MJCC-17	0m- 8m(8m)	0.464	0.201	0.263	13.69	Oxide Mineral. zone
MJCC-17	11m- 22m(11m)	0.531	0.253	0.278	20.53	Oxide Mineral. zone
MJCC-17	33m- 41m(8m)	0.464	0.258	0.206	20.21	Oxide Mineral. zone
MJCC-17	41m- 55m(14m)	0.911	0.573	0.338	22.81	Oxide Mineral. zone
MJCC-20	6m- 38m(32m)	0.454	0.208	0.246	21.63	Intermediate Mineral. zone
MJCC-20	55m-126m(71m)	0.407	0.127	0.281	30.35	Sulfide Mneral. zone

The content of iron oxide of the country rocks in the above mineralization zone is markedly high. Many of the "hydrothermal breccias" can be called semi-iron ore mineral. The necessity of study of the relationship between these kinds of iron oxides and copper ore deposit is pointed out.

In addition to the above, the survey area neighbors a great tectonic line. Many mineralized zones are detected in this area. Therefore, the relationship between the formation of ore deposits and the great tectonic line of Chile is pointed out as the worthy examination after the entire drilling survey is finished.

1—3—5 Description of each drilling hole

Core drilling was carried out in order to study the distribution and ore grades of a mineralization zone detected by the 1993 core drilling(MJCC-1 ~30) and geophysical prospecting. The position of the 1993 core drilling is shown in Fig.I-1-3-1. Regarding geology, alteration and mineralization, the geological description of 41 drilling holes, including 18 holes which could not describe in the 1992 report and 23 holes which were carried out in 1993, are as follows;

Refer to the geologic columnar section of each hole(Appendix) about the geology and alteration, also refer to the Table of ore grades of each hole (Fig.I-4-2-1) and the Table of microscopic observation(Table II-1-3-1 (1) & (2)) about mineralization.

MJCC-1

<Geology and alteration>

The core is composed of cataclasites(accompanied with Los Cerros Floridas-W fault) and Ad.2 in descending order.

Silicificated andesite and andesitic tuff(cataclasites) are markedly fractuated and distributed at a depth of 1.7m to 116m. Aphylic andesites(Ad.2) is distributed from 116m to the bottom of the hole(221.7m).

The fracture zones are observed at 116m and 165m underground.

Microscopic observation:

Hornblende porphyrite at a depth of 28.1m shows holocrystalline to porphyritic texture. It is rich in phenocrysts of plagioclase, hornblende and

Table II -1-3-1(1) Results of Microscopical Observation

ROCK SAMPLE				Phenocryst				Grandmass				Texture	Alt. Mineral							Description
No.	Drilling site	Depth(m)	Rock name	Pl	Hb	Op	Qz	Pl	Hb	Op	G		Qz	Pl	Se	Ch	Ep	Sh	Ca	
1	MJCC- 1	28.10	Hb Porphyrite	◎/	◎/					△		Holocry.- porphy.			△	△	△	△	△	with Apatite
2	MJCC- 2	58.20	Sp-Cc-Qz Vein					○				Pilotaxitic								Brecciate Andesite
3	MJCC- 3	88.00	Sp Ore					○				Intersertal			△					Hm-rich Andesite
4	MJCC- 4	186.40	Brecciate Andesite	◎/		△Mt		△/		◎Mt		Amyg-Hyalopilitic			△	△				amygdal cavity bearing
5	MJCC- 5	64.70	Banded Sp Ore			○Sp										△				
6	MJCC- 6	120.70	Mt bearing Hb-Andesite	○/	△/	○Mt	△	◎/	△			Holocry.- porphy.			△	△		·		Qz-Ch vein
7	MJCC- 7	138.70	Cp-Py-Sp-Mt Ore	○				○/				Intersertal	○					△		Brecciate Andesite
8	MJCC- 8	186.50	Mt Andesite	◎/	○/	△Mt		○/		◎Mt		Intersertal	◎		△	○				
9	MJCC-10	37.70	Sp-Mtt Ore			○Sp				△Hm		Colloform	△			○				
10	〃	69.00	Mt-Hm-Cp-Py Ore							△Mt		Pilo-Inter.								Brecciate Andesite
11	MJCC-14	90.05	Sp Ore	◎						△Hm		Inter- Hyalo.								Silic.aphyric Ad.
12	MJCC-15	145.00	Silicified Hb Andesite	○/	○/	△Mt				△Mt			◎		○	○	△	·	△	
13	MJCC-19	53.85	Sp-Mtt Ore	○						△Mt		Intersertal								
14	MJCC-21	137.10	Py-Cv-Qz-Ch Vein	○				○		△Mt		Inter- Amyg.								Intermediate Ad.
15	〃	268.60	Cp-Py Ore(Mt,Hm)					○Mt		○			○			○				
16	MJCC-24	94.80	Py-Cp-Cv-Cc-Sp Ore					○Sp					○			△				
17	〃	280.10	Hb Andesite	◎/	○/					○		Holocry.- porphy.				◎	·	△	△	Qz.Ca Vein
18	〃	280.10	Mt bearing Andesite	○/		·		○								◎				Qz.Ca Vein
19	MJCC-25	35.40	Mt Andesite	△				○		△Sp										
20	〃	211.50	Sp-Mt-Py-Qz assemblage	○/				○/		○Mt		Intersertal	△		△	△				Brecciate Andesite
21	MJCC-26	155.50	Cp-Py, Sp Veinlet	△				◎		○Mt			△			·				Mt-rich Andesite
22	MJCC-27	121.70	Sp-Mt-Ge-Qz-Ch Ore	△			△			○Mtt					△	△				Brecciate Andesite
23	〃	234.60	Cp-Py Vein in Sp-Mt Ore					△				Intersertal								
24	MJCC-28	117.40	Mt Andesite	△/				△/		◎Mt		Intersertal								Amygdal cavity bearing
25	MJCC-29	37.75	Sp-Gt-To-Qz in Andesite	△				△		○Mt		Intersertal								
26	〃	54.30	Py vein in Sp-Ore	○				○				Holocry.- porphy.								Sp rich Andesite
27	〃	113.00	Cp-Cv-Py Vein	△				△												Silic.Sp-rich Andesite
28	〃	151.00	Cp-Py,Sp vein in Mt Andesite	○				○		○Mt		Intersertal	△			△				Cp-Py,Sp vein
29	MJCC-30	84.00	Sp-Mtt Ore					○Sp		○Mt			○						△	Qz, Ca vein
30	〃	94.60	Sp-Qz Ore in Mtt Andesite	○				○		△Py		Intersertal								Mtt-rich Andesite
31	〃	226.30	Py-Cp-Mt in Mt Andesite					◎		○Mt		Intersertal				△		·		Amygdal cavity bearing
32	MJCC-35	132.20	Sp-Mt-Py-Qz Ore in Andesite	○				◎		○Mt		Intersertal								
33	MJCC-40	6.20	Meta-Andesite	○				○		○Mt		Intersertal		○Ab		◎				
34	MJCC-41	245.50	Mt Andesite with Py-Cp	○				○				Intersertal		○Ab		○				
35	MJCC-42	74.40	Andesitic Tuff	○				○			△	Pyroclastic			·	◎				
36	MJCC-43	47.55	Hm-Mt Ore in Brecciate Ad.	△				◎		○Mt,Hm		Intersertal								
37	〃	52.00	Meta Andesite with Mt ball	○				◎			△					○		·		mudball abundant
38	MJCC-44	164.40	Py-Mt-Hm Vein in Meta Andesite	○		△Mt		△		△Mt,Hm			○							silicified
39	MJCC-45	10.30	Hm-Qz Ore in Mt Andesite	○				◎		◎Mt										
40	〃	25.90	Sp Ore in Meta Andesite	○				◎				Intersertal					△			
41	MJCC-47	32.70	Brecciate Meta Andesite					○				Intersertal				○				
42	〃	122.80	Brecciate Meta Andesite	○		△Mt		○		△Mt										
43	MJCC-53	156.00	Meta Andesite	◎				◎		△Mt		Amyg. - Inter.			△	○				

Total 43 Sample

[Abandance]
◎:abandant
○:common
△:minor
・:rare

[Alteration]
/:partlly altered
*:completely altered

[Mineral names]
Ab:Albite
At:Atacamite
Ca:Calcite
Cc:Chalcosite
Ch:Chlorite
Cp:Chalcopyrite
Cv:Covellite
Ep:Epidote
G :Glass
Hb:Holnblend
Hm:Hematite
Mt:Magnetite
Mtt:Martite
Ms:Muscovite
Op:Opaqe minerals
Pl:Plagioclase
Py:Pyrite
Qz:Quartz
Se:Sericite
Sh:Sphene
Sp:Specularite
To:Tourmaline

[Other]
B :Brecciate
Ad:Andesite

Table II-1-3-1(2) Results of Microscopical Observation

ROCK SAMPLE				ORE MINERAL										GANGUE						DESCRIPTION	
No.	Drilling site	Depth(m)	Rock name	Cp	Py	Cc	Cv	At	Sp	Mt	Mtt	Gt	Hm	Qz	Ca	Ch	Se	Ac	To		
1	MJCC- 1	91.55	Cp-Py-Mt Ore	◎	◎		·			△			△	○	△	△				Mt→Hm	Brecciate Andesite
2	〃	196.80	Sp-Cc-Qz Vein	○	·					△			△	○	○	△			△	Mt→Hm	Brecciate Andesite
3	MJCC- 2	58.20	Sp-Cc-Qz Vein						△	△			△	○	◎	△			·	Mt→Hm	Brecciate Andesite
4	MJCC- 3	88.00	Sp Ore						○	·	·		○	◎		·		△		Mt→Mtt	
5	MJCC- 4	2.60	Sp Ore						◎	△	△		△	△		△				Mt→Mtt	Brecciate Andesite
6	MJCC- 5	64.70	Banded Sp Ore					△	○	·	·		○			△				Mt→Mtt	
7	MJCC- 7	20.50	Sp-Martite Ore	·				△	◎		△			△		○	△				
8	〃	60.90	Stratiform Sp Ore						○					◎		○			○		
9	〃	138.70	Cp-Py-Sp-Mt Ore	○	○				○	○			○	○		○				Mt→Hm	Brecciate Andesite
10	MJCC- 8	186.50	Mt Andesite							◎				○		◎	△				
11	MJCC-10	37.70	Sp-Martite Ore	·					○		○			△		○					
12	〃	69.00	Mt-Hm-Cp-Py Ore	△	○					◎			○	◎		△				silicified	Brecciate Andesite
13	MJCC-14	90.05	Sp Ore							◎		△		○		·				silicified	Aphynic Andesite
14	MCCC-19	53.85	Sp-Martite Ore					·	○		△	·		△		○					
15	MJCC-21	137.10	Py-Cv-Qz-Ch Vein	·	○		△						△	○		○					
16	〃	268.60	Cp-Py Ore(Mt,Hm)	◎	◎	·				○			△	○		○					
17	MJCC-24	94.80	Py-Cp-Cv-Cc-Sp Ore	△	○	△	△	·	○					○		△					
18	MJCC-25	35.40	Mt Andesite					○	○					○		△		△			
19	〃	211.50	Sp-Mt-Py-Qz assemblage		△				△	·				○	·	△					Brecciate Andesite
20	MJCC-26	155.50	Cp-Py, Sp Veinlet	○	△				△					△		△					Brecciate Andesite
21	MJCC-27	121.70	Sp-Mt-Gt-Qz-Ch Ore						○	·		○	△	△		△				Mtt bearing, Mt→Hm	
22	〃	234.60	Cp-Py Vein in Sp-Mt Ore	△	△				◎	○				◎							
23	MJCC-28	71.30	Mt Ore					·		◎		△		·		·					
24	〃	117.40	Amygdaloidal-Mt Andesite	△	△				△	△				○		△				Amygdal cavity bearing	
25	MJCC-29	37.75	Sp-Gt-To-Qz in Andesite					△	△			△		◎					·		
26	〃	54.30	Py vein in Sp-Ore		○		△		◎					△		·					
27	〃	113.00	Cp-Cv-Py Vein	△	△		△							·	·					Qz & Calcite network vein	
28	〃	136.10	Cp-Py-Sp Ore	◎	○				○					◎		·	△				
29	〃	151.00	Cp-Py vein in Andesite	○	○				△					○	·	·				Cp-Py, Sp vein	
30	MJCC-30	84.00	Sp-Mtt Ore					·	○		○			○	△						
31	〃	94.60	Sp-Qz-Mtt Ore in Andesite		△		·		○		◎			△						Mtt rich	
32	〃	226.30	Py-Cp-Mt in Andesite	·	△					△				○	△					Amygdal cavity bearing	
33	MJCC-35	132.20	Py-Mt-Sp-Qz Ore in Andesite		○				◎	○				◎				△			
34	MJCC-40	79.20	Py-Hm-Cv-Mt Ore in Tuff		◎		◎			△			◎	△					·		
35	MJCC-41	153.70	Py-Sp-Mt Ore		○				○	△				○							
36	〃	245.50	Mt Andesite with Py-Cp	○	·				·	○			△	△		△				in Sandstone	
37	MJCC-42	43.20	Mt-Sp-Qz Ore in Tuff						○	○	△			○							
38	MJCC-43	47.55	Hm-Mt Ore in Brecciate Andesite							○	△	△	○	△							
39	〃	52.00	Meta Andesite with Mt ball						·	·	○			△						Mt ball abundant	
40	MJCC-44	164.40	Py-Mt-Hm Vein in Meta Andesite	△	○					○			○	△						silicified	
41	〃	25.90	Sp Ore in Meta Andesite						◎					△							
42	MJCC-47	32.70	Brecciate Meta Andesite					△	◎		·										

Total 42 Samples

[abundance]
◎:abundant
○:common
△:minor
・:rare

[Mineral Name]

Ac:Actinolite	Ch:Chlorite	Hm:Hematite	Qz:Quartz
At:Atacamite	Cp:Chalcopyrite	Mt:Magnetite	Se:Sericite
Ca:Calcite	Cv:Covellite	Mtt:Martite	Sp:specularite
Cc:Chalcosite	Gt:Geothite	Py:Pyrite	To:tourmarine

opaque mineral. The matrix is filled by sericite, chlorite and calcite.
<Mineralization>
Microscopic observation:
Reticulated to fine veins of chalcopyrite are observed in brecciated andesite at a depth of 196.8m. Magnetite is hematized. Fine veins of quartz and calcite are observed as gangue minerals.
Copper mineralization:
Malachite filling up cracks at a depth of 80m to 100m is observed, also observed are pyrite and chalcopyrite filling up cracks and pores, respectively.
Sulfide mineralization zones are at depths of 84m ～98m and 171m～198m.
Iron mineralization:
Although magnetite and hematite are observed filling up the matrix of andesite, iron mineralization is generally weak.

MJCC-2
<Geology and alteration>
The core is composed of Ad.4(an andesite lava 4th unit).
Brecciated andeste is observed at a depth of 3.2m ～152m. Chloritizated andesite lava and marked iron disseminated andesitic breccia("hydrothermal breccia") are observed between 111m and 131m deep. Brecciated andesite and tuff (Ad.4) are observed from 152m to the bottom of the hole(162m in depth).
<Mineralization>
Microscopic observstion:
Brecciated andsite at a depth of 58.2m is rich in specularite and magnetite. Calcite and quartz are commonly seen as gangue minerals.
Copper mineralization:
Malachite is scattered and fills up cracks from the surface to the bottom of hole.
Iron mineralization:
Iron mineralization is generally weak. Magnetite, hematite and specularite with pyrite and quartz are observed at a depth of 130m.

MJCC-3
<Geology and alteration>
The core is composed of "hydrothermal breccia" and Ad.3 in descending order.
Markedly iron mineralized andesitic breccia("hydrothermal breccia") which inserts andesitic tuff breccias from 3m to 116m underground, and plagioclase porphyritic andesite lava(Ad.3) from 116m to the bottom of the hole(165m) is distributed, respectively.

<Mineralization>

Microscopic observation:

Aphylic andesite at a depth of 88.0m shows a pilotaxitic structure. This matrix is filled with plagioclase. Specularite and marmatited magnetite are dominant in ore minerals, and quartz is rich as gangue mineral.

Copper mineralization:

Malachite is successively distributed and fills up cracks and matrix from the surface to 115m in depth.

Oxide mineralization zone at a depth of 55m to 95m
Mixed mineralization zone at a depth of 15m to 28m
Sulfide mineralization zone at a depth of 116m to 125m

Iron mineralization:

Dissemination ~network of magnetite or specularite develop from the surface to 115m underground.

MJCC-4

<Geology and alteration>

The core is composed of "hydrothermal breccia", Ad.4 and Ad.3 in descending order.

Markedly iron disseminated andesitic breccia("hydrothermal breccia") is distributed from the surface to a depth of 50m. The alternation(Ad.3) of plagioclase porphyritic andesite, aphyric andesite and aphyric porphyritic tuff breccia with tuff layers are distributed at a depth of 50m~160m. Basaltic andesite to plagioclase porphyritic andesite(Ad.3) with amygdaloidal structure occurs from a depth of 16m to the bottom of the hole.

Fracture zone at a depth of 39m and at a depth of 162m~167m occurs. In addition, altered andesite which was chloritized at a depth of 130m ~140m is observed.

Microscopic observation:

Brecciated andesite which contacts iron ore mineral at a depth of 186.4m shows an amygdaloidal ~glassy flow texture with phenocrysts of plagioclase and opaque minerals. This is observed with the alteration minerals such as chlorite and sericite.

<Mineralization>

Microscopic observation:

Brecciated andesite at a depth of 2.6m includes iron minerals which are mainly specularite with very small magnetite and hematite. Quartz and chlorite are observed as gangue minerals.

Copper mineralization:

Malachite is scattered as dissemination or filled cracks from the surface to a depth of 100m. Pyrite and chalcopyrite are successively distributed and fill up cracks and matrix from a depth of 130m to the bottom of hole.

Oxide mineralization zone at a depth of 1m～10m

Mixed mineralization zone at a depth of 50m ～59m

Iron mineralization:

Specularite and hematite fill up matrix or pores from the surface to 40m underground, and dissemination of hematite, specularite and magnetite are observed, respectively.

MJCC-5

<Geology and alteration>

Th core is composed of "hydrothermal breccia," Ad.4 and Ad.3 in descending order.

Markedly iron disseminated andesitic breccia("hydrothermal breccia") occurs from the surface to a depth of 136m. Aphylic andesite(Ad.4) with thin layers of breccia, which is iron disseminated, occurs at a depth of 136m ～185m. Aphylic andesite(Ad.3) which partly shows an amygdaloidal structure is distributed from a depth of 185m to the bottom of hole(at a depth of 191.15m).

<mineralization>

Microscopic observation:

Many specularite, hematite and marmatized magnetite are observed as ore minerals in the rock. This occurs at a depth of 64.7m.

Copper mineralization:

Malachite fills up cracks from the surface to a depth of 70m. Chalcopyrite and pyrite are in the matrix from a depth of 155m to the bottom of hole. These are successively distributed, respectively.

Oxide mineralization zone at depths of 27m～36m, 42m～52m 63m ～72m

Sulfide mineralization zone at a depth of 159m～168m

Iron mineralization:

Dissemination of specularite and magnetite is mostly successive from the surface to a depth of 136m. Specularite or magnetite fill up the matrix and are distributed from a depth of 155m to the bottom of the hole.

MJCC-9

<Geology and alteration>

The core is composed of "hydrothermal breccia, Ad.4 and Ad.3 in descending order.

The core from a depth of 6m to 30m is composed of partly argillizated andesite(Ad.4). Andesitic breccia("hydrothermal breccia") which is markedly affected by iron disseminated and by partly chloritization occurs from a depth of 30m～170m. Aphylic andesite(Ad.3) with thin layers of tuff breccia or cataclasite occurs from a depth of 170m to the bottom of the hole(215.1m). Fracture zones are observed at a depth of 170m and 211m.

<Mineralization>

Copper mineralization:

Malachite fills the matrix and cracks from a depth of 70m ～120m. Pyrite and chalcopyrite occur as dissemination within the veins of specularite or fill up the matrix from a depth of 90m to the bottom of the hole.

Iron mineralization:

Specularite dissemination ore almost successively develops from a depth of 16m to the bottom of the hole.

MJCC-15

<Geology and alteration>

All the cores are cataclasite and are associated with the fracture zone of Los Cerros Floridas-W fault.

The cataclasite, which markedly affected shear failure and silicification, is originated from tuff, dacite and andesite from surface to the bottom(200.35m).

Microscopic observation:

Hornblende andesite which occurs at a depth of 145.0m depth is rich in plagioclase phenocryst, hornblende and opaque minarals. In addition fine quartz veins develop. Chlorite, sericite and epidote are observed as altered minerals.

<Mineralization>

Copper mineralization:

Malachite fills cracks from a depth of 70m～110m. Quartz veins and pyrite fill cracks and the matrix from a depth of 130m to the bottom. These are all observed.

Iron mineralization:

Iron mineralization is generally weak. Obvious veins or dissemination, except magnetite filling up pores and matrix, are not observed.

MJCC-19

<Geology and alteration>

The core is composed of Ad.4.

The core from the surface to the bottom(165.1m) is composed of alternation of tuff, tuffaceous breccia, and plagioclase porphyritic andesite. Iron disseminated andesitic breccia("hydrothermal brecia") is caught at a depth of about 88m.

<Mineralization>

Microscopic observation:

Plagioclase porphyritic andesite has phenocryst of plagioclase. In addition, specularite, marmatite, and fine veins of quartz develop. Chlorite is observed as an altered mineral.

Copper mineralization:

Malachite is observed filling up cracks at depths of 13m ~50m and 135m~160m.

Mixed mineralization zone at depths of 12m~22m, 27m~38m, 54m~70m

Iron mineralization zone:

Dissemination of hematite and magnetite is observed at a depth of about 87m.

MJCC-21

<Geology and alteration>

The core is composed of Ad.4 and Ad.3 in descending order.

The core from the surface to a depth of 135m consists of alternation (Ad.4) of basaltic andesite, aphylic andesite and plagioclase porphyritic andesite. At a depth of 135m to the bottom, the core mainly consists of plagioclase porphyritic andesite(Ad.3) with amygdaloidal structure which catches basaltic andesite and tuff.

Microscopic observation:

Plagioclase porphyritic andesite at a depth of 137.1m shows amygdaloidal~intersertal structure. Also, fine veins of quartz and chlorite develop.

<mineralization>

Microscopic observation:

Ore minerals at a depth of 268.6m are mainly composed of chalcopyrite and pyrite with small quantities of chalcosite. Quartz and clorite are observed as gangue minerals.

Copper mineralization:

Malachite occurs filling cracks at a depth of 16m ~200m, and chalcopyrite and pyrite almost successively occur filling cracks and matrix from 130m down to the bottom.

Iron mineralization:

Dissemination of specularite, hematite and magnetite including quartz is observed from the surface to a depth of 16m.

MJCC-22

<Geology and alteration>

The core consists of Ad.4 and Ad.3 in descending order.

Aphyric andesite includes tuff and brecciated andesite(Ad.4) and is distributed from the surface to a depth of 65m. Massive hornblende andesite (Ad. 3) is distributed from a depth of 65m to the bottom(165m).

