REPORT
ON
THE MINERAL EXPLORATION
IN
THE EASTERN BUKANTAU AREA
THE REPUBLIC OF UZBEKISTAN

(PHASE III)

MARCH 1997

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 Eastern Bukantau Area, situated some 500km northwest 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 third fiscal year(Phase III) of the survey commenced in the fiscal 1994, the MMAJ organized and sent to the Republic of Uzbekistan a six-man survey team for the period from June 17 to November 2, 1996. The field survey was completed as schduled, 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 III 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 the 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, 1997.

Kimio Fujita
President
Japan International Cooperation Agency

Shozaburo Kiyotaki
President
Metal Mining Agency of Japan

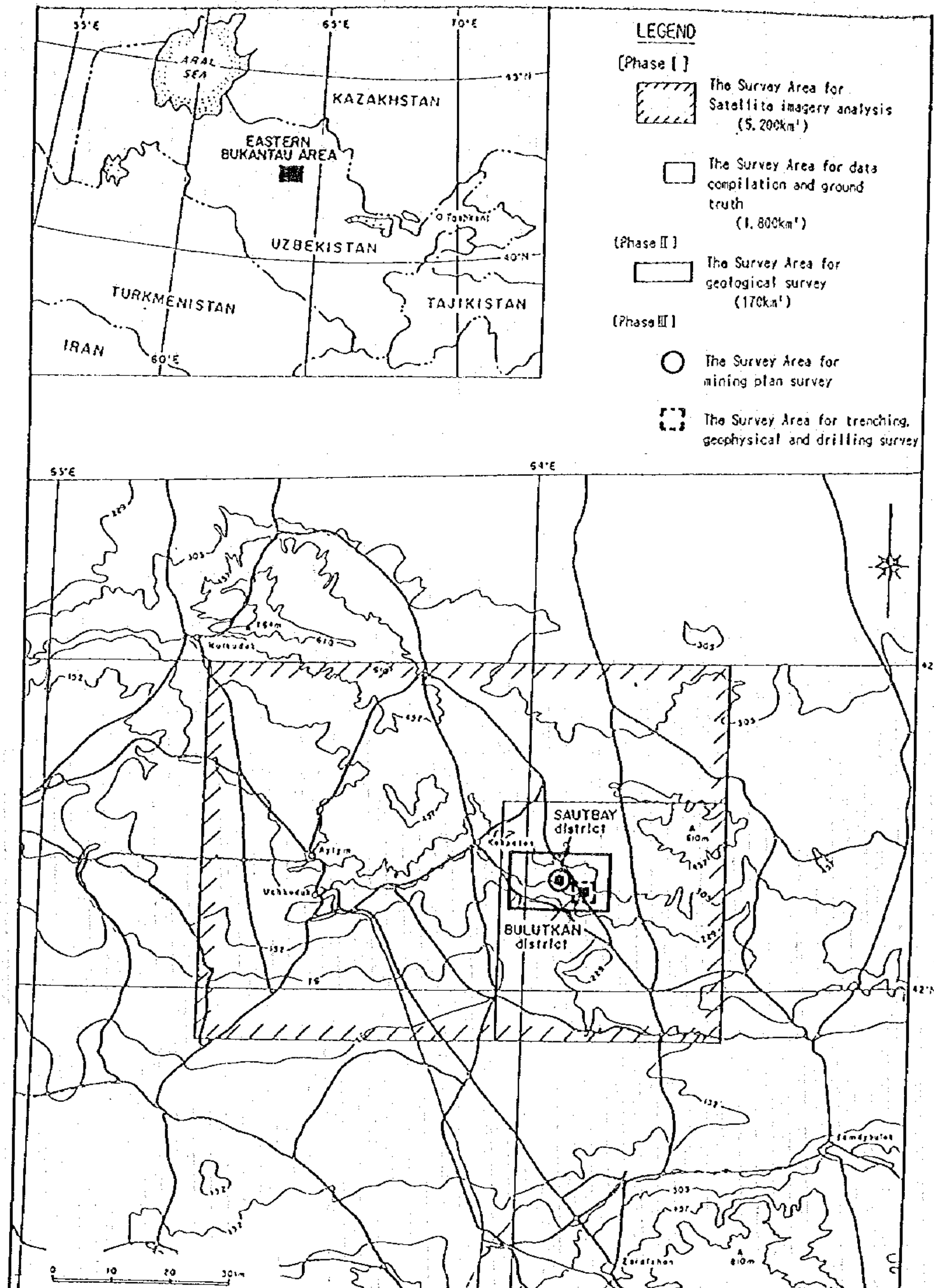

Fig. I -1 Location Map of the Survey Area

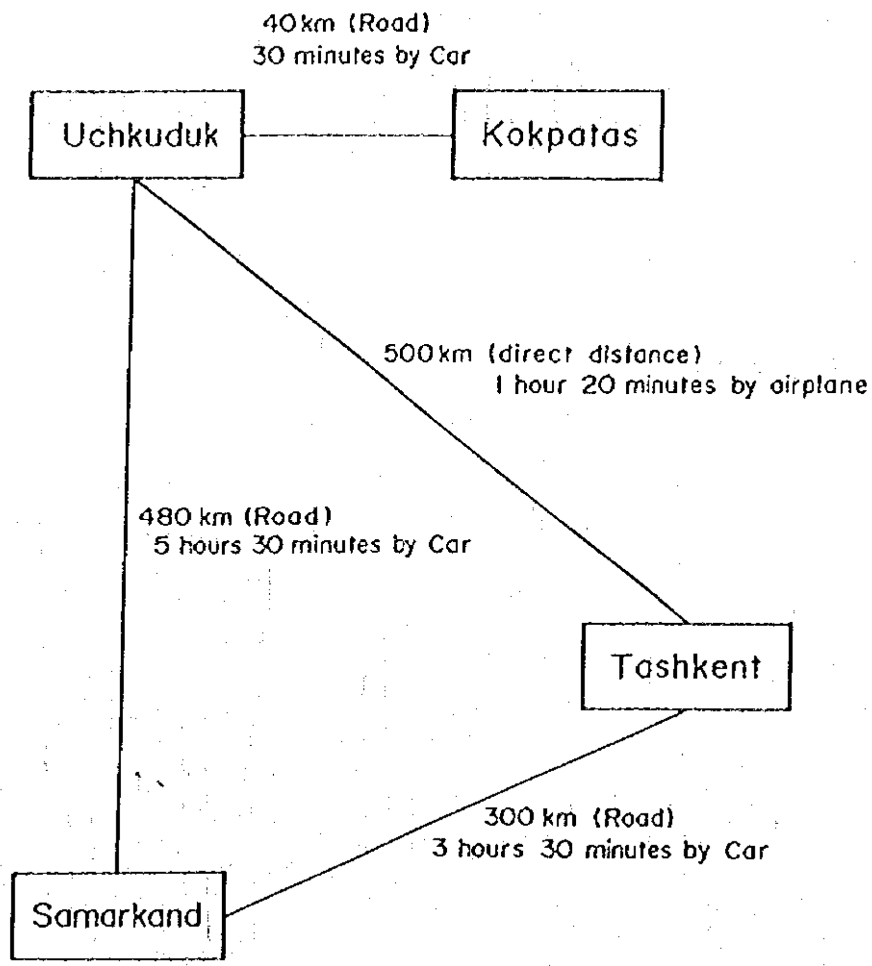

Fig. I -2 Accessibility of the Survey Area

СВОДКА

Настоящий отчет представляет собой сводку результатов геологоразведочных работ, проведенных в районе Восточного Букантау республики Узбекистана в третьем году выполнения Соглашения о сотрудничестве по оснвоным исследованиям для оказания помощи в разработке ресурсов. Целями этих работ было выяснить геологическое строение и рудоносность данного района, разработать направление дальнейших геологоразведочных работ, повторно оценить существующие месторожнения, составить план разработки, и тем самым оказать помощи исследуемым странам в разработке ресурсов. Полевые работы проводились с июня по ноябрь 1996 г.

В этих работах третьего года для Булутканского района проведены поиски канавами в 19 местах в объеме 2.010 м, геофизическая разведка по методу ТЕМ в 13 местах и разведка бурением в 14 скважинах в объеме 2.119,0 м на основе результатов геологического исследования второго года. Более того, для Саутбайского, Бургутского и Сагынканского рудных месторождений, был проведен подсчет запасов для повторной оценки рудного месторождения и был составлен план разработки.

Ниже дано описание результатов работ и предложения для геологоразведки, осуществляемой в будущем, по районам.

1) Саутбайский район

(1) Основным типом рудного месторождения является скарновое месторождение с содержанием вольфрама, организованное под действием гранодиоритом. В этом районе расположены Саутбайское, Бургутское и Сагынканское месторождения.

(2) Для Саутбайского, Бургутского и Сагынканского рудных месторождений был проведен подсчет рудных запасов, в результате чего, выяснено, что при бортовом содержании 0,05% (WO_3), рудные запасы составляют 25.257 тыс. тонн. Среднее содержание WO_3 составляет 0,27%, а запасы металла - приблизительно 69 тыс.тонн (WO_3). Среднее

содержание Au составляет 0,15 г/т, а запасы металла - приблизительно 3,7 тонны. Содержание полезных ископаемых этих месторождений довольно ниже содержания вольфрамных месторождений скарнового типа, введенных в эксплуатацию в западных странах после 1980 г.

(3) В результате рассмотрения возможности, освоение Саутбайского, Бургутского и Сагынканского рудных месторождений оценивается трудным, судя по содержанию, запасам руды и котировке концентрата руды этих месторождений.

2) Булутканский район

(1) Настоящее месторождение представляет собой золотоносные кварцевые и окремненные жилы и скарновое тело. В данном районе известно Булутканское месторождение.

(2) Рудный столб Булутканского месторождения расположен на стыке разрывных нарушений, развитых в направлениях ЗСЗ-ВЮВ, СЗ-ЮВ и ВСВ-ЗСЗ, с горизонтом, содержащим в себе карбонатные породы. Верхняя часть рудного тела представляет собой окремненную породу в сопровождении железной шляпы, мелкозернистой кварцевой породы и халцедона, а нижняя часть - скарновое тело с колчеданными породами, в котором отмечается золотое оруденение. Самородное золото организуется в кварцевых, кальцитных жилах, и отмечается в состоянии парагенезиса с графитом. Редко обнаруживается парагенезис самородного золота с колчеданными породами в амфиболо-пироксеновых скарнах, но оно не находится в колчеданных породах.

(3) В результате разведки канавами обнаружено содержание Au выше 1 г/т в следующих 3 местах: у канавы Т-11 в интервале 80,0-82,0 м содержание Au составляет 1,2 г/т; у канавы Т-28 в интервале 36,0-37,0 м - 3,8г/т; у канавы Т-29 в интервале 52,0-64,0 м - 1,3 г/т.

(4) При разведке западного продолжения Булутканского месторождения, было обнаружено золотое оруденение в следующих местах: у скважины MJUB-8 в глубине 18,1-19,3 м (истинная ширина 0,5м, содержание Au 1,1 г/т) и в глубине 27,7-37,4 м (истинная ширина 4,9 м, содержание Au 4,4 г/т), а у скважины MJUB-9 в глубине 47,0-48,0 м (истинная ширина 0,5 м, содержание Au 8,5 г/т). Кроме вышеуказанных, содержание Au больше 1 г/т было отмечено в следующих местах: у кважины MJUB-13 в глубине 39,5-41,5м (истинная ширина 1,1м, содержание Au 11,9 г/т); у скважины MJUB-17 в глубине 23,4-26,4м (истинная ширина 2,0м, содержание Au 1,3 г/т) и в глубине 74,8-75,5м (истинная ширина 0,5м, содержание Au 6,0 г/т); у скважины MJUB-18 в глубине 69,0-69,5м (истинная ширина 0,5м, содержание Au 9,8 г/т). Предполагается, что неразрывность и масштаб этих рудных тел невелики.

(5) В результате геофизической разведки по методу ТЕМ, обнаружено прерывистое распространение зоны с значительно высоким удельным сопротивлением. Эта зона, имеющая вид с падением к северу, коррелируется в основном с участком с густым распространением диоритовой дайковой породы, окремненной зоны, кварцитовых и кварцевых жил, или с окремненной или скарнизированной метосамотической породой, и обладает почти всеми характеристиками породы этих видов.

(6) Температура гомогенизации включения жидкости кварцевой дайковой породы и кальцита составляет от 100°C до 360°C. У образцов, взятых из скарновой породы температура гомогенизации включения жидкости составляет 250°C-350°C, а у образцов с золотым оруденением - 100°C-250°C (В среднем она составляет приблизительно 200°C). Из вышеуказанного предполагается, что после высокотемпературной скарнизации, произошло золотое оруденение при более низкой температуре.

(7) По результатам подсчета, рудные запасы настоящего района составляют 275 тыс.т, содержание Au - 13,1 г/т,

запасы золота - 3,6 т.

(8) Выбраны два участка, в том числе и Булутканское месторождение, и рассмотрена возможность освоения этих месторождений в небольшом масштабе по методу открытой разработки. Проведен подсчет на условиях транспортировки руды до обогатительного завода №3 в Учкудук по железной дороге для уменьшения капиталовложения в начале промышленного производства. Подсчет показывает, что при добыче 115 тыс.т. руды с промышленным содержанием Au 10,0 г/т в течение года, обеспечивается прибыль в размере приблизительно 15.000 тыс. сом (300 тыс.долларов). При освоении, рекомендуется управлять данным месторождением в качестве вспомогательного рудника Кокпатасского золоторудного месторождения.

Ниже даны предложения для геологоразведки, осуществляемой в будущем.

