1-2-3 Results of estimation

Table II-1-2-3 shows the results of estimation of Sautbay and Burgut deposits by the method described above.

Table II-1-2-3 Ore Reserves Estimation of Sautbay and Burgut Deposits

Cutoff (WO_3%)	Reserves (t)	WO_3 (%)	Au (g/t)	WO_3 (t)	Au (kg)
0.05	15,195,300	0.29	0.23	44,282.0	3,438.3
0.08	13,898,100	0.31	0.24	43,453.2	3,302.5
0.10	13,074,960	0.33	0.24	42,713.1	3,201.7
0.20	8,104,050	0.44	0.28	35,355.9	2,299.5
0.30	4,640,460	0.58	0.34	26,972.3	1,595.2
0.40	3,089,100	0.70	0.39	21,595.5	1,193.0
0.50	2,038,140	0.83	0.45	16,903.0	907.9

The total reserves of Sautbay and Burgut deposits are 15,195,300t at the cutoff of 0.05%(WO_3), averaging 0.29% WO_3 and 0.23 g/t Au, about 44,282t(WO_3) and 3.4t(Au) in terms of metal contents.

Table II-1-2-4 compares the Phase-III(1997) results with those of Phase I(1995) and of the Sarydjoy report(1993). As for the ore reserves within the open pit of Sautbay at the 0.05% cutoff, the Phase III estimation came up to approx. 2.7 million t, as compared to approx. 2.6 million t of the other two estimates. The increment in the ore reserves is considered attributable to the mentioned modifications to the geologic sections based on the latest data. The average grades of WO_3 and Au of the Phase III estimation are similar to those of Phase I.. On the whole, the results of the three estimates seem approximate to each other, as far as the Sautbay open-pit reserves are concerned.

Table II-1-2-4 Comparison of Ore Reserve Estimation Results by MMAJ(1997), MMAJ(1995)and Sarydjoy Team(1993) (on the Whole Area Basis)

Area	Reported by	Reserves (t)	WO_3 (%)	Au (g/t)	WO_3 (t)	Au (kg)
Open pit of Sautbay deposit	Sarydjoy(1993)	2,606,250	0.38	0.16	9,960.5	411.4
	MMAJ(1995)	2,621,000	0.35	0.13	9,173.5	340.7
	MMAJ(1997)	2,712,142	0.36	0.12	9,764.4	319.6
Sautbay,Burgut deposits	Sarydjoy(1993)	39,539,352	0.43	0.34	168,701.5	13,530.7
	MMAJ(1995)	25,885,000	0.27	0.24	70,631.7	6,335.1
	MMAJ(1997)	15,195,300	0.29	0.23	44,282.0	3,438.3

As regards the entire deposits of Sautbay and Burgut , however, significant differences come out between the three estimates, as seen in Table II-1-2-4. The Phase-III ore reserves are 15,195,300t, as compared to 25,885,000t of Phase I and to 39,539,352t of Sarydjoy. As to the average grade of WO_3 and Au, Phase III and Phase I are almost similar.

The differences in ore reserves are interpreted to be attributable to the following causes. As described eralier, the geologic sections attached to the Sarydjoy report were applied for the definition of orebodies for the Phase I and III calculations, with certain modifications based on the latest data. In interpolating average grade of a block, search distances were limited on the basis of variogram analysis. If no data are available within the search distance, average grade of the block is not interpolated. In other words, some of the blocks were excluded from the ore reserves unless their average grades were interpolated, even though the blocks are shown as orebodies in geologic sections. By contrast, the Sarydjoy calculation method has no such limitation, since all the portions once incorporated in the estimation area are regarded as orebodies.

In the Phase I calculation, clear variogram for WO_3 in the B-axis direction was unavailable; the search distance was made 100m on the supposition that the variogram is the same as that in the A-axis direction. In the Phase III calculation, however, clear variogram for WO_3 in the B-axis direction was obtained as drilling data built up, and the search distance was revised to 45m.

The mentioned difference between the methods produces little difference in ore reserves in a densely drilled area such as the Sautbay open pit, whereas in a sparsely drilled area, a large difference comes out. As only a few deep holes were drilled at the Sautbay and Burgut deposits, the Sarydjoy's ore reserves of the whole area turned out to be far larger than those of Phase III. In addition, influence due to difference in the search distance used in calculation is stronger in a sparsely drilled area. This explains the wide discrepancy in ore reserves between Phase I, II and Sarydjoy.

As regards the difference in the average grades, the following two causes are conceived:

① When calculating average grade of a component mineral in a section, the Sarydjoy method ignores area of the section, simply applying the length-weighted average of analysis values of samples as the average grade of the section. Therefore, a drillhole with accidentally high grade in a sparsely drilled area, if any, will
increase the average grade of the section.

② The Sarydjoy method divides one orebody into several ore blocks -- the 'ore block' is different from the concept of block used in the Phase III Kriging interpolation -- and calculates ore reserves of each ore block. When calculating average grade of a ore block of inferred ore reserves(P1), it ignores the volume between sections, choosing the highest-grade of all the sections intersecting the ore block, to use the grade as the average grade of the ore block. Consequently, the overall average grade increases.

Table II-1-2-5 compares the Phase III ore reserves estimation with that of Sarydjoy on the individual orebody basis. Of the 21 orebodies enumerated in the table, Nos. 1 thru 9, 20 and 21 pertain to the Sautbay deposit, while Nos. 10 thru 19 to the Burgut mineral indication area, in general terms.

To sum up, the Phase III results of ore reserves estimation of the densely drilled area(the Sautbay open pit) generally coincide with those of the Uzbek side, whilst the ore reserves and grade of the sparsely drilled area appear to be over-estimated by the Uzbek side.

Table II-1-2-5 Comparison of Ore Reserve Estimation Results by MMAJ(1997) and Sarydjoy Team(1993)

(on Individual Ore Body Basis)

MMAJ (1997)						Sarydjoy report (1993)					
Reserves		WO_3	Au	WO_3	Au	Reserves		WO_3	Au	WO_3	Au
(t)	(%)	(%)	(g/t)	(t)	(kg)	(t)	(%)	(%)	(g/t)	(t)	(kg)
8,422,980	55.4	0.30	0.19	25,579.3	1,624.0	15,190,300	38.4	0.40	0.19	60,761.2	2,886.2
313,980	2.1	0.13	0.07	402.8	21.4	379,680	1.0	0.30	0.08	1,139.0	30.4
587,850	3.9	0.20	0.13	1,202.4	74.4	1,542,800	3.9	0.27	0.04	4,165.6	61.7
247,785	1.6	0.14	0.05	336.8	12.4	836,499	2.1	0.40	0.08	3,346.0	66.9
155,235	1.0	0.12	0.01	182.6	1.1	478,689	1.2	0.30	0.11	1,436.1	52.7
78,945	0.5	0.25	0.01	199.3	0.9	267,300	0.7	0.87	0.02	2,325.5	5.3
359,640	2.4	0.13	0.06	477.6	21.7	803,475	2.0	0.25	0.01	2,008.7	8.0
287,940	1.9	0.16	0.21	472.9	60.0	1,684,510	4.3	0.39	0.16	6,569.6	269.5
157,890	1.0	0.11	0.05	174.5	8.6	355,680	0.9	0.40	0.45	1,422.7	160.1
1,508,595	9.9	0.49	0.47	7,427.1	708.4	7,512,810	19.0	0.54	0.56	40,569.2	4,207.2
183,105	1.2	0.13	0.13	242.6	23.4	200,520	0.5	0.20	0.00	401.0	0.0
1,141,560	7.5	0.38	0.47	4,313.9	538.7	4,922,300	12.4	0.60	0.85	29,533.8	4,184.0
552,900	3.6	0.18	0.18	988.0	99.2	2,116,870	5.4	0.25	0.24	5,292.2	508.0
290,010	1.9	0.20	0.17	566.6	50.6	1,216,790	3.1	0.23	0.27	2,798.6	328.5
223,080	1.5	0.37	0.32	815.6	70.5	1,367,690	3.5	0.37	0.52	5,060.5	711.2
374,505	2.5	0.12	0.20	466.5	76.3	266,824	0.7	0.23	0.08	613.7	21.3
16,920	0.1	0.16	0.11	26.4	1.8	143,970	0.4	0.32	0.20	460.7	28.8
97,290	0.6	0.09	0.16	85.0	15.5	-	-	-	-	-	-
112,080	0.7	0.17	0.21	190.3	23.6	-	-	-	-	-	-
74,655	0.5	0.15	0.01	112.6	1.0	93,480	0.2	0.24	0.01	224.4	0.9
8,355	0.1	0.23	0.00	19.0	0.0	159,165	0.4	0.36	0.00	573.0	0.0
15,195,300	100.0	0.29	0.23	44,281.9	3,433.4	39,539,352	100.0	0.43	0.34	168,701.5	13,530.7

2) Saghinkan deposit

In Phase III, recalculation was made for the Saghinkan deposit using the new variogram of the Sautbay deposit, as previously mentioned. Table II-1-2-6 shows the results of ore reserves estimation.

Table II-1-2-6 Ore Reserve Estimation Result of Saghinkan Deposit

Cutoff (WO3%)	Reserves (t)	WO3 (%)	Au (g/t)	WO3 (t)	Au (kg)
0.05	10,061,580	0.24	0.02	24,415	236
0.08	9,061,710	0.26	0.02	23,749	207
0.10	8,132,880	0.28	0.02	22,934	198
0.20	4,073,190	0.42	0.02	17,144	95
0.30	2,391,390	0.55	0.03	13,061	66
0.40	1,568,010	0.65	0.03	10,225	51
0.50	1,153,950	0.72	0.03	8,357	37

In case the cutoff grade is 0.05% WO_3, the ore reserves of the entire deposit of Saghinkan are 10,061,580t, averaging 0.24% WO_3. The metal content comes to about 24,415t of WO_3. The average grade of Au is as low as 0.02 g/t. The ore deposit is considered to be of practically no economic value for Au.

Table II-1-2-7 Comparison of Ore Reserve Estimation Results by MMAJ(1997) and Kokpatas Expedition(1994) (on Individual Ore Body Basis)

Ore body	MMAJ(1997)				Kokpatas Expedition(1994)			
	Reserves		WO3	WO3	Reserves		WO3	WO3
	(t)	(%)	(%)	(t)	(t)	(%)	(%)	(t)
1	527,790	6.5	0.24	1,271	1,470,000	11.6	0.21	3,120
2	1,210,290	14.9	0.23	2,766	2,180,000	17.2	0.23	4,950
3	460,290	5.7	0.32	1,494	790,000	6.2	0.55	4,340
4	805,260	9.9	0.39	3,150	1,370,000	10.8	0.40	5,490
5	254,760	3.1	0.17	425	470,000	3.7	0.23	1,090
6	1,612,020	19.8	0.25	4,095	1,510,000	11.9	0.28	4,260
7	1,479,600	18.2	0.36	5,253	2,010,000	15.8	0.45	9,080
8	1,118,370	13.8	0.22	2,498	1,540,000	12.1	0.28	4,370
8-1	124,140	1.5	0.43	537	180,000	1.4	0.36	650
8-2	86,070	1.1	0.22	191	100,000	0.8	0.29	290
8-3	30,660	0.4	0.55	168	30,000	0.2	0.57	170
9	204,780	2.5	0.30	618	330,000	2.6	0.25	810
10	116,970	1.4	0.18	215	170,000	1.3	0.21	350
11	32,610	0.4	0.54	177	140,000	1.1	0.28	390
12	34,590	0.4	0.10	35	200,000	1.6	0.32	640
13	34,680	0.4	0.12	42	150,000	1.2	0.12	180
14	0	0.0	0.00	0	70,000	0.6	0.41	290
Total	8,132,880	100.0	0.28	22,934	12,710,000	100.0	0.32	40,470

Table II-1-2-7 compares the Phase III results with those of the Uzbek estimation on the individual orebody basis, at the cutoff grade of 0.1%(WO_3). The Phase III estimation indicates total reserves of 8,132,880t, averaging 0.28% WO_3(WO_3 content: 22,934t), which compares to the Uzbek estimation of 12,710,000t, averaging 0.32% WO_3(about 40,000t). The Phase III ore reserves is smaller, and the average grade is lower.

Conceivably, the differences are explained by the following causes. In the Phase III estimation of the Saghinkan ore reserves, the definition of orebodies basically relies on the geologic sections attached to the Uzbek report. The Uzbek method divides orebody into ore blocks based on drilling data points and calculate average grade for every ore block. In ore reserves calculation by the Kriging interpolation, area of calculation is limited by search distances. In case of WO_3, the search distances along the axes A, B and C are 100m, 45m and 20m respectively. The difference in the ore reserves is considered to have come out from the difference in the area of calculation. Due to the same reason as the Sautbay and Burgut deposits, the overall average grade estimated by the Uzbek side also came out to be relatively high.

As the differences in the total ore reserves and grade are ascribed to the difference in the calculation area, the calculation results of the both sides are considered to be basically comformable to each other.

1-2-4 Conclusive summary and consideration

Ore reserves calculation of the Sautbay, Burgut and Saghinkan deposits were carried out for the purpose of revaluation of these deposits based on the data obtained from the Phase I to Phase III.

The chemical analysis data used for the calculation correspond to the samples taken from the drill cores obtained until 1996. The component minerals for the calculation were WO_3 and Au. For the definition of orebodies, the geologic sections elaborated by the Uzbek side were referred to. To examine distribution characteristics of component minerals in the 3-dimensional space, the analysis data were geostatistically processed. Variogram as considered to reflect the distribution characteristics was obtained only for the Sautbay deposit. Since the Burgut and Saghinkan deposits are situated so close to the Sautbay deposit that their ore formation may be considered correlated. The concept made it possible to estimate the Burgut and Saghinkan ore reserves by applying the variograms for WO_3 and Au of the Sautbay deposit. The ore reserves of these deposits at the cutoff of 0.05% WO_3 are shown in Table II-1-2-8.

Table II-1-2-8 Ore Reserve Estimation Result of Sautbay,Burgut and Saghinkan Deposits

Area	Reported by	Reserves (t)	WO_3 (%)	Au (g/t)	WO_3 (t)	Au (kg)
Sautbay,Burgut deposts	MMAJ(1997)	15,195,300	0.29	0.23	44,282	3,438
Saghinkan deposits	MMAJ(1997)	10,061,580	0.24	0.02	24,415	236
Total	MMAJ(1997)	25,256,880	0.27	0.15	68,697	3,674

As the result of the estimation by the mentioned method, the total ore reserves of the three deposits at the cutoff of 0.05% WO_3 came up to 25,256,880t, averaging 0.27% WO_3 and 0.15 g/t Au, or 68,697t(WO_3) and 3.7t(Au) in terms of metal contents.

The WO_3 grades of skarn-type tungsten mines which were/have been operating since 1980 in the Western countries, such as USA, Canada, Australia, Korea and Turkey, are mostly 0.5% or higher in case of open-pit mining while, in case of underground mining, 1% or higher. Compared to these, the WO_3 grades of the Sautbay, Burgut and Saghinkan are considerably low.