<Mineralization>

Both copper and iron mineralization are generally not observed.

MJCC-23

<Geology and alteration>

The whole core consists of Ad. 4.

Aphyric andesite～plagioclase porphyritic andesite and alternation(Ad. 4) of brecciated andesite and tuff consist of surface to bottom(165m). Andesite, which inserted by brecciated andesite, consists of the core at a depth of 35m ～ 73m and a depth of 132m to the bottom(165m). A depth of 35m ～73m and a depth of 111m ～132m mainly consist of chloritized tuff. It catches brecciated tuff.

<Mineralization>

Copper mineralization:

Malachite is observed filling up cracks and pores.

Iron mineralization:

Generally weak, dissemination of magnetite is only observed at a depth of 55m.

MJCC-24

<Geology and alteration>

The core is composed of "hydrothermal breccia", Ad. 4, Ad. 3 and Ad. 2 in descending order. Marked iron desseminated andesitic breccia("hydrothermal breccia") occurs from the surface to a depth of 92m. Alternation(Ad. 4) of magnetite desseminated plagioclase andesite and aphyric andesite is composed of a depth of 92m to 131m. Alternation(Ad. 3) of plagioclase andesite and aphyric andesite occurs at a depth of 131m to 271m. Alternation(Ad. 2) of basaltic andesite, aphyric andesite and plagioclase andesite occurs at a depth of 271m to the bottom of the hole(388m).

Microscopic observation:

Hornblende andesite which occurs at a depth of 94.8m shows holocrystalline ～porphyritic texture, and is rich in phenocrysts of plagioclase and hornblende. Chlorite is representative in altered minerals. Some sphane and calcite are also observed.

<Mineralization>

Microscopic observation:

The ore, which was sampled at a depth of 94.8m, is rich in pyrite. It includes chalcopyrite, chalcocite, covelline and specularite. Fine veins of quartz and chlorite are observed as gangue minerals.

Copper mineralization:

Malachite filling up cracks and matrix is observed from the surface to a depth of 50m. Pyrite and chalcopyrite is scattered and fill cracks and the matrix from a depth of 70m to the bottom.

Iron mineralization:

Hematite and specularite dissemination is observed in deeper place than 80m underground.

MJCC-25

<Geology and alteration>

The core is composed of "hydrothermal breccia", Ad.4 and Ad.3.

Marked disseminated andesitic breccia("hydrothermal breccia") occurs from the surface to a depth of 45m. Aphyric andesite, which catches plagioclase porphyritic andesite, occurs(Ad.4). Amygdaloidal structure is observed in plagioclase porphyritic andesite. Mainly plagioclase porphyritic andesite(Ad.3), which is partly changed to iron ore, occurs with basaltic andesite and tuff breccia.

Microscopic observation:

Brecciated andesite occurs at a depth of 211.5m. It shows intersertal texture and is rich in plagioclase phenocryst. Quartz, chlorite and sericite are observed as altered minerals.

<Mineralization>

Microscopic observation:

The ore, which was sampled at a depth of 35.4m, is rich in pyrite and includes chalcopyrite, chalcocite, covelline and specularite. Fine veins of quartz and chlorite are observed as gangue minerals.

Copper mineralization:

Malachite and chrysocolla from the surface to a depth of 55m. Pyrite and chalcopyrite fill up cracks and the matrix are distributed, respectively.

Mixed mineralization zone at a depth of 3m～21m

Iron mineralization:

Dissemination or fine veins of hemetite and specularite is observed from the surface to a depth of 45m.

MJCC-26

<Geology and alteration>

This hole is composed of "hydrothermal breccia" and Ad.3 in descending order.

Marked iron disseminated andesitic breccia("hydrothermal breccia") from the surface to a depth of 168m, andesite lava(Ad.3) from a depth of 168m to the bottom(184.2m) occurs, respectively.

Microscopic observation:

Andesite, which was sampled in a depth of 155.5m, shows intersertal texture. It is rich in plagioclase and magnetite. Fine veins of chalcopyrite, pyrite and specularite are observed.

<Mineralization>

Copper mineralization:

Malachite fills up cracks. Chalcopyrite and pyrite fill up cracks and the matrix. These sulfide minerals are observed within small veins of specularite and magnetite.

Iron mineralization:

Hematite, specularite and magnetite are observed all through the surface to the bottom.

MJCC-27

<Geology and altration>

The core is composed of "hydrothermal breccia", Ad.4, Ad.3, Ad.2 and Ad.1.

Mainly tuff(Ad.4) occurs from the surface to a depth of 15m. Marked iron disseminated andesitic tuff("hydrothermal breccia") occurs at a depth of 15m to 255m. At a depth of 255m to 281m markedly fractuated andesite and basaltic andesite(Ad.3), at a depth of 281m to 380m partly silicified basaltic andesite, aphyric andesite and plagioclase porphyritic andesite(Ad.2), occur, respectively. Basaltic andesite and plagioclase porphyritic andesite occur from a depth of 380m to the bottom(500m).

Chloritizated andesite at a depth of 245m and a depth of 340m to 350m, and siliceous rocks from a depth of 350m to 390m are observed, respectively.

Microscopic observation:

Brecciated andesite, which was sampled at a depth of 121.7m, is rich in plagioclase phenocryst. The matrix is filled up by magnetite, sericite, chlorite and quartz.

<Mineralization>

Microscopic observation:

The ore, which was sampled at a depth of 234.6m, is rich in specularite, chalcopyrite and pyrite. They are distributed forming spots and fine veins.

Copper mineralization:

Malachite and chrysocolla occur filling up cracks from the surface to a depth of 120m. Chalcopyrite and pyrite fill the matrix, pores and cracks from a depth of 170m to the bottom. Dissemination is particularly marked at a depth of 235m.

Oxide mineralization zone　　　at a depth of 32m to 45m

Mixed mineralization zone   at depths of 11m to 22m and 51m to 72m
Sulfide mineralization zone   at depths of 195m to 210m and 231m to 242m
Iron mineralization:

Dissemination of hemetite, specularite and magnetite develops at a depth of 15m to 255m.

MJCC-28

<Geology and alteration>

Only "hydrothermal breccia" occurs in this hole.

Markedly disseminated andesitic breccia("hydrothermal breccia") is almost successively distributed from surface to bottom(198.9m).

Microscopic observation:

Aphyric andesite, which was sampled at a depth of 117.4m, shows amygdaloidal structure. Chalcopyrite, pyrite, specularite and magnetite are observed filling up pores. Fine veins of quartz and chlorite develop as gangue mineral.

Copper mineralization:

Malachite occurs between a depth of 40m and 100m. Mainly pyrite fills up pores and cracks with small quantities of sulfide minerals including chalcopyrite.

Oxide mineralization zone   at a depth of 69m to 78m
Mixed mineralization zone   at a depth of 44m to 53m
Iron mineralization:

Dissemination to network of hematite, specularite and magnetite develops filling among breccias from surface to bottom.

MJCC-29

<Geology and altratio>

The core is composed of "hydrothermal breccia", Ad.4 and Ad.3 in descending order.

Alternation(Ad.4) of aphyric andesite, tuff breccia and tuff mainly occurs from the surface to a depth of 158m. Andesitic breccia("hydrothermal breccia") is intruded the above alternation which is markedly iron disseminated. Aphyric andesite(Ad.3) occurs from a depth of 158m to the bottom (230m).

The rocks are affected by chloritization from a depth of 120m to 130m. Argillization is partly observed.

Microscopic observation:

Aphyric andesite, which was sampled in the depth of 37.75m, shows intersertal texture. The matrix is filled by plagioclse, specularite and

magnetite.
<Mineralization>

Microscopic observation:

The ore which, was sampled at a depth of 136.1m, is rich in chalcopyrite. It includes specularite and pyrite. Quartz is commonly observed as gangue mineral.

Copper mineralization:

Malachite fills up cracks from the surface to a depth of 60m. Chalcopyrite commonly fills the matrix and cracks .

Oxide mineralization zone	at a depth of 3m to 12m
Mixed mineralization zone	at a depth of 38m to 64m
Sulfide mineralization zone	at depths of 84m to 101m, 110m to 119m, 133m to 156m

Iron mineralization:

Dissemination or network of specularite and magnetite develops at depths of 6m to 20m, 60m to 90m and 130m to 160m.

MJCC-30

<Geology and alteration>

The core is composed of "hydrothermal breccia", Ad.4, Ad.3, Ad.2 and Ad.1 in descending order.

Andesitic breccia, which is markedly affected by iron dissemination, is distributed from the surface to a depth of 103m. Aphyric andesite(Ad.4) is distributed at a depth of 103m to 125m. Alternation(Ad.3) of basaltic andesite, aphyric andesite, brecciated andesite and tuff breccia occurs at a depth of 125m to 280m. Alternation(Ad.2) of plagioclase porphyritic andesite and aphyric andesite with amygdaloidal structure occurs at a depth of 207m to 280m, alternation(Ad.1) of plagioclase porphyritic andesite and aphyric andesite occurs from a depth of 280m to the bottom(300m), respectively.

Microscopic observation:

Aphyric andesite, which was sampled in the depth of 226.3m, shows intersertal texture. Plagioclase and magnetite fill among plagioclase phenocrysts. Chlorite and sphane are observed as altered minerals.

<Mineralization>

Microscopic observation:

The ore, which was sampleed at a depth of 94.6m, is rich in specularite. It includes small quantities of pyrite and covelline. Quartz is observed as gangue mineral.

Copper mineralization:

Malachite fills up cracks from the surface to a depth of 95m. Pyrite and chalcopyrite almost successively occur filling cracks and the matrix from a depth of 105m to 240m.

Mixed mineraization zone at depths of 32m to 42m, 70m to 96m
Sulfide mineralized zone at a depth of 56m to 66m

Iron mineralization:

Disseminasion to network of hematite, specularite and megnetite develop filling among breccias from the surface to a depth of 120m.

MJCC-31

<Geology and alteration>

The core is composed of Ad. 4 and Ad. 3 in descending order.

Brecciated andesite(Ad. 4) occurs from the surface to a depth of 80m. Aphyric andesite ~plagioclase porphyritic andsite(Ad. 3) occurs from a depth of 80m to the bottom(160m). Reticulated vein of quartz develops in Ad. 3. Andesite, which occurs in a depth of 50m to 60m, is strongly affected by hydrothermal alteration, and whitish colored argillitated zone(probably kaolinite) is formed.

Reticulated quartz vein and small fractures develop in plagioclase porphyritic andesite. The rock is also affected by chloritization.

<Mineralization>

Copper mineralization:

Malachite and chalcocite are scattered from the surface to a depth of 100m. These copper oxide minerals fill up cracks and among breccias. Quartz veins are scarcely observed within breccias. Dissemination of iron or copper minerals is not observed. Coexisting iron ore minerals are hematite, specularite and magnetite. Scarce chalcopyrite fills pores and the matrix occurs from a depth of 110m to the bottom.

Iron mineralization:

Mineralization of iron is generally weak and obvious dissemination is not observed.

MJCC-32

<Geology and alteration>

This core is composed of Ad. 4 and Ad. 3 in descending order. The rocks are generally affected hydrothermal alteration.

Lapilli ~coarse-grained tuff mainly occurs from the surface to a depth of 30m. Massive aphyric andesite lava at a depth of 30m to 150m, and brecciated andsite at a depth of 110m to 150m is distributed, respectively(Ad. 4 above three rock facies). Massive aphyric andesite(Ad. 3) occurs from a depth of 150m to the bottom.

<Mineralization>

Copper mineralization:

Copper mineralization is generally weak. Distinct copper mineralization is not observed.

Iron mineralization:

Fine veins～reticulated dissemination of hematite and magnetite are observed at depths of 30m, 50m and 100m to 150m.

MJCC-33

<Geology and alteration>

The core is composed of Ad.4 and Ad.3 in descending order.

Brecciated andesite(Ad.4) occurs from the surface to a depth of 75m. Plagioclase porphyritic andsite lava(Ad.3) occurs from a depth of 75m to the bottom(130m). The geology is affected markedly hydrothermal alteration. Argillitated zone(kaolinite) is partly formed. Cracks markedly develop from the surface to a depth of 57m. The cracks are filled by calcite.

<Mineralization>

Copper mineralization:

Copper mineralization is successively observed from a depth of 50m to the bottom. Atacamite, malachite and chalcopyrite which forms fine vein or filling up pores are scattered at a depth of 100m to the bottom.

Iron mineralization:

Iron mineralization is generally weak, however, dissemination of hemetite, specularite and magnetite is observed from a depth of 113m to 127m.

MJCC-34

<Geology and alteration>

The core is composed of Ad.4 and Ad.3 in descending order.

Alternation(Ad.4) of plagioclase porphyritic andesite and aphyric andesite occurs from a depth of 52m to 100m. Plagioclase porphyritic andsite(Ad.3) with developed fine veins of calcite and gypsum occurs from a depth of 120m to 140m. Markedly disseminated andesitic breccia("hydrothermal breccia") with quartz veins intrudes the above rocks from the surface to depths of 50m, 100m to 120m and 140m to the bottom.

<Mineralization>

Copper mineralization:

Atacamite which is filling up cracks is widely distributed from the surface to a depth of 34m.

Oxide mineralization zone　　at a depth of 7m～34m

Iron mineralization:

Magnetite and hematite remarkably develop at depths of 17m to 52m, 100m to

120m and 140m to 160m.

MJCC-35

<Geology and alteration>

The core is only composed of "hydrothermal breccia".

Remarkably disseminated andesitic breccia("hydrothermal breccia") occurs from surface to bottom(141.95m). The rock at a depth of 125m to 140m is rich in andesitic breccia with amygdaloidal structure.

The geology is generally affected by hydrothermal alteration. Fine veins of calcite and chlorite develop. Argillizated zones(possibly chlorite and observed sericite) are observed at depths of 100m, 110m and 140m.

Microscopic observation:

Brecciated andesite, which was sampled at a depth of 132.2m, shows intersertal texture. Plagioclase and magnetite fill among plagioclase phenocrysts. Chlorite and sphane are observed as altered minerals.

<Mineralization>

Copper mineralization:

Atacamite and chrysocolla almost successively occur from the surface to a depth of 120m. Chalcopyrite successively fills in the matrix and pores from a depth of 120m to the bottom.

Oxide mineralization zone	from the surface to a depth of 10m
	at depths of 66m to 80m, 107m to 122m

Iron mineralization:

Reticulated veins of magnetite, hematite and specularite develop filling among breccias.

MJCC-36

<Geology and alteration>

The core is composed of "hydrothermal breccia" and Ad.2.

Markedly disseminated and hydrothermal alterated andesitic breccia ("hydrothermal breccia) occurs from the surface to a depth of 120m. Massive plagioclase porphyritic andesite occurs from a depth of 120m to the bottom of the hole(145m). The upper part of this andesite shows amygdaloidal structure.

<Mineralization>

Copper mineralization:

Disseminated chrysocolla and malachite is scattered.

Mixed mineralization zone	at depths of 31m～44m and 118m～127m.

Iron mineralization:

Reticulated fine veins of hematite wholly occurs. Dissemination ～fine veins of magnetite occurs from a depth of 120m to the bottom of the hole.

MJCC-37

<Geology and alteration>

The core is composed of "hydrothermal breccia", Ad.3 and Ad.2. Partly iron disseminated andesitic breccia("hydrothermal breccia") occurs from the surface to a depth of 60m. Alteration(Ad.3) of plagioclase porphyritic andesite with amygdaloidal structure and developed quartz veins and aphyric andesite occurs at a depth of 60m to 92m. Plagioclase andesite and brecciated andesite(Ad.2) occur at a depth of 92m to the bottom of the hole.

<Mineralization>

Copper mineralization:

Atacamite and malachite fill up cracks and pores from surface to bottom. Pyrite and chalcopyrite fill in cracks from a depth of 130m to the bottom.

Oxide mineralization zone at a depth of 19m ～38m

Mixed mineralization zone at depths of 1m ～10m and 61m ～70m

Iron mineralization:

Reticulated fine veins of magnetite and hematite develop at a depth of 6m to 46m.

MJCC-38

<Geology and alteration>

The core is composed of "hydrothermal breccia", Ad.3 and Ad.2.

Marked iron disseminated andesitic breccia("hydrothermal breccia") occurs from the surface to a depth of 85m. Aphyric andesite(Ad.3) mainly occurs at a depth of 85m to 125m, Plagioclase porphyritic andesite is caught in the upper part of the aphyric andesite. Massive aphyric andesite(Ad.2) occurs from a depth of 125m to the bottom(130m).

Breccia is wholly affected by hydrothermal alteration. And fine veins ～ reticulated veins of quartz develop. Tuff and andesitic breccia with amygdaloidal structure are mixed in the upper 30m of the breccia.

<Mineralization>

Copper mineralization:

Dissemination of malachite and atacamite is scattered at a depth of 15m ～80m.

Oxide mineralization zone at depths of 25m～34m and 41～52m

Iron mineralization:

Reticulated veins veins of hemetite and magnetite develop from the surface to a depth of 85m. Magnetite reticulated fine veins develop from a depth of 125m to the bottom.

MJCC-39

<Geology and alteration>

The core is composed of "hydrothermal breccia", Ad.4, Ad.3 and Ad.2. in descending order.

Pelitic rock and breccia mainly occur with tuff breccia(Ad.4) from the sur face at a depth of 55m. Iron disseminated andesitic breccia("hydrothermal brecci a) occurs at a depth of 50m to117m. Aphyric andesite and brecciated andesite(Ad. 3) occur at a depth of 117m to 149m. Plagioclase porphyritic andesite and the same andesitic tuff breccia with developed quartz reticulated fine veins occur at a depth of 149m to the bottom of the hole.

<Mineralization>

Copper mineralization:

Chrysocolla and malachite fill up cracks at depths of 15m to 35m and 90m to 125m. Chalcopyrite fills up cracks and pores, and partly fills the matrix at a depths of around 80m and 130m to the bottom.

Iron mineralization:

Reticulated fine veins of hematite, specularite and magnetite develop at depths of 35m to 117m and 150m.

MJCC-40

<Geology and altration>

The core is composed of "hydrothermal breccia", Ad.3 and Ad.2.

Partly hydrothermal alterated and marked iron disseminated andesitic breccia("hydrothermal breccia) occurs from the surface to a depth of 110m. Altrernation(Ad.3) of massive aphyric andesite lava and plagioclase porphyritic andesite with developed amygdaloidal structure occurs at a depth of 110m to 170m. Plagioclase porphyritic andesite with amygdaloidal structure and much magnetite is distributed at a depth of 170m to the bottom(190m).

Microscopic observation:

Andesite which was sampled at a depth of 6.2m shows intersertal texture. Plagioclase, hematite and magnetite fill among plagioclase phenocrysts. Albite, hematite, chlorite, atacamite and quartz fill cracks.

<Mineralization>

Microscopic observation:

The ore which was sampled at a depth of 79.2m is rich in pyrite, covelline and hematite. Quartz is observed as gangue mineral.

Copper mineralization:

Atacamite, malachite, pyrite and chalcopyrite fill up cracks and pores at depths of 110m and 110m to the bottom.

Mixed mineralization zone   at depths of 1m to 10m and 74m to 84m

Sulfide mineralization zone at depths of 33m to 42m and 120m to 129m

Iron mineralization:

Reticulated D ~fine veins of magnetite and hematite develop from the surface to a depth of 110m.

MJCC-41

<Geology and alteration>

The core is composed of "hydrothermal breccia", Ad.3 and Ad.2. in descending order.

Alteration of brecciated andesite, plagioclase porphyritic andesite and aphyric andesite occurs from the surface to a depth of 170m. Particularly, remarkably iron disseminated andesitic breccia("hydrothermal breccia) is caught by the alternation in the shallower part of a depth of 30m and at a depth of 150m and 170m. Alternation(Ad.3) of plagioclase porphyritic andesite with amygdaloidal structure, aphyric andesite and brecciated andesite occur at a depth of 170m to 227m. Plagioclase porphyritic andesite(Ad.2) with developed amygdaloidal structure occurs at a depth of 227m to the bottom(259m).

Hydrothermal altered andesite occurs at a depth of 30m to 50m. Quartz reticulated fine veins develop at depths of 90m to 150m and 185m to the bottom. the rock is affected chloritization at a depth of 170m to 227m.

Microscopic observation:

Aphyric andesite which was sampled at a depth of 245.5m shows intersertal texture. Plagioclase, magnetite and chlorite fill among albitized plagioclase phenocrysts.

<Mineralization>

Microscopic observation:

The ore which was sampled at a depth of 153.7m is rich in specularite, pyrite, and includes magnetite. Quartz is observed as gangue mineral.

Copper mineralization:

Chalcopyrite continuously occurs at a depth of 153m to the bottom. Chalcopyrite fills up cracks and pores. It also occurs along quartz veins and magnetite veins.

Mixed mineralization zone at a depth of 13m to 26m

Sulfide mineralization zone at depths of 151m to 160m, 172m to 190m, 220m to 229m and 239m to 250m

Iron mineralization:

Disseminated specularite and magnetite occur from the surface to a depth of 25m and at a depth of 150m to 170m.

MJCC-42

<Geology and altratio>

The core is only composed of "hydrothermal breccia". The rock is wholly affected hydrothermal alteration.

Remarkably iron disseminated andesitic breccia("hydrothermal breccia") occurs from the surface to a depth of 70m. Partly iron disseminated brecciated andesite and plagioclase porphyritic andesite(possibly Ad.3) occur at adepth of 70m to the bottom(150m).

Fracture zones are observed at depths of 75m to 90m and 135m to the bottom.

Microscopic observation:

Andesitic tuff which was sampled at a depth of 74.4m is rich in plagioclase phenocrist. Almost all glass which fills the matrix is chloritizated.

<Mineralization>

Microscopic observation:

The ore which was sampled in the depth of 43.2m is rich in specularite and marmatized magnetite. Quartz is commonly observed as gangue mineral.

Copper mineralization:

Atacamite and malachite fill up cracks from the surface to a depth of 50m. Atacamita and chalcopyrite fill up cracks at a depth of 50m to 70m. Chalcopyrite fills cracks at a depth of 80m to 90m.

Oxide mineralization zone	at depths of 1m to 13m and 21m to 38m
Mixed mineralization zone	at a depth of 52m to 67m
Sulfide mineralization zone	at a depth of 80m to 89m

Iron mineralization:

Reticulated fine veins of specularite and magnetite continuously occur from the surface to a depth of 75m. Disseminated hematite also continuously occurs at a depth of 75m to the bottom of the hole.

MJCC-43

<Geology and alteration>

The core is composed of "hydrothermal breccia", Ad.4. and Ad.3 in descending order.

Andesite lava occurs from the surface to a depth of 15m. Tuff(Ad.4) mainly occurs at a depth of 15m to 70m. Remarkably iron disseminated andesitic breccia("hydrothermal breccia") occurs at a depth of 70m to 125m. Plagioclase porphyritic andesite(Ad.3) with amygdaloidal structure occurs at a depth of 125m to the bottom.

Microscopic observation:

Aphyric andesite which was sampled at a depth of 52.0m is rich in plagioclase phenocryst. The matrix is filled by glass and plagioclase. Chlorite and sphane are observed as altered minerals.

