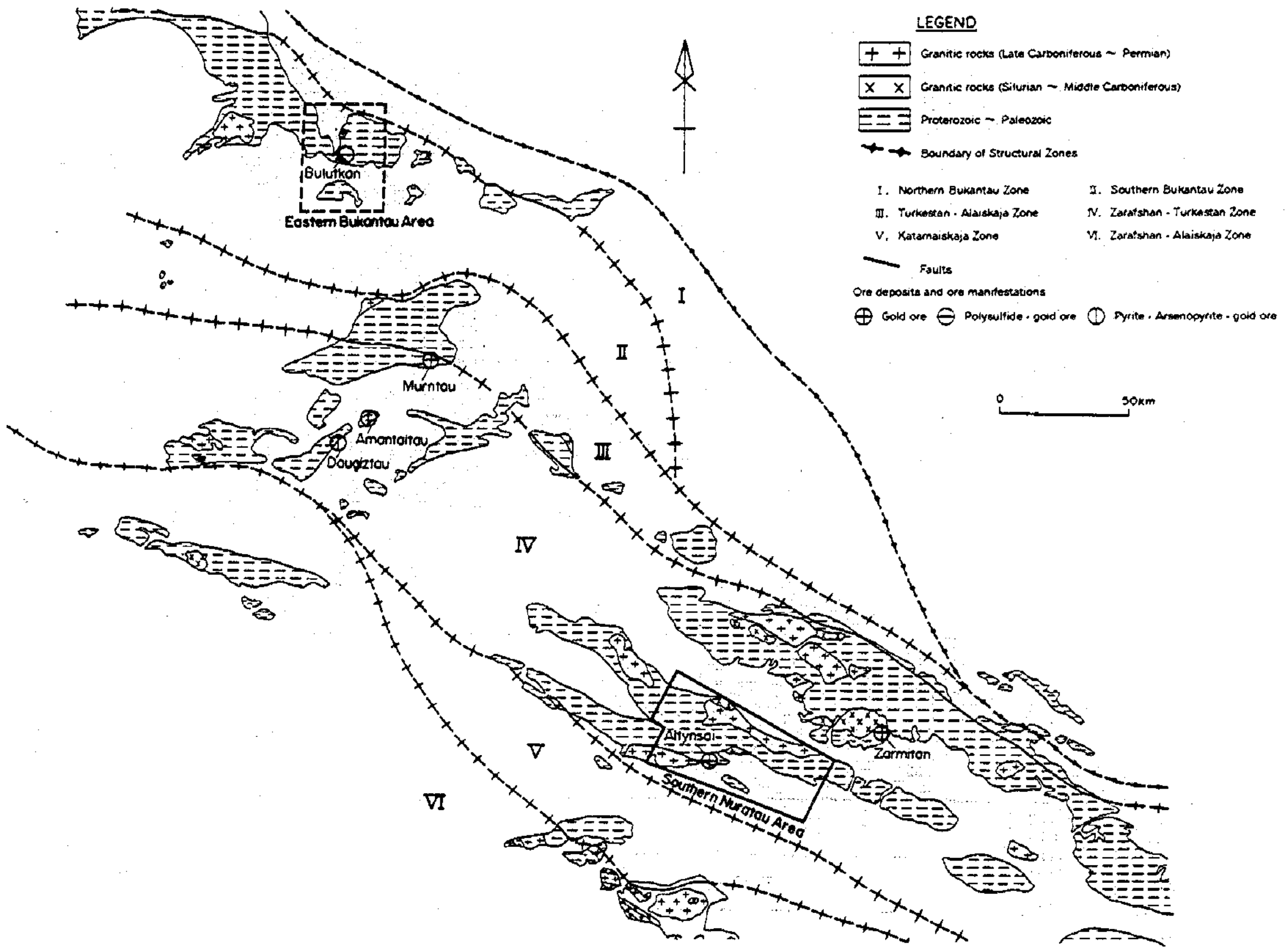
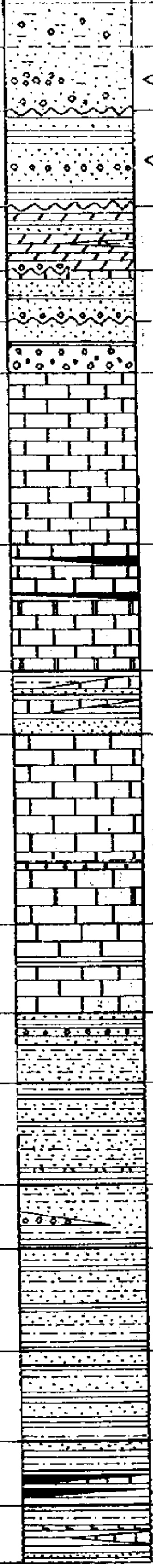


Fig. I -3-2 Structural Zones of the Western Uzbekistan



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

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

Chapter 4 Overall Review of Survey Findings

4-1 Relationship of Geology and Geologic Structure with Mineralization

The Paleozoic Erathem in the subject area is folded around an axis in the WNW-ESE direction, same as that of the extension of the Aktau Range in the north and of the Karatau Mountains in the south, and cut by fractures in almost the same directions, forming structural blocks which extend in the same direction as that of the fold structure. These blocks are further divided by fractures in the NE-SW direction into sub-blocks. The mentioned structure is considered to have been formed by the late Paleozoic Hercynian orogeny and perhaps by the early Paleozoic Caledonian orogeny.

Ore deposits and manifestations mainly of gold in the area spreading along the fracture zones in the WNW-ESE direction constitute 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 body (270-274 Ma) and the Aktau ore zone (70 km east to west and 2 km to 5 km north to south) which is located north of the Karatau ore zone and extends along the southern side of the Aktau granite body (295-322 Ma, 260-286 Ma and 265-268 Ma).

These ore zones occur chiefly in fracture zones which cut Paleozoic sandstone and slate. Fracture zones in the ore zones are intruded by Silurian rocks (diorite and porphyrite), early Pre-Permian rocks (granite porphyry) and late Permian to early Triassic rocks (lamprophyre and porphyrite). Inside fracture zones, fractures develop in various directions, of which those in the WNW-ESE direction (290° to 310°) are predominant, followed by those in the E-W (260° to 280°) and NE-SW (30° to 60°) directions. Fractures in the NE-SW direction are of later ages and cut fracture zones in the WNW-ESE direction to form blocks.

Along respective fracture zones, intensive hydrothermal activity is recognized, where quartz veins, stockwork zones and vein-like silicified zones are observed. Accompanying the hydrothermal activity, mineralization, mainly of gold, accompanied by silver, arsenic, bismuth, lead and copper occurs. Occurrence of major mineralization is controlled by geologic structure; bonanzas are presumably formed at intersections of fractures in diferent directions, especially where fractures in the WNW-ESE direction intersect those in the NE-SW direction.

The Karatau ore zone embraces ore deposits and manifestations of gold-silver bearing quartz vein type such as Subashi-Sarmich ore deposits, Biran deposit, -- these deposits are located out of the survey area --, Karamechet-Kurai manifestations and Altynsai deposit.

Those pertaining to the Aktau ore zone are gold-silver bearing quartz vein-type manifestations such as Bitab, Bashmet, Maulyan and Taulyan, as well as the Akmulla iron-manganese manifestation.

Besides, there are pneumatolytic deposits formed in granite bodies such as the Sartakchi niobium-tantalum manifestation and the Lyangar skarn-type tungsten-molybdenum deposit which is related with the Aktau granites.

Sedimentary rocks and metamorphic rocks in the Altynsai District, the area of detailed survey, are folded in anticline and sincline incline in the WNW-ESE direction, where many fracture zones in the WNW-ESE and NW-SE direction and numerous joints in the N-S direction develop. Ore deposits in the District are characterized by gold-bearing quartz veins controlled by fracture zones in the WNW-ESE and NW-SE directions and tourmaline-quartz veins accompanying joints with the N-S trend. More than 20 ore zones have been ascertained, which include the veins Nos. 1, 2, 5, 8 ("Northwest Vein"), 9 ("Kazanbulak Vein") and 10 ("Berkut Vein").

The major veins Nos. 1, 2 and 8 in the northern ore zone occur in fracture zones trending in the WNW-ESE direction and dipping 45° to 70° southward, whereas the veins Nos. 5, 6, 7, 10, 11, 12, etc. in the southern ore zone occur in fracture zones trending in the same direction but dipping 70° to 80° northward. Only the No. 9 vein occurs in fracture zones in the NW-SE direction, dipping northeastward.

