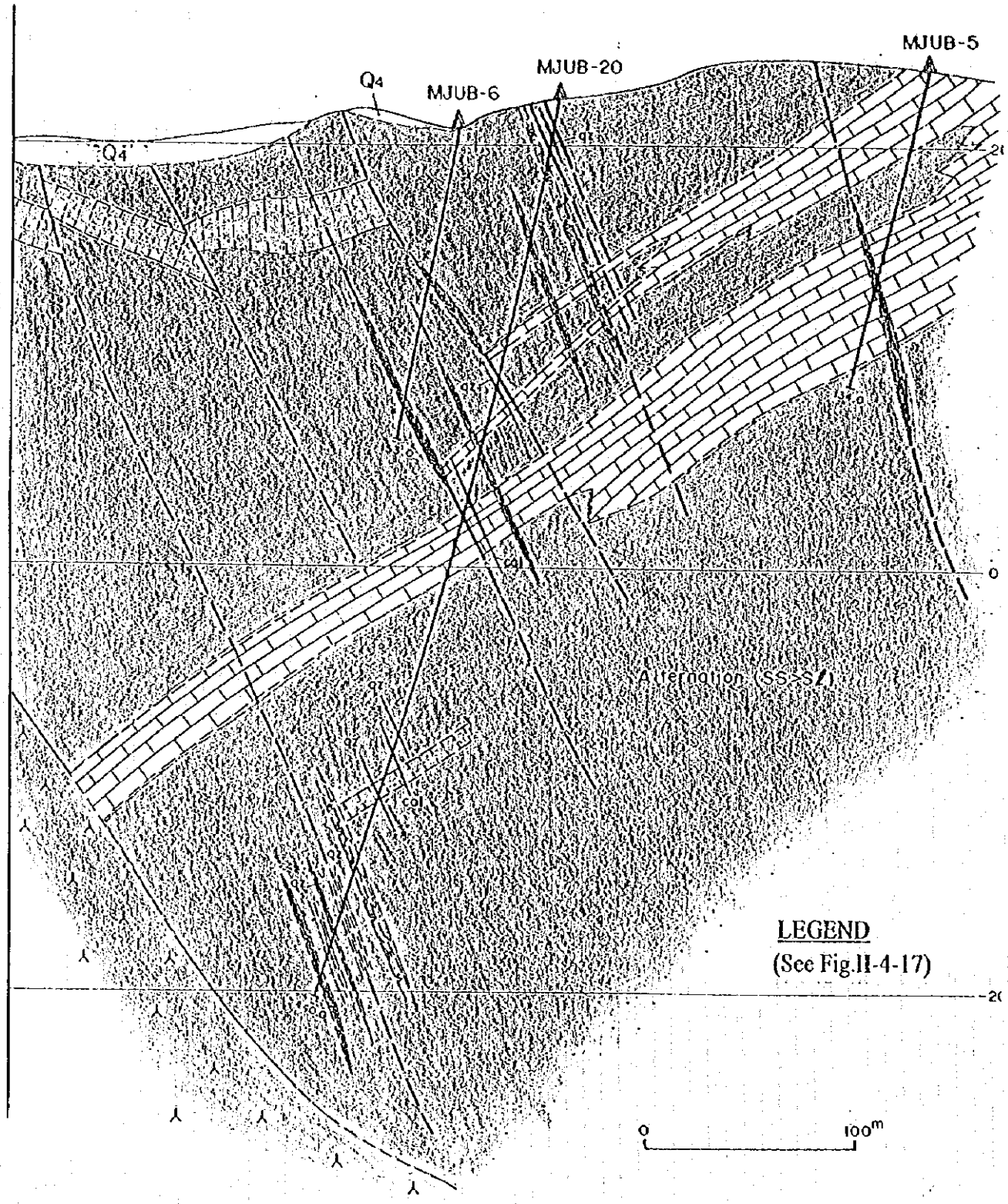

Fig. II-4-23 Geological Cross Section along MJUB-20

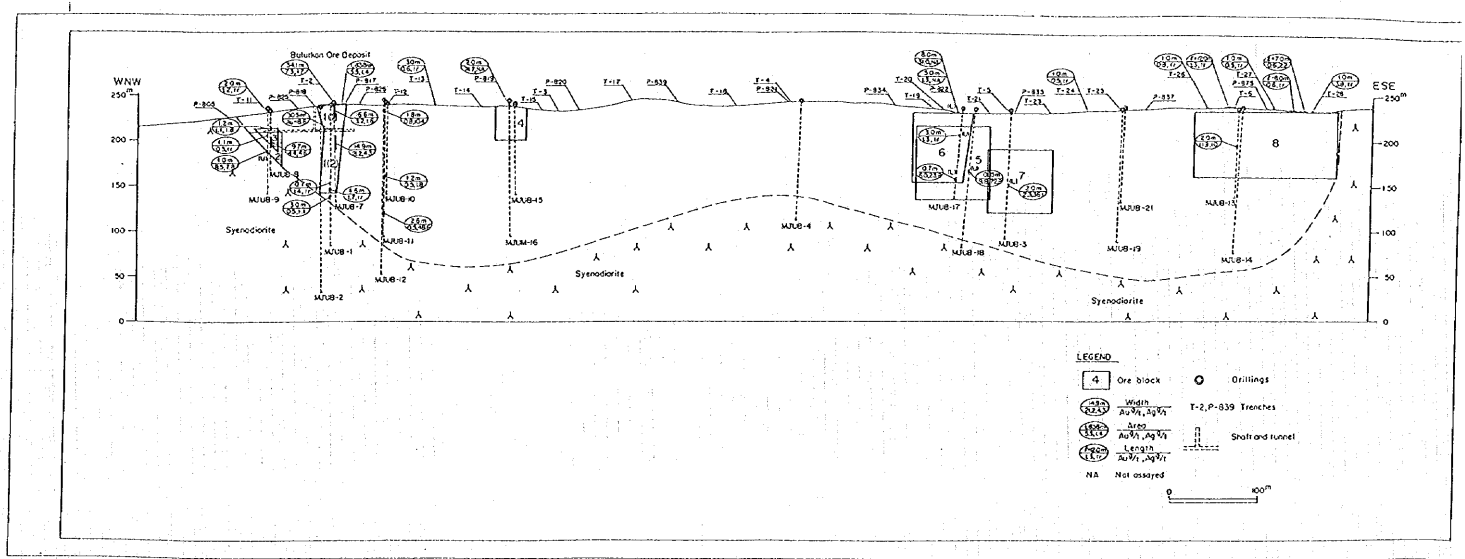

Fig. II-4-24 Perspective Section for Ore Reserve Calculation of Bulutkan District

PART III CONCLUSIONS AND RECOMMENDATIONS

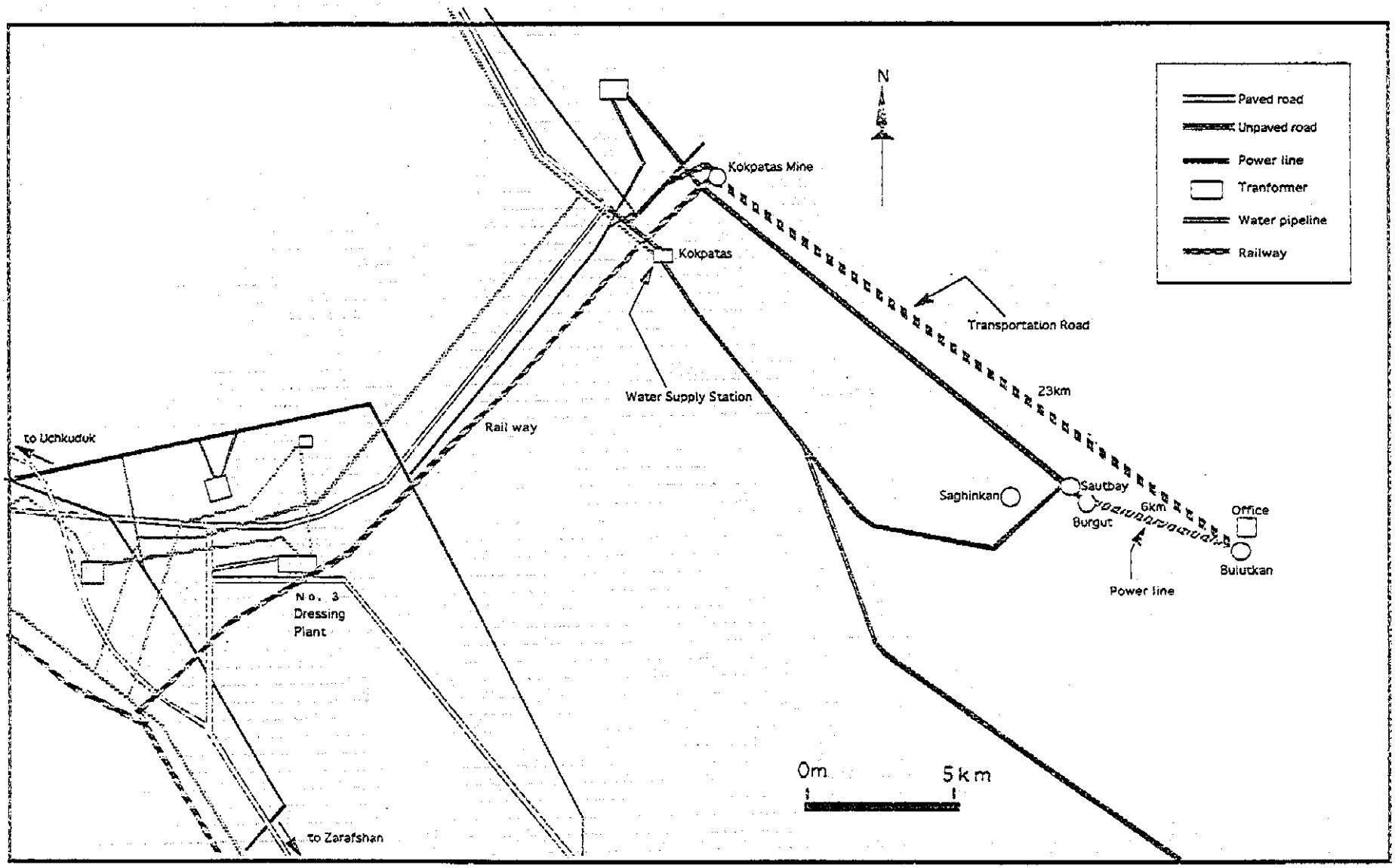

Fig. II-4-25 Location Map of Infrastructure in Bulutkan District

CHAPTER 1 Conclusions

In Phase I, analysis of existing data and the satellite imagery analysis were implemented. In Phase II, analysis of existing data, geological survey and drilling survey for the Sautbay district were conducted while, for the Bulutkan district, geological survey, trenching survey, geophysical survey and drilling survey were carried out. In Phase III, mining plans for the Sautbay district was studied, while for the Bulutkan district, geological survey, trenching survey, geophysical survey and drilling survey were performed. Generalized results of the survey in the Bulutkan district is demonstrated in Fig.III-1.

The findings of the three-year survey may be summarized as follows:

1-1 Whole Area of Survey

(1) Geology

Geology of the Eastern Bukantau Area is composed of the basement formation of Ripheian to Vendian ages of the Proterozoic, which underwent Hercynian(Late Paleozoic) folding, and the strata of Paleozoic, Mesozoic and Cenozoic ages which unconformably overlie the basement formation. Granites and dykes mainly of Late Carboniferous to Early Permian intrude into the Proterozoic and Paleozoic.

(2) Mineralization

In the Eastern Bukantau Area, ore deposits and showings of tungsten, gold, silver and copper occur. which are classified by types of minerals and ore deposits into the following seven groups:

① Gold quartz vein

② Gold·silver quartz vein

③ Gold·silver·copper quartz vein

④ Silver quartz vein

⑤ Tungsten·skarn deposit

⑥ Tungsten·quartz stockwork deposit

⑦ Tungsten·gold skarn deposit

Mineralization in the area is hosted in the Karashakh Formation and the Kokpatas Formation of Proterozoic age and in the Devonian to Carboniferous, and is related with the

granitic intrusion of Late Carboniferous to Early Permian and also with the faults and fractures with the WNW-ESE, NE-SW and NNW-SSE trends.

(3) Alteration zones

In the light of the field survey findings, the alteration zones extracted by the satellite imagery analysis may possibly correspond to iron oxidation zones, which are related to the high-sulfide type gold mineralization accompanied by pyrite and pyrrhotite as in the case of the Kokpatas mine. For gold deposits of this type, the method of extraction of iron oxide minerals around the ore deposits by spectral analysis of satellite images is considered effective. On the other hand, the method has certain limit when applied to extraction of low-sulfide type gold deposits consisting mainly of quartz veins, such as the Turbay deposit, due to the weak development of iron oxide zones. For this type of gold deposits, analysis of the geological structure by means of photogeological interpretation is considered to be better suited.

1-2 Sautbay District

(1) Geology and ore deposits

The Karashakh Formation and the Kokpatas Formation, of Proterozoic, occur in the Sautbay district. The Karashakh Formation, more than 500m thick, is composed of green rocks and schists of volcanic origin accompanied by quartzite, dolomite and limestone. The Kokpatas Formation, more than 1,000m thick, is composed of sandstone, slate, quartzite, schist and carbonate rocks(limestone, and dolomite). Stocks and dikes of the Late Carboniferous ~ Early Permian granodiorite, aplite, diorite, lamprophyre, etc. intrude into the Proterozoic.

(2) Mineralization

The major type of the ore deposit is the tungsten-bearing skarn-type, stratiform 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.

The horizon including carbonate rocks which controls occurrence of ore corresponds mainly to the upper part of the Karashakh Formation and the lower part of the Kokpatas Formation. The thickness of mineralization reaches about 500m on a vertical section.

At the Sautbay-Burgut deposits, some 20 skarn orebodies have been confirmed whilst 14 skarn orebodies have been confirmed at the Saghinkan deposit. Bonanzas are formed between 50m and 100m, occasionally 200m, from the contact points with the granodiorite bodies.

The ore of the Sautbay skarn orebodies is amphibole-pyroxene skarns accompanied by scheelite and amphibole-pyroxene-pyrrhotite skarns, containing pyrite, pyrrhotite, chalcopyrite and marcasite, occasionally accompanied by bismuthinite, native bismuth, arsenopyrite, sphalerite, galena, chalcocite and covelline.

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

(3) Results of drilling survey

Four drillholes at the Sautbay deposit ascertained that the No.1 orebody, the main orebody, strikes NNW-SSE and dips about 70° E and that the mineralization continues up to about 400m below the surface in the southeast of MJUS-2.

Portions where WO_3 grades are 0.30% or more and true width is over 2m were located at the No.1 orebody (true width 13.2m; WO_3 0.35%) caught between 319.8m and 338.5m of the drillhole MJUS-3, at the No.3 orebody (true width 2.3m; WO_3 2.31%) caught between 359.6m and 362.9m of MJUS-3, and at the No.1 ore body (true width 5.0m; WO_3 0.84%) caught between 309.3m and 315.8m of MJUS-4. In the light of the relationship between the locations of these bonanzas and those on the surface, the ore shoots are presumed to plunge in the SSE direction.

Therefore, the tungsten mineralization is highly likely to continue further downward and southeastward.

(4) Results of ore reserves estimation

Ore reserves of the Sautbay, Burgut and Saghinkan deposits were estimated, to revaluate these ore deposits.

The ore reserves of the Sautbay and Burgut deposits were estimated at 15,195,000t, grading 0.29% WO_3 and 0.23 g/t Au, at the cutoff grade of 0.05% WO_3, making considerable differences in ore reserves and grade, as compared to the Uzbek estimation (1993) of 39,539,000t, 0.43% WO_3 and 0.34 g/t Au. The discrepancy in ore reserves is

attributable to the difference in the area of calculation. Discrepancy is very little in the densely drilled upper portion, in contrast to the sparsely drilled lower portion where wide discrepancy has taken place. The discrepancy in the average grade is explicable by the fact that, in the Uzbek calculation of the inferred ore reserves(P1), the highest grade of drillholes intersecting an ore block was extracted and adopted as the grade of the ore block. Consequently, the overall average grade was uplifted.

The Saghinkan ore reserves at the cutoff grade of 0.05% (WO_3) came out at 10,062,000t, grading 0.24% WO_3 and 0.02 g/t Au. In case of a cutoff grade at 0.1%, the figures are 8,133,000t and 0.28% WO_3 showing declines in ore reserves and grade, as compared to the Uzbek estimation(1994) of 12,710,000t and 0.32% WO_3. These differences are ascribed to the same causes as those in case of the Sautbay and Burgut deposits.

The WO_3 grades of these ore deposits are lower than those of skarn-type tungsten mines operating since 1980 in the Western countries including USA, Canada, Australia and Korea, which are 0.5% and up in case of open-pit operation while 1.0% and up in case of underground operation.

(5) Study on development of the ore deposits

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 ore reserves and low grades, combined mining operation of more than one deposit was considered. Operation is optimized when combining 700-tpd openpitting of the portions over +100m(above sea level) of the Sautbay deposit for the 6.6-year operation, with 800-tpd underground mining of the Burgut deposit for the 10-year operation. The feasibility study revealed that 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 profitablity even under such exceptionally favorable conditions, development of the tungsten deposits in the Sautbay district is considered economically unfeasible, under the current levels of ore reserves, grade and WO_3 price.

1-3 Bulutkan District

(1) Geology and ore deposits

The Kokpatas Formation of the Proterozoic occurs in the district. The Formation, more than 1,000m thick, is composed of slate and sandstone accompanied by quartzite, chert lense, limestone and dolomite. Stocks and dikes of the Late Carboniferous ~ Pre-Permian syenodiorite, diorite, granite, porphyrite, lamprophyre, etc. intrude into the Formation.

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

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) Outline of the Bulutkan deposit

The results of the exploration conducted independently by the Uzbek side at the +210m-level tunnel indicate that 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 orebody is presumed to take the shape of a polygonal pyramid or pipe with a broad upper face(the surface portion), upright or inclined sharply northwestward. The upper portion 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. The gold grains take the oval, fine vein, porphrytic and xenomorphic forms, while the grain sizes are 0.003mm or less ~ 0.1mm.

(3) Results of trenching survey

Trenching survey confirmed portions where Au grades are 1g/t or more at the trench T-2, which was aimed to explore the upper part of the Bulutkan deposit: Au 11.7g/t and Ag 1.8g/t between 228.4-248.6m(true width 19.0m); Au 7.0g/t and Ag trace between 252.1-253.4m(true width 1.2m); and, Au 2.4g/t and Ag trace between 260.2-264.3m(true width 3.9m). At the other trenches than T-2, no gold indication exceeding Au1.0g/t was confirmed excepting the three portions, T-11(80.0-82.0m: Au 1.2g/t), T-28(36.0-37.0m: Au 3.8g/t), T-29(52.0-64.0m: Au 1.3g/t). Although many silicified and oxidized zones were found in trenches, few of them show high Au grades.