<Mineralization>

Microscopic observation:

The ore which was sampleed at a depth of 47.55m is rich in magnetite and hematite. The ore includes iron hydroxide and quartz as gangue mineral.

Copper mineralization:

Atacamite ,malachite and chrysocolla fill up cracks from the surface to a depth of 80m. Chalcopyrite fills the matrix and pors at a depth of 143m to the bottom.

Oxide mineraization zone at depths of 2m to 19m and 34m to 51m
Mixed mineralized zone at a depth of 66m to 81m

Iron mineralization:

Disseminasion of magnetite, hematite and specularite occurs at a depth of 60m to 125m.

MJCC-44

<Geology and alteration>

The core is composed of "hydrothermal breccia," Ad.4th and Ad.3. in descending order.

Markedly iron disseminated andesititic breccia("hydrothermal breccia") mainly occurs at a depth of 7m to 135m. "Hydrothermal breccia"(Ad.4) catches aphyric andesite and plagioclase porphyritic andsite. Aphyric andesite(Ad.3) including andesitic tuff breccia at a depth of 135m to the bottom.

Hydrothermal alteration with argillization(possibly chlorite and sericite)is obserbed at depths of 30m, 80m, 90m and 107m to 124m. The whole core is chloritized.

<Mineralization>

Microscopic observation:

The ore which was sampled at a depth of 164.4m is rich in hematite, magnetite and pyrite. It includes small amount of chalcopyrite. Quartz is observed as gangue mineral.

Copper mineralization:

Chalcopyrite and pyrite continuously fill the matrix and cracks at a depth of 40m to the bottom.

Sulfide mineralization zone at depths of 63m to 72m and 153m to 162m

Iron mineralization:

Dissemination ～fine veins of hematite and specularrite occur at a depth of 7m to 40m. Dissemination of magnetite occurs at a depth of 40m to 68m.

Magnetite and hematite fill up cracks and pores at a depth of 73m to the bottom.

MJCC-45

<Geology and alteration>

The core is composed of "hydrothermal breccia" and Ad.4 in descending order.

Markedly disseminated andesitic breccia("hydrothermal breccia) occurs from the surface to a depth of 100m. Aphyric andesite(Ad.4) occurs at a depth of 100m to the bottom(140m).

The core is affected by hydrothermal alteration from the surface to a depth of 110m.

<Mineralization>

Copper mineralization:

Atacamite is scattered from the surface to a depth of 70m. Pyrite and chalcopyrite are also scattered at a depth of 40m to the bottom.

Oxide mineralization zone at a depth of 1m to 11m

Sulfide mineralization zone at a depth of 50m to 60m

Iron mineralization:

Reticulated hematite veins continuously develops from the surface to a depth of 100m. Fine veins and dissemination of magnetite are scattered at a depth of 100m to the bottom.

MJCC-46

<Geology and alteration>

The core is composed of "hydrothermal breccia" and Ad.4 in descending order.

Markedly disseminated andesitic breccia("hydrothermal breccia) occur from the surface to a depth of 89m. Alteration(Ad.4) of plagioclase porphyritic andesite with amygdaloidal structure and aphyric andesite at a depth of 89m to the bottom of hole(140m).

Quartz fine veins develop from the surface to depths of 30m and 89m to the bottom. Fracture zone is observed at a depth of 108m to the bottom of the hole.

<Mineralization>

Copper mineralization:

Atacamite and malachite continuously fill cracks and pores at a depth of 15m to 60m. Pyrite and chalcopyrite fill up cracks and pores at a depth of 60m to the bottom.

Oxide mineralization zone at a depth of 14m to 24m

Sulfide mineralization zone at a depth of 57m to 70m

Iron mineralization:

Dissemination of hematite and magnetite occurs from the surface to a depth of 89m.

MJCC-47

<Geology and alteration>

The core is composed of Ad.4 and Ad.3 in descending

Aphyric andesite with brecciated andesite layers occurs from the surface to a depth of 42m. Mainly aphyric andesiteAd.4) lava with plagioclase porphyritic andesite and tuff breccia layers occurs at a depth of 42m to 118m. Alternation(Ad.3) of plagioclase porphyritic andesite and tuff occurs at a depth of 118m to the bottom.

The core is almost wholly affected by hydrothermal alteration from surface to bottim. Calcite fine veins and whitish argillization zone are partly observed. Fracture zones are observed at depths of 80m, 119m and 150m.

Microscopic observation:

Brecciated andesite which was sampled at a depth of 122.8m is rich in plagioclase.The matrix is filled by glass, quartz, plagioclase and magnetite.

<Mineralization>

Microscopic observation:

The ore which was sampled at a depth of 32.7m is rich in specularite. It includes small amounts of atacamite and magnetite. Magnetite is marmatized.

Copper mineralization:

Atacamite and malachite are scattered at a depth of 25m to 100m. Particularly, mainly malachite fills up cracks and pores in the fracture zone at a depth of about 80m.

Oxide mineralization zone at depths of 26m to 35m and 79m to 88m

Iron mineralization:

Dissemination of hematite successively occurs from the surface to a depth of 120m. Dissemination of magnetite and hematite also successively occurs at a depth of 120m to the bottom of the hole.

MJCC-48

<Geology and alteration>

The geology is composed of andesite 4th unit, andesite 3rd unit (fracture zone accompanied with Los Cerros Floridas-W fault) and andesite 2nd unit in descending order.

Aphyric andesite which is rich in calcite, quartz and gypsum vein and brecciated andeste is distributed from the depth of 2m to the bottom(165m).

Whitish colored argillization zone(sericite, chlorite and montmollilonite) by hydrothermal alteration is observed within andesite. Plagioclase porphyritic andesite(4th unit) which is partly fractuated and silicificated is observed in the depth of 20m to the depth of 104m. Markedly fractuated andesite(possibly 3rd unit) which is mostry composed of aphyric andesite occurs in the depth of 104m to the depth of 154m, and aphyric andesite(2nd unit) occurs from the depth of 154m to the bottom(165m).

<Mineralization>

Copper mineralization:

Dissemination of chalcopyrite and pyrite is almost successively observed from the depth of 85m to the bottom.

Sulfide mineralization zone in the depth of 119m to 147m

Iron mineralization:

Dissemination to fine veins of magnetite are almost continuously observed from the depth of 100m to the bottom.

MJCC-49

<Geology and alteration>

The geology is composed of "hydrothermal breccia" and andesite 3rd unit.

Markedly fractuated and iron disseminated andesitic breccia("hydrothermal breccia") is distributed from the surface to the depth of 65m, and alternation (3rd unit) of aphyric andesite in which quartz reticulated fine veins deverop and andesite with amygdaloidal structure occurs from the depth of 65m to the bottom(90m).

Whitish colored argillization zone(possibly kaolinite) by hydrothermal alteration is observed in the depth of 60m.

<Mineralization>

Copper mineralization:

Atacamite and chrysocolla occur filling up cracks and pores in the depth of 10m to the depth of 70m

Mixed mineralization zone in the depth of 11m to 31m
in the depth of 34m to 45m

Sulfide mineralization zone in the depth of 51m to 61m

Iron mineralization:

Dissemination to reticular fine veins of hematite, specularite and magnetite occurs among fragments from the surface to the depth of 65m.

MJCC-50

<Geology and alteration>

The geology is composed of "hydrothermal breccia" and andesite 4th unit.

Alternation(4th unit) of plagioclase porphyritic andesite with amygdaloidal structuere and breccia of the andesite occurs from the surface to the depth of 37m. Markedly iron disseminated andesitic breccia("hydrothermal breccia") is distributed from the depth of 37m to the bottom(80m).

Whitish colored argillization zone(possibly chlorite and sericite) is successively observed from the depth of 40m to the bottom.

<Mineralization>

Copper mineralization:

Atacamite and chrysocolla occur filling up cracks and pores from the surface to the depth of 47m and in the depth of about 65m.

Oxide mineralization zone	in the depth of 39m to 49m
	in the depth of 70m to 79m
Mixed mineralization zone	in the depth of 2m to 31m

Iron mineralization:

Hematite and specularite occur as fine veins or filling up pores and cracks from the depth of 30m to the bottom.

MJCC-51

<Geology and alteration>

The geology is composed of cataclasites, andesite 4th unit, andesite 3rd unit and andesite 2nd unit in descending order.

Fractuated and remarkably silicificated andesitic cataclasite from the surface to the depth of 44m and aphyric andesite(4th unit) occurs in the depth of 44m to 54m, respectively. Alternation(3rd unit) of plagioclase porphyritic andesite with amygdaloidal structuere and aphyric andesite occurs in the depth of 54m to 129m. Aphyric andesite is distributed from the depth of 129 to the bottom(150m).

Reticulated veins of quarts, calcite and gypsum caused by hydrothermal alteration develop from the surface to the depth of 40m.

<Mineralization>

Copper mineralization:

Malachite occurs filling up cracks and pores in the depth of about 45m, and pyrite and chalcopyrite occur filling up cracks and pores or within magnetite veins in the depth of 80m to 125m.

Sulfide mineralization zone	in the depth of 113m to 122m

Iron mineralization:

Disseminated or reticulated hematite is almost successinely distributed from the depth of 44m to the bottom. Fine veins of magnetite develop in the depth of about 50m, 115m and 135m.

MJCC-52

<Geology and alteration>

The geology is composed of andesite 4th unit and andesite 3rd unit in descending order.

Alternation(4th unit) of plagioclase porphyritic andesite and aphyric andesite occurs from the surface to the depth of 145m. Altration(3rd unit) of plagioclase porphyritic andesite, tuff breccia and tuff occurs from the depth of 145m to the bottom(210m). Reticulated quartz veins develop in the depth of 120m to 180m, and argillizated zones(possibly chlorite) caused by hydrothermal alteration are partly observed. Fracture zones are observed in the depth of about 135m and 200m.

<Mineralization>

Copper mineralization:

Malachite occurs filling up cracks from the surface to the depth of 57m. Pyrite and chalcopyrite occur filling up cracks, matrix and pores from the depth of 25m to the bottom.

Mixed mineralization zone	in the depth of 7m to 36m
Sulfide mineralization zone	in the depth of 54m to 63m
	in the depth of 140m to 151m
	in the depth of 190m to 199m

Iron mineralization:

Fine veins of hematite and magnetite are scattered from the surface to the depth of 135m. Magnetite dissemination is observed in the depth of 140m to 150m.

MJCC-53

<Geology and alteration>

The geology is composed of andesite 3rd unit and andesite 2nd unit in descending order.

Alternation(3rd unit) of plagioclase porphyritic andesite with amygdaloidal structure and aphyric andesite occurs in the depth of 4m to 116m. Aphyric andesite(2nd unit) which catchs plagioclase porphyritic andesite occurs from the depth of 116m to the bottom.

Gypsum veins occur in the shallower part of 15m in depth. Calcite veins develop from the depth of 183m to the bottom. Argillizated zones(chlorite, sericite and montmollilonite, etc) caused by hydrothermal alteration are observed.

Microscopic observation:

Plagioclase andesite which sampled in the depth of 156.0m shows amygdaloidal structure. Sericite and chlorite are observed as altered minerals.

<Mineralization>

Copper mineralization:

Atacamite occurs filling up cracks in the depth of 15m to the depth of 35m. Atacamite, chrysocolla and chalcopyrite occur filling up cracks and pores from the depth of 83m to the bottom.

Oxide mineralization zone in the depth of 17m to 28m

Iron mineralization:

Obvious dissemination by iron minerals is not observed due to weak iron mineralization.

1 — 4 Consideration

53 holes and a total depth of drilling of 10,028m(the depth of 80m～500m/hole) was carried out during two years of drilling survey, and then occurrence of the ore deposits and outline of ore reserves were confirmed.

The ore deposits are considered to be formed by metasomatic precipitation from ore solution. These rose up after the formation of country rock and major faults within "hydrothermal breccia," or the developed part of amygdaloidal structure of andesite. Therefore, this type of ore deposit is called "manto type," due to the tendency of the ore deposit to expand within the mother rock. However, the shape is irregular and not stratified. The occurrence is disseminated ～networks with the thickest part of 30cm. As the dr illing intervals of the maximum drilling density part was 100m, the continuities of ore veins of less than 30cm in thickness were not observed. Though the Cu grades of drilling cores were analyzed at every 1m, Cu grades variation are so strong that the variations prove the irregularity of the occurrences. Therefore, small amount but high grade ore reserves were difficult to calculate under these conditions, so the calculation of ore reserves was carried out under the supposition of some degree of scale ofore deposit.

The main purpose of the 1993 survey was to confirm the upper ore body. Besides the upper ore body, parts of the lower ore body, west ore body and east ore body were detected. In addition to these ore bodies, the prospectings to the lower horizon and adjacent ore bodies(particularly to the east and west direction) will be hopeful. As the geophysical prospecting has not satisfactorily been carried out to the deep horizon and the side of other ore bodies, further prospecting is expected.

CHAPTER 2 METALLURGICAL TESTS

2 — 1 Purpose

The purpose of the metallurgical tests are to develop the most suitable flowsheet in productive operation of Cerro Negro deposit, to estimate the complete metallurgical results and to obtain data and informations for plant design. For this purpose a series of tests were performed at Centro de Investigacin Minera y Metalurgica(CIMM) of the Republic of Chile with the rest of boring core samples obtained in the first year of the entire investigation period. Also, in Japan, another series of tests were carried out for confirmation of the results.

2 — 2 Test process

Test process is divided into a common part for each type of ore and an individual part for oxide and sulfide ores respectively. For the oxide and mixed ores, heap leaching(including bacteria leaching) — SX/EW method is studied, while for the sulfide and mixed ores flotation is adopted and then combined flowsheet is dicussed finally. The outline of the test process is described in Fig. II -2-2-1.

Sample preparation
↓
Chemical analysis &
Measurement of work index

(Oxide, Mixed ores)

Leaching-SX/EW tests
- Heap leaching tests
- Bacteria leaching tests
- Solvent extraction tests(SX)
- Electrowinning tests(EW)

(Sulfide, Mixed ores)

Flotation tests
- Rougher flotation tests
- Cleaner flotation tests
- Settling & dewatering tests on concentrate and tailing

Analysis of recirculating water
Design of flotation flowsheet

Development of complete flowsheet

Fig. II — 2 — 2 — 1 Flowsheet of Metallurgical Tests

2 — 3 Results of metallurgical tests

(1) Oxide ore

Principal copper minerals contained in the oxide ores are copper carbonates like malachite, chrysocola, copper silicate and copper sulfide like chalcocite, covelite and chalcopyrite etc.. For leaching these sulfide minerals bacteria leaching is inevitable.

As a result of X-ray difraction analysis quartz, actinolite, microcline and hematite were found as principal gangue minerals.

Copper content in this ore samples is: 0.78% Cu, of which 0.43% is soluble (55% of total Cu). Copper soluble in sulphuric acid is 0.50% (64% of total Cu). Analytical results are shown in Table II-2-3-1. Any other elements, which may bring dificulties in the leaching steps, were not detected.

Specific gravity of the ore sample is 3.18, which is consistent with others in the upper ore body. It is higher than that of the western ore body presumably due to existence of iron oxide minerals. Bond's work index is 14.45 kwH/short ton, which is situated in the range of normal porphyry copper deposit.

The oxide copper samples were acid leached through columns, without any reduction in size, with or without pretreatment, as flow rate of the leaching solution(sulphuric acid) was being changed. As the result, maximum 76% of coppe rcould be leached in comparatively short period (18 days). Additional 2% of copper was leached out by successive bacteria leaching, in which bacteria was vaccinated in the leach residue. It was concluded from these results that the pretreatment by strong acid was effective for this type of ore and acid consumption was estimatedat around 30kg/ton of ore (5kg/kg- Cu), which was average in Chile. Bacteria leaching was seemed to be less effective and insignificant.

The pregnant solution was tested by solvent extraction method to obtain basic data and an extraction curve. Then the solution was further leached by normal condition followed by stripping step to make up electrowinning solution. In the case of this ore samples two stage of extraction, two stage of washing and two stage of stripping were necessary.

The electrowinning solution thus obtained was electrolyzed by normal condition to produce cathode copper. Analytical results of the cathode copper are shown in Table II-2-3-2. Lead is detected noticeably, however, this is because the test scale is so small and any other impurities that could cause troubles in the productive operation were not detected.

(2) Sulfide ore

Two types of typical samples were prepared for the tests from the upper and western ore bodies respectively. Although these two samples differ in constituent minerals especially in volume of gangue minerals, they showed similar adaptability to flotation process.

Both samples contain chalcopyrite as a principal copper mineral and also chalcocite, covelite and native copper as minor components. As a result of X-ray diffraction, quartz, actinolite, microcline, serpentine, calcite and iron pyrite were detected in the sample from the upper ore body, while quartz, microcline, serpentine, calcite and iron pyrite were found in the sample from the western ore body.

Copper content in the sample of the upper part is 1.19%, of which 0.045%(4% of total Cu) is soluble. On the other hand, copper content in the sample of the western part is 0.66%, of which 0.013% (2% of total Cu) is soluble.

Analytical results of both samples are shown in Table II -2-3-1. In the sample of the western ore body arsenic and fluorine are to be noted as impurities. Possibility of recovering by-product like silver and molibdenum is so small.

Specific gravity of the sample of the upper ore body is 3.39, which is consistent with other samples of the same ore body. Specific gravity of the sample of the western ore body is 2.78, which is also consistent with others of the same ore body. It is considered that the sample of the upper ore body shows higher specific gravity due to iron oxide minerals contained in this ore body. Bond's work index of the sample from the upper ore body is 13.62 kwH/short ton, which is situated in the range of normal porphyry copper deposit. On the other hand, the work index of the sample from the western ore body is 17.65 kwH/short ton, which is somewhat higher than normal. Probably this difference comes from that of gangue minerals contained.

On each of these two samples a series of investigation, that is, rougher and cleaner flotation, settling and dewatering tests, analysis of recirculating water, design of flotation flowsheet etc., were carried out individually.

As flotation conditions in the rougher stage, size of grinding: 60% -75 micron(-200mesh), colector: SF-323 30g/t, frother: DF-250 30g/t, pH: 9.0, flotation time: 12 min. were selected for both samples. Also as conditions in cleaner stage, size of re-grinding: 95% -45 micron (-325mesh), pH: 11.0, flotation time: 3min. were selected. It was cleared that single step of cleaner flotation was sufficient but additional 7 min. of scavenger flotation was needed after the rougher.

Metallurgical results obtained by the above conditions were different among the two samples. Thus, from the sample of the upper ore body, copper concentrate of 35% grade was recovered with recovery rate of 93%, while from the sample of the western ore body the grade of concentrate was 33% with recovery rate of 87%. The difference in recovery rate among the two is probably caused by difference in copper grade of head samples and the difference in the grade of concentrate comes from variety of copper minerals.

Analytical results of the copper concentrates are shown in Table II-2-3-3. As the Table indicates arsenic in the concentrate from the western ore body is noticeable, however, no other elements are likely to bring problems.

As for settling velocity of concentrates and tailings, there exists some difference. Thus, the products from the upper part of the deposit show higher settling velocity and are easily handled. On the other hand, the products from the western ore body should be more difficult and need some floccurent in thickner.

Analytical results of the water that was used in the flotation stages and might be returned for reuse show no acumulation of any harmful components.

(3) Mixed ore

Two types of mixed ore sample were made up for the tests separately from the upper part and the western ore bodies. As these two samples differ remarkably in constituent minerals and their ratio, hardness, specific gravity, extraction rate in leaching, recovery in flotation etc., description is made in dividually as follows.

1) Mixed ore from the upper ore body

This sample contains sulfide copper minerals like chalcopyrite, chalcocite, covelite as well as chrysocola, atacamite and minor amount of native copper.

As the result of X-ray diffraction analysis, quartz, microcline, serpentine, hematite and forsterite were detected.

Copper content in this sample is 0.93%, of which 0.16% (17% of total Cu) is soluble. Analytical results are shown in Table II-2-3-1. Any components that may affect flotation or leaching process were not detected.

Specific gravity of this sample is 3.12, consistent with others of the ore body. It is higher than those of the samples of the western part probably due to iron oxide minerals contained. Bond's work index is 13.90 kwH/short ton, which is situated in the range of normal porphyry copper.

This ore samples were acid leached through columns with or without pretreatment as flow rate of leaching solution (sulphuric acid) was being changed. In this test maximum 40% of copper was extracted. As a result of successive bacteria leaching, in which bacteria was vaccinated in leach residue, additional 12% of copper was extracted and that made total extraction rate 52%. Acid consumption in this test was 52kg/ton of ore(11kg/kg-Cu), which is about five times as high as average in Chile. Probably this was caused by constituent gangue minerals.

The pregnant solution from acid leaching was tested by solvent extraction method to obtain basic data and an extraction curve. Then the solution was further leached by normal condition followed by stripping step to make up electrowinning solution. In the case of this ore samples two stage of extraction, two stage of washing and two stage of stripping were necessary.

The electrowinning solution thus obtained was electrolyzed by normal condition to produce cathode copper. Analytical results of the cathode copper are shown in Table II-2-3-2.

A series of flotation tests, that is, rougher, cleaner, settling and dewatering, analysis of recirculating water, design of flowsheet etc., were also carried outon this samples. Special attention was made on increase in copper recovery.

As flotation conditions in the rougher, size of grinding: 60% -75 micron (-200mesh), colector: AC-350 45g/t, frother: DF-250 30g/t, sulfidizing reagent : NaSH 300g/t (all the reagents were added step by step), pH: 9.1, flotation time: 12min. were selected. In successive scavenger, colector: AC-350 10g/t, frother: DF-250 10g/t, sulfidizing reagent: NaSH 100g/t(all were added step by step), pH: 11.0, flotation time: 12 min. were selected. In the cleaner stage, size of regrinding: 95% -45 micron(-325mesh), colector: AC-350 20g/t, NaSH: 200g/t, pH: 11.0, flotation time: 3 min. were selected. Single step of cleaner flotation was sufficient but additional 7 min. of scavenger flotation was needed.

It was estimated from these tests that copper concentrate, of which grade was 33% Cu could be recovered with about 77% of recovery rate. Copper recovery in this tests was lower than that of the sulfide ore samples and this was possibly caused by less flotable copper minerals like chrysocola and atacamite. Increase in total copper recovery may be attained by further leaching with agitation, however, additional costs should also be considered comparatively.

Analytical results of the copper concentrates are shown in Table II-2-3-3. Cobalt is somewhat noticeable but no other particular inpurities were detected.

Settling velocity of the concentrate and tailings was satisfactory. These products can be handled easily.

As the results of analysis of the water that was used and would be re-used in flotation, no acumulation of any harmful component was found.

2) Mixed ore from the western ore body

This sample contains malachite, covelite, chalcocite, chalcopyrite, atacamite, chrysocola, brochantite etc., as principal copper minerals.

As a result of X-ray diffraction analysis, quartz, actinolite, microcline, serpentine and calcite were detected.

Copper content of this ore sample is 1.10%, of which 0.54% (49% of total Cu) was soluble. The ratio, sol.Cu/total Cu, of this sample is nearly equal to that of oxide ore sample and this causes lower flotation recovery on one hand and higher leaching extraction on the other hand. Analytical results are shown in Table Ⅱ-2-3-1. Any other elements that may hinder flotation and leaching were not detected.