Inumerable joints trending in the N-S direction and dipping 45° to 80° westward develop in an area, 2.5 km long and 500 m to 800 m wide, which embraces the Nos, 1, 2, 5, 8 and 10 veins. In these joints, tourmaline-quartz veinlets, 0.1 cm to 25 cm wide, occur (Figs. II-3-3-1 and -2). The veinlet zones almost coincide with the area of occurrence of biotite-muscovite hornfels zones. From the anomalies (20-60 gamma) detected by the Uzbek airborne magnetic survey, it is inferred that granite stocks exist aligned in the WNW-ESE direction under the veinlet zone. The veinlet zones are considered to be tourmaline greisen formed by "pneumatolysis" of granites in cross joints formed by upward intrusion of the granite stocks.

The mentioned quartz veins and tourmaline-quartz veins increase in number and width more in sandstone than in slate, forming higher grade ore body.

4-2 Characteristics of Mineralization

Component minerals of the gold-bearing quartz veins in the District are quartz, pyrite, marcasite, arsenopyrite, chalcopyrite, sphalerite, goethite and lepidochrocite, accompanied by small quantities of galena, native bismuth, aikinite, wittichenite, scheelite, rutyle and electrum. The veins in the Altynsai deposit include more sulfide minerals such as marcasite, arsenopyrite, chalcopyrite and sphalerite than those in the other manifestations, and also include bismuth minerals.

The tourmaline-quartz veins with the N-S trend in the Altynsai deposit include mainly quartz, tourmaline, pyrite and arsenopyrite. While the Uzbek study indicates that wolframite, cassiterite, topaz, beryl and native gold are included, it was not verified in the subject year's survey.

It was in the Altynsai deposit, Maulyan and Taulyan manifestations that gold was macroscopically or microscopically observed. Electrum in the Altynsai District is 5-10μm in grain size and occurs in quartz, associated with chalcopyrite, native bismuth and wittichenite in vein-like alignment but is independently existing without contact with the other minerals, which is considered to be primary electrum. In Maulyan, independent gold grains, 2 mm in dia., are observed in quartz, which are also considered primary. Electrum confirmed by observation of polished sections from the Bitab manifestation is associated with pyrite and manganese oxide in cracks of quartz, which is likely to have been yielded 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.

Host rocks are altered by silicification, pyritization and tourmalinization. Alteration zones are mainly quartz-sericite zones or sericite-chlorite zones, acompanied by kaolinite in small quantities.

In the subject year's survey, homogenization temperature of fluid inclusions was measured of 30 samples from the general survey area, 50 samples from the detailed survey area and 20 drilling samples (Appendix 2-8). The samples used are vein, veinlet or stockwork quartz and silicified rocks.

The fluid inclusions are with vapor-liquid plase, while only one fluid inclusion (B10-1) containing solid (NaCl).

Homegenization temperature of fluid inclusions of quartz from repsective ore deposits and manifestations range between 110℃ to 350℃, which can be classified into the relatively low temperature group (110℃ to 200℃) and the high temperature group (250℃ to 350℃). In the general survey area, euhedral or semi-euhedral drusey quartz of Kurai, Sebistan and Sartakchi showed low temperatures, while those of the high temperature group are milky white-colored quartz veins of Karamechet, Maulyan, Taulyan and Lyangar. While the homogenization temperature of ores of the Altynsai deposit is 250℃ to 350℃, some of veins in the WNW-ESE and NW-SE directions indicate 110℃ to 200℃. Homogenization temperature of the tourmaline-quartz veins is 250℃ to 340℃. In view of the mode of occurrence, the low temperature group is inferred to indicate that of secondary fluid inclusions originated in hydrothermal solution of a later stage which was trapped in the cracks of quartz. Quartz samples which are of high homogenization temperature of fluid inclusions (309.7℃ in average of 40 pieces) averaged 3.09 g/t Au, while those of low temperature (182.4°C in average of 18 pieces) averaged 0.43 g/t Au. It was because five pieces of high grade ore from the drift at the No.1 vein of Altynsai deposit were included in the higher temperature samples that high temperature quartz showed higher gold grade. When the high grade ore samples are excepted, both groups are of similar grades, showing no significant difference.

4-3 Potentialities of Existence of Ore Deposits

Based on the analysis of existing data during the subject year's survey, ore deposits and manifestations in the survey area are classified into the six categories which follow:

① Gold-silver bearing quartz vein
② Tungsten-molybdenum skarn
③ Tungsten-copper skarn
④ Tantalum-niobium pneumatolytic deposit
⑤ Tin placer deposit
⑥ Iron-manganese hydroxide deposit

In terms of the size and grade of ore deposit, worthy of future exploration are the Maulyan manifestation and the Altynsai deposit, which fall within the category ① of gold-silver bearing quartz vein.

1) Maulyan manifestation

In the manifestation, some 10 of fracture-silicification zones in the WNW-ESE direction, 1m to 20-30 m wide, have been confirmed by trenching. Quartz veins and silicified veins along these fracture zones are accompanied by gold mineralization. The native gold, 2 mm in diameter, confirmed macroscopically during the survey, is included in fresh quartz accompanied by tourmaline, which is considered to be primary. The highest grades obtained at the Uzbek trenches K-3 and K-7 are Au 17.8 g/t, Ag 8.6 g/t (width 2.4 m) and Au 11.0 g/t, Ag 1.4 g/t (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. Homogenization temperature of a quartz sample showed 328°C, which is relatively high for a gold vein. 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. Therefore, the Maulyan manifestation is considered most promising of all in the general survey area.

2) Altynsai District

Ore deposits in the District are gold bearing quartz veins controlled by fracture zones with the WNW-ESE and NW-SE trends and tourmaline-quartz veins accompanying joints with the N-S trend. More than 20 ore zones have been ascertained, which include the veins Nos. 1, 2, 5, 8 ("Northwest Vein"), 9 ("Kazanbulak Vein") and 10 ("Berkut Vein"). The area of mineralization spreads 4 km from east to west and 2 km from north to south.

The drilling survey in the subject year discovered relatively strong mineralization on the hanging side of No.1 vein and in No.5 vein, while dominant mineralization (true width 1.6 m; Au 15.3 g/t) was confirmed by the drilling MJSN-8 in the lower portion of No.2 vein. The MJSN-4, -5, 9 and -10, aimed at portions beneath the drifts at Nos. 1 and 2 veins where high-grade ore zones had been discovered, however, only encountered low-grade mineralization. This is due presumably to the ore bodies being small in size and ununiform in grade distribution. The MJSN-8 captured good mineralization 250 m under the surface, which confirmed that the mineralization of No.2 vein continues fairly to the deep. At the Sarmich gold-silver vein-type deposit with a proven gold reserve of 26 tons, located some 50 km west in the same Karatau ore zone, it has been confirmed by drilling and tunneling that ore bodies continue up to 400 m under the surface. Ore bodies continue up to 700 m under the surface also at the Zarmitan vein-type gold deposit 60km northeast of the Altynsai deposit. Therefore, it can be expected that the Altynsai ore bodies should further continue toward the deep.

On the other hand, lower portions of the veins Nos. 5, 6, 7, 11, 12, etc, in the southern ore zone remain little explored, except the subject year's drilling MJSN-4 and -5 aimed at the No.5 vein and MJSN-2 at the No.11 vein. As fracture zones in the WNW-ESE direction, which control these veins, dip 70 to 80northward, they ought to intersect the No.1 and No. 2 veins dipping south in the deep. Which of these, after the intersection, continue up to a greater depth remains unclarified. It is likely, however, that the fracture zones dipping north continue to the deep as far as granite body and bear major ore bodies, and that the No.1 and No. 2 veins are their branch veins.

Tourmaline-quartz veinlet zones occur in an area, 2.5 km long and 500 m to 800 m wide, that embraces veins Nos.1, 2, 5, 8 and 10. The subject year's drilling results indicate that gold grade of the area is 0.3 g/t to 1.0 g/t, partially 2 - 5 g/t. Where veinlets are concentrated and gold grade is higher than 1 - 1.5 g/t, there remains certain possibility of open-pit mining.

