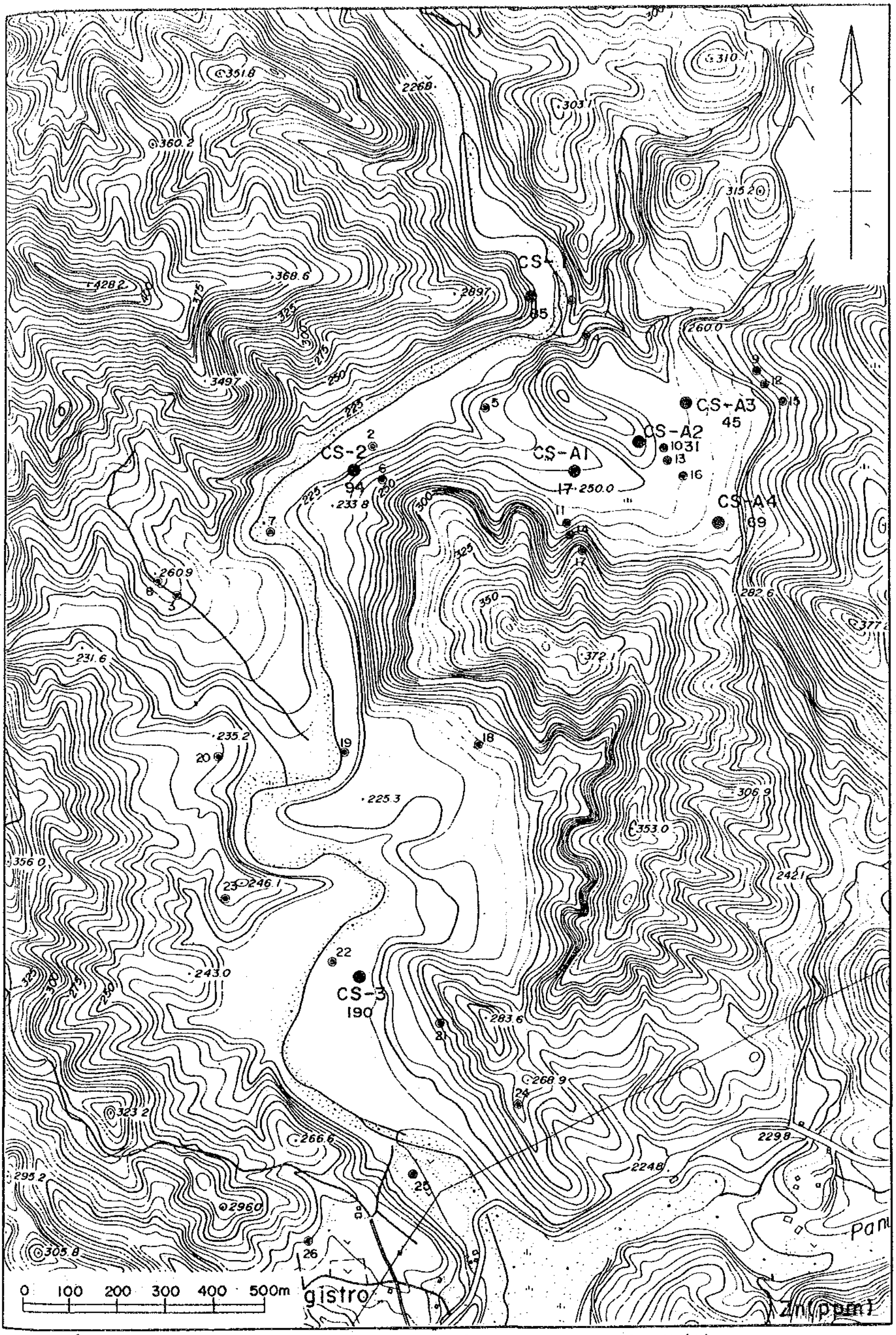


Fig. 5-5-1 Analysis Map of Chemical Data of Soil (3)

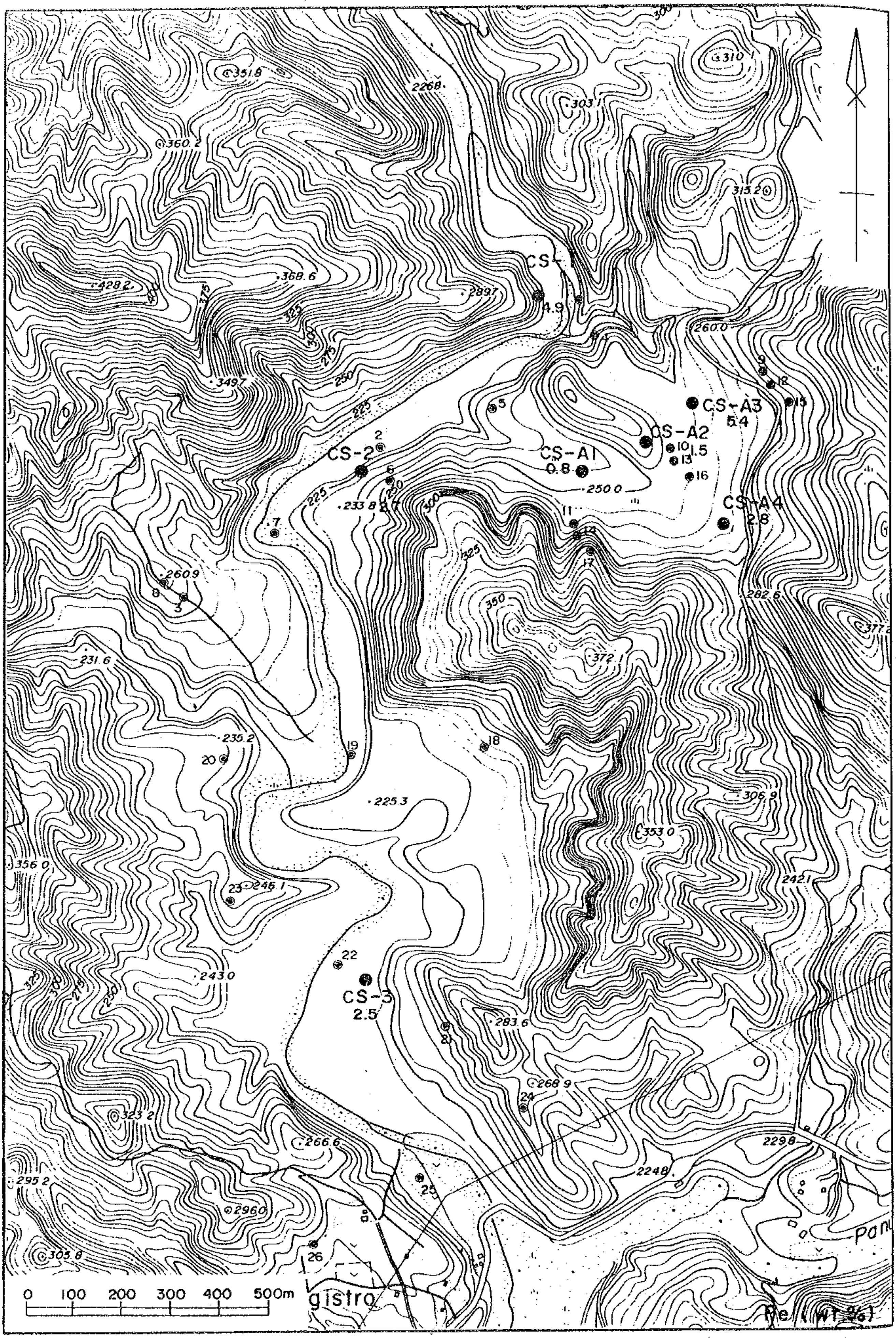


Fig. 5-5-1 Analysis Map of Chemical Data of Soil (4)

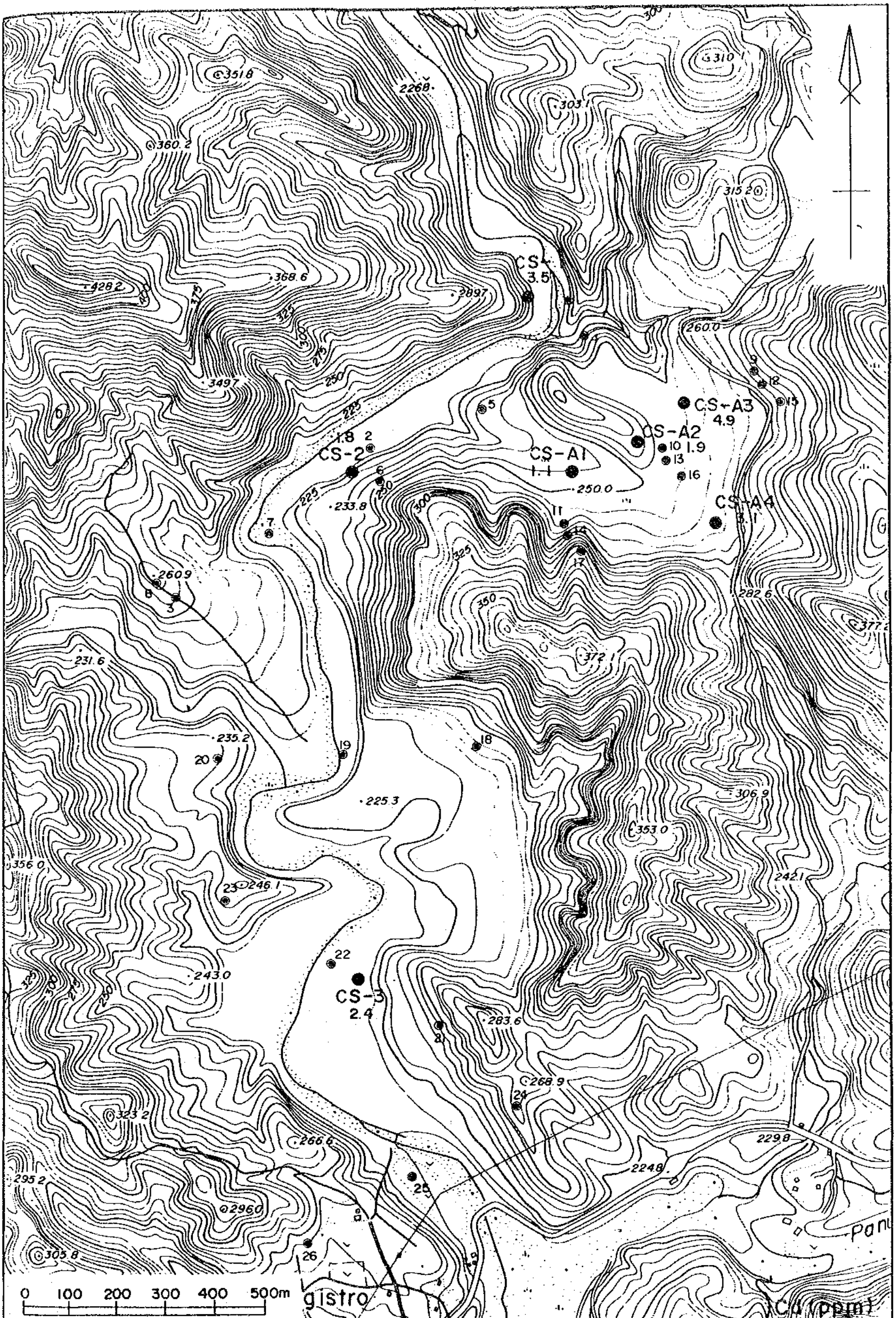


Fig. 5-5-1 Analysis Map of Chemical Data of Soil (5)

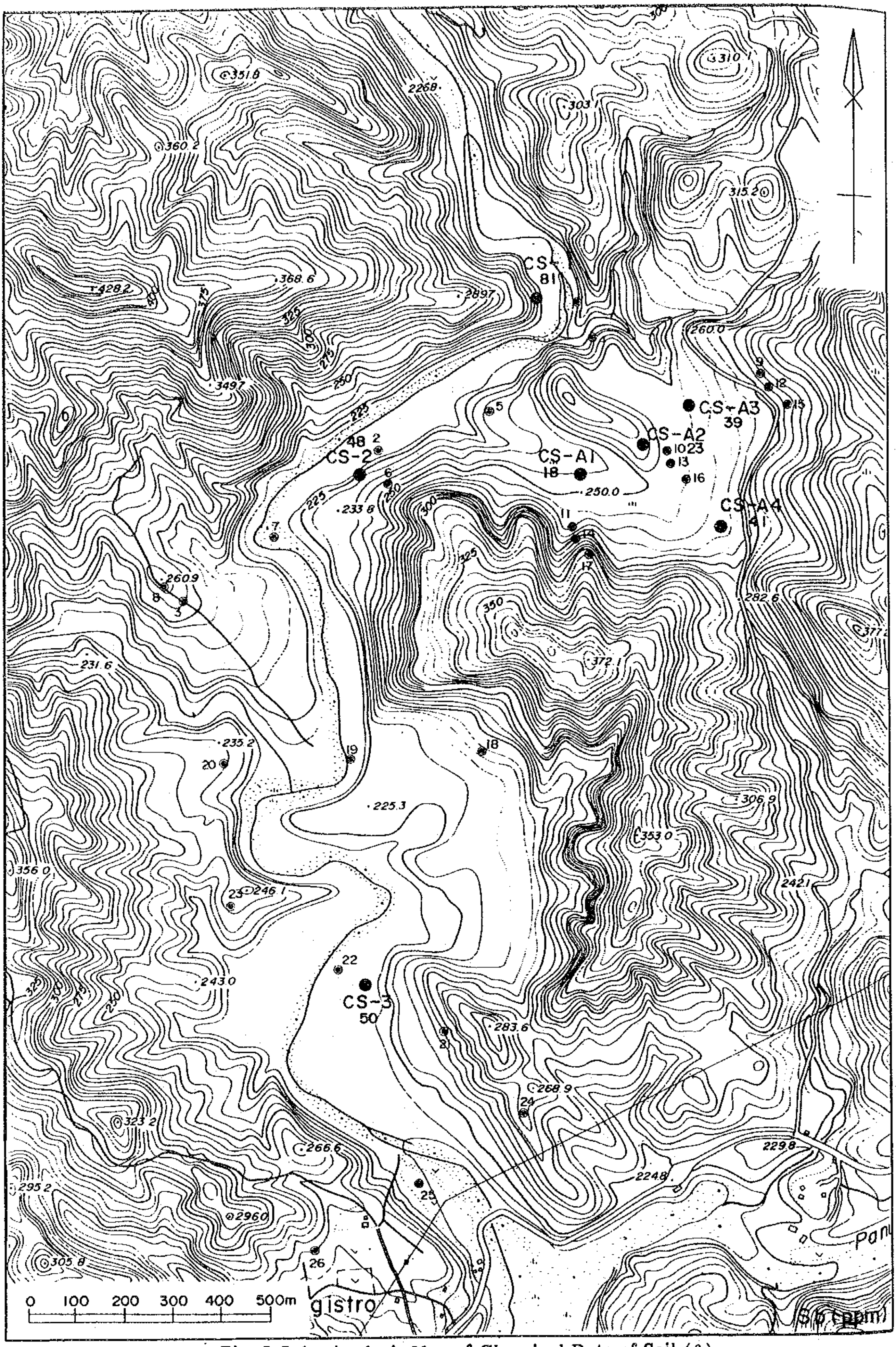


Fig. 5-5-1 Analysis Map of Chemical Data of Soil (6)

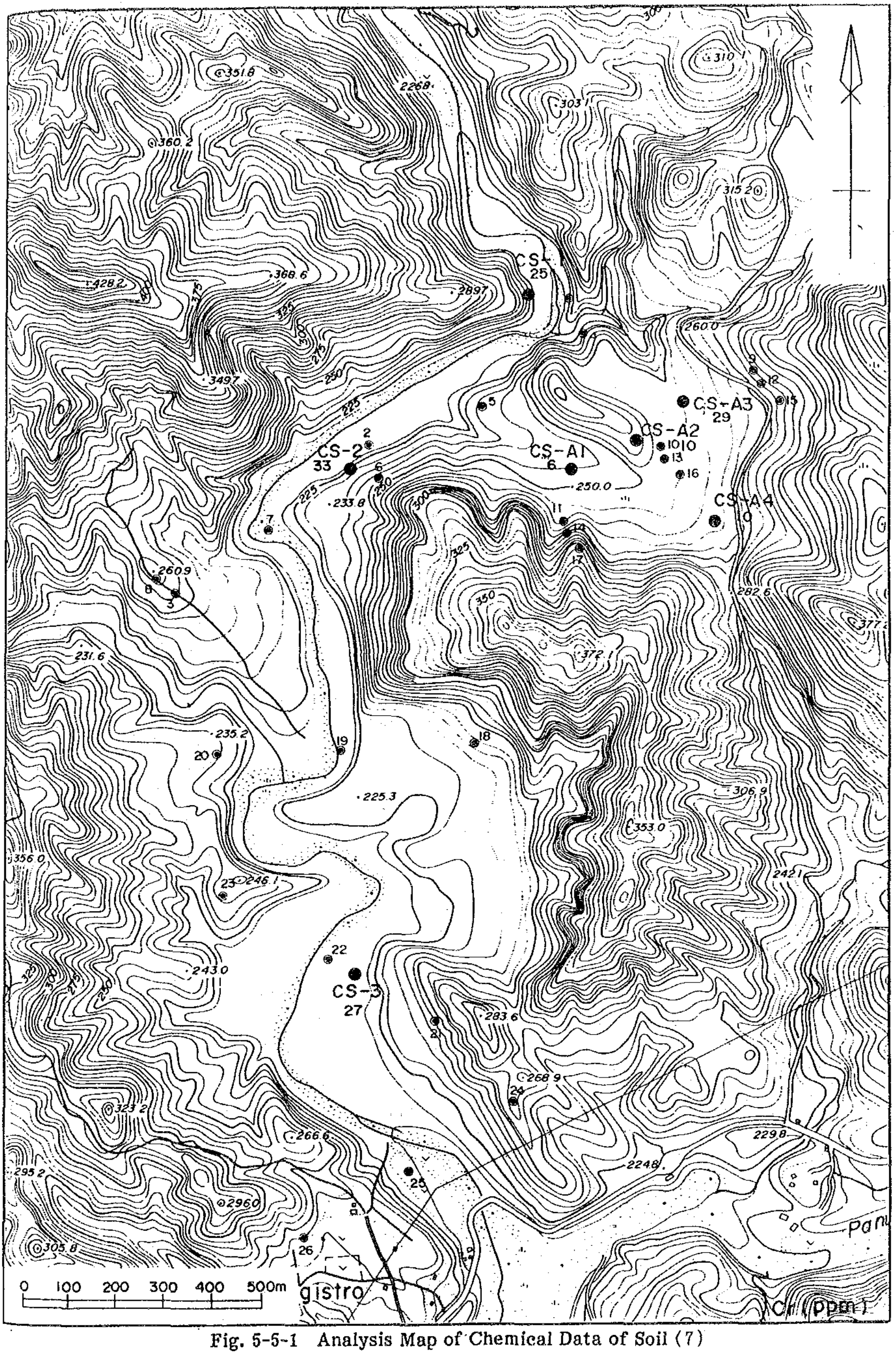


Fig. 5-5-1 Analysis Map of Chemical Data of Soil (7)