(1) В результате рассмотрения возможности освоения на основе подсчета рудных запасов, освоение Саутбайского месторождения оценивается трудным, с учетом содержания, рудных запасов и котировки концентрата руды данного месторождения. Если продолжить разведку, то можно ожидать увеличение рудных запасов, но значительное улучшение содержания WO3 не ожидается. Следовательно, рекомендуется прекратить разведку в Саутбайском районе и сохранить его в качестве запасного источника снабжения вольфрамными ресурсами в будущем.

(2) Выбраны два участка, в том числе и Булутканское месторождение, и рассмотрена возможность освоения этих месторождений. По результатам подсчета, при добыче 115 тыс. т. руды с промышленным содержанием Au 10,0 г/т в течение года, обеспечивается прибыль в размере приблизительно 125 сом (2,5 доллара) за 1 тонну. В связи с этим, необходимо принять соответствующие

меры в будущем. Частитное освоение разбросанных месторождений считается возможным. С учетом возможности выявления месторождения в таком же масштабе, как Булутканское, в восточной части канавы Т-6, желательно произвести поиски канавами, геофизическую разведку, разведку скважинами данного района, чтобы выяснить состояние минерализации.

SUMMARY

This Report summarizes the results of Phase III survey (FY1996, the third fiscal year) implemented in the Eastern Bukantau 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 the guiding principles for future exploration, to revalue the known ore deposits, and also to draw mining plans, thereby assisting the host country in the development of its mineral resources. The field survey was executed from June to November, 1996.

Performed during Phase III on the basis of the Phase II survey findings and recommendations were trenching survey(19 trenches, totaling 2,010m), geophysical survey(TEM method; 13 survey lines) and drilling survey(14 drillholes, totaling 2,119m), in the Bulutkan district. For the Sautbay, Burgut and Saghinkan deposits, ore reserves estimation for the purpose of revaluation was effected, as well as elaboration of mining plans,

Results of the survey and recommendations by district are as follows:

1) Sautbay district

(1) The major type of the ore deposit is the tungsten-bearing skarn deposit controlled by granodiorite, as represented by the Sautbay deposit which is the main ore deposit in the district, as well as the nearby Burgut and Saghinkan deposits.

(2) Estimation of the total ore reserves of the Sautbay, Butgut and Saghinkan deposits at a cutoff grade of 0.05% WO_3 came out at 25,257,000t, averaging 0.27% WO_3 and 0.15 g/t Au, or approx. 69,000t of WO_3 and approx. 3.7t of Au in terms of metal content. The WO_3 grades of these ore deposits are substantially lower than those of skarn-type tungsten mines operated since 1980 in the Western countries.

(3) As the result of a feasibility study, development of the Sautbay, Burgut and Saghinkan deposits is considered economically unfeasible under the current levels of ore reserves, grade and WO_3 price.

2) Bulutkan district

(1) Ore deposits in the Bulutkan district consist of gold-bearing quartz, silicified veins and skarn orebodies. The known ore deposit in this district is the Bulutkan deposit.

(2) The bonanzas of the Bulutkan deposit occur at intersections of the faults with WNW-ESE, NW-SE and ENE-WSW trends and the horizon including carbonate rocks.

The upper portion of the orebody is composed of silicified veins accompanied by ferrous oxide, fine-grained quartz veins and chalcedony while the lower portion comprises skarn orebodies accompanied by sulfide veins, which is also accompanied by

gold mineralization. Native gold occurs in quartz veins, calcite veins, and siderite veins, associated with graphite. Native gold is occasionally associated with sulfide minerals in amphibole-pyroxene skarns but not recognized in sulfide minerals.

(3) Au grades of 1g/t or higher were confirmed at the three trenches, T-11(80.0-82.0m; 1.2 g/t), T-28(36.0-37.0m; 3.8 g/t) and T-29(52.0-64.0m; 1.3 g/t).

(4) Gold mineralization was observed at drillholes aimed at the west extension of the Bulutkan deposit: MJUB-8(depths18.1-19.3m: true width 0.5m; 1.1g/t Au and 27.7-37.4m:4.9m; 4.4 g/t) and MJUB-9 (47.0-48.0m:0.5m; 8.5 g/t). Besides, Au grades of 1g/t or more were confirmed at MJUB-13(39.41.5m: 1.1m; 11.9 g/t), MJUB-17(23.4-26.4m:2.0m, 1.3 g/t) and MJUB-18(69.0-69.5m: 0.5m; 9.8 g/t). These orebodies are presumed to be poor in continuity and small in size.

(5) The geophysical survey by the TEM method caught zones, apparently inclined northward, where the high ~ very high-resistivity are intermittently distributed, at the area of occurrence of the Proterozoic along the northern periphery of the syenodiorite body. The high-resistivity zones correspond mainly to zones where diorite dikes, silicified rocks, quartzite and quartz veins are densely concentrated and to zones of silicified and skarnized metasomatites. Most of the major mineral showings in this district have been found at these high-resistivity zones.

(6) The homogenization temperatures of fluid inclusions in quartz veins and calcite veins range from 100℃ to 360℃. Samples taken from skarns show a range of 250℃-350℃, while samples with gold mineralization show a range of 100℃ to 250℃, generally around 200℃. This implies that high-temperature skarnization was followed by gold mineralization under lower temperature.

(7) A tentative calculation of ore reserves of the district indicated 275,000t, grading 13.1g/t Au(3.6t of Au content).

(8) Feasibility for small scale, open-pit operation of the two selected ore blocks including the Bulutkan deposit was studied on the assumptions that initial investment is to be minimized and that the ore is to be transported to the Uchkuduk No.3 ore-dressing plant by rail, for processing. A tentative calculation indicated that, if 115,000t of minable crude ore, grading 10.0 g/t Au, is mined out within one year, operating income of approx. 15 million sum(300,000$) would be gained. In case of development, the ore deposit would have to be placed under the control and administration of the Kokpatas gold mine as its subsidiary mine.

Recommendations may be summarized as follows:

(1) Sautbay district

As the result of a feasibility study on the ore deposits based on the ore reserves estimation, mine development in this district is considered to be economically unfeasible under the current levels of ore reserves, grade and WO_3 price. A certain increase in ore reserves by further exploration may be anticipated but a significant improvement in WO_3 grade is unlikely. It is advisable, therefore, to suspend exploration in this district and to reserve the district as a potential supply source of tungsten resources for the future.

(2) Bulutkan district

Two of the ore blocks, including the Bulutkan deposit, were extracted for the tentative feasibility study on open-pit operation. The study indicated that if 115,000t of minable crude ore, grading 10.0 g/t, is mined out within a period of one year, it would generate operating income of 125 sum(2.50$) per ton of crude ore. It is recommended to study how to deal with the ore deposit in the future.

Partial development of the other ore deposits scattered around in the district may be feasible. There also remains certain possibility for new discovery of small ore deposits of the Bulutkan-class, in the area east of the trench T-6. It is recommendable to carry out further trenching, geophysical and drilling surveys to ascertain mineralization in the area.

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PART I : GENERALITIES

Chapter 1 Introduction

1-1 Antecedents of the Survey

The subject survey of mineral resources in the Eastern Bukantau 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 August 10, 1994.

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

The Phase I survey comprised the satellite imagery analysis covering an area of 5,200km², collection and analysis of mineral resources-related data and the ground truth over 1,800km² in the selected districts within the designated area of survey.

The Phase II survey consisted of geological survey over an area of 170km² at the Sautbay-Bulutkan district and drilling survey at the Sautbay district (4 drillholes totaling 1,509.9m), as well as trenching survey (10 trenches totaling 6,300m), geophysical survey over 1.8km² and drilling survey (7 drillholes totaling 1,011.0m) at the Bulutkan district.

As regards the Saghinkan deposit adjacent to the northwest part of the Sautbay deposit in the survey area, ore reserves estimation was made for revaluation of the ore deposit.

The Phase III survey, performed on the basis of the Phase II survey findings and recommendations, consisted of the trenching survey(19 trenches, totaling 2,010m), the geophysical survey(TEM method, 13 survey lines) and the drilling survey(14 drillholes, totaling 2,119.0m), at the Bulutkan district. In addition, ore reserves estimation and mining plans were made respectively for the Sautbay, Burgut and Saghinkan deposits, for revaluation purpose.

1-2 Conclusions and Recommendations of the Phase II Survey

1-2-1 Conclusions

Conclusions of the Phase II survey may be summarized as follows:

1) Sautbay-Bulutkan district (geological survey area)

(1) The known ore deposits and showings at this district are the Sautbay deposit (W), Burgut deposit (W), Saghinkan deposit (W) and Bulutkan deposit (Au). The Phase II survey resulted in confirming no new deposits nor showings.

(2) Since most of the anomalies in the rock analysis are located at or near zones where stocks and dikes are concentrated, mineralization presumably extends over a wide area centering around the Sautbay and Bulutkan districts, accompanying intrusive rocks.

2) Sautbay district

(1) Ore reserves of the Saghinkan deposit was estimated with the computer software (microLYNX Plus) designed for ore reserve calculation, which was used in Phase I, as well. The ore reserves turned out to be 16,320,000t averaging 0.24% WO_3 and 0.02g/t Au, At a cutoff grade of 0.05% WO_3.

The Saghinkan is a medium-size ore deposit, but its ore grade is rather low.

(2) The drilling survey at four drillholes aimed at the Sautbay deposit caught a skarn ore body of more than 2m in true width, grading 0.30% WO_3 or more, at the drillholes Nos. 3 and 4. Consequently, it was ascertained that mineralization of the skarn ore bodies including the main ore body No.1 continues up to about 400m below the surface, which strengthens the possibility of the mineralization continuing further downward and south-southeastward.

3) Bulutkan district

(1) The geophysical prospecting confirmed five zones showing high resistivity structure and high IP values, similar to the Bulutkan deposit, in the Kokpatas Formation to the north of the syenodiorite stock.

(2) Drilling aimed at the lower extension of the Bulutkan deposit caught gold mineralization, at the drillholes Nos. MJUB-1 and -7, confirming that the mineralization continues up to about 100m under the surface.

The orebody with gold mineralization is formed with silicified rocks accompanied by gossan, fine-grained quartz veins and chalcedony in the upper portion, whilst the lower portion comprises skarn ore bodies accompanied by sulfide veins.

(3) The drilling, aimed at the lower part of the Bulutkan deposit, seized relatively high-grade and continuous gold mineralization: Au grade of 2.8 g/t at the drillhole MJUB-1 at the depths of 86.0-88.0m (true width 1.1m) ; Au 4.3 g/t at MJUB-7 at 0.0-10.4m (true width 5.5m) ; and, Au 21.2 g/t at the same drillhole at 36.1-51.0m (true width

7.9m). Outside of the Bulutkan deposit, Au 2.3 g/t and Ag 36.1 g/t were confirmed at MJUB-3 at 82.0-84.0m (true width 1.6m).

(4) At the trench T-2 for prospecting the upper part of the Bulutkan deposit, relatively high-grade and continuous gold mineralization was confirmed : Au 11.7 g/t at 228.4-248.6m (true width 19.0m), Au 7.0 g/t at 252.1-253.4m (true width 1.2m) and Au 2.4 g/t at 260.2-264.3m (true width 3.9m).

(5) Measurement of the homogenization temperature of fluid inclusions of quartz veins and chalcedony indicated that the samples collected from trenches at the Bulutkan deposit and near the gold showings zones are at a range of 150℃-250℃ whilst samples taken from skarns or syenodiorite range from 250℃ to 350℃. Drill core samples taken from the zones where gold mineralization is overlapped with skarnization range from about 150℃ to 330℃. From these results, it is presumed that the quartz veins were formed through more than one stage and the gold mineralization was accompanied by the late-stage, low temperature quartz.

(6) Geochemical anomalies at this district were found near the main mineralization zone confirmed by the trenching survey, the fracture zones and the dikes, and also in the syenodiorite body near the border with the Kokpatas Formation.

(7) The Phase II survey revealed that indications of mineralization continuously appear in zones near the north side of the syenodiorite stock extending in the WNW-ESE direction, which suggests high potentials of occurrence of ore deposits similar to the Bulutkan deposit.

1-2-2 Recommendations based on the Phase II survey

For Phase III, the following surveys were recommended.

(1) Trenching and drilling survey aimed at the east-west extension of the Bulutkan deposit.

(2) Geophysical prospecting by the TEM method, plus trenching and drilling survey, aimed at the area where the Kokpatas Formation occurs and occurrence of ore deposits similar to the Bulutkan deposit is expected, within the zones alongside of the north side of the syenodiorite body extending in the WNW-ESE direction.

(3) Drilling survey aimed at the southeast extension, at depths of 300-400m under the surface, of the No.1 ore body of the Sautbay deposit.

(4) Drawing conceptual mine development plans for the Sautbay-Burgut deposits and the Saghinkan deposit.

1-3 Outline of the Phase III Survey

1-3-1 Survey area

The Eastern Bukantau Area is situated southeast of the Bukantau range in the Central Kizil-kum Desert. Based on the Phase II recommendations, the Phase-III survey was implemented at the Sautbay and Bulutkan districts (Fig. I-1). The survey area is located some 500 straight-line kilometers WNW of Tashkent. The area is a gently inclined hilly country, 200-600m above the sea level, protruding in a flat desert.

1-3-2 Purpose of survey

The survey is aimed to clarify the geological conditions and occurrence of ore deposits in the Eastern Bukantau Area of the Republic of Uzbekistan, to provide the guiding principles for future exploration, to revalue the known ore deposits, and to draw up mining plans for them, thereby assisting the host country to develop her mineral resources. It is also intended to promote technological transfer to the host nation's organization concerned through the collaborative survey.

The survey is comprized of the following work:

(1) Ore reserves estimation of the Sautbay, Burgut and Saghinkan deposits in the Sautbay district, based upon the survey findings of previous years, and also drawing up conceptual mining plans for these deposits.