Table I-4-1 Correlations among 4 Elements in Ore Samples

General Survey Area (105 samples)

	Au	Ag	As	W
Au	1.00	0.49	-0.03	-0.03
Ag		1.00	-0.03	-0.03
As			1.00	-0.01
W				1.00

Detailed Survey Area (1,331 samples)

	Au	Ag	As	W
Au	1.00	0.70	0.05	0.01
Ag		1.00	0.09	-0.01
As			1.00	0.07
W				1.00

Total samples (1,436 samples)

	Au	Ag	As	W
Au	1.00	0.69	0.01	0.01
Ag		1.00	0.02	-0.01
As			1.00	0.00
W				1.00

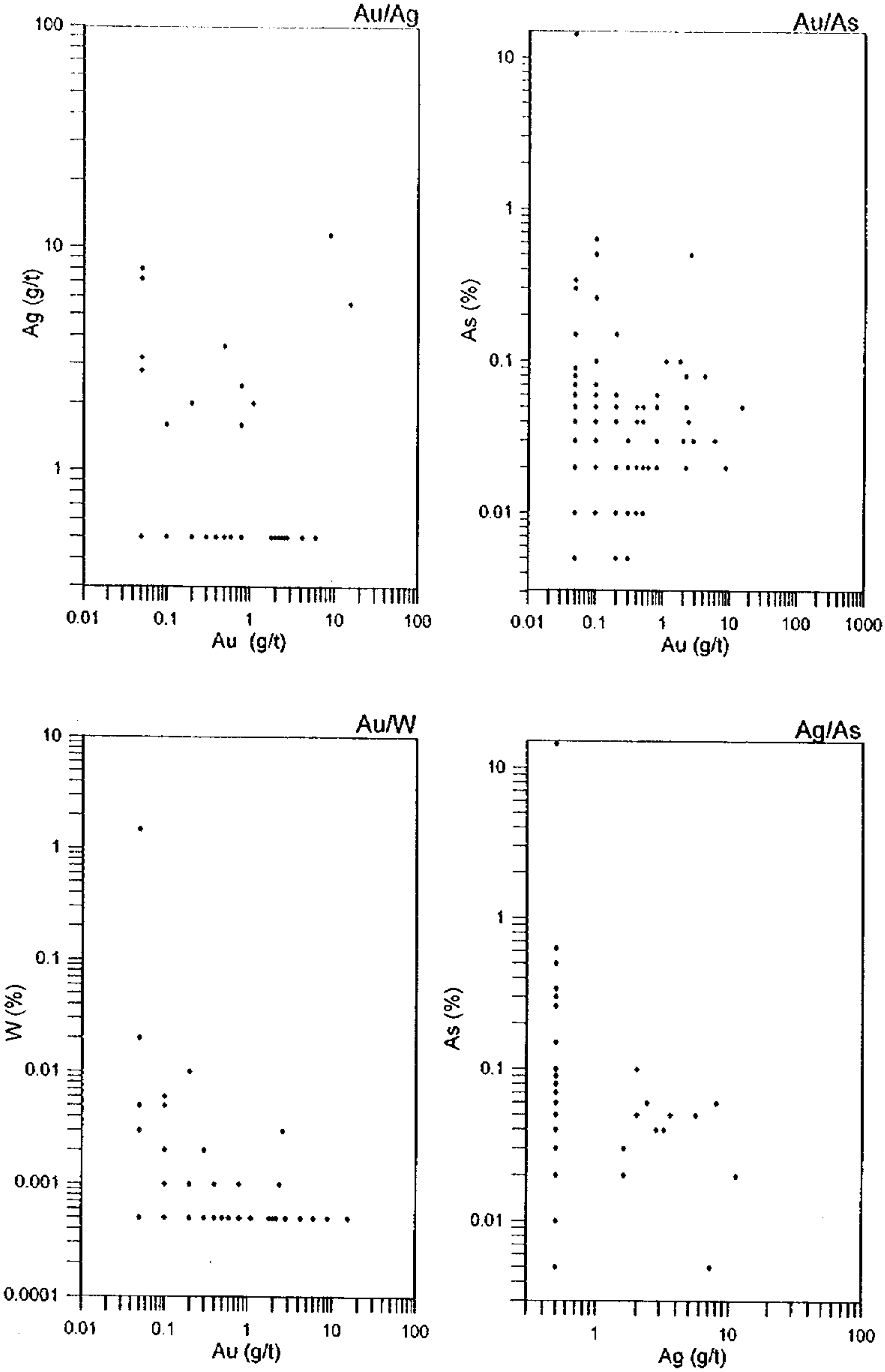


Fig.I-4-1 Scatter Plots (logarithmic) for Ore Samples in the General Survey Area

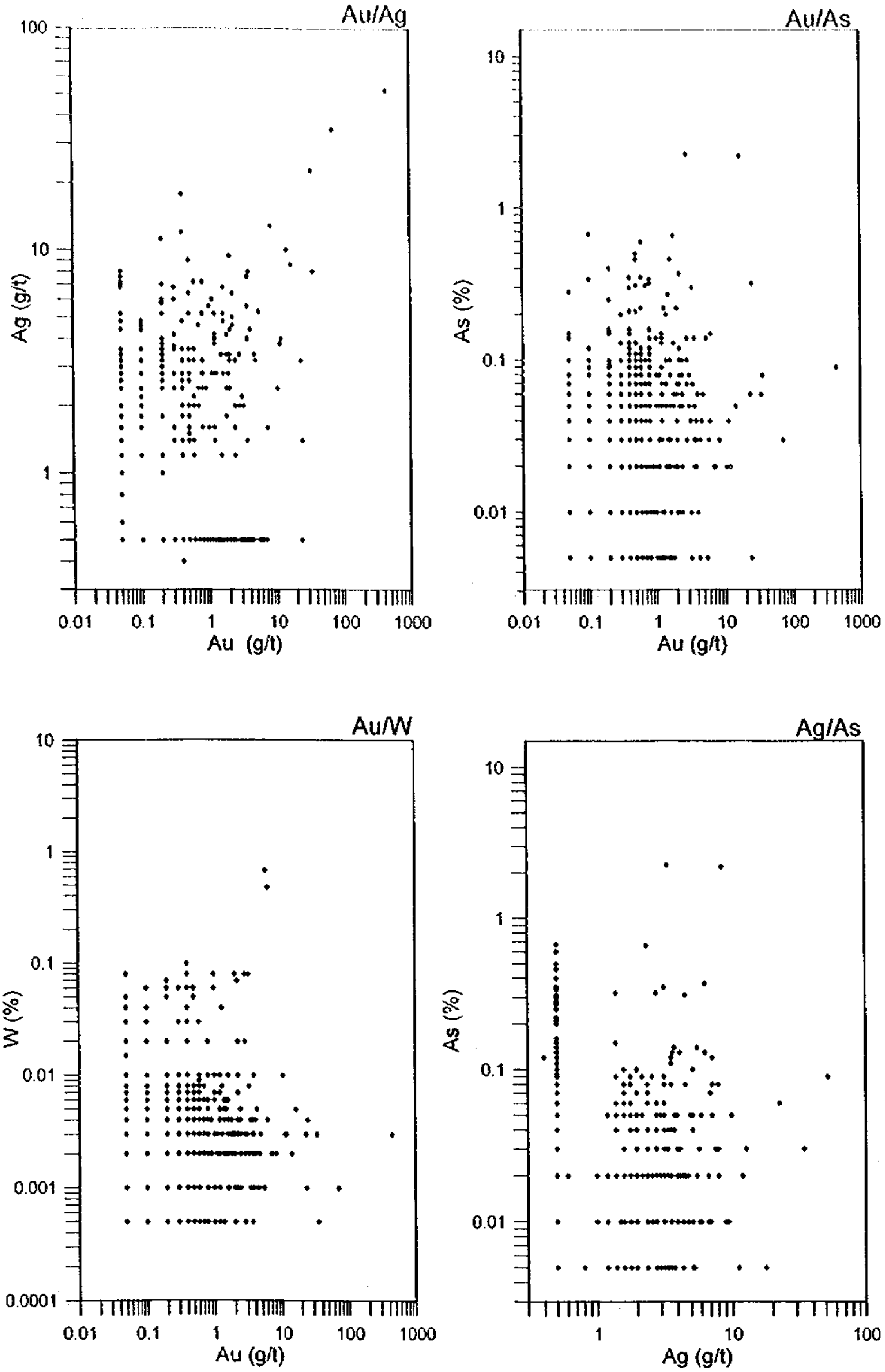


Fig.I-4-2 Scatter Plots (logarithmic) for Ore Samples in the Detailed Survey Area