The trenching carried out by the Uzbek side confirmed Au 74.7g/t between 107.0-109.0m(2.0m) at the trench P-819 (near the west side of the southern tip of T-3) ; and Au 31.0g/t between 98.0-106.0m(8.0m) at P-822(near the west side of the southern tip of T-5).

(4) Results of drilling survey

Au grades of 1g/t or more were confirmed at drillholes aimed at the lower portion of the Bulutkan deposit: MJUB-1 (depth 86.0-88.0m; true width 1.1m; Au 2.8g/t) and MJUB-7(0-10.4m; 5.5m; 4.3g/t and 36.1-51.0m; 7.9m; 21.2g/t)

Gold mineralization was observed at drillholes aimed at the western 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; 4.4g/t) and MJUB-9 (47.0-48.0m; 0.5m; 8.5g/t). Gold mineralization was confirmed also in the other areas than Bulutkan deposit: MJUB-3(82.0-84.0m; 1.6m; 2.3g/t), MJUB-13(39.5-41.5m; 1.1m; 11.9g/t), MJUB-17(23.4-26.4m; 2.0m, 1.3 g/t and 74.8-75.5m; 0.5m; 6.0g/t) and MJUB-18(69.0-69.5m; 0.5m; 9.8g/t). 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 drilling survey results.

(5) Results of geophysical survey

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-resistivity zones, apparently inclined northward, are intermittently distributed.

Most of the major mineral showings confirmed in the district by the trenching and drilling surveys have been found in these high-resistivity zones. The high resistivity zones correspond mainly to zones of diorite dikes, silicified zones, portions where 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 thickness of the low-resistivity zone tends to increase northward, and, in this district, stratiform distribution of resistivity is observed. The low-resistivity zones correspond to zones where limestone and slate occur. The resistivity distribution in the horizontal direction shows a block-like distribution controlled in the trends of WNW-ESE and NNE-SSW, similar to those of faults dominant in the survey area.

(6) Results of mesurement of homogenization temperature of fluid inclusions

The homogenization temperatures of fluid inclusions of quartz veins and calcite range from 100℃ to 378℃. Of these, samples taken from skarn or syenodiorite range from 250℃ to 350℃, while threnching samples with gold mineralization range from 150℃ to 250℃, generally around 200℃. Drilling samples of the Bulutkan deposit taken from a zone where gold mineralization and skarnization are overlapped are in a range of 150℃-330℃.

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.

Occurrence of the Bulutkan deposit is considered to have followed the process as mentioned below:

[1] By intrusion of the syenodiotite stock, the hornblende-clinopyroxene 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] Subsequently, gold mineralization accompanying quartz, pyrite and calcite veins was added.

(7) Results of Ore reserves estimation(tentative)

Calculation on the ore portions ascertained by the trenching and drilling surveys and also by the tunneling prospecting by the Uzbek side 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) Study on development of the ore deposit

In the Bulutkan district, large-scale development is unapplicable due to the small minable ore reserves, while small-scale open-pit mining is applicable to near-surface orbodies with wide veins. Feasibility for development of 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 toll 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 operation would have to be placed under the control and administration of the Kokpatas gold mine as its subsidiary mine in case the ore blocks are developed in reality.

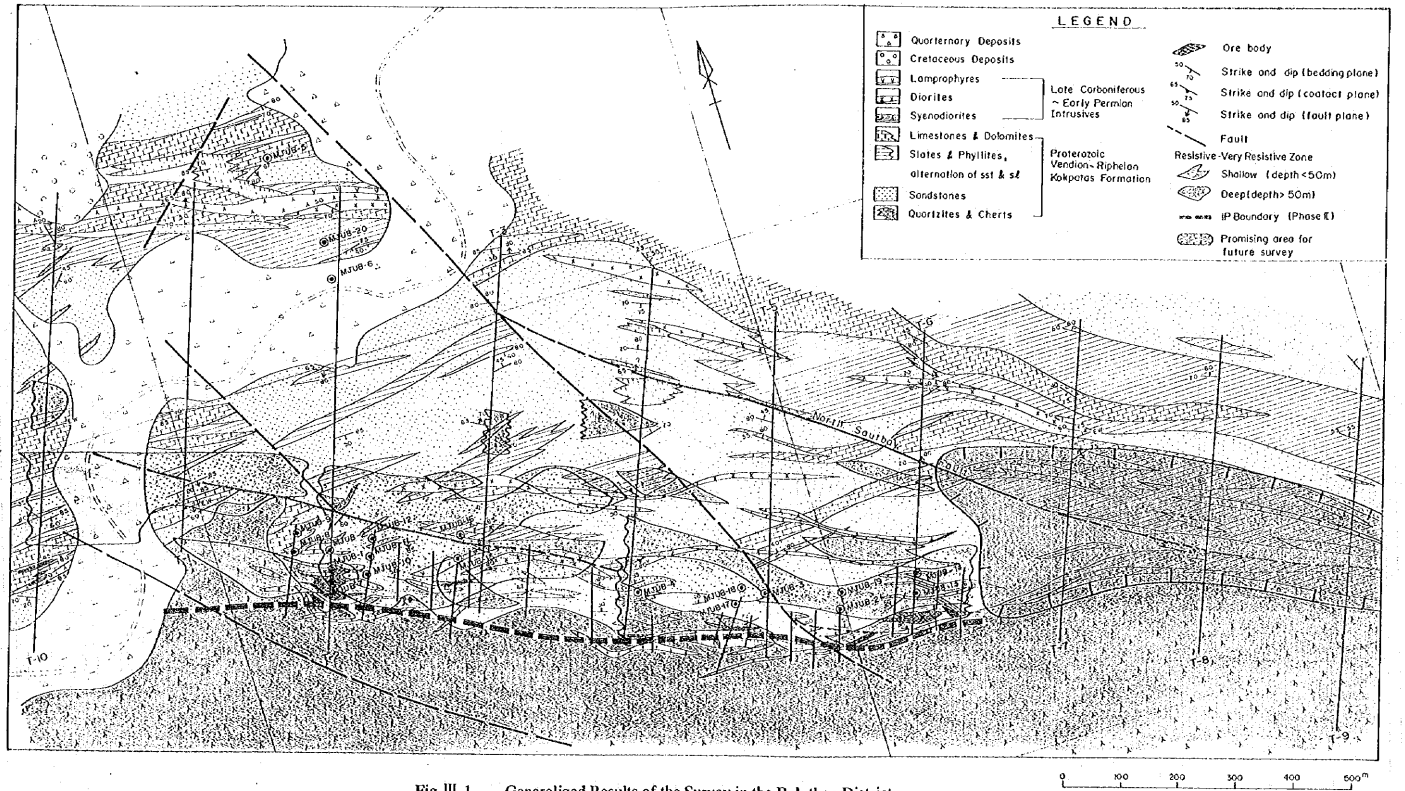

Fig. III-1 Generalized Results of the Survey in the Bulutkan District

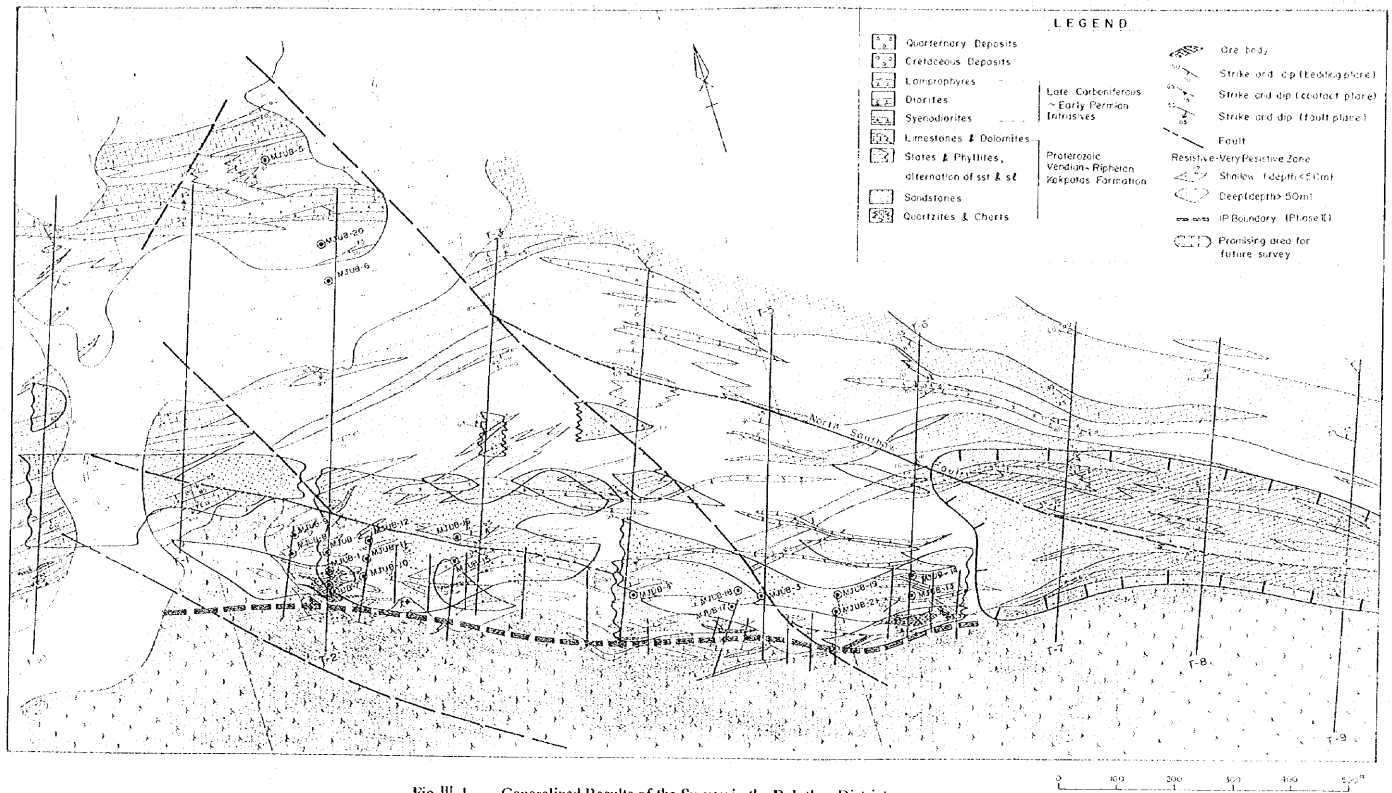

Fig. III-1 Generalized Results of the Survey in the Bulutkan District

Chapter 2 Recommendations

1) Sautbay district

The ore reserves of the Sautbay, Burgut and Saghinkan deposits were estimated at a cutoff grade of 0.05% WO_3. The Saubay-Burgut ore reserves are 15,195,000t, averaging 0.29% WO_3 and 0.23 g/t Au, while the Saghinkan reserves are 10,062,000t, averaging 0.24% WO_3 and 0.02 g/t Au.

Based on the estimates, feasibility for development of these 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. A certain increase in ore reserves by further exploration may be anticipated but a significant improvement in WO_3 grade is unlikely.

Under such circumstances, it is advisable 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 gold deposits in this district are scattered along the strike of the extension over 1,200m in the Proterozoic close to the northern periphery of the syenodiorite stock.

The tentative 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 profit 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 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. Since bonanzas of an orebody in this district occur at intersections of the faults with WNW-ESE trends, groups of fissures intersecting the faults and also the horizon of carbonate rocks, it is recommended, for successful exploration, to

make detailed studies on the structures of the horizon of carbonate rocks and of the faults intersecting the horizon.

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Collected Data

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APPENDICES

3-5 Study of Mining Plans

3-5-1 Purpose of survey

Based upon the ore reserves calculation and the field survey of Sautbay, Burgut and Saghinkan deposits, the respective mining plans are drawn up.

3-5-2 Method of survey

The site survy were conducted by the Survey Team Leader, Mining Engineer and Geologist, who collected data and information in Uzbekistan and studied local conditions of the Sautbay, Burgut and Saghinkan. Besides, the Kokpatas gold mine, the No.3 ore-dressing plant at Uchkuduk, the Chadak gold mine, the Inghichik tungsten mine and the Chirchik tungsten refinery were visited for observation and collection of information. In Tashkent, data and information were collected under the cooperation of the Feasibility Study Department of the State Committee of Geology and Mineral Reserves and the Institute of Industrial Technology of Tashkent.

3-5-3 Open-Pit Mining Plans for the Sautbay Deposit

1) Summary

The survey conducted since the first year of the Sautbay, Burgut and Saghinkan deposits has revealed that these are low-grade, medium-size ore deposits, respectively with ore reserves up to 20 million tons averaging WO_3 0.3% or less at a 0.05% cutoff.

Generally, the open-pit mining is considered less expensive than the underground mining although depending on the stripping ratio. Open-pit mining is applicable only to Sautbay, as its main ore body occurs near the surface. This Paragraph is based upon an assumption of exploiting the upper part of Sautbay deposit by open-pitting, and is intended to study the following three alternative plans.

Plan [1] : Mining starts from the +20m level(above sea level), at which the area of ore deposit abruptly expands.

Plan [2] : Mining starts from the +100m level, at which the area of high-grade portion expands.

Plan [3] : Mining starts also from the +100m level, but the cutoff grade is uplifted from Plan [2], thereby raising the value of crude ore.

2) Mining Conditions

The mining conditions for each alternative are summarized in Table II-3-5-1, which are elaborated in the succeeding paragraphs.

(1) Cutoff grade

In case of open-pit mining, excavation costs of ore and waste are practically the same inside a pit, even though there may be minor cost difference owing to difference in the hardness. Outside a pit, however, cost difference arises depending on whether excavation is hauled to an ore dressing plant for processing or dumped in a waste disposal. If the excavation is treated as ore, it needs to be of a value(ore grade) that compensates at least haulage cost(from the pit to an ore dressing plant) plus variable costs of ore processing. Such an ore grade is applied as the cutoff grade in this study, while lower-grade portions are regarded as wastes.

According to the pre-feasibility study conducted by the Feasibility Study Department of the Goskomgeology of Uzbekistan(hereafter abbreviated as "Pre-F/S"), the tailings grade 0.08%. (The actual record of Inghichik mine is 0.07-0.11%.) If dilution is 10% (the actual record of Kokpatas open-pit gold mine is 8%), the cutoff grade (X) may be found by the following formula :

$$(X \times 0.9 - 0.08)\% \times 61\$/t\text{-}\%^{*} \geq \text{(ore haulage cost + variable costs of processing)}$$

* WO_3 concentrate price = 61$/t-% (as of September, 1996)

The mentioned Feasibility Study Dept. calculated costs on the basis of the 1991 price of ruble(R), applying a certain adjustment coefficient on it, as the prices were unstable in the transitional period from the planned economy to the market economy. In this study, the following conversion rates are applied in order to evaluate the economic viability as of 1996, as accurately as possible.

1R in 1991 = 36 sum in 1996 = 0.72$ in 1996;
1$ in 1996 = 50 sum in 1996

At these conversion rate, ore haulage costs and variable costs of ore processing are calculated as follows:

• Ore haulage costs = truckage(17 kms from the pit to Kokpatas by 45-t trucks) + railroad freight(19 kms from Kokpatas to the No.3 ore dressing plant)

- Truckage: According to the Pre-F/S, truckage for 30kms by a 27-t truck is (2.65 + 0.6) rubles per ton. The 2.65 is proportional to the distance while the 0.6 represents loading-unloading charges; therefore, the truckage for 17 kms by a 45-t truck is:

  (2.65 x 27/45 x 17/30 +0.6) R/t x 36 sums/R = 54 sum/t

- Railroad freight: According to the Feasibility Study Dept's data, the freight for 422kms(Inghichke - Chirchik) is: (7.56 + 1) R/t x 1.05. The 7.56 is proportional to the distance, while the 1 is loading- unloading charges; therefore, freight for 19 kms is :

  (7.56 x 19/422 + 1) R/t x 1.05 x 36 sums/R = 51 sums/t

  Hence, the total ore haulage cost is : 54 + 51 = 105 sums/t

• Variable costs of processing = materials cost + electric power cost + water cost

The variable cost per ton is calculated from the tentative calculation data in the Pre-F/S for 400,000-tpy operation:

(1,514.5 + 912.0 + 593.9) x 10^3 R / 400,000t x 36 sum/R = 272 sum/t

Hence, the cutoff grade is : (X x 0.9 - 0.08) x 61 $\geqq$ (105 + 272) / 50 X $\geqq$ 0.23

In this study, however, the cutoff grade is lowered to 0.20%, in anticipation of future improvement in efficiency, cost reduction efforts and market price rise.

(2) Pit slope

On the assumption that 45t dump trucks (5.08m wide) and 8.6m^3 front-end loaders (4.45m wide) are used, the bench width, the angle of slope face and bench height are fixed at 7.5m, 70° and 10m, respectively; consequently, the bench slope comes to 42%. Since the geological maps and sections do not indicate a conspicuous fault line, no special consideration such as use of cable anchors or loosening of the slope is given to the pit design.

Table 3-5-1 Mining Conditions of 3 Plans

	Plan ①	Plan ②	Plan ③
Starting level	+20m	+100m	+100m
Ore cut-off grade(%)	0.2	0.2	0.3
Ore reserves('10^3t)	2,411	1,131	870
WO_3 grade(%)	0.47	0.53	0.62
Minable ore('10^3t)	2,545	1,194	918
WO_3 grade(%)	0.42	0.48	0.56
Surface area(m^2)	204,850	78,672	78,672
Pit bottom area(m^2)	2,160	1,600	1,600
Thickness(m)	195	115	115
Stripping ratio	16.5	7.8	10.5

(3) Starting levels

In open-pit mining of the skarn-type Sautbay deposit, if exploitation of ore in a deeper portion is planned, the ore reserves will increase accordingly, as well as the stripping ratio, whereas, on the contrary, these will decrease if exploitation is confined to a shallower portion. Analysis of the plans and sections for ore reserve estimation reveals that the ore-deposit area of the No.1 ore body, the main target of mining, increases abruptly at the level of +20m above the sea level, whilst an area of the higher-grade portion increases from the +100m level upward. Therefore, the plans have been drawn on the assumption that mining is started, respectively, from these two levels.(Ref. Fig.3-5-1 : Surface plan, Fig.3-5-2 : +100m level plan, Fig.3-5-3 : +20m level plan and Fig.3-5-4 : 400E section)

(4) Minable crude ore: quantity, grade and stripping ratio

·Basic assumptions for Plan [1]

The ore reserves within the bench slopes comes to 2,411,000t, grading WO_3 0.47%, at 0.2% cutoff. Assuming that the mining recovery and dilution are 95% and 10%, respectively:

- Minable crude ore: 2,411,000t x 0.95 / (1 - 0.9) = 2,545,000t
- Minable ore grade: 2,411,000t x 0.47% x 0.95 / 2,545,000t = 0.42%

Since the area of the pit bottom at the +20m level is 2,160m² while the area of the pit top at the +215m level(the average height of the surface) is 204,850m², therefore, the inner volume of the pit is:

$\{2,160 + 204,850 + (2,160 \times 204,850)1/2\} / 3 \times (215 - 20) = 14,823,000m^3$

If the specific gravity of ore is $3t/m^3$:

- Volume of ore: $2,545,000t / 3t/m^3 = 848,000m^3$
- Stripping volume: $14,823,000m^3 - 848,000m^3 = 13,975,000m^3$
- Stripping ratio: $13,975,000m^3 / 848,000m^3 = 16.5$

(Although the surface portion is partially weathered into sand and clay, it is assumed that all the portions consist of rocks that require drilling and blasting.)