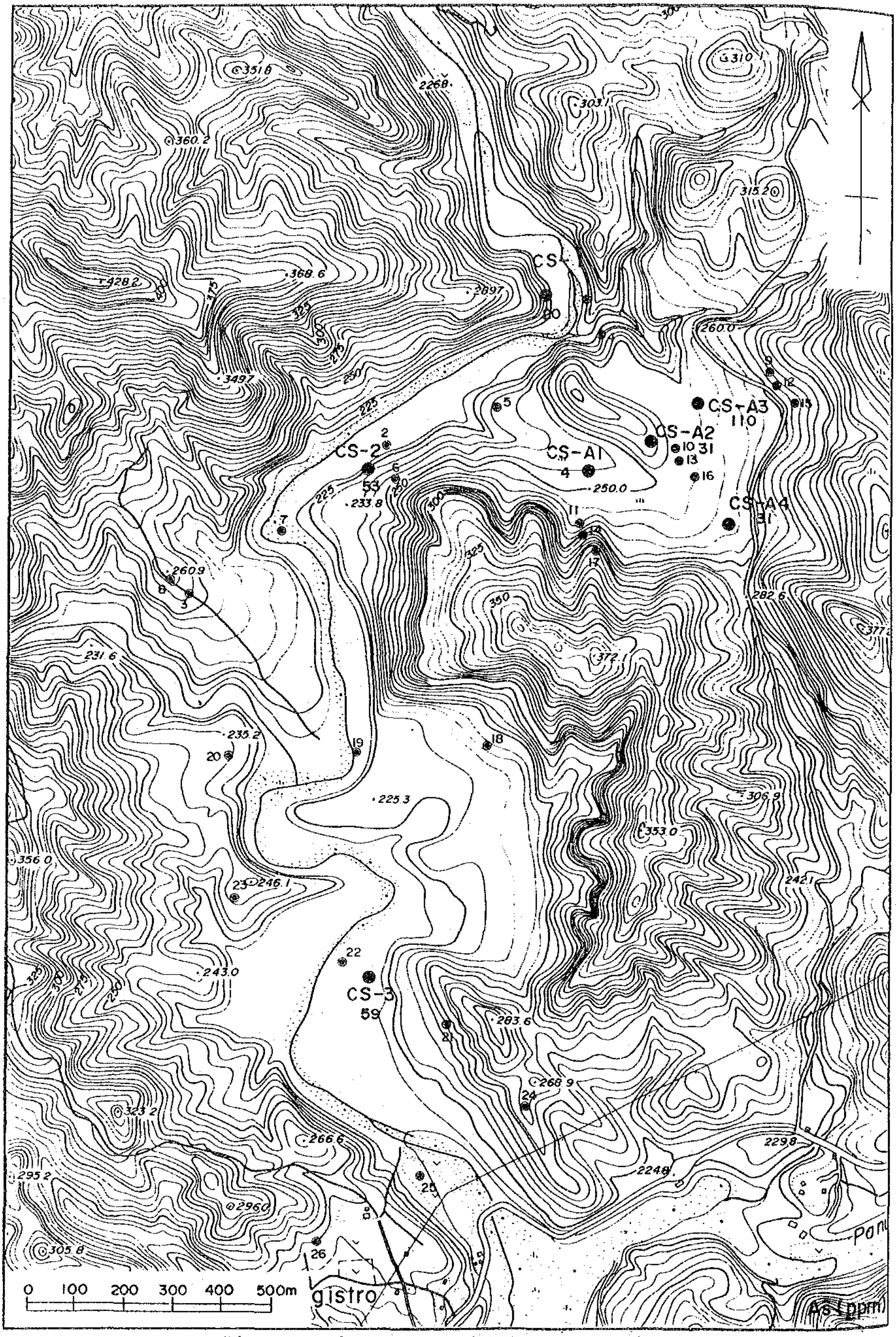


Fig. 5-5-1 Analysis Map of Chemical Data of Soil (8)

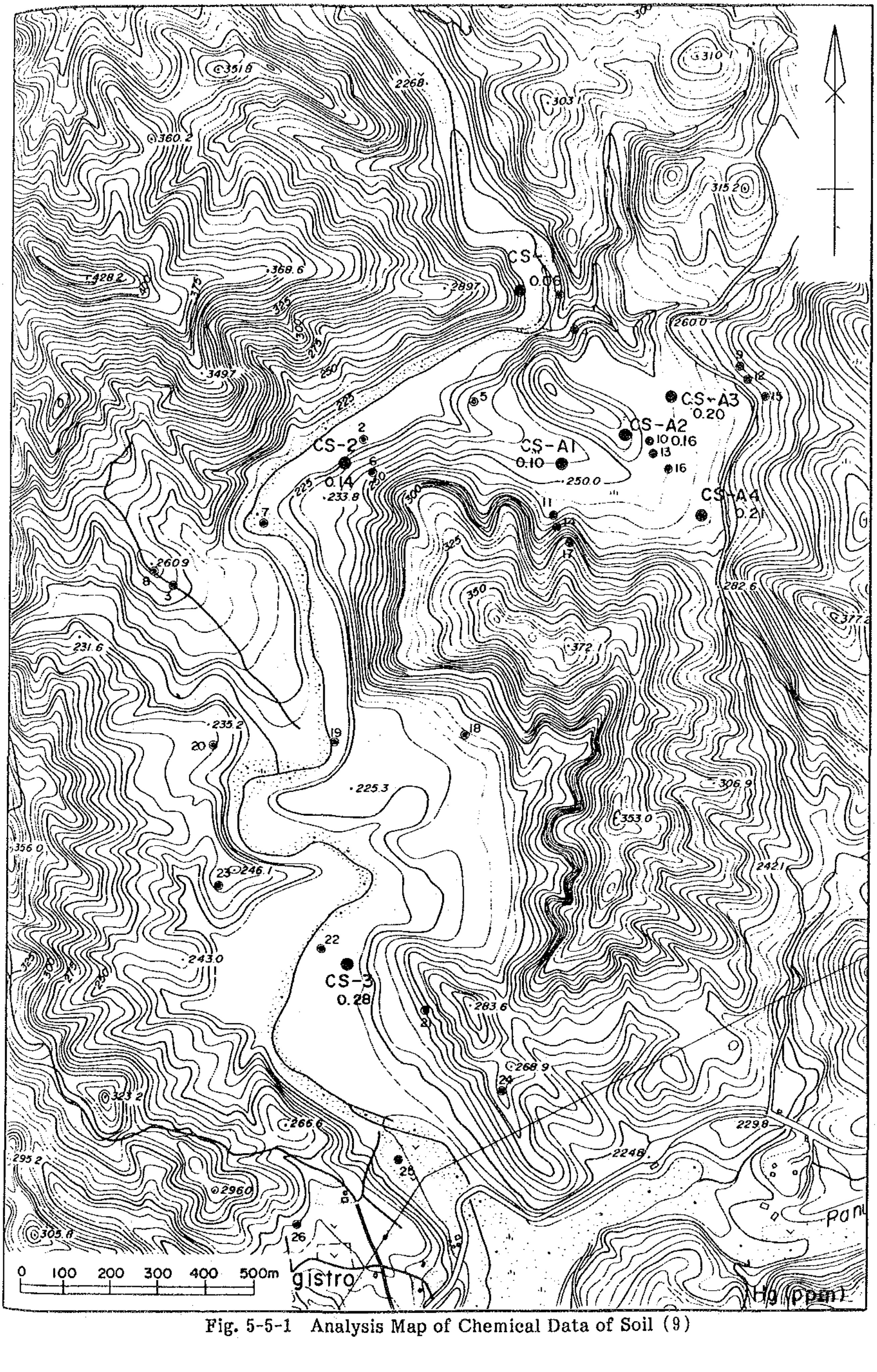


Fig. 5-5-1 Analysis Map of Chemical Data of Soil (9)

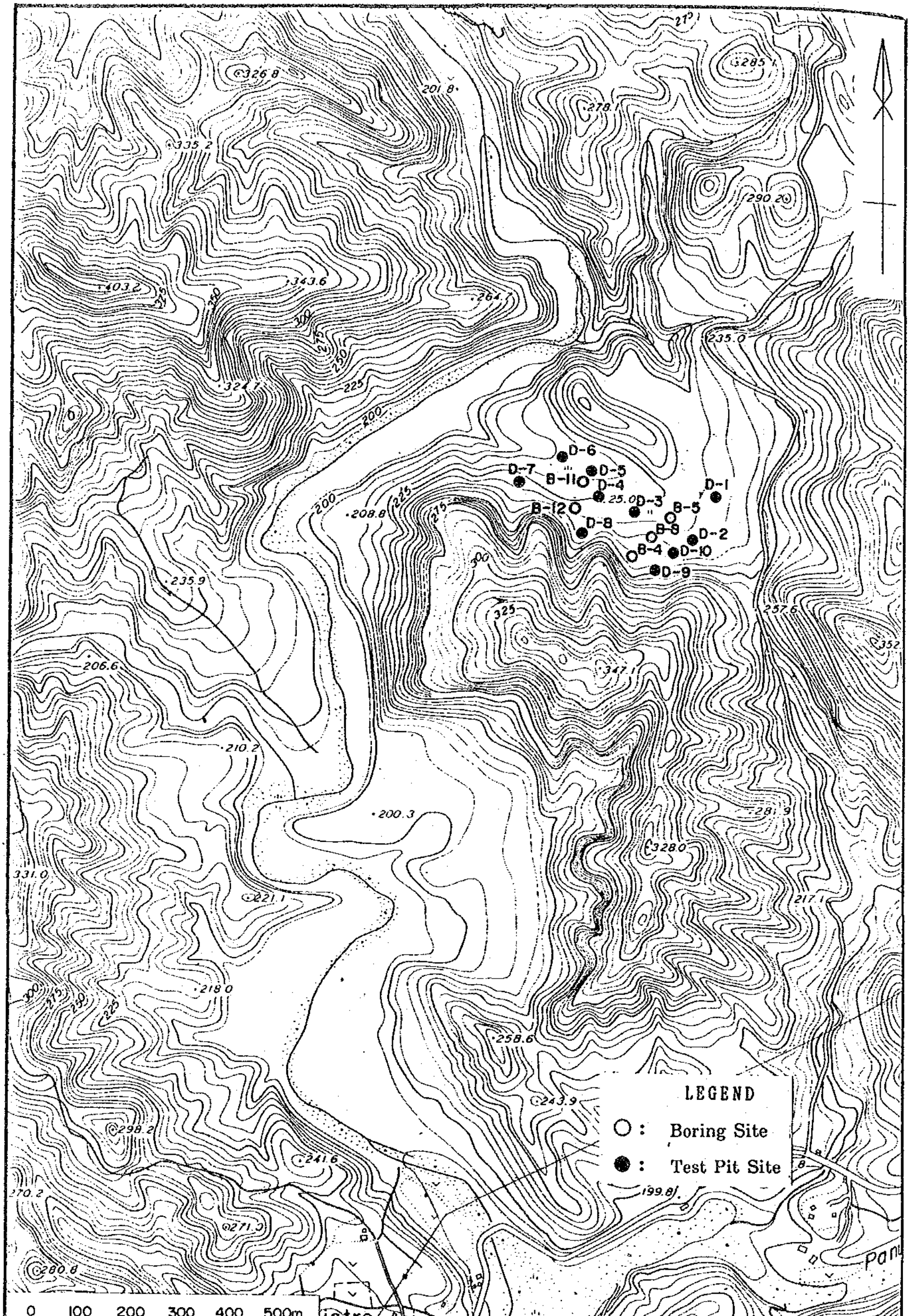


Fig. 5-6-1 Boring and Soil Test Sample Point

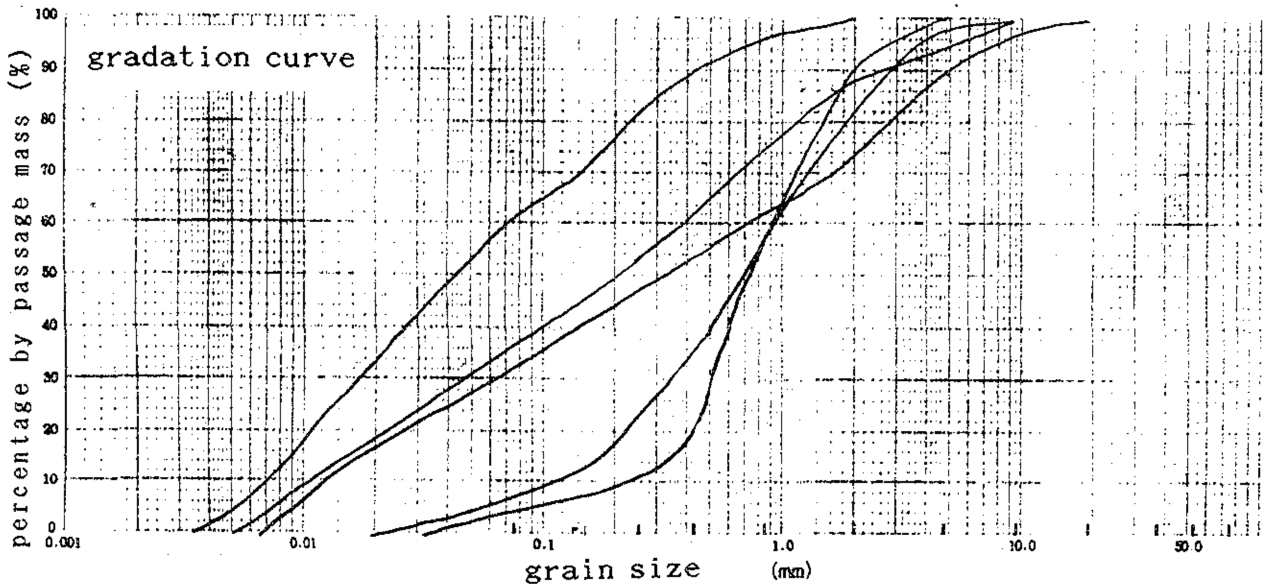


Fig. 5-6-2 Grain Size Accumulation Curve

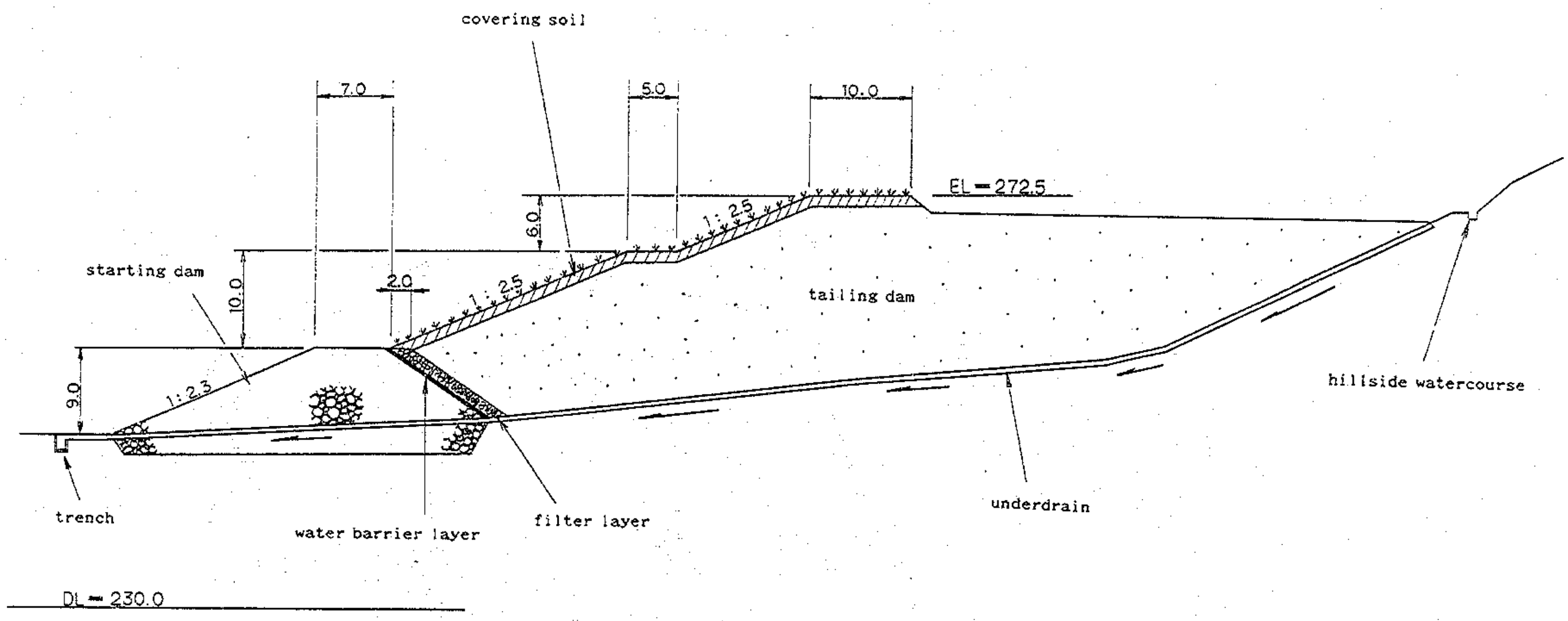


Fig. 5-6-3 Model of New El Coco Tailing Dam

NEW EL COCO TAILING DAM

CONDITION OF SOIL

Zone No.	SOIL	PARTIAL SATURATION DENSITY ρt (g/cm³)	SATURATION DENSITY ρsat (g/cm³)	COHESION C (kgf/cm²)	SHEARING RESISTANCE ANGLE φ (°)
①	SEDIMENT−1	1.689	1.816	0.10	23.0
②	SEDIMENT−2	1.910	2.094	0.00	30.0
③	SURFACE SOIL	1.443	1.801	0.50	33.0
④	GRAVEL	1.800	1.812	0.00	37.0
⑤	FOUNDATION GROUND	1.443	1.801	0.00	33.0