Specific gravity of this sample is 2.82, which is consistent with others from the western part of the deposit. Bond's work index is 16.90 kwH/short ton, which is higher than normal porphyry copper ores.

This sample was acid leached through columns, with or without pretreatment, as flow rate of the leaching solution (sulphuric acid) was being changed. As the result, maximum 75% of copper could be leached out. Furthermore, additional 6% of copper was leached by successive bacteria leaching and that made total extraction rate up to 81%. Acid consumption was estimated at about 125kg/ton of ore (14kg/kg-Cu), which is about four times as high as average in Chile. This high consumption of acid is probably caused by constituent gangue minerals like calcite. The pregnant solution was tested by solvent extraction method to obtain basic data and an extraction curve. Then the solution was further leached by normal condition followed by stripping step to make up electrowinning solution. In the case of this ore samples two stage of extraction, two stage of washing and two stage of stripping were necessary. The electrowinning solution was electrolyzed by normal condition to produce cathode copper. Analytical results of the cathode copper are shown in Table Ⅱ-2-3-2.

On the other hand, a series of flotation tests, that is, rougher, cleaner, settling and dewatering, analysis of recirculating water, design of flotation flowsheet etc., were carried out on this sample. Especially, attention was made to increase flotation recovery but was not enough to be satisfied.

As flotation conditions in the rougher stage, size of grinding: 60% -75 micron(-200mesh), colector: AC-350 45g/t, frother: DF-250 30g/t, sulfidizing reagent: NaSH300g/t, (all were added step by step) pH: 9.1, flotation time: 12 min. were selected. In successive scavenger, colector: AC-350 10g/t, frother: DF-250 10g/t, NaSH: 100g/t, (all added step by step) pH: 11.0, flotation time 12min. were adopted. In the cleaner, size of re-grinding: 95% -45micron(-325mesh), colector: AC-350 20g/t, NaSH: 200g/t, pH 11.0, flotation time 3min. were selected. Also it was cleared that single step of cleaner flotation was sufficient but 7 *min. ofadditional scavenger was necessary.*

Under these conditions it was estimated that copper concentrate, of which grade was 27%, could be recovered with low recovery rate of 56%.

Accordingly, in case of this ore sample heap leaching (including bacteria leaching) method seemed more suitable than flotation.

(4) Summary of the metallurgical results

Fig. Ⅱ-2-3-1 shows the flotation flowsheet developed for the treatment of sulfide ores and mixed ores of Cerro Negro deposit. Principal results of the metallurgical tests were summarized in Table Ⅱ-2-3-4.

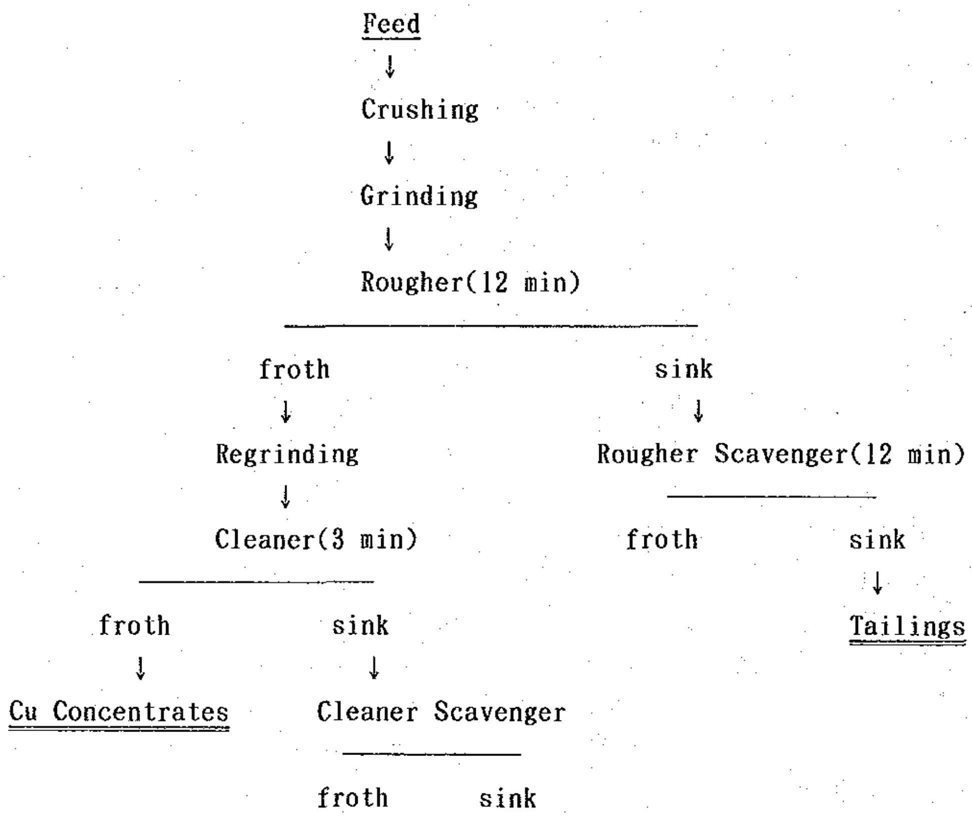

Fig. Ⅱ—2—3—1 Flowsheet of Flotation

Table II — 2 — 3 — 1　Head Assay of the Cerro Negro Ores

Sample	SC-1	SW-2	OX-1	MC-1	MW-2
Cu	1.19	0.66	0.78	0.93	1.10
Citric Sol. Cu	0.045	0.013	0.43	0.16	0.54
Sulfuric Sol. Cu	0.083	0.022	0.50	0.20	0.62
Fe	29.0	13.7	27.2	23.6	14.6
Al_2O_3	9.16	13.1	11.2	12.1	11.7
S	3.36	1.03	0.14	1.32	0.94
Na_2O	0.26	1.55	0.27	0.27	0.73
K_2O	4.43	2.76	5.58	5.70	3.12
MgO	2.22	2.16	1.66	1.97	1.67
CaO	0.39	3.20	0.17	0.39	2.85
SiO_2	32.7	49.6	37.4	39.6	48.5
Zn	0.003	0.006	0.005	0.004	0.007
Pb	<0.002	<0.002	<0.002	<0.002	<0.002
Mo	<0.004	0.006	<0.004	<0.004	0.005
Mn	0.042	0.061	0.057	0.063	0.11
Co	0.050	0.009	0.053	0.041	0.049
Ni	0.005	0.003	0.006	0.003	0.006
Cd	<0.005	<0.005	<0.005	<0.005	<0.005
As	<0.005	0.005	<0.005	<0.005	0.011
Sb	<0.005	<0.005	<0.005	<0.005	<0.005
Bi	<0.005	<0.005	<0.005	<0.005	<0.005
Se	<0.005	<0.005	<0.005	<0.005	<0.005
Te	<0.005	<0.005	<0.005	<0.005	<0.005
F	<0.02	0.03	<0.02	<0.02	<0.02
Cl	0.017	0.018	0.031	0.045	0.019
Hg (ppm)	<0.1	0.1	<0.1	<0.1	<0.1
Au (g/t)	0.2	0.2	0.1	0.2	0.2
Ag (g/t)	2	<1	<1	<1	<1
Total (%)	82.841	87.897	84.539	86.036	85.417

Table II — 2 — 3 — 2 Analytical Results of Cathode

Sample	OX-1	MC-1	MW-2
Components(ppm)			
Fe	<1	2	4
S	13	13	<5
Se	<0.1	<0.1	<0.1
Te	<0.1	<0.1	<0.1
Bi	<0.1	<0.1	<0.1
Sb	<0.1	<0.1	NA
As	<0.1	<0.1	<0.1
Pb	14	4	7
Sn	<0.2	<0.2	<0.2
Ni	<1	<1	1
Ag	<0.2	<0.2	<0.2

Table II－2－3－3　Analytical Results of Cu Concentrates

Sample	SC-1	SW-2	MC-1	MW-2
Component(%)				
Cu	33.7	28.4	22.7	25.2
Fe	27.30	27.10	31.20	25.30
S	33.31	30.46	40.36	21.54
Pb	0.004	0.004	0.002	0.002
Zn	0.022	0.021	0.012	0.008
As	<0.005	0.063	0.007	0.031
Sb	<0.005	<0.005	<0.005	<0.005
Bi	<0.005	<0.005	<0.005	<0.005
Se	<0.005	<0.005	<0.005	<0.005
Te	<0.005	<0.005	<0.005	<0.005
Ni	0.007	0.003	0.028	0.039
Co	0.087	0.047	0.49	0.24
Mo	0.05	0.12	0.006	0.041
F	NA	NA	NA	NA
Cl	<0.05	<0.05	0.06	<0.05
Hg (ppm)	<0.2	<0.2	<0.2	<0.02
SiO_2	2.30	7.10	2.10	9.20
Al_2O_3	0.81	0.42	1.22	1.11
MgO	0.33	0.56	0.41	0.61
CaO	0.07	0.48	0.47	0.51
K_2O	0.29	0.51	0.24	0.64
Na_2O	0.01	0.15	0.06	0.11
Au (g/t)	4.0	4.7	3.4	3.8
Ag (g/t)	6	40	2	31
Total (%)	94.545	95.328	99.345	84.581

Table II — 2 — 3 — 4　Summary of the Metallurgical Results

Sample	SC-1	SW-2	OX-1	MC-1	MW-2
Bond's Work Index (kWh/st)	13.62	17.65	14.45	13.90	16.90
Recovery by Flotation (%)	93.05	87.12	NA	76.60	55.53
Cu Grade of Cu Concentrates (%)	38.75	32.87	NA	33.40	26.63
Extraction by Leaching (%)	NA	NA	75.5	51.8	80.8
Consumption of Sulfuric Acid kg H2SO4/t ore) kg H2SO4/kg Cu)	 NA NA	 NA NA	 30.3 5.10	 51.9 10.8	 124.2 14.0
Unit Area of Conc. Thickener (m^2/tpd)	0.177	0.202	NA	0.108	0.614
Unit Area of Tail. Thickener (m^2/tpd)	0.106	1.084	NA	0.541	1.490
Unit Area of Conc. Filter (m^2/tpd)	0.028	0.047	NA	0.032	0.099

2 — 4 Confirmation tests in Japan

Also in Japan analysis of head samples, measurement of work index and a series of flotaton tests (rougher, cleaner, settling and dewatering tests with concentrates and tailings, analysis of recirculating water and design of flowsheet) were carried out with the two types of sulfide ore samples, which were taken after thesample preparation at CIMM.

Table II -2-4-1, II -2-4-2 and II -2-4-3 show the comparison of the metallurgical results obtained in Japan and by CIMM. This comparison concluded that the technology of metallurgical tests in CIMM was reliable.

Table II — 2 — 4 — 1 Comparison of the Metallurgical Results Obtained in Japan and CIMM

Laboratory	Japan	CIMM
Bond's Work Index		
SC-1(kWh/st)	12.6	13.62
SW-2(kWh/st)	14.8	17.65
Cu Recovery by Flotation		
SC-1(%)	92.04	90.89
SW-2(%)	88.44	85.17
Cu Grade of Concentrates		
SC-1(Cu%)	32.08	31.46
SW-2(Cu%)	30.96	29.08
Unit Area of Conc. Thickener		
SC-1(m^2/tpd)	0.163	0.177
SW-2(m^2/tpd)	0.22	0.202
Unit Area of Tail. Thickener		
SC-1(m^2/tpd)	0.38	0.106
SW-2(m^2/tpd)	0.92	1.084
Unit Area of Conc. Filter		
SC-1(m^2/tpd)	0.024	0.028
SW-2(m^2/tpd)	0.037	0.047
Specific Gravity		
SC-1	3.40	3.39
SW-2	2.80	2.78

Table II — 2 — 4 — 2 Comparison of Head Assays Obtained in Japan and CIMM

Sample	SC-1		SW-2	
Laboratory	Japan	CIMM	Japan	CIMM
Component (%)				
Cu	1.17	1.19	0.68	0.66
*Citric Sol. Cu	0.02	0.045	0.007	0.013
*Sulfur. Sol. Cu	0.06	0.083	0.02	0.022
Fe	32.0	29.0	13.8	13.7
Al_2O_3	8.39	9.16	11.7	13.1
S	3.05	3.36	1.12	1.03
Na_2O	0.12	0.26	1.37	1.55
K_2O	4.83	4.43	3.57	2.76
MgO	2.27	2.16	2.35	2.16
CaO	0.36	0.39	3.15	3.20
SiO_2	32.9	32.7	49.8	49.6
Zn	0.005	0.003	0.003	0.006
Pb	0.005	<0.002	0.007	<0.002
Mo	<0.02	<0.004	<0.02	0.006
Mn	NA	0.042	NA	0.061
Co	0.05	0.050	<0.02	0.009
Ni	<0.02	0.005	<0.02	0.003
Cd	NA	<0.005	NA	<0.005
As	0.04	<0.005	0.06	0.005
Sb	<0.02	<0.005	<0.02	<0.005
Bi	<0.02	<0.005	<0.02	<0.005
Se	<0.02	<0.005	<0.02	<0.005
Te	<0.02	<0.005	<0.02	<0.005
F	0.03	<0.02	0.04	0.03
Cl	0.05	0.017	0.09	0.018
*Hg (ppm)	<0.1	NA	<0.1	NA
*Au (g/t)	0.2	0.2	0.2	0.2
*Ag (g/t)	1	2	2	<1
Total(Excl. *)	85.270	82.841	87.740	87.897

Table II — 2 — 4 — 3 Comparison of Analytical Results of Cu Concentrates Obtained in Japan and CIMM

Sample	SC-1		SW-2	
Laboratory	Japan	CIMM	Japan	CIMM
Component (%)				
Cu	32.33	33.7	29.68	28.4
Fe	30.21	27.30	29.45	27.10
S	33.99	33.31	31.15	30.46
Pb	0.007	0.004	0.009	0.004
Zn	0.004	0.022	0.015	0.021
As	<0.01	<0.005	0.08	0.063
Sb	<0.01	<0.005	0.02	<0.005
Bi	<0.01	<0.005	<0.01	<0.005
Se	<0.01	<0.005	<0.01	<0.005
Te	<0.01	<0.005	<0.01	<0.005
Ni	0.019	0.007	0.009	0.003
Co	0.14	0.087	0.05	0.047
Mo	<0.01	0.005	0.14	0.12
F	0.02	NA	0.01	NA
Cl	<0.01	<0.05	0.01	<0.05
Hg (ppm)	0.5	<0.2	0.9	<0.2
SiO_2	1.56	2.30	4.09	7.10
Al_2O_3	0.39	0.81	1.22	0.42
MgO	0.15	0.33	0.41	0.56
CaO	0.10	0.07	0.47	0.48
K_2O	0.15	0.29	0.24	0.51
Na_2O	<0.01	0.01	0.06	0.15
Au (g/t)	4.8	4.0	6.4	4.7
Ag (g/t)	11	6	46	40
Total(%)	99.070	94.545	97.113	95.328

2 — 5 Consideration

As the metallurgical tests, flotation and heap leaching – SX/EW methods were applied to five types of ore samples, that is, one oxide ore from the upper ore body, two types of mixed ores from the upper and western ore bodies and two types of sulfide ores from the upper and western ore bodies, all of which were taken from boring core carried out in the year of 1992. As the resultof these tests, for the treatment of the oxide ore from the upper ore body and the mixed ore from the western ore body (ratio of soluble Cu/total Cu is about 50% in either ore) heap leaching – SX/EW method is suitable with about 76% of estimated extraction rate. In case of the western ore body, however, acid consumption was higher and this could bring higher operation costs. On the other hand, for the mixed ore from the upper ore body (soluble Cu/total Cu is under 20%) and for all the sulfideores flotation is more suitable with around 90% of recovery rate (about 77% in case of the mixed ore). As the results of analytical and other investigations on copper concentrates, tailings and also on cathod copper, any impurities that could cause troubles in commercial or environmental aspects were not detected.

As for the two types of mixed ores from the upper and western ore bodies, which are classified as geologically identical, treatment method should depend upon the ratio, sol.Cu/total Cu. It was found that for ores, of which ratio is under 20%, flotation is suitable, while for those, of which ratio is above 50%, leaching — SX/EW method is suitable. Accordingly, in the point of mineral processing, it is recommended that ores should be classified into oxide and sulfide only in terms of the ratio, soluble Cu/total Cu. Based on this idea for the treatment of Cerro Negro ore, the following flowsheet shown in Fig. II-2-5-1 was developed. In economical discussion, however, it should be noted that the treatment of these portion of mixed ores may bring lower metallurgical results and increased operation costs.

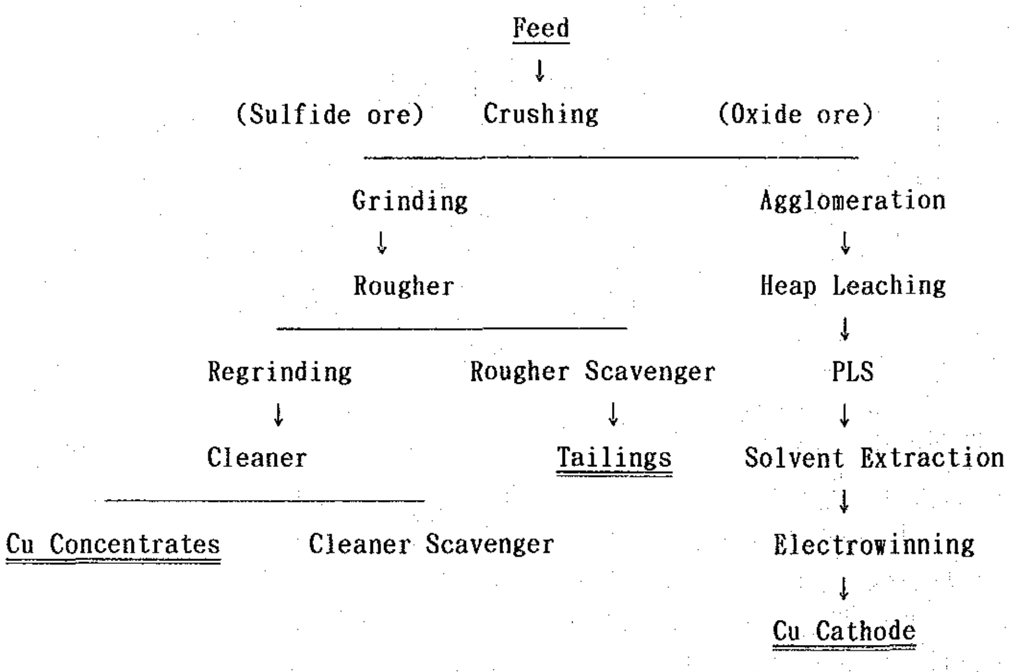

Fig. II — 2 — 5 — 1 Flowsheet of Ore Treatment

CHAPTER 3 CALCULATION OF ORE RESERVES

3—1 Method of calculation of ore reserves

Before the calculation of ore reserves, the graph in which the ratio of Sol-Cu(%) concerning To-Cu(%) on a cross axis and frequency on a vertical axis in the chemical analysis of each 1m of drilling core is shown in Fig. II-3-1-1. The Sol-Cu ratio concerning To-Cu shows the gap between 0.1 and 0.2 on the graph. The ores can be defined as sulfide ore is less than 10% of the Sol-Cu ratio concerning To-Cu. Oxide ore at more than 20% of the ratio. Although there are many parts which are defined as mixed ore, because copper oxide minerals and copper sulfide minerals closely coexist, the distribution of these mixed parts are not spacially big.

The method of calculation of ore reserves is as follows;

① At first, ore deposits are divided into the following five ore bodies; The upper, lower, middle, east and west ore body, respectively. However, since three other ore bodies are rich in sulfide minerals, the total number of ore bodies is eight, in addition to the above five ore bodies.

② Average Cu grades of each 10m in depth were calculated by chemical analysis of each 1m in drilling cores. The values were defined as the grade of each 10m of ore body. The values of chemical analysis of each 1m and each 10m on the section are shown in Fig. II-3-1-2(1) & (2).

③ All the grades were assigned as a unit block which is 25m×25m(plan) × 25m (depth) in all the ore bodies. The assigning method was the distance inverse-square method, because variogram was impractical by geo-statistic method.

④ The actual range of data assignment was a sphere of 400m radius. The reason was that the range of influence in the variogram of the NE-SW direction on the plane. However, the rauge of 400m is necessary to further examine.

⑤ Assigned grades are total Cu, soluble Cu and insoluble Cu. The example of assigned grades and ore body are shown if Fig. II-3-1-3(1) & (2). The average assignment in each block is shown in Fig. II-3-1-4. Specific gravity varies from 2.7 to 3.3, the value of 2.7 is adopted as specific gravity for safety.

As the result, 87,692,000tons of ore reserves and To-Cu 0.54%(Cut-off grade 0.4%) were estimated. The lowest level, including ore reserves, is 820mL above sea level. Refer to the colored figure of grades of blocks on the plan about assigned grades in all the blocks.