(5) Cost comparison by the site of ore dressing plant

Costs of required infrastructure facilities, as well as haulage and operating costs could not be calculated unless the site of ore dressing plant and the ore haulage method are fixed. For the site of ore dressing plant, the following four cases are cenceived.

(a) An ore dressing plant is built at the mine site.
(Plant building + 17-km road construction)

(b) The Uchkuduk No.3 ore dressing plant is utilized(with reinforcement of equipment).
[1] 24-km railroad is constructed.
[2] Ores are transported to Kokpatas(17 kms) by trucks and, afterwards, by the existing railroad(a 0.5-km sidetrack).
[3] 26-km road is built for trucking.

- Power transmission lines, water pipes and auxiliary facilities, which are common to every alternative, are excluded from the calculation.
- Rough estimates of the investment costs (for which the Pre-F/S for the 400,000-tpy operation is utilized):

	(10^3 sum)
- The new ore dressing plant	2,240,000
- The no.3 ore dressing plant (equipment reinforcement)	566,500

- Railroad(1 km)	50,000
- Road(1 km)	12,600

Following are rough estimation of the infrastructure investment costs plus haulage costs for each case, on the basis of minable crude ore of 2,545,000t.

(a)	: (2,240,000 + 12,600 x 17) / 2,545 + 13	= 977sum/t
(b) [1]	: (566,500 + 50,000 x 24) / 2,545 + 57	= 751
[2]	: (566,500 +12,600 x 17+50,000x0.5)/2,545+105	= 422
[3]	: (566,500 + 12,600 x 26) / 2,545 + 79	= 430

The alternatives (b)-[2] and (b)-[3] being slightly different, it requires careful comparative studies especially of respective advantages to determine the form of operation. For the two alternatives, therefore, calculation was made every 100 tpd from 500-tpd (130,000-tpy) to 1,600-tpd(416,000-tpy) operations, as demonstrated in Tables 3-5-2 and 3-5-3. In both alternatives, 700-tpd (182,000-tpy) operation requires the minimum investment costs per ton.

Table 3-5-4, which compares the two alternatives, indicates that they are little different in terms of operating costs but the initial investment cost of the (b)-[2] is lower by some 140 million sum than that of the (b)-[3]. Consequently, the alternative (b)-[2] is chosen for this study, wherein ores are assumed to be hauled by trucks to Kokpatas, and, from there to the No.3 dressing plant, by railroad.

Table 3-5-4 Comparison of Plans ② and ③

182,000t/year	Plan② (truck+railway)	Plan③ (truck)
Initial investment	1,135,440,000 sum	1,274,220,000 sum
(Road)	17km	26km
(Truck)	7units	8units
(Railway)	Branch line 0.5km	-
Annual operating cost	241,991,000 sum	241,749,000 sum
Characteristics	· Less investment · Short construction period · More investment for railway if more Kokpatas mine production	· Short transportation distance of personnel,material · Independent operation from Kokpatas mine and existing railway

3) Estimation of Operating Income

On the basis of the alternative (b)-[2] chosen for the study as mentioned in the preceding paragraph, revenues and expenditures of the Plans [1], [2] and [3] are respectively estimated. For exemplification purpose, an estimate for 700-tpd(182,000-tpy) operation of Plan [2] is demonstrated in the following paragraphs:

(1) Initial investment costs

(a) Infrastructure and ancillary facilities : (Ref. Fig.3-5-5 Locations of facilities)

	(10^3 sum/km)		10^3 sum/km)
[1] Asphalted road	12,600 x 17kms	=	214,200
[2] Railroad(sidetrack)	50,000 x 0.5kms	=	25,000
[3] Transmission lines*	1,500 x 20kms	=	30,000
[4] Water pipes(100mm)	1,350 x 16kms	=	21,600
[5] Auxiliary facilities			
(office, repair shop, warehouse, magazine, fuel tank, etc.)			40,000
[6] Sewage treatment			4,900
[7] Environment preservation	([1] + ~ + [5]) x 0.15	=	50,355
[8] Temporary facilities	([1] + ~ + [5]) x 0.05	=	16,785
Total - Infrastructure cost, etc. (10^3 sum)			402,840

Note: * Tele-communication lines are also laid alongside of the transmission lines.

(The infrastructure facilities are required either for open-pit mining or underground mining and irrespective of operation scales; therefore, the same facilities and amounts are considered.)

(b) Mining machinery

	(10^3\$) Q'ty		(10^3\$)
[1] Drilling machine(DHA 1000S - Tamrock)	500 x 1	=	500
[2] Loader(CAT990 - Caterpillar)	1,011 x 1	=	1,011
[3] Dump truck(CAT773B - ditto)	654 x 4	=	2,616
[4] Buldozer(CAT D7H - ditto)	372 x 1	=	372
[5] Grader(CAT G14H - ditto)	356 x 1	=	356
[6] Tank truck, sprinkling truck	120 x 2	=	240
[7] Pickup	30 x 6	=	180
[8] Bus	100 x 2	=	200
[9] Pump(44 kW)	13 x 3	=	39
Total - Mining equipment cost(10^3 sum)			5,514

\$5,514,000 x 50 sum/\$ =275.7 million sum

Note: The amounts of [1] thru [5] above = Fob prices x 1.2

(c) Ore processing equipment

	(10^3 sum)
[1] Equipment for WO_3 (including installation cost)	257,500 *
[2] Incidental expenses ([1] x 0.1)	25,750
Total - Ore processing equipment (10^3 sum)	283,250

Note: * The investment is limited only to the ore processing equipment, while the existing plant building, thickeners, tailing pond, etc.are to be utilized. The Pre-F/S estimates the ore processing equipment and installation costs at 10,300,000R. According to the Institute of Industrial Technology of Tashkent, 1R in 1991 is equivalent to 50 sum in 1996, in case of civil construction work.

10,300,000R x 50 sum/R = 515,000,000 sum

This study assumes that the investment costs for ore processing equipment is proportional to operation scale.

182,000 tpy / 400,000 tpy = 45.5% → 50%

515,000,000 sum x 0.5 = 257,500,000 sum

(d) Initial investment costs summary

	(10^3 sum)
[1] Infrastructure and ancillary facilities	402,840
[2] Mining machinery	275,700
[3] Ore processing equipment	283,250
Total - Investment costs (10^3 sum)	961,790

Investment costs/t : 961,790,000 sum / 1,194,000t = 806 sum/t

(2) Operating costs

(i) Mining costs

(a) Form and quantity of work

The mining operation is assumed to be carried out for 260 days a year on three shifts (eight hours per shift including one-hour rest). The vacation being 50 days a year, the annual working days of employees are 210 days.

Annual production: 182,000 tons

Specific gravity of ore: 3 t/m^3

Stripping ratio: 7.8

Stripping volume: 182,000t / 3t/m^3 x 7.8 = 473,000m^3

Annual work quantity: 473,000m^3 + 61,000m^3 = 534,000m^3

(b) Machinery requirement

[1] Drilling machine (DHA 1000S; drilling diameter 89-152mm; engine power 240hp)

The drilling diameter is assumed to be 125mm, the same as that of the machines used at Kokpatas gold mine. (The rock tools of the same specifications as those of the Kokpatas mine are to be used in an effort to reduce the stocks.) In case the drilling

diameter is 125mm, the least resistance line of 3.2m is considered adequate for drilling of hard rocks, while the intervals between drillholes are 4.0m(=3.2m x 1.25). If drillhole inclination is 70° and blasting efficiency 90%, the drilling length required for fragmentation blasting of 10m in the vertical length comes to 11.8m.

Fragmentation volume per hole: 3.2m x 4.0m x 11.8m sin 70° x 0.9 = 127.7m³

Annual drilling length: 534,000m³ / 127.7m³/drill x 11.8m/drill = 49,344m

The same per machine: 90m/sft x 3 sft/d x 260d/yr = 70,200m

Number of machines required: 49,318m / 70,200m/drill = 0.70* → 1 unit

Note: * The remaining drilling capacity of 0.30 can be used for the spalling of bouldery ores.

[2] Loader(CAT990; bucket capacity 8.6m³; engine power 610hp)

Total volume of loading: 534,000m³ x 1.6* = 854,400m³ (* Void factor)

Annual volume of loading per machine

360min/sft / 2.5min/bucket x 8.6m³/bucket x 0.9* x 3 sft/d x 260 d/yr

= 869,357m³ (* Loading factor)

Number of machine required: 854,400m³ / 869,357m³ = 0.98 → 1 unit

[3] Dump truck(CAT773B; load 45t; 650hp)

Annual cycles of ore haulage: 182,000t / (45t x 0.9*)

= 4,494 trips (* Loading factor)

Number of machine required:

4,494 trips/yr x 72min*/trip x 1.1** / 360min***/sft / 780 sft/yr

= 1.27 units (* Time per trip ** Haulage factor *** Working time)

Annual cycle of waste haulage:

473,000m³ x 2.7t/m³* / (45t x 0.9) = 31,534 trips

(* Specific gravity of waste)

Number of machine required for waste haulage:

31,534 trips/yr x 21min/trip x 1.1 / 360min/sft / 780 sft/yr = 2.60 units

Total number of machine required: 1.27 + 2.60 = 3.87 → 4 units

[4] Buldozer(CAT D7H; 230hp) 1 unit

[5] Grader 1 unit

[6] Auxiliary vehicles 8 units

(Fuel and lubricants 1 unit)

(Water sprinkling 1 unit)

(Blasting work 1 unit)

(Repair work 1 unit)

(Vigilance 4 units)

[7] Commuting bus 2 units

(c) Personnel(Ref. Table 3-5-5)

Engineers 9

Operators 56

One operator per shift is assigned to each of the machines. For blasting work, two operators per day will be sufficient. Since the annual working days of employees are 210 days as against 260 days of the annual operation, 1.24 operators are actually required against an operator.

Table 3-5-5 Personnel Rrequirement(Sautbay Open Pit:700t/day)

	1st shift	2nd shift	3rd shift	Total	Adjusted number
Manager	1			1	
Mining eng.					Manager add post
Surveyor	1			1	
Geologist	1			1	
Mechanic	1			1	
Foreman	1	1	1	3	
Staff	5	1	1	7(9)	7×1.24=8.7
Driller	1	1	1	3	
Blaster	2			2	
Mucker	1	1	1	3	
Trucker	4	4	4	12	
Bulldozer	1	1	1	3	
Grader	1	1	1	3	
Repairman	3	2	2	7	
Driver	2	2	2	6	Fuel 1,water 1
Guard	1	1	1	3	
Clerk	3			3	Nurse 1
Worker	19	13	13	45(56)	45×1.24=55.8
Total	24	14	14	52(65)	

＊1.24,Coefficient : Days operated 260, Vacation 50, Actual working days210

260÷210=1.24

(d) Mining costs

	(10^3 sum)	
- Labor	9,555	
- Explosives	9,103	
- Rock tools	4,256	
- Fuel and lubricant	37,689	
- Tires	5,970	
- Electric power	1,821	
- Repair	20,900	
Total - Mining cost(10^3 sum)	89,294	(=491 sum/t)

(ii) Ore processing costs

During the survey, the No.3 ore dressing plant and the Inghichke dressing plant were visited, however the former was only partially observed while the latter's operation had been suspended. As most of the necessary data were unavailable from the visit, the Pre-F/S data are substantially utilized for this study, instead.

(a) Basic assumptions of operation

It is assumed that, in order to minimize the investment costs, ore processing equipment are installed within the No.3 dressing plant and the existing equipment are utilized as far as possible. (The investment costs are 283,250,000 sum.)

- Annual operating days: 340 days/year(3 shifts)
- Vacation: 30 days/year
- Annual treatment of crude ore: 182,000t
- Grade of crude ore: WO_3 0.48%
- Grade of tailings: 0.08%
- Dresing recovery: 83.3% = (0.48-0.08) / 0.48
- Grade of concentrate: 55.3%
- Annual production of concentrate: 1,316t
- Personnel: 85 (8 enginners and 77 operators)*

Note: * The number of personnel is estimated from the Pre-F/S data, which assumes 10 engineers and 163 operator for 400,000-tpy operation.

(b) Ore processing costs

		(10^3 sum)
[1] Labor cost		11,526
[2] Supplies and chemicals cost		24,683
[3] Electric power: 38kWh/t x 2 sum/kWh x 182,000t	=	13,832
[4] Process water: 5.5m^3/t x 3.75sum/m^3 x 182,000t	=	3,754
[5] Potable water: 0.385m^3/t x 8.55 sum/m^3 x 182,000t	=	599
[6] Repair: ([1] + [2] + [3] + [4] + [5]) x 0.15		8,159
Total - Ore processing costs (10^3 sum)		62,553
		(344 sum/t)

(iii) Administration cost

The administration cost is assumed to be equivalent to10% of the mining and ore processing costs.

		(10^3 sum)
(89,288 + 62,553) sum x 0.10	=	15,184
		(83 sum/t)

(iv) Railroad freight cost

Since transportation operation is assumed to be undertaken by a railroad company, the rairoad freight is excluded from the administration cost.

(a) Freight for crude ore(Kokpatas - No.3 plant: 19kms):

(7.56 / 422 x 19 + 1)R/t x 1.05 x 36 sum/R	=	51 sum/t
51 sum/t x 182,000t	=	9.282 sum

(b) Freight for concentrate (No.3 plant - Chirchik: 805kms)

(10.18 + 1)R/t x 1.05 x 36 sum/R	=	423 sum/t
423 sum/t x 1.316t	=	557,000 sum

(c) Total railroad freight

	(10^3 sum)
Crude ore:	9,282
Concentrate:	557,000
Total - Railroad freight cost(10^3 sum)	9,839
	(54 sum/t)

(v) Annual operating cost summary

	(10^3 sum)	(sum/t)
- Mining costs	89,294	491
- Ore processing costs	62,553	344
- Administration cost	15,184	83
- Railroad freight cost	9,839	54
Total - Annual operating costs(10^3 sum)	176,870	972

Depreciation cost is excluded from the estimation as the depreciation methods for a project investment in Uzbekistan is not sufficiently clear.

(3) Operating income

(i) Ore value per ton

Concentrate production		Conc grade		Conc price*		Exch rate		Annual Revenues (10^3 sum)
1,316t	x	55.3%	x	61$/t-%	x	50 sum/$	=	221,963

(* Metal Bulletin price)

Annual revenues		Conc production		Value/t of ore
221,963,000 sum	/	182,000 t	=	1,220 sum/t*

Note: * Revenues from by-products(Cu and Au) are not considered.

(ii) Total operating income

Revenues (Sum/t)		Investment (Sum/t)		Operating cost(Sum/t)		Minable reserve(t)		Total operating income(10^3 sum)
(1,220	-	806	-	972)	x	1,194,000t	=	(-)662,252
								(-558 sum/t of crude)

(4) Comparison of operating income

The estimation of operating income for the Plans [1], [2] and [3] are tabulated in Tables 3-5-2, 3-5-6 and 3-5-7, respectively. In cases of the Plans [1] and [2], the 700-tpd(182,000-tpy) operation proves to be the optimum(cost-minimum) scale of operation, whilst that for the case of Plan [3] is 400-tpd(104,000-tpy) .

Table 3-5-8 demonstrates a comparison of operating income of the three Plans at their optimun operation scales, although none of them generates profit. In case mining starts from the +20m level at a cutoff grade of 0.3%(which is not shown in the Table), it results in an even greater loss, (-)932 sum/t. Among the three Plans, the Plan [2] suffers the minimum loss of (-)558 sum/t.

Table 3-5-8 Comparison of 3 Plans (Sautbay Open Pit)

	Plan ①	Plan ②	Plan ③
Ore cutoff grade(%)	0.2	0.2	0.3
Minable ore(10^3t)	2,545	1,194	918
Minable grade(%)	0.42	0.48	0.56
Stripping ratio	16.5	7.8	10.5
Production(t/day)	700	700	400
Mine life(years)	14.0	6.6	8.8
Initial investment(10^3sum)	1,135,440	961,790	815,790
Value of crude ore(sum/t)	1,037	1,220	1,464
Initial investment(sum/t)	446	806	889
Operating cost(sum/t)	1,330	972	1,194
Income(sum/t)	-739	-558	-619
Total income(10^3sum)	-1,880,755	-666,252	-568,242

3-5-4 Underground Mining Plans for the Sautbay District

1) Summary

Open-pit mining is unapplicable to Burgut and Saghinkan deposits whose main ore bodies occur in deeper parts than the 200m level under the surface. Instead, underground mining of these deposits have been planned.

The undeground mining costs vary widely depending on the rock conditions. As the previously existing exploration tunnel has collapsed and no rock quality designation (RQD) of the drill cores has been made, detailed data on the rock conditions of these deposits are lacking. This study is based on an assumption that the rock conditions are of regular grade, which require rock-bolt timbering at a ratio of 50% but do not require shotcrete nor frame support. The other assumptions will be referred to in respective paragraphs.

As project costs are subject to wide variation depending on a change in an assumption and as sufficient data have not been collected, the plans should be taken as tentative calculation models rather than as project feasibility study.

As regards the cutoff grade, the three alternatives -- [1] 0.3%, [2] 0.4% and [3] 0.5% -- are studied.

2) Mining Conditions

(1) Cutoff grade

As mentioned in the preceding chapter which deals with the open-pit mining, the ore haulage cost is 105 sum/t and the variable cost of ore processing is 272 sum/t. If variable cost of mining consist of materials cost(235 sum/t) and variable cost portion of electric power (9 kWh/t):

235 sum/t* + 9 kWh/t x 2 sum/kWh** = 253 sum/t

Note: * For materials cost, refer to the section of revenues and expenditures.

** Power rate: 2 sum/kWh

In case the tailings grade and the dilution are 0.08% and 20%, respectively, the cutoff grade (X) can be found by the following formula:

(X x 0.8-0.08)% x 61$/% ≧ (Variable mining cost + variable processing cost + ore haulage cost)

$$\geq (253+272+105)\text{sum} / 50\ \text{sum}/\$$$

$$X \geq 0.36\%$$

Although the cutoff grade is found to be 0.36%, it is changeable depending on data; therefore, the studies are effected on three alternatives: [1] 0.3%, [2] 0.4% and [3] 0.5%, in order that the sensitivity analysis may be made..