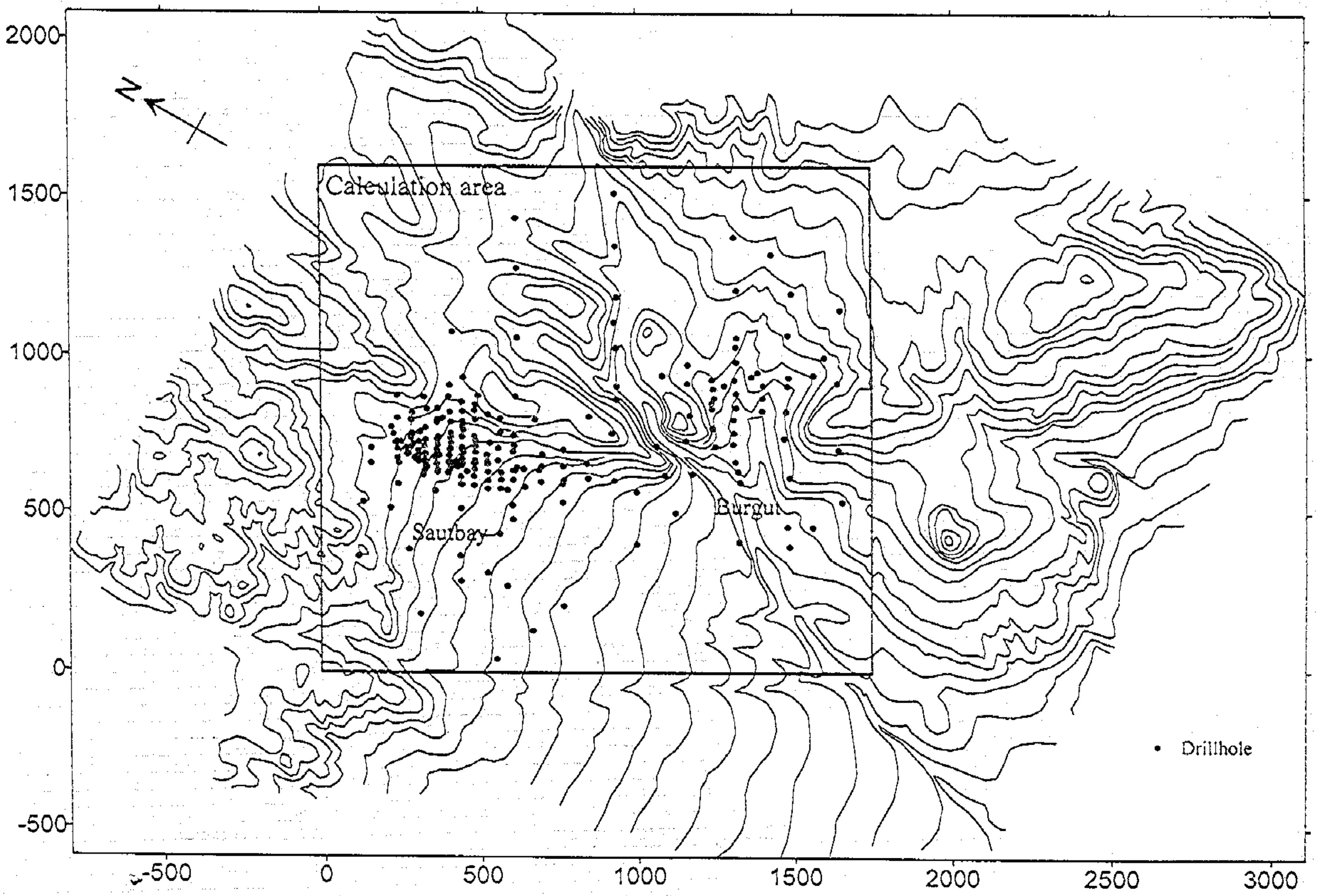


Fig.II-1-2-1 Location Map of the Ore Reserve Estimation Area

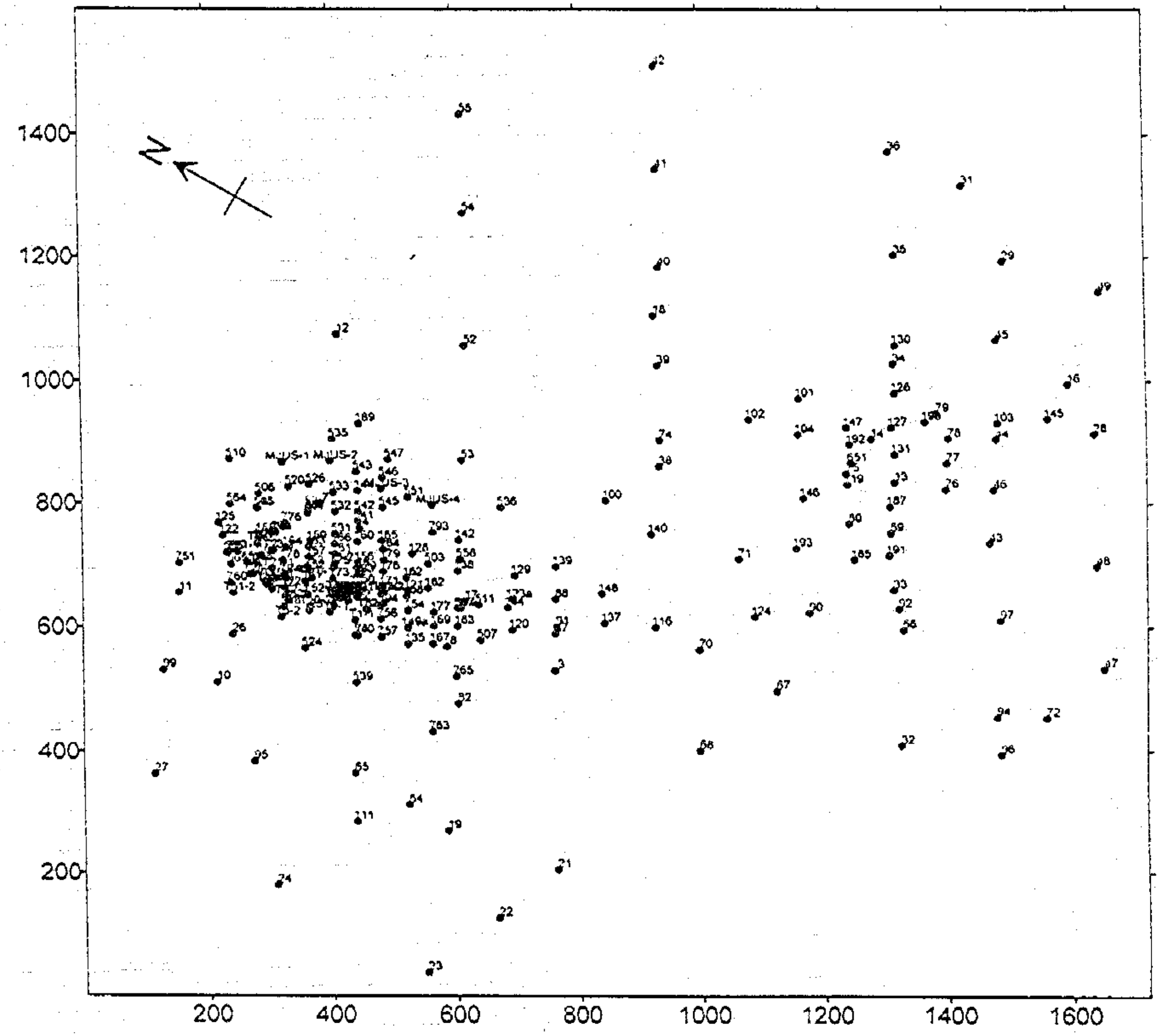


Fig.II-1-2-2 Location Map of the Drillholes used in the Ore Reserve Estimation

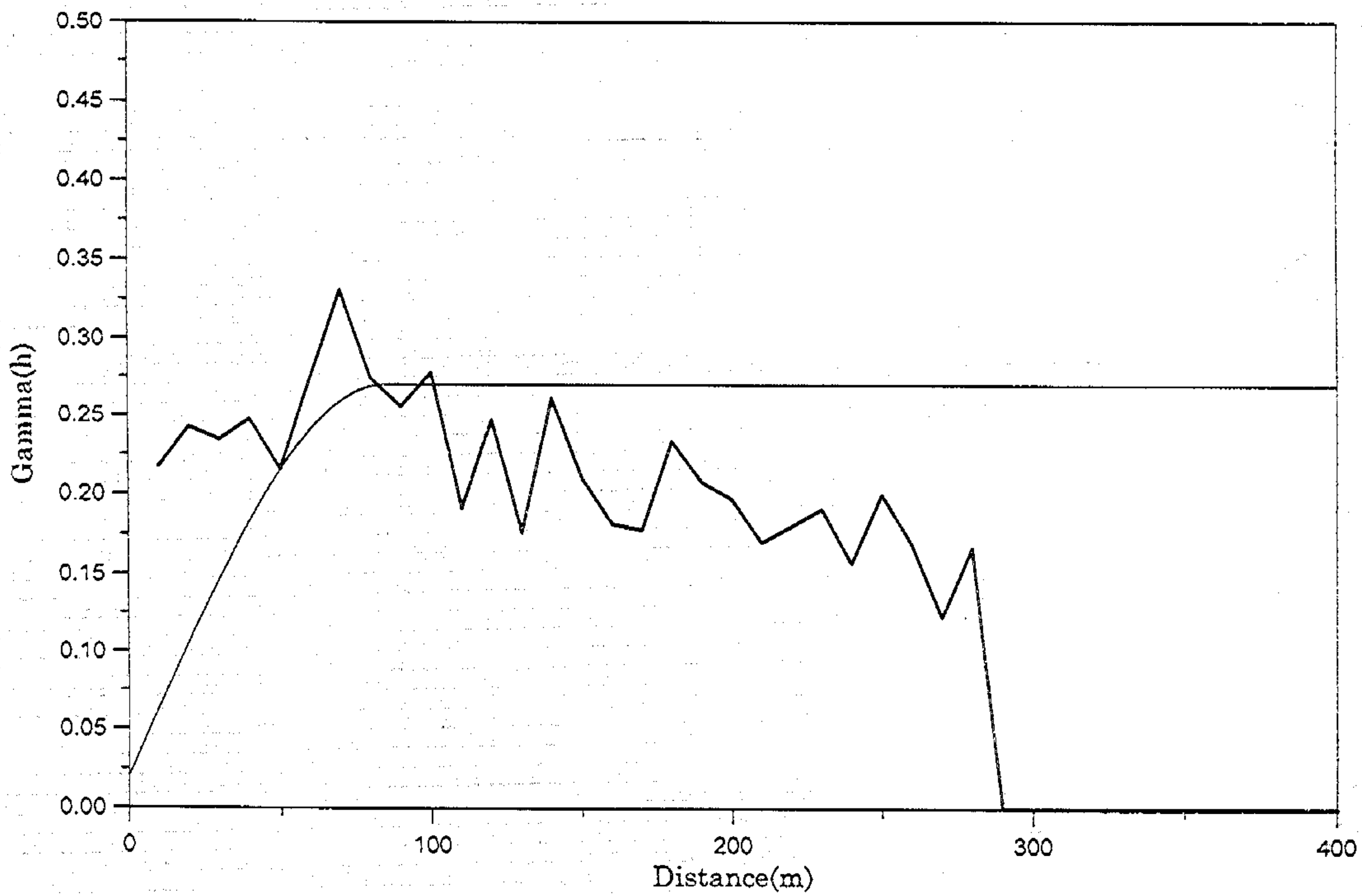


Fig.II-1-2-4 Variogram of WO_3 along Axis A

Fig.II-1-2-5 Variogram of WO_3 along Axis B

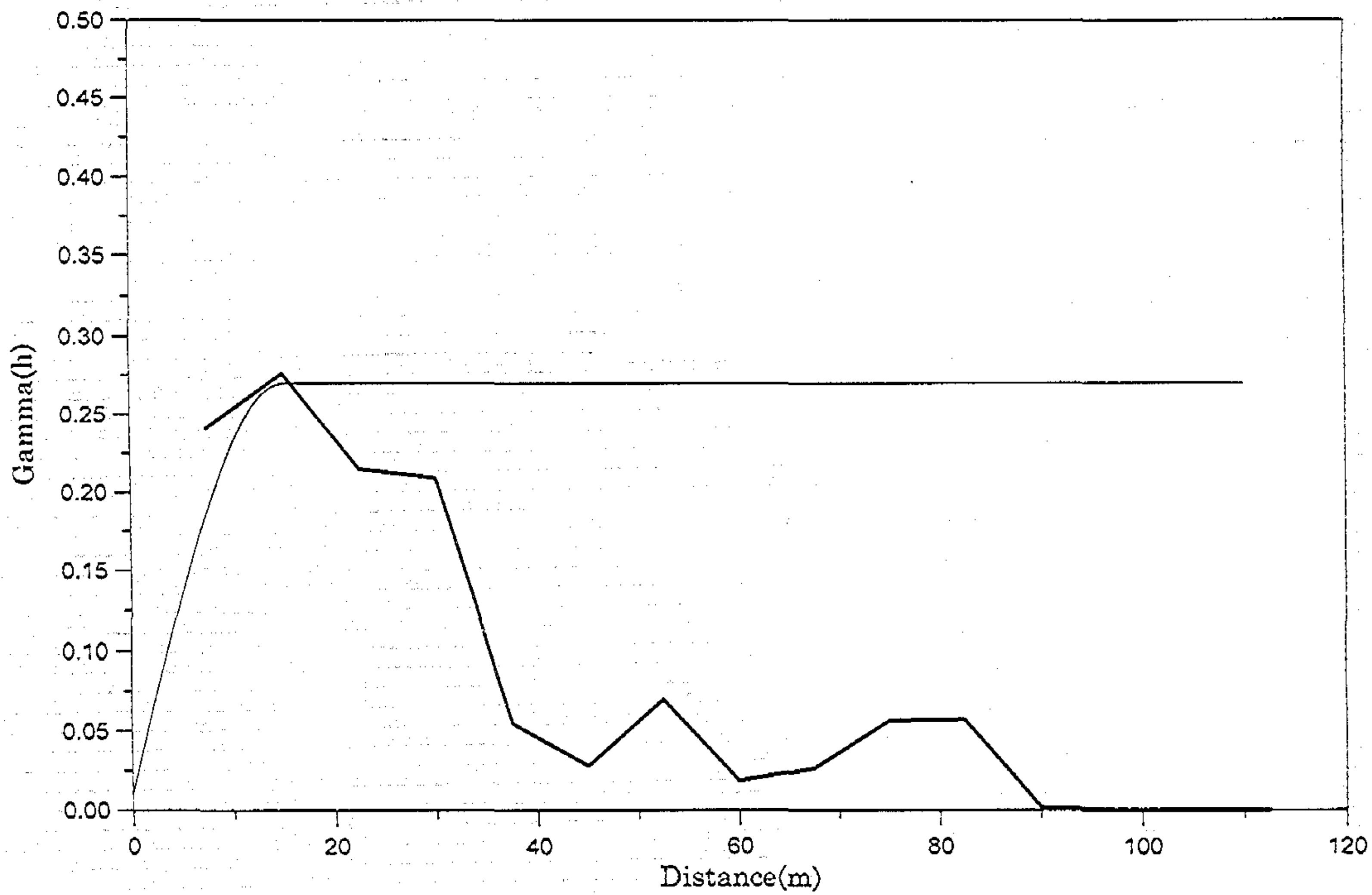


Fig.II-1-2-6 Variogram of WO_3 along Axis C

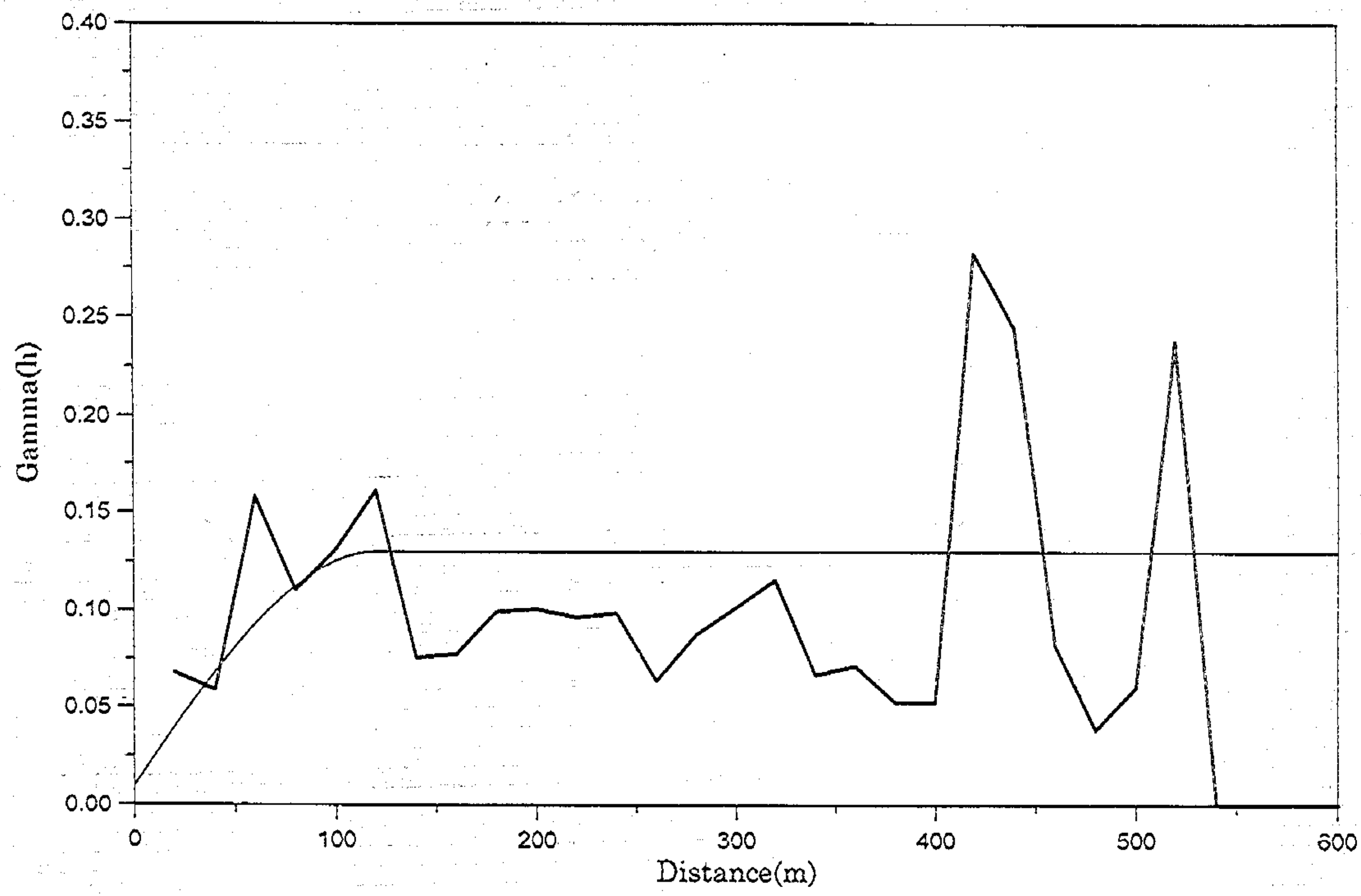


Fig.II-1-2-7 Variogram of Au along Axis A