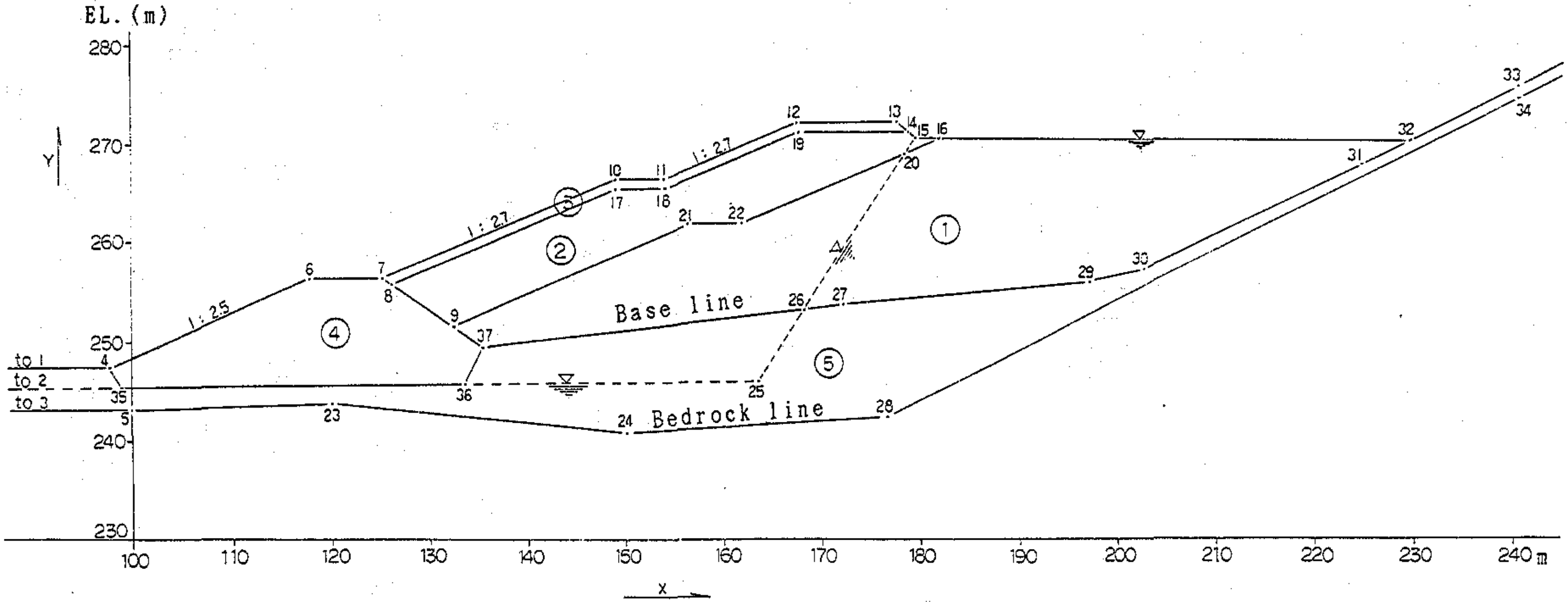


Fig. 5-8-1 The Model of Tailing Dam Stability Analysis

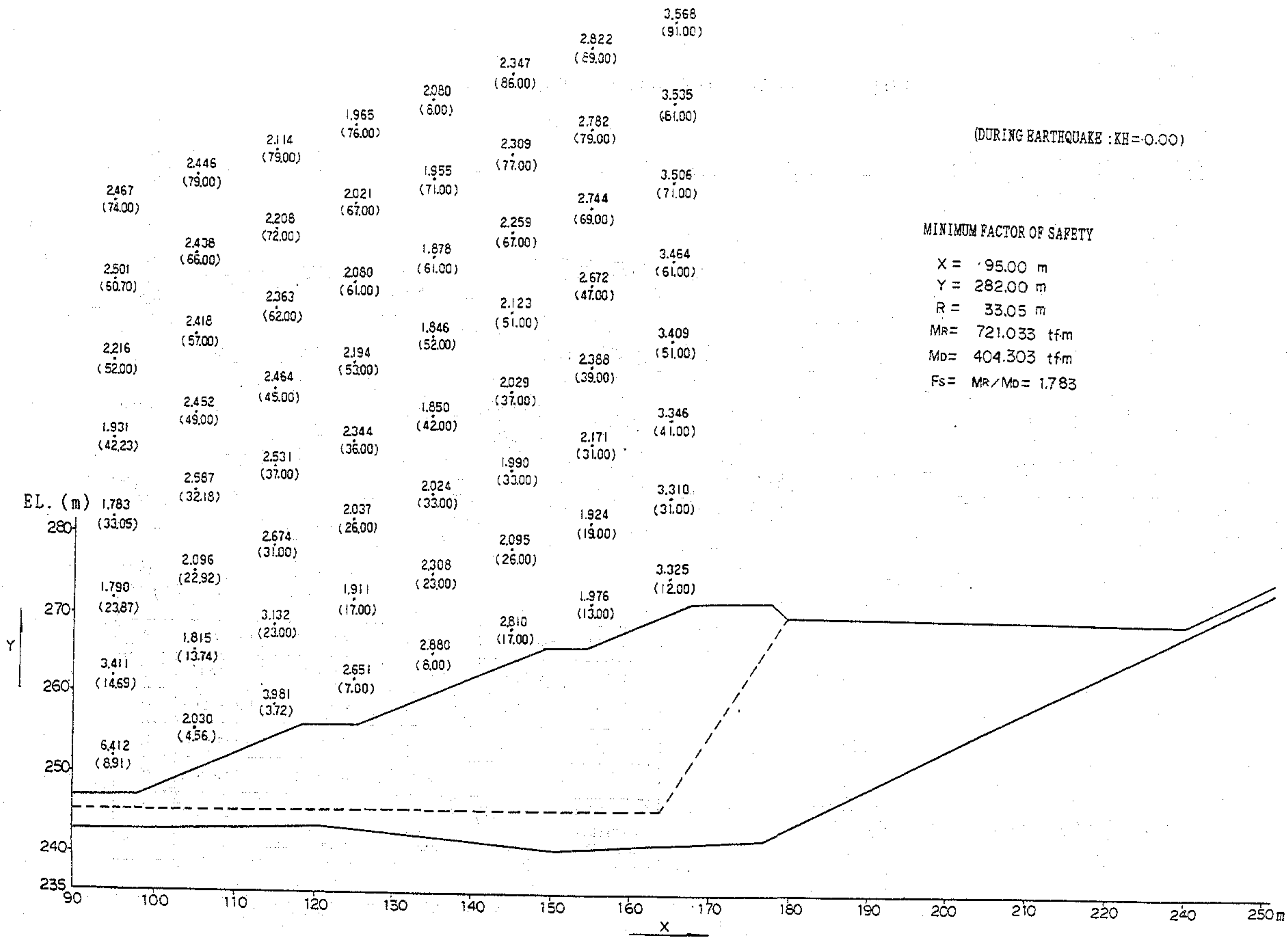


Fig. 5-8-2 A Result of Tailing Dam Stability Analysis (1)

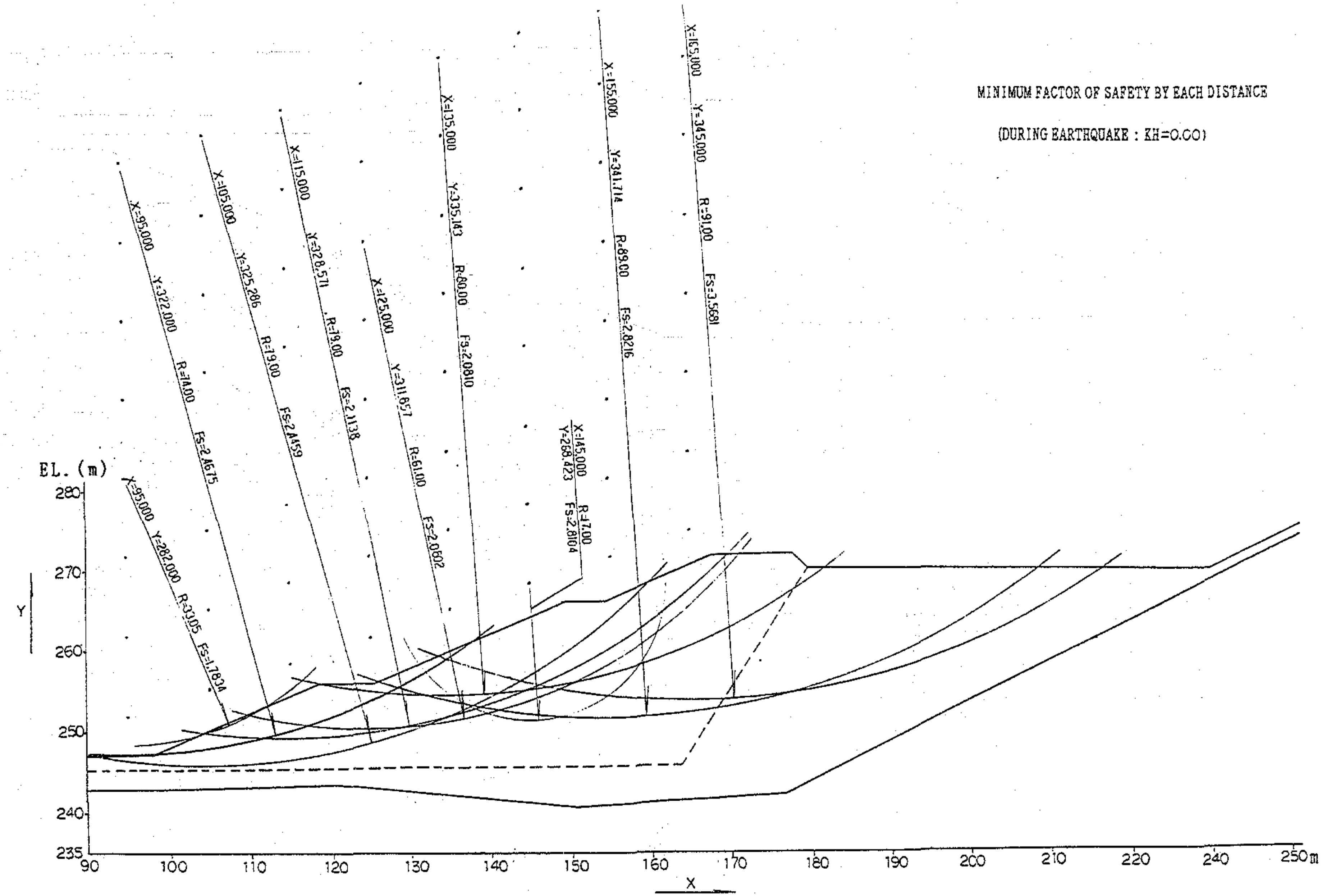


Fig. 5-8-3 A Result of Tailing Dam Stability Analysis (2)

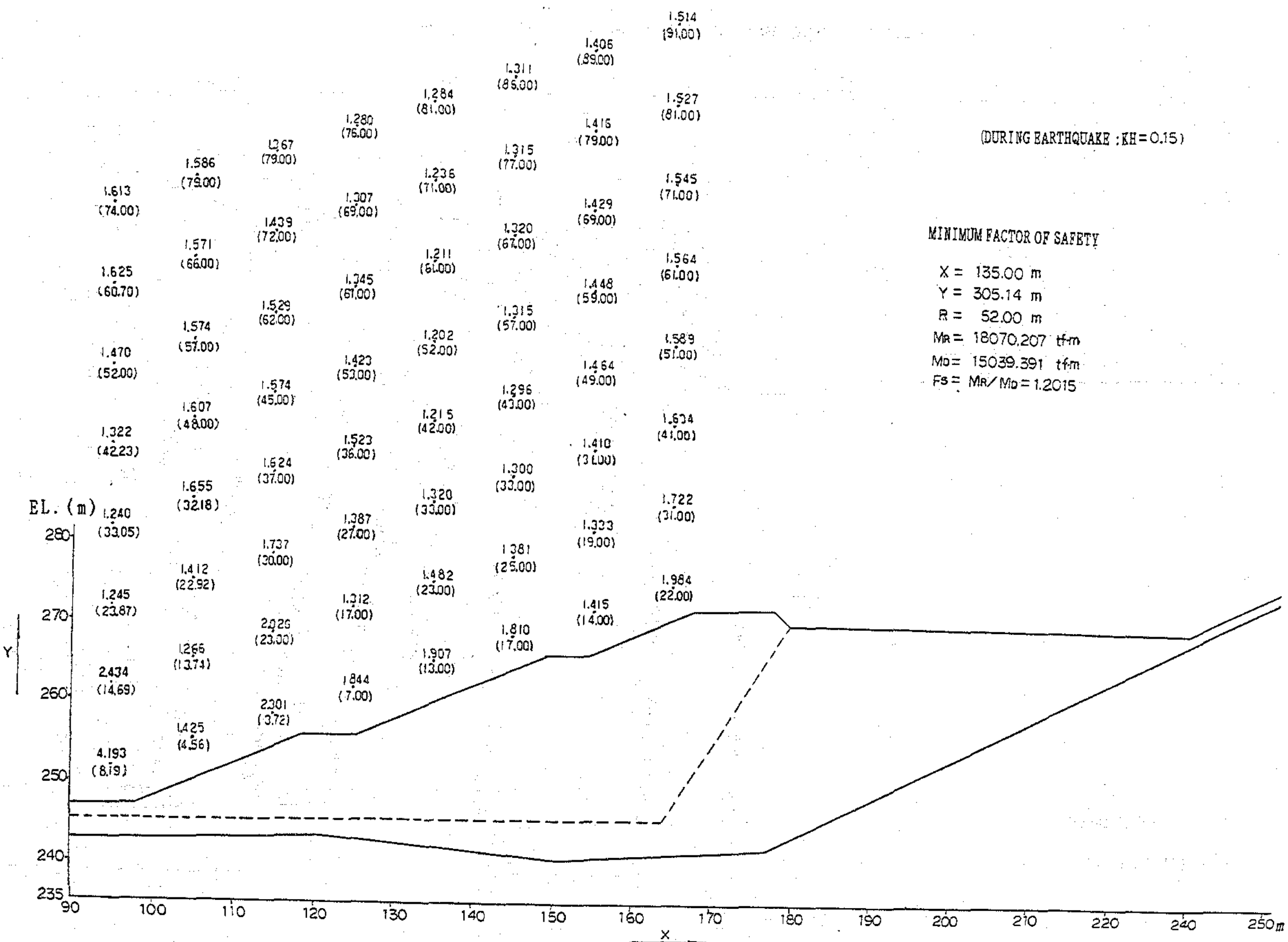


Fig. 5-8-4 A Result of Tailing Dam Stability Analysis (3)

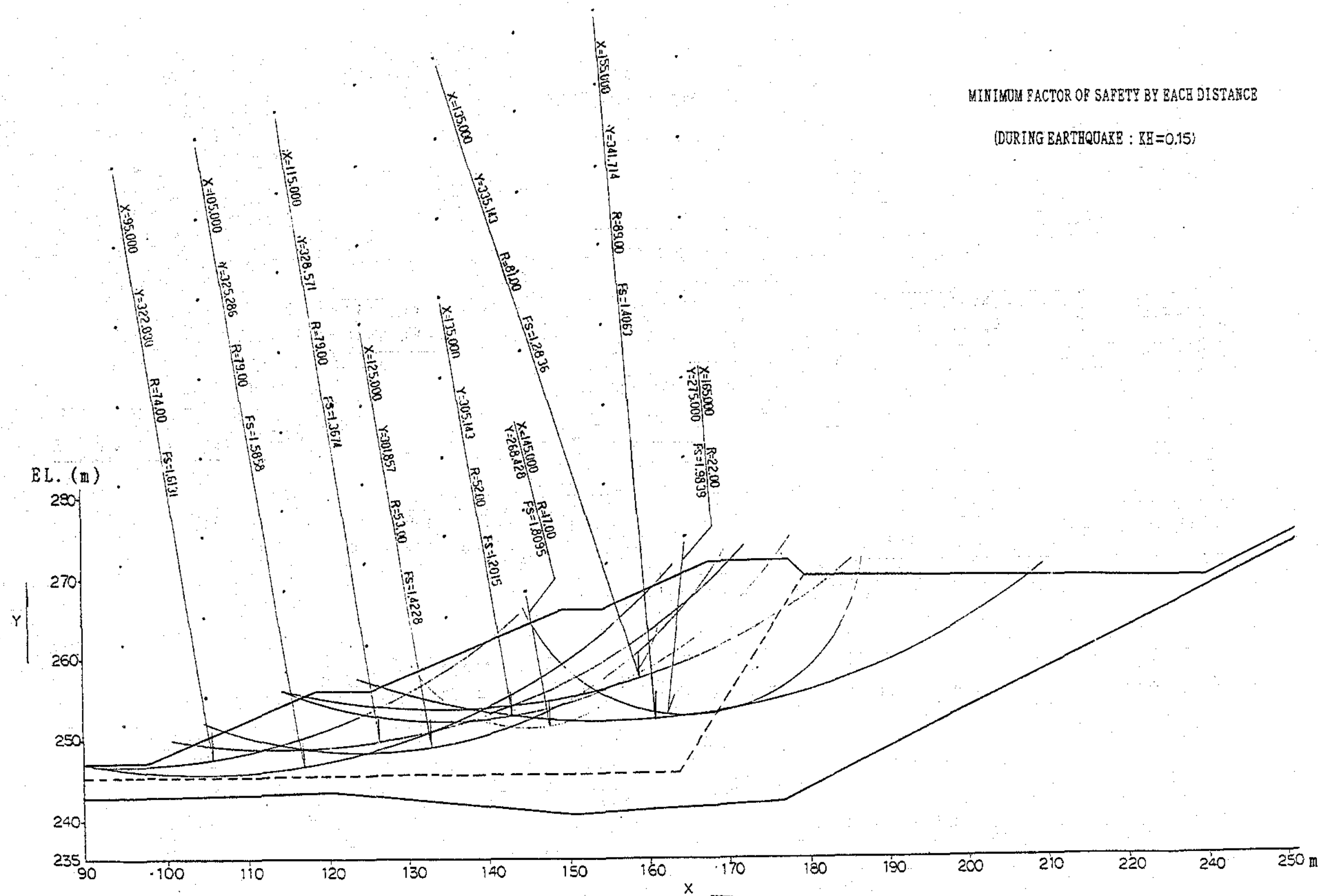


Fig. 5-8-5 A Result of Tailing Dam Stability Analysis (4)