(2) Undergound design basis

[1] Vertical shafts and raises: One for conveying ore and one for personnel and supplies, both 500m in length, 5m in diameter and equipped with winders; plus a ventilation raise(VR) and a waste raise(WR), both 500m in length, 3m in dia.; and, an ore raise(OR), 320m in length(-300m ~ +20m) and 3m in dia.

[2] Tunnels: A 500m horizontal tunnel at the lowest level(-300m); and, a ramp from -20m to the surface, with the section of 14.15m^2 (4.5m x 3.5m) and an inclination of 1/6(9.5$_\circ$).

[3] Development work: 15m per 1,000t, including the shafts, raises and tunnels. The run of mine from the development operation is estimated at 5% of excavation.

[4] Mining method: Mechanized(trackless) cut and fill method. Since locations of the shafts, raises and tunnels are not fixed, only numerical data are applied.

(3) Minable crude ore: quantity and grade

The mining recovery and dilution is determined by the mining method to be employed, occurrence of ore deposit, etc. In this study, the mining recovery and dilution are assumed to be 80% and 20%, respectively. The tonnage and grade of minable ore at each alternative cutoff grade are tabulated in Table 3-5-9.

Table 3-5-9 Minable Ore and Grade(Burgut and Saghinkan)

	Burgut	Saghinkan
Cut-off grade 0.3%		
Minable ore(10^3t)	3,473	3,775
WO3grade(%)	0.54	0.42
Cut-off grade 0.4%		
Minable ore(10^3t)	2,812	2,325
WO3grade(%)	0.60	0.52
Cut-off grade 0.5%		
Minable ore(10^3t)	2,072	1,665
WO3grade(%)	0.68	0.58

3) Estimation of Operating Income

The operating income estimated in Table 3-5-10 indicate that the alternative of 800-tpd(208,000-tpy) operation of Burgut deposit at a cutoff grade of 0.5% is the most profitable of all the underground mining plans. The calculation methods are shown in the following paragraphs:

1) Initial investment costs

(a) Infrastructure and ancillary facilities (same as the open-pit mining) (10^3 sum) 402,840

(b) Mining machinery

	10^3\$*		Unit		10^3\$
[1] Drilling machine(Tamrock):	471	x	3	=	1,413
[2] Blasting machine(Normet):	201	x	2	=	402
[3] Dump truck(Kawasaki):	529	x	4	=	2.166
[4] Rock-bolting machine(Tamrock):	443	x	1	=	443
[5] Surface truck(Caterpillar):	654	x	2	=	1,308
Total - Mining machinery(10^3\$)					5,682

(5,682,000\$ x 50 sum/\$ = 284,100,000 sum)

Note: * Fob prices x 1.2

(c) Mining facilities and equipment

		10^3 sum
[1] Vertical shafts(for ore and for personnel/supplies):		
(500m x 200,000 sum/m + 70,000,000 sum) x 2	=	340,000
[2] Raises(VR, WR and OR):		
(500m x 2 + 320m) x 100,000 sum/m	=	132,000
[3] Horizontal tunnel(-300m level) & ramp :		
(500 + 1,080)m x 40,000 sum/m	=	63,200
[4] Pumps(44kW; 1m3/min; head 500m):		
60,000$ x 8 x 50 sum/$	=	24,000
[5] Fan(150,000 cfm): 30,000$ x 1 x 50 sum/$	=	1,500
[6] Compressor(900 cfm): 105,000$ x 1 x 50 sum/$	=	52,500
[7] Ore bin		5,000
[8] Underground communication system		2,500
[9] Surface machinery, etc.(CAT990; aux. vehicles)		69,500
Total - Mining facilities & equipment(10^3 sum)		690,000

(d) Ore processing equipment

	(10^3 sum)
[1] Equipment for WO_3 incl. installation cost*	283,250
[2] Incidental expenses ([1] x 0.10)	28,325
Total - Ore processing equipment(10^3 sum)	311,575

Note: * For estimating the investment costs of the processing equipment, the Pre-F/S data(515,000,000 sum for 400,000-tpy operation) are applied, as follows:

208,000tpy / 400,000 tpy = 0.52% → 0.55%

515,000,000 sum x 0.55 = 283,250,000 sum

(e) Initial investment costs summary

	(10^3 sum)
[1] Infrastructure and ancillary facilities	402,840
[2] Mining machinery	284,100
[3] Mining facilities and equipment	690,200

[4] Ore processing equipment 311,575

Total - Initial investment costs(10^3 sum) 1,668,715

(1,688,715,000 sum / 2,072,000t = 815sum/t)

(2) Operating costs

(i) Mining cost

(a) Machinery requirement

[1] Drilling machine(two-boom mobile jumbos with two 45-kW hydraulic rock drills; engine power 68hp)

- Drilling diameter: Charge hole 53mm; burn hole 80mm
- Tunneling length: 15m/1,000t x 208,000t = 3,120m
- Drilling length/m of tunneling: (42 + 4)m/m
- Drilling length for mining of ore: 1.1m/m^3
- Run of mine from development operation: 5% of mined ore

Therefore, the total annual drilling length is:

3,120m x 46m/m + 208,000t x 0.95 / 3t/m^3 x 1.1m/m^3 = 215,973m

- Annual drilling capacity per machine:

96m/sft x 3 sft/d x 260d/yr = 74,880m

- Number of machine required:

215,973m / 74,880m = 2.88 → 3 units

[2] Blasting machines(ANFO truck with a 500L cap. explosives tank; charging of explosives into charge holes by compressed air; one-man operated; engine power 139hp)

- Explosives consumption: 28kgs/m for tunneling; 1.89kgs/m^3 for mining of ore
- Annual consumption of explosives:

3,120m x 28kgs/m + 208,000t x 0.95 / 3t/m^3 x 1.89kgs/m^3 = 211,848kgs

- Annual work quantity per machine:

200kgs/sft x 3 sft/d x 260d/yr = 156,000kgs

- Number of machine required:

211,848kgs / 156,000kgs = 1.36 → 2 units

[3] Haulage machines(Load haul dumps for underground use, with a 6.5-m^3 cap bucket; engine power 277hp; fuel consumption 33L/hr)

The tunneling/ore mining operations and the waste haulage /secondary ore haulage operations are different in terms of work efficiency; they have to be treated distinctively.

- Work volume for tunneling:

3,120m x 14.15m^3 x 1.6 = 70,637m^3

- Work volume for mining of ore:

208,000t x 0.95 / 3t/m^3 x 1.6 = 105,389m^3

- Annual work volume per machine:

83.2m^3 x 3 sft/d x 260d/yr = 64,896m^3

- Number of machine required:

(70,637 + 105,389)m^3 / 64,896m^3 =2.71 units

- Filling volume: 208,000t / 3t/m^3 = 69,333m^3

- Volume of waste haulage and secondary haulage of ore:

(70,637 + 105,389 + 69,333) x 0.12 =29,443m^3

- Annual work quantity per machine:

166.4m^3/sft x 3 sft/d x 260d/yr = 129,792m^3

- Number of machine required:

(69,333 + 29,443)m^3 / 129,443m^3 = 0.76 units

- Total requirement: 2.71 + 0.76 = 3.47 → 4 units

[4] Rock-bolting machine(Jumbo, with a 30-kW hydraulic rock drill for mortar-bolting; engine power 84hp)

For tunneling: 9 bolts per line; line spacing 1.2m; timbering ratio 50%

- Annual tunneling length: 15m/1,000t x 208,000t/yr =3,120m/yr

- Number of bolts: 3,120m / 1.2m x 9 x 0.5 = 11,700 bolts

For mining of ore: Specific gravity of ore 3.1, slice 4m; bolting density 1 bolt/m^2; waste to ore ratio 20%; and, timbering ratio 50%

208,000t x 0.95 / 3t/m^3 / 4m x 1 bolt/m^2 x 1.2 x 0.5 = 9,880 bolts

In case of 10 bolts/hr, 4 hrs/shift and operation rate of 80%, the annual work quantity of rock-bolting machine is:

10 bolts/hr x 4 hrs/sft x 0.8 x 3 sft/d x 260d/yr = 24,960 bolts

- Number of machine required:

(11,700 + 9,880)bolts / 24,960 bolts = 0.86 → 1 unit

[5] Trucks for surface use (CAT773B; load 45t; engine power 650hp; the same specifications as those for open-pit use)

- Ore haulage between the mine and Kokpatas:

208,000t / (45t x 0.9) = 5,136 trips

- Number of truck required for ore haulage:

5,136 trips/yr x 72 min/trip x 1.1 / 360min/sft / 780 sft/yr = 1.45 units

- Waste volume for underground filling: 208,000t / 3t/m^3 -208,000t

x (15*- 1.2**)m/1,000t x 14.15m^2 *** x 1.6 = 4,348m^3

* Development work(m) ** Run of mine from development operation

*** The section of ramp

- Number of truck required for waste haulage:

4,348m^3 / 21.6m^3/trip x 21min/trip x 1.1 / 360min/sft / 780 sft/yr = 0.02 unit

- Total number of trucks required: 1.45 + 0.02 = 1.47 → 2 units

Table 3-5-11 Personnel Requirement(Burgut:800t/day)

	1st shift	2nd shift	3rd shift	Total	Adjusted number
Manager	1			1	
Mining eng.					Manager add post
Surveyor	1			1	
Geologist	1			1	
Mechanic	1			1	
Foreman	1	1	1	3	
Staff	5	1	1	7(9)	7×1.24=8.7
Driller	3	3	3	9	
Blaster	2	2	2	6	
L.H.D man	4	4	4	12	
Timber man	1	1	1	3	
Trucker	2	2	2	6	
Repairman	4	2	2	8	
T.Service	1	1	1	3	T=Trackless
Hoisting	2	2	2	6	
Geo.Survey	4			4	
Guard	1	1	1	3	
Clerk	3			3	Nurse 1
Worker	27	18	18	63(79)	63×1.24=78.1
Total	32	19	19	70(88)	

*Coefficient,1.24 : Days operated260,Vacation50,Actual working days210
260÷210=1.24

(b) Personnel(Ref. Table 3-5-11 Personnel Requirement)

- Engineers 9
- Operators 79

An operator per shift is assigned to each of the machines. Actual working days of an operator being 210 days per year as against 260 days of annual operating days, 1.24 operators are actually required per operator.

(c) Mining costs

	(10^3 sum)
- Labor	12,822
- Explosives	12,457
- Rock tools	4,940
- Fuel and lubricant	16,070
- Tires	4,688
- Rock bolts	10,790
- Electric power	8,842

- Repair	44,440
Total - Mining costs(10^3 sum)	115,049
	(553 sum/t)

Materials cost per ton: (12,457 + 4,940 + 16,070 + 4,688 +10,790) x 10^3 sum / 208,000t = 235 sum/t

(ii) Ore processing costs

(a) Basic assumptions of operation

- Annual treatment of crude ore: 208,000t
- Grade of crude ore: 0.68%
- Ore processing recovery: 88.2%
- Grade of tailings: 0.08%
- Grade of concentrate: 55.3%
- Annual production of concentrate: 2,257t
- Personnel: 95(8 engineers and 87 operators)

(b) Ore processing costs

[1] Labor

		(10^3 sum)	
- Engineers: 8p x 10,000sum/p/mo x 12 mos	=	960	... a
- Operators: 87p x 8,000 sum/p/mo x 12 mos	=	8,352	... b
- Fringe benefit: (a + b) x 0.38		3,539	
Sub-total - Labor cost(10^3 sum)		12,851	
[2] Supplies and chemicals: 135.62 sum/t x 208,000t	=	28,209	
[3] Electric power: 38kWh/t x 2sum x 208,000t	=	15,808	
[4] Process water: 5.5m^3/t x 3.75 sum x 208,000t	=	4,200	
[5] Potable water: 0.385m^3/t x 8.55 sum x 208,000t	=	685	
[6] Repair: ([1] + [2] + [3] + [4] + [5]) x 0.15		9,276	
Total - Ore processing cost(10^3 sum)		71,119	
		(342 sum/t)	

(iii) Administration cost

	(10^3 sum)
(115,049 + 71,119) x 10^3 sum x 0.10	= 18,617
	(90 sum/t)

(iv) Railroad freight cost

Transportation operation is assumed to be undertaken by a railroad company.

- Freight for crude ore (Kokpatas - No.3 Plant):51 sum/t x 208,000t =	10,608
- Freight for concentrate (No.3 Plant - Chirchik): 433 sum/t x 2,257t =	955
Total - Railroad freight(10^3 sum)	11,563
	(56 sum/t)

(v) Annual operating cost summary

	(10^3 sum)	(sum/t)
- Mining costs	115,049	553
- Ore processing cost	71,119	342
- Administration cost	18,617	90
- Railroad freight	11,563	56
Total - Annual operating cost	216,348	1,040

(3) Operating income

(i) Ore value per ton:

2,257t x 55.3% x 61$/t-% x 50 sum/$ / 208,000t = 1,830 sum/t

(ii) Total operating income:

(1,830-815-1,40)sum/t x 2,072,000t = (-)51,800,000 sum

(4) Comparison of operating income

Table 3-5-12 and Table 3-5-13 compare total operating income of the optimum operations, at three different cutoff grades, of the Burgut and Saghinkan deposits. Both Burgut and Saghinkan suffer losses, even at their optimum operation scales and cutoff grades; the 800-tpd operation at 0.5% cutoff of Burgut results in a loss of 25 sum/t, while a

loss of 428 sum/t is suffered by Saghinkan in the case of 800-tpd operation at a 0.4% cutoff grade.

As for Sautbay, which generates a loss of 558 sum/t if mined by open-pitting, an income estimation for underground mining indicates a loss of 487 sum/t, as tabulated in Table 3-5-14. Although the figure turned out somewhat better than that of open-pit mining, the initial investment in the underground mining equipment, some 700 million sum, considerably depresses the profitability.

Table 3-5-12 Comparison of 3 Plans(Burgut Underground)

	Plan ①	Plan ②	Plan ③
Ore cut-off grade(%)	0.3	0.4	0.5
Reserves of minable ore(10^3t)	3,473	2,812	2,072
Minable grade(%)	0.54	0.60	0.68
Production(t/day)	800	800	800
Mine life(years)	16.7	13.5	10.0
Value of crude ore(sum/t)	1,403	1,586	1,830
Initial investment(sum/t)	486	601	815
Operating cost(sum/t)	1,039	1,040	1,040
Income(sum/t)	-122	-55	-25
Total income(10^3sum)	-423,706	-154,660	-51,800

Table 3-5-13 Comparison of 3 Plans (Saghinkan Underground)

	Plan ①	Plan ②	Plan ③
Ore cut-off grade(%)	0.3	0.4	0.5
Reserves of minable ore(10^3t)	3,775	2,325	1,665
Minable grade(%)	0.42	0.52	0.58
Production(t/day)	800	800	500
Mine life(years)	18.1	11.2	12.8
Value of crude ore(sum/t)	1,037	1,342	1,525
Initial investment(sum/t)	447	726	908
Operating cost(sum/t)	1,043	1,044	1,135
Income(sum/t)	-453	-428	-518
Total income(10^3sum)	-1,710,075	-995,100	-862,470

Table 3-5-14 Comparison of 3 Plans (Sautbay Underground)

	Plan ①	Plan ②	Plan ③
Ore cut-off grade(%)	0.3	0.4	0.5
Reserves of minable ore(10^3t)	3,396	2,221	1,309
Minable grade(%)	0.42	0.51	0.62
Production(t/day)	800	800	500
Mine life(years)	16.3	10.7	10.1
Value of crude ore(sum/t)	1,037	1,312	1,647
Initial investment(sum/t)	497	760	1,154
Operating cost(sum/t)	1,038	1,039	1,130
Income(sum/t)	-498	-487	-637
Total income(10^3sum)	-1,691,208	-1,081,627	-833,833

3-5-5 Conclusions

1) Evaluation of the Ore Deposits

The ore reserve estimation, at a cutoff grade of 0.05%, indicates that the ore reserves totaling Sautbay and Burgut are approx. 15,195,000 tons, averaging 0.29%, whilst Saghinkan's ore reserves are approx. 10,062,000 tons, averaging 0.24%. In terms of the minable crude ore at the optimum operation scale, however, Sautbay has only 1,194,000 tons, averaging 0.48%(minable ore grade) at a 0.2% cutoff grade, Burgut 2,072,000 tons, averaging 0.68% at a 0.5% cutoff grade and Saghinkan 2,325,000 tons, averaging 0.52% at a 0.4% cutoff grade, respectively. This implies that

[1] these deposits are dominated by low-grade ore; the ore value is accordingly low;
[2] to elevate the ore value(grade), the quantity of ore has to be reduced, which inevitably increases in the initial investment per ton; thus,
[3] these ore deposits are not considered so excellent as to permit individual development.

2) An Alternative for Development

Feasibility for development of the Sautbay, Burgut and Saghinkan deposits was studied in the preceding articles. Since separate development of these ore deposits is difficult due to the small ore reserves and low grades, the optimum operation of more than one deposit, combined, was pursued(Table 3-5-15~16). Operation is 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.

3) Evaluation of the Alternative Project

The feasibility study revealed that 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 foe equipment replacement, mine closure and taxes are considered. Due to the lack of profitablity even under such exceptionally favorbale conditions, development of the tungsten deposits in the Sautbay district is considered economically unfeasible, under the current levels of ore reserves, grade and WO_3 price.

In addition, the Chirchik refinery, the prospective buyer, is said to purchase WO_3 concentrate at a price equivalent to 80% of the international price. If the purchase price is applied as such, the project revenues are curtailed by 20%, making the project feasibility even slimmer.

Table 3-5-15 Income without Common Initial Investment

	Sautbay OP	Burgut	Saghinkan	Sautbay UG
Ore cut-off grade(%)	0.2	0.5	0.4	0.4
Reserves of minable ore(10^3t)	1,194	2,072	2,325	2,221
Minable grade(%)	0.48	0.68	0.52	0.51
Production(t/day)	700	800	800	800
Mine life(years)	6.6	10.0	11.2	10.7
Initial investment				
Infrastructure(10^3sum)	0	0	0	0
Mining(10^3sum)	275,700	974,300	974,300	974,300
Dressing(10^3sum)	0	0	0	0
Initial investment(sum/t)	231	470	419	439
Operating cost(sum/t)	972	1,040	1,044	1,039
Value of crude ore(sum/t)	1,220	1,830	1,342	1,312
Income(sum/t)	17	320	-121	-166
Total income(10^3sum)	20,298	663,040	-281,325	-368,686

Table 3-5-16 Comparison of Total Income

	Sautbay open pit	Burgut underground	Saghinkan underground	Sautbay OP+ Burgut UG
Ore cut-off grade(%)	0.2	0.5	0.4	0.2,0.5
Minable ore('10^3t)	1,194	2,072	2,325	3,266
Minable grade(%)	0.48	0.68	0.52	0.61
Production (t/day)	700	800	800	700→800
Mine life(years)	6.6	10.0	11.2	16.6
Initial investment('10^3sum)	961,790	1,688,715	1,688,715	1,964,415
Crude ore value(sum/t)	1,220	1,830	1,342	1,607
Initial investment(sum/t)	806	815	726	601
Operating cost(sum/t)	972	1,040	1,044	1,015
Income(sum/t)	-558	-25	-428	-9
Total income('10^3sum)	-666,252	-51,800	-995,100	-29,394

4) Variation of Operating Income

In this study, the Metal Bulletin price of WO_3 concentrate, currently 61$/t-%, is used.