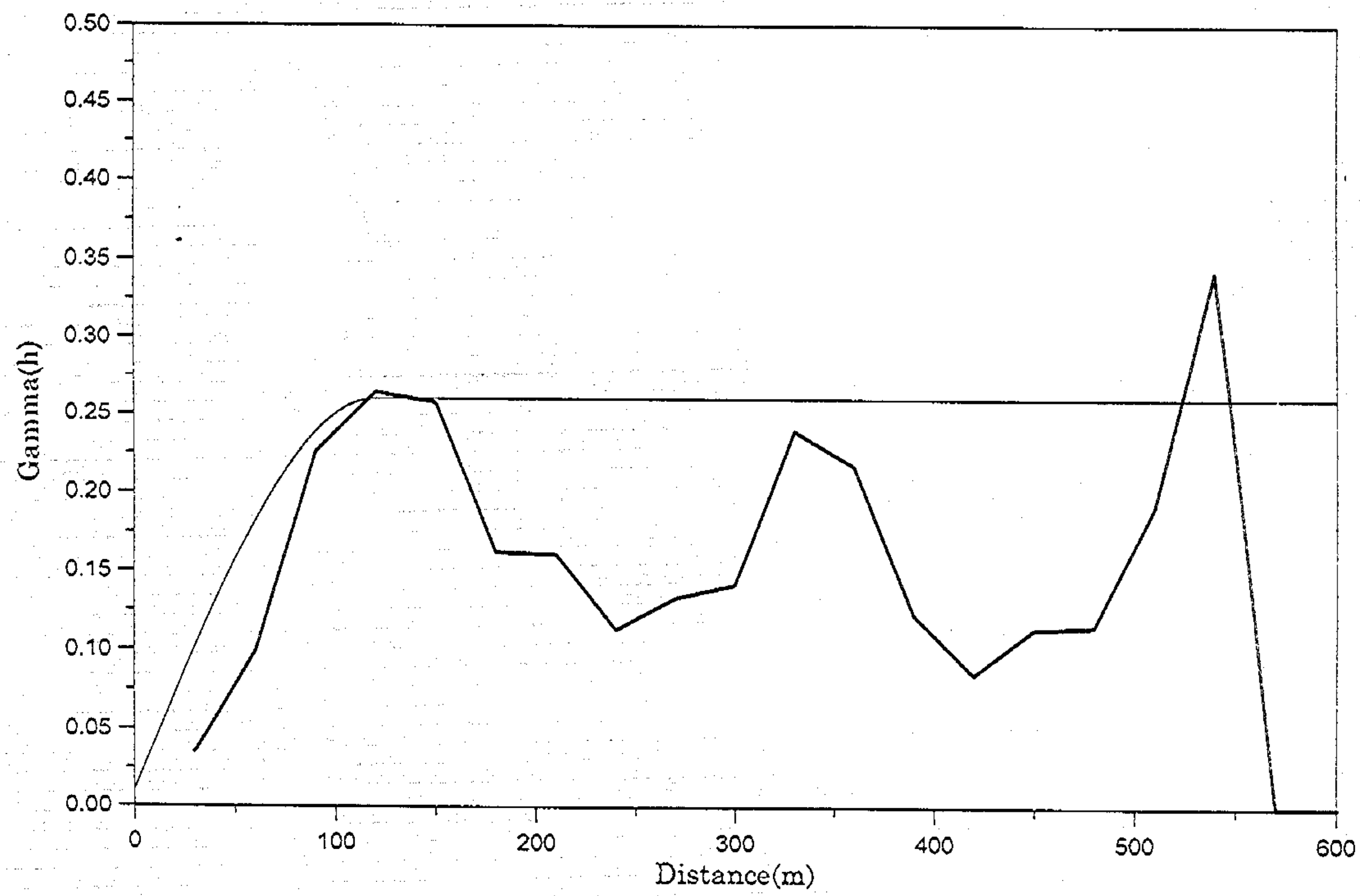


Fig.II-1-2-8 Variogram of Au along Axis B

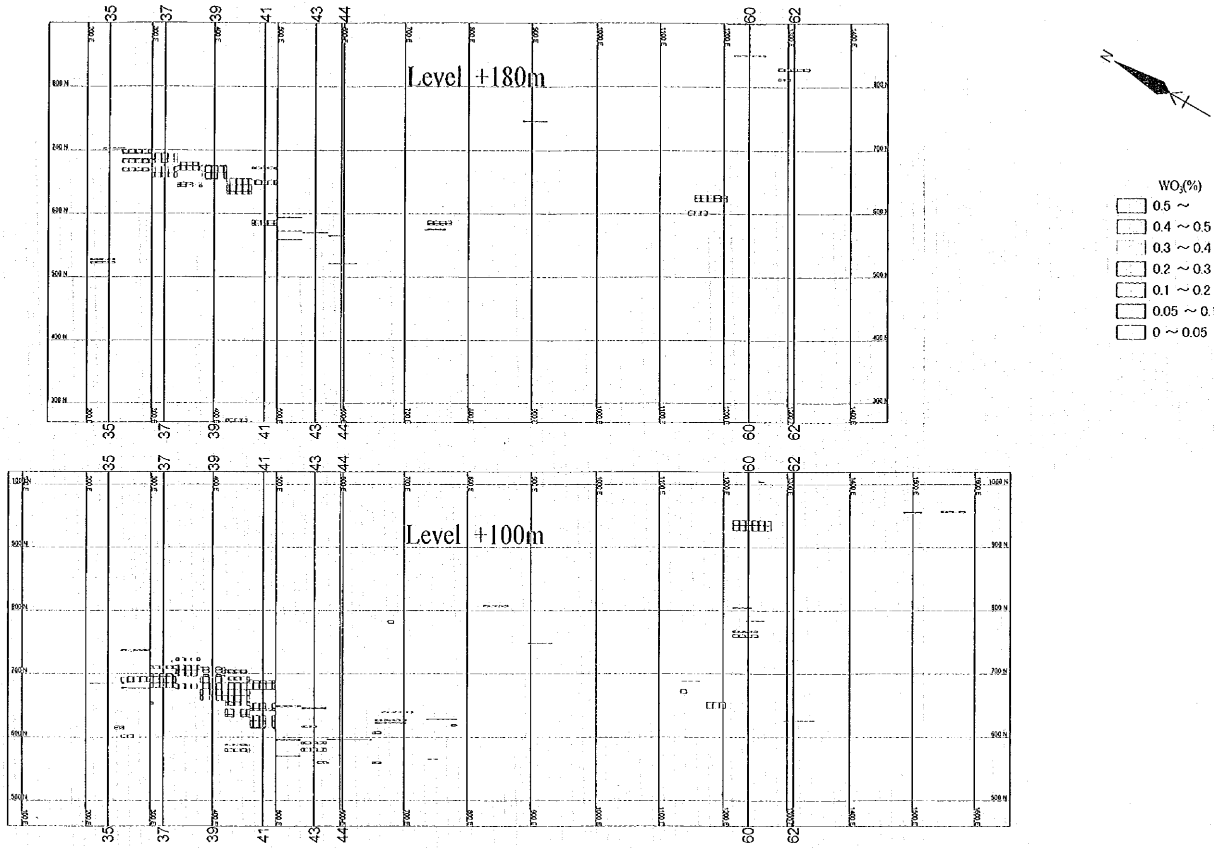


Fig.II-1-2-9 Estimated Grade of WO_3 at the Level of +180m,+100m

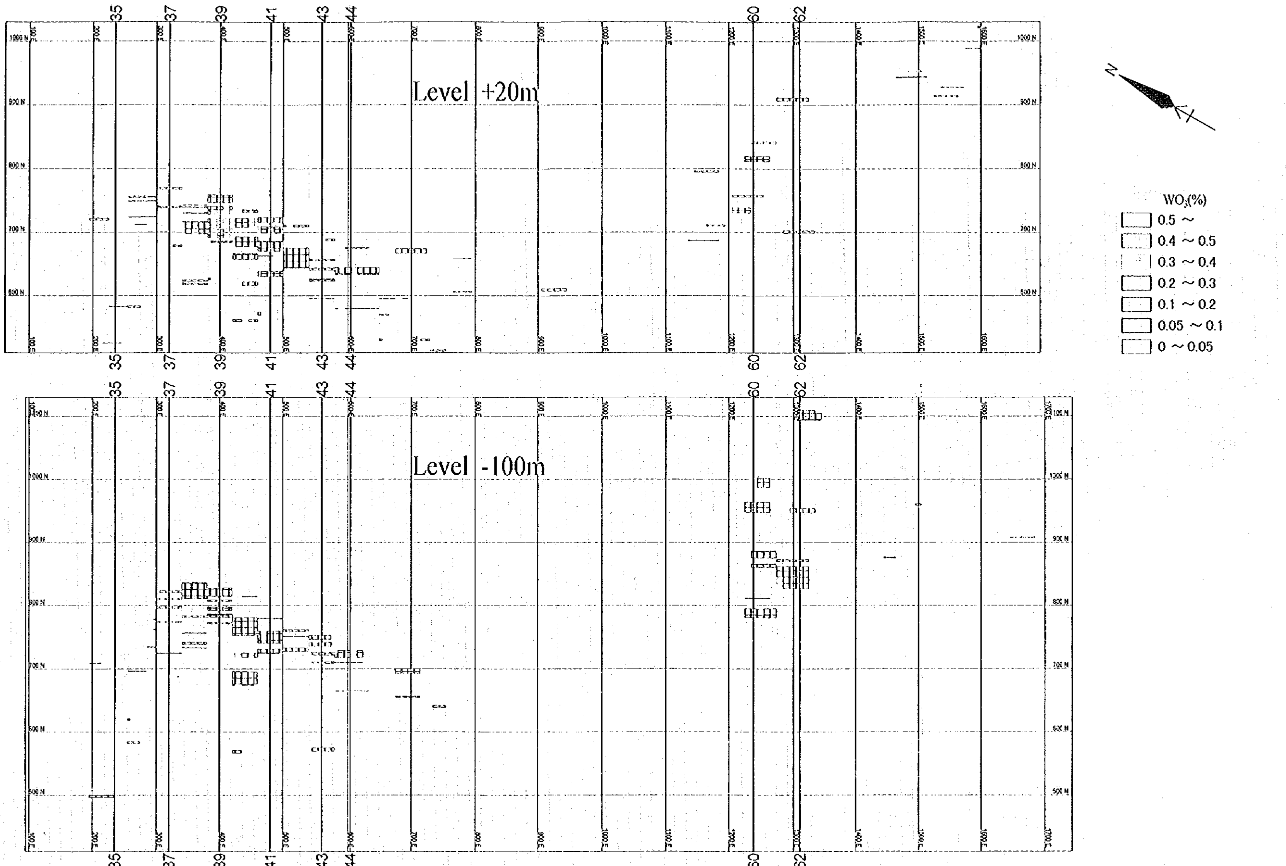


Fig.II-1-2-10 Estimated Grade of WO_3 at the Level of +20m,-100m

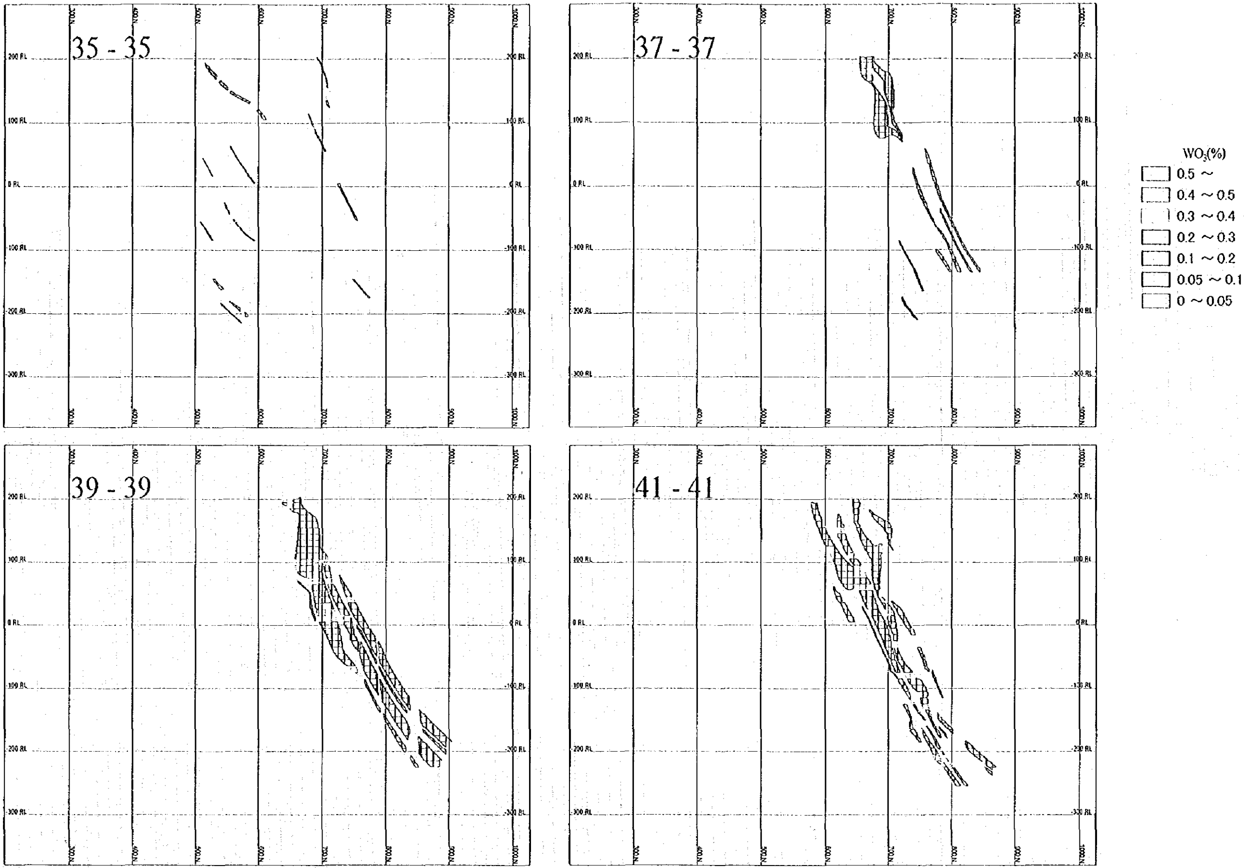


Fig.II-1-2-11 Estimated Grade of WO_3 along line 35-35,37-37,39-39,41-41

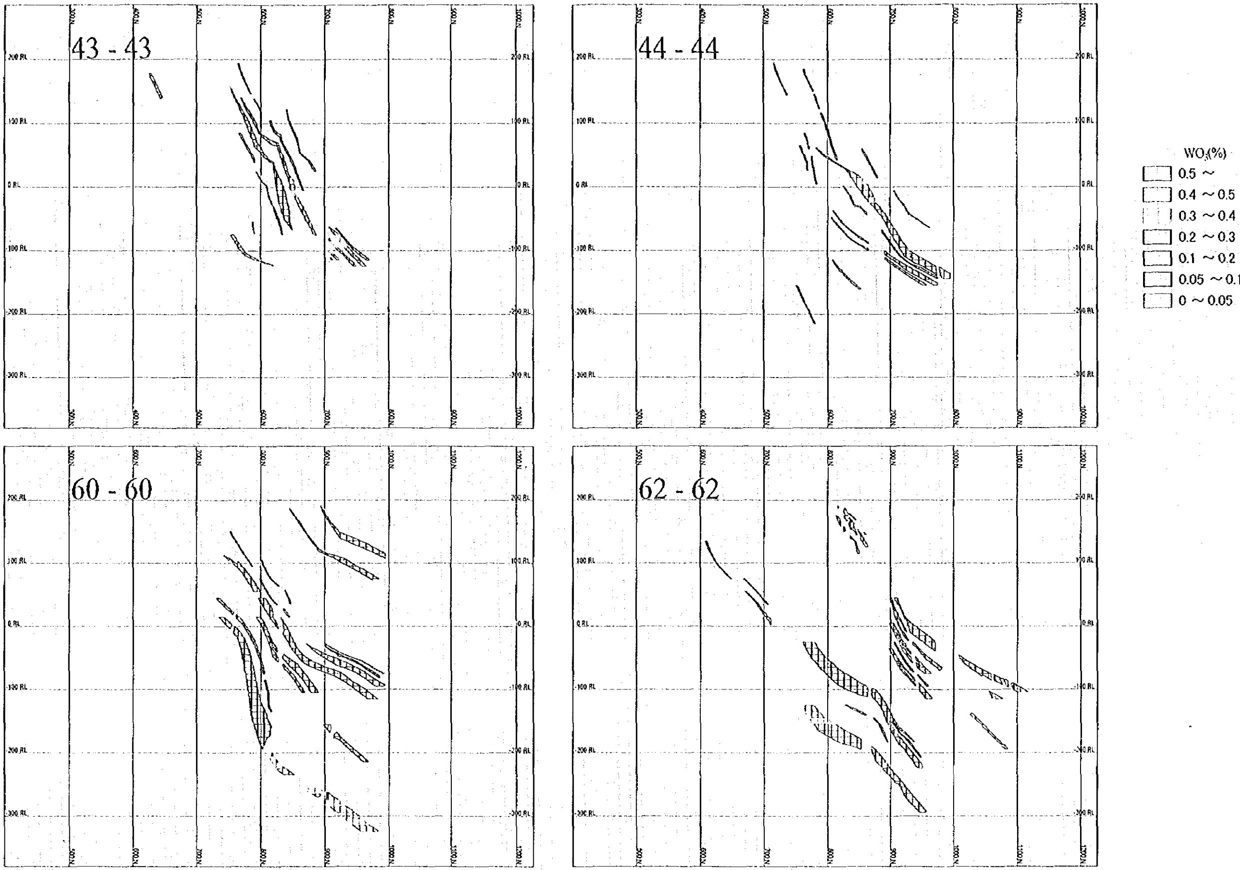


Fig.II-1-2-12 Estimated Grade of WO_3 along line 43-43,44-44,60-60,62-62