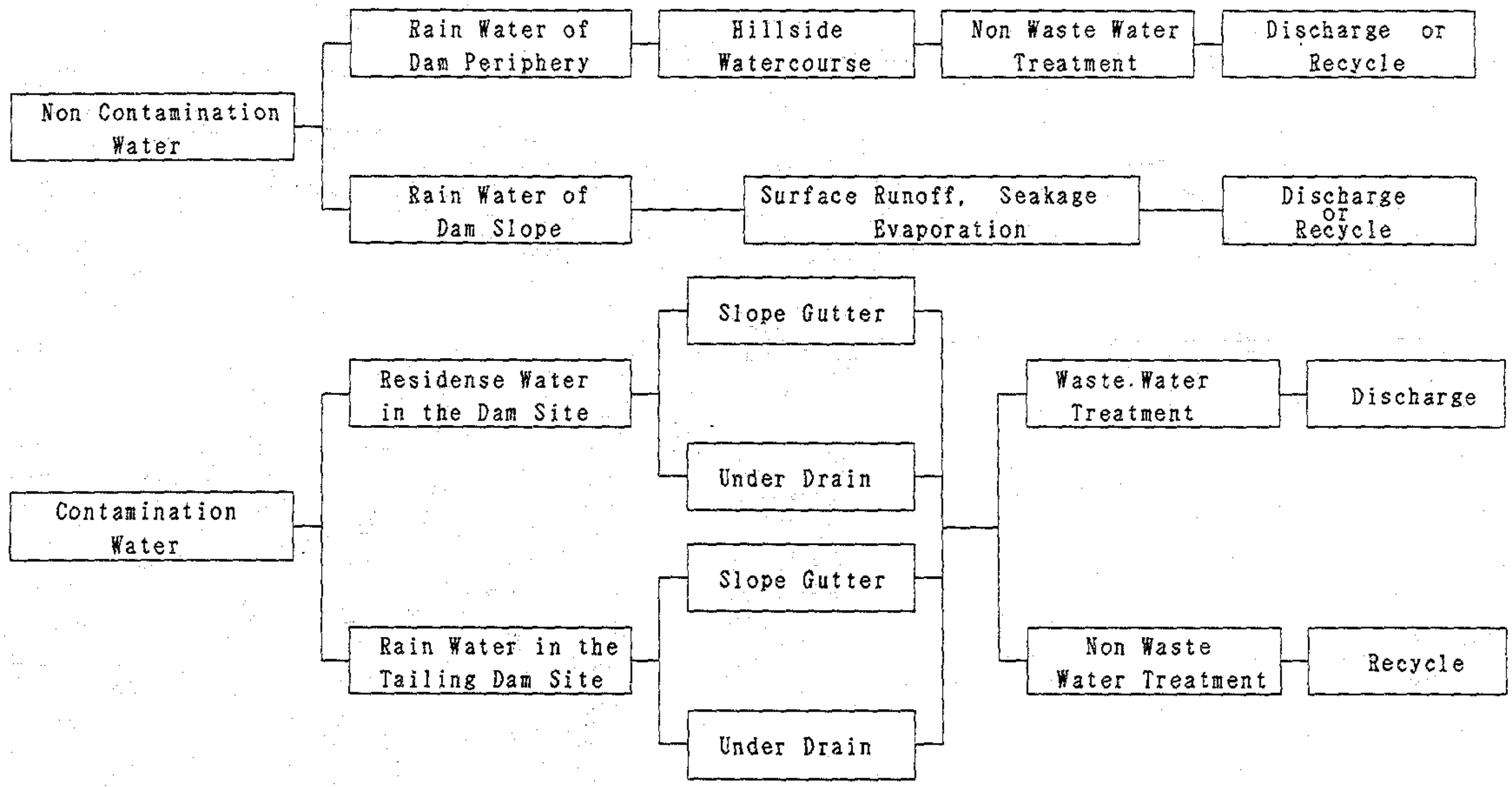


Fig. 5-8-6 Drainage Flow

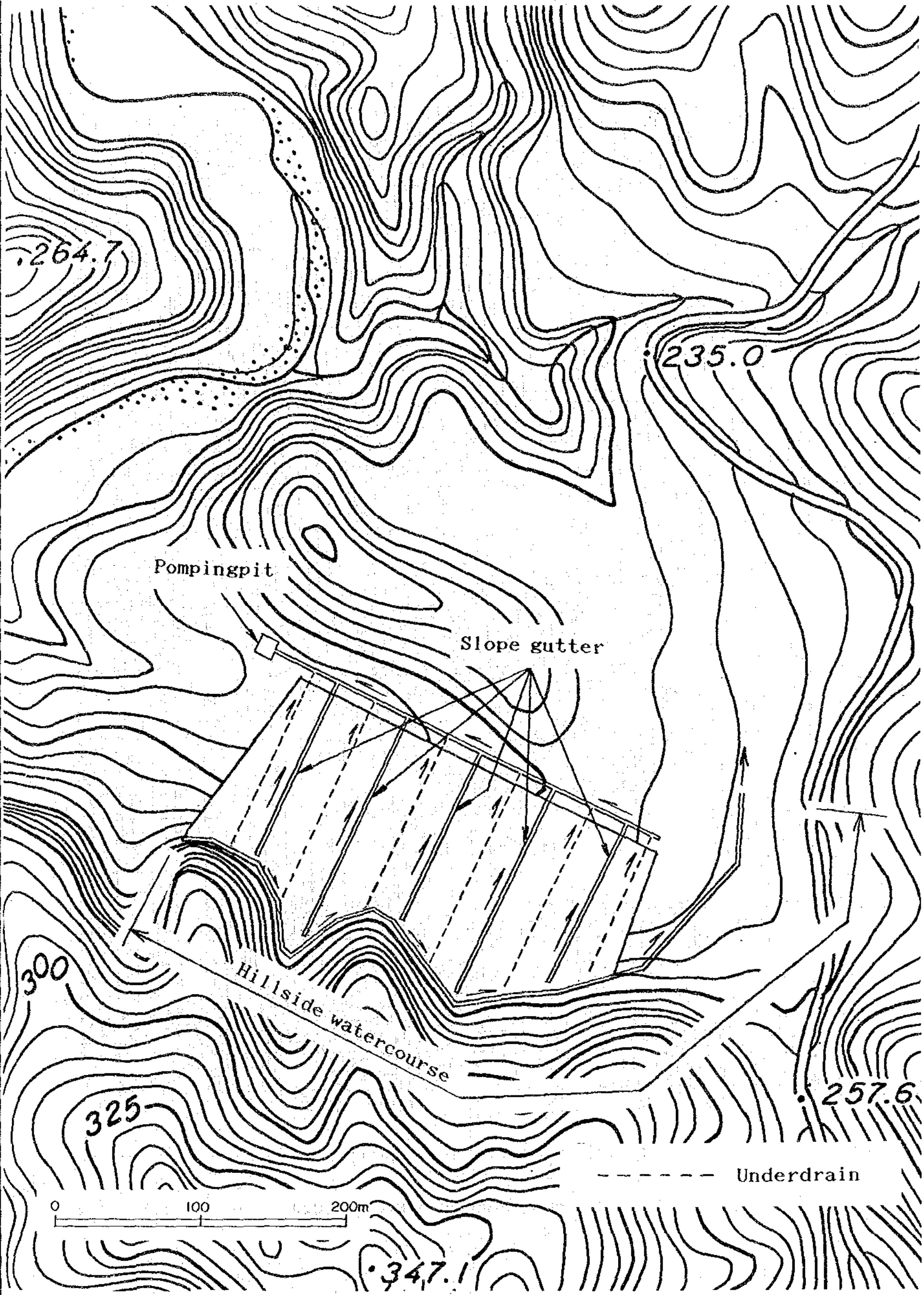


Fig. 5-8-7 New El Coco Tailing Dam Drainage Plan

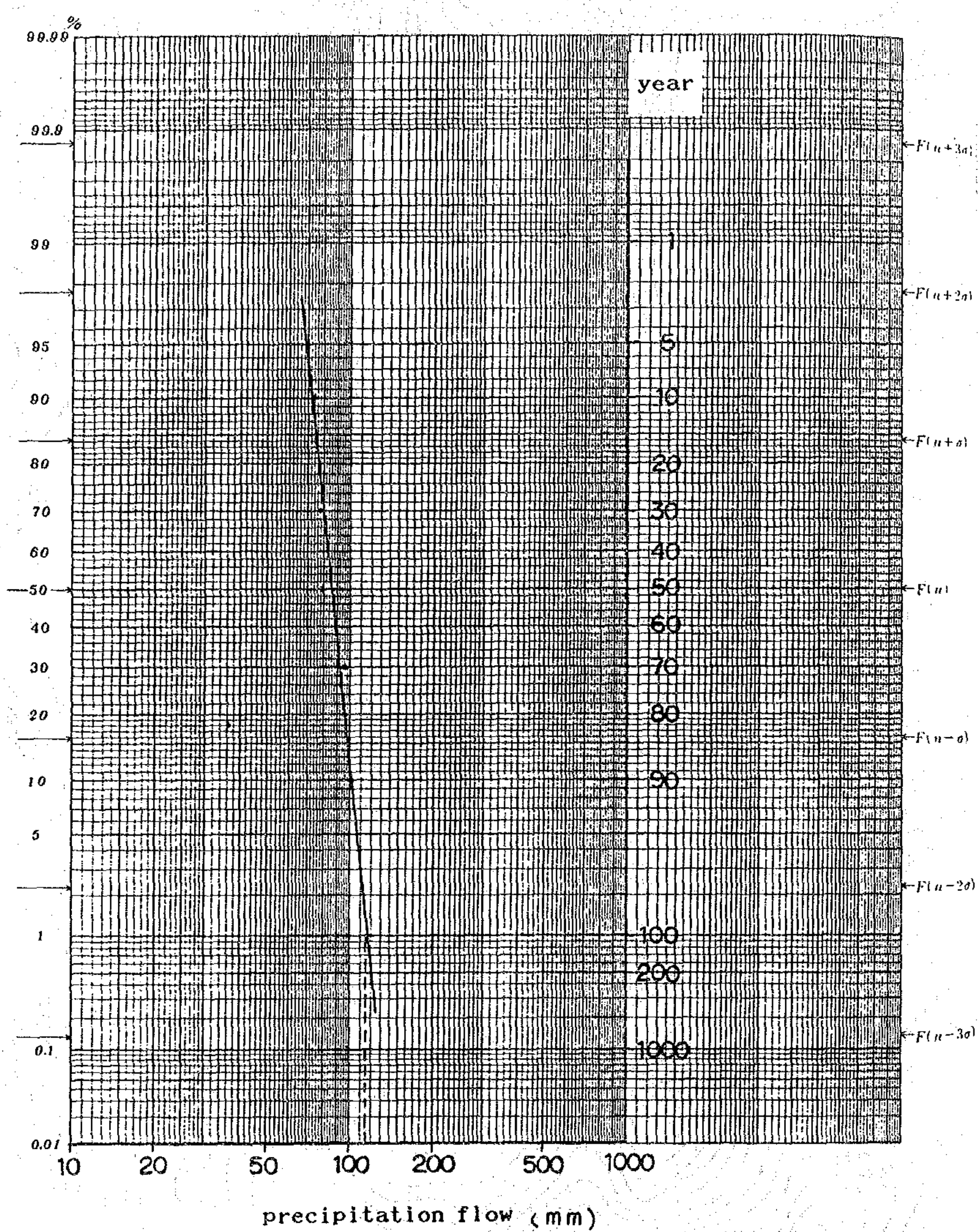


Fig. 5-8-8 Probability Precipitation

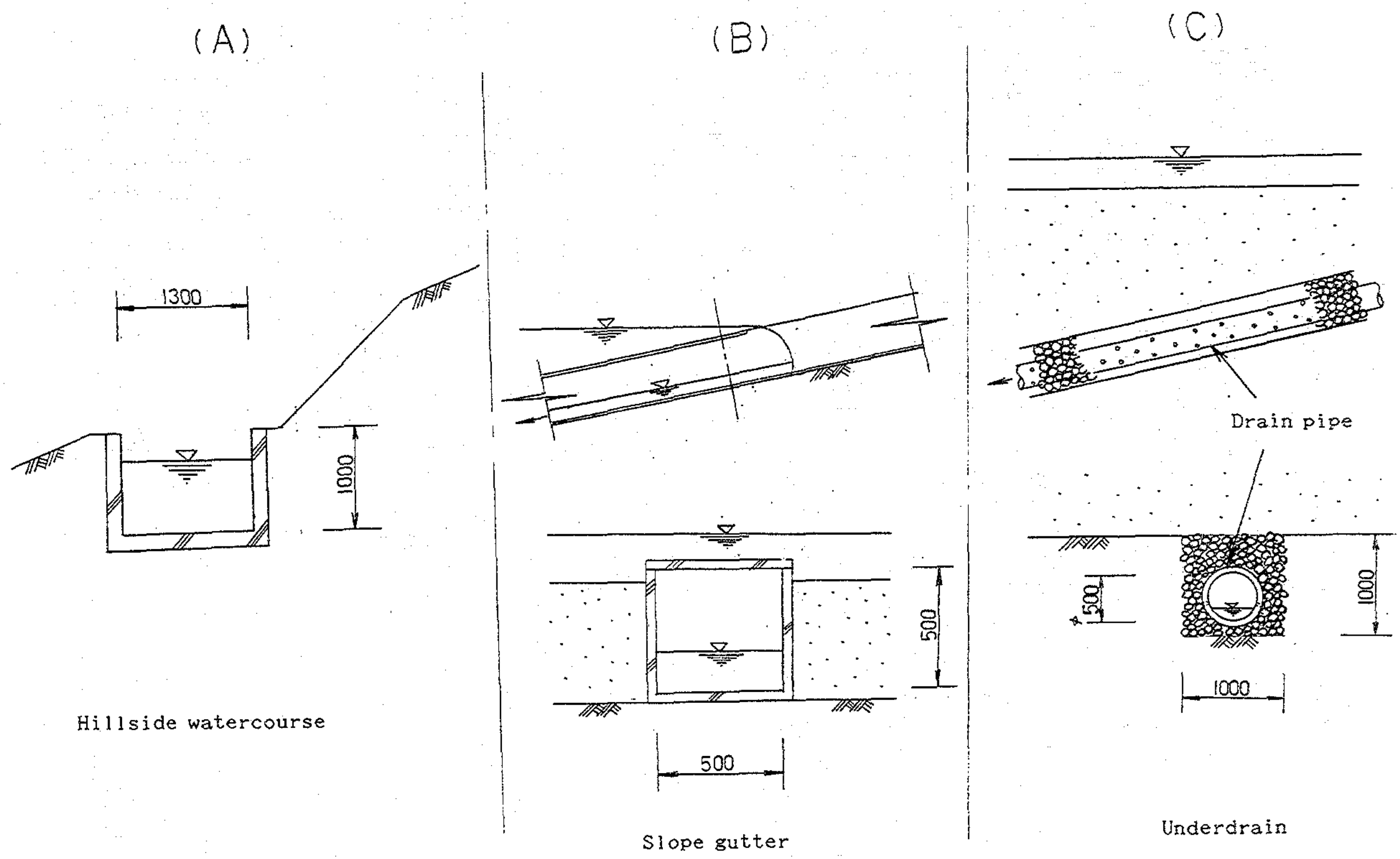


Fig. 5-8-9 Typical Cross Section of Drainage

Table 5-4-1 Hydrologic Measurement of Surface Water (New El Coco)

Site	Season	Date	Section of Flow (m^2)	Velocity (m/sec)	Flow Rate (m^3/sec)	Daily Flow (m^3/day)
No. 1	Dry	15, Mar.	0.4012	0.0120	0.481×10^{-2}	415.6
	Rainy	26, Jul.	0.1575	0.3040	4.788×10^{-2}	4,136.6
	Rainy	6, Aug.	1.6660	0.5980	0.963	86,077.3
No. 2	Dry	15, Mar.	1.1338	0	0	0
	Rainy	26, Jul.	1.2950	0.0639	8.278×10^{-2}	7,152.1
	Rainy	7, Aug.	2.0888	0.1587	0.3313	28,624.3
No. 3	Dry	15, Mar.	0.5225	0	0	0
	Rainy	27, Jul.	1.0183	0.0823	8.382×10^{-2}	7,241.8
	Rainy	6, Aug.	4.5850	0.1769	0.811	70,076.8
No. 4	Dry	15, Mar.	0	0	0	0
	Rainy	26, Jul.	0.0232	0.0706	0.164×10^{-2}	141.7
	Rainy	6, Aug.	0.0144	0.1537	0.175×10^{-2}	151.0
No. 5	Dry	15, Mar.	0	0	0	0
	Rainy	26, Jul.	0.0351	0.0650	0.228×10^{-2}	197.0
	Rainy	6, Aug.	0.0083	0.0833	0.069×10^{-2}	59.4
No. 6	Rainy	27, Jul.	0.0570	0	0	0
	Rainy	7, Aug.	0.0570	0	0	0