In order to see how the operating income varies as WO_3 price fluctuates and as interest rate for borrowing changes, calculation is made of four combinations of 0% and 5% interest, and WO_3 concentrate selling prices equivalent to 100% and 80% of the international price.(Fig 3-5-6)

Table 3-5-17 shows the project operating incomes and the WO_3 prices at which operating income turns out to be zero, for the mentioned four cases. The parameters are limited only to the WO_3 price, interest rate and concentrate selling price. The MB prices of WO_3 from 1977 to 1996(September) appear in Table 3-5-18.

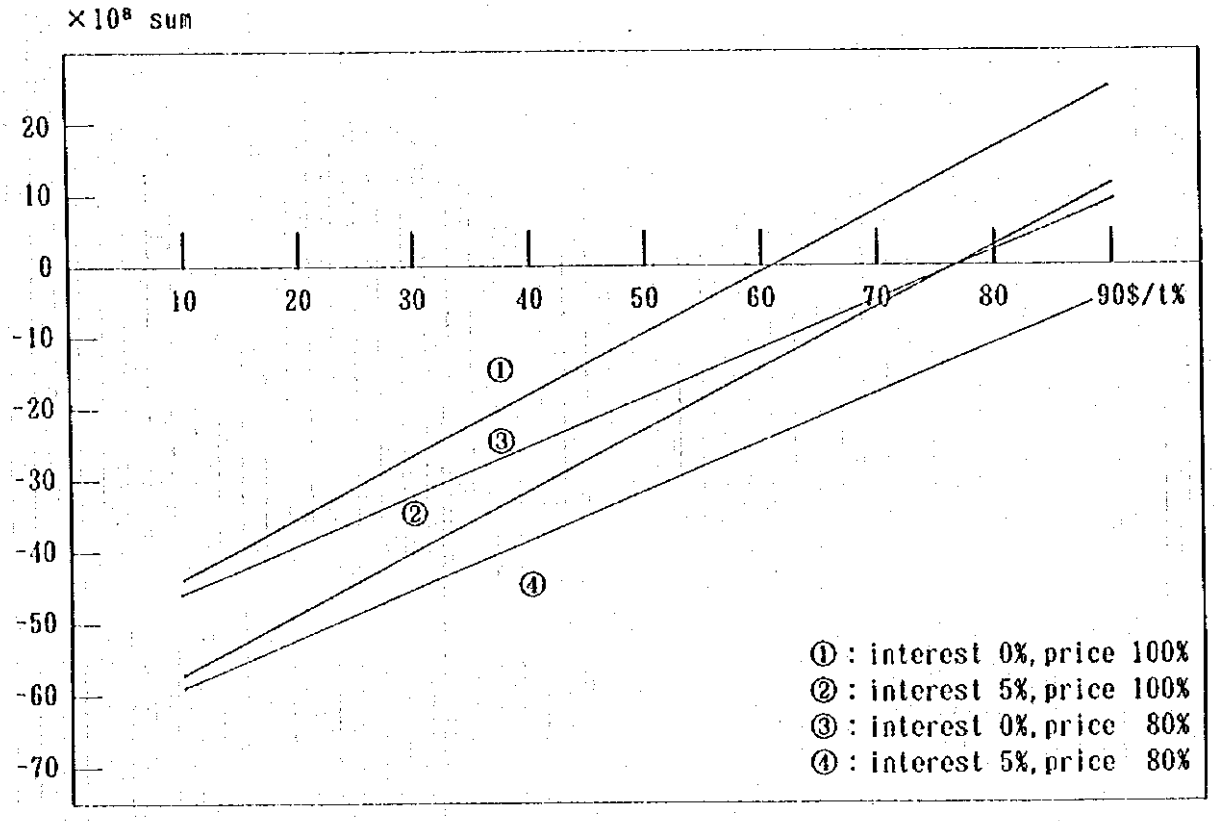

Fig.3-5-6 Change of Income by WO_3 Price

Table 3-5-17 Income and WO_3 Price at Income=0

	Income at 61$/t·%	WO_3 Price at Income=0
Interest 0% Price 100%	$\times 10^8$ sum -0.3	$/t·% 62
Interest 5% Price 100%	-13.7	77
Interest 0% Price 80%	-10.8	77
Interest 5% Price 80%	-24.2	97

Table 3-5-18 Price of WO_3 Concentrate ($/t·%)

Year	Highest	Lowest
1977	175	167
78	147	141
79	142	136
80	147	143
81	146	142
82	108	104
83	83	79
84	83	79
85	70	65
86	52	43
87	54	44
88	60	52
89	63	50
90	54	38
91	60	53
92	62	52
93	40	29
94	48	37
95	69	59
96.9	65	61

Standard grade : WO_3 65%

List of Abbreviations

(in alphabetical order)

- **cfm**	cubic feet per minute	**p**	person(s)
- **d**	day(s)	**pc(s)**	piece(s)
- **hp**	horse power	**R**	ruble(s)
- **hr**	hour(s)	**$**	US dollar(s)
- **kW**	kilo-watt	**sft**	shift(s)
- **kWh**	kilo-watt-hour(s)	**t**	metric ton(s)
- **L**	liter(s)	**tpd**	ton(s) per day
- **m**	meter(s)	**tpy**	ton(s) per year
- **min**	minute(s)	**yr(s)**	year(s)
- **mo(s)**	month(s)		