(2) At the Bulutkan district, (i) trenching survey to grasp the metallogenic characteristics of the gold mineralization and also to ascertain its horizontal extension, (ii) geophysical survey(TEM method) to examine the resistivity structure from the surface to the depths, to examine the vertical distribution of the gold mineralization zone, and (iii) drilling survey to clarify mineralization in the depths of the gold deposit.

1-3-3 Method of survey

(1) Study on mining plans

In order to revaluate the Sautbay, Burgut and Saghinkan deposits in the Sautbay district on the basis of data obtained from the previous years' surveys, ore reserves calculation was effected, using the Western method. The computer software (microLYNXPlus), which is suitable for ore reserves calculation of skarn-type and vein-type ore deposits, was utilized in continuation from the previous years. Existing data were collected again at the State Committee of Geology and Mineral Reserves and the Kokpatas Expedition, which were analyzed in Japan.

Based on results of the ore reserves estimation and field survey, mining plans were drawn up. The site survey was conducted by the survey team leader, a mining engineer and a geologist, who also collected relevant data and information and studied local conditions.

(2) Trenching survey

At the Bulutkan district, trenching survey was conducted along 19 survey lines to confirm the geology and mineralization. Quantities of the survey work are indicated in Table I-1-3-1. The base camp for the survey was placed within the Kokpatas Expedition base. After observation of the geology and mineralization, trenching sketches with scales of 1/1000 for the whole work area and 1/100 for the ore showings were drawn up. In parallel with the trenching survey, various types of sampling in the quantities shown in Appendix 2-1 were carried out, as well as laboratory tests.

(3) Geophysical survey

At the Bulutkan district, geophysical survey in the quantities indicated in Table I-1-3-1 was conducted to investigate continuity of the gold mineralization zones to the depth and surrounding zones and to clarify relationship between the mineralized zones and the geological structure, in order to extract promising ore-bearing zones. The survey equipment excepting some consumable items were transported from Japan. The base camp was placed within the Kokpatas Expedition base.

To verify the resistivity structure up to the depth of 150-200m, and to extract the resistivity distribution related to the mineralization, the TEM method was applied.

The measurement was done along 13 survey lines at 30-60m intervals, totaling not less than 6 kms.

(4) Drilling survey

To clarify details of mineralization toward the depths of the quartz-silicified veins accompanied by gold mineralization and of the skarn orebodies at the Bulutkan district, drilling survey in the quantities indicated in Table I-1-3-1 was conducted. The drilling work was undertaken by a local contractor.

After observation and photographing of the drill cores, various sampling in the quantities indicated in Appendix 2-1 was done, as well as laboratory tests. The observation results were recorded in geologic core logs with a 1/200 scale.

1-3-4 Organization of survey team

1) Survey team

Japan		Uzbekistan	
Name	Entity	Name	Entity
Katsuji Fukumoto(Leader)	MINDECO	R.V.Tsoi(Coordinator)	SCG
Akimitsu Takebe(Geologist)	〃	F.M.Bayazitova(Coordinator)	〃
Hirotaro Fujii(Mining Engineer)	〃	A.L.Ogarkov(Geologist)	〃
Kazuhiko Kinoshita(Geophysist)	〃	N.E.Kozarez(Geologist)	〃
Nobuhiko Shiga(Geophysist)	〃	E. Tarasov(Geologist)	〃
Yoshiaki Ogawa(Geophysist)	〃	A.T.Zakirov(Geologist)	SKG
		V.F.Gbizdon(Geologist)	KE
		Lev.A.Sim(Geophysist)	SCG
		A.A.Horsov(Geophysist)	〃
		I.Shaimardanov(Technical engineer)	〃
		N.A.Akhmedov(Coordinator)	SKG
		A.A.Akramov(Coordinator)	KE
		V.S.Protopopov(Technical engineer)	〃

2) Field inspection

Junichi Tominaga MMAJ
Hirofumi Ono MMAJ Almaty Office
Tohru Nawata JICA

JICA : Japan International Cooperation Agency
MMAJ : Metal Mining Agency of Japan
SCG : State Committee of Geology and Mineral Reseves
SKG : Samarkandgeology
KE : Kokpatas Expendition
MINDECO : Mitsui Mineral Development Engineering Co., Ltd.

1-3-5 Period of survey

	1996							1997	
	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Jan.	Feb.
Planning, Preparation	16								
Field survey	17					2			
Tests and analysis			1						15
Compilation of report						3			

Table I-1-3-1 Outline of the Survey

Items	Quantity
Mining plan (Sautbay, Burgut and Saghinkan deposits)	Field survey ; 1 mining engineer 20 days 1 geologist 15 days
Trench survey (Bulutkan district)	Trench No. Length T-11 160 m T-12 160 m T-13 100 m T-14 100 m T-15 90 m T-16 120 m T-17 120 m T-18 130 m T-19 60 m T-20 50 m T-21 50 m T-22 130 m T-23 80 m T-24 100 m T-25 80 m T-26 120 m T-27 70 m T-28 110 m T-29 180 m Total length 2,010 m
Geophysical survey (Bulutkan district)	TEM method ; Total length of lines 6.4 km Total number of lines 13 lines Total number of stations 631 stations
Drilling survey (Bulutkan district)	Hole No. Length Dip Direction MJUB- 8 100.0 m -80° S 25° W MJUB- 9 100.0 m -80° S 25° W MJUB-10 110.0 m -80° S 25° W MJUB-11 152.0 m -80° S 25° W MJUB-12 194.0 m -80° S 25° W MJUB-13 100.0 m -80° S 20° W MJUB-14 161.0 m -80° S 20° W MJUB-15 102.0 m -80° S 20° W MJUB-16 151.0 m -80° S 20° W MJUB-17 100.0 m -80° S 35° W MJUB-18 154.0 m -80° S 35° W MJUB-19 150.0 m -80° S 20° W MJUB-20 440.0 m -80° S 20° W MJUB-21 105.0 m -80° S 20° W Total 14 holes, Total length 2,119.0m

Chapter 2 Geography of the Survey Area

2-1 Location and Accessibility

The Eastern Bukantau Area is located southeast of the Bukantau range of hills in the Central Kizil-kum Desert. In administrative division terms, the area constitutes a part of Uchkuduk District of Navoi Region.

The area is situated some 500km in straight-line distance northwest of Tashkent, the national capital. The Kokpatas Expedition is placed in the central part of the area, which has the total population of approximately 1,200. The largest population center of the area is Uchkuduk located 30km west of the Kokpatas Expedition, which are linked by an unasphalted road, about 30-minute car ride.

Some 80km southeast of the area, Zarafshan is located; 28km east of Zarafshan, there is the Muruntau gold mine and gold extraction complex.

Tashkent and Uchkuduk are connected by three air-flights a week, which takes about 80 minutes. A road from Tashkent to Kokpatas via Samarkand, the ancient capital, has an extension of about 820km, some 10 hours by car (Fig. I-2).

2-2 Topography and Drainage Systems

The Bukantau Range is a narrow range of hills, 230km long and 30-50km wide, protruding through the Kizil-Kum Desert in the WNW-ESE direction. The highest point, alt. 750m above sea level, is located near Kulkuduk in the western side of the range. The altitude of the range diminishes eastward. The Sautbay deposit area, alt. 200-300m, is located in the east side of the range, having gently undulating topography.

The area has no water system with constant flow of water but there are a number of dried stream beds where water flow is occasionally seen only when it rains in spring or fall. The water systems represent dendritic or parallel patterns stretching in the NNE direction.

2-3 Climate and Vegetation

The area has the typically continental climate, characterized with dry, hot summer and windy, cold winter. The annual average temperature is 14.7℃. The monthly average temperature comes to the lowest, -1.2℃, in January when the minimum temperature of -30℃ has been recorded. July is the hottest month when the temperature is 31.2℃ in average and 45℃ at the maximum (Table I-2-2-1).

The annual average precipitation is 118mm whereas the humidity varies widely between 18% in summer and 74% in winter.

Northeasterly winds are dominant, with occasional northwesterly and southerly. The annual average wind speed is 6m per second while the maximum is 35m. Sand storms are frequent.

Owing to the desert climate, the area has unique vegetation. In a hilly area covered by earth and sand, a variety of annual and perennial grasses flourish, as well as mushrooms in springtime, whilst various deep-rooted shrubs are observed on flatland covered by aeolian sand.

Table I-2-3-1 Mean Monthly and Annual Temperature (℃) in the Eastern Bukantau Area

Year	Mean Monthly											
	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sep.	Oct.	Nov.	Dec.
1969	-13.4	12.9	3.4	14.6	14.6	28.6	29.5	27.0	21.5	13.2	6.0	4.6
1970	-5.6	3.4	7.0	17.4	24.2	27.7	—	—	21.7	—	5.7	-2.9
1971	-3.8	-0.7	8.6	13.5	22.4	27.7	30.6	27.2	22.9	15.2	10.0	4.4
1972	9.3	8.8	3.1	15.2	20.3	27.9	28.7	25.9	21.2	14.3	8.4	-2.4
1973	-5.5	2.7	6.4	16.3	22.1	29.8	31.3	28.8	18.8	13.2	7.8	0.4
1974	6.0	-6.2	6.4	14.0	24.4	28.7	31.2	26.2	21.2	15.2	7.1	-3.4
1975	0.1	-1.1	8.2	17.9	22.9	29.2	32.7	29.1	22.9	12.2	2.4	1.3
1976	3.2	-4.9	3.6	16.2	23.5	28.4	31.4	30.8	21.2	9.6	1.4	-4.1
1977	1.1	1.2	9.9	19.1	24.7	38.2	30.7	27.9	22.8	11.2	7.2	0.5
1978	-1.8	-5.1	5.0	16.0	20.3	26.9	30.9	26.4	24.3	13.1	4.2	—
1983	0.9	5.3	6.4	18.1	23.0	29.0	33.7	29.7	27.3	12.9	8.0	—
1984	—	—	5.8	—	20.9	28.7	33.7	—	24.0	13.7	5.7	—
1985	-3.6	3.9	4.6	17.5	23.0	29.9	31.3	26.0	22.0	11.0	3.7	—
1986	-2.3	1.8	3.0	15.1	23.3	27.3	30.7	27.6	27.6	24.1	12.8	4.5
Average	-1.2	1.7	5.8	16.2	22.1	29.1	31.3	27.7	22.8	13.8	6.5	0.3

Chapter 3 General Geology

In the survey area, there occur the Karashakh and Kokpatas Formations of the Proterozoic Ripheian System ~ Vendian System, the Late Carboniferous ~ Early Permian intrusive rocks which cut the formations, and the Cretaceous and Quaternary Systems unconformably overlying these. A geological map, geologic cross-sections and a schematic geologic column are exhibited in Figs. I-3-1, I-3-2 and I-3-3, respectively.

In the Proterozoic and intrusive rocks in the area, faults in the NW-SE direction are dominant, followed by those in the NE-SW and NNW-SSE directions. The West Sautbay Fault (NE-SW) in the west of the Sautbay district, the Okjetpes Fault (NW-SE) to the south, the South Sautbay Fault (NW-SE) in the south of the Sautbay district, and the North Sautbay Fault (NW-SE) extending from near the Bulutkan deposit to the north of Sautbay deposit are known as the main faults.

In the Karashakh and Kokpatas Formations, many small folds are visible at outcrops while large size folding structures are seen in the Sautbay Anticline (NW-SE or NNW-SSE) west of the Sautbay deposit, and also in a presumed anticline (NW-SE) in the northwest of the Bulutkan deposit. In the vicinity of the both anticlines, the lowermost part of the Karashakh Formation occurs. Generally, the Proterozoic strikes NW-SE, in the northeast side of the North Sautbay Fault which passes through the Bulutkan deposit, whereas, in the southwest side where the Sautbay deposit is situated, the strike varies from E-W to NW-SE and N-S depending on location.

The Karashakh Formation, more than 500m thick, is composed of green rocks of volcanic origin and schists accompanied by quartzite, dolomite and limestone. The formation extends from the northeastern part of the survey area to the Sautbay anticline near the Sautbay deposit and also along the NW-SE anticline axis and faults northeast of Bulutkan. The formation is considered to be conformably overlain by the Kokpatas Formation with partial interfingering. The Karashakh Formation is also considered to occur in the flatland to the south of the Sautbay deposit, overlain by the Cretaceous. On the surface, the two formations contact at faults in most cases.

The Kokpatas Formation is composed of sandstone, slate and quartzite intercalated by dolomite and limestone at the base, which is overlain by thick sandstone accompanied by slate, quartzite, schist, limestone and dolomite. Some of these rocks contain carbonaceous substances, turning black. This formation widely spreads over the survey area and its thickness reaches 1,000m or more.

The Cretaceous is composed of semi-consolidated, marine mudstone, sandstone, dolomite and conglomerate. This formation unconformably overlies the Proterozoic. Those which have escaped erosion widely spread over the gently inclined lands. The thickness of the formation is estimated to be 80m or less.

The Quarternary comprises silt, sand, gravel and gypsum. This formation occurs in most of valleys, stream beds and flatlands in thicknesses of 1 to 10m. Gypsum beds mingled with mud, about 1m thick, are frequently visible on flatlands.

In the survey area, stocks and dikes of syenodiorite, quartzdiorite, diorite, granite, granodiorite, lamprophyre and aplite occur, which are considered to have intruded into the Late Carboniferous ~ Early Permian. Among these rocks, those in stocks are represented by the granodiorite aligned in the NW-SE direction near the Sautbay deposit, syenodiorite, granodiorite and quartzdiorite near the Bulutkan deposit, and granite or granodiorite in the northeast part of the survey area.

Proterozoic rocks in the survey area underwent regional metamorphism of Baikal orogenic movement at the end of Proterozoic age and also underwent more or less contact metamorphism by Carboniferous to Permian intrusive rocks.