In addition to the calculation, designing the open pit was carried out by

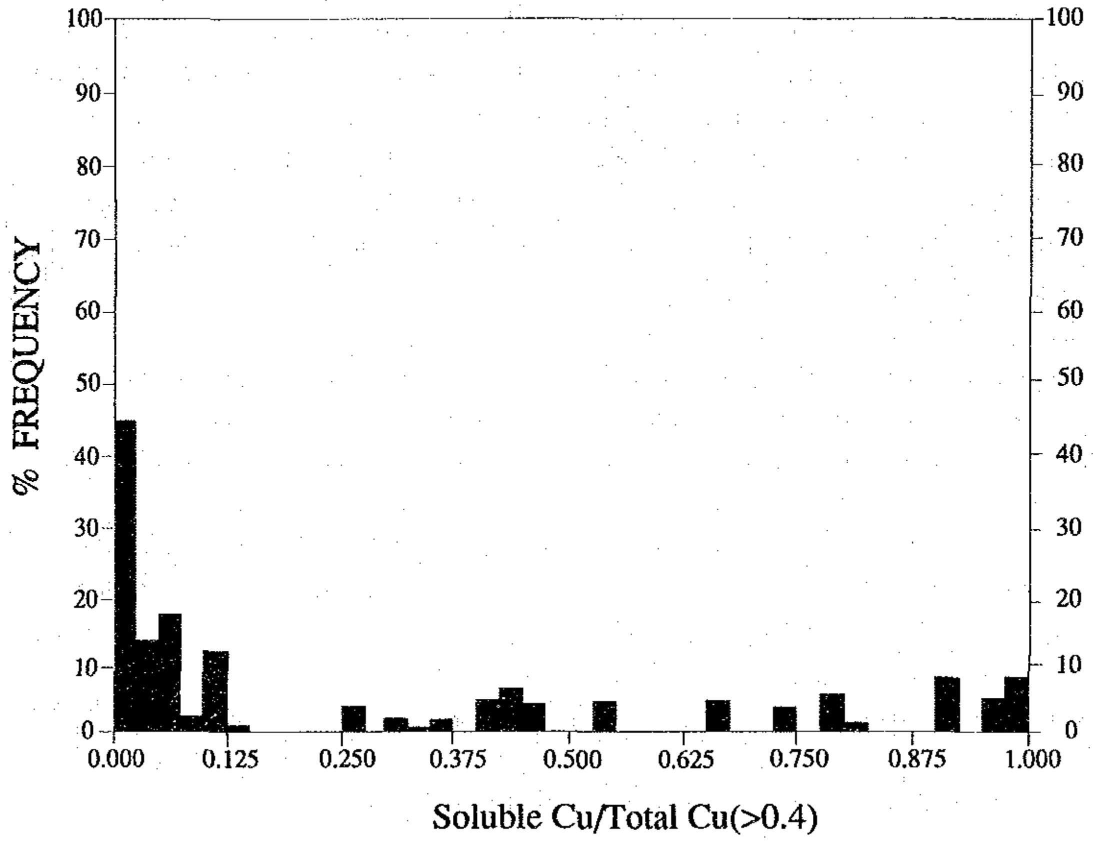

Fig. Ⅱ-3-1-1 Histogram of Soluble Cu/Total Cu

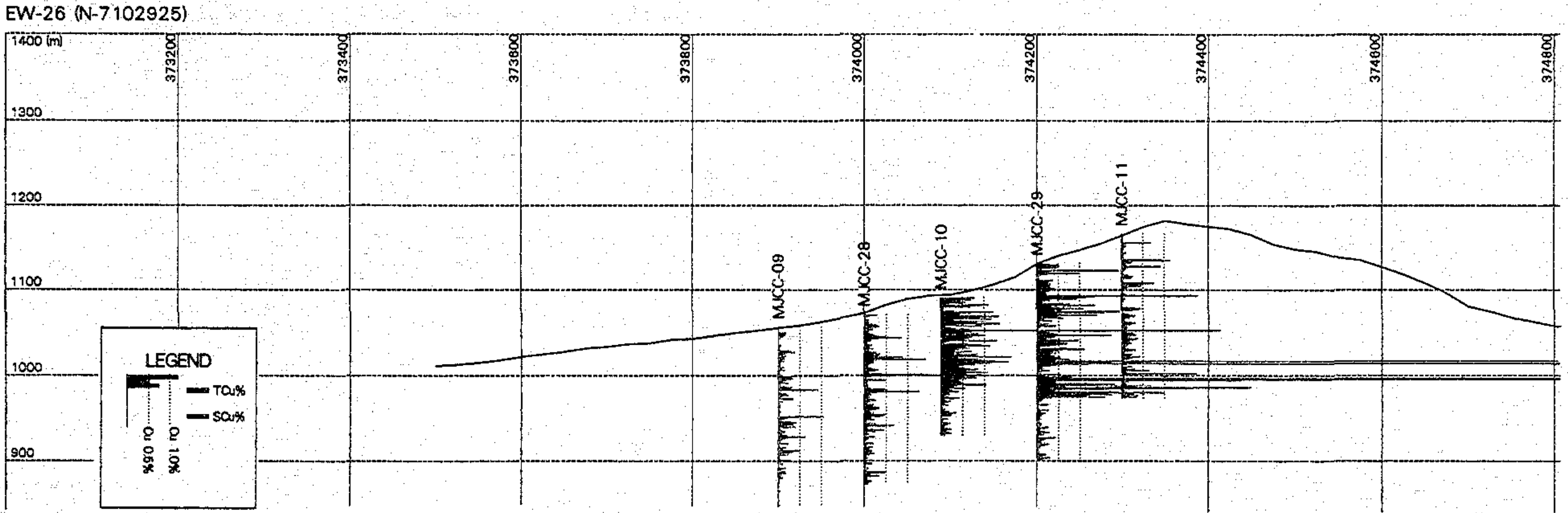

Fig. II-3-1-2(1) Cross Section of Cu Assay(every 1m on drilling core)

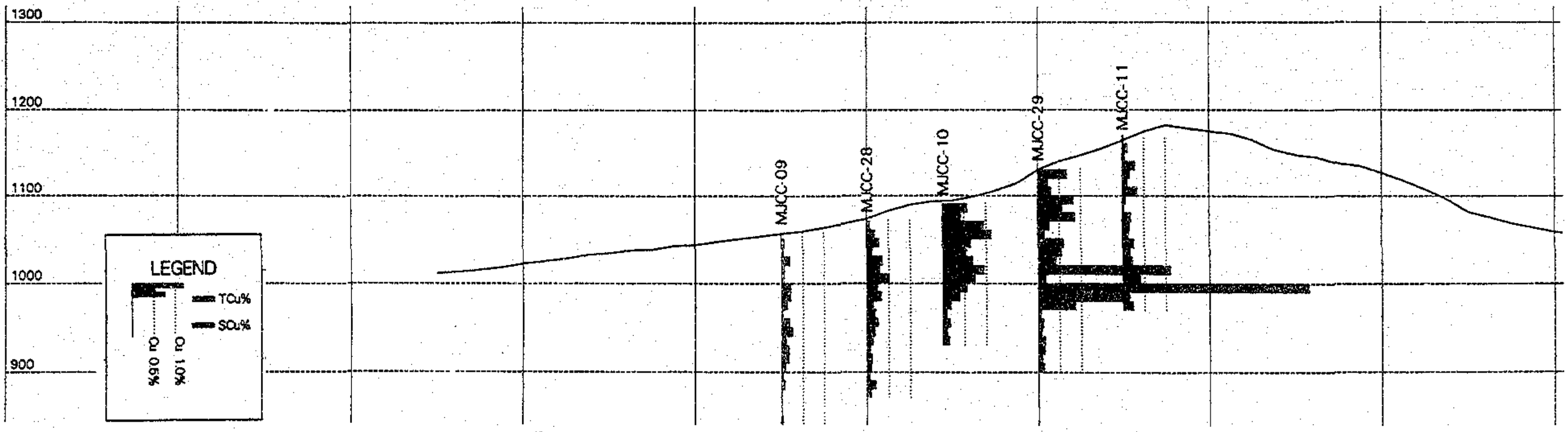

Fig. II-3-1-2(2) Cross Section of Cu Assay(every 10m on drilling core)

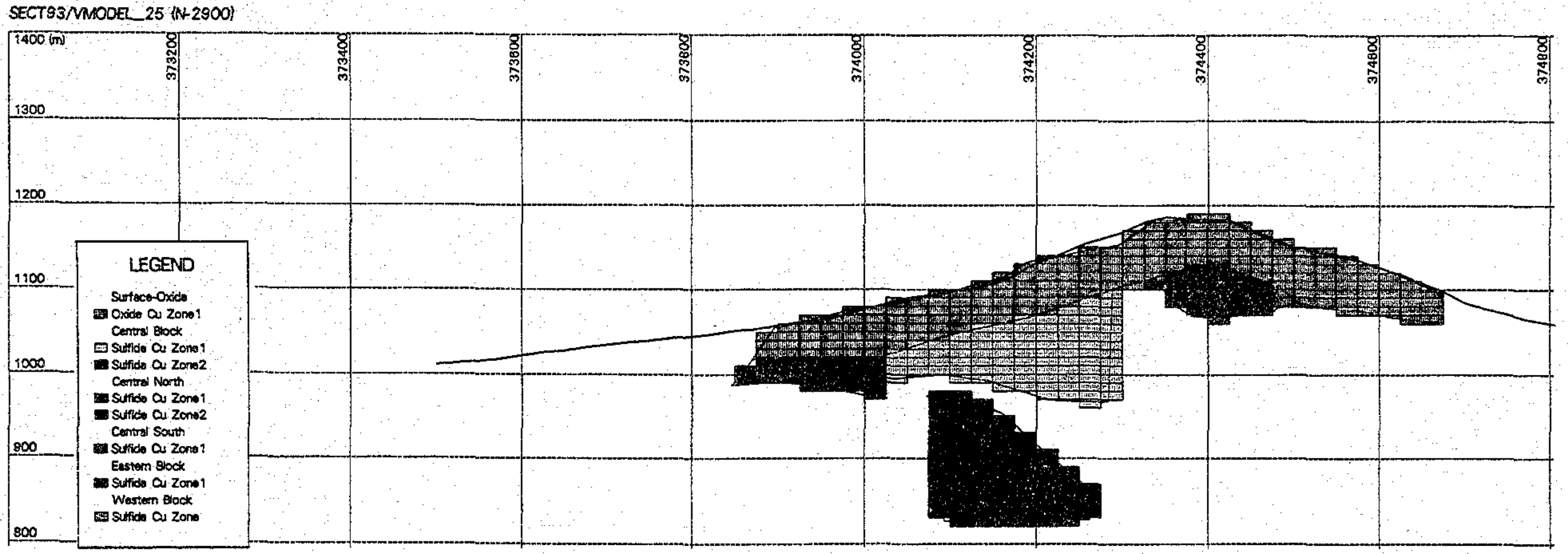

Fig. Ⅱ-3-1-3(1) Cross Section of Ore bodies Assigned to Each Block

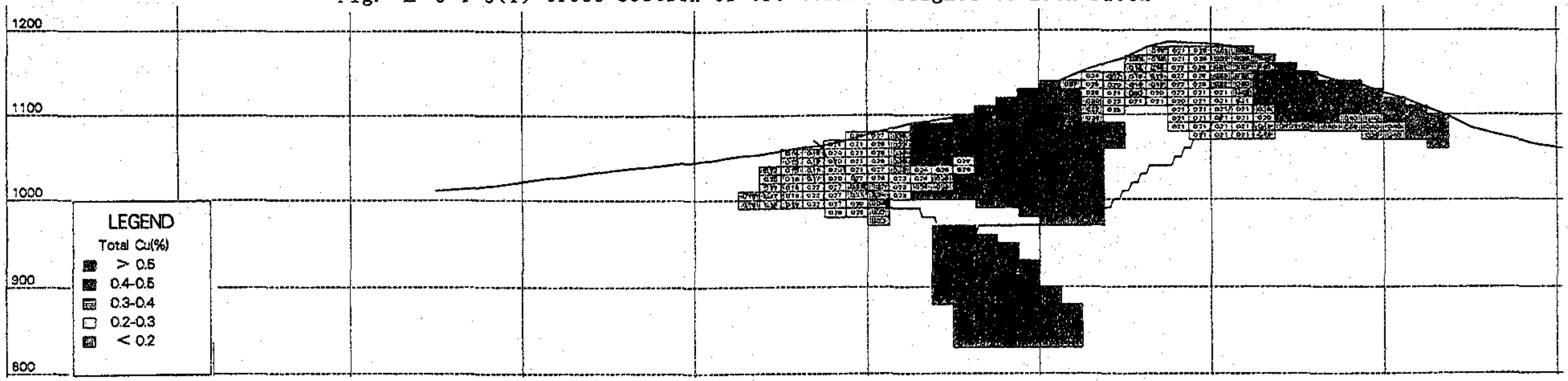

Fig. Ⅱ-3-1-3(2) Cross Section of Cu Assay Assigned to Each Block

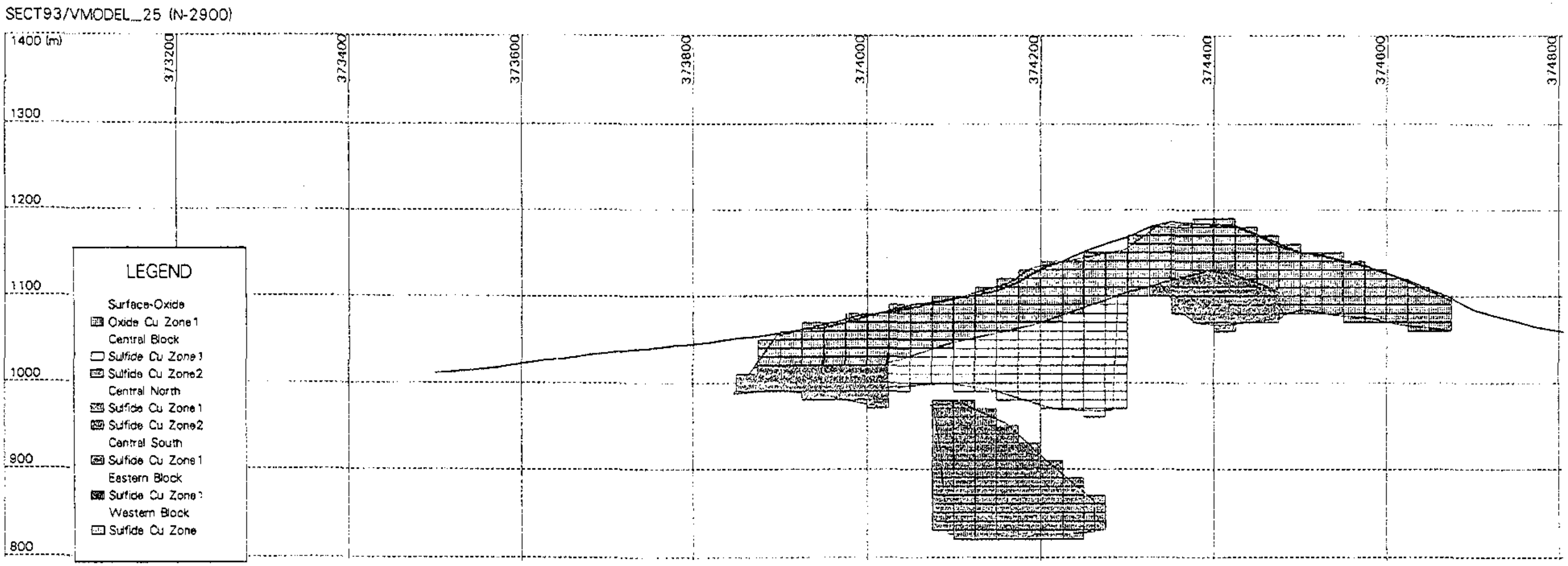

Fig. II 3 1 3(1) Cross Section of Ore bodies Assigned to Each Block

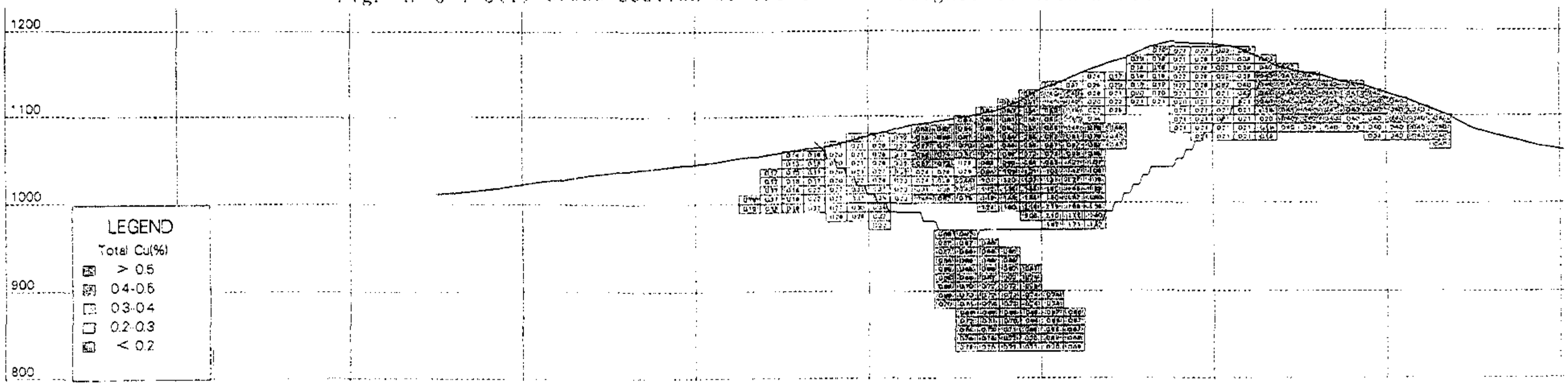

Fig. II 3 1 3(2) Cross Section of Cu Assay Assigned to Each Block

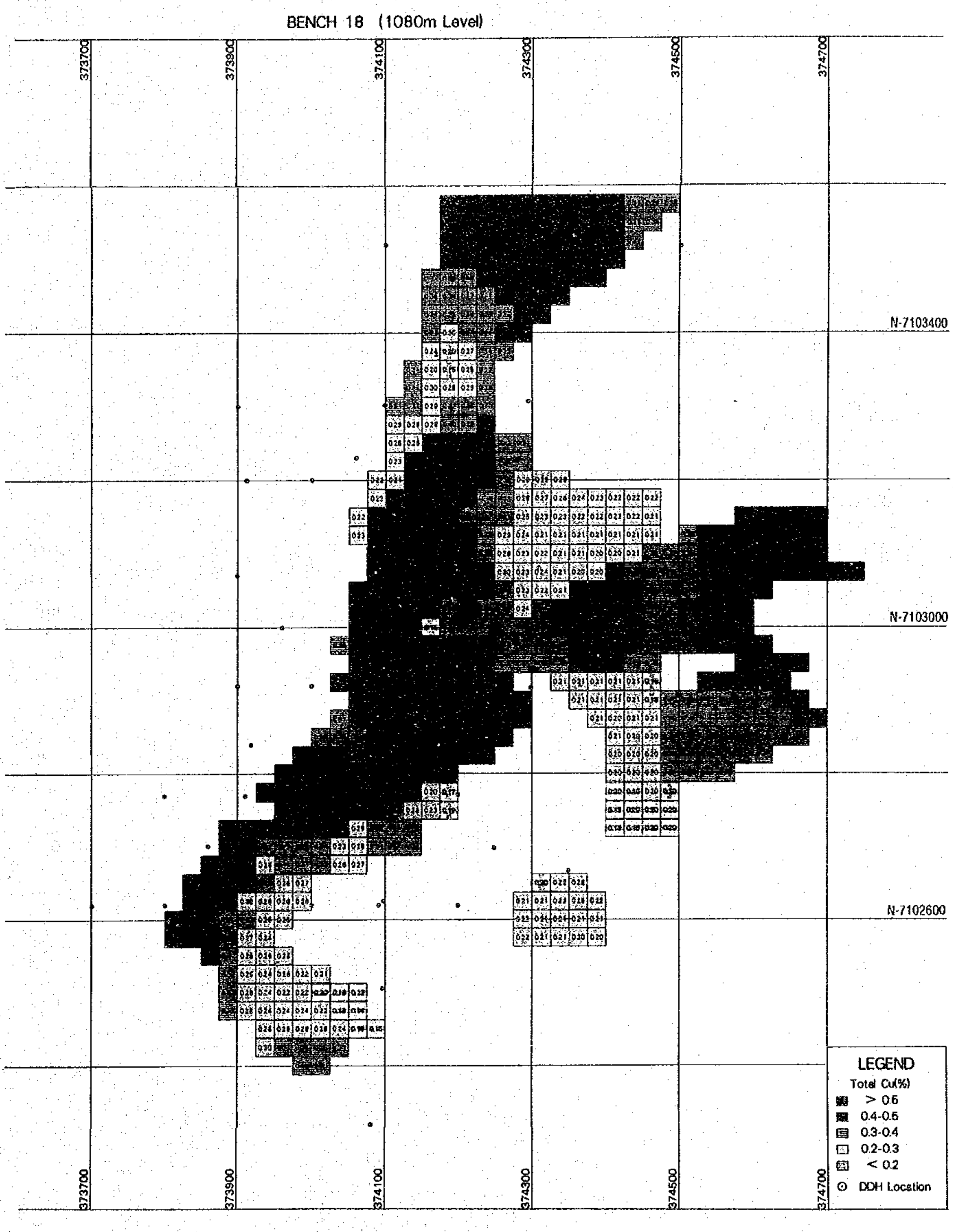

Fig. II-3-1-4 Cu Assay Map Assigned to Each Block

Fig. II 3 1 4 Cu Assay Map Assigned to Each Block

Moving Cone Method under the following supposition:

① Cut-off grade is 0.4%(Total Cu).

② Total mining recovery is 80%.

③ Copper price is US$1.05/Pound. Though this price is significantly higher than the actual price, it is considered better that the setting up of an open pit is larger.

④ Total expences of mining, metallurgy, refining, shipping and sales, etc, are US$6.91/ton of ore.

⑤ Pit slope is 45°, road width within the pit is 20m, and the road slope is 45°.

The result is shown in Fig.I-4-5-1.

The ore reserves within the open pit are considered to be minable reserves 33,787,120tons(To-Cu grade is 0.61%) are estimated. In this case, the lowest level is 960mL above sea level.

3—2 Results of calculation of ore reserves

The summary of ore reserves and minable ore reserves is shown in Table I-4-5-1. Detail of minable ore reserves is shown in Table II-3-2-1.

3—3 Consideration

Although variogram was made before calculation of ore reserves, the variogram shows impractical features. This means that the drilling interval of 100m was too wide to examine the occurrences of ore deposits. However, if the drilling interval was narrowed one half, it would be very difficult to obtain realistic variogram because of the complicated features of the ore deposits

The calculation was carried out with the sphere with 400m radius in ore grade decision in each block. However, the decision of 400m radius was fairly flimsy. Further examination will be necessary.

Ore reserves of oxide ore body markedly decrease when the grade of ore becomes higher. On the other hand, decreasing rate of sulfide ore reserves is moderate in calculation ore reserves. Therefore, the target ore body must be sulfide ore body in next project.

Table II -3-2-1 Summary of Calculation of Economical Exploitable Ore Reserves

Minable Oxide Ore Reserves

Cut-off grade (To-Cu %)	0.0000	0.2000	0.3000	0.4000	0.5000	0.6000	0.7000	0.8000
Ores (t)	39,411,100	38,392.736	31,843,674	24,175,456	13,378,579	4,289,118	596,869	125,719
Volume (cubic meters)	14,596,704	14,219,532	11,793,954	8,953,874	4,955,030	1,588,562	221,062	46,562
Average grade (To-Cu %)	0.436	0.443	0.481	0.522	0.581	0.656	0.781	0.970

Minable Sulfide Ore Reserves

Cut-off grade (To-Cu %)	0.0000	0.2000	0.3000	0.4000	0.5000	0.6000	0.7000	0.8000
Ores (t)	20,080,660	18,214,288	13,570,201	9,611,663	6,385,162	5,149,575	4,882,275	4,430,869
Volume (cubic meters)	7,437,282	6,746,032	5,026,000	3,559,875	2,364,875	1,907,250	1,808,250	1,641,062
Average grade (To-Cu %)	0.543	0.581	0.697	0.842	1.040	1.162	1.190	1.235

Waste (in the proposed open pits)

weight (t)	15,570,548
Volume (cubic meters)	5,766,870
Average grade (To-Cu %)	0.0000

Total of Minable Ore Reserves

Cut-off grade (To-Cu %)	0.0000	0.2000	0.3000	0.4000	0.5000	0.6000	0.7000	0.8000
Ores (t)	75,062,304	56,607,024	45,413,876	33,787,120	19,763,740	9,438,694	5,479,144	4,556,588
Volume (cubic meters)	27,800,856	20,965,564	16,819,954	12,513,749	7,319,904	3,495,812	2,029,312	1,687,625
Average grade (To-Cu %)	0.374	0.487	0.545	0.613	0.729	0.932	1.145	1.228

CHAPTER 4 PRE-FEASIBILITY STUDY

4 — 1 Method and supposition

Pre-feasibility study for production of commercial basis by the DCF methd was carried out based on the results of calculation of ore reserves, dressing test and collected information for calculation of construction expenses and operation expenses.