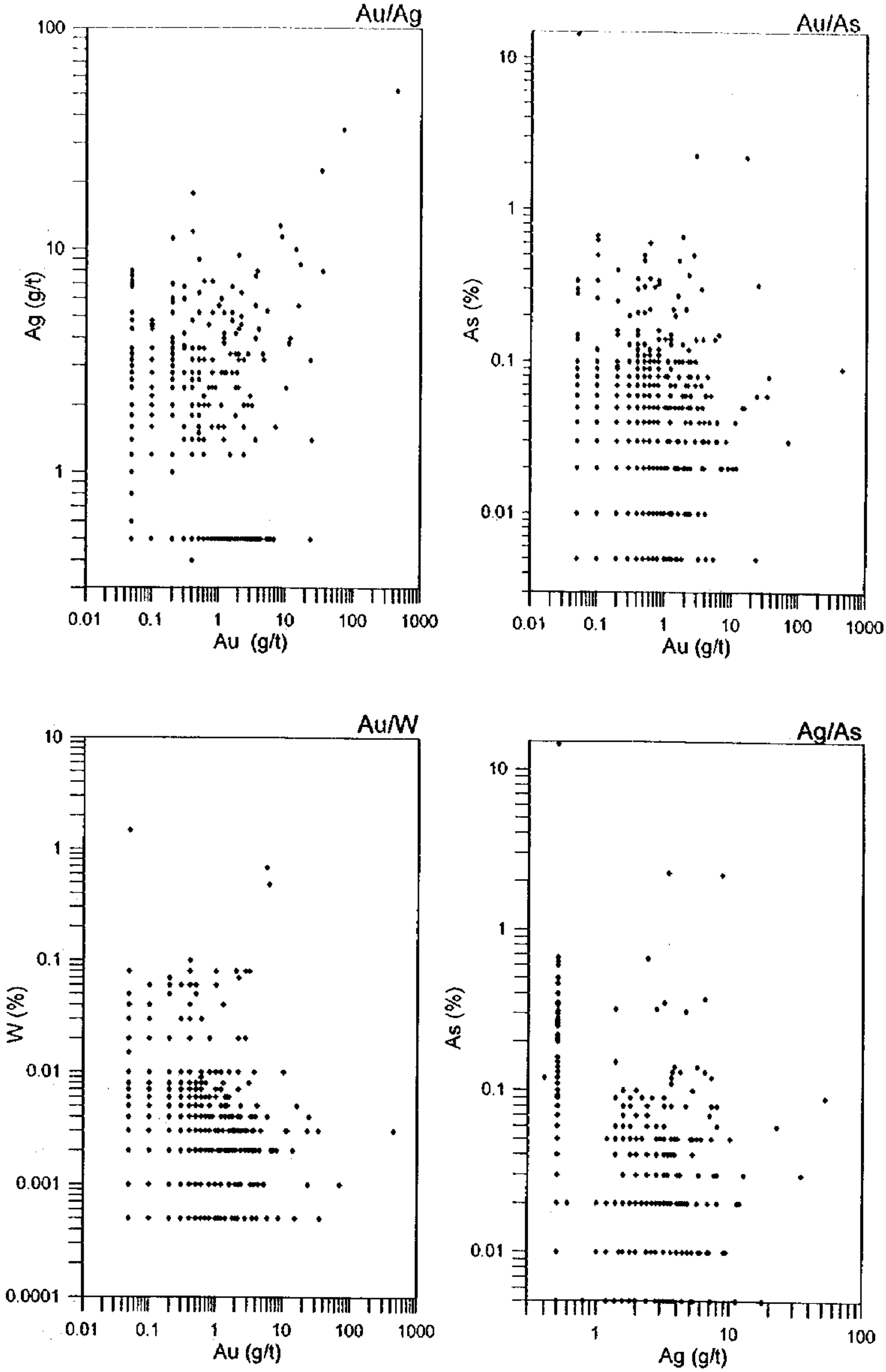


Fig.I-4-3 Scatter Plots (logarithmic) for All Ore Samples

Chapter 5 Conclusions and Recommendations

5-1 Conclusions

1) Entire Area of Southern Nuratau

(1) The survey area is situated in the Zarafshan-Turkestan Tectonic Zone of the Southern Tien-Shan Zone, underlain by Lower Cambrian to Lower Silurian terrigenous sediments in the central to southern part, while in the northern part, mainly by Upper Silurian to Middle Carboniferous limestones. The rocks are intruded by Silurian to Triassic dikes and Carboniferous to Permian granites. 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 E-W direction.

(2) The satellite image produced on a basis of the LANDSAT TM data clearly reflects the geological units and tectonic structure, proving to be effective for the geologic interpretation in the survey area. It was learned that the clear lineament in the NW-SE direction traversing the center of the survey area represents a fault with fracture zones, about 100 m wide. In the zone extracted as an iron oxide zone by the ratioing processing of TM data, iron oxide zones were really verified in some parts while the rest represented a shaded slope. 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.

(3) Ore deposits and manifestations mainly of gold in the survey area occur along fracture zones in the WNW-ESE direction, forming the Karatau ore zone (70 km east to west and 2 km to 4 km from north to south) along the northern side of the Karatau granite bodies 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.

(4) 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 in the detailed survey area. 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.

(5) Component minerals of the gold bearing quartz veins are mainly quartz, pyrite, goethite and lepidochrocite, accompanied, in minor quantities, by marcasite, arsenopyrite,

chalcopyrite, sphalerite, galena, pyrrhotite, scheelite and electrum.

(6) At the Maulyan manifestation, independent gold grains, 2 mm in diameter, were observed in quartz, which was determined to be primary gold. Electrum confirmed by observation of polished section from the Bitab manifestation is associated with pyrite and manganese oxide in cracks of quartz, which has possibly be generated by the secondary enrichment.

(7) Homogenization temperature of fuild inclusions of quartz ranges between 140°C and 340°C, which is divided into a relatively low temperature group (140°C to 170°C) and a high temperature group (270°C to 340°C). In view of the mode of occurrence, the low temperature group is inferred to indicate that of secondary fluid inclusions originated in hydrothermal solution of a later stage which was trapped in the cracks of quartz. Quartz of Kurai, Sebistan and Sartakchi fall within the low temperature group whilst the high temperature group includes Karamechet, Maulyan, Taulyan and Lyangar.

(8) In the Maulyan manifestation, gold mineralization accompanies quartz veins and silicified veins along about 10 of fracture or silicified zones in the WNW-ESE direction. Three ore bodies, 1 m to 4 m wide and 150 m, 200 m and 800 m long, have been ascertained up to now. Their gold grade varies from 1 g/t to 18 g/t. Homogenization temperature of fluid inclusions of quartz, as measured of a sample, showed 328°C, which is rather high for a gold vein. Native gold, 2 mm in diameter, is included in fresh quartz accompanied by tourmaline, which was determined to be primary gold. The manifestation has relatively good continuity of mineralization zones and high gold grade. The east and west extensions and the lower portion of the ore bodies are worthy of exploration; the Maulyan manifestation is considered to be most promising of all in the general survey area.

2) Altynsai District

(1) The area is underlain by the Ordovician-Silurian slate, siltstone, sandstone and phyllite, as well as lower Silurian slate, siltstone and sandstone, intruded by lamprophyre dikes during late Permian to early Triassic times in the vicinity of the No.10 vein ("Berkut Vein") in the west. Ore deposits in the District are either gold-bearing quartz veins controlled by fracture zones with the WNW-ESE and NW-SE trends, or vein-type deposits composed of tourmaline-quartz veins which accompanies joints with the N-S trend. More than 20 ore zones have been ascertained, which include the veins Nos. 1, 2, 5, 8 ("Northwest Vein"), 9 ("Kazanbulak Vein") and 10 ("Berkut Vein").

(2) In an area, 2.5 km long and 500 m to 800 m wide, that embraces the veins Nos. 1, 2, 5, 8 and 10, inumerable joints with the N-S trend develop, forming tourmaline-quartz veinlet zones. In view of the fact that the veinlet zones almost coninceide with the areas of occurrence of biotite-muscovite hornfels as the host rocks and of the Uzbek airborne magnetic survey findings, it is inferred that granite stocks extist aligned in the WNW-ESE direction beneath the veinlet zones.

(3) Component minerals of the quartz veins that occur in fractures zones 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, rutile and electrum. Electrum, 5-10μm in grain size, observed in polished sections in the subject survey occurs in quartz, associated with chalcopyrite, native bismuth and wittichenite in a vein-like alignment but exists independently, which was determined to be primary electrum.

(4) The tourmaline-quartz veins with the N-S trend are composed mainly of quartz, tourmaline, pyrite, arsenopyrite. The Uzbek study indicates inclusion of wolframite, cassiterite, topaz, beryl and native gold. The veins are considered to be tourmaline greisen-type.