The regional metamorphism shows green schist facies dominantly. Metamorphic rocks are characterized by development of schistosity and quartz veins, recrystallization and occurrence of porphyroblasts. They consist mainly of chlorite, epidote, sericite, amphibole, carbonate minerals, albite and quartz.

The contact metamorphism generally assumes amphibolite facies while the pelitic hornfels are observed within the area up to 2km from the intrusive rocks.

Skarnization often occurs at the contact zones of intrusive rocks and surrounding sedimentary rocks. The skarns are mainly composed of hedenbergite, diopside, tremolite-actinolite, wollastonite with small amounts of grossular.

Eastern Bukantau metallogenic zones are characteristic of tungsten and gold-silver mineralization together with copper and molybdenum. Wide spread tungsten occurrence is particularly characteristic. At the early and latest stages of Hercynian orogeny in parallel with thermal metamorphism and batholithic granitic magmatism in the Eastern Bukantau Area, stockwork gold-silver quartz vein, tungsten quartz vein and tungsten skarn deposits were formed.

Situated in the survey area are the Sautbay deposit(W) and the adjacent Burgut and Saghinkan deposits(W), and the Bulutkan deposit(Au)(Table.I-3-1).

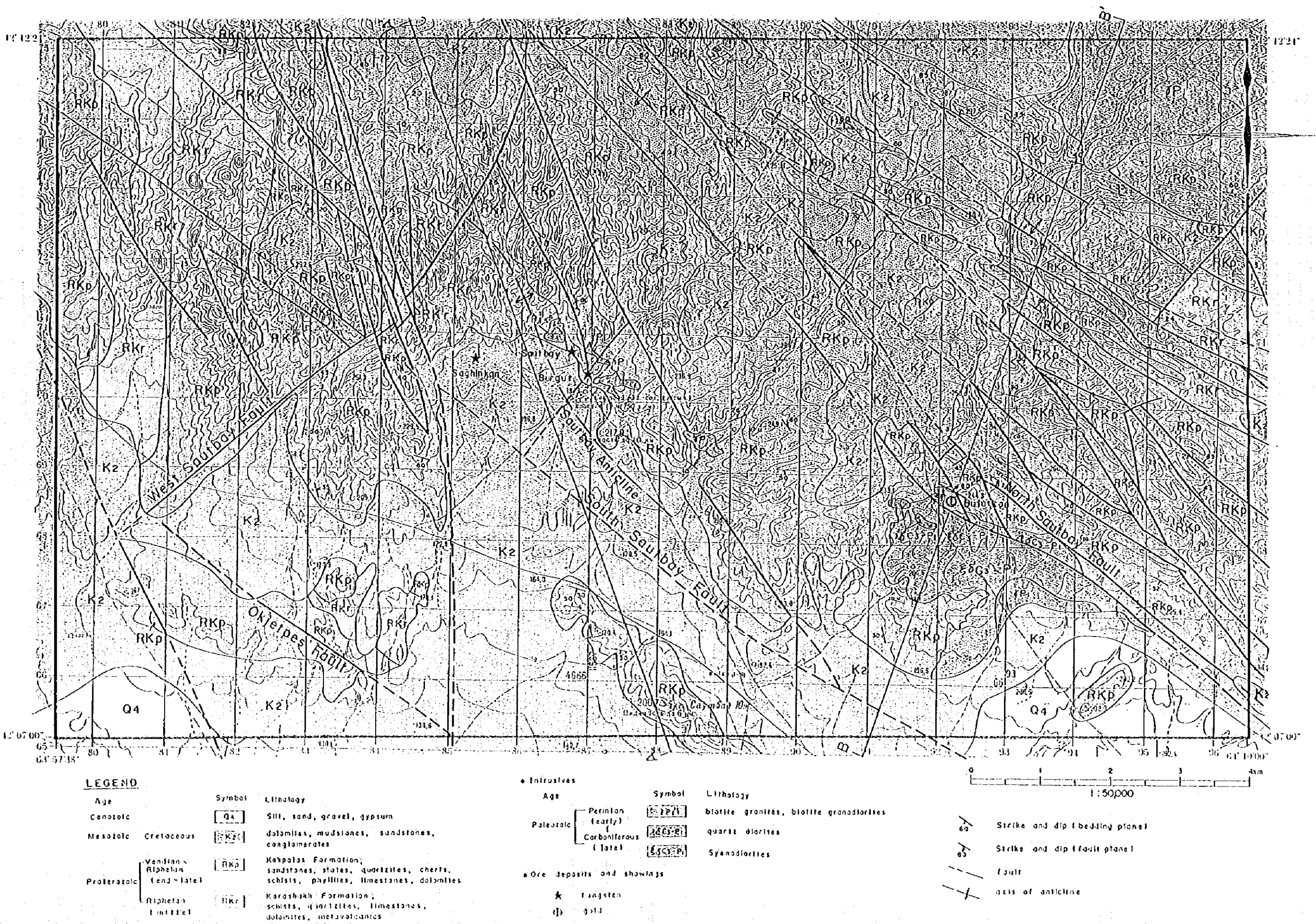
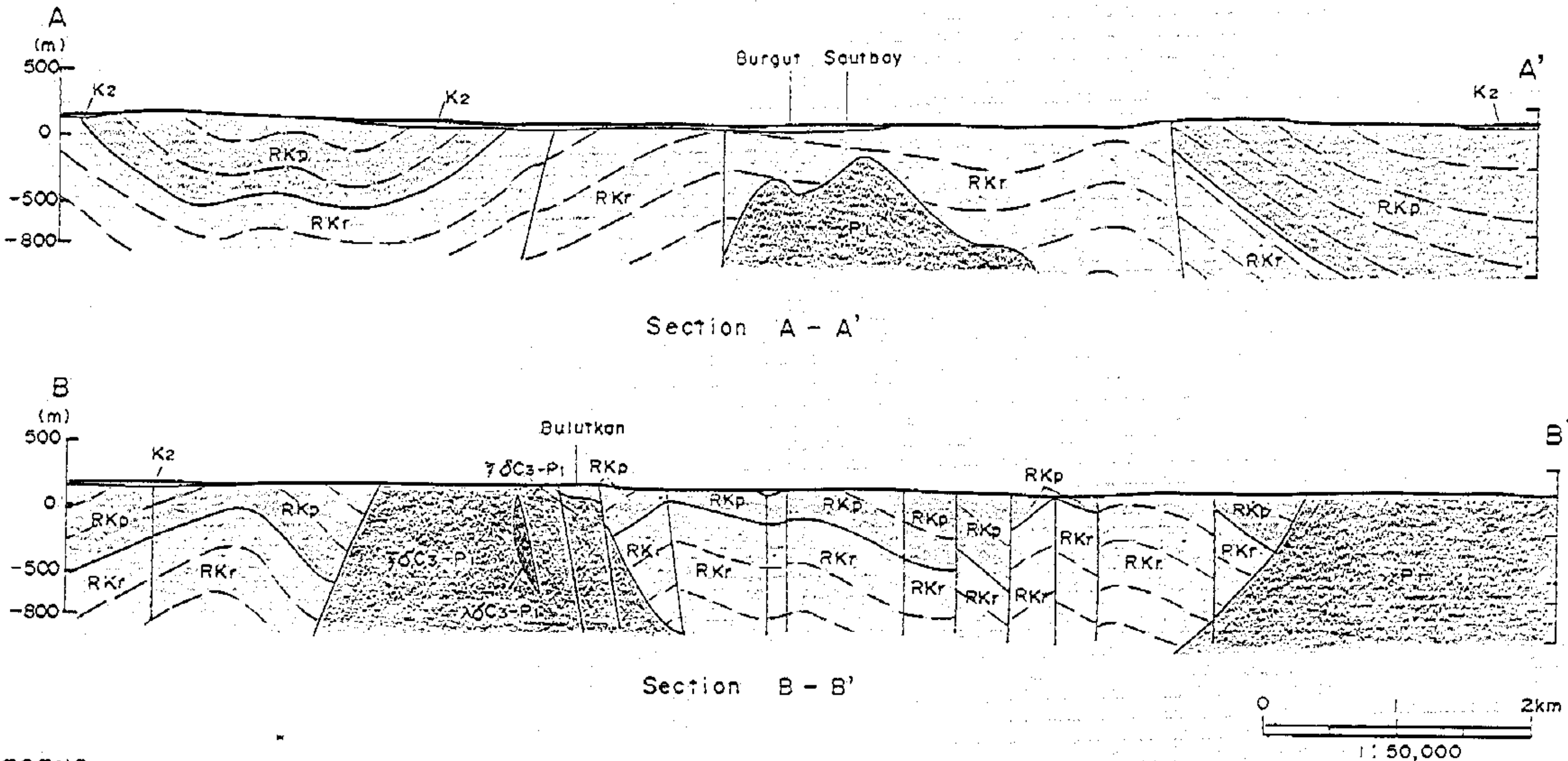


Fig. I -3-1 Geological Map of the Survey Area



LEGEND

Age		Symbol	Lithology
Mesozoic	Cretaceous	K2	dolomites, mudstones, sandstones, conglomerates
Proterozoic	Vendian ~ Riphean (end ~ late)	RKp	Kokpatas Formation; sandstones, slates, quartzites, cherts, schists, phyllites, limestones, dolomites
	Riphean (middle)	RKr	Karashakh Formation; schists, quartzites, limestones, dolomites, metavolcanics

• Intrusives

Age		Symbol	Lithology
Paleozoic	Permian (early) ~ Carboniferous (late)	γP1	biotite granites, biotite granodiorites
			quartz diorites
		δC3-P1	Syenodiorites

Fig. I -3-2 Geological Cross Sections of the Survey Area

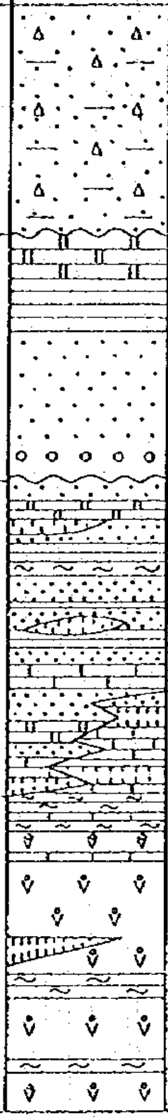
Age			Formation	Thickness (m)	Geologic Column	Lithology
Cenozoic	Quaternary			< 10		silt, sand, gravel, gypsum
Mesozoic	Cretaceous			< 80		dolomites mudstones sandstones conglomerates
Proterozoic	Vendian		Kokpatas	>1,000		sandstones, slates quartzites, cherts schists, phyllites limestones, dolomites
Proterozoic	Ripheian	end ~ late	Kokpatas	>1,000		schists, quartzites limestone, dolomites metavolcanics
Proterozoic	Ripheian	middle	Karashakh	> 500		

Fig. I -3-3 Schematic Geologic Column of the Survey Area.

Table I-3-1 List of Ore Deposits and Ore Showings in the Survey Area

Name	Host Rock	Minerali-zation	Type of Ore bodies	Size	Grade	Ore Reserves	Exploration
Sautbay·Burgut Ore deposits	Kokpatas Formation Karashakh Formation Granodiorite (stock)	W (Au)	Skarn (Stockwork)	21 skarn ore bodies l=1,600m(total) w=0.5-50m d=0-600m	(1993) WO_3=0.20-0.87% (Grade of ore bodies) (MMAJ,1997) WO_3=0.09-0.49% (Grade of ore bodies)	(1993) cut off WO_3=0.05, 0.08% $C_1+C_2+P_1$: 39,539,352t WO_3=0.43%, Au=0.34g/t (MMAJ,1997) cut off WO_3=0.05% Reserves: 15,195,300t WO_3=0.29%, Au=0.23g/t	Underway Prospecting activities(1985-1993): magnetic survey 70km² and 10km², trenching-9,044m³, non-coring drilling-4,440m, coring drilling 300m deep on average-42,030m, exploration shaft with drifts and cross-cuts-3,294m. (MMAJ,1996) Coring drilling-4 drillholes-1,509.9m.
Saghinkan Ore deposit	Karashakh Formation	W	Skarn	14 skarn ore bodies l=460-960m w=1-40m d=110-400m	(1994) WO_3=0.12-0.64% (Grade of ore bodies) (MMAJ,1997) WO_3=0.10-0.54% (Grade of ore bodies)	(1994) cut off WO_3=0.10% C_2+P_1: 12,710,000t WO_3=0.32% (MMAJ,1997) cut off WO_3=0.10% Reserves: 8,132,880t WO_3=0.28%	Completed Prospecting activities: trenching-1,152m³, mapping drilling-3,456m, coring drilling by 160m×80m and 80m×80m grid-19,051m.
Bulutkan Ore deposit	Kokpatas Formation Lamprophyres (dikes)	Au	Silicified rocks Skarn	1 ore bodies l=50m w=34.1m, Au=7.3g/t(T-2) d=0-110m	l= 0.7M, Au= 1.4g/t(MJUB-1) l= 2.0M, Au= 2.8g/t(MJUB-1) l=10.4M, Au= 4.4g/t(MJUB-7) l= 1.0M, Au= 6.6g/t(MJUB-7) l=14.9M, Au=21.2g/t(MJUB-7)	(MMAJ,1997) Reserves: (tentative estimate) 108,434t Au=7.8g/t	Underway Prospecting activities(1993-1994): trenching, 70 non-coring drillings(depth up to 70m), shaft(28.5m), tunnel(400m). Further prospecting works such as trenching, drilling and geophysical survey are scheduled until 1998.
Another showings in Bulutkan district	Kokpatas Formation	Au	Silicified rocks Skarn	w= 2.0m, Au= 1.2g/t(T-11) w= 1.0m, Au= 3.8g/t(T-28) l=12.0m, Au= 1.3g/t(T-29) w= 2.0m, Au=74.7g/t(P-819) w= 8.0m, Au=31.0g/t(P-822)	l= 2.0M, Au= 2.3g/t(MJUB-3) l= 1.2M, Au= 1.1g/t(MJUB-8) l= 9.7M, Au= 4.4g/t(MJUB-8) l= 1.0M, Au= 8.5g/t(MJUB-9) l= 2.0M, Au=11.9g/t(MJUB-13) l= 3.0M, Au= 1.3g/t(MJUB-17) l= 0.7M, Au= 6.0g/t(MJUB-17) l= 0.5M, Au= 9.8g/t(MJUB-18)	(MMAJ,1997) Reserves: (tentative estimate) 166,421t Au=16.4g/t	(MMAJ,1996 - 1997): Coring drilling-21 drillholes-3,130m Trenching-8,310m.