Minable ore reserves of 33,787,000tons in case of 0.4%(To-Cu) of Cut-off grade was adopted as the base case in this study. The break down of the minable ore reserves is as follows; Amounts of oxide ore is 24,170,000tons(To-Cu 0.522%), sulfide ore is 9,610,000tons(To-Cu 0.842%), respectively. Large amount of mining of low grade of ore coincides the purpose of this study. Around 0.6% (to-Cu) is considered to internationally proper as low grade of ore. In case of small amount of mining of high grade ore, the location of each ore grade can be recognized in the map of ore grade of each block in the attached information. Although specific gravity of ore minerals varies from 2.7 to 3.3, value of 2.7 is selected as specific gravity of ore minerals for safety.

The details of proposed flow sheet based on the metallurgical tests is described in Chapter 2, Part II. The outline is described here again.

The calculation was carried out on the basis of 10 year's life time of this mine. Since the longest depreciation terms of mine facilities are eight years, performance of maximum production within the term is the most prefarable mining.

Internal rate of return was calculated by the DCF method based on the exploitation, operation and other expenses which are described later. The variation of IRR was also estimated by the sensitivity analysis. At the calculation by the DCF method, the expression such as +1 fiscal year as commencement of production, +10 fiscal year as completion of operation and -3 to -1 fiscal year as preparation term of production was used, and avoid 0 fiscal year.

4 — 2 Development plan

1) Mining section

① Minable ore reserves

Initial conditions are as follows:

Minable ore reserves are 33.8 million tons, waste is 41.3 million tons, production Cu grade is 0.61%(Cut-off grade o.40%) and final ratio of waste:ore is W:O=1.20:1.0.

Two pits are constructed. the first pit is located in the northeastern side and the second pit is in the southeastern side. The bench whose hight is 10 m is installed in the first pit between 1,180mL and 960mL above sea level.

The pit whose hight is 10m is also installed in the second pit between 1,220mL above sea level and SL+990m.

The maximum inclination of the pits is θ=45 ° ,and the inclination of working slope is θ=about 25 ° .

Mining plan is completed considering to working slope, width of mining, amounts of ore and waste, grade of crude ore, maximum amount of mining at a face. The number of faces of daily operation are set as ore:waste=1:1.

The ore within pit is roughly divided into oxide ore and sulfide ore.The two kind ore are separately mined, carried out and treated. Ore reserves within the pits(minable ore reserves) will be mined during ten years. The minable ore reserves is as follows:

Ore minerals	oxide ore minerals sulfide ore minerals sub-total	24,170 thousand tons 9,610 thousand tons 33,780 thousand tons	To-Cu 0.522% To-Cu 0.842% To-Cu 0.613%
Waste		41,280 thousand tons	
Ore+waste(Material)		75,060 thousand tons	

The lower ore body which is mainly composed of sulfide minerals lies under the first pit. Almost all the ore body must be the target of underground mining. However, since the details of the lower ore body is indistinct, only minable ore reserves by open pit mining is the target of this study.

② Drillig and blasting

The angle of drilling for charging is 70° . The diameter of drill hole is 6 1/8"(155mm) and the depth is 12.0m(including 1.4m of sub-drill length). The separation of holes is 5m.

Blasting is carried out using MS fuse, slutty explosives and ANFO, and is performed at two positions once a day.

Drilling ia carried out by DHD(Down the Hole Drill). Drilling rate is 150m/. Amount of explosives is 128/t, and amount of breaking ground at one explosion is estimated 12,000t.

Drilling machine with diameter of 6 1/8"(155mm) caliber, front-end loader with backet capacity of 4.0m third class and dump truck with 46tons loading capacity are mainly used.

The auxiliary machines are prepared for the maintenance of base course and other services.

Major drilling machines

Machine	Specification	Number
drilling machine loading machine dump truck	caliber ϕ=6 1/8""(ϕ155mm) capacity of backet V=4.0m3 power...295 HP loading capacity W=46t power...712 HP	2 3 12

Auxiliary machine

bulldoser backhoe others	weight W=42t power 320 HP capacity of backet V=0.7m2 power 120HP water sprinkler truck(1), service truck(3), patrol car(6)	2 1

③ Loading and transportation

4.0m third class front-end loader with mobility is used in loading of ore and waste.

46t class dump truck is used in transportation. The round-trip distance of both ore and waste is 3,200m and 27minutes cicle time is estimated.

Bulldoser and backhoe are used in readjustment of final walls, assistant work of loading of loader after finishing the blasting, road construction work, maintenance of course and readjustment of tailin dam.

Working rate of loading and transpotation machine

front-end loader dump truck	4.0m third class 46t class	Max 3,000t/ one car & a shift 700t/ one car & a shift

④ Plan of investment

It is shown in Table II-4-2-1.

2) *Metallurgical section*

Oxide ore minerals of the upper ore bodies are seeped out by heap leaching, and cathode copper is producted by electrolysis(EX/EW) and solvent extraction from seeping solution, based on the dressing test of CIMM. Copper concentrate is producted by floatation for sulfide ore minerals of the lower part of the upper ore body and the lower or body. Dressing of mixed ore which is composed of oxide and sulfide minerals is out of consideration due to the small amount of occurrence. 2,420,000tons by leaching and 960,000tons by flotation in a year, total 3,380,000tons, is estimated. Parallel treatments of oxide and sulfide ore mierals are planned from the beginnin of operation.

Table II — 4 — 2 — 1 Plan of Investment in Mining Section

(Amount : 1000US$)

	Items of investment	Unit	Unit price	1st year		5th year		Total	
				Numbers	Amount	Numbers	Amount	Numbers	Amount
Initial Investment	1. Building								
	(1)Office, warehouse, watersupply	Set	200	1	200			1	200
	(2)Repair shop	〃	500	1	500			1	500
	(3)Explosive warehouse	〃	50	1	50			1	50
	Sub-total				750				750
	2. Structure								
	Sub-total								
	3. Machine								
	(1)Drilling machine (φ6•1/8"D.H.D.)	Number	113	2	226			2	226
	(2)Compressor(28m3/min 280HP)	〃	80	2	160			2	160
	(3)Front-end loader (bucket 4m3 295HP)	〃	254	3	762			3	762
	(4)Bulldozer (Weight 42t 320HP)	〃	387	2	774			2	774
	(5)Hydraulic shovel(bucket 0.7m3 120HP)	〃	103	1	103			1	103
	Sub-total				2,025				2,025
	4. Vehicles								
	(1)Dump truck (Carrying 46t 712HP)	Number	455	12	5,460			12	5,460
	(2)Sprinkler truck(Carrying 11t 300HP)	〃	80	1	80			1	80
	(3)Service truck (Carrying 4t 180HP)	〃	30	3	90			3	90
	(4)Service vehicle(120HP)	〃	15	6	90			6	90
	Sub-total				5,720				5,720
	5. Tools								
	(1)Tools	Set	100	1	100			1	100
	Sub-total				100				100
	6. Land								
	Sub-total								
	Total				8,595				8,595
Additional Investment	1. Building								
	(1)Office, warehouse, watersupply	Set							
	(2)Repair shop	〃							
	(3)Explosive warehouse	〃							
	Sub-total (Described in Metallurgical)								
	2. Structure								
	Sub-total								
	3. Machine								
	(1)Drilling machine (φ6•1/8"D.H.D.)	Number	113			2	226	2	226
	(2)Compressor(28m3/min 280HP)	〃	80			2	160	2	160
	(3)Front-end loader (bucket 4m3 295HP)	〃	254			3	762	3	762
	(4)Bulldozer (Weight 42t 320HP)	〃	387			2	774	2	774
	(5)Hydraulic shovel(bucket 0.7m3 120HP)	〃	103			1	103	1	103
	Sub-total						2,025		2,025
	4. Vehicles								
	(1)Dump truck (Carrying 46t 712HP)	Number	455			12	5,460	12	5,460
	(2)Sprinkler truck(Carrying 11t 300HP)	〃	80			1	80	1	80
	(3)Service truck (Carrying 4t 180HP)	〃	30			3	90	3	90
	(4)Service vehicle(120HP)	〃	15			6	90	6	90
	Sub-total						5,720		5,720
	5. Tools								
	(1)Tools	Set	100						
	Sub-total								
	6. Land								
	Sub-total								
	Total						7,745		7,745
Total					8,595		7,745		16,340

① Leaching and EX/SW

The facilities are divided into comminution plant, leaching heap, solvent extraction plant and electrolysis plant. The main machines are 42 x 70inch gyratory crusher, 5feet standard cone crusher, 5feet short head cone crusher (3), aggromerater, 10t truck(6) mixer settler(2 extraction, 2 washing, 2 reverse extraction) and copper electrolysis tank and so on.

Particle size by crushing is less than 1/4 inch, leaching term is about one month. slime after seeping is kept in existing place and only sprinkler moves. All the solution is circulated within the system, and insufficiency by evaporation is supplied.

Cathode copper which is producted is conveyed to dressing plant in Chile or Barquito port(Chanaral).

Estimated copper recovery is 72%.

② Flotation plant

The crushing plant is supplied from leaching plant. The flotationd plant is composed of grinding plant, flotation plant and dehydration plant. The major machines are ball mill(4.72mϕ x 4.57mL/375KW Motor), roughing flotator(500cubic feet x 8cells), re-wearing ball mill(2.89ϕ x 2.74mL/375KW Motor), cleaning and scavenging flotator(total 100cubic feet x 8cells), concentrate thickner (20feet ϕ) and concentrate filter(6' x 4').

Finess of final grinding product(80% pass) is 115 micron. Method of flotation is plain flotation of copper. Cleaning and scavenging flotation are carried out.

Producted copper concentrates are conveyed to the rifinery in Chile or Barquiro port(Chanaral) by truck.

Estimated grade of copper concentrates is cu 35%, Au 5g/t and Ag 11g/t. Copper recovery is 93%.

③ Tailing diposal instruments

Tailing of flotation is sent through drain pipe by pump after concentration by tailing thickner. The length of pipeline is 3km. Overflow of tailing thickner and decant water is circulated within system, and is used as treatment water. 45% of the treatment water is circulated.

④ Plan of investment in metallurgical section

Described later with machinery section.

3) Machinery section

Construct the following facilities and insruments in the early stage:

A transformer substation, power transmission lines, comunication facilities, pumping wells(in Veraguas area), water supply pipeline(40km), water tanks, maintenance workshop, central office(including refectory) and storehouse. Jeeps and buses are purchased in the early stage, and additional investment is made in seventh year. Secure houses for rent in Chanaral as company houses.

① Electricity; Anual demand for electricity at a point of commencement of leaching and SX/EX of sulfide ore minerals is estimated about 103,000MWH, and maximum demand of electricity is estimated about 21MWH. The electricity is branched and supplied by the existing high voltage power line(132KV) which is installed 1km from the planned plant, and the electricity is purchased. The transformer substation for receiving electricity is constructed, and power line is installed.

② Comunication facilities; Radio communication equipment is installed in order to communicate within and out of mine.

③ Instruments of water supply; 298 litter/sec(17.9 cubic meter/min) of fresh service water water including for industrial use will be necessary. Present water sources are overflow water(300 litter/sec) from the tailing dam of El Salvador mine which flows down about 20km south or well water(500 litter/sec) of ENAMI's water resource located 40km north. There is no information about water quarity of both water source. About 45% of necessary water is circulated within mine facilities. It is necessary to secure electricity for pump operation.

④ Maintenance workshop; Workshops of machine maintenance, electric equipment and car maintenance will be constructed neighboring dressing plant.

⑤ Access road;As planned mine is neighboring the existing main local road(not paved), road construction within mine premises is the main construction work.

⑥ Incidental facilities; Mine office, storehouse, refactory, locker room, laboratory, service water network, fire hydrants, drainage treatment and so on are constructed. Cars for official use such as jeep and bus are purchased.

⑦ Company house and welfare facilities; Since the mine is 50km from Chanaral, employers come from Chanaral by bus.

⑧ Plan of investment;

Described here with metallurgical section.

	-2nd year	-1 year	7th year	Total
buildings		4.10		4.10
structure	10.30	12.57		22.87
machines		12.58		12.58
vehicles	1.00	1.80	1.20	4.00
tools		2.90		2.90
land				
Total	11.30	33.95	1.20	46.45

(unit;million US$)

Arrangement of mine facilities is shown in Fig. II-4-2-1.

4—3 Operation plan

1) Production plan

① Mining amount; Copper oxide ore minerals 2,417 thousand tons/year (To-Cu 0.522%)

Copper sulfide ore minerals 961 thousand tons/year (To-Cu 0.842%)

Waste 4,128 thousand tons/year

Plan of mining is shown in Fig. II-4-3-1.

② Production; Copper oxide ore(recovery 72%)

--->Cathode Copper 9,110tons/year (Cu 99.99%)

Amount of copper 9,109tons

Copper sulfide ore(recovery 93%)

--->Copper concentrate 21,500tons/year (Cu 35.0%)

Flow sheet of ore treatment is shown in Fig. II-4-3-2.

2) Plan of personnel

Personnel administration with personnel expenses is shown in Table II-4-3-1 (Table of personnel administration). Drilling is entrusted with subcontractor.

3) Operation expenses

Operation expenses except personnel expenses is shown in Table II-4-3-2.

4—4 Financial plan

1) Outline

(1) Outline

Income and expenditure in this report is that of the newly established mining company with joint contribution of ENAMI and foreign enterprises. The exploitation of these copper deposit is carried out by the newly established company.

Therefore, Acquisition expenses of mining right and so on are left out of consideration in the capital.

(2) Cash flow of each fiscal year was calculated after investment to the ore deposits exploitation from one fourth of capital. The balance after the investment is supplied by long-term accurued amount payable.

(3) Income tax, tax privilege in foreign investment, incentive and so on which had been confirmed to be possibly adopted at a point of time December, 1993,