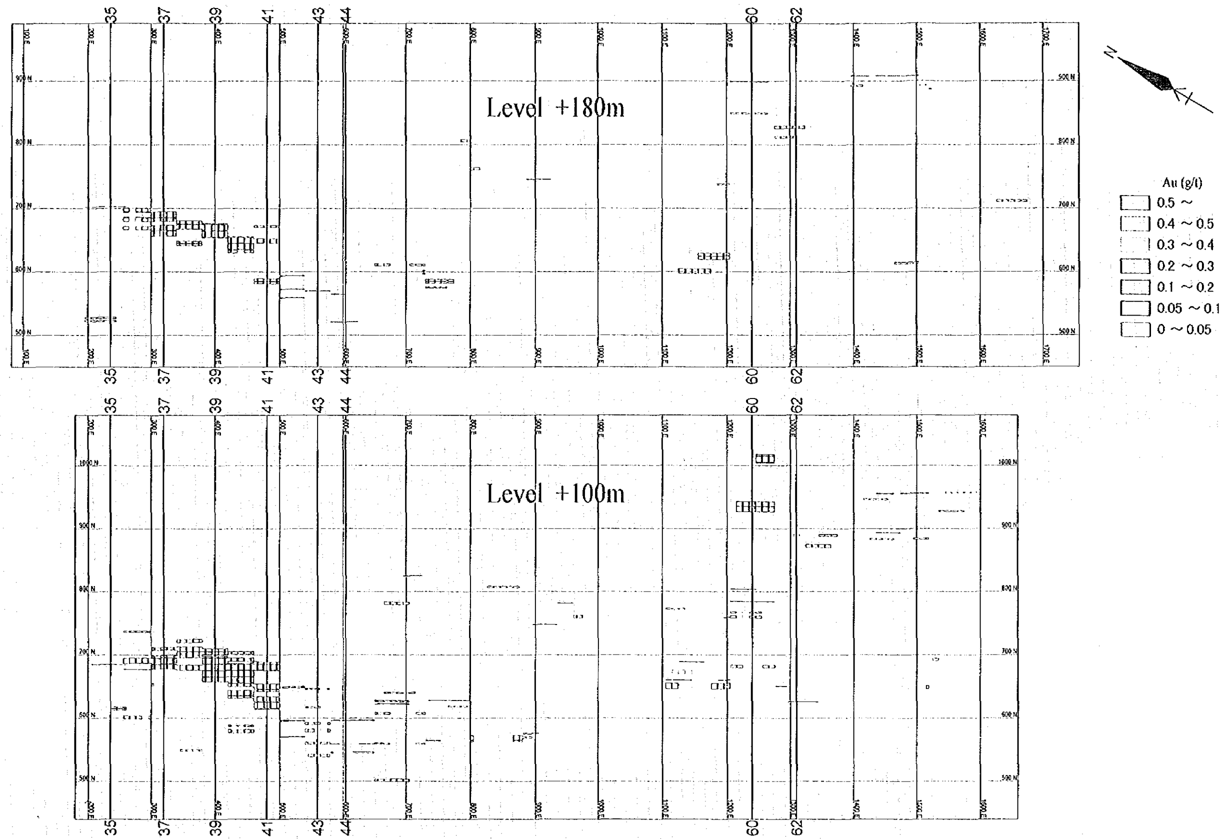


Fig.II-1-2-13 Estimated Grade of Au at the Level of +180m,+100m

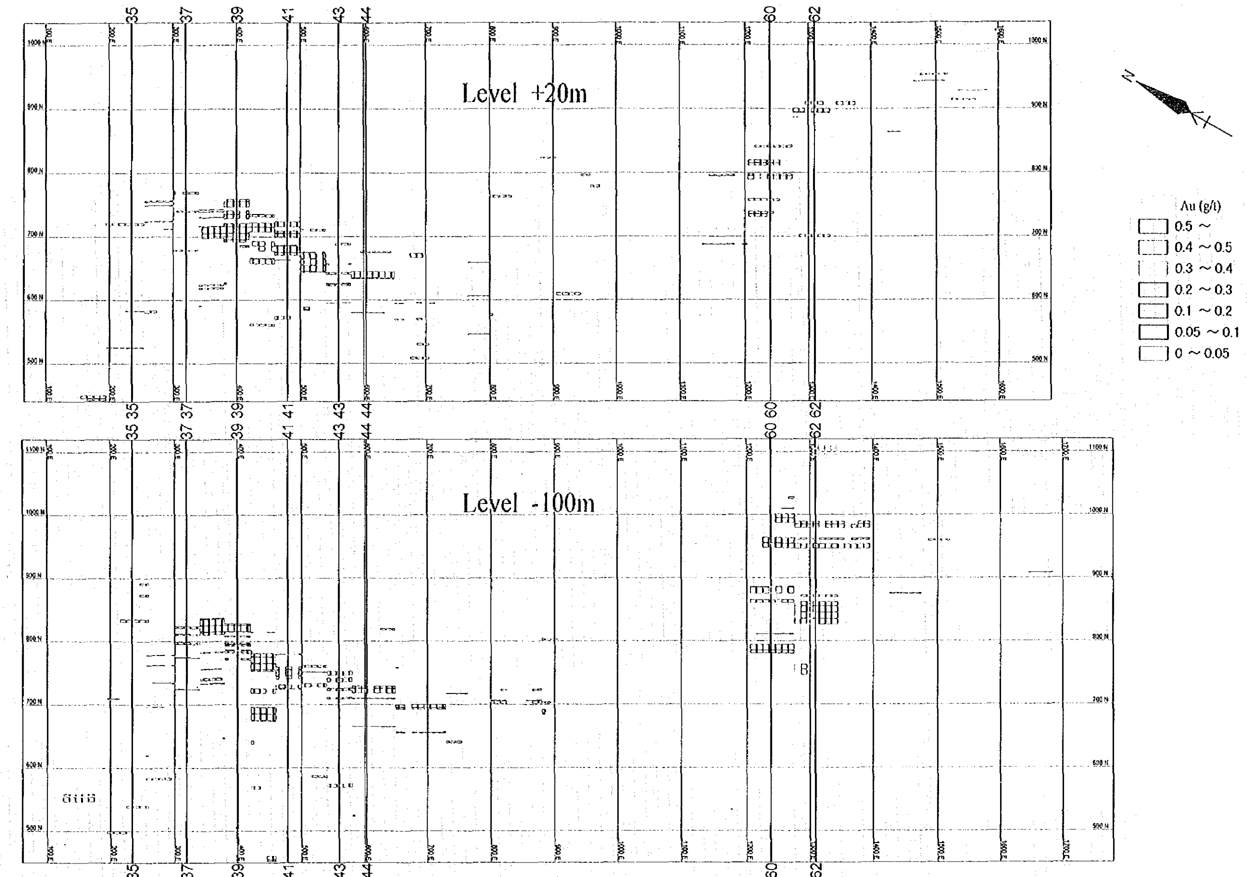


Fig.II-1-2-14 Estimated Grade of Au at the Level of +20m,-100m

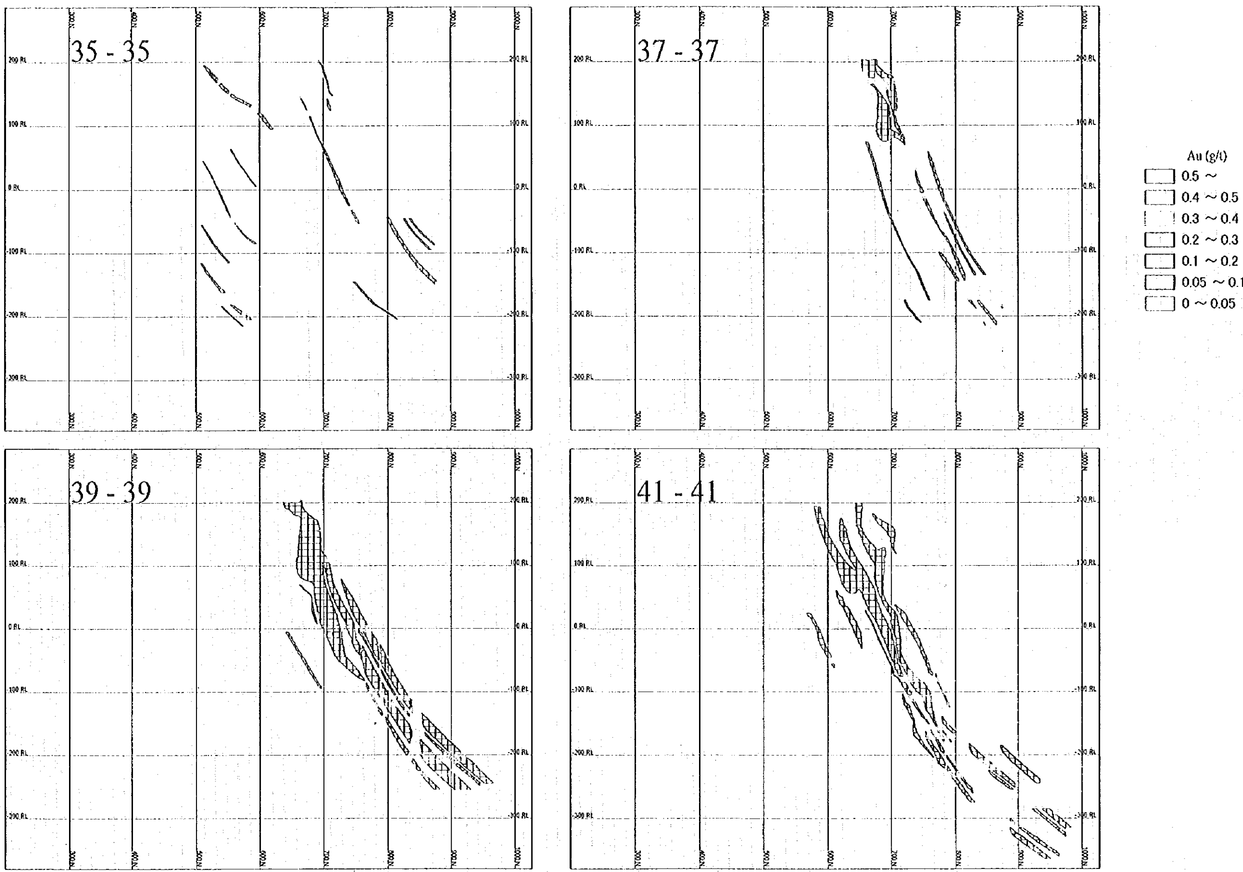


Fig.II-1-2-15 Estimated Grade of Au along line 35-35,37-37,39-39,41-41

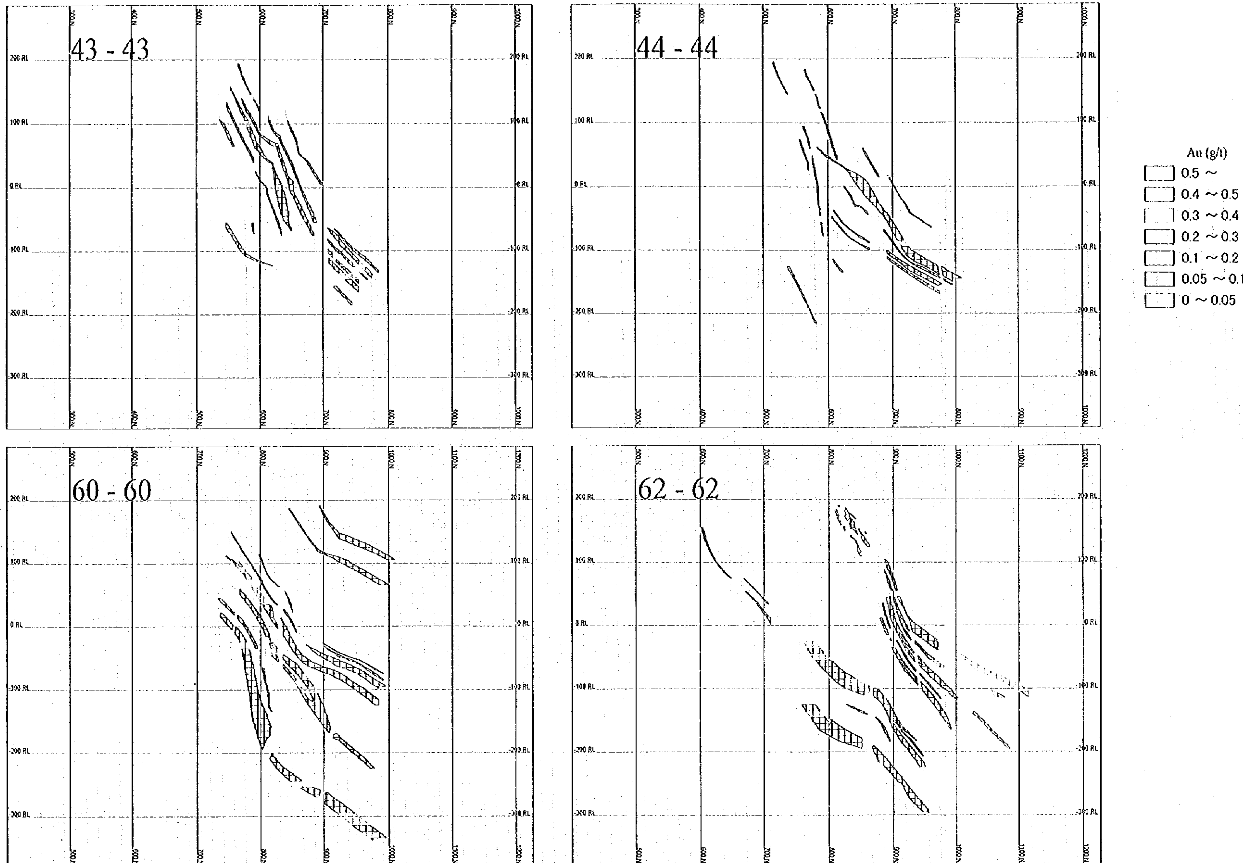


Fig.II-1-2-16 Estimated Grade of Au along line 43-43,44-44,60-60,62-62

1-3 Study of Mining Plans

1-3-1 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.