(5) Homogenization temperature of fluid inclusions of quartz is generally 250℃ to 350℃, while some of the veins in the WNW-ESE and NW-SE direction showed the low teperature from110℃ to 200℃. The low temperature group is inferred to indicate that of secondary fluid inclusions, as well as in the general survey area. Homogenization temperature of tourmaline-quartz veins with the N-S trend being 250℃ to 340℃, which makes no significant difference from that of the veins with WNW-ESE and NW-SE directions.

(6) The Phase I drilling survey discovered relatively rich mineralization (true width 0.2 m to 1 m; Au 2 g/t to 20 g/t) on the hanging side of No.1 vein and in No.5 vein, while dominant mineralization (true width 1.6 m; Au 15.3 g/t) was confirmed by the drilling MJSN-8 in the lower portion of No.2 vein. The MJSN-4, -5, 9 and -10, aimed at portions beneath the bonanzas confirmed by the drift at No. 1 vein (extension 135 m; average width 2.29 m; Au 15.7 g/t) and the drift at No. 2 vein (extension 55 m, average width 4.28 m; Au 4.5 g/t), however, only encountered low-grade mineralization (Au 4 g/t or less). This is due presumably to the ore bodies being small in size and ununiform in grade distribution. The MJSN-8 captured good mineralization 250 m under the surface, which confirmed that the mineralization of No.2 vein continuous fairly into the deep.

5-2 Recommendations for the Phase II Survey

1) Maulyan District

The analysis of existing data and geological surveys conducted during Phase I indicated that the Maulyan manifestation has relatively good continuity of mineralization zones and high gold grade. It is advisable to execute drilling survey, in order to clarify mineralization in the deep portions of the ore bodies confirmed by the Uzbek trenching survey. It is also advisable to execute detailed geological survey in the Maulyan district, including adjacent ore manifestations such as Taulyan and Beshbulak.

2) Altynsai District

(1) The drilling survey during the subject year revealed good mineralization 250 m under the surface, which indicates continuation of the mineralization into the deep; it is advisable to continue the drilling survey to verify mineralization in the western extension and deeper portion of the No. 2 vein.

(2) As the downward extension of the bonanza of the No. 1 vein (extension 135 m; average width 2.29 m; Au 15.7 g/t), which was discovered at the drift, remains to be investigated; it is advisable to explore the portion by drilling survey.

(3) The lower portions of the veins Nos. 5, 6, 7, 11, 12, etc. in the southern ore zone remain almost unexplored, except the portions surveyed by drilling in Phase I. It is likely that the fractures dipping north continue to the deep as far as granite body, bearing major ore bodies and that the No.1 and No. 2 veins are its branch veins. In order to verify mineralization in the deep, it is advisable to carry out drilling survey.

(4) As the result of the Phase I drilling, gold grades in the tourmaline-quartz veinlet zones with the N-S trend were 0.3 g/t to 1 g/t, partially 2 g/t to 5 g/t. Zones where veinlets concentrate in stockworks and gold grades 1 - 1.5 g/t or higher can posssibly be open-pitted. It is advisable to explore the lower portions of the veinlet concentration zones by drilling survey.

PART II PARTICULARS

Chapter 1 Analysis of Existing Data

1-1 Purpose

In order to study an outline of known ore deposits and manifestations in the Southern Nuratau Area and their occurrence, esisting data and information were collected, sorted and analysed.

1-2 Past Surveys

1-2-1 Summary of existing data

1) Geological surveys

Fig. II-1-1 indicates the areas, methods, years, etc. of major geological surveys hitherto executed in the Southern Nuratau Area. Methods employed for these surveys range from hydrogeologic survey, surface geologic survey, trenching and litho-geochemical survey to drilling survey including non-core and core drilling, shaft, crosscut and drive prospecting, and so forth. The past surveys concentrated especially in the Lyangar mine (W), Altynsai deposit (Au), Bitab-Bashtut manifestations (Au), Kurai-Karamechet manifestations (Au) and Maulyan manifestation (Au).

2) Geochemical surveys

Fig. II-1-2 indicates the areas, methods, years, etc. of major geochemical surveys hitherto executed in the Southern Nuratau Area.

Since 1954 to date, most part of the areas where the Paleozoic Erathem occurs in Southern Nuratau has been covered by geochemial surveys.

In 1962 and 63, geochemical survey was conducted in the Southern Nuratau Mountains on a scale of 1:50,000 which resulted in detection of anomalies of As, Mo, Cu, Au and Hg. Anomalies of Nb, W, Be, Mo and As were detected in 1964 along the contact zone on the north of the Karatau granite body. These early geological surveys were unable to produce promising results owing to the undeveloped assay technology and insufficient geological survey.

Between 1963 and 68, geochemical surveys were conducted in the Nuratau Mountains, which detected an anomalous area of As and Au in the Aktau Range and Karatau Mountains, thanks to the improvement in assay precision of As, Ag, Zn and Au. The surveys including geochecmical survey executed in the area on a scale of 1:50,000 to 1:10,000 resulted in discovery of the Subashi-Sarmichi gold deposits and the Maulyan and Taulyan manifestation.

A 1:10,000 scale geochemical survey carried out in 1968 at the Altynsai deposit has led to discovery of a new gold mineralization zone.

1-2-2 Outline of existing geophysical prospecting data

Since 1950, geophysical prospectings in the Nuratau Mountains have been effected, as follows:

① Electric prospectings and magnetic prospectings in ore deposits and manifestations of ferrous metals and rare metals.

② Seismic, electric and magnetic prospectings aimed at mapping of the concealed Paleozoic structure and rocks.

The past geophysical prospectings by method executed in the Nuratau Mountains are listed in Fig. II-1-3 and II-1-4. The prospecting results are summarized below:

1) Airborne magnetic prospecting

The prospectings since 1954 have revealed that magnetic anomalies are basically related to dioritic igneous rocks and are corresponding to granites and granodioritic intrusive rock bodies. Concealed granodioritic intrusive rock bodies were extracted, while dioritic portions of rock bodies abundant with ferromagnetic minerals were discriminated.

2) Ground magnetic prospecting

Since 1950, basic and ultrabasic rocks were traced by ground magnetic prospectings, which led to mapping of the granodioritic intrusive rock bodies. Besides, a detailed ground magnetic prospecting was conducted on a scale of 1:10,000 in the Subashi-Sarmich gold deposit(outside of the west of survey area), the Kurai-Karamechet gold manifestations, etc. By these magnetic prospectings, granodioritic intrusive rock bodies were mapped and many magnetic anomalies were confirmed in the vicinity of the intrusive rocks, which, combined with other prospecting methods, permitted extraction of promising areas of useful minerals.

3) Electric prospecting

As a result of electric prospectings by the VES, SP and IP methods executed since 1954, occurrence of the Paleozoic Erathem in the concealed basement has become inferable and a geologic tectonic map was drawn. The prospectings conducted in ore deposit areas and promising areas resulted in discovery of new ore zones. Between 1963 and 67, electric prospectings on a scale of 1:10,000 were carried out at the Subashi-Sarmich and Kurai-Karamechet manifestations, to trace sulfide mineralization as the negative anomaly and silicified zones and intensive quartz vein zones as the positive anomaly. Sites with high sulfide mineral contents(8% or more) were extracted by the IP method as local anomalies whilst fracture zones were indicated with low resistivity(30 Ω·m or less).

In 1969, the Sarmich-Altynsai mineralization zone was investigated by IP method, which clarified the fracture zones with the NW-SE and NE-SW trends. In the prospecting, weak positive anomaly zones and resistivity transition zones corresponded with silicified zones, whereas IP anomaly zones conformed with fracture zones in the rocks and sulfide mineralization.

4) Gravity prospecting

Gravity prospectings in the subject area have clarified concept of the deep structure of the earth crust, depth and approximate structure of the concealed Paleozoic, as well as occurrence of the granitic rock bodies.

5) Seismic prospecting

Seismic prospectings were executed on a scale of 1:50,000 to 1:500,000 in the piedmonts and intramountain valleys within the area and the Paleozoic structure was mapped.

6) Airborned gamma-ray prospecting

Since 1968, prospectings by gamma-ray spectrometry were carried out, which detected uranium concentration at 11 locations of 12 gold deposits and manifestations. Similar to uranium, thorium and potassium contents have also increased. All these ore deposits and manifestation are related to dikes or stocks of intermediate or acidic intrusive rocks. These granitic intrusive rocks and also the sedimentary rocks which contact the intrusive rocks are of higher radioactivity, compared with the other igneous and sedimentary rocks. This suggested that airborne gamma-ray prospecting is effective for prospecting of concealed intermediate/acidic dike zones and stocks.