Chapter 4 Overall Analysis of the Survey Results

4-1 Relationship of Geology and Geological Structure to Mineralization

1) Sautbay district

The skarn-type tungsten deposit at the Sautbay district occurs at the contact zone of the intrusive granodiorite body with the carbonate rocks in the Proterozoic. The Sautbay stock of granodiorite intrudes along the axis of the Sautbay Anticline, whilst, on the surface, several granodiorite bodies occur in the NW-SE direction. The Sautbay intrusive rock body has been considered as one of the cupolas of the deep concealed South Bukantau batholith, characteristic of numerous comb-like protrusions from the stock itself. The comb-like protrusions, together with the stock, played an important role in the formation of skarns.

The carbonate rocks which control the mineralization appear at various horizons at the Proterozoic and the mineralization extends over about 500m in the vertical section, whilst the horizons, at which orebodies are mainly controlled, are in the upper portion of the Karashakh Formation and in the lower portion of the Kokpatas Formation. The Sautbay-Burgut deposits are controlled mainly by the lower portion of the Kokpatas Formation, where some 20 skarn orebodies are formed. The Saghinkan deposit is controlled by the upper portion of the Karashakh Formation where 14 skarn orebodies have been confirmed.

The skarn orebodies are stratiform, almost conformable with the bedding plane of the host rock.

Bonanzas are generally formed between 50 and 100m -- rarely 200m -- from the contact zones with the granodiorite body.

In addition to these stratiform ore bodies, stockwork-type tungsten mineralization consisting of veins-veinlets controlled by fractures develop mainly within granodiorite bodies, which has no economic value because of the low grades.

2) Bulutkan district

The Bulutkan deposit in the Bulutkan district is situated near the intersection of the North Sautbay Fault with the WNW-ESE trend and the faults with the NW-SE trend.

A syenodiorite stock, 9km long and 3km wide including latent body, which controls the gold mineralization of Bulutkan deposit, intrudes along the southern side of the North Sautbay Fault. This suggests that the North Sautbay Fault controlled the syenodiorite intrusion. The Kokpatas Formation around the orebody is composed of sandstone, slate, quartzite, limestone and dolomite, as well as those metamorphosed from these rocks, such as hornfels, silicified rocks, silicified-skarnized metasomatite and skarns.

The upper portion of the orebody consists of silicified rocks accompanied by ferrous oxide, fine-grained quartz and chalcedony while the lower portion is a skarn orebody with gold mineralization accompanied by sulfide minerals. From the trenching, drilling and tunneling survey findings, the bonanza of the orebody is presumed to assume a polygonal pyramid or pipe shape with a wide top face(the surface portion), either upright or sharply inclined northward. At the surface portion, the major axis of the bonanza shows the WNW-ESE trend. The bonanza occurs in close relations with lamprophyre and syenodiorite dikes intruding in the same direction. These intrusive rocks and the ore body are considered to be controlled by a group of fractures striking WNW-ESE. The skarn ore body in the lower portion occurs at the intersection of the faults with the trends of WNE-ESE, NW-SE and ENE-WSW at the +210m-level tunnel, with the horizon including carbonate rocks.

Also in other areas than the Bulutkan deposit, most of the silicified rocks in the gold mineralization areas, as confirmed by the Phase III trenching survey, strike WNW-ESE, accompanied by dikes of lamprophyre, syenodiorite, etc. in the same direction. From this, it is presumed that the fractures with the WNW-ESE trend paralleling the North Sautbay Fault have certain relationship to the mineralization. It is also presumed that these bonanzas of the gold mineralization, like those of the Bulutkan deposit, occur at the intersection of the faults with WNW-ESE trend, and the group of fractures intersecting the mentioned faults and the horizon including carbonate rocks.

4-2 Characteristics of Mineralization

(1) Sautbay district

The main type of mineralization at this district is that of tungsten, as represented by the Sautbay-Burgut deposits and the Saghinkan deposit.

The deposits have two types of tungsten mineralization, one of which is a stratiform skarn orebody along carbonate rocks while the other is a stockwork orebody occurring in granodiorite stocks, skarns, quartzite and hornfels.

Ores of the Sautbay deposit's skarn orebodies are hornblende-clinopyroxene skarns accompanied by scheelite and hornblende-clinopyroxene-pyrrhotite skarns, containing pyrite, pyrrhotite, chalcopyrite and marcasite, rarely accompanied by bismuthinite, native bismuth, arsenopyrite, sphalerite, galena, chalcocite and covelline.

The stockwork ore bodies are composed of veins/veinlets of quartz and a small quantity of feldspar, accompanied by scheelite. They develop mainly in granodiorite and has little economic value as the tungsten mineralization is so weak.

Although the skarn orebodies are accompanied by some gold, no auriferous minerals have been confirmed by the microscopic observation of the polished sections.

The fluid inclusions of two samples of quartz veins are those with vapor-liquid phases, and their homogenization temperature range is 110℃-346℃, distributed similarly to those of the Bulutkan district.

(2) Bulutkan district

The orebodies of Bulutkan deposit is composed of silicified rocks accompanied by ferrous oxide, fine-grained quartz veins and chalcedony in the upper portion while the lower portion comprises skarn orebodies accompanied by sulfide veins, with gold mineralization. The mineral components of the silicified rocks in the upper portion are mainly quartz, chalcedony, calcite, siderite, and goethite, accompanied by pyrrhotite and gypsum. The skarns in the lower portion are hornblende-clinopyroxene skarns composed mainly of tremolite, actinolite, chlorite, pyrite, marcasite, pyrrhotite, arsenopyrite and chalcopyrite, containing some wollastonite, scheelite, epidote and grossular. Lamprophyre, calcite and siderite intrude into the hornblende-clinopyroxene skarns.

The auriferous mineral occurs in the form of native gold in quartz and chalcedony, according to macroscopic observation. The X-ray refractory analysis and observation of polished sections by the Uzbek side indicate that native gold occurs in quartz, calcite and siderite veins, associated with graphite. Rarely, native gold is associated with pyrite, pyrrhotite, marcasite and chalcopyrite in hornblende-clinopyroxene skarns, but it is not observed in sulfide minerals. The gold grains are in oval, fine-vein, porphyritic and polymorphic forms, and their sizes are from 0.003mm or less to 0.1mm.

Alteration of the host rock is silicification, pyritization or skarnization. Alteration zones are mainly quartz-sericite zones or sericite-chlorite zones, accompanied by smectite and some kaolinite.

During the Phase III survey, the homogenization temperature of fluid inclusions was measured of 19 trenching samples and 16 drill-core samples of the Bulutkan district. (Appendix 2-8) The samples represent quartz in veins, quartz or calcite in veinlets or networks and silicified rock.

All the fluid inclusions are with vapor-liquid phase, while none of solid phase or polyphasic fluid inclusions containing liquid-phase carbon dioxide, as observed in Phase II, were found.

The homogenization temperatures of liquid inclusions range from 101℃ to 361℃. Samples taken from the skarns tend to range from 250℃ to 350℃, whereas those from the sedimentary rocks of the Kokpatas Formation from 100℃ to 250℃. Although some of the samples from the sedimentary rocks of the Kokpatas Formation exceed 300℃(TL12L3, TL-17L4, etc.), these samples were taken from the vicinity of syenodiorite stocks or diorite dikes.

The homogenization temperatures of samples accompanied by gold mineralization are in the range of 100℃ ~ 250℃, while samples from skarns fall within the range of 250℃ ~ 350℃, showing a tendency similar to that in Phase II.

From these findings, it is presumed that the quartz veins were formed through plural stages and the gold mineralization was accompanied by low-temperature quartz of a late stage.

The process of occurrence of the Bulutkan deposit may be concluded as follows:

(1) By the intrusion of the syenodiotite stock, the amphibole-pyroxene skarns were formed, which have paragenetic mineral composition of chalcopyrite-pyrrhotite and pyrite-arsenopyrite in the horizon including carbonate rocks of the Kokpats Formation.

(2) Later on, gold mineralization accompanying quartz, siderite and calcite veins was added. Graphite is considered to have occurred by alteration of carbonaceous substances in the carbonate rocks under reaction with gold-bearing silicious solution.

4-3 Relationship between Geophysical Anomalies and Mineralization

The geophysical survey by the TEM method clarified the resistivity strucure up to some 200m under the surface or 0m above the sea level.

Most of the ore showings caught in the trenching survey are located within the shallower resistive - very resistive zones adjacent to the IP boundary(Fig.II-2-3-6). From the comparison of results among the trenching survey, the drilling survey and the geophysical survey, IP boundary corresponds to the northern contact of syenodiorite stock and sedimentary rocks. And the shallower resistive - very resistive zones correspond to portions where diorite dikes, quartzite, silicified rocks and quartz veins are densely concentrated.

Most of the ore showings caught by drilling survey at the level of 100-150m A.S.L. are located within the deeper resistive - very resistive zones. From the comparison of the results among the drilling survey and the geophysical survey, these zones correspond to portions where dikes of syenodiorite and diorite, quartzite, silicified rocks, skarnized metasomatite and quartz veins are densely concentrated.

In the Phase III survey, detailed distribution of these resistive - very resistive zone has been confirmed. These zones extend in the WNW-ESE direction, but the discontinuities of these zones are found on the survey lines L-14, L-19 and L-5. The distribution of the resistive zones in the syenodiorite stock is also controlled by these discontinuities. The top of the deeper resistive zone is deepening in west of L-14.

The prominent directions of faults in the survey area are the WNW-ESE and the NNE-SSW directions. The resistivity distribution of the survey area is also controlled by this directions.

4-4 Potentialities of Occurrence of Ore Deposits

As the result of analysis of the existing data during the Phase I survey, these ore deposits were classified into seven types: ①gold-bearing quartz veins, ②gold-silver-bearing quartz veins, ③gold-silver-copper-bearing quartz veins, ④silver-bearing quartz veins, ⑤ tungsten-skarn deposits, ⑥tungsten-quartz stockwork deposits, and ⑦tungsten-gold-skarn deposits.

Economically viable ore deposits located in the survey area are the Bulutkan deposit with the gold-bearing quartz veins①, the Sautbay deposit and the adjacent Burgut and Saghinkan deposits, which are the tungsten-skarn deposits⑤.

1) Sautbay district

Based on the ore reserves estimation, feasibility for development of deposits was studied, which however led to the negative conclusion that mine development in this district is economically unfeasible under the current levels of ore reserves, grade and WO_3 price, since the operations generate losses even on the most favorable assumptions. While a certain increase in ore reserves by means of further exploration may be anticipated, a significant improvement in WO_3 grade is unlikely.

2) Bulutkan district

In the district, gold deposits occurring in the Proterozoic close to the north side of the syenodiorite stock are scattered over an extension of 1,200m in strike.

In the light of the Phase III trenching and drilling survey findings, the orebodies are presumed to be poor in continuity and small in size(extension 50-150m; depth up to 100m).

The ore reserves calculation(tentative) of the gold deposit in the district indicated 275,000t of ore reserves totaling eight ore blocks, grading 13.1 g/t Au(gold content 3.6t), which is rather small for a gold deposit in Uzbekistan.

A feasibility study on development of the selected two ore blocks including the Bulutkan deposit indicated that, in case 115,000t of minable crude ore, grading 10.0 g/t, is mined out in a year, it would generate operating income of 125 sum(2.5$) per ton of crude ore.

Occurence of orebodies similar to those of the Bultukan deposit can be anticipated in an area east of the trench T-6, in the Proterozoic close to the north side of the syenodiorite stock. In view of the exploration findings so far obtained, however, it is inferred that mineralization in this area is weak and potentialities for occurrence of large gold deposits is low. Nonetheless, there remains certain probability that some Bulutkan-class ore deposits are discovered.