Table 5-4-2 Background and Water Supply Ceiling of Chemical Components in Water

(ppm)

Background Value	Cu	Pb	Zn	Fe	Cd	Total Cr	As	Hg	Cr^{6+}	CN
Fresh Water	0.003	0.003	0.020	0.1	0.032×10^{-3}	0.001	0.002	0.07×10^{-3}	0.001	0
Water Supply Ceiling	1	0.05	5	0.3	0.01	0.05	0.05	0.002	0.05	0

after Rose, W., Hawkes, H. E., and Webb, J. S. (1979): Geochemistry in Mineral Exploration
Water Supply Ceiling is by U.S. Enviromental Protection Agency (1977)

Table 5-4-3 Chemical Analysis of Surface Water (New El Coco)

Site	Season	Date	Cu (ppm)	Pb (ppm)	Zn (ppm)	Fe (ppm)	Cd (ppm)	Total Cr (ppm)	As (ppm)	Hg (ppm)	Cr^{6+} (ppm)	pH
C-R1	Dry	15, Mar.	n.d.	n.d.	0.005	0.28	n.d.	n.d.	n.d.	n.d.	n.d.	6.88
	Rainy	26, Jul.	0.012	n.d.	0.085	0.29	n.d.	0.001	0.003	n.d.	n.d.	7.28
C-R2	Dry	15, Mar.	n.d.	n.d.	0.01	0.06	n.d.	n.d.	0.027	n.d.	n.d.	7.28
	Rainy	26, Jul.	0.004	0.002	0.089	0.25	n.d.	0.002	0.004	n.d.	n.d.	7.68
C-R3	Dry	15, Mar.	0.001	n.d.	n.d.	0.03	n.d.	n.d.	n.d.	n.d.	n.d.	8.44
	Rainy	27, Jul.	0.003	0.009	0.090	0.31	n.d.	0.001	0.003	n.d.	n.d.	7.52
C-R4	Rainy	26, Jul.	0.005	n.d.	0.082	0.79	n.d.	0.003	0.026	n.d.	n.d.	7.40
C-R5	Rainy	26, Jul.	0.004	n.d.	0.079	0.24	n.d.	0.001	0.058	n.d.	n.d.	7.01
C-R6	Rainy	27, Jul.	n.d.	n.d.	0.028	0.95	n.d.	0.001	n.d.	n.d.	n.d.	6.58
	Rainy	21, Aug.	0.006	0.17	0.12	0.86	n.d.	0.048	0.003	n.d.	n.d.	6.88

Electric Conductivity (μs/cm) is:
C-R1(Dry)=43, C-R1(Rainy)=45, C-R2(Dry)=43, C-R2(Rainy)=46,
C-R3(Dry)=44, C-R3(Rainy)=47, C-R4(Rainy)=43, C-R5(Rainy)=43,
C-R6(Rainy)=42, 43

R: River

Table 5-4-4 Micro Flow Measurement Data (New El Coco B-1) (1)

Depth (m)	Time (sec)	Impellor Count	Flow Direction	Velocity (cm/sec)
6.98	60	0	Up-flow	0.40
7.98	60	0	Up-flow	0.40
8.98	60	0	Up-flow	0.40
9.98	60	0	Up-flow	0.40
10.98	60	0	Up-flow	0.40
11.98	60	0	Up-flow	0.40
12.98	60	0	Up-flow	0.40
13.98	60	0	Up-flow	0.40
14.98	60	7	Up-flow	1.22
15.98	60	6	Up-flow	1.11
16.98	60	7	Up-flow	1.22
17.98	60	4	Up-flow	0.87
18.98	60	6	Up-flow	1.11
19.98	60	3	Up-flow	0.75
20.98	60	0	Up-flow	0.40
21.98	60	2	Up-flow	0.63
22.98	60	0	Up-flow	0.40
23.98	60	4	Up-flow	0.87
24.98	60	10	Up-flow	1.58
25.98	60	5	Up-flow	0.99
26.98	60	2	Up-flow	0.63
27.98	60	1	Up-flow	0.51
28.98	60	0	Up-flow	0.40
29.98	60	1	Up-flow	0.51
30.98	60	0	Up-flow	0.40
31.98	60	0	Up-flow	0.40
32.98	60	0	Up-flow	0.40
33.98	60	0	Up-flow	0.40
34.98	60	0	Up-flow	0.40
35.98	60	0	Up-flow	0.40
36.98	60	0	Up-flow	0.40
37.98	60	0	Up-flow	0.40
38.98	60	0	Up-flow	0.40
39.98	60	0	Up-flow	0.40
40.98	60	0	Up-flow	0.40
41.98	60	0	Up-flow	0.40
42.98	60	1	Up-flow	0.51
43.98	60	0	Up-flow	0.40
44.98	60	0	Up-flow	0.40
45.98	60	0	Up-flow	0.40
46.98	60	0	Up-flow	0.40
47.98	60	0	Up-flow	0.40

DATE 26 JUL 1991
TIME 03:43:43 PM
HOLE No.=B-1
WATER LEVEL=5.98m
DEPTH=50m

Table 5-4-4 Micro Flow Measurement Data (New El Coco B-1) (2)

Depth (m)	Time (sec)	Impellor Count	Flow Direction	Velocity (cm/sec)
6.90	60	0	Up-flow	0.40
7.90	60	0	Up-flow	0.40
8.90	60	0	Up-flow	0.40
9.90	60	0	Up-flow	0.40
10.90	60	0	Up-flow	0.40
11.90	60	10	Up-flow	1.58
12.90	60	1	Up-flow	0.51
13.90	60	14	Up-flow	2.05
14.90	60	20	Up-flow	2.76
15.90	60	22	Up-flow	3.00
16.90	60	21	Up-flow	2.88
17.90	60	21	Up-flow	2.88
18.90	60	22	Up-flow	3.00
19.90	60	14	Up-flow	2.05
20.90	60	10	Up-flow	1.58
21.90	60	0	Up-flow	0.40
22.90	60	0	Up-flow	0.40
23.90	60	12	Up-flow	1.82
24.90	60	12	Up-flow	1.82
25.90	60	10	Up-flow	1.58
26.90	60	7	Up-flow	1.22
27.90	60	6	Up-flow	1.11
28.90	60	4	Up-flow	0.87
29.90	60	2	Up-flow	0.63
30.90	60	2	Up-flow	0.63
31.90	60	0	Up-flow	0.40
32.90	60	0	Up-flow	0.40
33.90	60	0	Up-flow	0.40
34.90	60	0	Up-flow	0.40
35.90	60	0	Up-flow	0.40
36.90	60	0	Up-flow	0.40
37.90	60	0	Up-flow	0.40
38.90	60	0	Up-flow	0.40
39.90	60	0	Up-flow	0.40
40.90	60	6	Up-flow	1.11
41.90	60	6	Up-flow	1.11
42.90	60	0	Up-flow	0.40
43.90	60	5	Up-flow	0.99
44.90	60	0	Up-flow	0.40
45.90	60	0	Up-flow	0.40
46.90	60	1	Up-flow	0.51
47.90	60	0	Up-flow	0.40
48.90	60	0	Up-flow	0.40

DATE 06 AUG 1991
TIME 10:20:43 AM
HOLE No.=B-1
WATER LEVEL=5.90m
DEPTH=50m

Table 5-4-4 Micro Flow Measurement Data (New El Coco B-1) (3)

Depth (m)	Time (sec)	Impellor Count	Flow Direction	Velocity (cm/sec)
6.85	60	0	Up-flow	0.40
7.85	60	0	Up-flow	0.40
8.85	60	0	Up-flow	0.40
9.85	60	0	Up-flow	0.40
10.85	60	1	Up-flow	0.51
11.85	60	0	Up-flow	0.40
12.85	60	0	Up-flow	0.40
13.85	60	0	Up-flow	0.40
14.85	60	0	Up-flow	0.40
15.85	60	0	Up-flow	0.40
16.85	60	0	Up-flow	0.40
17.85	60	0	Up-flow	0.40
18.85	60	0	Up-flow	0.40
19.85	60	0	Up-flow	0.40
20.85	60	0	Up-flow	0.40
21.85	60	0	Up-flow	0.40
22.85	60	0	Up-flow	0.40
23.85	60	0	Up-flow	0.40
24.85	60	0	Up-flow	0.40
25.85	60	0	Up-flow	0.40
26.85	60	0	Up-flow	0.40
27.85	60	0	Up-flow	0.40
28.85	60	0	Up-flow	0.40
29.85	60	0	Up-flow	0.40
30.85	60	0	Up-flow	0.40
31.85	60	0	Up-flow	0.40
32.85	60	0	Up-flow	0.40
33.85	60	0	Up-flow	0.40
34.85	60	0	Up-flow	0.40
35.85	60	0	Up-flow	0.40
36.85	60	0	Up-flow	0.40
37.85	60	0	Up-flow	0.40
38.85	60	0	Up-flow	0.40
39.85	60	0	Up-flow	0.40
40.85	60	2	Up-flow	0.63
41.85	60	7	Up-flow	1.22
42.85	60	2	Up-flow	0.63
43.85	60	4	Up-flow	0.87
44.85	60	0	Up-flow	0.40
45.85	60	0	Up-flow	0.40
46.85	60	0	Up-flow	0.40
47.85	60	0	Up-flow	0.40

DATE 20 AUG 1991
TIME 03:07:38 PM
HOLE No.=B-1
WATER LEVEL=5.85m
DEPTH=50m

Table 5-4-4 Micro Flow Measurement Data (New El Coco B-2) (1)

Depth (m)	Time (sec)	Impellor Count	Flow Direction	Velocity (cm/sec)
0.00	120	6	Up-flow	0.75
1.00	120	0	Up-flow	0.40
2.00	120	0	Up-flow	0.40
4.00	120	0	Up-flow	0.40
6.00	120	0	Up-flow	0.40
8.00	120	0	Up-flow	0.40
10.00	120	0	Up-flow	0.40
12.00	120	0	Up-flow	0.40
14.00	120	0	Up-flow	0.40
16.00	120	0	Up-flow	0.40
18.00	120	0	Up-flow	0.40
20.00	120	0	Up-flow	0.40
22.00	120	0	Up-flow	0.40
24.00	120	0	Up-flow	0.40
26.00	120	0	Up-flow	0.40
28.00	120	0	Up-flow	0.40
30.00	120	0	Up-flow	0.40
32.00	120	0	Up-flow	0.40
34.00	120	0	Up-flow	0.40
36.00	120	0	Up-flow	0.40
37.00	120	0	Up-flow	0.40
38.00	120	0	Up-flow	0.40
39.00	120	0	Up-flow	0.40
40.00	120	0	Up-flow	0.40
41.00	120	69	Up-flow	4.48
42.00	120	0	Up-flow	0.40
43.00	120	68	Up-flow	4.42
44.00	120	72	Up-flow	4.66
45.00	120	69	Up-flow	4.48
46.00	120	72	Up-flow	4.66
47.00	120	1	Up-flow	0.45
48.00	120	11	Up-flow	1.05
49.00	120	76	Up-flow	4.89
50.00	120	61	Up-flow	4.00
51.00	120	70	Up-flow	4.54
52.00	120	0	Up-flow	0.40
53.00	120	0	Up-flow	0.40
54.00	120	0	Up-flow	0.40
55.00	120	0	Up-flow	0.40
56.00	120	5	Up-flow	0.69
57.00	120	1	Up-flow	0.45
58.00	120	2	Up-flow	0.51
59.00	120	0	Up-flow	0.40

DETA 25 JUL 1991
TIME 11:59:57 AM
HOLE No.=B-2
WATER LEVEL=0.00m
DEPTH=105m

Table 5-4-4 Micro Flow Measurement Data (New El Coco B-2) (2)

Depth (m)	Time (sec)	Impellor Count	Flow Direction	Velocity (cm/sec)
0.00	60	0	Up-flow	0.40
2.00	60	0	Up-flow	0.40
4.00	60	0	Up-flow	0.40
6.00	60	0	Up-flow	0.40
8.00	60	0	Up-flow	0.40
10.00	60	0	Up-flow	0.40
12.00	60	0	Up-flow	0.40
14.00	60	0	Up-flow	0.40
16.00	60	0	Up-flow	0.40
18.00	60	0	Up-flow	0.40
20.00	60	0	Up-flow	0.40
22.00	60	0	Up-flow	0.40
24.00	60	0	Up-flow	0.40
26.00	60	0	Up-flow	0.40
28.00	60	0	Up-flow	0.40
30.00	60	1	Up-flow	0.51
32.00	60	0	Up-flow	0.40
34.00	60	0	Up-flow	0.40
36.00	60	0	Up-flow	0.40
37.00	60	0	Up-flow	0.40
38.00	60	0	Up-flow	0.40
39.00	60	0	Up-flow	0.40
40.00	60	0	Up-flow	0.40
41.00	60	35	Up-flow	4.54
42.00	60	34	Up-flow	4.42
43.00	60	0	Up-flow	0.40
44.00	60	37	Up-flow	4.77
45.00	60	0	Up-flow	0.40
46.00	60	38	Up-flow	4.89
47.00	60	1	Up-flow	0.51
48.00	60	0	Up-flow	0.40
49.00	60	0	Up-flow	0.40
50.00	60	0	Up-flow	0.40
51.00	60	38	Up-flow	4.89
52.00	60	38	Up-flow	4.89
53.00	60	36	Up-flow	4.66
54.00	60	37	Up-flow	4.77
55.00	60	32	Up-flow	4.18
56.00	60	39	Up-flow	5.01
57.00	60	33	Up-flow	4.30
58.00	60	34	Up-flow	4.42
59.00	60	0	Up-flow	0.40

DATE 05 AUG 1991
TIME 09:54:40 AM
HOLE No.=B-2
WATER LEVEL=0.00m
DEPTH=105m

Table 5-4-4 Micro Flow Measurement Data (New El Coco B-2) (3)

Depth (m)	Time (sec)	Impellor Count	Flow Direction	Velocity (cm/sec)
0.00	60	0	Up-flow	0.40
2.00	60	1	Up-flow	0.51
4.00	60	0	Up-flow	0.40
6.00	60	0	Up-flow	0.40
8.00	60	0	Up-flow	0.40
10.00	60	0	Up-flow	0.40
12.00	60	0	Up-flow	0.40
14.00	60	0	Up-flow	0.40
16.00	60	0	Up-flow	0.40
18.00	60	0	Up-flow	0.40
20.00	60	0	Up-flow	0.40
22.00	60	0	Up-flow	0.40
24.00	60	0	Up-flow	0.40
26.00	60	0	Up-flow	0.40
28.00	60	0	Up-flow	0.40
30.00	60	0	Up-flow	0.40
32.00	60	0	Up-flow	0.40
34.00	60	0	Up-flow	0.40
36.00	60	0	Up-flow	0.40
37.00	60	0	Up-flow	0.40
38.00	60	0	Up-flow	0.40
39.00	60	0	Up-flow	0.40
40.00	60	0	Up-flow	0.40
41.00	60	35	Up-flow	4.54
42.00	60	32	Up-flow	4.18
43.00	60	0	Up-flow	0.40
44.00	60	0	Up-flow	0.40
45.00	60	0	Up-flow	0.40
46.00	60	45	Up-flow	5.72
47.00	60	0	Up-flow	0.40
48.00	60	44	Up-flow	5.60
49.00	60	45	Up-flow	5.72
50.00	60	39	Up-flow	5.01
51.00	60	35	Up-flow	4.54
52.00	60	37	Up-flow	4.77
53.00	60	35	Up-flow	4.54
54.00	60	0	Up-flow	0.40
55.00	60	0	Up-flow	0.40
56.00	60	1	Up-flow	0.51
57.00	60	0	Up-flow	0.40
58.00	60	0	Up-flow	0.40
59.00	60	0	Up-flow	0.40

DATE 07 AUG 1991
TIME 10:02:28 AM
HOLE No.=B-2
WATER LEVEL=0.00m
DEPTH=105m

Table 5-4-4 Micro Flow Measurement Data (New El Coco B-2) (4)

Depth (m)	Time (sec)	Impellor Count	Flow Direction	Velocity (cm/sec)
0.00	60	0	Up-flow	0.40
2.00	60	0	Up-flow	0.40
4.00	60	0	Up-flow	0.40
6.00	60	1	Up-flow	0.51
8.00	60	0	Up-flow	0.40
10.00	60	0	Up-flow	0.40
12.00	60	0	Up-flow	0.40
14.00	60	0	Up-flow	0.40
16.00	60	0	Up-flow	0.40
18.00	60	0	Up-flow	0.40
20.00	60	0	Up-flow	0.40
22.00	60	0	Up-flow	0.40
24.00	60	0	Up-flow	0.40
26.00	60	0	Up-flow	0.40
28.00	60	0	Up-flow	0.40
30.00	60	0	Up-flow	0.40
32.00	60	0	Up-flow	0.40
34.00	60	0	Up-flow	0.40
36.00	60	0	Up-flow	0.40
38.00	60	0	Up-flow	0.40
40.00	60	1	Up-flow	0.51
41.00	60	51	Up-flow	6.43
42.00	60	59	Up-flow	7.38
43.00	60	46	Up-flow	5.84
44.00	60	54	Up-flow	6.79
45.00	60	0	Up-flow	0.40
46.00	60	46	Up-flow	5.84
47.00	60	0	Up-flow	0.40
48.00	60	45	Up-flow	5.72
49.00	60	63	Up-flow	7.85
50.00	60	42	Up-flow	5.37
51.00	60	57	Up-flow	7.14
52.00	60	60	Up-flow	7.50
53.00	60	43	Up-flow	5.48
54.00	60	37	Up-flow	4.77
55.00	60	9	Up-flow	1.46
56.00	60	41	Up-flow	5.25
57.00	60	7	Up-flow	1.22
58.00	60	42	Up-flow	5.37
59.00	60	40	Up-flow	5.13