Radioactivity and magnetism of rocks are characterized by inverse relationship; acidic rocks are high in radioactivity and low in magnetism, whilst basic rocks are high in magnetism and low in radioactivity. Intermediate or acidic intrusive rocks related to the gold deposits and manifestations in the Southern Nuratau Area are distinguished by the weak positive magnetism(+150 gamma or less), clearly showing uranium, potassium and thorium anomalies. Thus, combination of airborne gamma-ray prospecting and magnetic prospecting has been considered effective for exploration of gold deposits related to concealed intermediate/acidic intrusive rocks.

1-3 Geology and Geologic Structure of the Survey Area

The survey area abounds with thick terrigenous sediments of lower Cambrian to Silurian ages and also by middle Devonian limestones. These sedimentary rocks, together with the granites that intruded in middle Carboniferous to early Permian times, constitute the basement rocks.

Sedimentary rocks in the basement that spread in the survey area are of highly complex geologic structure owing to abundant, intensive fractures and isoclinal folds.

The basement rocks are folded around the WNW-ESE axis, the direction being the same as that of the extension of the Aktau Mountains in the north and the Karatau Mountains in the south. The rocks are also cut by fractures with similar trends, forming belt-like blocks stretching in the same direction as that of the fold structures. These blocks are further divided into smaller blocks by fractures with the NE-SW trend.

The geologic structure of the Southern Nuratau Area is represented by the Karatau Anticlinorium in the west and the Aktau Antiform in the east. (PL.II-2-2-1) The former is 20 km to 30 km long and its wings reach several kilometers. In the anticlinal axis, there exist the Kutanbulak Formation of Cambrian age composed of terrigenous sedimentary rocks and the Karakargin Formation of Ordovician age. In the survey area, the Karatau anticlinorium is not very clear as its main portion is situated to the west of the area. Along the axis of the Aktau Antiform, located some 2 km north of the Sartakchi niobium-tantalum manifestations, the Aktau Formation composed of Silurian(?) to Devonian limestone beds and the Darasai Formation composed of Devonian terrigenous sedimetary rocks extend.

Faults are abundant in the Karatau Mountains, forming the Karatau Fault Zone with the WNW-ESE trend. The fault zone is devided, on the north of the Karatau granite body in the fault zone, into three parallel zones - Sarmich, Central Biran and Southern Biran, in the order of north to south. In the three fault zones, gold deposits and manifestations exist, altogether forming the Karatau Ore Zone.

On the south of the Aktau granite complex, manifestations of gold, niobium-tantalum, etc., occur in the WNW-ESE direction, which are collectively called the Aktau Ore Zone.

1-4 Ore Deposits and Manifestations within the Survey Area

18 ore deposits and manifestations exist in the survey area. (Fig. I-3-1 and Table II-1-1). Of these, those which pertain to the Karatau Ore Zone are, in the order of west to east, gold deposits/manifestations including Karamechet, Kurai, Berkut, Kazanbulak and Altynsai, whereas the gold manifestations pertaining to the Aktau Ore Zone include Bitab-South, Bitab, Bashtut, Quartz Vein-II, Maidan, Maulyan, Taulyan, Beshbulak, Sebistan. Besides, there are the Akumulla iron-manganese manifestation, the Lyangar tungsten-molybdenum skarn-type deposit and the Sartakchi niobium-tantalum manifestation.

Number	Issue year	Scale of maps	Activities	Report's author
1	1924-25	1 210,000	Hydrogeologic survey	Nikolaev V. A.
	1930-33	1 500,000	Hydrogeologic survey	Smirnov N. A.
2	1938	1 500,000	Hydrogeologic survey	Leonov V. M.
3	1950	1 100,000	Geologic survey	Zlenko N. D. Sonnikova I. I Golynets Yu. V. Popov V. F.
4	1951	1 100,000	Geologic survey	Popov V. F.
4a	1952	1 100,000	Geologic survey	Vasilevskiy B. F. Mikhno I. M.
5	1952	1 100,000	Geologic survey	Urmanov Kh. Kh. Popov V. F. Vasilevskiy B. F.
6	1952	1 100,000	Geologic survey	Chikryvov O. S. Ryskina Kh. V. Voinova K. A.
7	1954	1 25,000	Geologic survey	Kuznetsova R. P. With participation of Jidkov V. I.
8	1962	1 200,000	Geologic survey	Ryskina Kh. V.
9	1962	1 200,000	Geologic survey	Ryskina Kh. V.
10	1965-68	1 50,000	Geologic survey and prospecting	Ogarev D. M. Chalbyskeva N. V. Klimenko E. D.
11	1965-66	1 50,000	Geologic survey	Loshkin Yu. I. Emeljanov V. G. & others
12	1928	1 50,000	Geologic survey and prospecting	Kultiasov S. V.
13	1930	1 50,000	Geologic survey and prospecting	Kultiasov S. V.
14	1931	1 50,000	Geologic survey and prospecting	Sikstel Yu. A.
15	1935	1 100,000 1 10,000	Geologic survey and prospecting	Petrov N. P.

Number	Issue year	Scale of maps	Activities	Report's author
16	1935	1 25,000	Prospecting	Necheljustov N.
17	1940-41	1 50,000	Geologic survey and prospecting	Davydov D. M.
18	1940	1 25,000	Prospecting	Necheljustov N.
19	1946	1 10,000	Geologic survey and prospecting	Shuljatnikov K.
20	1952	1 25,000 1 50,000	Prospecting	Jakovleva N.
21	1956	Prospecting	Prospecting	Trojanov M. D. Gostev R. P.
22	1957	1 25,000	Geologic survey and prospecting	Borniolov R. G.
23	1959	1 25,000 prospecting	Prospecting	Kumanikin N.
24	1960	1 25,000 prospecting	Prospecting	Rumjantsev E. Spirin Yu. G. & others
25	1960	prospecting	Prospecting	Talalov V. A. Chernjavskiy Yu.
26	1961	Prospecting	Prospecting	Chernjavskiy Yu. Rumjantsev E.
27	1962	1 25,000	Prospecting	Spirin Yu. G.
28	1962	Prospecting	Prospecting	Chernjavskiy Yu. Rumjantsev E.
29	1970-72	1 50,000 1 10,000	Prospecting	Djakov Yu. F. Narkulov A.
30	1974-75	1 25,000 1 10,000	Prospecting	Ogarev D. M. & others
31	1967	1 50,000	Geologic survey	Ministry of Geology
32	1973	1 50,000	Geologic survey and prospecting	Ministry of Geology
33	1983-84	1 50,000	Aerial photogeologic survy	Pyanovskaya I. A.
34	1989	1 100,000	Geologic survey	Xan R. S.
35	1989	1 50,000	Geologic survey	Ministry of Geology