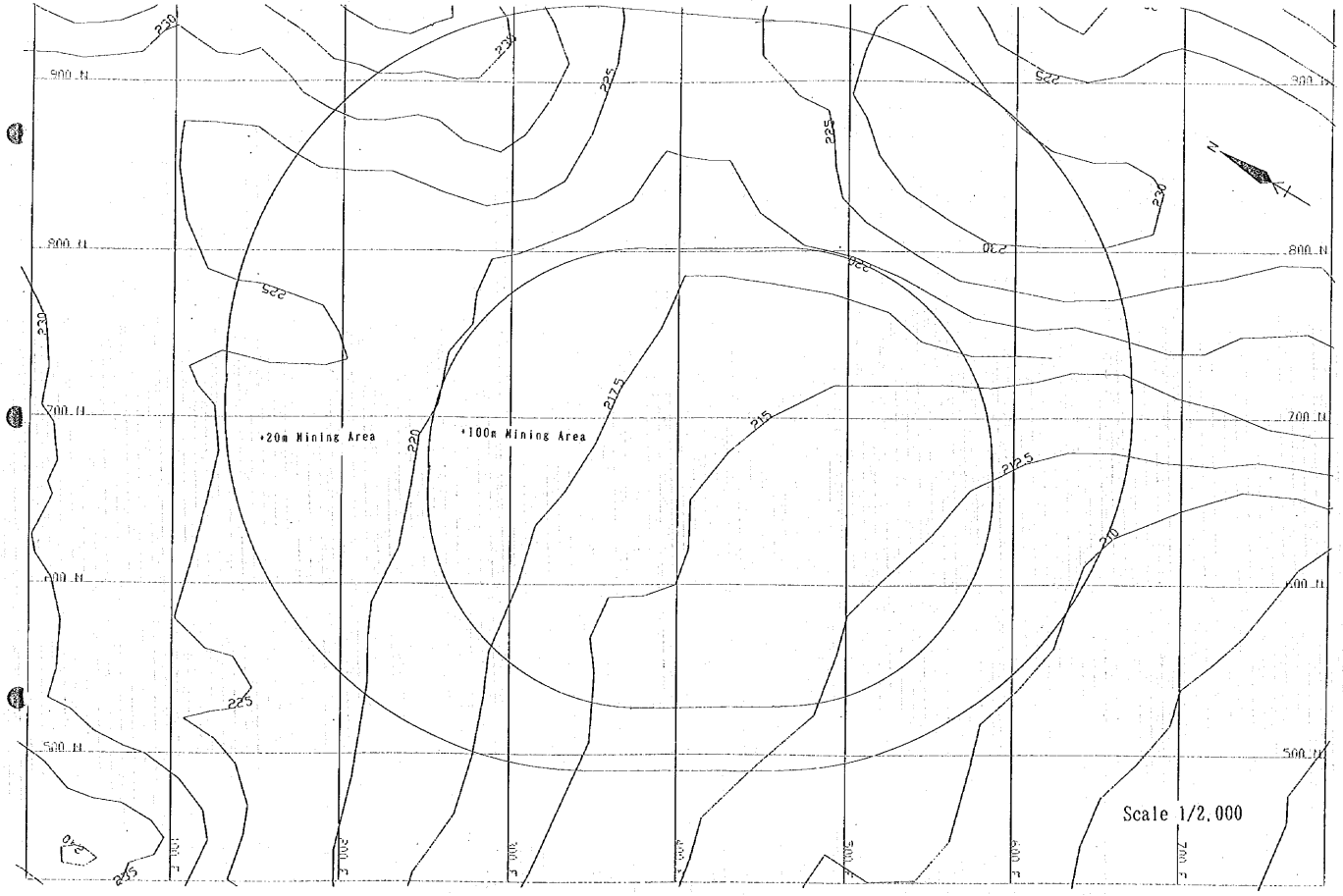

Fig.3-5-1 Surface Plan View

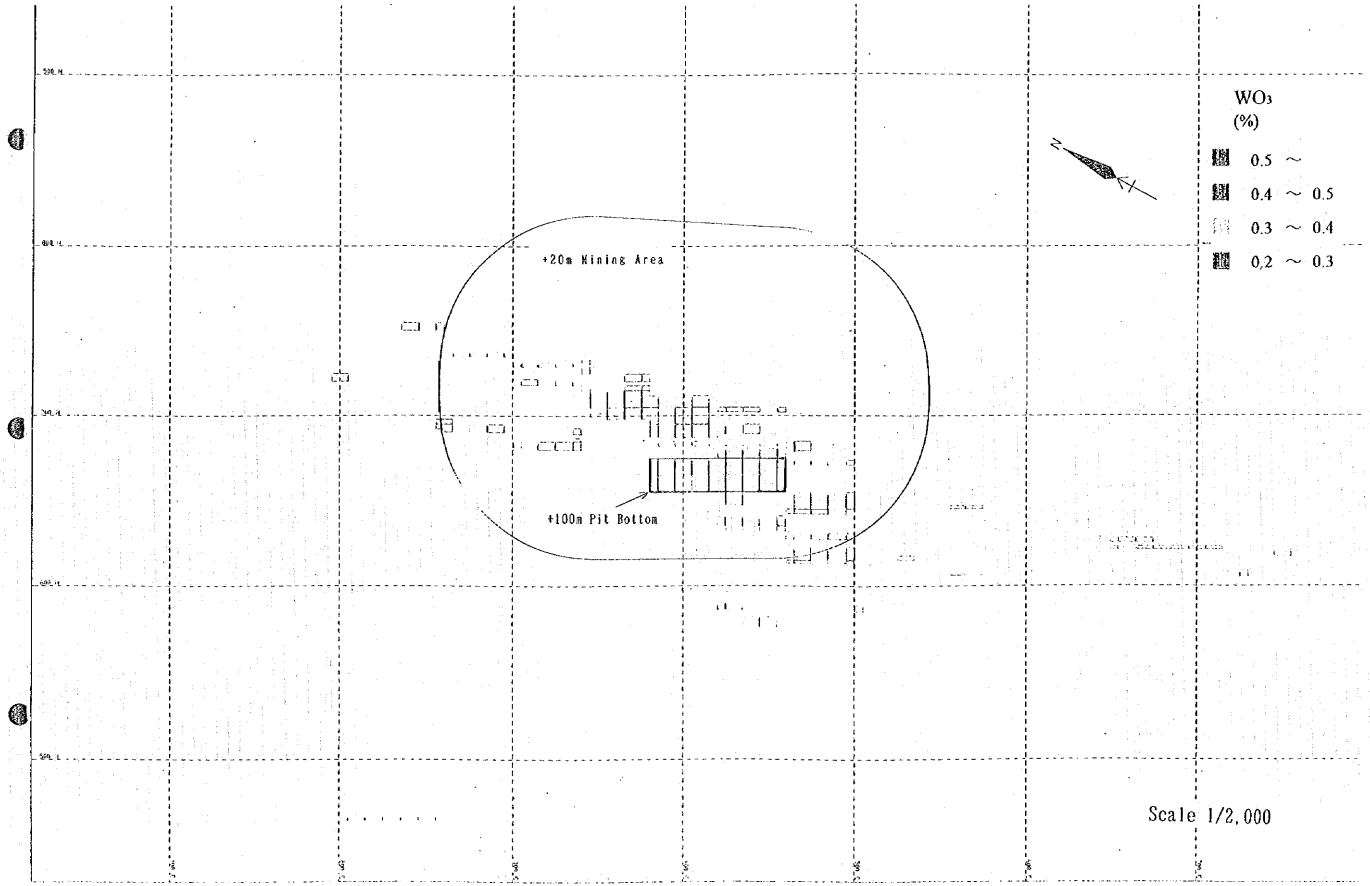

Fig.3-5-2 +100m Plane Figure

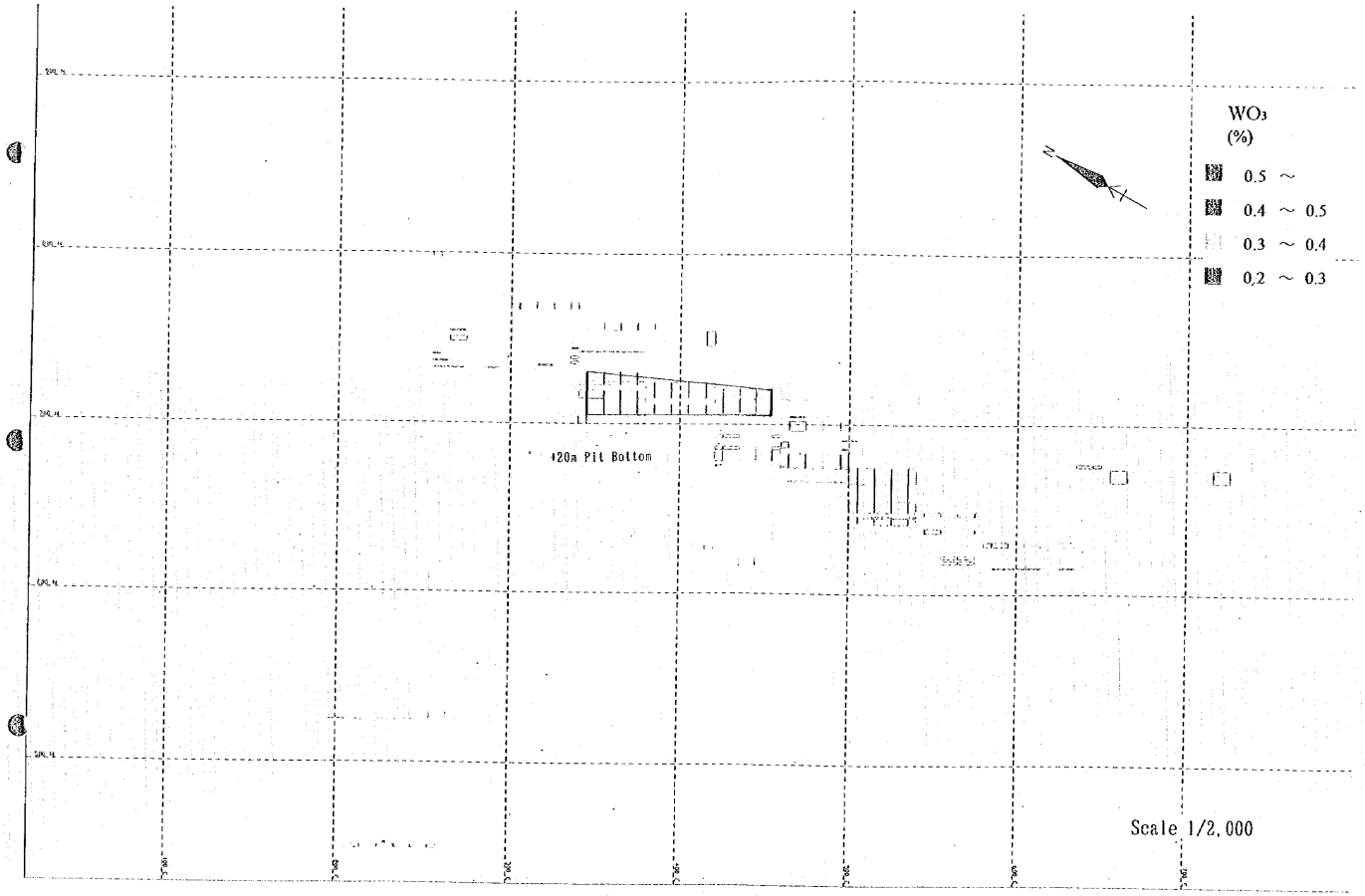

Fig.3-5-3 +20m Plane Figure

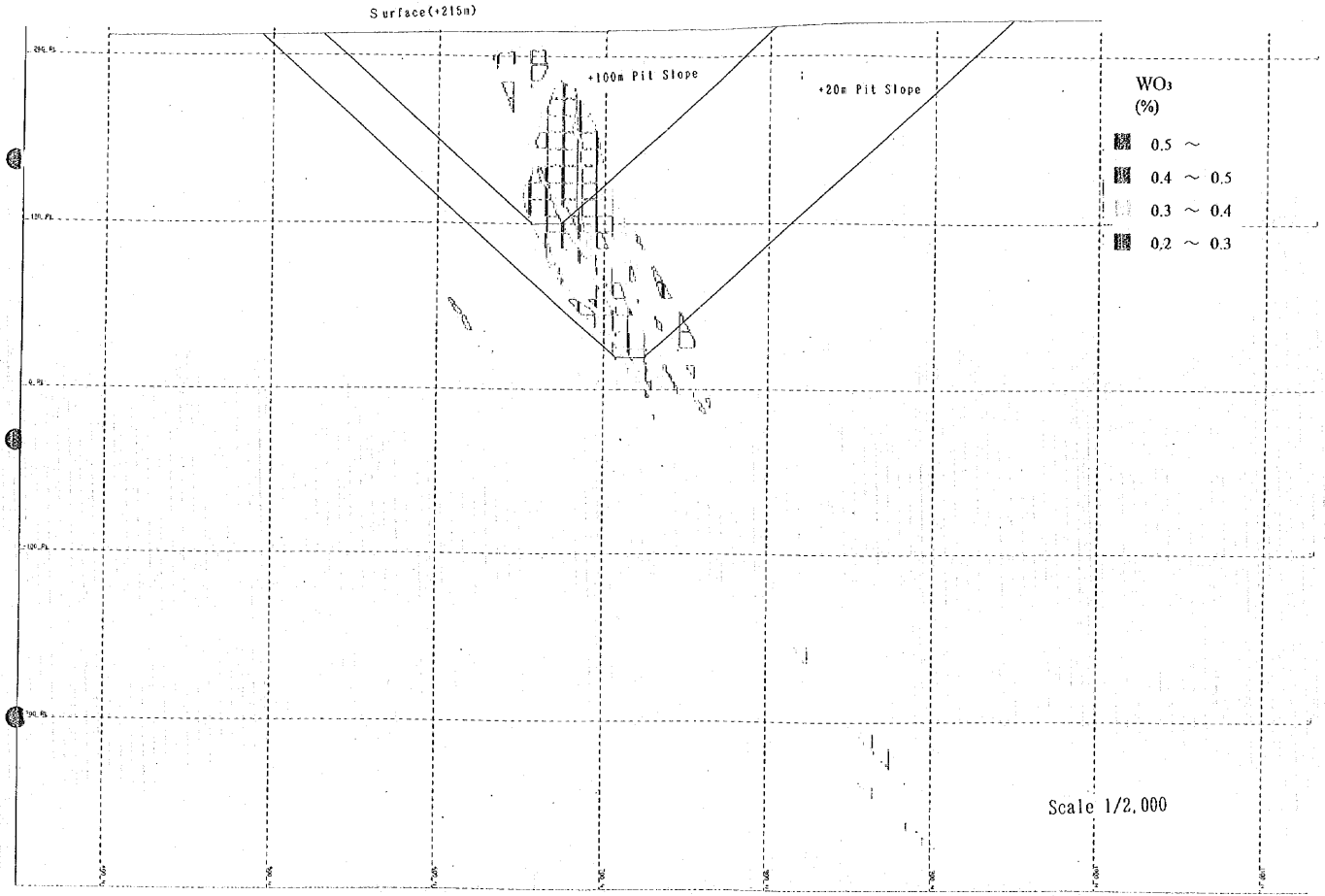

Fig.3-5-4 Cross Section along 400E

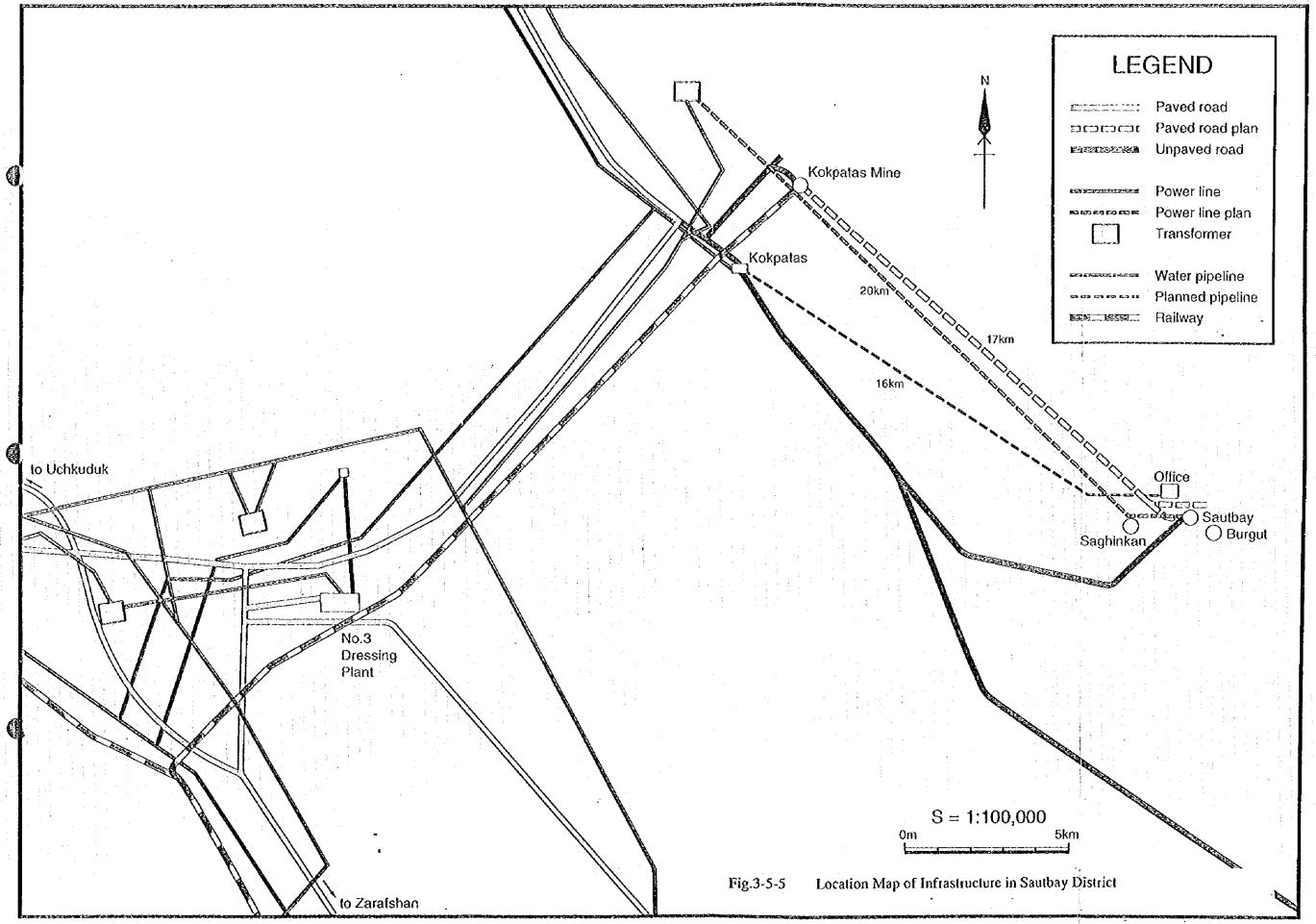

Fig.3-5-5 Location Map of Infrastructure in Sautbay District

Table 3-5-2 Comparison of Production Cost(Mining Plan ① in Case of Railway and Truck Transportation)

Production (t/day)	500		600		700		800		900		1,000		1,100		1,200		1,300		1,400		1,500		1,600	
Production(thou.t/year)	130		156		182		208		234		260		286		312		338		364		390		416	
Mine life(years)	19.6		16.3		14.0		12.2		10.9		9.8		8.9		8.2		7.5		7.0		6.5		6.1	
Concentrate(t/year)	799		959		1,119		1,279		1,439		1,599		1,758		1,918		2,078		2,238		2,398		2,558	
Conc. income(thou.sun)	134,763	1,037	161,750	1,037	188,736	1,037	215,723	1,037	242,709	1,037	269,695	1,037	296,513	1,037	323,499	1,037	350,486	1,037	377,472	1,037	404,459	1,037	431,445	1,037
Initial investment(thou.sun)	1,013,390	398	1,074,115	422	1,135,840	446	1,217,015	490	1,338,365	525	1,397,390	549	1,533,965	603	1,594,990	627	1,684,340	662	1,745,365	686	1,856,940	730	1,952,140	767
Infrastructure	402,840		402,840		402,840		402,840		402,840		402,840		402,840		402,840		402,840		402,840		402,840		402,840	
Drilling equipment	50,000	2	50,000	2	50,000	2	50,000	2	50,000	2	50,000	2	75,000	3	75,000	3	75,000	3	75,000	3	75,000	3	100,000	4
Mucking equipment	101,100	2	101,100	2	101,100	2	151,650	3	151,650	3	151,650	3	202,200	4	202,200	4	202,200	4	202,200	4	252,750	5	252,750	5
Truck	163,500	5	196,200	6	228,900	7	261,600	8	294,300	9	327,000	10	359,700	11	392,400	12	425,100	13	457,800	14	490,500	15	523,200	16
Others(mining)	69,350		69,350		69,350		69,350		69,350		69,350		69,350		69,350		69,350		69,350		69,350		69,350	
Dressing	226,600		254,925		283,250		311,575		368,225		396,550		424,875		453,200		509,850		538,175		566,500		604,270	
Mining cost	116,942	900	132,749	851	148,571	816	167,680	806	183,487	784	199,754	768	223,706	782	239,651	768	255,461	756	271,267	745	290,427	745	311,345	748
Personnel(staff)	9		9		9		9		9		10		10		10		10		10		11		11	
(worker)	71		75		79		87		91		97		108		113		117		121		128		137	
Wages	11,686		12,251		12,822		13,959		14,528		15,558		17,121		17,831		18,399		18,968		20,110		21,419	
Explosives	12,925		15,510		18,095		20,680		23,265		25,850		28,435		31,020		33,605		36,190		38,775		41,360	
Rock tool	6,042		7,251		8,459		9,667		10,876		12,084		13,293		14,501		15,710		16,918		18,126		19,335	
Fuel, lubricant	47,171		55,446		63,738		71,997		80,272		88,547		96,822		105,098		113,373		121,648		129,923		138,199	
Tire	7,597		9,117		10,636		12,156		13,675		15,194		16,711		18,233		19,753		21,272		22,792		24,311	
Electricity	1,821		1,821		1,821		1,821		1,821		1,821		1,821		1,821		1,821		1,821		1,821		1,821	
Maintenance	29,700		31,350		33,000		37,400		39,050		40,700		49,500		51,150		52,800		54,450		58,850		64,900	
Dressing cost	43,116	347	53,834	345	62,553	344	71,119	342	80,027	342	88,746	341	97,465	341	106,183	340	115,092	341	123,810	340	132,377	339	141,095	339
Personnel(staff)	8		8		8		8		9		9		9		9		10		10		10		10	
(worker)	55		66		77		87		98		109		120		131		142		153		163		174	
Wages	8,611		10,068		11,526		12,851		14,473		15,931		17,388		18,845		20,468		21,925		23,250		24,708	
Materials	17,631		21,137		24,683		28,209		31,735		35,261		38,788		42,314		45,840		49,366		52,892		56,418	
Electricity, water	12,989		15,587		18,185		20,783		23,381		25,978		28,576		31,174		33,772		36,370		38,968		41,565	
Maintenance	5,885		7,022		8,159		9,276		10,438		11,576		12,713		13,850		15,012		16,149		17,287		18,404	
General management	18,206	125	18,638	120	21,112	116	23,880	115	26,351	113	28,850	111	32,117	112	34,581	111	37,055	110	39,508	109	42,280	108	45,214	109
Freight rates	6,968	54	8,362	54	9,755	54	11,149	54	12,543	54	13,936	54	15,330	54	16,723	54	18,117	54	19,511	54	20,904	54	22,298	54
Ore freight	6,630		7,958		9,282		10,608		11,934		13,260		14,586		15,912		17,238		18,564		19,890		21,216	
Concentrate freight	338		406		473		541		609		676		744		811		879		947		1,014		1,082	
Annual operating cost	185,232	1,425	213,603	1,369	241,991	1,330	273,828	1,316	302,408	1,292	331,286	1,271	368,618	1,289	397,144	1,273	425,725	1,260	454,096	1,248	485,988	1,245	519,982	1,250
Total cost(initial invest. ment+operating cost)		1,823		1,791		1,776		1,806		1,817		1,823		1,892		1,900		1,922		1,934		1,976		2,017
Total income	2,000,370	786	2,418,930	751	1,880,755	739	1,957,105	769	1,985,100	780	2,000,370	786	2,175,975	855	2,196,335	863	2,232,325	885	2,282,865	897	2,389,755	939	2,491,100	980

Table 3-5-3 Comparison of Production Cost(Mining Plan ① in Case of Truck transportation)

Production(t/day)	500		600		700		800		900		1,000		1,100		1,200		1,300		1,400		1,500		1,600	
Production(thou.t/year)	130		158		182		208		234		260		286		312		338		364		390		416	
Mine life(years)	19.6		16.3		14.0		12.2		10.9		9.8		8.9		8.2		7.5		7.0		6.5		6.1	
Concentrate(t/year)	799		939		1,119		1,279		1,439		1,599		1,758		1,918		2,078		2,238		2,398		2,558	
Conc. income(thou.sun)	134,763	1,037	161,750	1,037	188,736	1,037	215,723	1,037	242,709	1,037	269,695	1,037	296,313	1,037	323,499	1,037	350,486	1,037	377,472	1,037	404,459	1,037	431,445	1,037
Initial investment(thou.sun)	1,152,170	453	1,213,195	477	1,274,220	501	1,385,295	545	1,475,145	580	1,536,170	604	1,672,745	657	1,766,470	694	1,855,820	729	1,916,845	753	2,028,420	797	2,123,890	835
Infrastructure	508,920		508,920		508,920		508,920		508,920		508,920		508,920		508,920		508,920		508,920		508,920		508,920	
Drilling equipment	50,000	2	50,000	2	50,000	2	50,000	2	50,000	2	50,000	2	75,000	3	75,000	3	75,000	3	75,000	3	75,000	3	100,000	4
Making equipment	101,100	2	101,100	2	101,100	2	151,650	3	151,650	3	151,650	3	202,200	4	202,200	4	202,200	4	202,200	4	252,750	5	252,750	5
Truck	196,200	6	228,900	7	261,600	8	294,300	9	327,000	10	359,700	11	392,400	12	457,800	14	490,500	15	523,200	16	555,900	17	588,600	18
Others(mining)	69,350		69,350		69,350		69,350		69,350		69,350		69,350		69,350		69,350		69,350		69,350		69,350	
Dressing	226,600		254,925		283,250		311,575		368,225		396,550		424,875		453,200		509,850		538,175		566,500		604,270	
Mining cost	123,559	950	140,245	899	156,789	861	176,935	851	193,621	827	210,768	811	235,743	824	254,647	816	271,191	802	287,876	791	308,200	790	329,712	793
Personnel(staff)	9		9		9		9		9		10		10		10		10		10		11		11	
(worker)	75		79		82		91		95		101		113		121		121		128		137		141	
Wages	12,254		12,822		13,249		14,528		15,096		16,126		17,831		18,968		19,394		19,962		21,419		22,413	
Explosives	12,925		15,510		18,095		20,680		23,265		25,850		28,435		31,020		33,605		36,190		38,775		41,360	
Rock tool	6,042		7,251		8,459		9,667		10,876		12,084		13,293		14,501		15,710		16,918		18,126		19,335	
Fuel, lubricant	50,761		59,754		68,747		77,740		86,733		95,726		104,720		113,713		122,706		131,699		140,692		149,685	
Tire	8,106		10,087		11,768		13,449		15,130		16,811		18,493		20,174		21,855		23,536		25,217		26,898	
Electricity	1,821		1,821		1,821		1,821		1,821		1,821		1,821		1,821		1,821		1,821		1,821		1,821	
Maintenance	31,350		33,000		34,650		39,050		40,700		42,350		51,150		54,450		56,100		57,750		62,150		68,200	
Dressing cost	45,116	347	53,834	345	62,553	344	71,119	342	80,027	342	88,746	341	97,465	341	106,183	340	115,092	341	123,810	340	132,377	339	141,095	339
Personnel(staff)	8		8		8		8		9		9		9		9		10		10		10		10	
(worker)	55		66		77		87		98		109		120		131		142		153		163		174	
Wages	8,611		10,068		11,526		12,851		14,473		15,931		17,388		18,845		20,468		21,925		23,250		24,708	
Materials	17,631		21,157		24,683		28,209		31,735		35,261		38,788		42,311		45,840		49,366		52,892		56,418	
Electricity, water	12,989		15,587		18,185		20,783		23,381		25,978		28,576		31,174		33,772		36,370		38,968		41,565	
Maintenance	5,885		7,022		8,159		9,276		10,438		11,576		12,713		13,850		15,012		16,149		17,287		18,404	
General management	16,868	130	19,408	124	21,931	121	24,805	119	27,365	117	29,931	115	33,321	117	36,083	116	38,628	111	41,169	113	44,058	113	47,081	113
Freight rates	338	3	406	3	473	3	541	3	609	3	676	3	744	3	811	3	879	3	947	3	1,014	3	1,082	3
Ore freight																								
Concentrate freight	338		406		473		541		609		676		744		811		879		947		1,014		1,082	
Annual operating cost	185,881	1,130	213,893	1,371	241,719	1,328	273,100	1,311	301,622	1,289	330,141	1,270	367,273	1,281	397,724	1,275	425,790	1,260	453,892	1,247	485,619	1,245	518,970	1,248
Total cost(Initial investment operating cost)		1,883		1,848		1,829		1,859		1,869		1,874		1,911		1,969		1,989		2,000		2,042		2,083
Total income	-2,153,020	846	-2,063,995	811	-2,015,640	792	-2,094,990	822	-2,117,110	-832	-2,130,165	837	-2,300,880	904	-2,371,910	932	-2,422,810	952	-2,450,835	963	-2,557,775	1,005	-2,667,070	1,048

Table 3-5-6 Comparison of Production Cost(Mining Plan ②)