DATE 20 AUG 1991
TIME 09:35:07 AM
HOLE No.=B-2
WATER LEVEL=0.00m
DEPTH=105m

Table 5-4-4 Micro Flow Measurement Data (New El Coco B-3)

Depth (m)	Time (sec)	Impellor Count	Flow Direction	Velocity (cm/sec)
7.37	120	0	Up-flow	0.40
8.37	120	0	Up-flow	0.40
9.37	120	0	Up-flow	0.40
10.37	120	0	Up-flow	0.40
11.37	120	0	Up-flow	0.40
12.37	120	0	Up-flow	0.40
13.37	120	0	Up-flow	0.40
14.37	120	0	Up-flow	0.40
15.37	120	0	Up-flow	0.40
16.37	120	0	Up-flow	0.40

DATE 25 JUL 91
TIME 04:35:49 PM
HOLE No.=3
WATER LEVEL=6.37m
DEPTH=20m

Depth (m)	Timer (sec)	Impellor Count	Flow Direction	Velocity (cm/sec)
5.86	60	0	Up-flow	0.40
6.86	60	0	Up-flow	0.40
7.86	60	0	Up-flow	0.40
8.86	60	0	Up-flow	0.40
9.86	60	0	Up-flow	0.40
10.86	60	0	Up-flow	0.40
11.86	60	0	Up-flow	0.40
12.86	60	0	Up-flow	0.40
13.86	60	0	Up-flow	0.40
14.86	60	0	Up-flow	0.40
15.86	60	0	Up-flow	0.40
16.86	60	0	Up-flow	0.40

DATE 06 AUG 1991
TIME 04:35:44 PM
HOLE No.=B-3
WATER LEVEL=4.86m
DEPTH=20m

Depth (m)	Time (sec)	Impellor Count	Flow Direction	Velocity (cm/sec)
5.00	60	0	Up-flow	0.40
6.00	60	4	Up-flow	0.87
7.00	60	4	Up-flow	0.87
8.00	60	0	Up-flow	0.40
9.00	60	0	Up-flow	0.40
10.00	60	1	Up-flow	0.51
11.00	60	0	Up-flow	0.40
12.00	60	0	Up-flow	0.40
13.00	60	0	Up-flow	0.40
14.00	60	0	Up-flow	0.40
15.00	60	0	Up-flow	0.40
16.00	60	0	Up-flow	0.40
17.00	60	1	Up-flow	0.51

DATE 20 AUG 1991
TIME 12:32:12 PM
HOLE No.=B-3
WATER LEVEL=5.00m
DEPTH=20m

Table 5-4-4 Micro Flow Measurement Data (New El Coco B-4)

DATE 24 JUL 1991
TIME 02:06:56 PM
HOLE No.=B-4
WATER LEVEL=10.74m
DEPTH=30m

Depth (m)	Time (sec)	Impellor Count	Flow Direction	Velocity (cm/sec)
11.74	60	0	Up-flow	0.40
12.74	60	1	Up-flow	0.51
13.74	60	0	Up-flow	0.40
14.74	60	0	Up-flow	0.40
15.74	60	2	Up-flow	0.63
16.74	60	0	Up-flow	0.40
17.74	60	2	Up-flow	0.63
18.74	60	0	Up-flow	0.40
19.74	60	0	Up-flow	0.40
20.74	60	1	Up-flow	0.51
21.74	60	0	Up-flow	0.40
22.74	60	0	Up-flow	0.40
23.74	60	0	Up-flow	0.40
24.74	60	0	Up-flow	0.40
25.74	60	0	Up-flow	0.40
26.74	60	0	Up-flow	0.40
27.74	60	0	Up-flow	0.40
28.74	60	0	Up-flow	0.40

DATE 05 AUG 1991
TIME 11:45:32 AM
HOLE No.=B-4
WATER LEVEL=11.19m
DEPTH=30m

Depth (m)	Time (sec)	Impellor Count	Flow Direction	Velocity (cm/sec)
12.19	60	0	Up-flow	0.40
13.19	60	2	Up-flow	0.63
14.19	60	0	Up-flow	0.40
15.19	60	0	Up-flow	0.40
16.19	60	0	Up-flow	0.40
17.19	60	0	Up-flow	0.40
18.19	60	0	Up-flow	0.40
19.19	60	0	Up-flow	0.40
20.19	60	0	Up-flow	0.40
21.19	60	0	Up-flow	0.40
22.19	60	0	Up-flow	0.40
23.19	60	0	Up-flow	0.40
24.19	60	0	Up-flow	0.40
25.19	60	0	Up-flow	0.40
26.19	60	0	Up-flow	0.40
27.19	60	0	Up-flow	0.40
28.19	60	0	Up-flow	0.40

DATE 19 AUG 1991
TIME 10:58:42 AM
HOLE No.=B-4
WATER LEVEL=11.22m
DEPTH=30m

Depth (m)	Time (sec)	Impellor Count	Flow Direction	Velocity (cm/sec)
12.22	60	0	Up-flow	0.40
13.22	60	0	Up-flow	0.40
14.22	60	6	Up-flow	1.11
15.22	60	1	Up-flow	0.51
16.22	60	0	Up-flow	0.40
17.22	60	21	Up-flow	2.88
18.22	60	20	Up-flow	2.76
19.22	60	31	Up-flow	4.06
20.22	60	23	Up-flow	3.12
21.22	60	0	Up-flow	0.40
22.22	60	0	Up-flow	0.40
23.22	60	0	Up-flow	0.40
24.22	60	0	Up-flow	0.40
25.22	60	0	Up-flow	0.40
26.22	60	0	Up-flow	0.40
27.22	60	0	Up-flow	0.40
28.22	60	0	Up-flow	0.40
29.22	60	0	Up-flow	0.40

Table 5-4-4 Micro Flow Measurement Data (New El Coco B-5)

Depth (m)	Time (sec)	Impellor Count	Flow Direction	Velocity (cm/sec)
5.35	60	0	Up-flow	0.40
6.35	60	1	Up-flow	0.51
7.35	60	2	Up-flow	0.63
8.35	60	7	Up-flow	1.22
9.35	60	6	Up-flow	1.11
10.35	60	6	Up-flow	1.11
11.35	60	3	Up-flow	0.75
12.35	60	0	Up-flow	0.40
13.35	60	3	Up-flow	0.75
14.35	60	4	Up-flow	0.87
15.35	60	0	Up-flow	0.40

DATE 24 JUL 1991
TIME 12:09:09 PM
HOLE No.=B-5
WATER LEVEL=4.35m
DEPTH=14.30m

Depth (m)	Time (sec)	Impellor Count	Flow Direction	Velocity (cm/sec)
5.57	60	0	Up-flow	0.40
6.57	60	1	Up-flow	0.51
7.57	60	6	Up-flow	1.11
8.57	60	4	Up-flow	0.87
9.57	60	4	Up-flow	0.87
10.57	60	0	Up-flow	0.40
11.57	60	0	Up-flow	0.40
12.57	60	0	Up-flow	0.40

DATE 30 JUL 1991
TIME 11:06:35 AM
HOLE No.=B-5
WATER LEVEL=4.57m
DEPTH=14.50m

Depth (m)	Time (sec)	Impellor Count	Flow Direction	Velocity (cm/sec)
5.57	60	0	Up-flow	0.40
6.57	60	0	Up-flow	0.40
7.57	60	0	Up-flow	0.40
8.57	60	0	Up-flow	0.40
9.57	60	0	Up-flow	0.40
10.57	60	0	Up-flow	0.40
11.57	60	0	Up-flow	0.40
12.57	60	0	Up-flow	0.40
13.57	60	0	Up-flow	0.40

DATE 05 AUG 1991
TIME 03:09:46 PM
HOLE No.=B-5
WATER LEVEL=4.57m
DEPTH=14.30m

Depth (m)	Time (sec)	Impellor Count	Flow Direction	Velocity (cm/sec)
5.63	60	0	Up-flow	0.40
6.63	60	0	Up-flow	0.40
7.63	60	1	Up-flow	0.51
8.63	60	1	Up-flow	0.51
9.63	60	0	Up-flow	0.40
10.63	60	0	Up-flow	0.40
11.63	60	0	Up-flow	0.40
12.63	60	0	Up-flow	0.40
13.63	60	0	Up-flow	0.40

DATE 19 AUG 1991
TIME 00:20:33 PM
HOLE No.=B-5
WATER LEVEL=4.63m
DEPTH=14.50m

Table 5-4-4 Micro Flow Measurement Data (New El Coco B-6)

Depth (m)	Time (sec)	Impellor Count	Flow Direction	Velocity (cm/sec)
6.50	60	0	Up-flow	0.40
7.00	60	0	Up-flow	0.40
7.50	60	0	Up-flow	0.40
8.00	60	0	Up-flow	0.40
8.50	60	0	Up-flow	0.40
9.00	60	0	Up-flow	0.40
9.50	60	0	Up-flow	0.40

DATE 25 JUL 1991
TIME 09:48:55 AM
HOLE No.=B-6
WATER LEVEL=6.00m
DEPTH=10m

Depth (m)	Time (sec)	Impellor Count	Flow Direction	Velocity (cm/sec)
7.36	60	0	Up-flow	0.40
8.36	60	0	Up-flow	0.40
9.36	60	0	Up-flow	0.40

DATE 06 AUG 1991
TIME 02:35:31 PM
HOLE No.=B-6
WATER LEVEL=6.36m
DEPTH=10m

Depth (m)	Time (sec)	Impellor Count	Flow Direction	Velocity (cm/sec)
7.40	60	0	Up-flow	0.40
8.40	60	3	Up-flow	0.75
9.40	60	2	Up-flow	0.63

DATE 19 AUG 1991
TIME 02:11:19 PM
HOLE No.=B-6
WATER LEVEL=6.40m
DEPTH=10m

Table 5-4-4 Micro Flow Measurement Data (New El Coco B-7)

Depth (m)	Time (sec)	Impellor Count	Flow Direction	Velocity (cm/sec)
7.74	60	0	Up-flow	0.40
8.24	60	0	Up-flow	0.40
8.74	60	0	Up-flow	0.40
9.24	60	0	Up-flow	0.40
9.74	60	0	Up-flow	0.40
10.24	60	0	Up-flow	0.40
10.74	60	0	Up-flow	0.40
11.24	60	0	Up-flow	0.40

DATE 25 JUL 1991
TIME 10:26:13 AM
HOLE No.=B-7
WATER LEVEL=7.24m
DEPTH=14m

Depth (m)	Time (sec)	Impellor Count	Flow Direction	Velocity (cm/sec)
8.22	60	0	Up-flow	0.40
9.22	60	0	Up-flow	0.40
10.22	60	0	Up-flow	0.40
11.22	60	0	Up-flow	0.40

DATE 06 AUG 1991
TIME 02:55:59 PM
HOLE No.=B-7
WATER LEVEL=7.22m
DEPTH=14m

Depth (m)	Time (sec)	Impellor Count	Flow Direction	Velocity (cm/sec)
8.25	60	0	Up-flow	0.40
9.25	60	0	Up-flow	0.40
10.25	60	0	Up-flow	0.40
11.25	60	0	Up-flow	0.40

DATE 19 AUG 1991
TIME 02:39:44 PM
HOLE No.=B-7
WATER LEVEL=7.25m
DEPTH=14m

Table 5-4-4 Micro Flow Measurement Data (New El Coco B-8)

Depth (m)	Time (sec)	Impellor Count	Flow Direction	Velocity (cm/sec)
7.00	60	0	Up-flow	0.40
8.00	60	0	Up-flow	0.40
9.00	60	3	Up-flow	0.75
10.00	60	2	Up-flow	0.63
11.00	60	5	Up-flow	0.99
12.00	60	7	Up-flow	1.22
13.00	60	4	Up-flow	0.87

DATE 24 JUL 1991
TIME 11:27:01 AM
HOLE No.=B-8
WATER LEVEL=6.00m
DEPTH=14.5m

Depth (m)	Time (sec)	Impellor Count	Flow Direction	Velocity (cm/sec)
7.07	60	0	Up-flow	0.40
8.07	60	0	Up-flow	0.40
9.07	60	0	Up-flow	0.40
10.07	60	0	Up-flow	0.40
11.07	60	0	Up-flow	0.40
12.07	60	0	Up-flow	0.40
13.07	60	0	Up-flow	0.40

DATE 05 AUG 91
TIME 01:06:48 PM
HOLE No.=B-8
WATER LEVEL=6.07m
DEPTH=14.5m

Depth (m)	Time (sec)	Impellor Count	Flow Direction	Velocity (cm/sec)
7.12	60	0	Up-flow	0.4
8.12	60	0	Up-flow	0.4
9.12	60	0	Up-flow	0.4
10.12	60	0	Up-flow	0.4
11.12	60	0	Up-flow	0.4
12.12	60	0	Up-flow	0.4
13.12	60	0	Up-flow	0.4

DATE 19 AUG 1991
TIME 11:51:39 PM
HOLE No.=B-8
WATER LEVEL=6.12m
DEPTH=14.3m

Table 5-4-4 Micro Flow Measurement Data (New El Coco B-9)

Depth (m)	Time (sec)	Impellor Count	Flow Direction	Velocity (cm/sec)
6.05	60	0	Up-flow	0.40
7.05	60	0	Up-flow	0.40
8.05	60	0	Up-flow	0.40
9.05	60	0	Up-flow	0.40
10.05	60	0	Up-flow	0.40
11.05	60	0	Up-flow	0.40
12.05	60	0	Up-flow	0.40
13.05	60	0	Up-flow	0.40
14.05	60	0	Up-flow	0.40

DATE 05 AUG 1991
TIME 03:51:23: PM
HOLE No.=B-9
WATER LEVEL=5.05m
DEPTH=20.20m

Depth (m)	Time (sec)	Impellor Count	Flow Direction	Velocity (cm/sec)
5.57	60	0	Up-flow	0.4
6.57	60	0	Up-flow	0.4
7.57	60	0	Up-flow	0.4
8.57	60	0	Up-flow	0.4
9.57	60	0	Up-flow	0.4
10.57	60	0	Up-flow	0.4
11.57	60	0	Up-flow	0.4
12.57	60	0	Up-flow	0.4
13.57	60	0	Up-flow	0.4

DATE 06 AUG 1991
TIME 03:26:57 PM
HOLE No.=B-9
WATER LEVEL=4.57m
DEPTH=20.20m

Depth (m)	Time (sec)	Impellor Count	Flow Direction	Velocity (cm/sec)
8.70	60	0	Up-flow	0.40
9.70	60	0	Up-flow	0.40
10.70	60	0	Up-flow	0.40
11.70	60	0	Up-flow	0.40
12.70	60	0	Up-flow	0.40
13.70	60	0	Up-flow	0.40

DATE 19 AUG 1991
TIME 03:16:52 PM
HOLE No.=B-9
WATER LEVEL=7.70m
DEPTH=20m

Table 5-4-4 Micro Flow Measurement Data (New El Coco B-10)

Depth (m)	Time (sec)	Impellor Count	Flow Direction	Velocity (cm/sec)
8.25	60	0	Up-flow	0.40
9.25	60	0	Up-flow	0.40

DATE 05 AUG 91
TIME 04:26:37 PM
HOLE No.=B-10
WATER LEVEL=7.25m
DEPTH=15m

Depth (m)	Time (sec)	Impellor Count	Flow Direction	Velocity (cm/sec)
8.25	60	0	Up-flow	0.40
9.25	60	0	Up-flow	0.40
10.25	60	0	Up-flow	0.40

DATE 06 AUG 91
TIME 03:12:02 PM
HOLE No.=B-10
WATER LEVEL=7.25m
DEPTH=15m

Depth (m)	Time (sec)	Impellor Count	Flow Direction	Velocity (cm/sec)
7.80	60	0	Up-flow	0.40
8.30	60	0	Up-flow	0.40
8.80	60	0	Up-flow	0.40
9.30	60	0	Up-flow	0.40
9.80	60	0	Up-flow	0.40
10.30	60	0	Up-flow	0.40
10.80	60	0	Up-flow	0.40
11.30	60	0	Up-flow	0.40
11.80	60	0	Up-flow	0.40
12.30	60	0	Up-flow	0.40
12.80	60	0	Up-flow	0.40
13.30	60	0	Up-flow	0.40

DATE 21 AUG 1991
TIME 09:27:09 AM
HOLE No.=B-10
WATER LEVEL=7.30m
DEPTH=15m

Table 5-4-4 Micro Flow Measurement Data (New El Coco B-13)

Depth (m)	Time (sec)	Impellor Count	Flow Direction	Velocity (cm/sec)
3.86	60	0	Up-flow	0.40
4.86	60	0	Up-flow	0.40
5.86	60	0	Up-flow	0.40
6.86	60	0	Up-flow	0.40
7.86	60	0	Up-flow	0.40

DATE 19 AUG 1991
TIME 03:50:38 PM
HOLE No.=B-13
WATER LEVEL=2.86m
DEPTH=10m

Table 5-4-5 Characteristic of Aquifer (New El Coco)