1-3-2 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.

1-3-3 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-1-3-1, 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 beneficiation 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 beneficiation. 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 x 0.9 - 0.08)% x 61\$/t-%* ≧ (ore haulage cost + variable costs of beneficiation)

* 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 beneficiation 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:

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

- 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 :

$$(7.56 \times 19/422 + 1)\ R/t \times 1.05 \times 36\ sums/R = 51\ sums/t$$

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

· Variable costs of benefication = 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:

$$(1{,}514.5 + 912.0 + 593.9) \times 10^3\ R / 400{,}000t \times 36\ sum/R = 272\ sum/t$$

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

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 8.6m³ 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 II-1-3-1 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.II-1-3-1 : Surface plan, Fig.II-1-3-2 : +100m level plan, Fig.II-1-3-3 : +20m level plan and Fig.II-1-3-2 : 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 II-1-3-2 and II-1-3-3. In both alternatives, 700-tpd (182,000-tpy) operation requires the minimum investment costs per ton.

Table II-1-3-4, 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 II-1-3-4 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.II-1-3-5 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 II-1-3-5)

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.

TableII-1-3-5 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(Appendix 4)

	(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 beneficiation 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

		(10³ sum)
[1] Labor cost		11,526(Appendix 4.)
[2] Supplies and chemicals cost		24,683(Appendix 4.)
[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 (10³ 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.

		(10³ 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

	(10³ sum)
Crude ore:	9,282
Concentrate:	557,000
Total - Railroad freight cost(10³ sum)	9,839
	(54 sum/t)

(v) Annual operating cost summary

	(10³ 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(10³ 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 (10³ 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 II-1-3-2,II-1-3-6 and II-1-3-7, 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 II-1-3-8 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 II-1-3-8 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

1-3-4 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 beneficiation 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 beneficiation cost + ore haulage cost)

$\geq$ (253+272+105)sum / 50 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 14.15m² (4.5m x 3.5m) and an inclination of 1/6(9.5°).

[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 II-1-3-9.

Table II-1-3-9 Minable Ore and Grade(Burgut and Saghinkan)

	Burgut	Saghinkan
Cut-off grade 0.3%		
Minable ore(10^3t)	3,473	3,775
WO_3grade(%)	0.54	0.42
Cut-off grade 0.4%		
Minable ore(10^3t)	2,812	2,325
WO_3grade(%)	0.60	0.52
Cut-off grade 0.5%		
Minable ore(10^3t)	2,072	1,665
WO_3grade(%)	0.68	0.58

3) Estimation of Operating Income

The operating income estimated in Table II-1-3-10 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 beneficiation 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 beneficiation equipment(10^3 sum)	311,575

Note: * For estimating the investment costs of the beneficiation 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 beneficiation 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
- Drlling length for mining of ore: 1.1m/m³
- 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/m³ x 1.1m/m³ = 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/m³ for mining of ore
- Annual consumption of explosives:

3,120m x 28kgs/m + 208,000t x 0.95 / 3t/m³ x 1.89kgs/m³ = 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-m³ 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 14.15m³ x 1.6 = 70,637m³

- Work volume for mining of ore:

  208,000t x 0.95 / 3t/m³ x 1.6 = 105,389m³

- Annual work volume per machine:

  83.2m³ x 3 sft/d x 260d/yr = 64,896m³

- Number of machine required:

  (70,637 + 105,389)m³ / 64,896m³ =2.71 units

- Filling volume: 208,000t / 3t/m³ = 69,333m³

- Volume of waste haulage and secondary haulage of ore:

  (70,637 + 105,389 + 69,333) x 0.12 =29,443m³

- Annual work quantity per machine:

  166.4m³/sft x 3 sft/d x 260d/yr = 129,792m³

- Number of machine required:

  (69,333 + 29,443)m³ / 129,443m³ = 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 II-1-3-11 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 II-1-3-11 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(Appendix 4.)

	(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 beneficiation 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: 5.5m³/t x 3.75 sum x 208,000t	=	4,200
[5] Potable water: 0.385m³/t x 8.55 sum x 208,000t	=	685
[6] Repair: ([1] + [2] + [3] + [4] + [5]) x 0.15		9,276
Total - Ore beneficiation 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 II-1-3-12 and Table II-1-3-13 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 II-1-3-14. 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 II-1-3-12 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 II-1-3-13 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 II-1-3-14 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

1-3-5 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 II-1-3-15~16). 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 for 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 II-1-3-15 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 II-1-3-16 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.II-1-3-6)

Table II-1-3-17 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 II-1-3-18.

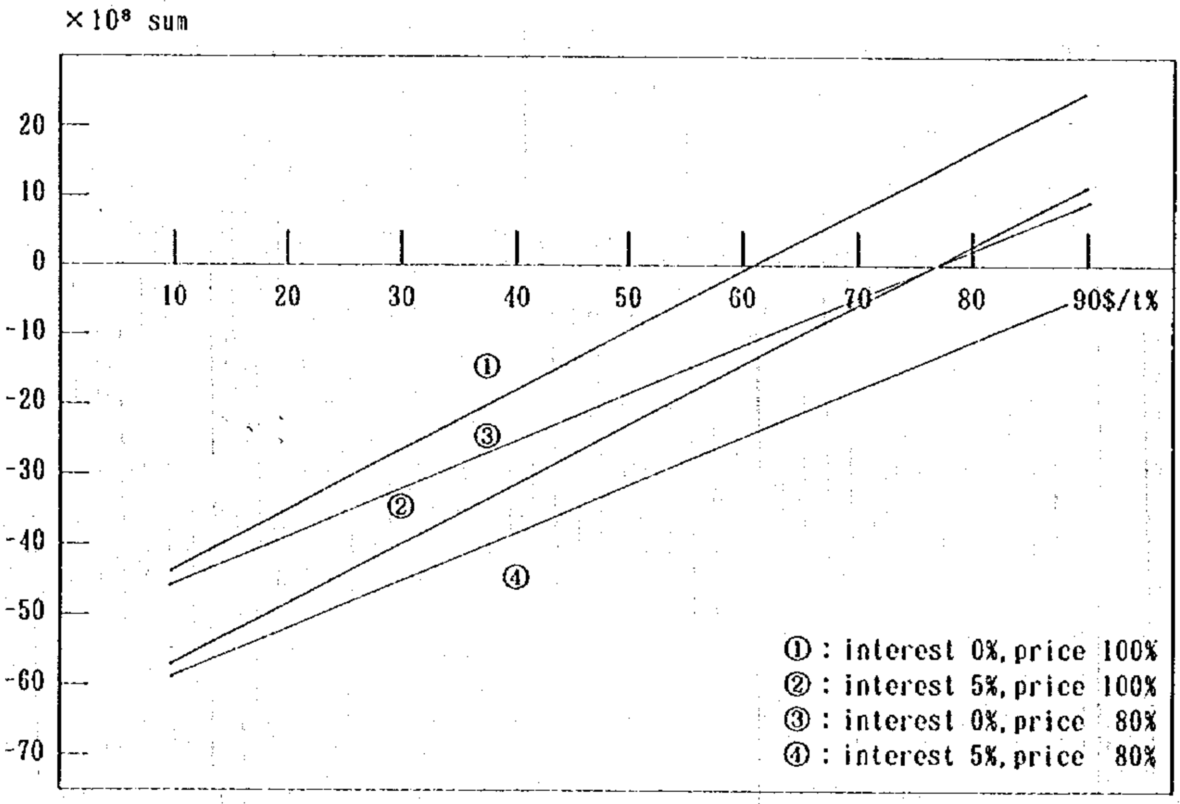


Fig.II-1-3-6 Change of Income by WO_3 Price

Table II-1-3-17 Income and WO_3 Price at Income=0

	Income at 61$/t·%	WO_3 Price at Income=0
	×10⁸ sum	$/t·%
Interest 0% Price 100%	-0.3	62
Interest 5% Price 100%	-13.7	77
Interest 0% Price 80%	-10.8	77
Interest 5% Price 80%	-24.2	97

Table II-1-3-18 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)		