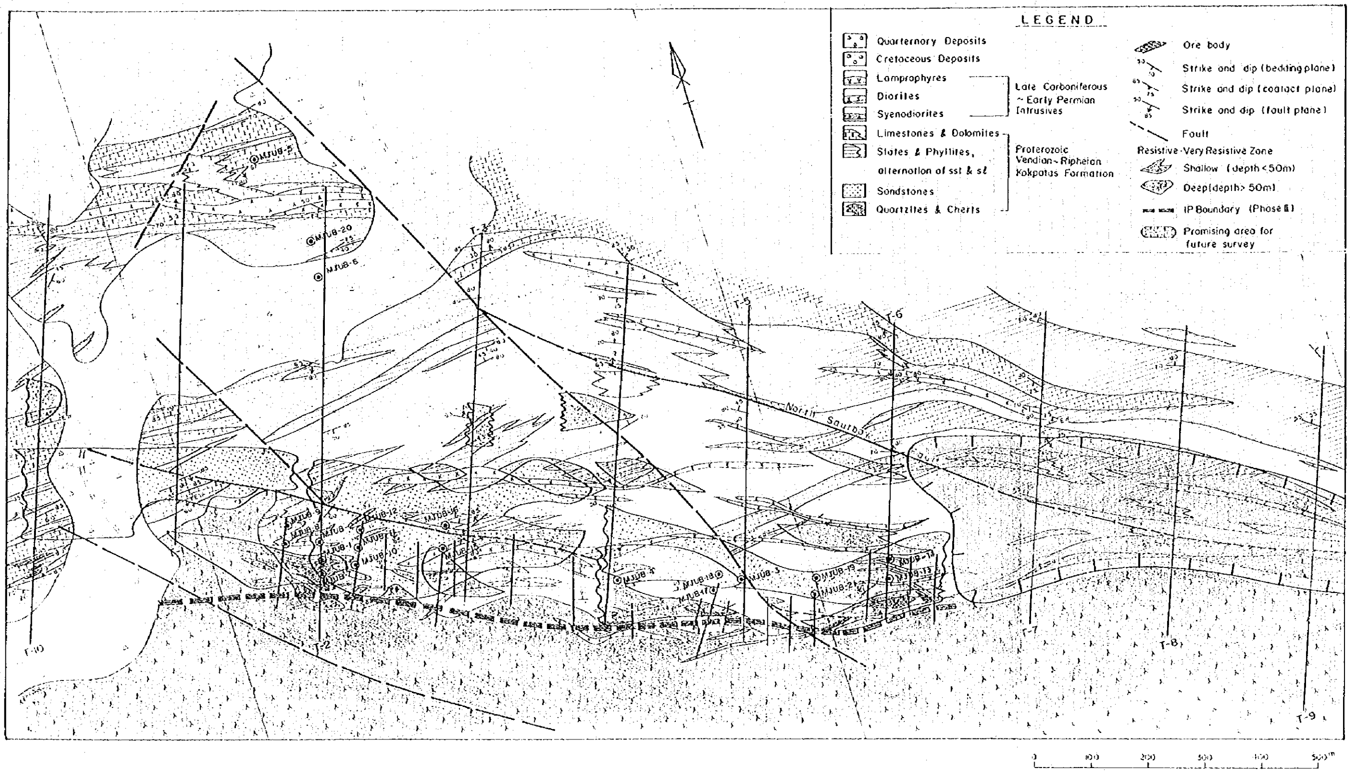


Fig. I-4 Relation between Geophysical Results and Geological Structure in Bulutkan District

Chapter 5 Conclusions and Recommendations

5-1 Conclusions

1) Sautbay District

(1) The Karashakh Formation and the Kokpatas Formation, both pertaining to the Proterozoic, occur in the Sautbay district, where stocks and dikes of the Late Carboniferous ~ Early Permian granodiorite, aplite, diorite, lamprophyre, etc. intrude into the Proterozoic.

The major type of the ore deposit is the tungsten-bearing skarn deposit controlled by granodiorite, as represented by the Sautbay deposit which is the main ore deposit in the district, as well as the nearby Burgut and Saghinkan deposits.

(2) Ore reserves of the Sautbay, Burgut and Saghinkan deposits were estimated, based on the recollected data, for the purpose of revaluation of these deposits.

At a cutoff grade of 0.05% WO_3, the total ore reserves of the Sautbay, Burgut and Saghinkan deposits add up to approx. 25,257,000t, averaging 0.27% WO_3 and 0.15 g/t Au, or approx. 69,000t of WO_3 and approx. 3.7t of Au in terms of metal content.

The WO_3 grades of these ore deposits are substantially lower than those of skarn-type tungsten mines operated since 1980 in the Western countries.

(3) Feasibility for development of the Sautbay, Burgut and Saghinkan deposits was studied. Since separate development of these ore deposits is difficult due to the small minable crude ore reserves and low grades, the mining plan of plural deposits combined was pursued. Operation was optimized by combining 700-tpd openpitting of the portions over +100m(above sea level) of the Sautbay deposit and 800-tpd underground mining of the Burgut deposit.

However, even the optimized operation would leave accumulated deficits of 30 million sum(600,000$) as against the initial investment of about 2 billion sum(40 million$). The estimation was based on the assumptions that the entire investment is catered for by own funds while no escalation of labor and materials expenses nor costs for equipment replacement, mine closure and taxes are considered.

Due to the lack of profitability even under such exceptionally favorbale conditions, development of the tungsten deposits in the Sautbay district is considered economically unfeasible, under the current levels of the ore reserves, grade and WO3 price.

2) Bulutkan district

(1) The Kokpatas Formation of the Proterozoic occurs in the district, where stocks and dikes of the Late Carboniferous ~ Early Permian syenodiorite, diorite, granite,

porphyrite, lamprophyre, etc. intrude into the Formation.

The dominant directions of faults in this district are NW-SE ~ E-W and NNW-SSE trends.

Ore deposits consist of gold-bearing quartz, silicified veins and skarn orebodies. The known ore deposit in this district is the Bulutkan deposit.

(2) According to results of the exploration conducted independently by the Uzbekistan at the +210m-level tunnel, the bonanza of the Bulutkan deposit occurs at intersections of the faults with the WNW-ESE, NW-SE and ENE-WSW trends and the horizon including carbonate rocks.

The orebody is presumed to take the shape of a polygonal pyramid or pipe(width 20-35m ; depth about 100m) with a broad upper face(the surface portion), upright or inclined sharply northwestward. The upper potion of the orebody is composed of silicified rocks accompanied by ferrous oxide, fine-grained quartz veins and chalcedony while the lower portion comprises skarn orebodies accompanied by sulfide veins, which is also accompanied by gold mineralization. Component minerals of the silicified rocks in the upper portion are mainly quartz, chalcedony, calcite, siderite and goethite accompanied by pyrrhotite and gypsum. Those of the skarns in the lower portion are amphibole-pyroxene skarns composed mainly of tremolite, actinolite, chlorite, pyrite, marcasite, goethite, pyrrhotite, arsenopyrite and chalcopyrite, as well as wollastonite, scheelite, epidote and grossular in small quantities.

The Uzbek mineralogical study indicates that native gold occurs in quartz veins, calcite veins, and siderite veins, associated with graphite. Native gold is occasionally associated with sulfide minerals in amphibole-pyroxene skarns but not recognized in sulfide minerals.

(3) Au grade of 1g/t or higher were confirmed at the following three portions at the trenches T-11(80.0-82.0m; 1.2 g/t), T-28(36.0-37.0m; 3.8 g/t) and T-29(52.0-64.0m; 1.3 g/t). Many silicified and oxidized zones were confirmed by trenching but few of them showed high grade of Au.

(4) Gold mineralization was observed at drillholes aimed at the west extension of the Bulutkan deposit: MJUB-8(depths18.1-19.3m: true width 0.5m; 1.1g/t Au and 27.7-37.4m:4.9m; 4.4 g/t) and MJUB-9 (47.0-48.0m:0.5m; 8.5 g/t).

Au grades of 1g/t or more were also confirmed at MJUB-13(39.5-41.5m: 1.1m; 11.9 g/t), MJUB-17(23.4-26.4m:2.0m, 1.3 g/t) and MJUB-18(69.0-69.5m: 0.5m; 9.8 g/t). However, these orebodies are presumed to be poor in continuity and small in size(extension 50-150m; depth up to 100m), in the light of the trenching and drilling survey results.

(5) Geophysical survey results

The geophysical survey by the TEM method clarified the resistivity structure up to some 200m under the surface or 0m above the sea level. At the zone where syenodiorite occurs in the south of the survey area, the resistivity ranged from the medium to the very high. At the zone where Proterozoic occurs along the northern periphery of the syenodiorite body in the central part of the survey area, the high ~ very high resistivity zones, apparently inclined northward, are intermittently distributed. Most of the major mineral showings in this district have been found in these high resistivity zones. The high resistivity zones correspond mainly to zones where diorite dikes, silicified rocks, quartzite and quartz veins are densely concentrated, and also to zones of silicified and skarnized metasomatites.

To the north of the high resistivity zones, low resistivity zones spread. The resistivity zones correspond to zones where limestone and slate occur. The resistivity in the horizontal direction shows block-like distribution controlled in the trends of WNW-ESE and NNE-SSW, similar to those of faults dominant in the survey area.

(6) The homogenization temperatures of fluid inclusions in quartz veins and calcite veins range from 100℃ to 360℃. Samples with gold mineralization generally showed the homogenization temperatures of around 200℃, ranging from 100℃ to 250℃. This is concordant with the conclusion of the Phase II survey that high-temperature skarnization (homogenization temperature: 250℃-350℃) was followed by gold mineralization under lower temperature(150℃-250℃).

The formation process of the Bulutkan deposit can be interpreted as follows:

① By the intrusion of the syenodiorite stock, amphibole-pyroxene skarns which have paragenetic mineral compositions of chalcopyrite-pyrrhotite and pyrite-arsenopyrite in the horizon including carbonate rocks of the Kokpatas Formation were formed.

② Afterwards, gold-silver mineralization accompanying quartz veins, siderite veins and calcite veins was added.

(7) A tentative calculation on the ore portions ascertained by the exploration indicated the ore reserves of 275,000t, grading 13.1g/t Au(3.6t of Au content), which is small for a gold deposit in Uzbekistan.

(8) Small-scale open-pit mining is applicable to near-surface orebodies with wide veins in the Bulutkan district. Feasibility for development of the two selected ore blocks

including the Bulutkan deposit was studied on the assumptions that initial investment is to be minimized and that the ore is to be hauled to the Kokpatas gold mine by 45-t trucks and to the Uchkuduk No.3 ore-dressing plant by rail, for processing. A tentative calculation indicated that, if 115,000t of minable crude ore, grading 10.0 g/t Au, is mined out within one year, operating income of approx. 15 million sum(300,000$) would be gained. As it is not realistic to newly organize an independent mine only for the one-year operation, the ore blocks would have to be placed under the control and administration of the Kokpatas gold mine as its subsidiary mine, if the ore blocks are to be developed in reality.

5-2 Recommendations for the Future

1) Sautbay district

Based on the ore reserves estimation, feasibility for development of deposits in this district was studied, which however led to the negative conclusion that mine development in this district is economically unfeasible under the current levels of ore reserves, grade and WO_3 price, since the operations generate losses even on the most favorable assumptions. While a certain increase in ore reserves by means of further exploration may be anticipated, a significant improvement in WO_3 grade is unlikely. It is advisable, therefore, to suspend exploration in this district and to reserve the district as a potential supply source of tungsten resources for the future.

2) Bulutkan district

The Phase III estimation of the total ore reserves of eight ore blocks indicated 275,000t, grading 13.1g/t Au and 6.5 g/t Ag. Two of the ore blocks, including the Bulutkan deposit, were extracted for the tentative feasibility study for open pit operation. The study indicates that if 115,000t of minable crude ore, grading 10.0 g/t, is mined out within a period of one year, it would generate operating income of 125 sum(2.50$) per ton of crude ore. It is necessary to study how to deal with the ore deposit in the future..

There remains certain possibility for discovery of other small ore deposits of a Bulutkan-class, to the north of the syenodiorite stock in the area east of the trench T-6, where the Phase II trenching and geophysical surveys were conducted. It is recommendable to carry out further trenching, geophysical and drilling surveys in the area, in order to ascertain mineralization in the area. For successful exploration, it is recommended to make detailed studies on the structures of the horizon of carbonate rocks and of the faults intersecting the horizon.

PART II PARTICULARS

Chapter 1 Sautbay District

1-1 Geology and Ore Deposits in Sautbay District

The geology of Sautbay district is composed of sedimentary rocks of the Karashakh Formation and the Kokpatas Formation -- both the Proterozoic. The Karashakh Formation forms the core of the Sautbay Anticline while the Kokpatas Formation forms its wings (Fig. II-1-1-1).

The Karashakh Formation, more than 500m in thickness, is composed of green rocks of volcanic origin and schists associated with, quartzite, dolomite and limestone.

The Kokpatas Formation has the base composed of dolomite and limestone beds, 100-150m thick, which intercalate sandstone, slate and quartzite and is overlain by thick sandstone accompanied by slate, quartzite, schist, limestone and dolomite. The upper part of the formation is composed of sandstone and slate rarely intercalating dolomite and chert. The total thickness of the Kokpatas Formation reaches 1,000m or more. The relationship between the formation and the underlying Karashakh Formation is conformable and presumed to be partially interfingering.

Stocks and dikes of granodiorite, aplite, diorite, lamprophyre, etc. of the Late Carboniferous ~ Early Permian intrude into the Proterozoic.

The folding system in the district is represented by the Sautbay Anticline. The Sautbay stock of granodiorite which controls the occurrence of skarn accompanied by tungsten mineralization is situated in the axis of the fold.

The horizon including carbonate rocks which controls the ore correspond to the upper part of the Karashakh Formation or the lower part of the Kokpatas Formation, the extent of mineralization in the vertical section reaching 500m.

The main type of the mineralization is a tungsten-bearing skarn deposits. Not merely the Sautbay deposit -- the major deposit in the district -- but the Burgut deposit and Saghinkan deposit situated in the surrounding areas fall within this type, as well.

1) Sautbay deposit

The Sautbay deposit is situated 15km east of the Kokpatas Expedition base. Since 1985, exploration and evaluation of this district, including the Burgut ore deposit, have been conducted while the full scale prospecting was commenced in 1993.

The deposit is situated in the contact zone east of the Sautbay granitic stock. The ore bodies are divided into two types: stratiform or stratiform-stockwork skarn ore bodies along carbonate rocks; and, stockwork ore bodies in granitic intrusive rocks, skarn, quartzite and hornfels.

11 skarn ore bodies of different thicknesses and lengths (Nos. 1-9, 20 and 21) have been confirmed by drilling (Fig. II-1-1-2).

The main skarn ore body (No.1 ore body) is stratiform, dipping 40-80° east. Its thickness varies from 1 to 50m, averaging 15m.

The main mineral components of the ore are hornblende-clinopyroxene skarn accompanied by scheelite and hornblende-clinopyroxene-pyrrhotite skarn. The ore usually contains quartz, pyrite, pyrrhotite and chalcopyrite. No oxide zone is visible.