Site	Season	Date	Elevation (m)	Thickness of Aquifer	Flow Rate (m^3/sec)	Flow in Bore Hole (m^3/day)	Width of Aquifer	Total Flow (m^3/day)
B-1	Dry	25, Apr.	187 to 192	5m	0.0054	116.6	100m	233,280
	Rainy	26, Jul.			0.0042	90.7		181,440
		6, Aug.			0.0074	159.8		319,680
		20, Aug.			0.0069	149.0		298,080
	Dry	25, Apr.	200 to 208	8m	0.0069	238.5		476,930
	Rainy	26, Jul.			0.0070	241.9		483,840
		6, Aug.			0.0112	387.1		774,140
		20, Aug.			0.0040	138.2		276,480
	Dry	25, Apr.	210 to 221	11m	0.0074	351.6		703,300
	Rainy	26, Jul.			0.0074	351.6		703,300
		6, Aug.			0.0192	912.4		1,824,770
		20, Aug.			0.0041	194.8		389,660
B-2	Dry	25, Apr.	141 to 144	3m	0.0097	125.7	90m	226,280
	Dry	25, Apr.	165 to 184	19m	0.0310	2,544.5	80m	4,071,170
	Rainy	25, Jul.			0.0210	1,723.7		2,757,890
		5, Aug.			0.0295	2,421.4		3,874,180
		7, Aug.			0.0246	2,019.2		3,230,670
		20, Aug.			0.0479	3,931.6		6,290,610
	Dry	25, Apr.	216 to 220	4m	0.0063	108.9	100m	217,730
	Rainy	25, Jul.			0.0040	69.1		138,240
		5, Aug.			0.0040	69.1		138,240
		7, Aug.			0.0040	69.1		138,240
		20, Aug.			0.0044	76.0		152,060
B-3	Rainy	20, Aug.	201 to 202	1m	0.0087	376.	250m	187,920
B-4	Dry	25, Apr.	236 to 240	4m	0.0040	69.1	—	—
	Rainy	24, Jul.			0.0047	81.2		
		5, Aug.			0.0040	69.1		
		19, Aug.			0.0264	456.2		
B-5	Dry	25, Apr.	238 to 244	6m	0.0091	235.9	100m	471,740
	Rainy	24, Jul.			0.0089	230.7		461,380
		30, Jul.			0.0065	168.5		336,960
		5, Aug.			0.0040	103.7		207,360
		19, Aug.			0.0043	111.5		222,910
B-6	Rainy	19, Aug.	244 to 246	2m	0.0069	59.6	—	—
B-8	Rainy	24, Jul.	239 to 244	5m	0.0081	175.0	—	—

Table 5-4-6 Chemical Analysis of Groundwater (New El Coco)

site	Season	Date	Cu (ppm)	Pb (ppm)	Zn (ppm)	Fe (ppm)	Cd (ppm)	Total Cr (ppm)	As (ppm)	Hg (ppm)	Cr^{6+} (ppm)	pH
C-B1	Dry	15, Mar.	0.03	0.13	0.16	30	n.d.	0.007	0.25	n.d.	n.d.	7.60
	Rainy	26, Jul.	n.d.	0.020	0.11	1.5	n.d.	0.001	0.14	n.d.	n.d.	7.61
C-B2	Dry	15, Mar.	0.01	0.91	0.044	1.9	0.001	n.d.	n.d.	n.d.	n.d.	8.87
	Rainy	26, Jul.	0.003	0.029	0.12	1.3	n.d.	0.006	0.001	n.d.	n.d.	8.46
C-B3	Dry	16, Mar.	0.03	n.d.	0.05	3.8	n.d.	0.003	0.015	n.d.	n.d.	8.71
	Rainy	27, Jul.	0.039	5.3	0.22	12	0.002	0.036	0.018	n.d.	n.d.	7.26
C-B4	Dry	15, Mar.	0.02	0.011	0.04	9.3	n.d.	0.009	0.024	n.d.	n.d.	7.45
	Rainy	27, Jul.	0.011	0.042	0.06	8.0	n.d.	0.020	0.010	n.d.	n.d.	7.40
	Rainy	19, Aug.	0.009	0.037	0.11	0.93	n.d.	0.005	0.032	n.d.	n.d.	7.38
C-B5	Dry	15, Mar.	0.03	0.05	0.075	22	0.003	0.006	0.045	n.d.	n.d.	8.64
	Rainy	27, Jul.	0.014	0.12	0.044	6.3	n.d.	0.008	0.030	n.d.	n.d.	7.60
	Rainy	19, Aug.	0.10	0.033	0.14	0.58	0.0006	0.006	0.014	n.d.	n.d.	7.77
C-B6	Rainy	27, Jul.	0.093	0.11	0.085	20	0.0008	0.037	0.041	n.d.	n.d.	7.53
	Rainy	19, Aug.	0.022	0.045	0.043	1.7	n.d.	0.012	0.031	n.d.	n.d.	7.69
C-B7	Dry	15, Mar.	0.03	0.1	0.06	5.2	0.002	n.d.	0.12	n.d.	n.d.	7.94
	Rainy	27, Jul.	0.048	0.15	0.20	30	0.0004	0.058	0.10	n.d.	n.d.	7.45
	Rainy	22, Aug.	0.008	0.001	0.009	2.0	0.001	0.017	0.075	n.d.	n.d.	6.71
C-B8	Rainy	27, Jul.	0.022	0.20	0.10	16	0.003	0.029	0.026	n.d.	n.d.	7.41
	Rainy	19, Aug.	0.010	0.001	0.055	1.7	n.d.	0.024	0.019	0.004	n.d.	7.71
C-B9	Rainy	19, Aug.	0.007	0.059	0.080	1.9	n.d.	0.033	0.011	0.001	n.d.	7.86
C-B10	Rainy	9, Sep.	0.015	0.032	0.25	0.77	n.d.	0.003	0.019	n.d.	n.d.	-
C-B11	Rainy	9, Sep.	0.033	0.093	0.17	2.2	0.001	0.010	0.011	0.001	n.d.	7.95
C-B12	Rainy	9, Sep.	0.045	0.12	0.15	2.4	0.001	0.006	0.005	n.d.	n.d.	7.71
C-B13	Rainy	19, Aug.	0.011	0.026	0.091	1.8	n.d.	0.045	0.005	n.d.	n.d.	7.55

Electric Conductivity (μ℧/cm) is:
C-B1(Dry)=50, C-B1(Rainy)=48, C-B2(Dry)=53, C-B2(Rainy)=50,
C-B3(Dry)=47, C-B3(Rainy)=49, C-B4(Dry)=45, C-B4(Rainy)=41, 44,
C-B5(Dry)=48, C-B5(Rainy)=44, 44, C-B6(Rainy)=48, 47, C-B7(Dry)=46,
C-B7(Rainy)=47, 45 C-B8(Rainy)=45, 43, C-B9(Rainy)=45, C-B11(Rainy)=42,
C-B12(Rainy)=43, C-B13(Rainy)=45

Table 5-4-7 Permeability Coefficient Data

(New El Coco)

Sample Number	CR-1	CR-2	CR-3	CR-4	CR-5	CR-6
D 10(mm)	0.0005	0.0020	0.0004	0.0008	0.0023	0.0060
D 60(mm)	0.5000	0.2800	0.0200	0.2300	0.3700	0.3800
Uniformity Coeffcient	1000.0	140.0	50.0	287.5	160.9	63.3
K (cm/sec) by Hazen's Formula	3.34E-07	5.34E-06	2.13E-07	8.54E-07	7.06E-06	4.80E-05

K:Permeability Coefficient(cm/sec)

D10(mm):Particle-size(mm) on 10% Cumulative Curve = Effecitve Size(de)

Table 5-4-8 Permeability and Porosity Model

Legend No.	Matrix Permeabilty pkm(cm/sec)	Fracture Permeability pkf(cm/sec)	Fracture Zone Width hef(m)	Matrix Porosity porm(%)	Fracture Porosity porf(%)
1 (Aquiclude)	5×10^{-5}	10^{-3}	0	15	30
2 (Aquifer)	10^{-6}	10^{-3}	20	10	30
3 (Aquitard)	10^{-4}	10^{-3}	0	20	30
4 (Aquifuge)	10^{-7}	10^{-3}	0	5	30

Model's Block Permeability(K) = $(hef/\triangle x)\times pkf+(1-hef/\triangle x)\times pkm$

$\triangle x$ = block width(m)

Table 5-5-1 Chemical Analysis of Soil

(New El Coco) (ppm)

No.	Cu	Pb	Zn	Fe(wt%)	Cd	Sb	Cr	As	Hg
CS-1	34	130	85	4.9	3.5	81	25	20	0.06
CS-2	27	45	94	2.7	1.8	48	33	53	0.14
CS-3	30	58	190	2.5	2.4	50	27	59	0.28
CS-A1	5	22	17	0.8	1.1	18	6	4	0.10
CS-A2	7	38	31	1.5	1.9	23	10	31	0.16
CS-A3	16	50	45	5.4	4.9	39	29	110	0.20
CS-A4	9	37	69	2.8	3.1	41	10	31	0.21

(Background in Soil) (ppm)

Elemnts	Cu	Pb	Zn	Fe(wt%)	Cd	Sb	Cr	As	Hg
Background	15	17	36	2.1	0.5	2	43	7.5	0.056

by Rose, A.T. et al. (1979): Geochemistry in Mineral Exploration, Academic Press, 657P.

Table 5-6-1 Soil Test Quantity

Dry Season		Rainy Season	
No.	Depth (m)	No.	Depth (m)
D-1	0.5- 0.7	B-11	2.0- 2.6
D-2	0.5- 0.7		4.0- 4.6
	1.2- 1.4	B-12	2.0- 2.6
D-3	0.5- 0.7		4.0- 4.6
	1.2- 1.4		6.0- 6.6
D-4	0.5- 0.7		
	1.2- 1.4		
D-5	0.5- 0.7		
	1.2- 1.4		
D-6	1.0- 1.2		
D-7	0.5- 0.7		
D-8	0.5- 0.7		
D-9	0.5- 0.7		
D-10	0.5- 0.7		
Total	14 samples	Total	5 samples

Table 5-6-2 Soil Test Data

(dry season)

Sample No.	D-1	D-2		D-3		D-4		D-5		D-6
Depth (m)	0.5～0.7	0.5～0.7	1.2～1.4	0.5～0.7	1.2～1.4	0.5～0.7	1.2～1.4	0.5～0.7	1.2～1.4	1.0～1.2
Water Content (%)	10.5	14.6	8.9	18.0	16.0	8.0	7.5	13.5	8.7	8.5
Specific Gravity	2.63	2.70	2.69	2.67	2.63	2.58	2.61	2.64	2.62	2.57
Wet Density (g/cm³)	1.859	1.694	1.593	1.609	1.553	1.281	1.290	1.170	1.426	1.370
Liquid Limit (%)	40.2	72.2	63.2	64.0	53.2	26.3	27.3	32.0	26.2	22.9
Plastic Limit (%)	20.7	20.0	21.5	22.0	21.6	19.0	18.0	19.0	20.2	19.8
Angle of Internal Fliction (°)	26.5	28.0	32.2	25.0	30.5	32.6	31.6	35.2	33.5	32.0
Cohesion (tf/m²)	7.2	6.0	4.5	5.0	5.3	3.6	3.8	4.5	5.5	4.0
Coefficient of Permeability (cm/sec)	1.87×10^{-5}	1.19×10^{-5}	1.18×10^{-5}	1.18×10^{-5}	2.99×10^{-4}	2.74×10^{-4}	3.15×10^{-4}	2.70×10^{-4}	4.21×10^{-4}	1.65×10^{-4}

(dry season)

Sample No.	D-7	D-8	D-9	D-10
Depth (m)	0.5～0.7	0.5～0.7	0.5～0.7	0.5～0.7
Water Content (%)	15.3	7.4	8.1	10.3
Specific Gravity	2.61	2.59	2.56	2.55
Wet Density (g/cm³)	1.409	1.180	1.474	1.485
Liquid Limit (%)	44.0	24.7	27.0	30.5
Plastic Limit (%)	22.0	19.9	21.0	22.3
Angle of Internal Fliction (°)	35.6	33.5	33.0	32.0
Cohesion (tf/m²)	5.5	5.0	5.3	4.8
Coefficient of Permeability (cm/sec)	2.83×10^{-4}	1.90×10^{-4}	2.15×10^{-4}	5.38×10^{-4}

(rainy season)

Sample No.	B-11		B-12		
Depth (m)	2.0～2.6	4.0～4.6	2.0～2.6	4.0～4.6	6.0～6.6
Water Content (%)	16.4	25.3	10.2	8.3	19.5
Specific Gravity	2.59	2.63	2.65	2.66	2.58
Wet Density (g/cm³)	1.78	1.95	1.81	1.81	2.01
Liquid Limit (%)	32.4	42.5	19.2	21.5	25.0
Plastic Limit (%)	21.1	22.4	N.P.	N.P.	14.0
Angle of Internal Fliction (°)	33.5	34.6	34.2	35.3	30.1
Cohesion (tf/m²)	5.0	6.3	5.8	4.0	3.0
Coefficient of Permeability (cm/sec)	5.59×10^{-3}	2.75×10^{-3}	7.38×10^{-3}	2.75×10^{-3}	1.20×10^{-3}

Table 5-6-3 Natural Moisture Content and Wet Density

Site	Natural Water Content (W)	Wet Density (ρ_t)
B-11	20.9 (%)	1.87
B-12	12.7 (%)	1.88
Average	16.8 (%)	1.875

Table 5-8-1 A Result of Tailing Dam Stability Analysis

Element		Ordinary Condition (Kh=0.00)	Earthquake Condition (Kh=0.15)
Center of Circular Arc	X(m)	95.00	135.00
	Y(m)	282.00	305.143
Radius R(m)		33.048	52.00
Resisting Moment MR(tf・m)		721.033	18070.207
Sliding Moment MD(tf・m)		404.303	15039.391
Safety Factor Fs=MR/MD		1.7834	1.2015

Table 5-8-2 Day Probability Precipitation

Order i	Date	Precipitation (mm)	$\frac{2i-1}{2N}$ x100
1	1986.9	101.2	10.0
2	1985.9	96.2	30.0
3	1989.9	79.6	50.0
4	1987.9	77.6	70.0
5	1988.8	73.6	90.0

6. 結　　言

6．結言

本調査内容は，業務指示書（1990年12月）に記載されているとおり，次の各段階から構成されている。

第一段階　既存資料の収集とレビュー

第二段階　現地踏査および乾期と雨期の集中観測

第三段階　鉱害対策計画の策定

既存資料の収集については，ＣＦＭ本部ならびに各鉱山において地形，地質，鉱山，選鉱，堆積場関連の諸データを収集したほか，各調査地域における気象観測所から関連諸データを入手した。

現地踏査と集中観測は，Ｓ／Ｗに指定された三地域において，それぞれ堆積場またはその予定地周辺の地質，水理，土壌，粉塵飛散状況の調査・観測を実施した。

以上の収集データならびに現地調査結果を，国内において総合的に解析し，鉱山に由来する鉱害の実態を把握すると共にその防止対策を検討・立案した。

調査期間を通じてＣＦＭ側カウンターパートに対し，鉱山公害調査の要点，方法および測定機器の原理，使用方法について技術移転を行った。

以下，地域毎に結果を要約して記述する。

エルボテ地域　この地域では，第一に既設堆積場の提体の一部がすでに崩壊して，土砂が流出するなど危険な状態にあり，緊急対策が必要である。解析の結果，堆積場自体の 安定性も非常に悪いと判断される。これらの対策として，堆積場法面に盛土を行う“押さえ盛土工法”を提案する。

堆積場から発生する粉塵公害も，現状では市街地に直接の被害はないが，鉱山の作業員ならびに周辺環境に対しては放置できない問題である。これに対しては，表面を土砂で覆土する“覆土工法”を提案する。

地域周辺の表流水，地下水および土壌からは，Cuをはじめ各種の重金属イオンが検出されている。これらの発生源としては次の三つが考えられる。

（１）　ＣＦＭエルボテ選鉱場・堆積場から排水に由来するもの

（２）　他の民間の鉱山からの排水に由来するもの

（３）　地域全般の鉱化作用など自然現象に由来するもの

当地域の環境汚染は，これらの発生源のいずれもが関与していることは間違いないが，それらの影響の度合いを求めるのはきわめて困難であり，今回の調査範

囲では解明することはできなかった。しかし，当地域の場合，選鉱場，堆積場の上流にすべての金属がいちじるしく濃縮している地点（B-R2）が見いだされることから，ＣＦＭの鉱山活動のみが発生源ではないと判断される。このB-R2地点は水量が少なく，乾期には水が滞留している地点なので，周辺の鉱化帯から金属が溶解，濃縮したものと考えるのが妥当であろう。

ＣＦＭ選鉱場，堆積場からの排水（B-D1,B-W1）は，パラル選鉱場排水と比較すると金属含有量は全般に低く，シアンは全く検出されていない。従って，現状では直ちに排水処理まで行う必要はないものと考えられる。当面の方策として次の三点を指摘する。

（１）　選鉱場からの排水をできるだけ循環再使用する。

（２）　堆積場内に排水施設を設け，雨水が堆積物に接触する機会をできるだけ少なくする。

（３）　堆積場の堆積面を平坦にし，蒸発面積を大きくする。

排水施設については第3-8節に記述している。

<u>パラル地域</u>　この地域についてはエルボテの場合と同様，堆積場自体の安定性が先ず第一に問題である。パラル堆積場の場合には，上部の土砂を排土し荷重を軽減する“排土工”を“押さえ盛土工法”と併用するのが最適と考えられるので，この両法を崩壊防止対策として提言する。

堆積場からの粉塵発生については，エルボテ堆積場におけると同様，“覆土工法”を提言する。

排水については，当地域の場合ＣＦＭパラル選鉱場，堆積場からの排水中の重金属含有量が相当に高いので，地域の表流水に影響を与えていることは明らかである。特にシアンが河川水から検出されることは重要な問題で，何らかの排水処理が必要である。第4-8節にはアルカリ塩素法について記述している。

また，排水処理の方法として，堆積場とパラル川の間に簡易な排水沈澱池を設けることも提案する。沈澱池を設けることで，乾期には排水の蒸発が促進され汚染物質が地下に浸透するのを防ぎ，雨期には集中雨による廃滓の流出を防ぐことができる。

パラル鉱山坑内から揚水している地下水は，パラル市の生活用水として利用されているが，水質は飲料に適さない。この坑内水は深層地下水であり温泉に近い性質を有する。従って，水質を改善するには，集水面積が非常に大きいパラル河川沿いで地下水用の浅層ボーリングを数多く実施し，この地下水を利用すべきである。

新エルココ地域　この地域においても，周辺の水系，土壌中に重金属による汚染が認められるが，エルボテ・パラル両地域と比較すると程度は低く，現在何らの鉱業活動が行われていないことから，地域の鉱化作用による自然汚染と断定できる。将来，鉱業活動が行われたのち，再度比較のための調査を提言する。