Production(t/day)	100		500		600		700		800		900		1,000		1,100		1,200		1,300		1,400		1,500	
Production(thou.t/year)	101		120		136		182		208		231		260		286		312		338		364		390	
Mine life(years)	11.5		9.2		7.7		6.6		5.7		5.1		4.6		4.2		3.8		3.5		3.3		3.1	
Concentrate(t/year)	752		940		1,128		1,316		1,505		1,693		1,881		2,069		2,257		2,445		2,633		2,821	
Conc. income(thou.won)	126,836	1,220	158,545	1,220	190,254	1,220	221,963	1,220	253,811	1,220	285,550	1,220	317,259	1,220	348,968	1,220	380,677	1,220	412,386	1,220	444,095	1,220	475,804	1,220
Initial investment(thou.won)	815,790	683	872,140	731	933,175	782	991,790	806	1,073,363	899	1,130,015	946	1,216,010	1,018	1,271,065	1,070	1,305,390	1,093	1,391,740	1,168	1,423,065	1,192	1,534,640	1,285
Infrastructure	402,840		402,840		402,840		402,840		402,840		402,840		402,840		402,840		402,840		402,840		402,840		402,840	
Drilling equipment	25,000	1	25,000	1	25,000	1	25,000	1	25,000	1	25,000	1	50,000	2	50,000	2	50,000	2	50,000	2	50,000	2	50,000	2
Mucking equipment	50,550	1	50,550	1	50,550	1	50,550	1	101,100	2	101,100	2	101,100	2	101,100	2	101,100	2	101,100	2	101,100	2	151,650	3
Truck	98,100	3	98,100	3	130,800	4	130,800	4	163,500	5	163,500	5	196,200	6	228,900	7	228,900	7	261,600	8	261,600	8	294,300	9
Others(mining)	69,350		69,350		69,350		69,350		69,350		69,350		69,350		69,350		69,350		69,350		69,350		69,350	
Dressing	169,950		226,600		254,935		283,250		311,575		368,225		396,550		424,875		453,200		509,850		538,175		566,500	
Mining cost	65,264	628	72,581	558	81,975	525	89,294	491	102,289	492	109,606	468	124,394	478	133,929	468	141,247	453	150,644	446	157,958	434	170,954	438
Personnel(staff)	9		9		9		9		9		9		9		9		9		9		9		9	
(worker)	53		53		56		56		65		65		75		79		79		82		82		91	
Wages	9,129		9,129		9,555		9,555		10,834		10,834		12,254		12,822		12,822		13,249		13,249		14,528	
Explosives	5,202		6,502		7,803		9,103		10,404		11,704		13,005		14,305		15,606		16,906		18,207		19,507	
Rock tool	2,432		3,040		3,648		4,256		4,863		5,473		6,081		6,689		7,297		7,905		8,513		9,121	
Fuel, lubricant	24,017		28,573		33,129		37,689		42,240		46,796		51,351		55,907		60,463		65,019		69,574		74,130	
Tire	3,413		4,266		5,119		5,970		6,825		7,678		8,532		9,385		10,238		11,091		11,944		12,797	
Electricity	1,821		1,821		1,821		1,821		1,821		1,821		1,821		1,821		1,821		1,821		1,821		1,821	
Maintenance	19,250		19,250		20,900		20,900		25,300		25,300		31,350		33,000		33,000		34,650		34,650		39,050	
Dressing cost	36,207	348	45,116	347	53,834	345	62,553	344	71,119	342	80,027	342	88,746	341	97,465	341	106,183	340	115,092	341	123,810	340	132,377	339
Personnel(staff)	7		8		8		8		8		9		9		9		9		10		10		10	
(worker)	44		55		66		77		87		98		109		120		131		142		153		163	
Wages	6,988		8,611		10,068		11,526		12,851		14,473		15,931		17,388		18,845		20,168		21,925		23,250	
Materials	14,105		17,631		21,157		24,683		28,209		31,735		35,261		38,788		42,314		45,840		49,366		52,892	
Electricity, water	10,391		12,989		15,587		18,185		20,783		23,381		25,978		28,576		31,174		33,772		36,370		38,968	
Maintenance	1,723		5,885		7,022		8,159		9,276		10,438		11,576		12,713		13,850		15,012		16,149		17,287	
General management	10,117	98	11,770	91	13,381	87	15,185	83	17,341	83	18,963	81	21,311	82	23,139	81	24,743	79	26,573	79	28,177	77	30,333	78
Freight rates	5,622	54	7,028	54	8,433	54	9,839	54	11,245	54	12,650	54	14,056	54	15,461	54	16,867	54	18,272	54	19,678	54	21,083	54
Ore freight	5,301		6,630		7,956		9,282		10,608		11,934		13,260		14,586		15,912		17,238		18,564		19,890	
Concentrate freight	318		398		477		557		637		716		796		875		955		1,034		1,114		1,193	
Annual operating cost	117,240	1,127	138,495	1,050	157,823	1,012	176,871	972	201,994	971	221,246	945	248,510	956	269,994	941	289,040	928	310,578	919	329,623	906	351,717	910
Total cost(Initial investment+operating cost)		1,810		1,781		1,794		1,778		1,870		1,891		1,974		2,011		2,019		2,087		2,098		2,195
Total income	701,160	590	869,934	564	885,356	574	886,252	538	776,100	650	801,171	671	900,276	751	918,036	791	951,006	799	1,045,198	867	1,018,337	878	1,161,150	975

Table 3-5-7 Comparison of Production Cost(Mining Plan ③ in Case of Cut Off WO_3 0.3%)

Production(t/day)	400		500		600		700		800		900		1,000		1,100		1,200		1,300		1,400		1,500	
Production(thou. t/year)	104		130		156		182		208		234		260		286		312		338		364		390	
Mine life(years)	8.8		7.1		5.9		5.0		4.4		3.9		3.5		3.2		2.9		2.7		2.5		2.4	
Concentrate(t/year)	903		1,128		1,354		1,580		1,805		2,031		2,257		2,482		2,708		2,934		3,159		3,385	
Conc. income(thou.sun)	152,304	1,464	190,251	1,464	228,372	1,464	266,491	1,464	304,440	1,464	342,559	1,464	380,677	1,464	418,627	1,464	456,745	1,464	494,863	1,464	532,813	1,464	570,931	1,464
Initial investment(thou.sun)	815,790	889	905,140	988	1,016,725	1,108	1,045,040	1,138	1,131,065	1,232	1,220,115	1,329	1,218,740	1,360	1,360,315	1,482	1,421,340	1,548	1,477,990	1,610	1,539,015	1,676	1,600,040	1,743
Infrastructure	402,840		402,840		402,840		402,840		402,840		402,840		402,840		402,840		402,840		402,840		402,840		402,840	
Drilling equipment	25,000	1	25,000	1	25,000	1	25,000	1	50,000	2	50,000	2	50,000	2	50,000	2	50,000	2	50,000	2	50,000	2	50,000	2
Working equipment	50,550	1	50,550	1	101,100	2	101,100	2	101,100	2	101,100	2	101,100	2	151,650	3	151,650	3	151,650	3	151,650	3	151,650	3
Truck	98,100	3	130,800	4	163,500	5	163,500	5	196,200	6	228,900	7	228,900	7	261,600	8	294,300	9	294,300	9	327,000	10	359,700	11
Others(mining)	69,350		69,350		69,350		69,350		69,350		69,350		69,350		69,350		69,350		69,350		69,350		69,350	
Dressing	169,950		226,600		254,935		283,250		311,575		368,225		396,550		424,875		453,200		509,850		538,175		566,500	
Mining cost	71,176	697	82,423	634	96,973	622	105,813	582	121,757	585	132,845	568	142,113	547	156,550	547	167,539	537	176,509	522	187,598	515	198,545	509
Personnel(staff)	9		9		9		9		9		9		9		9		9		9		9		9	
(worker)	53		56		65		65		72		76		79		87		91		91		95		98	
Wages	9,129		9,535		10,834		10,834		11,828		12,396		12,822		13,939		14,528		14,528		15,096		15,522	
Explosives	6,792		8,490		10,188		11,887		13,585		15,283		16,981		18,679		20,377		22,075		23,773		25,471	
Rock tool	3,176		3,970		4,764		5,557		6,351		7,145		7,939		8,733		9,527		10,321		11,115		11,909	
Fuel, lubricant	27,655		33,121		38,586		44,051		49,516		54,981		60,447		65,912		71,377		76,842		82,307		87,773	
Tire	3,653		4,566		5,480		6,393		7,306		8,219		9,133		10,046		10,959		11,872		12,786		13,699	
Electricity	1,821		1,821		1,821		1,821		1,821		1,821		1,821		1,821		1,821		1,821		1,821		1,821	
Maintenance	19,250		20,900		25,300		25,300		31,350		33,000		33,000		37,400		39,050		39,050		40,700		42,350	
Dressing cost	36,207	348	45,116	347	53,834	345	62,553	344	71,119	342	80,027	342	88,746	341	97,465	341	106,183	340	115,092	341	123,810	340	132,377	339
Personnel(staff)	7		8		8		8		8		9		9		9		9		10		10		10	
(worker)	44		55		66		77		87		98		109		120		131		142		153		163	
Wages	6,988		8,611		10,068		11,526		12,851		14,473		15,931		17,388		18,845		20,468		21,925		23,250	
Materials	11,105		17,631		21,157		24,683		28,209		31,735		35,261		38,788		42,314		45,840		49,366		52,892	
Electricity, water	10,391		12,989		15,587		18,185		20,783		23,381		25,978		28,576		31,174		33,772		36,370		38,968	
Maintenance	1,723		5,885		7,022		8,159		9,276		10,438		11,576		12,713		13,850		15,012		16,149		17,287	
General management	10,768	101	12,751	98	15,081	97	16,840	93	19,288	93	21,287	91	23,089	89	25,402	89	27,382	88	29,160	86	31,141	86	33,092	85
Freight rates	5,686	55	7,107	55	8,529	55	9,950	55	11,372	55	12,793	55	14,215	55	15,636	55	17,057	55	18,479	55	19,900	55	21,322	55
Ore freight	5,304		6,630		7,956		9,282		10,608		11,934		13,260		14,586		15,912		17,238		18,564		19,890	
Concentrate freight	382		477		573		668		764		859		955		1,050		1,145		1,241		1,336		1,432	
Annual operating cost	124,137	1,191	147,490	1,131	174,117	1,118	195,186	1,072	223,536	1,075	248,952	1,055	268,193	1,032	295,053	1,032	318,261	1,020	339,240	1,004	362,119	996	385,336	988
Total cost(Initial investment operating cost)		2,080		2,120		2,226		2,210		2,307		2,384		2,392		2,514		2,568		2,614		2,672		2,731
Total income	568,242	619	602,208	656	699,516	762	684,828	716	773,871	843	811,560	930	851,901	928	963,900	1,050	1,013,472	1,104	1,055,700	1,150	1,108,911	1,208	1,163,106	1,267

Table 3-5-10 Comparison of Production Cost(Mining Plan ③ in Case of Cut Off WO_3 0.5%)

Production(t/day)	400		500		600		700		800		900		1,000		1,100		1,200		1,300		1,400		1,500	
Production(thou.t/year)	104		130		156		182		208		234		260		286		312		338		364		390	
Mine life(years)	19.9		15.9		13.3		11.4		10.0		8.9		8.0		7.2		6.6		6.1		5.7		5.3	
Concentrate(t/year)	1,128		1,410		1,691		1,975		2,257		2,539		2,821		3,103		3,385		3,667		3,949		4,231	
Conc. income(thou.won)	190,234	1,830	237,818	1,830	285,350	1,830	333,113	1,830	380,677	1,830	428,240	1,830	475,801	1,830	523,367	1,830	570,931	1,830	618,495	1,830	666,058	1,830	713,622	1,830
Initial investment(thou.won)	1,127,890	689	1,310,990	729	1,605,623	775	1,660,390	801	1,688,715	915	1,795,365	866	1,845,790	891	1,906,855	920	1,995,210	963	2,031,890	980	2,130,215	1028	2,158,540	1042
Infrastructure	402,840		402,840		402,840		402,840		402,840		402,840		402,840		402,840		402,840		402,840		402,840		402,840	
Drilling equipment	47,100	2	47,100	2	70,650	3	70,650	3	70,650	3	94,200	4	94,200	4	94,200	4	117,750	5	117,750	5	141,300	6	141,300	6
Blasting equipment	10,050	1	10,050	1	20,100	2	20,100	2	20,100	2	20,100	2	20,100	2	20,100	2	30,150	3	30,150	3	30,150	3	30,150	3
Load Haul Dump	52,900	2	79,350	3	79,350	3	105,800	4	105,800	4	132,250	5	132,250	5	132,250	5	158,700	6	158,700	6	185,150	7	185,150	7
Timbering equipment	22,150	1	22,150	1	22,150	1	22,150	1	22,150	1	22,150	1	44,300	2	44,300	2	44,300	2	44,300	2	44,300	2	44,300	2
Truck	32,700	1	32,700	1	65,400	2	65,400	2	65,400	2	65,400	2	65,400	2	98,100	3	98,100	3	98,100	3	98,100	3	98,100	3
Others(mining)	690,200		690,200		690,200		690,200		690,200		690,200		690,200		690,200		690,200		690,200		690,200		690,200	
Dressing	169,950		226,600		254,925		283,250		311,575		368,225		396,500		424,875		453,200		509,850		538,175		566,500	
Mining cost	71,896	691	81,888	630	98,744	633	108,556	596	113,049	553	129,831	555	141,470	544	150,184	525	168,282	539	174,778	517	189,557	521	198,230	503
Personnel(staff)	8		9		9		9		9		9		10		10		10		10		10		11	
(worker)	60		64		75		79		79		87		91		93		107		107		115		115	
Wages	9,916		10,692		12,254		12,822		12,822		13,959		14,705		15,274		16,979		16,979		18,115		18,293	
Explosives	6,228		7,786		9,343		10,900		12,457		14,014		15,571		17,128		18,685		20,243		21,800		23,357	
Rock tool	2,470		3,088		3,705		4,323		4,940		5,558		6,175		6,793		7,410		8,028		8,645		9,263	
Fuel, lubricant	8,392		10,312		12,231		14,151		15,070		17,990		19,909		21,829		23,748		25,668		27,587		29,507	
Tire	2,344		2,930		3,516		4,102		4,688		5,274		5,860		6,446		7,032		7,618		8,204		8,790	
Rockbolt	5,395		6,741		8,093		9,441		10,790		12,139		13,488		14,836		16,185		17,534		18,883		20,231	
Electricity	6,984		7,416		7,912		8,377		8,842		9,307		9,772		10,238		10,703		11,168		11,633		12,099	
Maintenance	30,110		32,890		41,690		44,440		44,440		51,390		55,990		57,640		67,540		67,540		74,690		74,690	
Dressing cost	36,207	348	45,116	347	53,831	345	62,553	344	71,119	342	80,027	342	88,716	341	97,165	341	106,183	340	115,092	341	123,810	340	132,377	339
Personnel(staff)	7		8		8		8		8		9		9		9		9		10		10		10	
(worker)	44		55		66		77		87		98		109		120		131		142		153		163	
Wages	6,988		8,611		10,068		11,526		12,831		14,473		15,931		17,388		18,845		20,468		21,925		23,250	
Materials	11,105		17,631		21,157		24,683		28,209		31,735		35,261		38,788		42,314		45,840		49,366		52,892	
Electricity, water	10,391		12,989		15,587		18,185		20,783		23,381		25,978		28,576		31,174		33,772		36,370		38,968	
Maintenance	1,723		5,885		7,022		8,159		9,276		10,438		11,576		12,713		13,850		15,012		16,149		17,267	
General management	10,810	101	12,700	98	15,258	98	17,111	94	18,617	90	20,988	90	23,022	89	24,765	87	27,147	88	28,987	86	31,337	86	32,861	84
Freight rate	5,781	56	7,226	56	8,672	56	10,117	56	11,563	56	13,008	56	14,454	56	15,899	56	17,344	56	18,789	56	20,234	56	21,680	56
Ore freight	5,301		6,630		7,956		9,282		10,608		11,934		13,260		14,586		15,912		17,238		18,564		19,890	
Concentrate freight	477		596		716		835		955		1,074		1,193		1,313		1,432		1,551		1,670		1,790	
Annual operating cost	121,691	1,199	118,930	1,130	176,508	1,131	198,337	1,090	216,348	1,040	244,852	1,042	267,691	1,030	288,344	1,008	319,256	1,023	337,846	999	364,958	1,003	383,118	982
Total cost(initial invest-ment+operating cost)		1,888		1,859		1,906		1,891		1,855		1,908		1,921		1,928		1,986		1,989		2,031		2,024
Total income	190,176	58	80,088	-29	157,172	76	126,492	61	51,809	25	161,616	78	185,552	91	203,056	98	223,237	136	279,118	139	116,172	201	101,968	141

Appendix 2. Study of the Mining Development Plan in Bulutkan District

4-7 Development Plan in the Bulutkan District

4-7-1 Basic concept for development

1) Locations

The Bulutkan district is located some six kilometers away from the Sautbay tungsten deposit and 23km from the Kokpatas gold mine. 30km to the west of the Bulutkan deposit, there is the Uchkuduk No.3 ore-dressing plant which is treating the Kokpatas ore. The Kokpatas mine and the No.3 plant are linked by rail.
(Fig.4-7-1)

2) Ore reserves to be mined

Based on the findings of surveys up to Phase III, it has been known that the gold deposit in the Bulutkan district extends over about 1,200m in strike, but the orebodies are scattered about and none of them is large in size. The Phase-III tentative calculation worked out at 275,000t of ore reserves, grading 13.1 g/t Au and 6.5 g/t Ag, of the nine ore blocks. All these ore blocks are located near the surface, allowing open-pit mining, but not in a large scale. In this mining plan, two orebodies are selected for open-pit mining, the ore reserves of which is 115,000t, grading 11.1 g/t Au, while the minable ore is 115,000t, grading 10 g/t Au as discussed later. While the ore grade is relatively high, the ore reserves are very small.

3) Development policy

Since the minable ore reserves are as small as 115,000t, it is difficult to develop the orebodies as an independent mine. Instead, it is planned to develop them as a sub-mine of the nearby Kokpatas gold mine currently operating at a rate of 10,000tpd of crude ore, and to send the ore to the Uchkuduk No.3 plant for processing.

If 115,000t of ore is to be mined over several years, accumulated maintenance and administration costs put a strain on the project income; therefore, the mining operation shoud desirably be finished in a short period. Thus, it is planned to mine out the orebodies in one year, at the operation rate of 450tpd and 260 operating days per year as in the case of the Kokpatas mine. The ore is assumed to be hauled by 45-t trucks to the Kokpatas mine, from where to the Uchkuduk No.3 plant by the existing railroad, as in the case of the kokpatas ore.

4) Initial investment

(1) Infrastructure facilities, etc.

Planning is made on the assumptions that the Kokpatas mine serves as the base and the initial investment is to be minimized. A 23-km road is constructed for the ore haulage to the Kokpatas mine

A temporary transmission line(10,000V, 600kW) only for the lighting and office use is extended from Sautbay. Potable water is conveyed by a tank truck.

	(10^3 sum/km)						(10^3 sum)
① Roads	12,600	x	0.7*	x	23km	=	202,860
② Temporary transmission line	1,500	x	0.7*	x	6km	=	6,300
③ Temporary office							4,840
④ Environmental preservation			([1]+[2]+[3])	x	0.15	=	32,100
Total - Infrastructure cost, etc.(10^3 sum)							246,100

Note: * 70% of normal cost.

(2) Mining machinery

In case the orebodies are developed in reality, the necessary mining machinery would be procured either by utilization of surplus mining machinery of the kokpatas mine, or by purchasing of new machinery, which, after completion of the mining operation, could be used at the Kokpatas mine. In the tentative calculation, however, 40% of purchase prices of the mining machinery is appropriated for the lease rentals, on an assumed depreciation period of 3 years.

	($10^3$$)				($10^3$$)
① Drilling machine (Tamrock DHA 1000S, drilling dia. 89-152mm)	500	x	1	=	500
② Loader(Caterpillar CAT990, bucket cap. 8.6m³)	1,011	x	1	=	1,011
③ Truck(Ditto, but CAT 773B, loading cap. 45t)	654	x	3	=	1,962
④ Buldozer(Ditto, but CAT D7H, 230hp)	372	x	1	=	372
⑤ Grader	356	x	1	=	356
⑥ Tank truck	120	x	2	=	240
⑦ Pickup	30	x	6	=	180
Total - Mining machinery cost ($10^3$$)					4,621

4,621,000$ x 0.4 x 50 sum/$* = 92,420,000 sum

Note: Exchange rate 1$ = 50 sum

(3) Ore processing equipment

As ore is assumed to be treated on a toll basis by the No.3 ore-dressing plant at Uchkuduk, no new investment is contemplated.