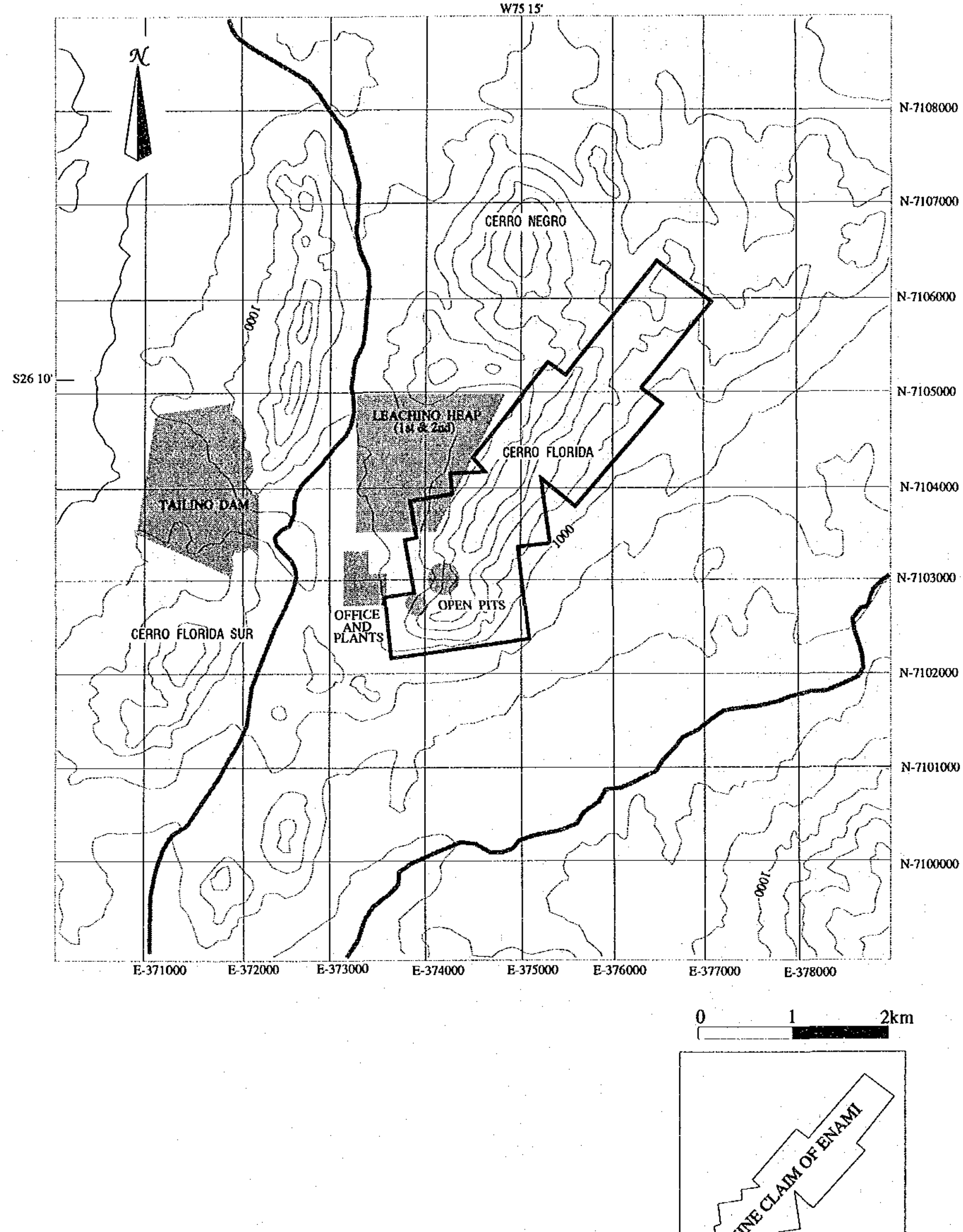

Fig. II-4-2-1 Supposed Arrangement of Mining Facilities

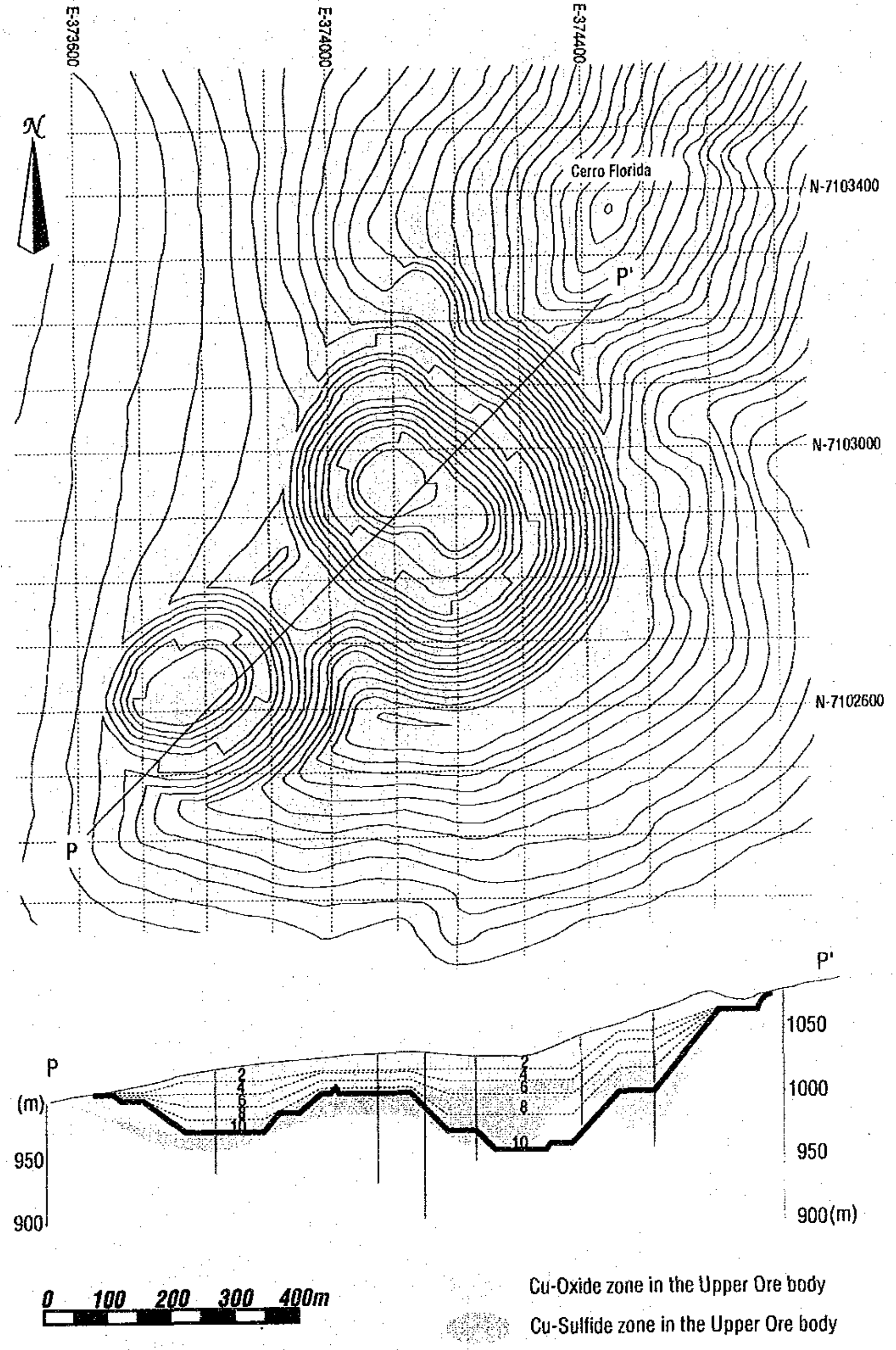

Fig. II-4-3-1 Map of Mining PLan

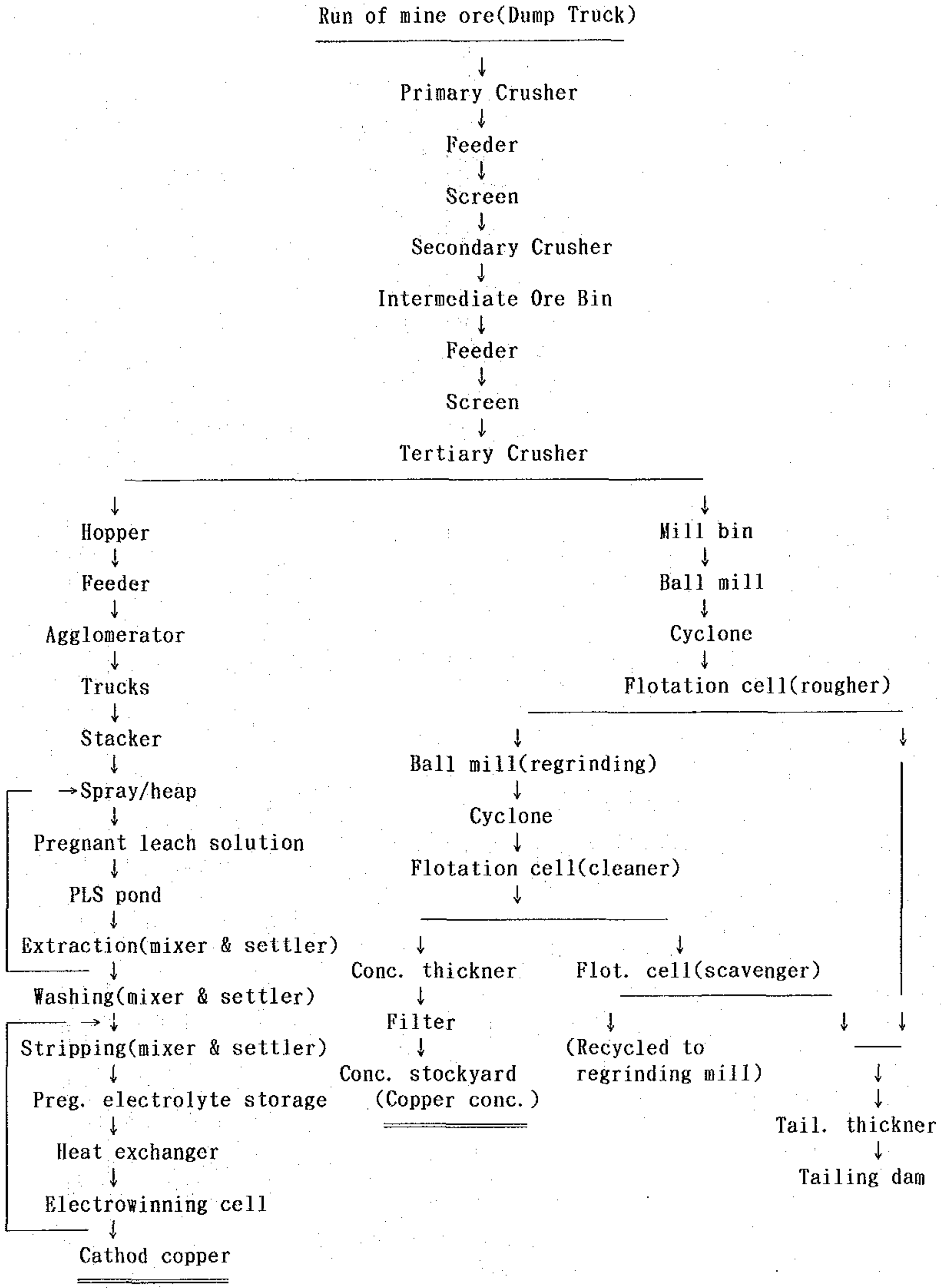

Fig. II—4—3—2 Flowsheet of Ore Treatment

Table II—4—3—1 Plan of Personnel

Items	Unit price (US$/Month)	-3rd year		-2nd year		-1st year		+1st～+10th year	
		Numbers	Amount (US$/Year)	Numbers	Amount (US$/Year)	Numbers	Amount (US$/Year)	Numbers	Amount (US$/Year)
Mining section									
Manager	3,900					1	47,000	1	47,000
Staff	1,825					2	44,000	3	66,000
Foreman	650					2	16,000	5	39,000
Worker	305					10	37,000	55	201,000
Sub-total						15	144,000	64	353,000
Metallurgical sec.									
Manager	3,900	1	47,000	1	47,000	1	47,000	1	47,000
Staff	2,500			2	60,000	2	60,000	3	90,000
Foreman	650					5	39,000	9	70,200
Clerk	400					3	14,400	4	19,200
Worker	305							156	570,960
Sub-total		1	47,000	3	107,000	11	160,400	173	797,360
Machinery section									
Manager(concur.)									
Staff	2,500			1	30,000	1	30,000	1	30,000
Foreman	650					4	31,200	4	31,200
Clerk	400							1	4,800
Worker	305							45	164,700
Sub-total				1	30,000	5	61,200	51	230,700
Administrative sec									
Director	6,000	1	72,000	1	72,000	1	72,000	1	72,000
Manager	3,900					1	46,800	1	46,800
Ass. manager	2,500	2	60,000	2	60,000	2	60,000	5	150,000
Clerk	400					3	14,400	10	48,000
Sub-total		3	132,000	3	132,000	7	193,200	15	316,800
Total		4	179,000	7	269,000	38	558,800	303	1,697,860

Table II—4—3—2 List of Operation Cost

[Mining section]

Materials & expenses	Unit	① Unit price (US$)	② Used quantity per material 1 ton	Amount per material 1 ton (US$)	③ Material production (t/Year)	Amount per year (①×②×③) +1～+10year (US$)
1. Light oil	liter	0.26000	0.3710000	96.456168	7,506,000	724,000
2. Oil and fats	set			19.451106	(Ore :3,378,000)	146,000
3. Drill bit	number	800.00000	0.0000225	17.985612	(Waste:4,128,000)	135,000
4. Drill rod	set	1500.00000	0.0000090	13.455902		101,000
5. Detonator	set	1.94000	0.0015000	2.930989		22,000
6. Slurry explosive	gram	0.00250	0.7500000	1.865175		14,000
7. AMFO	gram	0.00040	128.0000000	51.159073		384,000
8. Tire, spare parts	set			88.062883		661,000
Sub-total(material)				291.366906		2,187,000
1. Electrical	KWH	0.08000	0.0200000	0.001600	7,506,000	12,000
2. Water					(Ore :3,378,000)	
3. Maintenance					(Waste:4,128,000)	
4. Depreciation						
5. Others						
Sub-total(expenses)				0.001600		12,000
Total				291.368506		2,199,000

[Metallurgical and machinery section] (+1st year～ +10th year)

Material

- Ball & reagent 6,344,000 US$/Year
- Others 990,000 US$/Year

Expenses

- Electrical power 6,454,000 US$/Year
- Others 1,944,000 US$/Year

[Administrative section]

	-3rd year	-2nd year	-1st year	+1st～+10th year
Materials and expenses (US$/Year)	113,000	113,000	158,000	259,200

Total of materials and expenses in administrative section was calculated as 45% of whole expenditures of the section.

was incorporated in calculation of this income and expenditure,
(4) DCF-R(profit by DCF)for evaluation of profit was calculated as cash-flows in two stages, those are, one is before interst, and the other is after interest.

2) Supposition of income and expenditure calculation.
(1) A point of evaluation time

All the factors such as facilities, production costs and so on are the costs at December, 1993. Escalation and inflation of prices of commodities during terms of exploitation and mininng operation were left out of consideration.

(2)Production(Copper concentrate and electrowinning copper)

Production of copper concentration is 21,500tons, Cu 35%, Au grade 5g/t, Ag grade 11g/t.

Inpurities which obstacles of ore treatment process such as As, Co, Ni are not included

Electro winning copper production is 9,110tons, Cu grade 99.99%.

(3) Life of mine

Life of mine is ten years except a term of preparation.

(4) Income

All the producted copper concentrates and electrowinning copper are exported under the following conditions.

a. Copper conncentrate

(a) Valuable metal	Cu(lb/DMT), Au(Oz/DMH), Ag(Oz/DMT)
(b) Official quotation	Cu:90¢, 110¢, 130¢/lb (three level)
	Ag:400$/Oz only
(c) T/C	Cu:95$/DMT, CIF Japan
(d) R/C	9.5¢/lb(P.P.=90¢/lb base)
(e) R/C Scale	±10%(P.P.=90¢/lb base)
	Au:6$/DMT
(f) Grade condition	Cu:1 Unit less,(grade-1%)/grade
	Au:94%
(g) Payment	Prov 90% 10 days after arrival at Japan

(Remarks)

The sales conditions of this estimation are at a point of December, 1993. The costs of smelting, refining and R/C is changeable by rising of energy costs and other factors. In such case, this mining company negotiate to change conditions of contract of ore treatment based on the sales contract to each treatment company.

b. Electro winnig copper

(a) Valuable metal　　Cu(lb/DMT)
(b) Official quotation　　Cu:90¢, 110¢, 130¢/lb (three level)
(c) T/C　　Cu:95$/DMT, CIF Japan

c. Transportation of production

(a) concentrate loss　　2%(before shipment 1%, after shipment 1%)
(b) transportation cost　　6.5¢/km
(c) moisture content　　8%
(d) marine transport　　42$/WMT(Chile Barquito port ~Japan)
(e) embarkment　　5$/WMT(at Chile Barquito port)
(f) marine insurance　　FOB cost×0.264%

(5) Depreciation

a. Initial investment, additional investment and renewal cost was calculated by fixed amount depreciation method(actually depreciate 100%, memorandum 1 Peso) which is regulated by cooporation income tax law.

b. Depreciation rate and depreciation term was calculated by special depreciation of tax privilege.

	ordinary depreciation		special depreciation	
	term	rate	term	rate
(a) Building(permanent	25 years	4%	8 years	12.5%
(b) ditto(temporary)	10	10.0	3	33.3
(c) structure	5	20.0	1	100.0
(d) machinary	10	10.0	3	33.3
(e) vehicle	7	14.3	2	50.0
(f) tools(heavy)	10	10.0	3	33.3
(g) tools(light)	5	20.0	1	100.0

(6) Capital

One fourth of initial investment is supplied during three years according to the expenditure. The interest of Capital is left out of consideration.

(7) Loans payable

a. All the rising fund is long-term loans payable except capital within initial investment(fund of facilities). The loans is gathered according to the expenditure of preoaration term.

b. Initial working fund(estimated 50% of total anual expenditure except interest and depreciation cost) is supplied by short-term loans payable, and yearly insufficiency(delayed income+balance of expenditure) is also supplied by short-term loans payable.

c. Japan raises long and short-term loans payable, and finances to Chilean mining company. The interests of loans are estimated 7.5%(5%/70%=7.1%+ α) for long-term loans and 5.5%(3.5%/70%=5.0%+ α) for short-term loans, respectively, in consideration of the deposition(30% of total fund) in the Chile National Bank.

This calculation was carried out under the following supposition;

Initial working fund is transfered into the cash-flow of the final fiscal year. Short-term loans payable are returened in final fiscal year. In addition, long-term loans, which remains payment limit, are also returned in the final fiscal year.

(a) long-term loans payable	Borrow at the middle of the year/ return at the middle of the year. Unredeemable for two years, equally return for five years. Interest returning is six months after.
(b) short-term loans payable	Borrow at the end of the year/ return at the end of the two years after. Terms of loans are one year Interest returning is six months after.

(8) System of taxation(major taxations)

(a) Income tax(person(=progressive taxation), Coporation)

(b) Value-added tax(IVA)

(c) Stamp duty(0.1～1.2% of written price)

(d) Fixed property tax(0.2% of estimated value)

(e) Donation tax and inheritance tax(1.0-25% of progressive taxation)

(f) Special sales tax(luxuries, liquors, beverage, tobacco, used car< etc)

(9) Income tax

Application of cooporation tax is principle. The cooporations which are approved for the rule of foreign investment low are able to apply.

a. Cooperation tax

(a) Basic tax rate 15%

(b) Remittance of profit 35%
(dividends, etc)

b. Foreign investment low

(a) Basic tax rate 15%

(b) Remittance of profit 35%
(dividends, etc)

(c) Applied for ten years after commencement of operation, or for twenty years in case of investment more than US$5 million of manufacturing or mining industry.

(10) Value-added tax(IVA)

a. Exemption is applied in export.

b. Exemption is applied in import designated items by the Government of Chile of stckckholder approved by foreign investmment low.

c. Exemption is applied in the interest payment of loans and bond.

d. Basic tax rate 18%

(11) Tariff

Basic tax rate 18%

3) Summary

The DCF calculation was carried out in three cases of 90¢, 110¢ and 130¢ official quotation of copper, and profit rates were also calculated. In this report, the cash-flows in cases of 90¢ and 110¢ are shown in Table II-4-4-1(1) & (2) because the quotation of 130¢ is not realistic. Copper price calculate back to meet zero IRR before interest was 104.3¢/lb. The cash-flow is shown in Table II-4-4-1(3). The summary is as following;

Items	Official quotation of copper		
	90¢/lb	110¢/lb	130¢/lb
Income	288	357	426
Operation expenses	203	203	203
Depreciation expenses	63	63	63
Interest	14	14	14
Profit before tax	8	77	146
Cooperation tax	5	12	22
Profit after tax	3	65	85
DCF-R(before interest)	-6.411%	1.937%	7.537%
DCF-R(after interest)	-8.520%	0.311%	6.133%

(unit;million US$)

DCF-R is used in the same meaning as IRR.

4—5 Consideration

IRRP before interest were calculated under various suppositions, profit was minus and plus in cases of copper price of 90¢ and 110¢, respectively. IRR zero before interest was in case of copper price of 104.3¢. IRR before interest of more than 15% is ordinarily necessary. The copper price which was

Table II-4-4-1(1) Results of DCF Calculation(Cu price;90¢)

(UNIT ; 1,000 us$)

【 Profit & loss statement 】	Total	(-3Y)	(-2Y)	(-1Y)	1Y	2Y	3Y	4Y	5Y	6Y	7Y	8Y	9Y	10Y
Production														
Crude ore (1,000MT)	33,780				3,378	3,378	3,378	3,378	3,378	3,378	3,378	3,378	3,378	3,378
Cu grade (%)	0.61				0.61	0.61	0.61	0.61	0.61	0.61	0.61	0.61	0.61	0.61
Oxide ore (1,000lb)	278,150				27,815	27,815	27,815	27,815	27,815	27,815	27,815	27,815	27,815	27,815
Sulfide ore(1,000lb)	178,390				17,839	17,839	17,839	17,839	17,839	17,839	17,839	17,839	17,839	17,839
Production of Cu Conc. (D M T)	215,000				21,500	21,500	21,500	21,500	21,500	21,500	21,500	21,500	21,500	21,500
Sales quantity of metals	361,910				36,191	36,191	36,191	36,191	36,191	36,191	36,191	36,191	36,191	36,191
Electrowinning Cu(1,000lb)	200,820				20,082	20,082	20,082	20,082	20,082	20,082	20,082	20,082	20,082	20,082
Cu concentrates (1,000lb)	161,090				16,109	16,109	16,109	16,109	16,109	16,109	16,109	16,109	16,109	16,109
Revenue														
Rough revenue	144,980				14,498	14,498	14,498	14,498	14,498	14,498	14,498	14,498	14,498	14,498
Cu concentrates :														
Treating & refining	35,730				3,573	3,573	3,573	3,573	3,573	3,573	3,573	3,573	3,573	3,573
Net revenue	109,250				10,925	10,925	10,925	10,925	10,925	10,925	10,925	10,925	10,925	10,925
Gold : Net revenue	12,810				1,281	1,281	1,281	1,281	1,281	1,281	1,281	1,281	1,281	1,281
Rough revenue	180,740				18,074	18,074	18,074	18,074	18,074	18,074	18,074	18,074	18,074	18,074
Electrowinning Cu :														
Treating & refining	910				91	91	91	91	91	91	91	91	91	91
Net revenue	179,830				17,983	17,983	17,983	17,983	17,983	17,983	17,983	17,983	17,983	17,983
Total	301,890				30,189	30,189	30,189	30,189	30,189	30,189	30,189	30,189	30,189	30,189
Freight	12,860				1,286	1,286	1,286	1,286	1,286	1,286	1,286	1,286	1,286	1,286
Insurance	740				74	74	74	74	74	74	74	74	74	74
Total	288,290				28,829	28,829	28,829	28,829	28,829	28,829	28,829	28,829	28,829	28,829
Expenditure														
Mining cost	25,664	0	0	144	2,552	2,552	2,552	2,552	2,552	2,552	2,552	2,552	2,552	2,552
Metallargical cost	168,292	94	199	279	16,772	16,772	16,772	16,772	16,772	16,772	16,772	16,772	16,772	16,772
Supporting cost	6,601	245	245	351	576	576	576	576	576	576	576	576	576	576
Transportation etc.	2,720	0	0	0	272	272	272	272	272	272	272	272	272	272
Depreciation	62,790	0	10,800	25,306	9,235	5,475	607	606	4,141	4,140	1,880	600	0	0
Interest	14,255	0	0	1,466	3,042	2,583	2,013	1,440	1,180	905	601	497	371	152
Total	280,322	339	11,244	27,546	32,449	28,235	22,792	22,218	25,493	25,217	22,653	21,269	20,543	20,324
Profit before tax	7,968	-339	-11,244	-27,546	-3,620	594	6,037	6,611	3,336	3,612	6,176	7,560	8,286	8,505
Cumulative total		-339	-11,583	-39,129	-42,749	-42,155	-36,118	-29,507	-26,171	-22,559	-16,383	-8,823	-537	7,968
Deduction for loss brought from previous year	20,190	0	0	0	0	594	6,037	6,611	3,336	3,612	0	0	0	0
Limit of deduction for present year	42,749	339	11,244	27,546	3,620	0	0	0	0	0	0	0	0	0
Loss carried to next year	0	339	11,583	39,129	42,749	42,155	36,118	29,507	(22,551)	(8)	0	0	0	0
Corporate income tax (basically 15%)	4,579	0	0	0	0	0	0	0	0	0	926	1,134	1,243	1,276
Net profit	3,389	-339	-11,244	-27,546	-3,620	594	6,037	6,611	3,336	3,612	5,250	6,426	7,043	7,229
Cumulative total		-339	-11,583	-39,129	-42,749	-42,155	-36,118	-29,507	-26,171	-22,559	-17,309	-10,883	-3,840	3,389
【 Capital balance 】														
I N :														
Net profit	3,389	-339	-11,244	-27,546	-3,620	594	6,037	6,611	3,336	3,612	5,250	6,426	7,043	7,229
Depreciation	62,790	0	10,800	25,306	9,235	5,475	607	606	4,141	4,140	1,880	600	0	0
Equity	15,500	339	11,244	3,917										
Loan	52,602	0	500	41,368	0	0	33	485	8,422	594	1,200	0	0	0
Total	134,281	0	11,300	43,045	5,615	6,069	6,677	7,702	15,899	8,346	8,330	7,026	7,043	7,229
O U T :														
Investment	62,790	0	11,300	42,545	0	0	0	0	7,745	0	1,200	0	0	0
(Interest during construction)	(0)	( )	( )	(1,466)										
Short term loan repayment	5,312	0		500	3,023	0		33	485	677	594	0	0	0
Long term loan repayment	47,290	0	0	0		7,669	7,669	7,669	7,669	7,669	1,549	1,549	1,789	4,058
Total	115,392	0	11,300	43,045	3,023	7,669	7,669	7,702	15,899	8,346	3,343	1,549	1,789	4,058
Net generated cash	18,889	0	0	0	2,592	-1,600	-992	0	0	0	4,987	5,477	5,254	3,171
Cumulative total		0	0	0	2,592	992	0	0	0	0	4,987	10,464	15,718	18,889
【 C A S H - F L O W 】														
CASH - FLOW (without interest)	17,644	-339	-11,744	-43,319	8,657	8,657	8,657	8,657	912	8,657	6,531	7,523	7,414	7,381
Cumulative total		-339	-12,083	-55,402	-46,745	-38,088	-29,431	-20,774	-19,862	-11,205	-4,674	2,849	10,263	17,644
CASH - FLOW (with interest)	3,389	-339	-11,744	-44,785	5,615	6,069	6,644	7,217	-268	7,752	5,930	7,026	7,043	7,229
Cumulative total		-339	-12,083	-56,868	-51,253	-45,184	-38,540	-31,323	-31,591	-23,839	-17,909	-10,883	-3,840	3,389

Remarks

Grade 0.4%
Minable ore reserves 33,780 (To-Cu 0.61%)

Metallurgical recovery
Sulfide ore 93.0%
Oxide ore 72.0%

Sales condition
Sulfide ore 97.1%
Electrowinning Cu 100.0%

Cu-Price	C90.0	Cu-Price	C90.0
T/C	$95.0	T/C	$10.0
R/C	C9.5		
Au-Price	$400.0		
R/C	$6.0		

Chile/Japan $42.0
FOB VALUE 0.236%

Transportation 6¢/t·Km + Handling charge
Fixed amount (100% Depreiation) 5$/MT
Interest
Long term 7.5%
Short term 5.5%

Loss can be carried for 5 years.

Corporate income tax
Basically 15.0%
Dividend 27.0%

(UNIT : 1,000 us$)

Fixed amount (100% Depreiation)
Capital 25.0%

@IRR Internal rate of return
@NPV Net present value

@IRR(before interest)	@IRR(after interest)
Internal rate of return -6.411%	Internal rate of return -8.520%

(UNIT : 1,000 us$)

@NPV(before interest) Rate of return	@NPV	@NPV(after interest) Rate of return	@NPV
5.0%	770	5.0%	-9,881
7.0%	-3,511	7.0%	-13,060
12.0%	-10,433	12.0%	-17,818
15.0%	-12,831	15.0%	-19,225

Table II-4-4-1(2) Results of DCF Calculation(Cu price;110¢)

(UNIT : 1,000 us$)

【 Profit & loss statement 】

	Total	(-3Y)	(-2Y)	(-1Y)	1Y	2Y	3Y	4Y	5Y	6Y	7Y	8Y	9Y	10Y
Production														
Crude ore (1,000MT)	33,780				3,378	3,378	3,378	3,378	3,378	3,378	3,378	3,378	3,378	3,378
Cu grade (%)	0.61				0.61	0.61	0.61	0.61	0.61	0.61	0.61	0.61	0.61	0.61
Oxide ore (1,000lb)	278,150				27,815	27,815	27,815	27,815	27,815	27,815	27,815	27,815	27,815	27,815
Sulfide ore(1,000lb)	178,390				17,839	17,839	17,839	17,839	17,839	17,839	17,839	17,839	17,839	17,839
Production of Cu Conc. (D M T)	215,000				21,500	21,500	21,500	21,500	21,500	21,500	21,500	21,500	21,500	21,500
Sales quantity of metals	361,910				36,191	36,191	36,191	36,191	36,191	36,191	36,191	36,191	36,191	36,191
Electrowinning Cu(1,000lb)	200,820				20,082	20,082	20,082	20,082	20,082	20,082	20,082	20,082	20,082	20,082
Cu concentrates (1,000lb)	161,090				16,109	16,109	16,109	16,109	16,109	16,109	16,109	16,109	16,109	16,109
Revenue														
Rough revenue	177,200				17,720	17,720	17,720	17,720	17,720	17,720	17,720	17,720	17,720	17,720
Cu concentrates : Treating & refining	38,960				3,896	3,896	3,896	3,896	3,896	3,896	3,896	3,896	3,896	3,896
Net revenue	138,240				13,824	13,824	13,824	13,824	13,824	13,824	13,824	13,824	13,824	13,824
Gold : Net revenue	12,810				1,281	1,281	1,281	1,281	1,281	1,281	1,281	1,281	1,281	1,281
Rough revenue	220,900				22,090	22,090	22,090	22,090	22,090	22,090	22,090	22,090	22,090	22,090
Electrowinning Cu : Treating & refining	910				91	91	91	91	91	91	91	91	91	91
Net revenue	219,990				21,999	21,999	21,999	21,999	21,999	21,999	21,999	21,999	21,999	21,999
Total	371,040				37,104	37,104	37,104	37,104	37,104	37,104	37,104	37,104	37,104	37,104
Freight	12,860				1,286	1,286	1,286	1,286	1,286	1,286	1,286	1,286	1,286	1,286
Insurance	910				91	91	91	91	91	91	91	91	91	91
Total	357,270				35,727	35,727	35,727	35,727	35,727	35,727	35,727	35,727	35,727	35,727
Expenditure														
Mining cost	25,664	0	0	144	2,552	2,552	2,552	2,552	2,552	2,552	2,552	2,552	2,552	2,552
Metallurgical cost	168,292	94	199	279	16,772	16,772	16,772	16,772	16,772	16,772	16,772	16,772	16,772	16,772
Supporting cost	6,601	245	245	351	576	576	576	576	576	576	576	576	576	576
Transportation etc.	2,720	0	0	0	272	272	272	272	272	272	272	272	272	272
Depreciation	62,790	0	10,800	25,306	9,235	5,475	607	606	4,141	4,140	1,880	600	0	0
Interest	14,156	0	0	1,466	3,042	2,588	2,013	1,438	1,153	868	568	497	371	152
Total	280,223	339	11,244	27,546	32,449	28,235	22,792	22,216	25,466	25,180	22,620	21,269	20,543	20,324
Profit before tax	77,047	-339	-11,244	-27,546	3,278	7,492	12,935	13,511	10,261	10,547	13,107	14,458	15,184	15,403
Cumulative total		-339	-11,583	-39,129	-35,851	-28,359	-15,424	-1,913	8,348	18,895	32,002	46,460	61,644	77,047
Deduction for loss brought from previous year	39,129	0	0	0	3,278	7,492	12,935	13,511	1,913	0	0	0	0	0
Limit of deduction for present year	39,129	339	11,244	27,546	0	0	0	0	0	0	0	0	0	0
Loss carried to next year	0	339	11,583	39,129	35,851	28,359	15,424	1,913	0	0	0	0	0	0
Corporate income tax (basically 15%)	11,557	0	0	0	0	0	0	0	1,252	1,582	1,966	2,169	2,278	2,310
Net profit	65,490	-339	-11,244	-27,546	3,278	7,492	12,935	13,511	9,009	8,965	11,141	12,289	12,906	13,093
Cumulative total		-339	-11,583	-39,129	-35,851	-28,359	-15,424	-1,913	7,096	16,061	27,202	39,491	52,397	65,490

Remarks:

Grade 0.4%
Minable ore reserves 33,780 (To-Cu 0.61%)

Metallurgical recovery
Sulfide ore 93.0%
Oxide ore 72.0%

Sales condition
Sulfide ore 97.1%
Electrowinning Cu 100.0%

Cu-Price	C90.0	Cu-Price	C90.0
T/C	$95.0	T/C	$10.0
R/C	C9.5		
Au-Price	$400.0		
R/C	$6.0		

Chile/Japan $42.0
FOB VALUE 0.236%

Transportation 6¢/t·Km + Handling charge 5$/MT
Fixed amount (100% Depreiation)
Interest
Long term 7.5%
Short term 5.5%

Loss can be carried for 5 years.