Stockwork ore bodies develop mainly in granitic stocks, which consist of quartz and small quantities of feldspar in vein or veinlets. These veins occur intruding into skarn beds and contact metasomatite. The stockwork mineralization in granitic rocks at the Sautbay deposit is too weak to have a certain economic value.

The ongoing Uzbek exploration work is expected to continue till 1998. Ore reserve estimation and feasibility study on the development by open pit (up to 150m below the surface) and underground mining (up to 600m below the surface) were effected in 1993.

During the first fiscal year of this survey, the existing data regarding the Sautbay and Burgut deposits were collected, on the basis of which ore reserves were calculated with a computer to evaluate the deposits. The calculation indicates that, at a cutoff grade of 0.05% WO_3, the total ore reserves of the both deposits came to 25,885,000t, averaging WO_3 0.27% and Au 0.24g/t. Compared to the Sarydjoy Report elaborated by the Uzbek side, the calculation results are generally similar as far as the planned open pit area is concerned but a wide discrepancy is seen in the total ore reserves of the Sautbay and Burgut deposits (Table II-1-1-1).

Table II-1-1-1 Comparison of Ore Reserves Estimation Results by MMAJ(1995) and Sarydjoy Team(1993)(on the Whole Area Basis)

Area	Reported by	Reserves (t)	WO_3 (%)	Au (g/t)	WO_3 (t)	Au (kg)
Open pit of Sautbay deposit	Sarydjoy(1993)	2,606,250	0.38	0.16	9,960.5	411.4
	MMAJ(1995)	2,621,000	0.35	0.13	9,173.5	340.7
Sautbay,Burgut deposits	Sarydjoy(1993)	39,539,352	0.43	0.34	168,701.5	13,530.7
	MMAJ(1995)	25,885,000	0.27	0.24	70,631.7	6,335.1

2) Burgut deposit (W)

The Burgut deposit, 0.5km southeast of the Sautbay deposit, is situated at the contact zone of the granitic stock extending in the WNW-ESE direction (Fig. II-1-1-1). Gold and tungsten occur in skarn which develop selectively in siliceous-clastic sedimentary rocks. It has been known by drilling that the mineralized zone extends 600m in strike and 340m in dip while the ore body is 2.1-13.8m thick.

Most part of the ore body is of clinopyroxene skarn and clinopyroxene-garnet skarn, situated at various levels. The Nos. 10-19 ore bodies have been confirmed by drilling.

Ore reserves of the Burgut deposit was estimated in 1993, together with those of the Sautbay deposit. In the first fiscal year of this survey, the ore reserves of the both deposits were calculated.

The two deposts are currently under exploration by core drilling.

3) Saghinkan deposit(W)

The Saghinkan deposit is adjacent (1km west) to the Sautbay deposit (Fig. II-1-1-1). Presence of the Saghinkan deposit had been inferred in the course of the magnetic anomaly processing.

Mineralization is recognizable in sedimentary rocks mainly of the Karashakh Formation which is intruded by the Sautbay stock, between the depths of 110m and 400m (Fig. II-1-1-4). The surface portion is covered by Mesozoic-Cenozoic sediments of 30-50m in thickness.

14 skarn orebodies have been confirmed, which are stratiform, almost conformable with the host rock. The deposit is 1-40m thick, continuing almost horizontally over 460-960m.

At present, the exploration in the district has been completed. At the end of 1994, evaluation of the exploration, as well as ore reserves estimation, was effected by the Uzbek side.

The total ore reserves of the Saghinkan deposit estimated at Phase II came to 16,320,000t, in case of the cutoff grade at WO_3 0.05%. The average WO_3 grade is 0.24% and the metal content is 40,000t of WO_3, while the Au grade averages only 0.02 g/t. Saghinkan has almost no value for gold.

As compared to the Uzbek estimation of 12,710,000t, averaging 0.32%(40,000t of metal content) in case of the cutoff at WO_3 0.1%, the Phase II estimation comes to 13,944,000t, averaging 0.27% (38,000t of metal content). The ore reserves somewhat increases and the average grade declines, which is presumably attributable to a difference in the area of estimation. The two estimations are considered to be basically in agreement.

(after V.A.Aleksashechkin;1993)

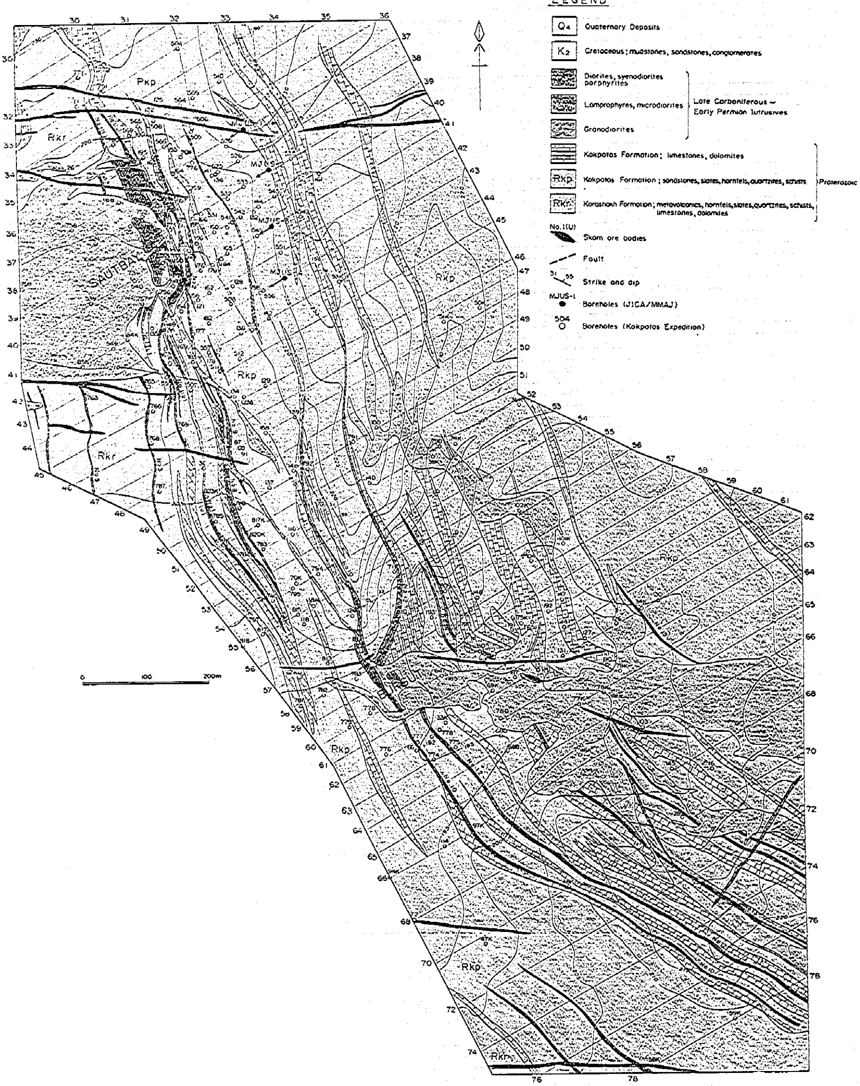


Fig. II-1-1-1 Geological Map of the Sautbay District

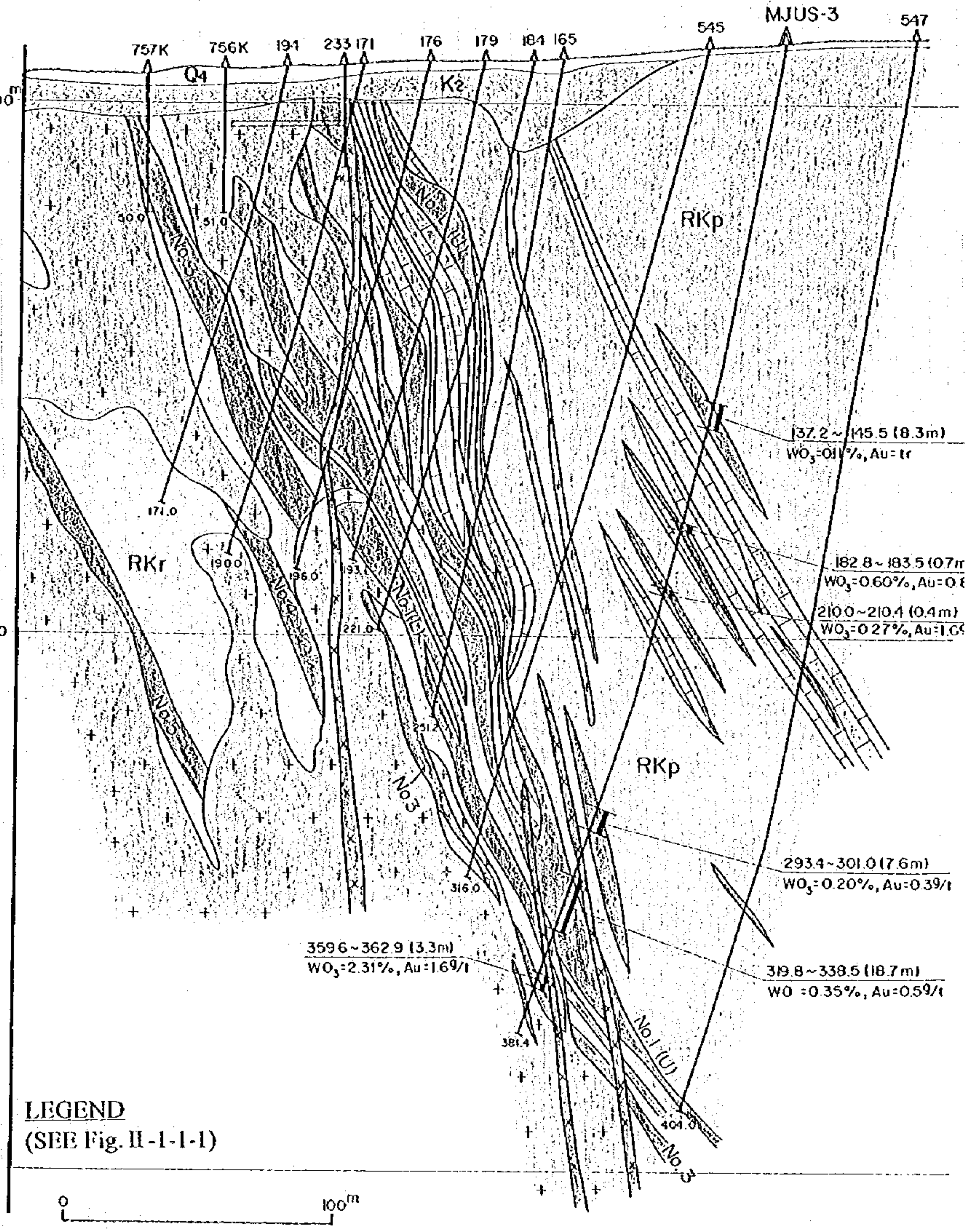


Fig. II-1-1-2 Geological Cross Section of the Sautbay Deposit(Line 41)

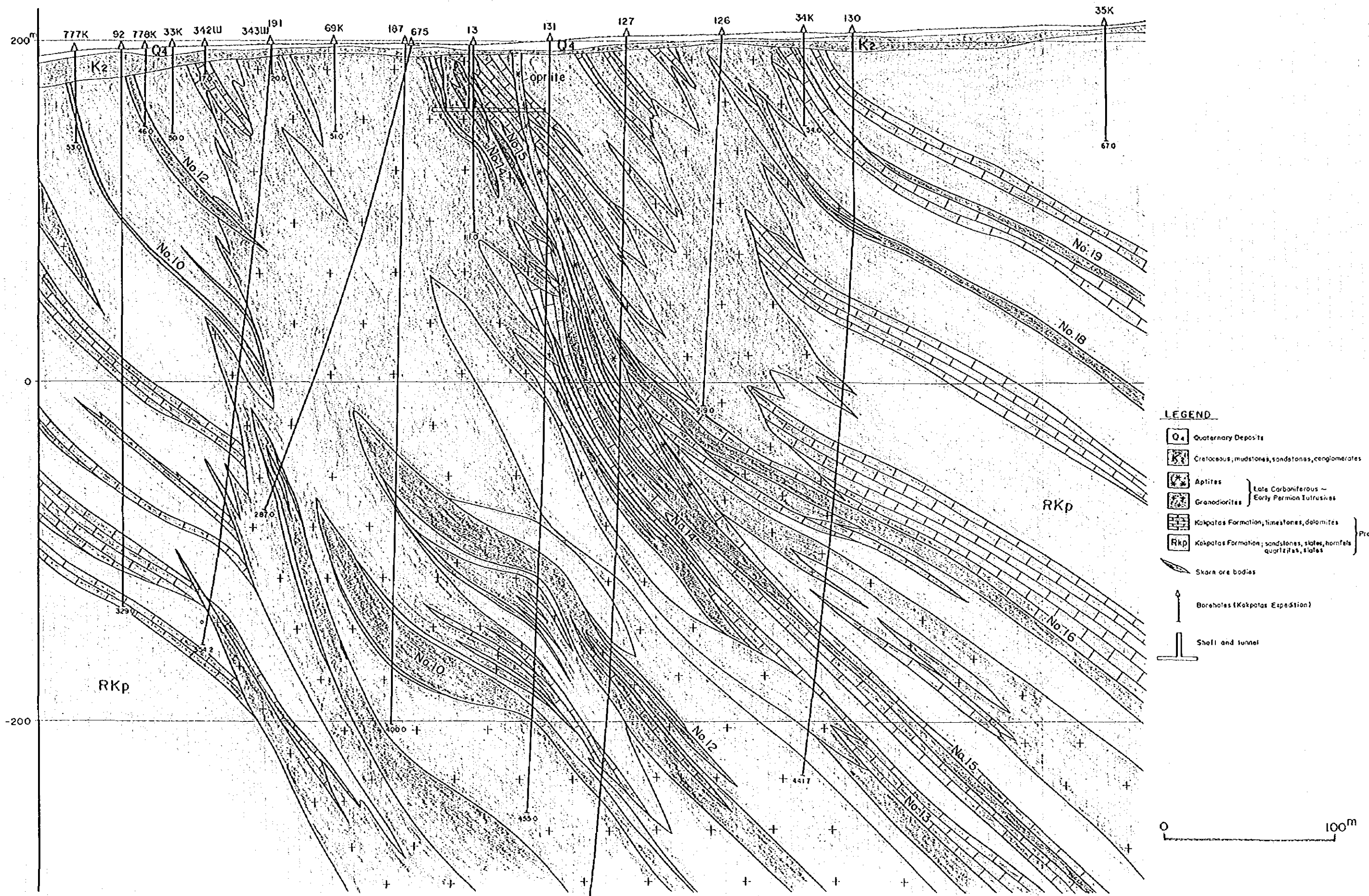


Fig. II-1-1-3 Geological Cross Section of the Burgut Deposit(Line 62)