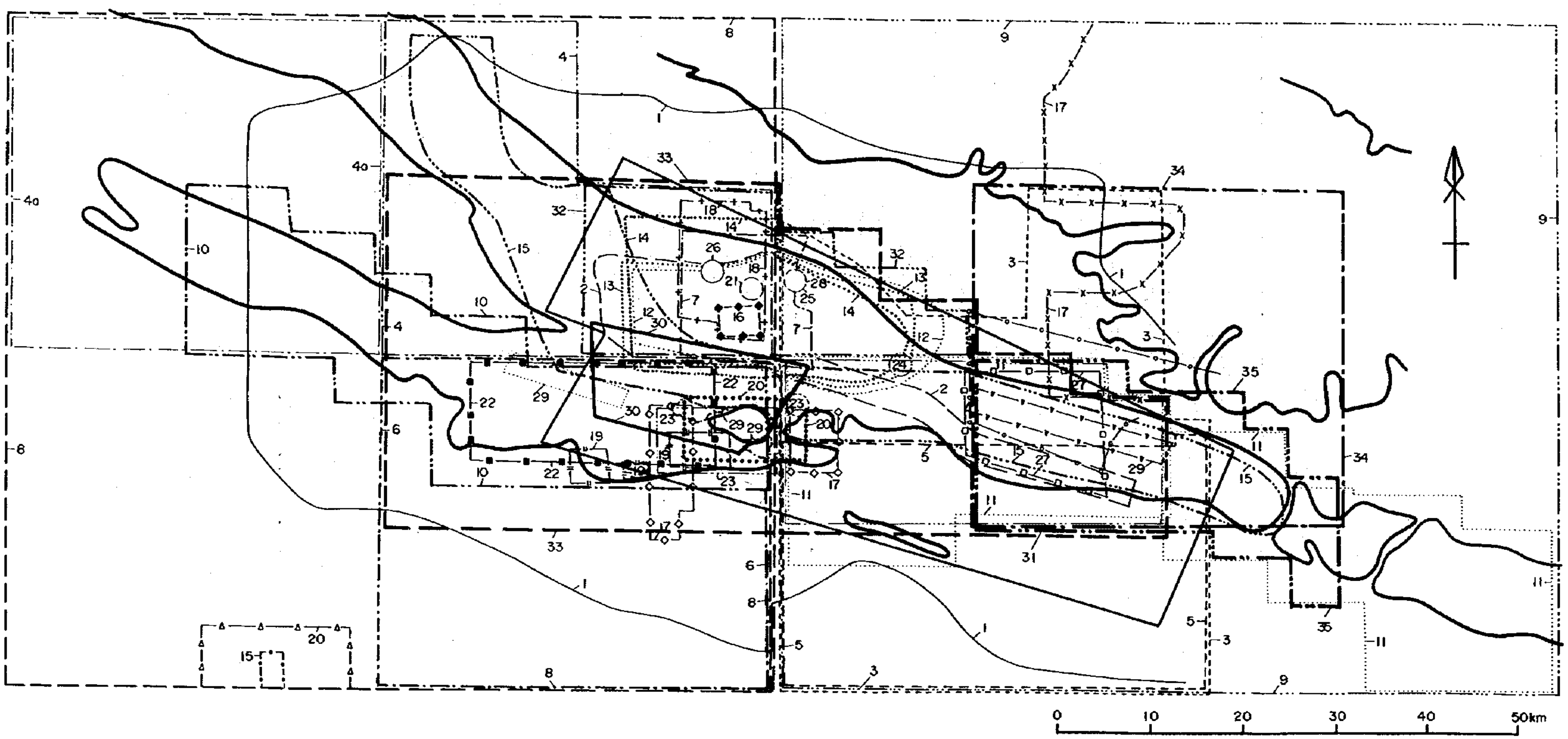


Fig. II-1-1 Existing Geologic Data

Number	Issue year	Scale of maps	Activities	Report's auther
1	1984	1:500,000 1:50,000	Prospecting on stray fluxes	Kubrakova L. V.
2	1976	1:25,000 1:10,000	Prospecting on secondary aureoles	Shumakov Yu. V.
3	1978	1:25,000 1:10,000	Prospecting on secondary aureoles	Mezentsev V. I.
4	1967	1:50,000 1:25,000 1:10,000	Prospecting on secondary aureoles	Degtyarev N. G.
5	1972	1:25,000 1:10,000	Prospecting on secondary aureoles	Dyukov Yu. F.
6	1988	1:25,000 1:10,000	Prospecting on secondary aureoles	Kubrakova L. V.
7	1985	1:50,000	Prospecting on secondary aureoles	Kostyuk A. M.
8	1971	1:10,000	Prospecting on secondary aureoles	Korobeynikov G. N.
9	1989	1:50,000 1:10,000	Prospecting on stray fluxes and secondary aureoles	Khan R. S.
10	1979	1:25,000 1:10,000 1:50,000	Prospecting on secondary aureoles, biochemical prospecting	Ilyasov A. J.

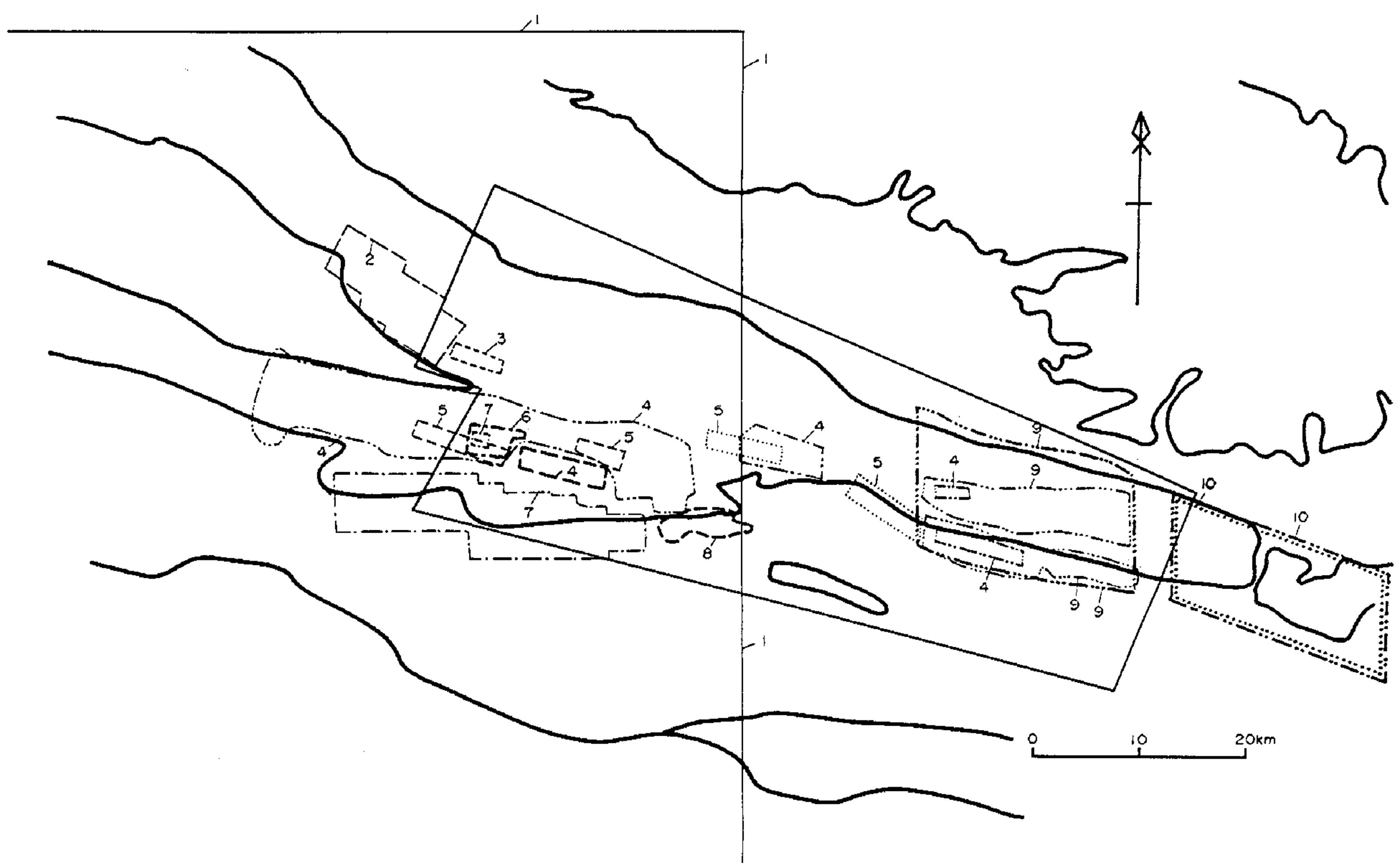


Fig. II-1-2 Existing Geochemical Data

Number	Issue year	Scale of maps	Activities	Report's auther
1	1963	1:100,000	Vertical electric sounding (VES)	Ivanov G. A.
2	1958	1:100,000	VES	Galkin A. I.
3	1966	Works out of scale	VES	Umurzakov K. R.
4	1976	1:25,000	Provoked polarization IP, Natural field SP	Shumakov Yu. V.
5	1978	1:25,000 1:10,000	IP, SP	Mezentsev V. I.
6	1971	1:25,000 1:500,000	IP, SP	Korobeynikov G. I.
7	1967	1:200,000 1:100,000	IP, SP	Degtyarev N. G.
8	1972	1:50,000 1:10,000	IP, SP	Dyukov Yu. F.
9	1983	1:5,000	IP	Shubin E. N.
10	1961	1:100,000 1:50,000	VES	Shagaev M. M.
11	1959	1:25,000	IP	Kirillov N. I.
12	1959	1:10,000	IP	Nyusser E. G.
13	1975	1:200,000	VES	Izbagambetov M. B.
14	1965	1:50,000	VES	Gorshkov B. A.