(4) Initial investment costs summary

	(10^3sum)	(sum/t)
① Infrastructure, etc.	246,100	(2,140)
② Mining machinery	92,420	(804)
Total - Initial investment costs	338,520	(2,944)

4-7-2 Minable crude ore and stripping ratio

1) Minable ore

The ore blocks 1(1), and portions of the blocks1(2) and 6 are selected for the mining operation. The mining recovery is assumed to be 90% while the dilution to be10%. The block 1(1) is to be mined at its entirety, while the 1(2) is mined up to 22m from its top. (Fig 4-7-2) On these assumptions, the ore reserves are calculated at 94,000t, grading 7.1 g/t Au.

- Minable crude ore: 94,000t x 0.9 / (1 - 0.1) = 94,000t
- Minable ore grade: 94,000t x 7.1 g/t x 0.9 / 94,000t = 6.4 g/t

The block 6 is to be mined up to 30m from the surface; the ore reserves come to 21,000t, grading 29.0 g/t Au.

- Minable crude ore: 21,000t x 0.9 / (1 - 0.1) = 21,000t
- Minable ore grade: 21,000t x 29.0 g/t x 0.9 / 21,000t = 26.1 g/t

The total minable crude ore adds up to 115,000t, grading 10.0 g/t.

2) Stripping volume

On the assumption that 45t dump trucks, 5.08m wide, are used, and that the bench width, the bench height and the angle of slope face are 7.5m, 10m and 70° , respectively, the pit slope comes to 42° . The ore deposit area of the bottom face, the thickness and the area of the top face(the surface) of the block 1(2) are 192m², 50m and 12,600m², respectively, while those of the block 6 are 246m², 30m and 8,816m², respectively.(Fig. II-2-6-2) The inner volumes of the pits are as follows:

- Block 1(1) and 1(2):	{ 192 + 12,600 + (192 x 12,600)1/2} / 3 x 50	=	239,123m³
- Block 6:	{ 246 + 8,186 + (246 x 8,186)1/2} / 3 x 30	=	98,511m³
Total volume			338,634m³

The total volume comes to approximately 338,000m³, of which some 40,000m³ represents the ore portion. Therefore,

- Stripping volume: 338,000m³ - 40,000m³ = 298,000m³
- Stripping ratio:s:

Block 1(1) and (2) : (239,123m³ - 94,000t / 2.9t/m³) / (94,000t / 2.9t/m³) = 6.4

Block 6 : (98,511m³ - 21,000t / 2.9t/m³) / (21,000t / 2.9t/m³)=12.6

Total stripping ratio : 298,000m³ / 40,000m³ = 7.5

4-7-3 Operating Costs

1) Mining costs

(1) Labor cost

The mining operation is assumed to be carried out for 260 days a year on a three-shift basis(eight hours per shift including one-hour rest), to mine out 115,000t of ore in a year. The production rate is 450tpd. The personnel arrangement is shown in Table 4-7-1.

						(10^3 sum)
- Engineers :	9p	x	10,000 sum/p/mo	x 12 mos	=	1,080 ... a
- Operators :	51p	x	8,000 sum/p/mo	x 12 mos	=	4,896 ... b
- Fringe benefit:			(a + b)	x 0.38	=	2,271
- Extra pay for mine labor : (a + b)			x	0.1	=	598
Total - Labor cost(10^3 sum)						8,845
					=	77 sum/t

(2) Explosives cost	50
(3) Rock tools cost	23
(4) Fuel and lubricant cost	244
(5) Tires cost	36
(6) Electric power cost	1
(7) Repair cost	172
(8) Ore haulage cost	51
(9) Administration cost (10% of the above total)	65
Total - Mining costs	719 sum/t

Table 4-7-1 Personnel Requirement

	1st shift	2nd shift	3rd shift	Total	Adjusted number
Manager	1			1	
Mining eng.	1			1	
Geologist	1			1	
Mechanic	1			1	
Foreman	1	1	1	3	
Staff	5	1	1	7(9)	7×1.24*=8.7
Driller	1	1	1	3	
Blaster	2			2	
Mucker	1	1	1	3	
Trucker	3	3	3	9	
Bulldozer	1	1	1	3	
Grader	1	1	1	3	
Repair man	2	2	2	6	
Driver	2	2	2	6	Fuel 1,Water 1
Guard	1	1	1	3	
Clerk	3			3	Nurse 1
Worker	17	12	12	41(51)	41×1.24*=50.9
Total	22	13	13	48(60)	

*1.24,Coefficient:Days operated 260,Vacation 50,Actual working days 210
260÷210=1.24

2) Toll-processing costs

(1) Labor cost	50 sum/t
(2) Materials cost	435
(3) Electric power cost	90
(4) Repair cost	190
(5) Administration cost(10% of the above total)	77
Total - Toll-processing cost	842 sum/t

4-7-4 Conclusive summary and consideration

1) Revenues

(1) Assumptions for calculation

Calculation is made on the assumptions of the minable ore grade at 10.0 g/t Au, the gold price at 360$/tr-oz, and the total recovery of ore processing at 80%*. Revenues from by-produced silver are not considered.

Note: * While the ore processing process and recovery of the No.3 Plant are unknown, rates of recovery in general are as follows:

Flotation: flotation recovery 95% x cyanidation recovery for concentrate 85% = 81%

Gravity separation: Concentrate 10% + tailing 90% x cyanidation recovery for tailing

85% = 87%

In this calculation, the recovery in the sales terms is assumed to be 99% and the flotation recovery is applied; therefore, the total recovery is: 81% x 99% = 80%

(2) Revenues per ton:

10.0 g/t x 0.8 x 360$/tr-oz / 31.1g/tr-oz x 50 sum/$= 4,630 sum/t

2) Expenditures

(1) Assumptions for calculation

The initial investment is devided by the minable crude ore, to obtain the investment amount per ton. Depreciation is not considered. No interest on borrowings of development and operation funds is considered, nor reserves for mine closure.

(2) Expenditures per ton of crude ore

	(sum/t)
- Initial investment costs	
Infrastructure, etc.	2,140
Mining machinery	804
- Mining	719
- Ore processing	842
Total costs (sum/t)	4,505

3) Operating income (sum/t)

- Revenues per ton of crude ore	4,630
- Less: Expenditures	-4,505
Operating income (sum/t)	125

- Total operating income: 125 sum/t x115,000t =14,375,000 sum

4) Feasibility for development

The overall ore reserves of the Bulutkan district is 275,000t, grading 13.1 g/t, which is insufficient for the mine to be developed in a large scale. However, if only the near-surface and wide orebodies(the block 1(1), and parts of the blocks 1(2) and 6) are selected so that 115,000t of minable crude ore, grading 10.0 g/t Au is mined, it would generate the operating income of 125 sum per ton of crude ore, or nearly 15,000,000 sum in total.

Likewise, certain feasibility is conceivable for partial development of the other orebodies scattered around in the district. However, it is not realistic to newly organize an

independent mine to be mined out in a year. In order for such orebodies to be actually developed, they should be placed under control and administration of the Kokpatas gold mine as its subsidiary mine.

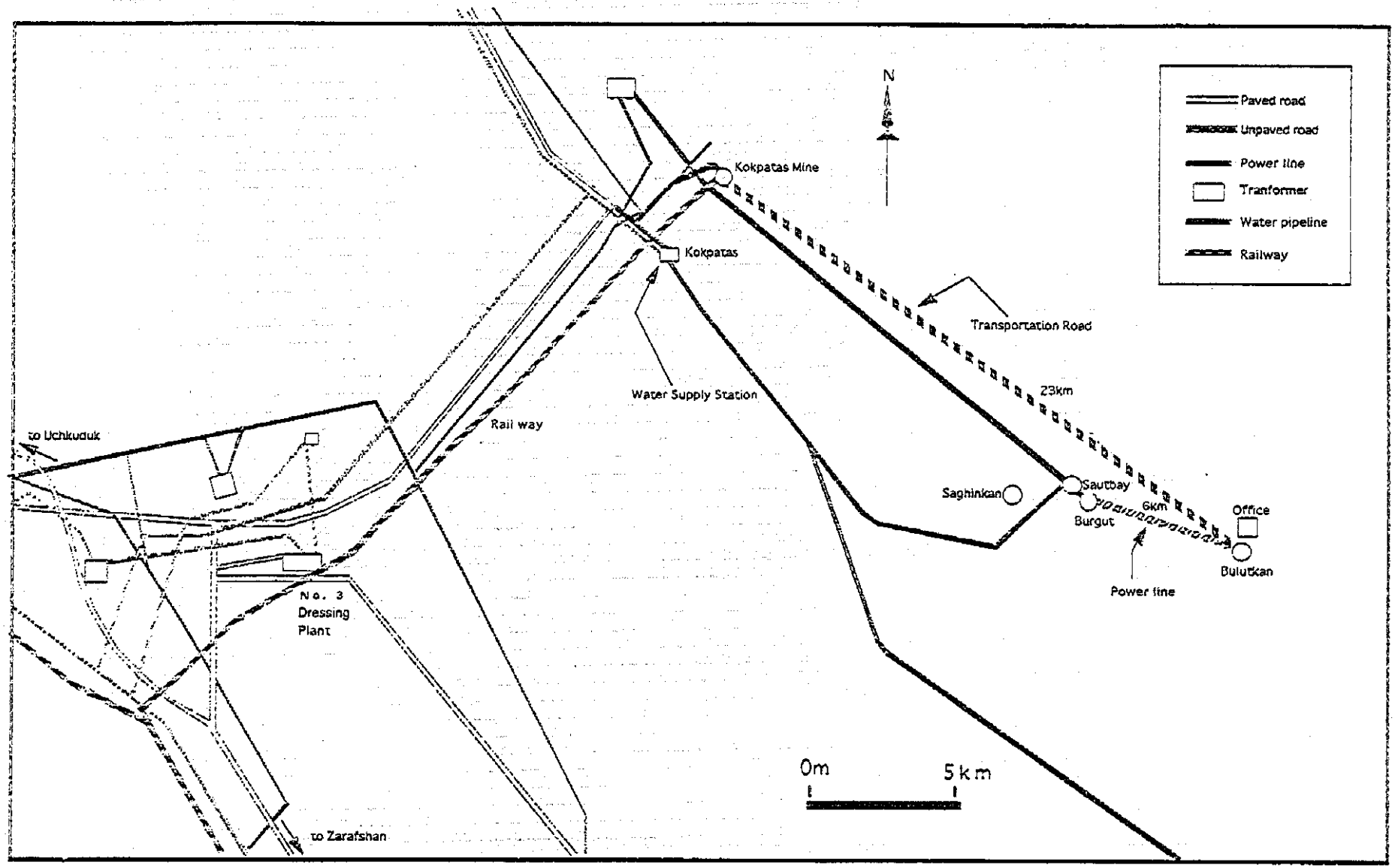

Fig.4-7-1 Location Map of Infrastructure in Bulutkan District

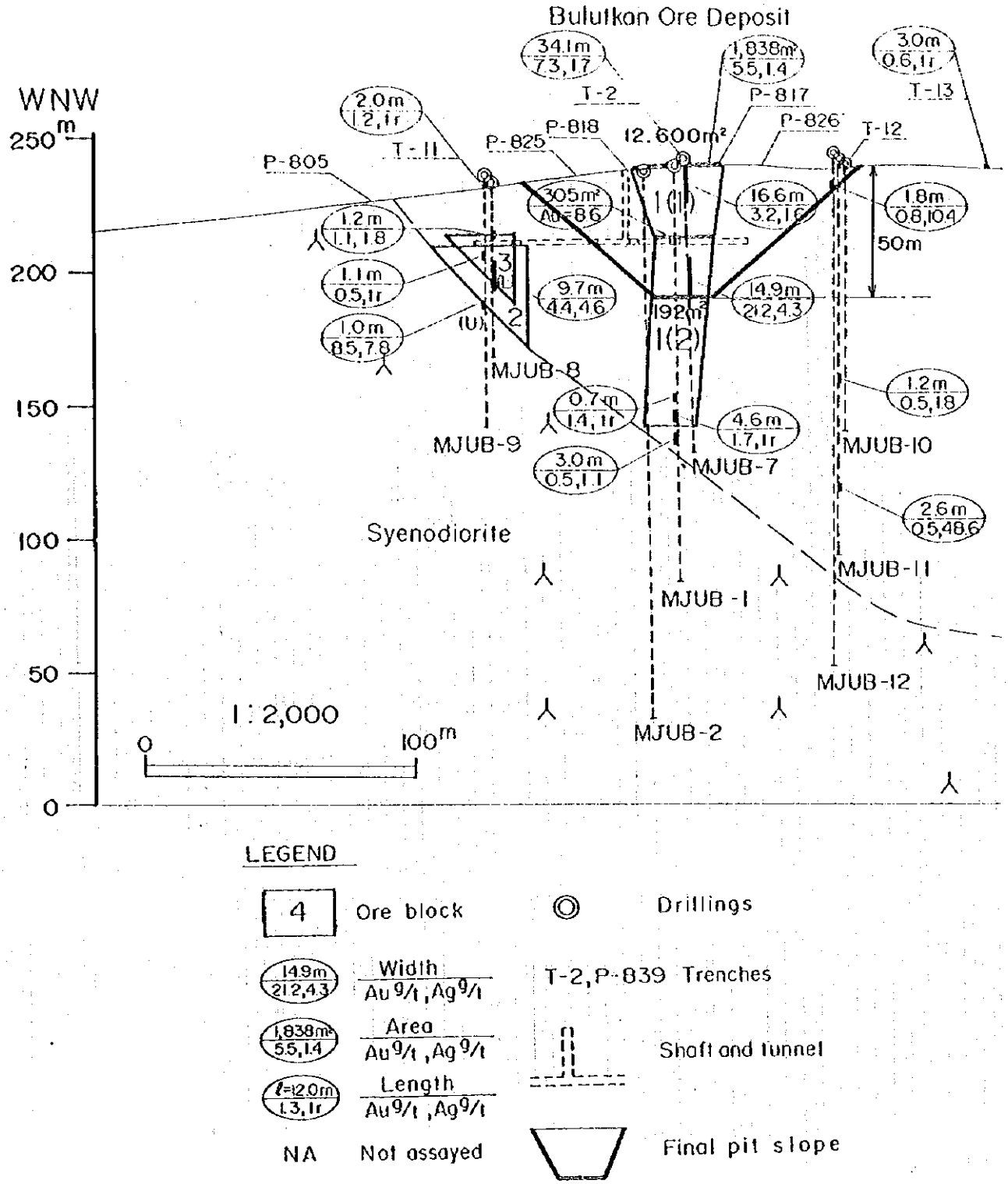

Fig.4-7-2(1) Final Pit Slope (Ore Block 1)

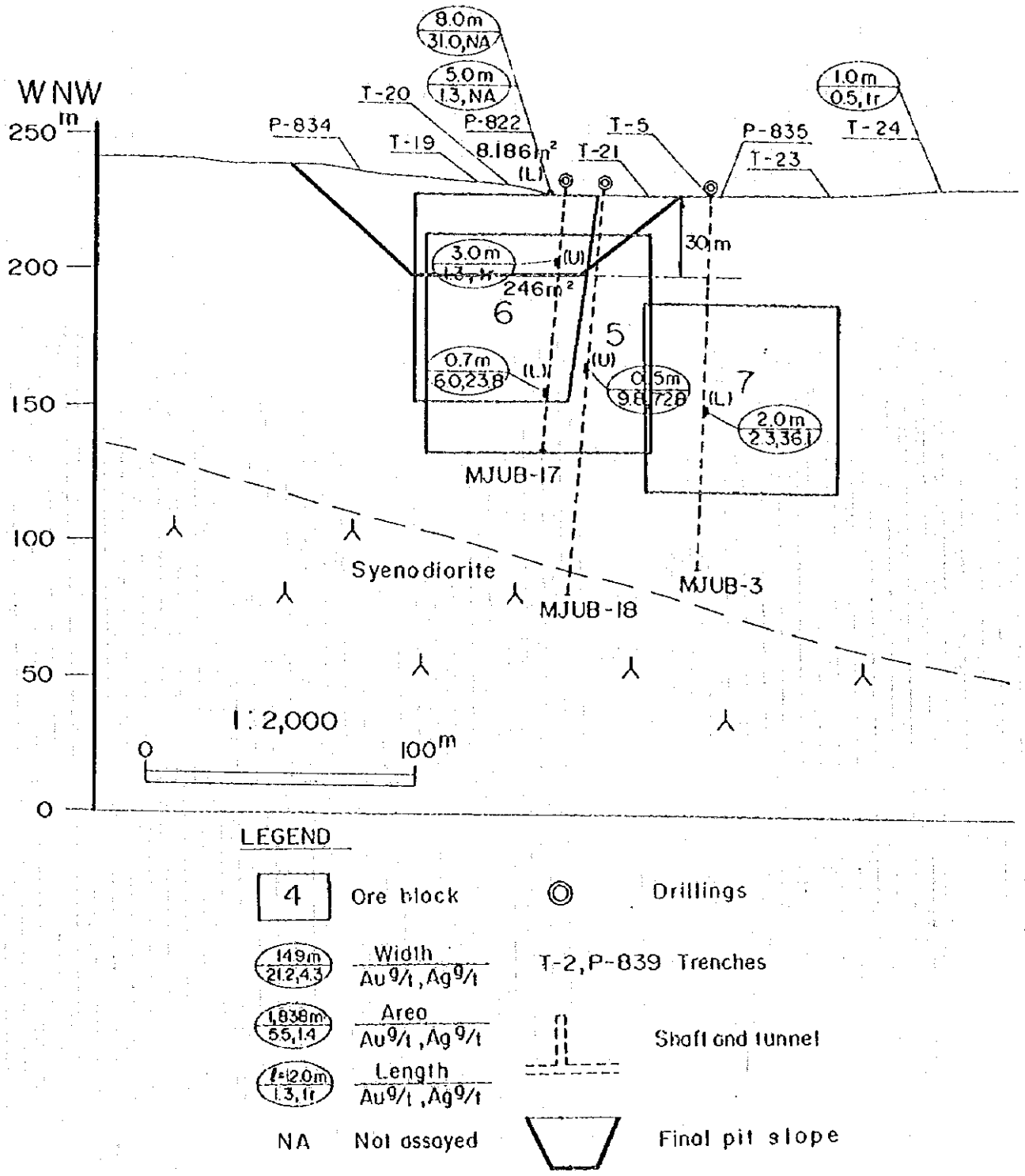

Fig.4-7-2(2) Final Pit Slope (Ore Block 6)