(after T.P.Radajeva,H.B.Khan,O.G.Kim;1994)

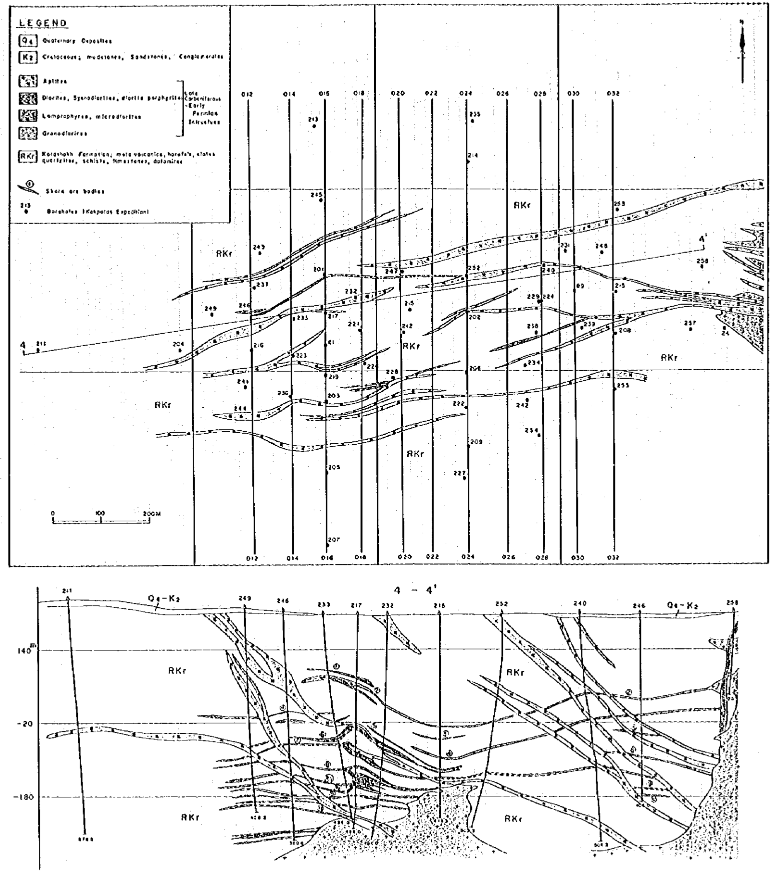


Fig. II -1-1-4 Geological Map and Cross Section of the Saghinkan Deposit

1-2 Ore Reserves Estimation of Sautbay, Burgut and Saghinkan Deposits

1-2-1 Purpose

With a view to revaluating the Sautbay, Burgut and Saghinkan deposits in the Sautbay district utilizing the data obtained from the surveys up to Phase III, the ore reserves of these deposits were estimated by the Western method, and mining plans were drawn up on the basis of results of the estimation and the field survey.

1-2-2 Method of estimation

1) Software

For the ore reserves calculation, microLYNX Plus released by Lynx Geosystem Inc. of Canada was used. The microLYNX Plus is a synthetic analysis system designed for subsoil resources exploration and mine development, suitable for ore reserves calculation of skarn-type and vein-type ore deposits, whose major functions/features are as follows:

① A project-oriented program to manage more than one project in a computer system.

② Entry of drill hole data including assay and geological information, editing where necessary.

③ Graphics display and plotting of drill hole data in section and plan to assist in the interpretation of the spatial nature of the mineralization.

④ Statistical and geostatistical analyses of grade variables to determine the distribution and variability of grade within the deposit.

⑤ Definition of geology, in section or plan, for control of ore reserve modelling.

⑥ Generation of ore reserve models, and interpolation of grades of target components

⑦ Calculation of geological reserves based on the interpolated grades.

⑧ Visual display and plotting of the model in section ore plan to assist in the mining design.

⑨ Designing of open pit or underground tunnel, calculation of mineable reserves.

⑩ Updating the reserve models to reflect the more abundant data available during mining.

2) Area of estimation

The Burgut deposit is incorporated in the ore reserves calculation of Sautbay deposit, as was done in Phase I.(Fig. II-1-2-1) As to the Saghinkan deposit, recalculation was made using the new variogram of WO_3 and Au of the Sautbay deposit.

The coordinate system used in Sarydjoy report is in accordance with true north but the geologic section maps are along N60° E. Therefore, a new coordinate system was created by rotating the old system by 60°, clockwise, and moving the origin to a proper point. This new system was used in the calculation. Fig. II-1-2-2 shows the ore reserves calculation area of 1,750m by 1,600m, from -5 to 1,745m along X axis and from -5 to 1,595m along Y axis respectively in the new coordinate system.

3) Chemical analysis and components

Some 700 holes were drilled at and around Sautbay and Burgut deposits, more than half of which are coreless. 244 among the 700 holes were used in the ore reserves estimation (Fig. II-1-2-2). Data of 85 holes were added to those of Phase I. Samples for analysis were collected from the cores at intervals of 1 ~ 2m. Samples collected from the walls of the tunnel at the level of 193m at the Sautbay deposit were regarded as 36 horizontal drillholes in view of the tunnel directions, which were included in the calculation. As WO_3 and Au are the primary components of the deposits and very few or no data were available for other components, the estimation targets were limited to WO_3 and Au. Numbers of samples for WO_3 and Au are 14,597 and 16,516, respectively.

4) Definition of orebodies

In December, 1993, the Sarydjoy working team of Uzbekistan submitted a geological report including ore reserves estimation of the Sautbay and Burgut deposits. Attached to the report are 23 sheets of geologic sections, intersecting nearly at right angles the strike of orebodies. According to these materials, 21 orebodies have been identified in the Sautbay and Burgut deposits, to each of which identification numbers are assigned. Since the two deposits are situated so closely and some of the orebodies stretch over the both deposits, they are considererd as practically one single deposit.

For definition of orebodies, 22 of the above-referred 23 geologic sections were utilized with minor modifications, as were done in Phase I. Further modifications were made to 10 of the sections, based on the latest data. As shown in PL.II-1-2-3, the intervals between sections are 40 - 170m, and about 40m at the Sautbay deposit. The section along the line 78 was excluded from the calculation because the section 78 at the southeastern end is some 320m away from the section 70 and few data were available around the section. The ranges of a section in positive and negative directions, within which geologic interpretation will be considered to be the same as that of the section, were considered to be equal to halves of the distances between the section and adjacent sections in both directions respectively. Unique geologic codes were assigned to all of the ore bodies for identification.

5) Variogram

All of the samples should have the same size (length in this case) in geostatistical analysis. Therefore the assay data were composited before the calculation of variograms. Compositing is a procedure in which sample assay data are combined by computing a weighted average over longer intervals to provide a smaller number of data with greater length for use in reserve esitmation. Compositing is usually a length-weighted average. The length of composites used in our calculation is 5m, and the compositing process is as follows: ① assigning geologic codes to assay data based on the geologic cross sections and their ranges, ② computing composites by length-weighted average method according to the geologic codes.21 ore bodies are separated spatially. Origionally, they are differernt from each other, having different variograms. All of the ore bodies except No.1 have no enough data to produce meaningful variograms. Therefore, only variograms for No.1 ore body were computed in order to examine the charateristics of grade distributions in 3-dimensional space.

No.1 ore body is in the shape of a plate on the whole, striking N10° W and dipping 60° E. The ore body forms a large block from the surface to 150m deep in Sautbay deposit, and branches into four stratiformed ore bodies below the depth. An new axis system for No.1 ore body was defined for later explaination as shown in Fig. II-1-2-3.

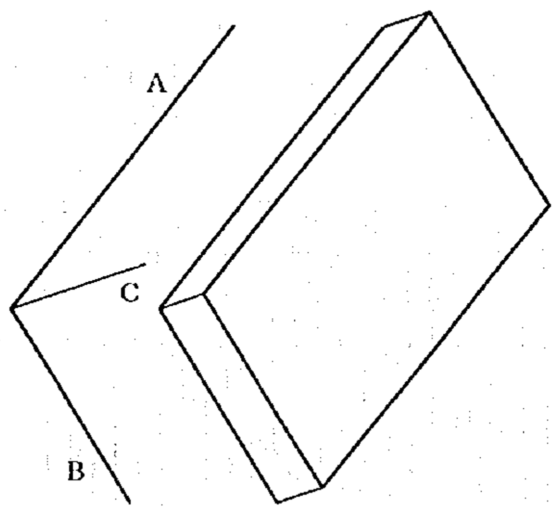


Fig. II-1-2-3 Definition of 3 axes for No.1 ore body

A axis: along the strike of No.1 ore body, N10° W
B axis: dipping of No.1 ore body, -60° to the horizontal plane
C axis: vertical to the plate of No.1 ore body, +30° to the horizontal plane

Distributions of variables in geological units(for example, Au grade in a deposit) in nature show various characteristics. Some of them are isotropic, others are anisotropic. Anisotropy is expressed geostatistically by the existing of different variograms in different directions. Even the same data set will produce different variograms according to the computing conditions(distance between pairs of samples, angles within which pairs of samples will be found, etc.). Therefore, while doing variogram analysis, it is very important to change conditions to compute various variograms, and then select most typical ones from them.

Fig. II-1-2-4 ~ II-1-2-8 show the representative variograms of WO_3 and Au along the different directions for No.1 ore body. They are selected from many variograms examined using various conditions. Table II-1-2 shows the parameters obtained from the variograms, which can represent the variograms. No clear variograms were obtained for Au in C axis direction.

Table II-1-2-1 Parameters of the Variograms for No.1 Orebody

Component	Nugget	Sill	Range (A axis)	Range (B axis)	Range (C axis)
WO_3	0.020	0.27	85	36	15
Au	0.010	0.13	120	120	-

As shown in Table II-1-2-1, the ranges of WO_3 along A, B and C axis directions are 85m, 36m and15m, respectively. In other words, WO_3 grade distribution in the 3-dimentional space loses correlation when distance exceeds about 85m along the A axis, about 36m along the B axis and about 15m along the C axis.

As to Au, a range of about 120m was observed along both A and B axes, which means that distribution of Au grade shows the same characteristics along both directions.

On the whole, the distribution characteristics of WO_3 and Au in the 3-dimensional space are considered to be a flat ellipsoid with the two long axes parallel to the A and B axes.

6) 3-D block model

In order to estimate average grade of portions of a deposit, a 3-dimensional block model was created. The model covers an area shown in Table II-1-2-2 by the new coordinate system.

Table II-1-2-2 Attributes of the 3-D Block Model

Direction	Minimum	Maximun	Range (m)	Block size (m)	Block number	Subblock size(m)
X axis	-5	1745	1750	10	175	5
Y axis	-5	1595	1600	10	160	1
Z axis	-405	250	650	10	65	1

The size of a block is10m in the X, Y, Z directions. But many of the orebodies are so thin that shapes of such orebodies cannot be presented by a 10x10x10(m) block. For this reason, each block was subdivided into sub-blocks. The size of a sub-block is 5x1x1(m) along the X, Y, Z directions, respectively, as indicated in Table II-1-2-2.

7) Kriging interpolation

Kriging interpolation is a geostatistical estimation procedeure which uses limited data to estimate grades of components within a block or whole deposit by minimizing the estimation error(Kriging error) based on the geostatistical characteristic of the components in the deposit. In another word, the grade estimated by Kringing interpolation method is most close to the "true value" in the deposit.

The Kriging interpolation is a process that relies on the development of geostatistical analysis, variogram. The parameters obtained from the variogram analysis as described previously were used in the interpolation of grades for blocks of No.1 ore body. Spherical model was used as the variogram model. As to other ore bodies, no meaningful variograms were obtained, and the origins of these ore bodies can be considered to be similar to that of No.1 ore body, therefore, the variogram parameters of No.1 ore body were applied to the interpolations of other ore bodies.

In the interpolating procedure of the average grades of blocks, it is necessary to limit the data by search distance. Only the data which are within the search distances will be used in interpolation process. Search distances are usually determined based on the Range value obtained from variogram analysis. 100m ,45m and 20m were adopted as the search distances of WO_3 along A axis , B axis and C axis respectively. As to Au, a search distance of 130m was adopted for A and B axes according to the range values, and 20m, which is the same as WO3, for C axis because no meaningful variogram was obtained for C axis.

In addition, the interpolation was controlled by geology, that is, only the data which belong to the same ore body were used in the interpolation of the block. Figs. II-1-2-9 ~ II-1-2-16 indicate the inferred grade distribution of WO_3 and Au.

8) Summarization of ore reserves

The reserves and average grades by the cutoffs at 0.05%, 0.08%, 0.1%, 0.2%, 0.3%, 0.4% and 0.5% (WO_3) were calculated, based on the interpolated grades of blocks.