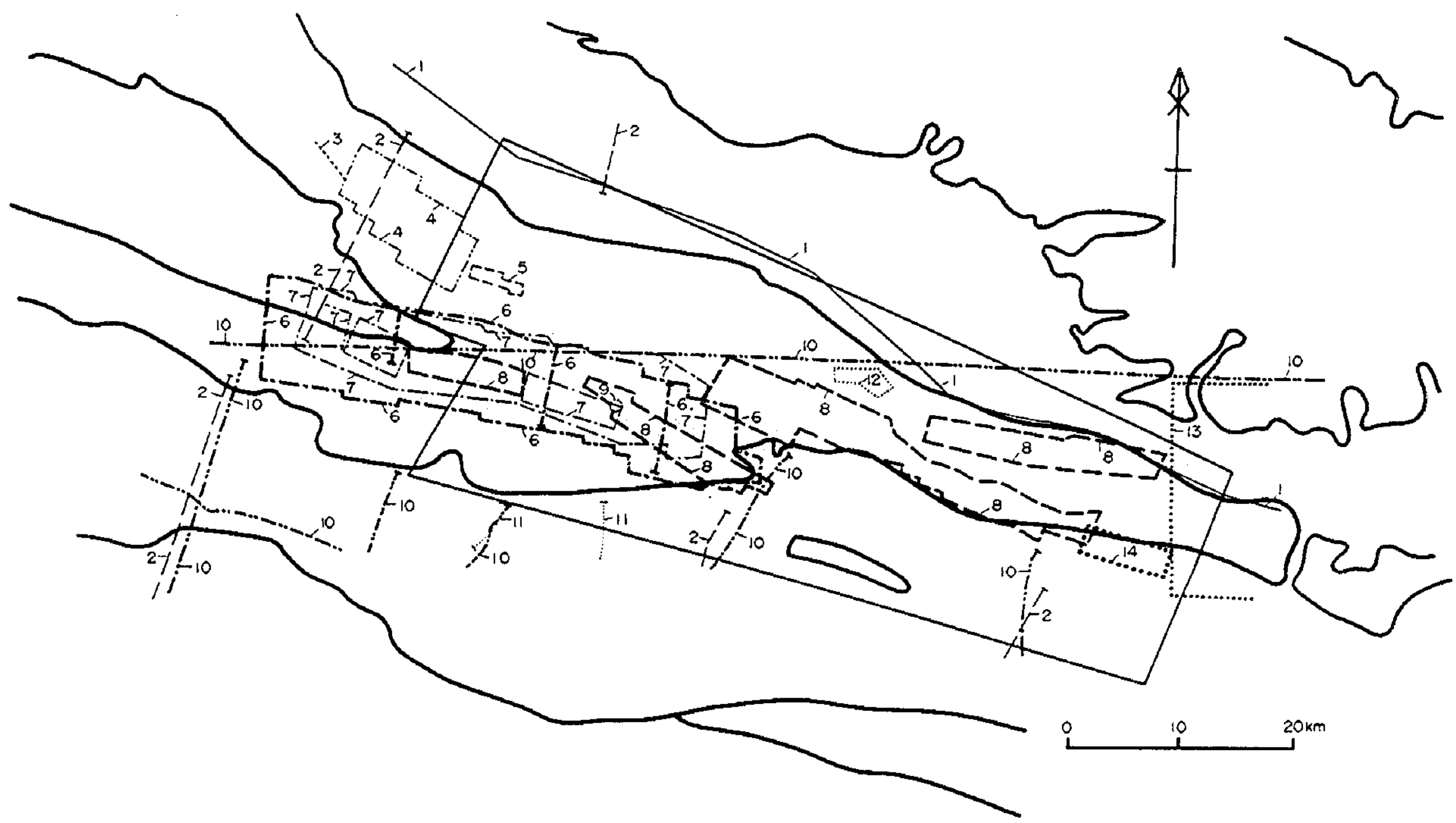


Fig. II-1-3 Existing Electric Prospecting Data

Number	Issue year	Scale of maps	Activities	Report's auther
1	1976	1:25,000	Superficial magnetic prospecting (SMP)	Shumakov Yu. V.
2	1958	1:100,000 1:50,000	Airborne magnetic prospecting (AMP)	Kotlyarevsky L. N.
3	1956	1:200,000 1:100,000	AMP	Shukevich A. M.
4	1970	1:25,000 1:10,000	AMP	Klimov V. I.
5	1963	Works out of scale	AMP	Kotlyarevsky L. N.
6	1967	1:10,000	SMP	Degtyarev N. G.
7	1972	1:10,000	SMP	Dyukov Yu. F.
8	1959	1:10,000	SMP	Nyusser E. G.
9	1972	1:25,000	AMP	Evstigneev A. V.
10	1956	1:25,000	SMP	Khvalovsky A. G.
11	1979	1:25,000	AMP	Kotlyarevsky L. N.
12	1987	1:50,000	SMP in complex with gravity prospecting	Krivolapov A. N.
13	1991	1:50,000	SMP in complex with gravity prospecting	Krivolapov A. N.
14	1985	1:50,000	SMP	Kostyuk A. M.

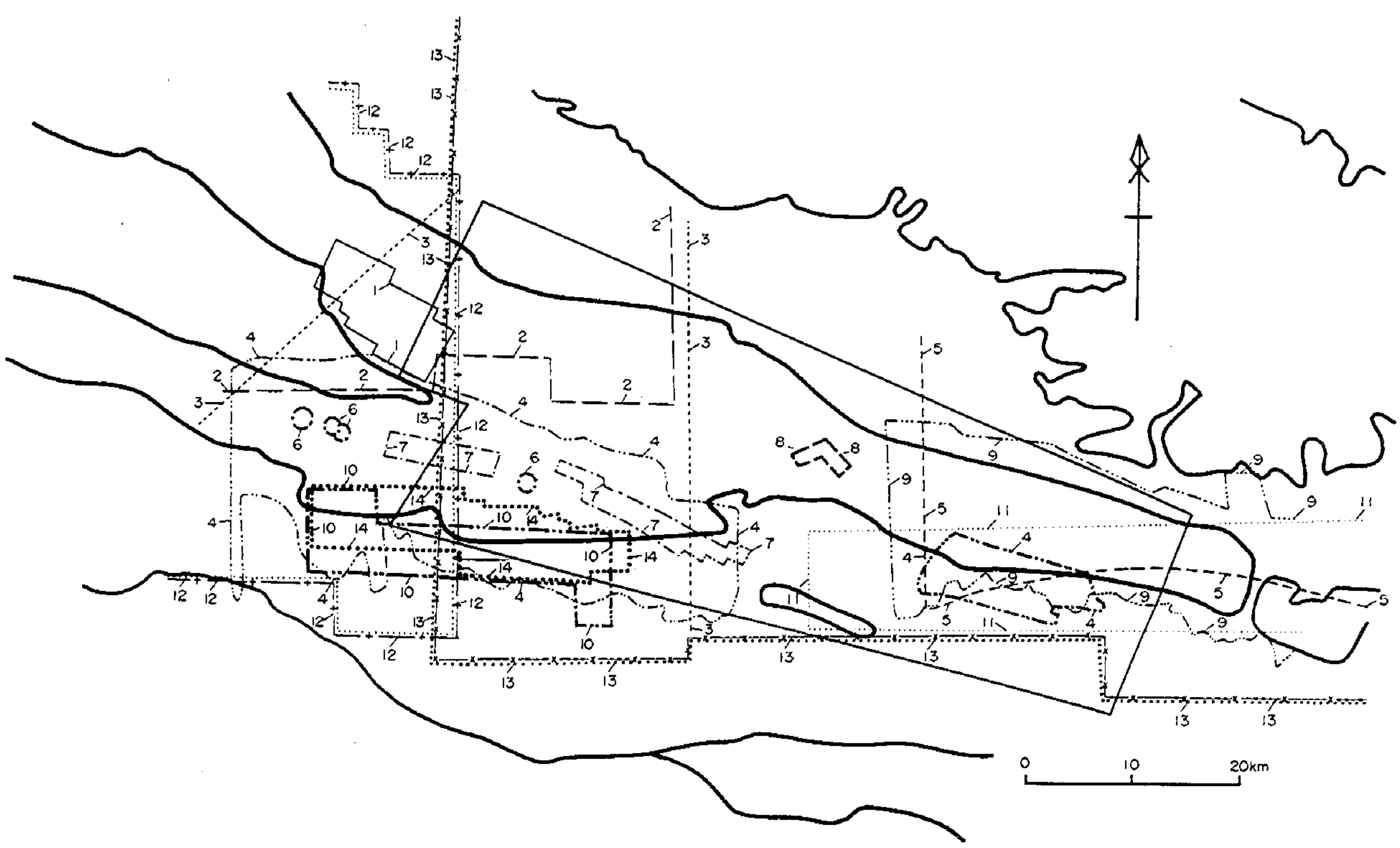


Fig. II-1-4 Existing Magnetic and Gravity Prospecting Data