Corporate income tax
Basically 15.0%
Dividend 27.0%

【 Capital balance 】 (UNIT : 1,000 us$)

	Total	(-3Y)	(-2Y)	(-1Y)	1Y	2Y	3Y	4Y	5Y	6Y	7Y	8Y	9Y	10Y
I N :														
Net profit	65,490	-339	-11,244	-27,546	3,278	7,492	12,935	13,511	9,009	8,965	11,141	12,289	12,906	13,093
Depreciation	62,790	0	10,800	25,306	9,235	5,475	607	606	4,141	4,140	1,880	600	0	0
Equity	15,500	339	11,244	3,917										
Loan	50,813	0	500	41,368	0	0	0	0	7,745	0	1,200	0	0	0
Total	194,593	0	11,300	43,045	12,513	12,967	13,542	14,117	20,895	13,105	14,221	12,889	12,906	13,093
O U T :														
Investment	62,790	0	11,300	42,545	0	0	0	0	7,745	0	1,200	0	0	0
(Interest during construction)	(0)	( )	( )	(1,466)										
Short term loan repayment	3,523	0		500	3,023	0	0	0	0	0	0	0	0	0
Long term loan repayment	47,290	0	0	0		7,669	7,669	7,669	7,669	7,669	1,549	1,549	1,789	4,058
Total	113,603	0	11,300	43,045	3,023	7,669	7,669	7,669	15,414	7,669	2,749	1,549	1,789	4,058
Net generated cash	80,990	0	0	0	9,490	5,298	5,873	6,448	5,481	5,436	11,472	11,340	11,117	9,035
Cumulative total		0	0	0	9,490	14,788	20,661	27,109	32,590	38,026	49,498	60,838	71,955	80,990

Remarks:

Fixed amount (100% Depreciation)
Capital 25.0%

@IRR Internal rate of return
@NPV Net present value

@IRR(before interest)	@IRR(after interest)
Internal rate of return 1.937%	Internal rate of return 0.311%

【 C A S H - F L O W 】 (UNIT : 1,000 us$)

	Total	(-3Y)	(-2Y)	(-1Y)	1Y	2Y	3Y	4Y	5Y	6Y	7Y	8Y	9Y	10Y
CASH - FLOW (without interest)	79,646	-339	-11,744	-43,319	15,555	15,555	15,555	15,555	6,558	13,973	12,389	13,386	13,277	13,245
Cumulative total		-339	-12,083	-55,402	-39,847	-24,292	-8,737	6,818	13,376	27,349	39,738	53,124	66,401	79,646
CASH - FLOW (with interest)	65,490	-339	-11,744	-44,785	12,513	12,967	13,542	14,117	5,405	13,105	11,821	12,889	12,906	13,093
Cumulative total		-339	-12,083	-56,868	-44,355	-31,388	-17,846	-3,729	1,676	14,781	26,602	39,491	52,397	65,490

@NPV(before interest) Rate of return	@NPV	@NPV(after interest) Rate of return	@NPV
5.0%	42,547	5.0%	31,959
7.0%	32,540	7.0%	23,044
12.0%	15,098	12.0%	7,748
15.0%	8,232	15.0%	1,866

Table II-4-4-1(3) Results of DCF Calculation(Cu price;104.3¢)

(UNIT : 1,000 us$)

【 Profit & loss statement 】

	Total	(-3Y)	(-2Y)	(-1Y)	1Y	2Y	3Y	4Y	5Y	6Y	7Y	8Y	9Y	10Y	Remarks
Production															
Crude ore (1,000MT)	33,780				3,378	3,378	3,378	3,378	3,378	3,378	3,378	3,378	3,378	3,378	Grade 0.4%
Cu grade (%)	0.61				0.61	0.61	0.61	0.61	0.61	0.61	0.61	0.61	0.61	0.61	Minable ore reserves 33,780 (To-Cu 0.61%)
Oxide ore (1,000lb)	278,150				27,815	27,815	27,815	27,815	27,815	27,815	27,815	27,815	27,815	27,815	
Sulfide ore(1,000lb)	178,390				17,839	17,839	17,839	17,839	17,839	17,839	17,839	17,839	17,839	17,839	Metallurgical recovery
Production of Cu Conc. (D M T)	215,000				21,500	21,500	21,500	21,500	21,500	21,500	21,500	21,500	21,500	21,500	Sulfide ore 93.0% Oxide ore 72.0%
Sales quantity of metals	361,910				36,191	36,191	36,191	36,191	36,191	36,191	36,191	36,191	36,191	36,191	
Electrowinning Cu(1,000lb)	200,820				20,082	20,082	20,082	20,082	20,082	20,082	20,082	20,082	20,082	20,082	Sales condition
Cu concentrates (1,000lb)	161,090				16,109	16,109	16,109	16,109	16,109	16,109	16,109	16,109	16,109	16,109	Sulfide ore 97.1% Electrowinning Cu 100.0%
Revenue															
Rough revenue	168,030				16,803	16,803	16,803	16,803	16,803	16,803	16,803	16,803	16,803	16,803	Cu-Price C90.0 / Cu-Price C90.0
Cu concentrates :															
Treating & refining	37,990				3,799	3,799	3,799	3,799	3,799	3,799	3,799	3,799	3,799	3,799	T/C $95.0 / T/C $10.0 R/C C9.5
Net revenue	130,040				13,004	13,004	13,004	13,004	13,004	13,004	13,004	13,004	13,004	13,004	Au-Price $400.0
Gold : Net revenue	12,810				1,281	1,281	1,281	1,281	1,281	1,281	1,281	1,281	1,281	1,281	R/C $6.0
Rough revenue	209,470				20,947	20,947	20,947	20,947	20,947	20,947	20,947	20,947	20,947	20,947	
Electrowinning Cu :															
Treating & refining	910				91	91	91	91	91	91	91	91	91	91	
Net revenue	208,560				20,856	20,856	20,856	20,856	20,856	20,856	20,856	20,856	20,856	20,856	
Total	351,410				35,141	35,141	35,141	35,141	35,141	35,141	35,141	35,141	35,141	35,141	
Freight	12,860				1,286	1,286	1,286	1,286	1,286	1,286	1,286	1,286	1,286	1,286	Chile/Japan $42.0
Insurance	860				86	86	86	86	86	86	86	86	86	86	FOB VALUE 0.236%
Total	337,690				33,769	33,769	33,769	33,769	33,769	33,769	33,769	33,769	33,769	33,769	
Expenditure															
Mining cost	25,664	0	0	144	2,552	2,552	2,552	2,552	2,552	2,552	2,552	2,552	2,552	2,552	
Metallurgical cost	168,292	94	199	279	16,772	16,772	16,772	16,772	16,772	16,772	16,772	16,772	16,772	16,772	
Supporting cost	6,601	245	245	351	576	576	576	576	576	576	576	576	576	576	
Transportation etc.	2,720	0	0	0	272	272	272	272	272	272	272	272	272	272	Transportation 6¢/t·Km + Handling charge
Depreciation	62,790	0	10,800	25,306	9,235	5,475	607	606	4,141	4,140	1,880	600	0	0	Fixed amount (100% Depreiation) 5$/MT
Interest	14,156	0	0	1,466	3,042	2,588	2,013	1,438	1,153	868	568	497	371	152	Interest
Total	280,223	339	11,244	27,546	32,449	28,235	22,792	22,216	25,466	25,180	22,620	21,269	20,543	20,324	Long term 7.5% Short term 5.5%
Profit before tax	57,467	-339	-11,244	-27,546	1,320	5,534	10,977	11,553	8,303	8,589	11,149	12,500	13,226	13,445	
Cumulative total		-339	-11,583	-39,129	-37,809	-32,275	-21,298	-9,745	-1,442	7,147	18,296	30,796	44,022	57,467	
Deduction for loss brought from previous year	37,687	0	0	0	1,320	5,534	10,977	11,553	8,303	0	0	0	0	0	
Limit of deduction for present year	39,129	339	11,244	27,546	0	0	0	0	0	0	0	0	0	0	Loss can be carried for 5 years.
Loss carried to next year	0	339	11,583	39,129	37,809	32,275	21,298	9,745	(1,442)	0	0	0	0	0	
Corporate income tax (basically 15%)	8,836	0	0	0	0	0	0	0	0	1,288	1,672	1,875	1,984	2,017	Corporate income tax Basically 15.0%
Net profit	48,631	-339	-11,244	-27,546	1,320	5,534	10,977	11,553	8,303	7,301	9,477	10,625	11,242	11,428	Dividend 27.0%
Cumulative total		-339	-11,583	-39,129	-37,809	-32,275	-21,298	-9,745	-1,442	5,859	15,336	25,961	37,203	48,631	

【 Capital balance 】

(UNIT : 1,000 us$)

	Total	(-3Y)	(-2Y)	(-1Y)	1Y	2Y	3Y	4Y	5Y	6Y	7Y	8Y	9Y	10Y	Remarks
I N :															
Net profit	48,631	-339	-11,244	-27,546	1,320	5,534	10,977	11,553	8,303	7,301	9,477	10,625	11,242	11,428	
Depreciation	62,790	0	10,800	25,306	9,235	5,475	607	606	4,141	4,140	1,880	600	0	0	Fixed amount (100% Depreiation)
Equity	15,500	339	11,244	3,917											Capital 25.0%
Loan	50,813	0	500	41,368	0	0	0	0	7,745	0	1,200	0	0	0	
Total	177,734	0	11,300	43,045	10,555	11,009	11,584	12,159	20,189	11,441	12,557	11,225	11,242	11,428	
O U T :															
Investment	62,790	0	11,300	42,545	0	0	0	0	7,745	0	1,200	0	0	0	
(Interest during construction)	(0)	( )	( )	(1,466)											
Short term loan repayment	3,523	0		500	3,023	0	0	0	0	0	0	0	0	0	
Long term loan repayment	47,290	0	0	0		7,669	7,669	7,669	7,669	7,669	1,549	1,549	1,789	4,058	@IRR Internal rate of return
Total	113,603	0	11,300	43,045	3,023	7,669	7,669	7,669	15,414	7,669	2,749	1,549	1,789	4,058	@NPV Net present value
Net generated cash	64,131	0	0	0	7,532	3,340	3,915	4,490	4,775	3,772	9,808	9,676	9,453	7,370	
Cumulative total		0	0	0	7,532	10,872	14,787	19,277	24,052	27,824	37,632	47,308	56,761	64,131	

@IRR(before interest)	@IRR(after interest)
Internal rate of return 0.000%	Internal rate of return -1.716%

【 C A S H - F L O W 】

(UNIT : 1,000 us$)

	Total	(-3Y)	(-2Y)	(-1Y)	1Y	2Y	3Y	4Y	5Y	6Y	7Y	8Y	9Y	10Y
CASH - FLOW (without interest)	62,787	-339	-11,744	-43,319	13,597	13,597	13,597	13,597	5,852	12,309	10,725	11,722	11,613	11,580
Cumulative total		-339	-12,083	-55,402	-41,805	-28,208	-14,611	-1,014	4,838	17,147	27,872	39,594	51,207	62,787
CASH - FLOW (with interest)	48,631	-339	-11,744	-44,785	10,555	11,009	11,584	12,159	4,699	11,441	10,157	11,225	11,242	11,428
Cumulative total		-339	-12,083	-56,868	-46,313	-35,304	-23,720	-11,561	-6,862	4,579	14,736	25,961	37,203	48,631

@IRR(before interest) Rate of return	@NPV	@IRR(after interest) Rate of return	@NPV
5.0%	31,195	5.0%	20,607
7.0%	22,744	7.0%	13,248
12.0%	8,157	12.0%	807
15.0%	2,502	15.0%	-3,864

calculate back to interest of 15% was 167.5¢.

0.70%(To-Cu) of crude or grade is necessary in the copper price of 90¢. 0.70%(To-Cu) of crude or grade is realism in case of oxide ore grade of 0.61% (To-Cu) and sulfide ore grade of 0.97%(To-Cu) which is alloted the increment of copper. In order to perform IRR of 15%, crude ore grade of 1.13%, oxide ore grade of 0.97%(To-Cu) and sulfide ore grade of 0.1.54%(To-Cu) are necessary.

In this ore deposit, crude oxide ore grade becomes higher, the ore reserves is markedly decreases. On the other hand, sulfide ore reserves slightly declines according to higher grade of sulfide ore. However, the lower ore body which is mainly composed of sulfide ore minerals was not the target ore deposit in this survey. Therefore, the details are indistinct. As the lower ore body lies in deep underground, so the open pit mining is not practical. As the result, the prospecting for lower ore bodies must be carried out, and research for production on commercial basis must be again carried out near future.

PART III

CONCLUSION AND RECOMMENDATION

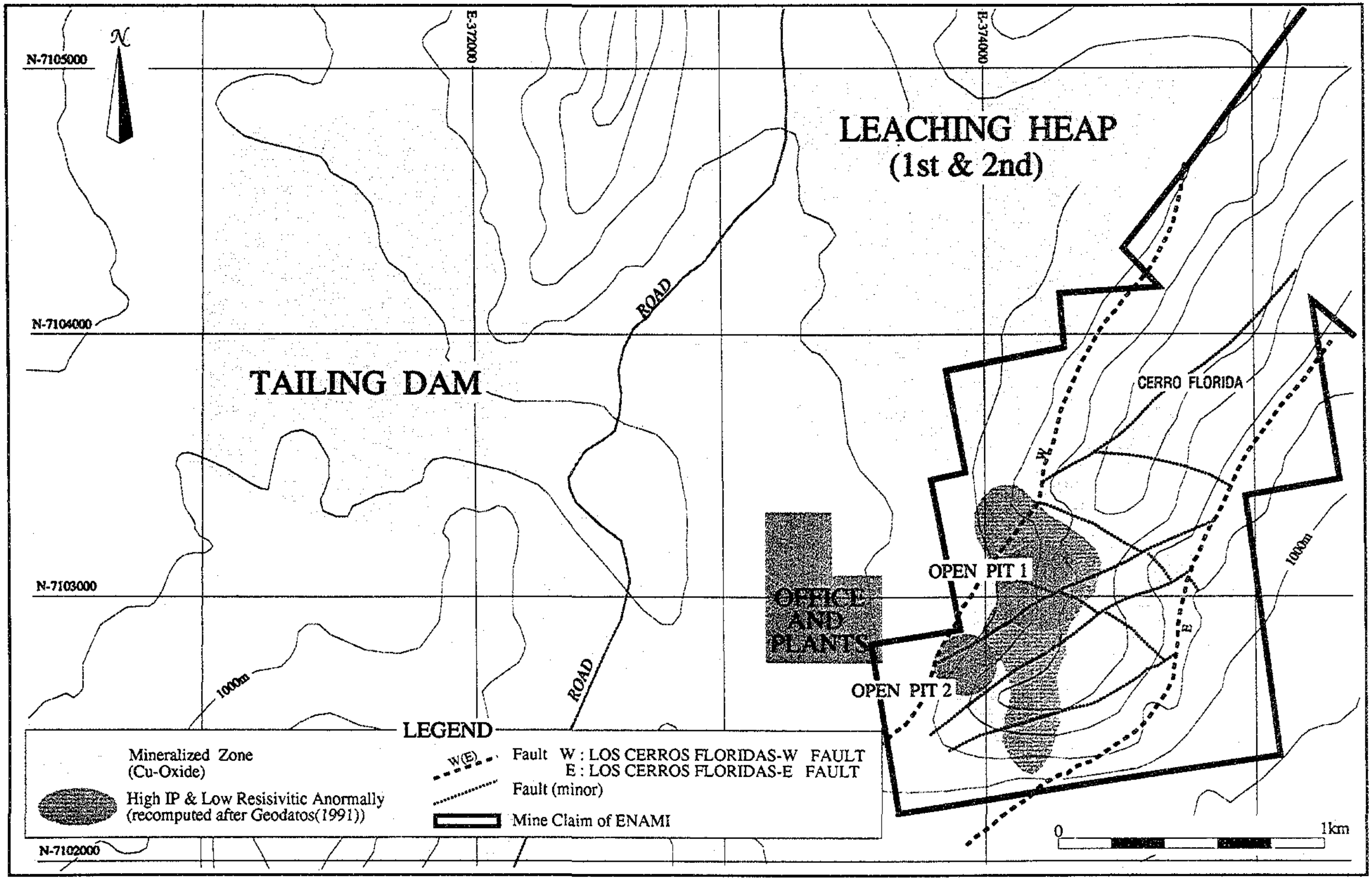

Fig. Ⅲ-1-1-1 Summary Figure

PART Ⅲ CONCLUSION AND RECOMMENDATION

CHAPTER 1 CONCLUSION

1 — 1 Drilling survey

The geology and stratigraphy are shown in Fig. I -3-2-1 and Table I -3-2-1, respectively. The geological structure the area is shown in Fig. Ⅲ-1-1-1.

The ore deposits are the copper deposits which was metasomatically precipitated within the andesite of Los Cerros Floridas formation and "hydrothermal breccita" which is the same origin of the andesite of Los Cerros Floridas formation. The shape of the deposits is generally called mantle shaped. Four units of lavas of andesite (Ad. 4~Ad. 1 in descending order) was confirmed by their flow units. The country rocks of ore deposits are in the upper horizon of Ad. 2. Refer to the cross section in the appendix of this final report about the detailed relationship between the ore deposits and the country rocks.

The ore deposit is considered to be metasomatic deposit, and the deposits apparently occur in two or three horizons for the shape like mantle. The deposits are classified into five ore bodies (the upper, middle, lower, east and west ore bodies) by the three dimensional distribution features as shown in Fig. I -4-2-1.

The upper ore body is mainly composed of copper oxide ore minerals. Sulfide ore body mainly composed of copper sulfide ore minerals, and mixed ore body composed of copper sulfide minerals and copper oxide minerals coexist are sometimes occur in the lower part of copper oxide ore body. The other ore bodies are mainly composed of sulfide minerals. However, the parts of them sometimes show the occurrence of oxide ore body or mixed ore body.

The juvenile copper mineral is considered to be chalcopyrite. It changes to chalcocite, atacamite, malachite and chalcanthite by oxidation in the shallow part and along the faults. Occurrence of chalcopyrite is dissemination ~ reticulated, on the other hand, ordinary occrrence of copper oxide is menbrane. Copper minerals generally coexist with iron oxide minerals such as specularite and magnetite in this survey area because iron mineralization went ahead of copper mineralization. Division of oxide ore body and sulfide ore body is possible on the map. However, division of mixed ore body is difficult because of the complicated occurrence with other two ore bodies.

Two of the drillings (MJCC-27 & 41) caught the lower ore bodies which was not the target of the 1993 survey. In addition to these drillings, some drillings caught the parts of the west and east ore bodies in the western and the eastern part of this survey area. Therefore, both of geophysical prospecting and drilling survey to the deeper horizon and to both side of this area is hopeful expect mining area.

1 — 2 Geophysical prospecting

IP logging in the drilling holes (10 holes), measurement of physical properties of drilling cores (IP characterisitics and resistivity for 424 specimens in 12 holes, and magnetic susceptibility for 458 specimens) and reanalysis of the existing IP prospecting data and geomagnetic survey data were carried out in 1992. The following points were clarified refer to Fig. Ⅲ-1-1-1.

① High IP/low resistivity is caused by the mineralization zone of chalcopyrite and pyrite concentration around the MJCC-7 drilling hole.

② High magnetic anomaly is caused by magnetite concentration. The high anomalous zone coinsid to the iron mineralization zone around the MJCC-10 and 13 drilling holes. The high anomalous zones are distributed outside of above copper mineralization zone. Existance of sulfide minerals within iron mineralization zone is judged by resistivity measurement. Resistivity decreasesin case of existance of sulfide minerals within iron mineralization zone.

1 — 3 Metallurgical tests

A series of metallurgical tests consisting of flotation and heap leaching—SX/EW methods were applied to five types of ore samples, that is, one oxide ore from the upper ore body, two types of mixed ores from the upper and western ore bodies and two types of sulfide ores from the upper and western ore bodies, all of which were taken from boring cores carried out in the year of 1992. As the results of these tests, for the treatment of the oxide ore from the upper part and the mixed ore from the western part, heap leaching—SX/EW method is suitable with about 76% of estimated extraction rate. But in case of the ore sample from the western ore body, acid consumption was so high that operationcosts are presumably higher than normal. For the treatment of the mixed ores from the upper ore body and all the sulfide ores as well flotation methodis suitable with about 90% of estimated recovery rate. As the results of analytical and other investigations on copper concentrates, tailings and also on cathode copper, any impurities that might cause troubles in commercial and environmental aspects werenot detected. According to the synthetic evaluation of these test results, the flowsheet shown in Fig. Ⅲ-1-3-1 seemed most suitable for the treatment of Cerro Negro ores.