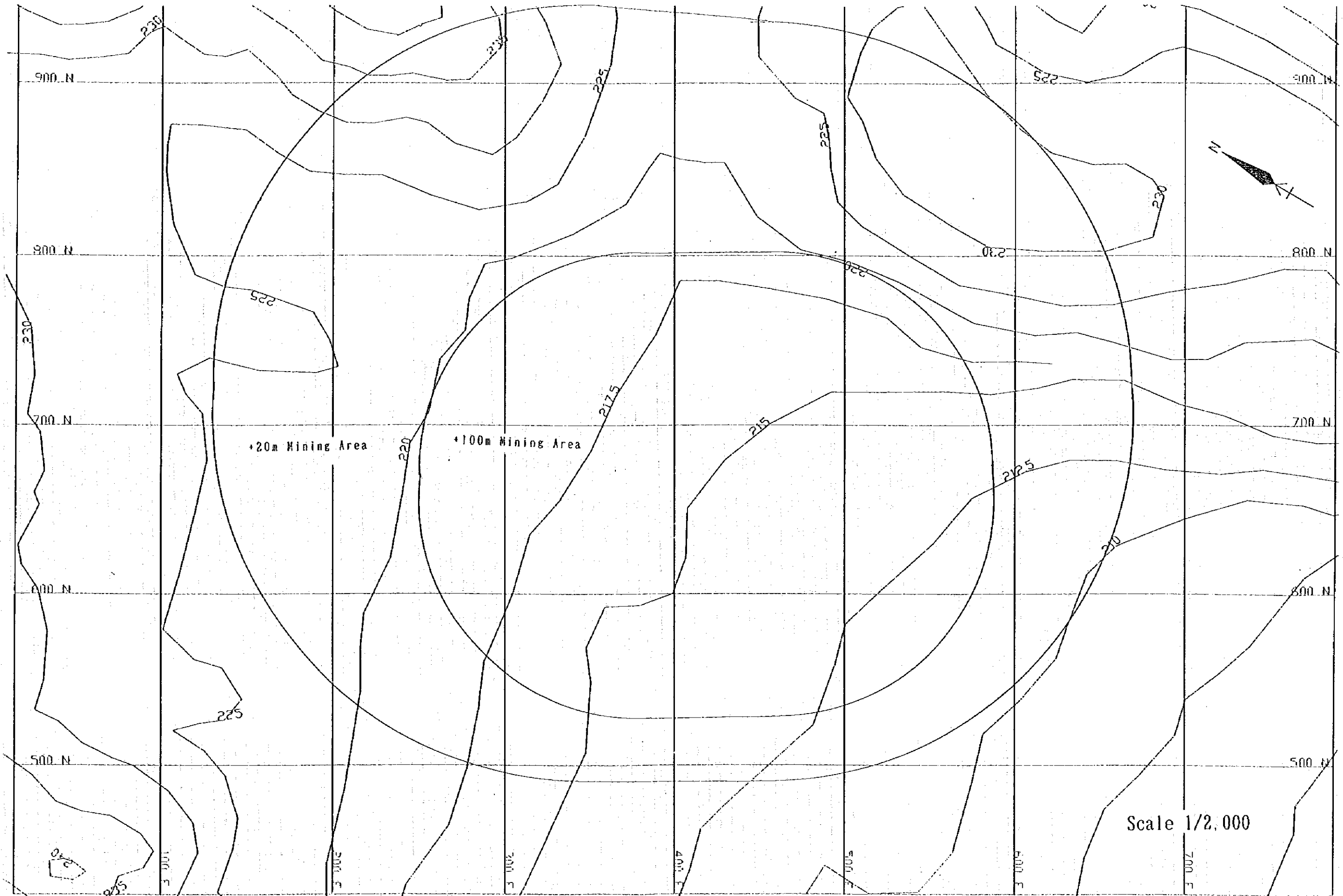


Fig. II-1-3-1 Surface Plan View

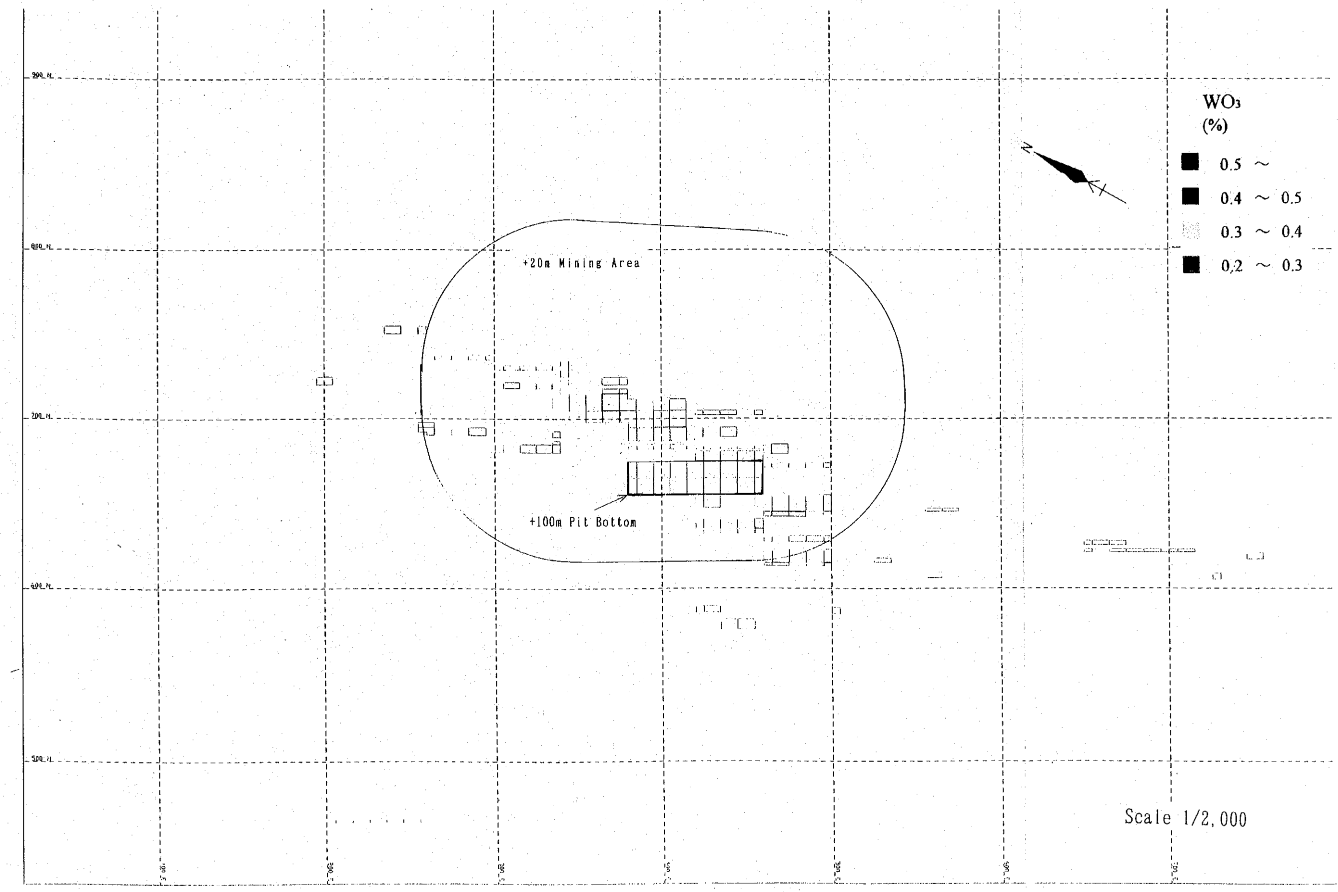


Fig. II-1-3-2 +100m Plane Figure

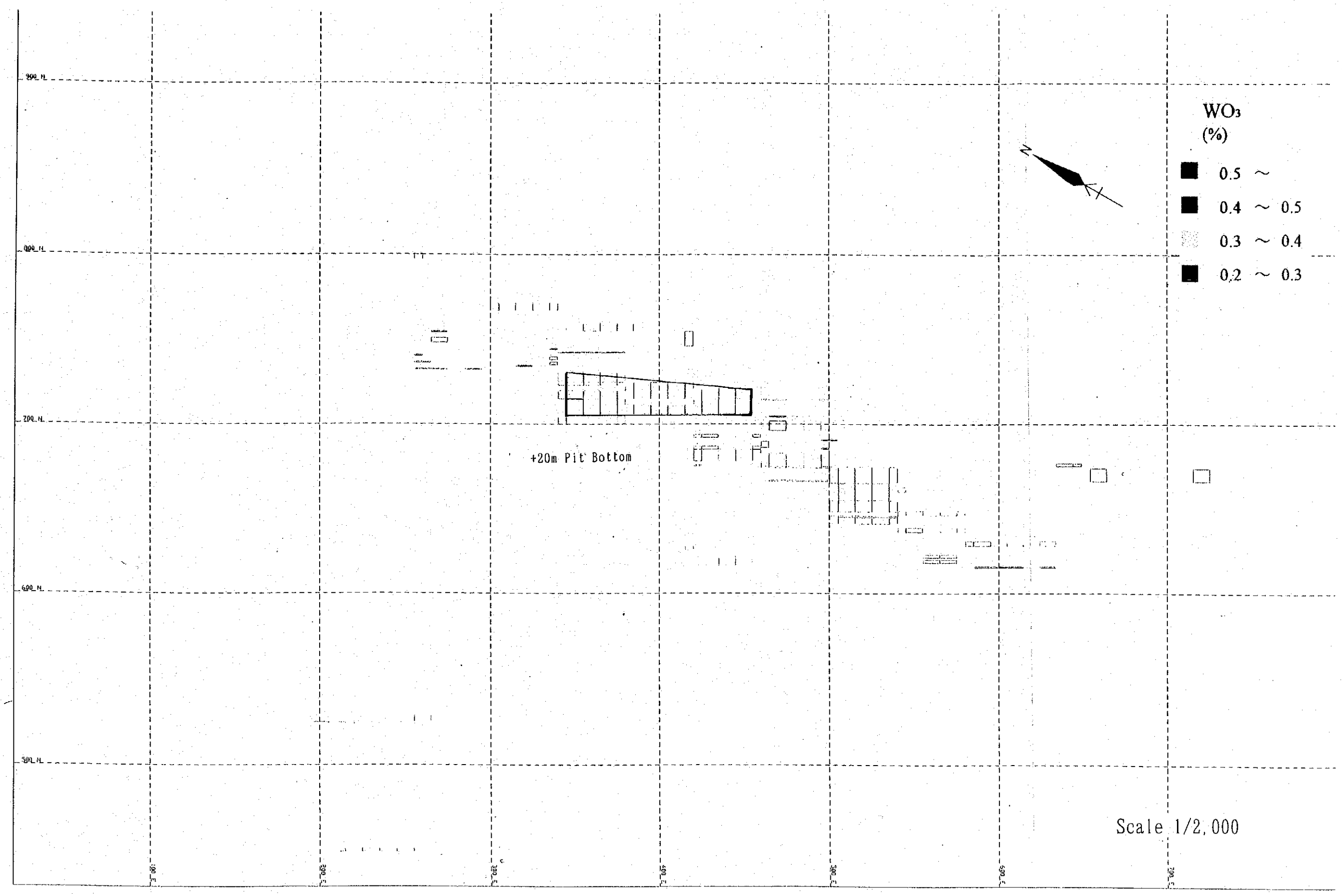


Fig. II -1-3-3 +20m Plane Figure

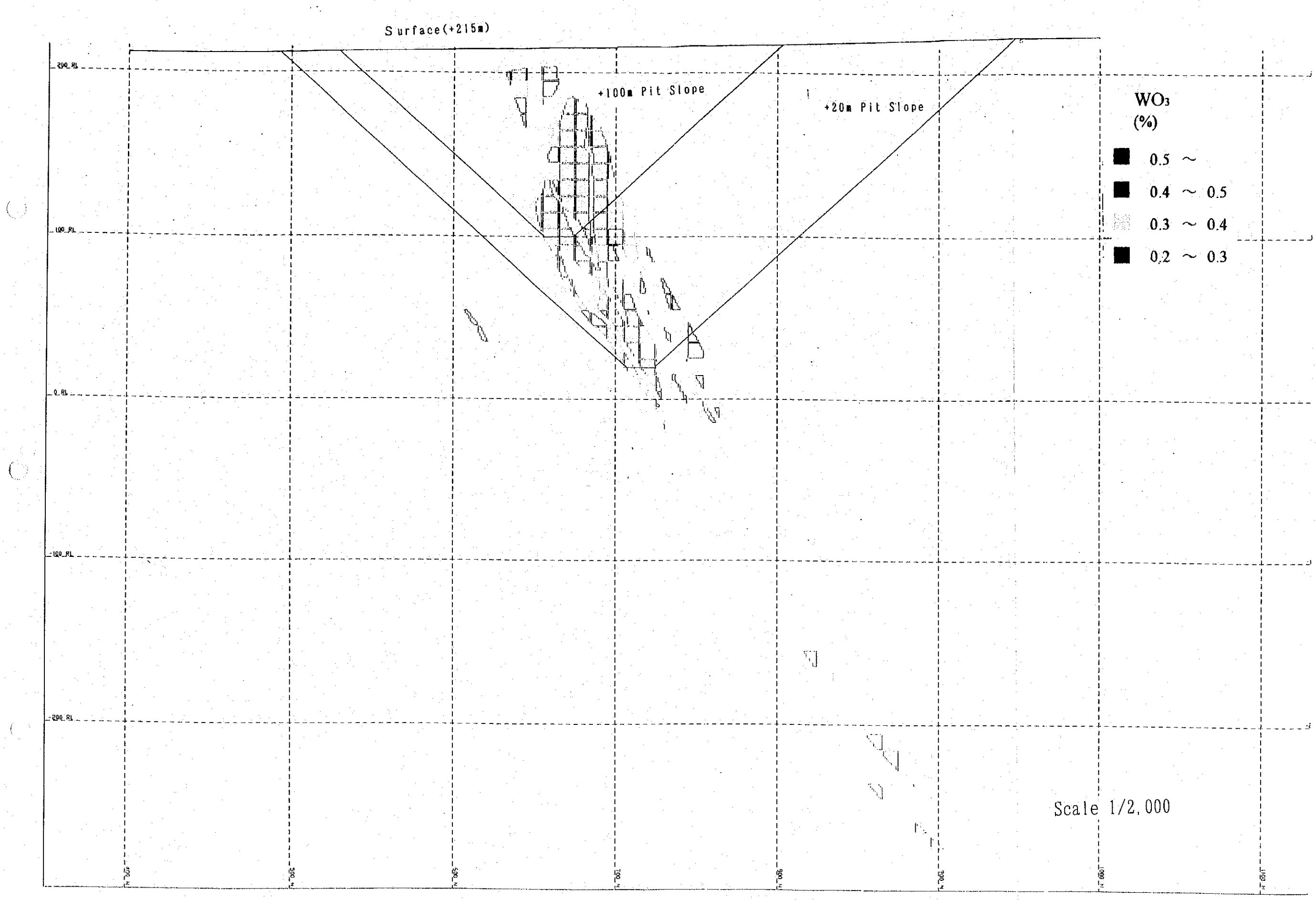


Fig. II-1-3-4　Cross Section along 400E

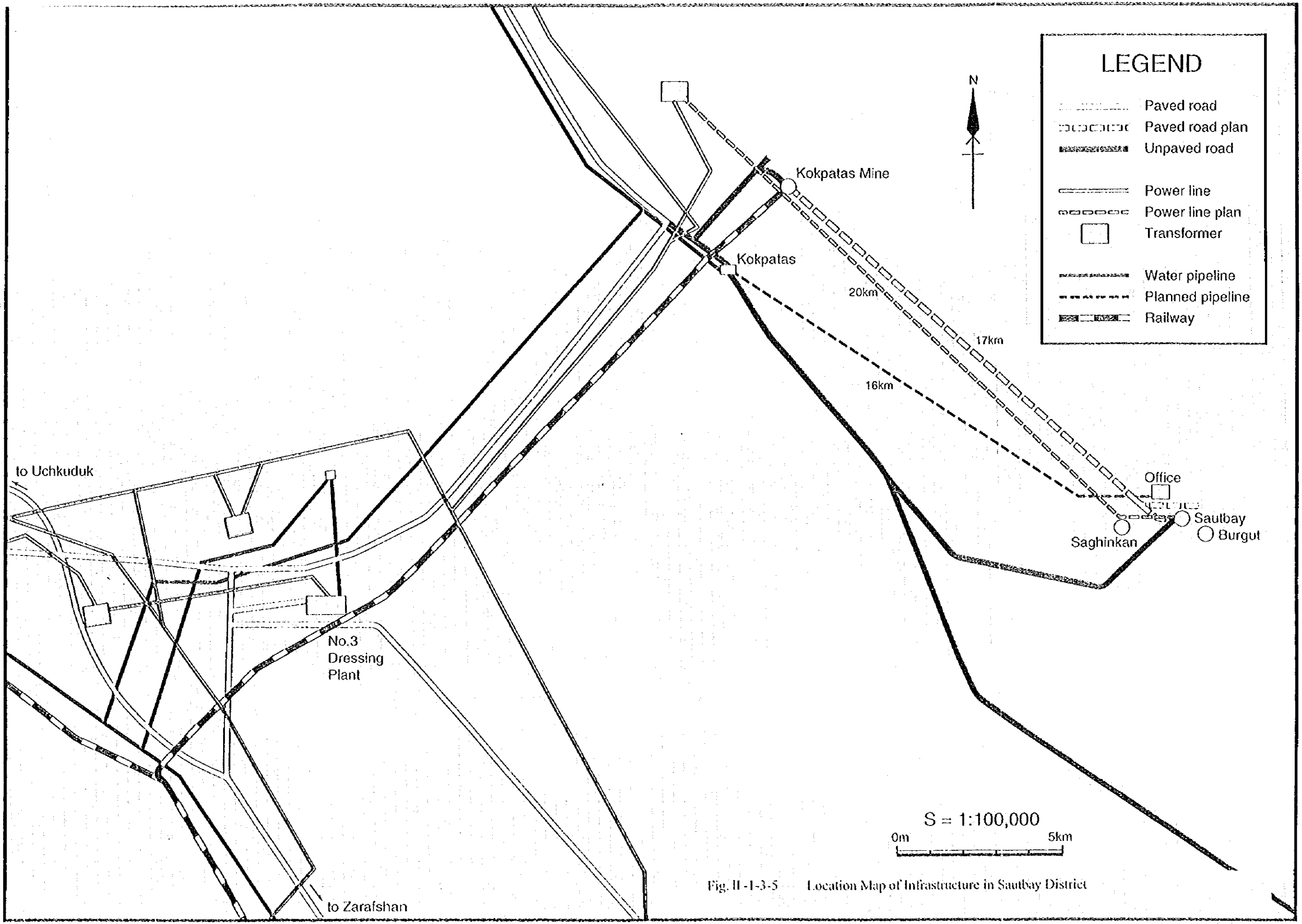


Fig. II-1-3-5 Location Map of Infrastructure in Sautbay District

Table II-1-3-2 Comparison of Production Cost (Mining Plan① in Case of Railway and Truck Transportation)

Production (t/day)	500		600		700		800		900	
Production(thou. t/year)	130		156		182		208		234	
Mine life(years)	19.6		16.3		14.0		12.2		10.9	
Concentrate(t/year)	799		959		1,119		1,279		1,439	
Conc. income(thou. sum)	134,763	1,037	161,750	1,037	188,736	1,037	215,723	1,037	242,709	1,037
Initial investment(thou. sum)	1,013,390	398	1,074,415	422	1,135,440	416	1,247,015	490	1,336,365	525
Infrastructure	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
Mucking equipment	101,100	2	101,100	2	101,100	2	151,650	3	151,650	3
Truck	163,500	5	196,200	6	228,900	7	261,600	8	294,300	9
Others(mining)	69,350		69,350		69,350		69,350		69,350	
Dressing	226,600		254,925		283,250		311,575		368,225	
Mining cost	116,942	900	132,749	851	148,571	816	167,680	806	183,487	784
Personnel(staff)	9		9		9		9		9	
(worker)	71		75		79		87		91	
Wages	11,686		12,254		12,822		13,959		14,528	
Explosives	12,925		15,510		18,095		20,680		23,265	
Rock tool	6,042		7,251		8,459		9,667		10,876	
Fuel, lubricant	47,171		55,446		63,738		71,997		80,272	
Tire	7,597		9,117		10,636		12,156		13,675	
Electricity	1,821		1,821		1,821		1,821		1,821	
Maintenance	29,700		31,350		33,000		37,400		39,050	
Dressing cost	45,116	347	53,834	345	62,553	344	71,119	342	80,027	342
Personnel(staff)	8		8		8		8		9	
(worker)	55		66		77		87		98	
Wages	8,611		10,068		11,526		12,851		14,473	
Materials	17,631		21,157		24,683		28,209		31,735	
Electricity, water	12,989		15,587		18,185		20,783		23,381	
Maintenance	5,885		7,022		8,159		9,276		10,438	
General management	16,206	125	18,658	120	21,112	116	23,880	115	26,351	113
Freight rates	6,968	54	8,362	54	9,755	54	11,149	54	12,543	54
Ore freight	6,630		7,956		9,282		10,608		11,934	
Concentrate freight	338		406		473		541		609	
Annual operating cost	185,232	1,425	213,603	1,369	241,991	1,330	273,828	1,316	302,408	1,292
Total cost(initial invest-ment+operating cost)		1,823		1,791		1,776		1,806		1,817
Total income	-2,000,370	-786	-1,918,930	-754	-1,880,755	-739	-1,957,105	-769	-1,985,100	-780

Production (t/day)	1,000		1,100		1,200		1,300		1,400		1,500		1,600	
Production(thou. t/year)	260		286		312		338		364		390		416	
Mine life(years)	9.8		8.9		8.2		7.5		7.0		6.5		6.1	
Concentrate(t/year)	1,599		1,758		1,918		2,078		2,238		2,398		2,558	
Conc. income(thou. sum)	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. sum)	1,397,390	549	1,533,965	603	1,594,990	627	1,684,340	662	1,745,365	686	1,856,940	730	1,952,410	767
Infrastructure	402,840		402,840		402,840		402,840		402,840		402,840		402,840	
Drilling equipment	50,000	2	75,000	3	75,000	3	75,000	3	75,000	3	75,000	3	100,000	4
Mucking equipment	151,650	3	202,200	4	202,200	4	202,200	4	202,200	4	252,750	5	252,750	5
Truck	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	
Dressing	396,550		424,875		453,200		509,850		538,175		566,500		604,270	
Mining cost	199,754	768	223,706	782	239,654	768	255,461	756	271,267	745	290,427	745	311,345	748
Personnel(staff)	10		10		10		10		10		11		11	
(worker)	97		108		113		117		121		128		137	
Wages	15,558		17,121		17,831		18,399		18,968		20,140		21,419	
Explosives	25,850		28,435		31,020		33,605		36,190		38,775		41,360	
Rock tool	12,084		13,293		14,501		15,710		16,918		18,126		19,335	
Fuel, lubricant	88,547		96,822		105,098		113,373		121,648		129,923		138,199	
Tire	15,194		16,714		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	
Maintenance	40,700		49,500		51,150		52,800		54,450		58,850		64,900	
Dressing cost	88,746	341	97,465	341	106,183	340	115,092	341	123,810	340	132,377	339	141,095	339
Personnel(staff)	9		9		9		10		10		10		10	
(worker)	109		120		131		142		153		163		174	
Wages	15,931		17,388		18,845		20,468		21,925		23,250		24,708	
Materials	35,261		38,788		42,314		45,840		49,366		52,892		56,418	
Electricity, water	25,978		28,576		31,174		33,772		36,370		38,968		41,565	
Maintenance	11,576		12,713		13,850		15,012		16,149		17,267		18,404	
General management	28,850	111	32,117	112	34,584	111	37,055	110	39,508	109	42,280	108	45,244	109
Freight rates	13,936	54	15,330	54	16,723	54	18,117	54	19,511	54	20,904	54	22,298	54
Ore freight	13,260		14,586		15,912		17,238		18,564		19,890		21,216	
Concentrate freight	676		744		811		879		947		1,014		1,082	
Annual operating cost	331,286	1,274	368,618	1,289	397,144	1,273	425,725	1,260	454,096	1,248	485,988	1,246	519,982	1,250
Total cost(initial invest-ment+operating cost)		1,823		1,892		1,900		1,922		1,934		1,976		2,017
Total income	-2,000,370	-786	-2,175,975	855	-2,196,335	-863	-2,252,325	-885	-2,282,865	-897	-2,389,755	-939	-2,494,100	-980

Table Ⅱ-1-3-3 Comparison of Production Cost (Mining Plan① 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		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. sum)	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. sum)	1,152,170	453	1,213,195	477	1,274,220	501	1,385,795	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
Muking 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		124		128		137		144	
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	8,406		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		42,314		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		17,267		18,404	
General management	16,868	130	19,408	124	21,934	121	24,805	119	27,365	117	29,951	115	33,321	117	36,083	116	38,628	114	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	1,430	213,893	1,371	241,749	1,328	273,400	1,314	301,622	1,289	330,141	1,270	367,273	1,281	397,724	1,275	125,790	1,260	153,802	1,247	485,649	1,245	518,970	1,248
Total cost(Initial investment+operating cost)		1,883		1,848		1,829		1,859		1,869		1,874		1,941		1,969		1,989		2,000		2,012		2,083
Total income	-2,153,070	-846	-2,063,995	-811	-2,015,640	-792	-2,091,990	822	-2,117,140	-832	-2,130,165	-837	-2,300,680	-904	2,371,940	932	-2,122,840	-952	-2,150,835	-963	-2,557,725	-1,005	-2,662,070	-1,046

Table II-1-3-6 Comparison of Production Cost(Mining Plan②)

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)	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. sum)	126,836	1,220	158,545	1,220	190,254	1,220	221,963	1,220	253,844	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. sum)	815,790	683	872,440	731	933,475	782	961,790	806	1,073,365	899	1,130,015	946	1,216,040	1,018	1,277,065	1,070	1,305,390	1,093	1,394,740	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	150,641	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		4,865		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	4,723		5,885		7,022		8,159		9,276		10,438		11,576		12,713		13,850		15,012		16,149		17,267	
General management	10,147	98	11,770	91	13,581	87	15,185	83	17,341	83	18,963	81	21,314	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	5,304		6,630		7,956		9,282		10,608		11,934		13,260		14,586		15,912		17,238		18,564		19,890	
Concentrate freight	318		398		477		557		637		716		796		875		955		1,034		1,114		1,193	
Annual operating cost	117,240	1,127	136,495	1,050	157,823	1,012	176,871	972	201,994	971	221,246	945	248,510	956	269,994	944	289,010	926	310,578	919	329,623	906	354,717	910
Total cost(Initial invest-ment+operating cost)		1,810		1,781		1,794		1,778		1,870		1,891		1,974		2,014		2,019		2,087		2,098		2,195
Total income	701,460	-590	669,834	-561	685,356	-574	-666,252	-558	-776,100	-650	-801,174	-671	-900,276	-751	918,036	791	-951,006	799	1,035,198	867	-1,048,332	-878	-1,164,150	-975

Table Ⅱ1-3-7 Comparison of Production Cost(Mining Plan③ in Case of Cut Off WO3 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. sum)	152,304	1,464	190,254	1,464	228,372	1,464	266,491	1,464	304,410	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. sum)	815,790	889	905,140	986	1,016,725	1,108	1,045,040	1,138	1,131,065	1,232	1,220,415	1,329	1,248,740	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
Mucking 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	71,476	687	82,423	634	96,973	622	105,813	582	121,757	585	132,845	568	142,143	547	156,550	547	167,639	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		9,555		10,834		10,834		11,828		12,396		12,822		13,959		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	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	4,723		5,885		7,022		8,159		9,276		10,438		11,576		12,713		13,850		15,012		16,149		17,267	
General management	10,768	104	12,754	98	15,081	97	16,810	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	1,194	147,400	1,134	171,117	1,118	195,186	1,072	223,536	1,075	246,952	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 invest-		2,093		2,120		2,226		2,210		2,307		2,384		2,392		2,514		2,568		2,614		2,672		2,731
ment+operating cost)																								
Total income	-568,242	619	602,208	656	-699,516	-762	681,828	-716	-773,871	813	-814,560	-920	-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 II-1-3-10 Comparison of Production Cost(Mining Plan③ 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		1,693		1,975		2,257		2,539		2,821		3,103		3,385		3,667		3,949		4,231	
Conc. income(thou. sum)	190,254	1,830	237,818	1,830	285,550	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. sum)	1,427,890	689	1,510,990	729	1,605,625	775	1,660,390	801	1,688,715	815	1,795,365	866	1,845,790	891	1,906,865	920	1,995,240	963	2,051,890	990	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		254,935		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	98,741	633	108,556	596	115,049	553	129,831	555	141,470	544	150,184	525	168,282	539	174,778	517	189,557	521	196,230	503
Personnel(staff)	8		9		9		9		9		9		10		10		10		10		10		11	
(worker)	60		64		75		79		79		87		91		95		107		107		115		115	
Wages	9,946		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		16,070		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		6,744		8,093		9,441		10,790		12,139		13,488		14,836		16,185		17,534		18,883		20,231	
Electricity	6,981		7,446		7,912		8,377		8,842		9,307		9,772		10,238		10,703		11,168		11,633		12,099	
Maintenance	30,140		32,890		41,690		44,440		44,440		51,590		55,990		57,640		67,540		67,540		74,690		74,690	
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	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	4,723		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	104	12,700	98	15,258	98	17,111	94	18,617	90	20,986	90	23,022	89	24,765	87	27,447	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	14,453	56	15,899	56	17,344	56	18,789	56	20,234	56	21,680	56
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	477		596		716		835		955		1,074		1,193		1,313		1,432		1,551		1,670		1,790	
Annual operating cost	124,691	1,199	146,930	1,130	176,508	1,131	198,337	1,090	216,348	1,040	243,852	1,042	267,691	1,030	288,313	1,008	319,256	1,023	337,616	999	361,938	1,003	383,148	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	-120,176	-58	-60,088	-29	-157,172	-76	-126,392	-61	-51,800	-25	-161,616	-78	-188,552	-91	-203,056	-98	-323,232	-156	-329,118	-159	-416,172	-201	-401,968	-194

Chapter 2 Bulutkan District

2-1 Geology and Ore Deposits in the Bulutkan District

The geology in the Bulutkan district is composed mainly of sedimentary rocks of the Proterozoic Kokpatas Formation. The Kokpatas Formation, more than 1,000m thick, consists of slate and sandstone accompanied by quartzite-chert lenses, limestone and dolomite. (Fig. II-2-1-1) Stocks and dikes of the Late Carboniferous ~ Early Permian syenodiorite, diorite, granite, porphyrite, lamprophyre, etc. intrude into these rocks.

Covering unconformably the Proterozoic and intrusive rock, the Cretaceous and the Quarternary Systems are distributed. The Cretaceous consists of marine mudstone, sandstone, conglomerates and dolomite whereas the Quarternary comprises continental silt, sand, gravels and gypsum.

Conspicuous faults in this district are with the WNW-ESE and NNW-SSE trends. Along the north side of a syenodiorite stock, the North Sautbay Fault extends, intersected by a fault with a NNW-SSE trend.

Mineralization has taken place at the intersection of the faults with WNW-ESE and NNW-SSE trends and at quartz veins, silicified veins and skarn ore bodies containing gold controlled by syenodiorite. Known in this district is the Bulutkan deposit.

1) Bulutkan deposit (Au)

Discovered in 1993, the Bulutkan deposit is situated 5.5km east of the Sautbay deposit, at the north contact zone of the syenodiorite body (Fig. II-2-1-2). The Kokpatas Formation around this deposit is composed of sandstone, slate, quartzite, limestone and dolomite, as well as those metamorphosed from these rocks, such as hornfels, silicified rocks, silicified-skarnized metasomatite and skarn.

The orebodies are in the WNW-ESE direction. Numerous dikes of lamprophyre, diorite, granite, etc. are distributed, intruding in the same direction.

Since the discovery in 1993, the Kokpatas Expedition carried out trenching, non-core drilling and tunneling surveys which resulted in confirming that the deposit has a maximum thickness of 30m, a maximum extension of 50m and a depth of more than 70m.

The non-core drilling results to a depth of 70m indicated that the gold grade ranges from 1 to 420g/t (averaing 6.9g/t) but it is higher in the upper part (Au 3-50g/t) where some samples assay 100g/t or higher. In the lower part, the gold grade varies between 1.5 and 6g/t.

The drilling of three holes conducted during Phase II revealed that the upper part of the ore body is made up of ferrous oxide, fine-grained quartz and chalcedony, whilst, in the lower part, skarn accompanied by sulfide minerals has undergone gold mineralization. Ferruginous oxidation products develop to the depth of 40m.

The Phase III drilling of two holes aimed at the west extension of the orebody ascertained gold mineralization accompanied by silicified-skarnized metasomatite, skarns and quartz-sulfide veins. On the other hand, silicified-skarnized metasomatite and skarns accompanying weak gold mineralization were caught at three drillholes aimed at the east extention of the orebody.

The survey findings obtained from the +210m-level tunnel from the No.29 vertical shaft, 28m below the surface, developed by the Uzbek side on its own in the central part of the orebody, indicate that the bonanza of Bulutkan ore deposit is controlled by faults with the trends of WNW-ESE, NW-SE and ENE-WSW, while the orebody presumably is in a shape of polygonal pyramid or pipe(width 25-35m ; depth about 100m) with a wide top face(the surface portion), either upright or sharply inclined somewhat northward. It is presumed, therefore, that the mineralization confirmed by the Phase III drilling at the east and west extensions of Bulutkan orebodies is not directly connected with the orebodies.

The component minerals of the silicified rocks in the upper part are mainly quartz, chalcedony, calcite, pyrite, natrojarosite, goethite, accompanied by pyrrhotite and gypsum.

The lower part comprises hornblende-clinopyroxene skarns accompanied mainly by tremolite, actinolite, chlorite, pyrite, marcasite, pyrrhotite, arsenopyrite and chalcopyrite, and rarely by wollastonite, scheelite, epidote and grossular. Quartz-calcite-siderite veins intrude into the hornblende-clinopyroxene skarns.

Native gold is recognizable in quartz and chalcedony by macroscopic observation.

According to the X-ray refractory analysis and observation of polished sections by the Uzbek side, native gold occurs in quartz veins, calcite veins and siderite veins, associated with graphite. Native gold are rarely associated with pyrite, pyrrhotite, marcasite and chalcopyrite within amphibole-pyroxene skarns, whilst it is not confirmed within sulfide minerals. The gold grains are in oval, fine-vein, porphyritic and polymorphic shapes. The grain sizes range from 0.003mm or less to 0.1mm.

In the Bulutkan district, it has been confirmed by the past geological and trenching surveys that, besides the mentioned Bulutkan deposit, a 600 ~ 700m-wide zone containing silicified rocks, brecciated and ferruginizated, continuously extends; above all, a 100 ~150m-wide zone adjoining the syenodiorite body is dotted with gold showings. To clarify the horizontal and vertical extension of the gold mineralization in this zone, trenching, geophysical and drilling surveys were conducted in this fiscal year.

The Uzbek-side exploration is currently ongoing in the district. The exploration, including trenching, drilling and geophysical surveys, is expected to continue until 1998.

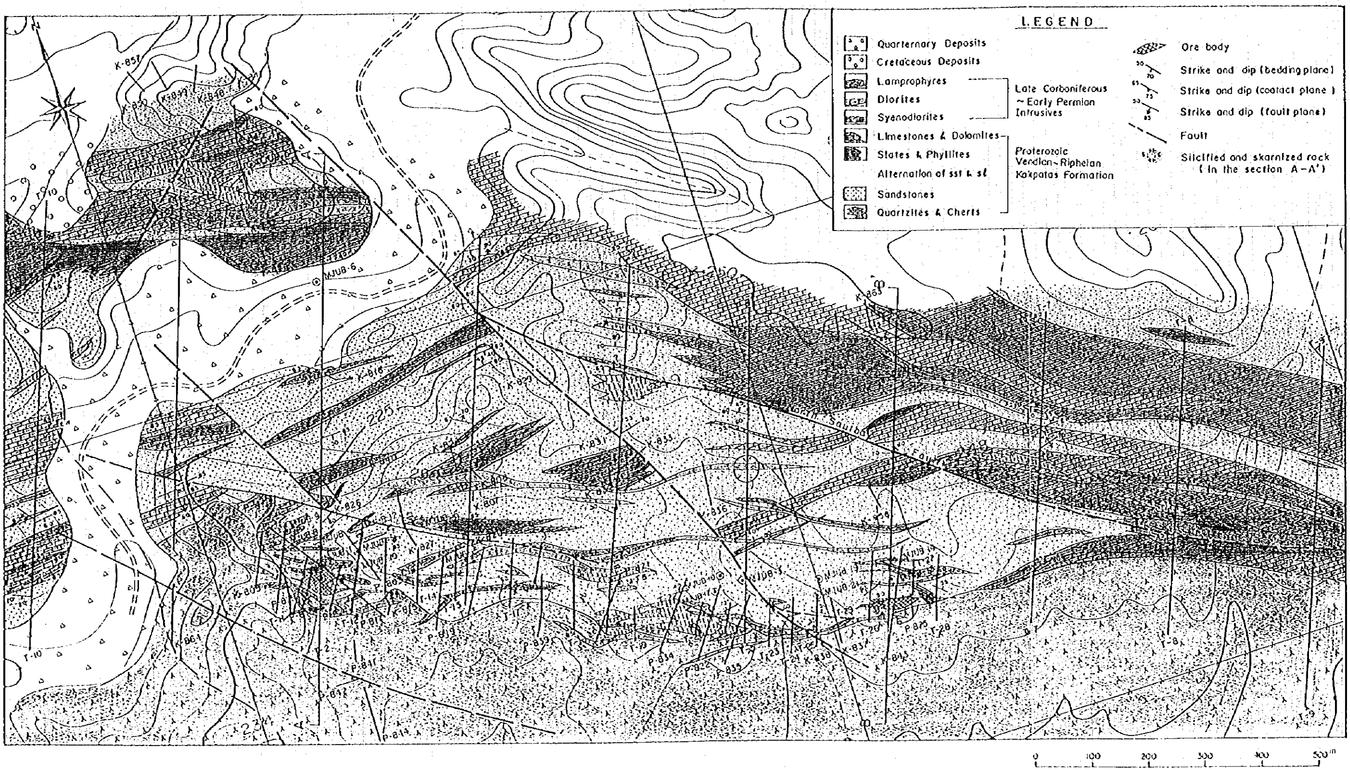


Fig. II-2-1-1 Geological Map of the Bulutkan District

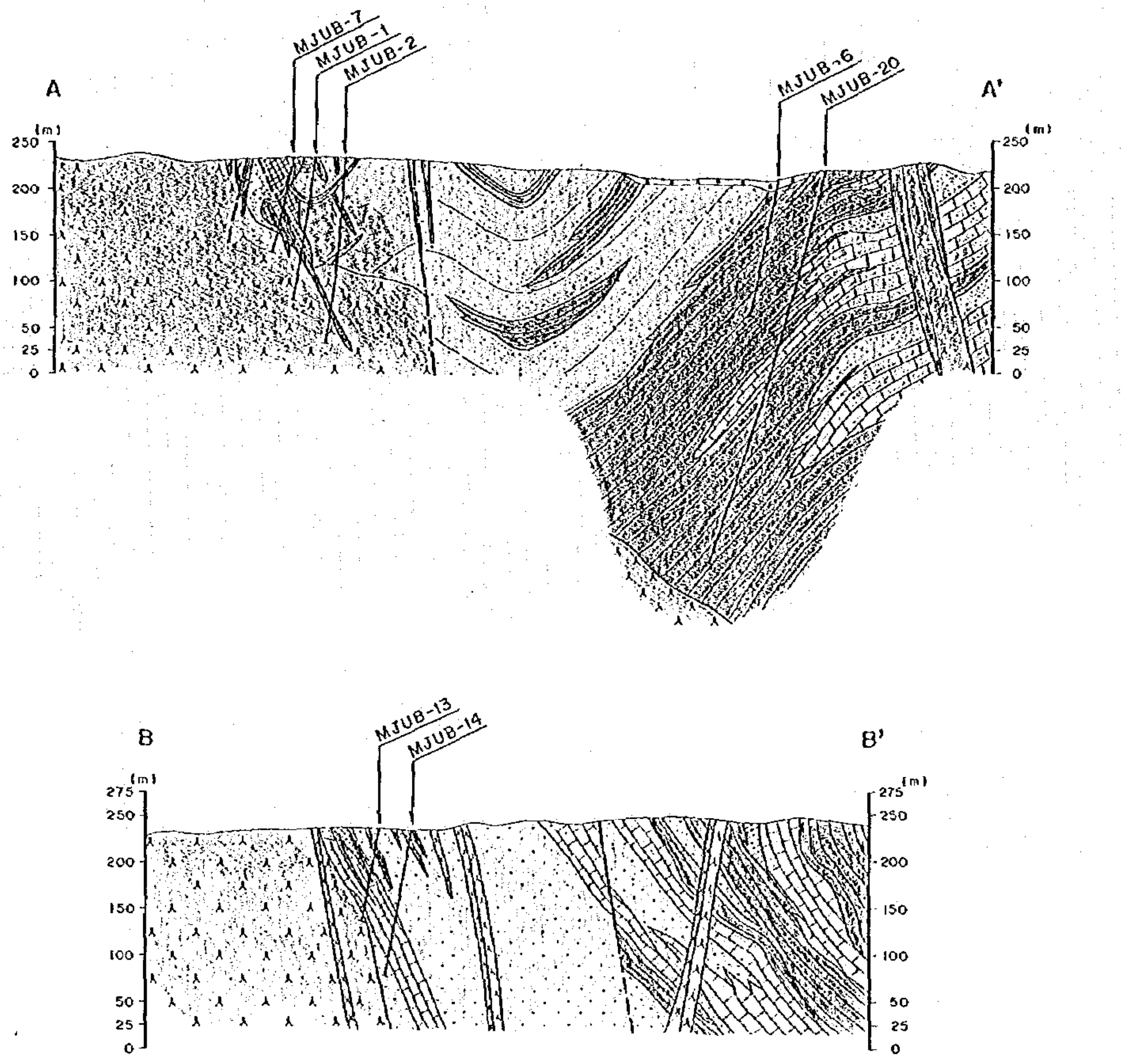


Fig. II-2-1-2 Geological Cross Section of the Bulutkan District

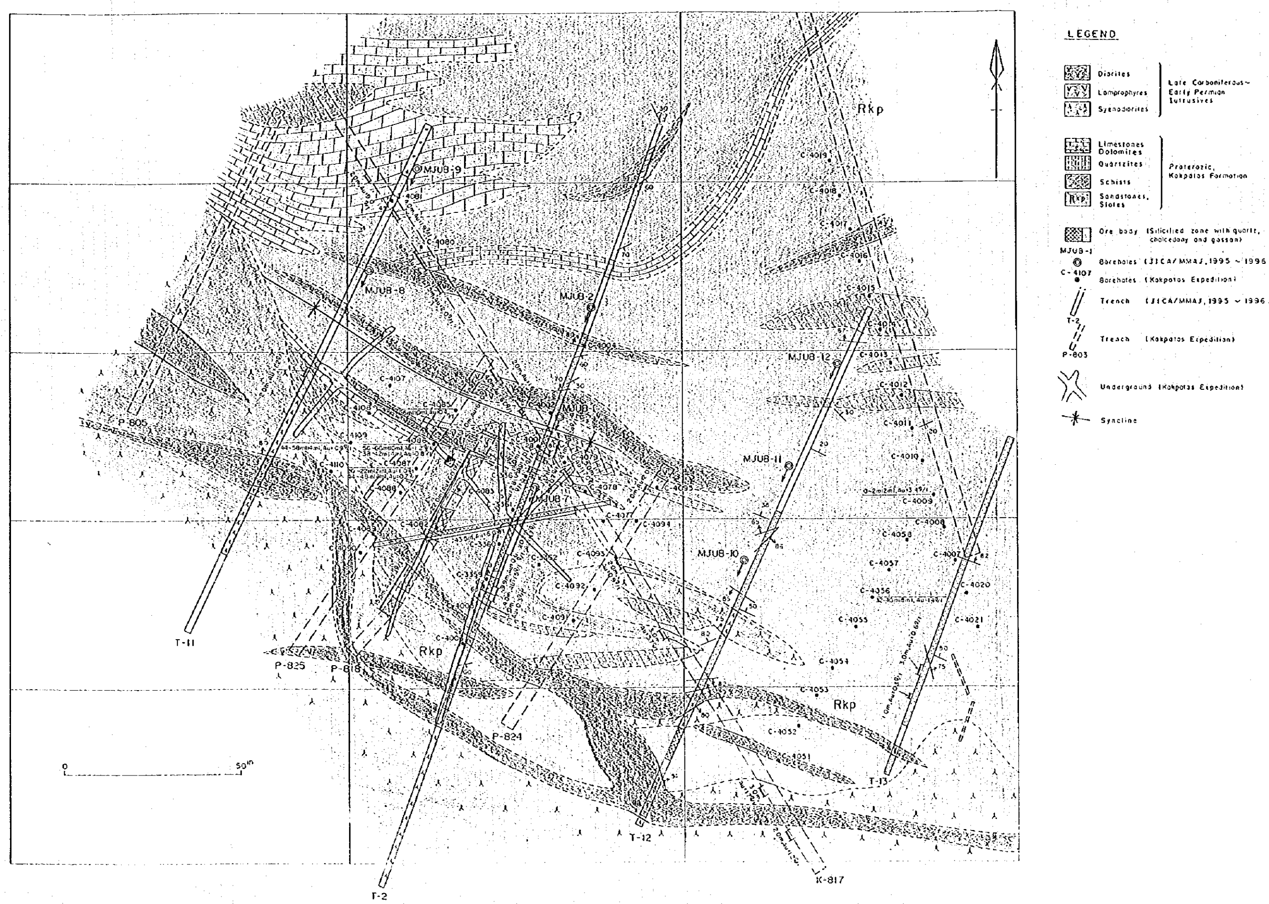
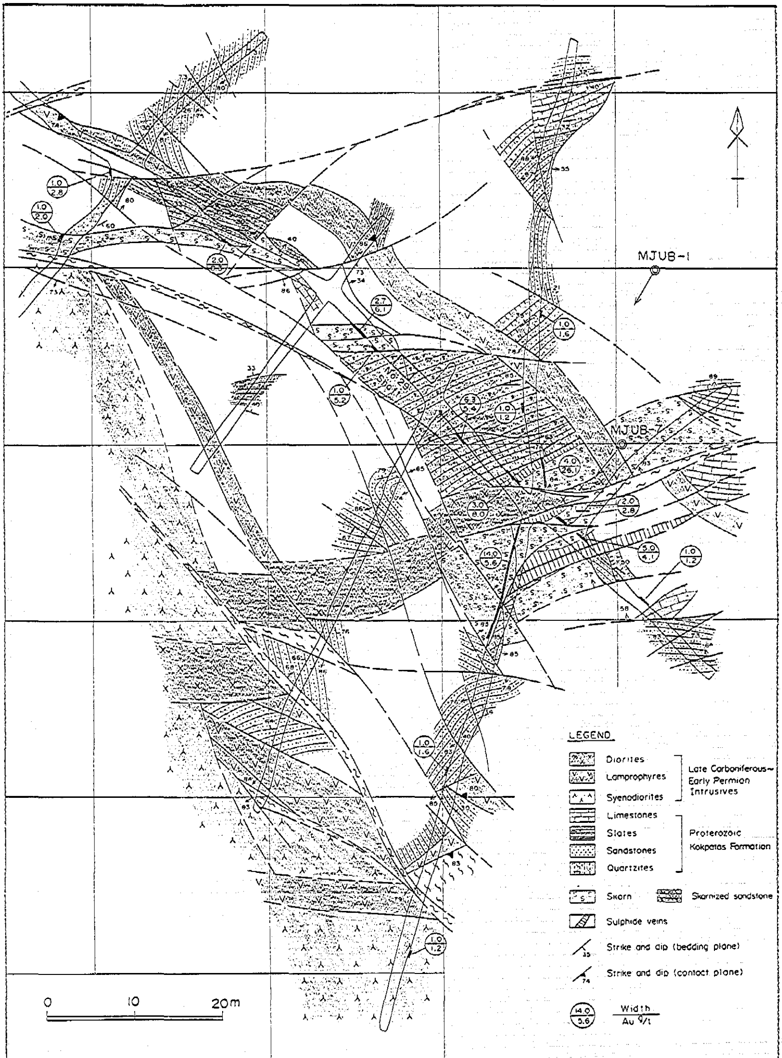


Fig. II-2-1-3 Geological Map of the Bulutkan Ore Deposit



Kokpatas Expedition (1996)

Fig. II -2-1-4 Underground Geological Map of the Bulutkan Ore Deposit(+210m Level)

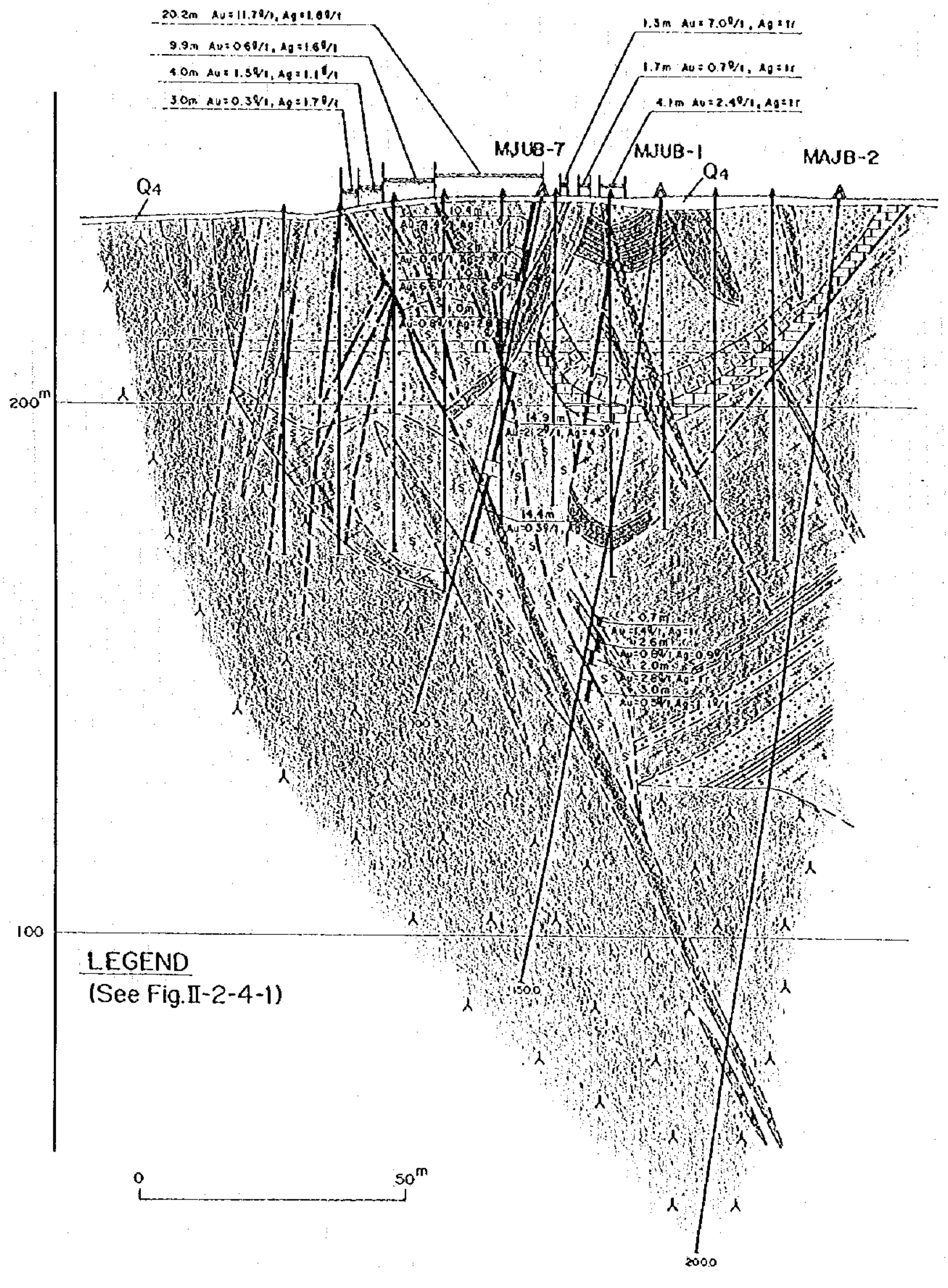


Fig. II-2-1-5 Geological Cross Section of the Bulutkan Ore Deposit

2-2 Trenching Survey

2-2-1 Purpose of survey

The survey was aimed to examine the metallogenic characters and the horizontal extension of the gold mineralization zone in the Bulutkan district.

2-2-2 Method of survey

Trenching survey was executed to examine the showings and geochemical anomalies of gold which were caught during the Phase II survey. 19 trenches were disposed in the two directions, one intersecting at right angles the strike of a presumed mineralization zone(in principle, N20° E) and the other pursuing the confirmed mineralization zone in strike.

Locations of the trenches are shown in Fig. II-2-2-1. Lengths of trenches are 70-180m, totaling 2,010m. Of all the trenches, observation and sketching of geology and mineralization, sample collection and laboratory tests were effected. The lengths of respective trenches are shown in Table I-1-3-1 while the laboratory test items and quantities appear in Appendix 2-1.

Trenching were performed by manpower. Explosives were used when necessary. The trenches, about 1m wide, were excavated to the maximum depth of 2m. Immediately before geological observation, the trench floor was cleaned by manpower.

Since most parts of the side walls comprize sand or gypsum beds, or strongly weathered rocks, sketching was done with a scale of 1/1,000 of trench floors and with a 1/100 scale of portions with mineral indications. The sketches with 1/1,000 and 1/100 scales are demonstrated in PLs. II-2-2-1 and II-2-2-2, respectively.

The laboratory tests consisted of chemical analysis of ore, microscopic observation of thin sections of rocks and polished sections of ore, X-ray diffractive analysis and measurement of homogenization temperature of fluid inclusions. As regards ore samples, some 10kg of them were taken from 1~2m-long channels, to be sujected to chemical analysis. The analyses are shown in Appendix 2-6(2). The collection points of the other laboratory test samples are shown in the trench sketch in PL. II-2-2-1. The microscopic observation and the photomicrographs of the thin sections of rocks are exibited in Appendices 2-2 and 2-3, respectively, while those of the polished sections of ore are exhibited in Appendices 2-4 and 2-5. The X-ray diffractive analysis is demonstrated in Appendix 2-7, while Appendix 2-8 indicates the measurements of the homogenization temperature of fluid inclusions.

2-2-3 Results of survey

Observation findings are incorporated in the geological map with a 1/5,000 scale (Fig. II-2-1-1). The survey area is dominated by the Kokpatas Formation, as well as the syenodiorite stock and dikes of lamprophyre, diorite and syenodiorite which intrude into the Kokpatas Formation.

In the district, faults develop in the WNW-ESE and NNW-SSE directions and fractures chiefly in the NW-SE ~ E-W directions. Many of the fracture zones are several decimeters to several meters wide. The main fault is the North Sautbay Fault in the WNW-ESE direction. Generally, the Kokpatas Formation strikes NW-SE ~ WNW-ESE at the northeast side of the North Sautbay Fault and E-W ~ ENE-WSW at the southwest side of the fault.

Along the faults and fractures, dikes of 20cm to several meters wide and silicification or skarnization of several decimeters to several meters wide are frequently visible, which are often accompanied by ferrous oxide. In general, pyrite and goethite disseminated by diagenesis are recognized in slate and muddy sandstone in this district.

Conspicuous ferrous oxide zones observed at the trenches are listed below:

Trench T-17 : 89.0m - 98.0m
Trench T-22 : 114.0m - 118.0m
Trench T-25 : 74.0m - 79.7m
Trench T-26 : -16.5m - -21.5m; -31.0m - -34.0m
Trench T-28 : 36.6m - 39.0m
Trench T-29 : 144.5m - 147.5m

These ferrous oxide zones occur, accompanied by faults and fractures which strike WNW-ESE in the Kokpatas Formation.

The main gold mineralization zones confirmed by the chemical analysis of ores are exhibited in Table II-2-2-1.

Main mineralization zones are sometimes accompanied by the mentioned ferrous oxide zones but, in many cases, they are accompanied by fractures, intrusive rocks(lamprophyre and diorite), or silicified rocks/skarns in the vicinity of the fractures or the intrusive rocks. However, it is not macroscopically possible to distinguish gold-bearing mineralization zones, from ferrous oxide zones and silicified, skarnized zones unaccompanied by gold mineralization.

In many cases, ore minerals of the samples collected from the trenches are altered into geothite and lepidochrocite due to oxidization. No auriferous minerals were recognized in any of the samples, by the observation of polished sections.

In the samples T-12L3 and T-22L1, ore minerals such as chalcopyrite, chalcocite and covelline were identified. The other ore minerals observed are pyrite, arsenopyrite, pyrrhotite, rutile and titanite.

By the X-ray diffractive analysis, quartz, amphibole, clinopyroxene, calcite,