堆積場予定地の基礎地盤については，建設上適当であるとの結論を得た。これに基づいて，公害発生のおそれのない堆積場を経済性も加味して立案し，モデル堆積場として提案する。

堆積場を新設した場合，排水による地下水の汚染を防止するには，第5-8節では有害成分を含む堆積物を雨水と直接接触させなかったり，排水が地下に浸透しない土木的な方法を提案した。一方，第5-4節で解析した水理調査に基づく地下水流動シミュレーションによれば，排水を積極的に地下に浸透させ，地下水と混合し，これを堆積場付近のボーリングから揚水してリサイクルする方法も，地下水を汚染することなく，かつ堆積場下の地下水も有効利用できるため，地下水汚染対策の第二案として提案する。

以上に記述した公害防止対策は，いずれも比較的簡単に実行可能なことであり，早急に実現されるよう期待する。加えて公害調査は短期一過性なもので終わることなく，長期的連続調査が必要と考えられる。本調査結果を基本として地域毎に長期にわたる調査計画を作成し，常に実態を把握すると共に積極的対策を講ずることが望まれる。鉱害問題は鉱山開発に伴って発生するものであるから，その対策工事費は当然開発費に含まれるべきである。しかし，本件のように事後に鉱害対策を実施する場合には，別途対策工事費の予算化と資金対策が急務である。

近年，生活の基盤である環境の汚染が世界的な関心を集めている。鉱業活動は，生活基準の向上に不可欠のものであるが，時に周辺地域に対して環境の悪化を引き起こすおそれがないとはいえない。従って，開発に伴う汚染と破壊には格別の配慮が必要である。

国際協力事業団は，ここに，鉱山開発と環境保全を両立させるためのガイドラインをメキシコ合衆国においても公式に制定することを提言する。また，すでに規制あるいは基準が存在する場合は，それらを遵守すべきである。

ガイドラインに記載されるべき主な項目は次のとおりである。

粉塵による大気の汚染

鉱山排水による水質汚染

鉱山廃さい，排水，粉塵等による土壌汚染

廃さい堆積場の建設基準

開発地域における地盤沈下

騒音，振動

森林の破壊

なお，参考のため，わが国における基準の主なものを以下に記載する。

公害対策基本法	1967年 8月
大気汚染防止法	1968年 6月
水質汚濁防止法	1968年12月
捨石，鉱さいたい積場建設基準及び解説，通産省立地公害局	1954年11月
環境配慮のためのＯＥＣＦガイドライン，海外経済協力基金	1989年10月

付　録　A

付録A　地下水流動シミュレーション法

APPENDIX A

Numerical Simulation Technology for Subsurface Fluid Flow

A.1 Introduction

The numerical simulation techniques for subsurface fluid flow problems have been widely studied in several related fields, such as petroleum, geothermal, mining and civil engineerings, water resources field, agricultural field, and so on.

Current technological developments in numerical techniques and computer hardwares/softwares have made us solve the fluid flow equations on a large domain of space and time under realistic conditions. In many fields, successful applications have been made for evaluating reserves of fluids, explaining fluid behavior in the past and present, and for predicting the future performance.

In this Appendix, the numerical simulation techniques are described on a 2-phase, 3-dimension general purpose simulator, GWS3D2P, originally developed by Hiroyuki TOSAKA of Tokyo University.

A.2 Basic Equations of 2-Phase Subsurface Fluid Flow

The basic governing relationship for the flow through porous media was obtained in the middle of 19th century, and it is known as Darcy's law which has the form of pressure diffusivity equation. Today, Darcy's law is recognized applicable to general geological media such as soil, rock and rock fractures, when the flow is thought to be laminar.

The subsurface fluid system can be modeled as a system comprising of two phases, air and water. The flow of two immiscible fluids through porous media is generally described by employing the extended form of Darcy's law and mass balance equations as,

$$\nabla \cdot \frac{Kkrw}{\mu w Bw} \nabla (Pw - \gamma w \nabla D) - qw = \frac{\partial}{\partial t} \left(\frac{\phi Sw}{Bw}\right) \qquad \text{(A. 1)}$$

$$\nabla \cdot \frac{Kkrg}{\mu g Bg} \nabla (Pg - \gamma g \nabla D) - qg = \frac{\partial}{\partial t} \left(\frac{\phi Sg}{Bg}\right) \qquad \text{(A. 2)}$$

where, $\nabla = (\frac{\partial}{\partial x}, \frac{\partial}{\partial y}, \frac{\partial}{\partial z})$:Laplace's differential operator,

Pw and Pg :phase pressure of water and gas respectively,

μw and μg :viscosities of water and gas, respectively,

rw and rg :column density of water and gas, respectively,

Bw and Bg :formation volume factors of water and gas, respectively,

krw and krg :effective permeabilities of water and gas, respectively,

Sw and Sg :saturation of water and gas, respectively,

qw and qg :production/injection rate of water and gas, respectively,

ϕ :porosity of porous media,

and D :depth of points.

Supplementarily, we have a constraint relationship between Sw and Sg as

$$Sw+Sg=1 \qquad \text{(A.3)}$$

and one for phase pressures as

$$Pw=Pg-Pc \qquad \text{(A.4)}$$

where, Pc is the capillary pressure explained later.

The fluid and rock properties listed above are usually dependent upon pressure or saturation if isothermal condition is assumed.

Substituting Sg and Pw in eqs.(A.1) and (A.2) using eqs(A.3) and (A.4), we finally have two equations consisting of unknown pressure Pg and unknown saturation Sw for each spatial point.

For practical purposes, it is necessary to use numerical technique to solve basic equations giving proper initaial and boundary conditions and rock/fluid properties.

In the following sections, points of numerical treatment are witten based upon the simulator GWS3D2P.

A.3 Discretization and Geological Setting

Discretization of Space and Time

To approximate the domain that the differential equations are defined and solved, Finite Difference Method(FDM) is applied. The entire portion of objective three dimensional spatial domain is discretized into a number of rectangular parallel-piped gridblocks, and for each gridblock, the fully implicit FDM expansion of the basic equations in terms of pressure and water saturation is done. The time domain is also divided into proper finite time difference. If the objective space is discretized into N finite gridblocks, we have 2xN unknowns in 2xN equations, therefore, it is solvable under proper condition. Fig.A-1 shows the typical grid system used in the simulation. To treat irregular outer boundary shape in field-scale problems, which is usually a tracing line of surrounding watersheds, the grid system can be taken as shown in Fig. A-2.

Geological Setting

In numerical simulation, required geological data to describe the objective field structure are depth and thickness of each discretized gridblocks. Their distributions prescribe the surface topography and subsurface structure as shown in Fig. A-3. To keep precision of finite difference approximation in case of inclined, thickness-varying and permeability-varying formation, proper averaging and correction methods are used as explained in the later section A.4.

A.4 Treatment of Rock Parameters

Porosity

For simulation purpose, a effective porosity, which is defined as the ratio of block pore volume having pressure communication and block bulk volume, is used. Note that whenever "porosity" is referred to, it is the "effective" one without exceptions.

It is treated as a pressure dependent property with the form

$$\phi=\phi_{ref}\{1+C_r(P-P_{ref})\} \quad \text{(A.5)}$$

where, ϕ_{ref} is the porosity at reference pressure P_{ref}, and C_r is the rock compressibility which corresponds to the rate of expansion of rock pore or fractures with the unit increase of fluid pressure. For wide field problem where it is thought to have no significant effect on the flow, rock compressibility can be set at 0.0.

Permeability

The rock permeability, K, is treated as one of inherent physical constants of rock. It is usually treated as an independent parameter of pressure and saturation, but is treated dependent on flow direction to model anisotropic rock media. In general, the interblock permeability of neighboring gridblocks $\overline{K}$ with different permeability and thickness is calculated by harmonic averaging as

$$\overline{KH} = \frac{L_1 + L_2}{L_1/(K_1 H_1) + L_2/(K_2 H_2)} \quad \cdots\cdots (A.6)$$

where, K_1 and K_2 are permeabilities of two neighboring gridblocks, L_1 and L_2 are their lengths in one of discretized coordinates, and, H_1 and H_2 are thicknesses of respective gridblocks. For the flow between gridblocks with different depth points, above permeability value is corrected further as

$$\overline{KH}_{cor} = \overline{KH} \frac{0.25(L_1 + L_2)^2}{0.25(L_1 + L_2)^2 + (Z_1 - Z_2)^2} \quad \cdots\cdots (A.7)$$

Fig.A-4 shows schematically the averaging and correction process.

For special cases, non-neighboring connections can be defined to model faulted combination of gridblocks as shown in Fig.A-5.

Relative permeability

The relative permeabilites for water and gas are nonlinear functions of water saturation. The typical curves measured for core samples in the laboratory are shown in Fig. A-6.

For practical simulation purpose, relative permeability curves on core samples is not valid and should be modified. The reason is that the relative permeability may be direction-dependent for the system with high contrast of densities. In such system, gravitational segregation of phases have to be considered and, at least, three different relative permeability curves should be used for horizontal, upward and downward directions.

Capillary Pressure

The capillary pressure in the porous media is defined by the difference of pressures of both sides of phase interface. In the laboratory, it is measured as a function of wetting phase saturation. The typical curve is shown in Fig. A-7.

In the simulation using large gridblocks, it should not be used directly as was noted for relative permeability. It should be used in a pseudofunction form, by which gravitatinal segregation of phases can be modeled.

A.5 Treatment of Fluids Parameters

Formation Volume Factor

Assuming isothermal condition, density of the fluid is treated as a function of phase pressure. To treat it in the mass balance equation, the notation of Formation Volume Factor (FVF, denoted as Bw or Bg in the basic equations) is used by defining

$$B=V/V_o \qquad \text{(A.8)}$$

where, V is the fluid volume at arbitrary pressure P, and Vo is that at the standard temperature and pressure. Using this, density is expressed as

$$\rho=\rho_s/B \qquad \text{(A.9)}$$

where, ρ is the fluid density at arbitrary pressure P, and ρ_s is the density of fluid at standard temperature and pressure.

For the air which is strongly compressible, the formation volume factor decreases nonlinearly as pressure increases. The water formation volume factor is around 1.0 at atomospheric pressure and decreases almost linearly with the slope of the order of about $10^{-5}atm^{-1}$. The water and air FVFs are shown in Fig. A-8(a) and A-9(a), respectively.

<u>Viscosity</u>

Under isothemal condition, viscosity of fluid varies as pressure changes. The water viscosity is almost constant in the pressure range of our interest. The gas viscosity increases as its density increases with the pressure. The typical curves for water and air viscosities are presented in Fig. A-8(b) and A-9(b), respectively.

A.6 Treatment of Boundary and Initial Conditions

<u>Boundary Conditions</u>

The external boundaries to be specified for a 3-dimensional hydrological problem are side, bottom, and upper ones.

The side boundary of wide areal problem is usually set on the watershed line surrounding the objective region, and is treated as no-flow boundary (Dirichlet boundary condition). But practically, as there may some water spills through river or subsurface openings to the external groundwater system, constant pressure boundary or constant influx boundary is required for proper modeling. Constant pressure boundary is realized by giving unrealistically large pore volume, i.e.,porosity, to the gridblock which should keep constant pressure, while constant influx boundary can be set by allocating a constant rate well to the objective gridblock.

The bottom bondary is, usually with few exceptions, a closed boundary set at sufficiently deep underground.

The upper boundary is the atomosphere that has almost constant pressure value. In the application of 2-phase simulation technique, the top layer is a air-saturated layer with the pressure at atomospheric value of the region and the water saturation at almost 0.0. To maintain constant pressure at the top layer at any simulation stage, permeabilities and porosities of the gridblocks of the top layer are set at very large values.

The well boundary condition, i.e., inner boundary condition, plays an important role when evaluating the areal fluid flow behavior including some pumping/injecting wells. Wells are specified on the gridblock basis. Considering the practical well operations, they are classified as bottomhole pressure specified wells and total rate specified wells. For the former, bottomhole pressure is specified and the rate of each productive block is calculated using analytical method. For the latter, total well rate is given and the production/injection rate of each gridblock is calculated based upon similar method as above.

To treat rainfall in hydrological simulation, it is necessary to allocate some amount of rain in mm/day for all of the surface gridblocks.

Conveniently it is realized utilizing the same treatment as rate-specified, multiple-perforation horizontal well. In groundwater simulation, the input rainfall is usaully the downward filtration rate which is calculated by subtracting river flow rate and evaporated rate from total rainfall. The surface and river flows, which are characterized as much faster flows compared with subsurface flow, are not directly treated.

Initial Conditions

Initial distributions of pressure(usually air pressure) and saturation(usually water saturation) are set simultaneously for all of the domain modelled. The initialization process usually requires the following two steps.

In the first step, the distribution of free water level over the objective region is estimated by utilizing field measurements and geological occurences/knowledges. Using this, the pressure distribution is determined hydrostatically according to the depth of gridblock from the free water surface. For the gridblock above the free water level whose pores are filled with dominant air and irreducible trace of water, pressure is set at atomospheric one. The saturation value of the gridblock is also calculated by considering the relative position of the depth of the gridblock to the free water level.

In the second step of initialization, dynamic condition is checked by initiating simulation run for proper period of time. The distributions of pressure and saturation set in the first step may change dynamically to its final equilibrium condition as the time is proceeded. The hydrological condition that we seek for as the starting point may be found elsewhere in this process if the first step initialization is something good. If there are much field information about free graundwater level and seepages, it is useful for determining the desirable starting condition.

A.7 Solution Procedures and Features of GWS3D2P

Solution Procedures

The basic equations are solved simultaneously for gas pressure Pg and water saturation Sw of each discretized gridblock by the fully implicit FDM, which is, nominally, unconditionally stable. The FDM expansion of the basic equations results in a matrix equation having tri-diagonal structure for 1-D problem, pentadiagonal one for2-D problem, or heptadiagonal one for 3-D problem, respectively. Such structured sparse matrix equation can be solved by using conventional direct or iterative matrix solvers. The truncated conjugate residual algorithm, called ORTHOMIN method, preconditioned by the Nested Factorization, is used for the matrix solution in GWS3D2P.

The Nonlinearity associated with saturation functions and fluid compressibility is overcome by the Newton-Raphson iterative procedure.

The flow chart of the simulator is shown in Fig. A. 10.

Features of GWS3D2P

The features of the numerical simulator GWS3D2P used in this study can be briefly summarized as follows.

- Compressible and immiscible two fluids, such as water-air, water-oil or oil-gas, can be dealt with.
- Cartesian and cylindrical coordinate systems can be used.
- Fully implicit Finite Difference Method(FDM) is used to solve basic equations.
- Non-linearity is treated by Newton-Raphson iterative procedure.
- Linear matrix equations system is solved by Preconditioned Conjugate Residual(PCR) algorithm.
- Irregular Geometry of external boundary can be set.
- Block permeability can be set directionally for each of 6 surfaces

of a rectangular parallel-piped grid. Relative permeability can also be set in 6 directions

- Production/injection wells can be treated by specifying either bottomhole pressure or total rate. Wells operating for multiple layers, or penetrating horizontally, can be set.
- Rainfalls to all of the surface gridblocks can be allocated by utilizing horizontal well option.
- Faulted connections among diferent geological formations can be set through special FAULT option for non-neiboring connections.
- Artificially boundaries arising from underground caverns such as tunnels in mines, or large underground caverns, can be properly set into the numerical model time by time.
- A Special technique to reduce the CPU time required for large-scale field problems can be used.

Conventional FDM Gridding

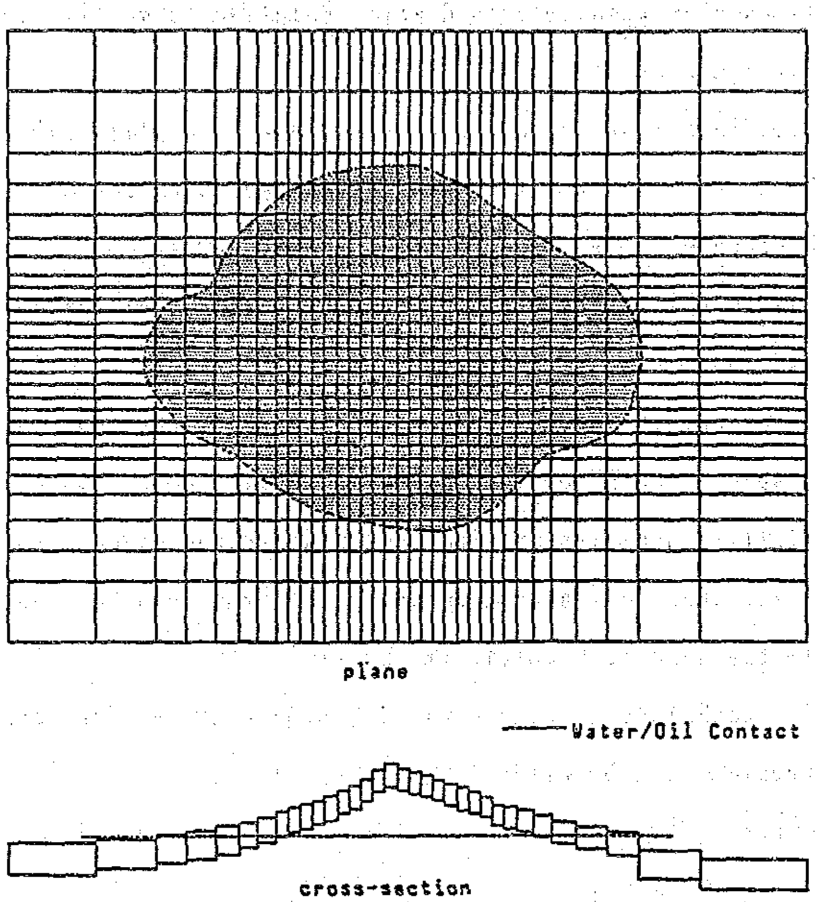


Fig. A-1 A Typical FDM Gridding

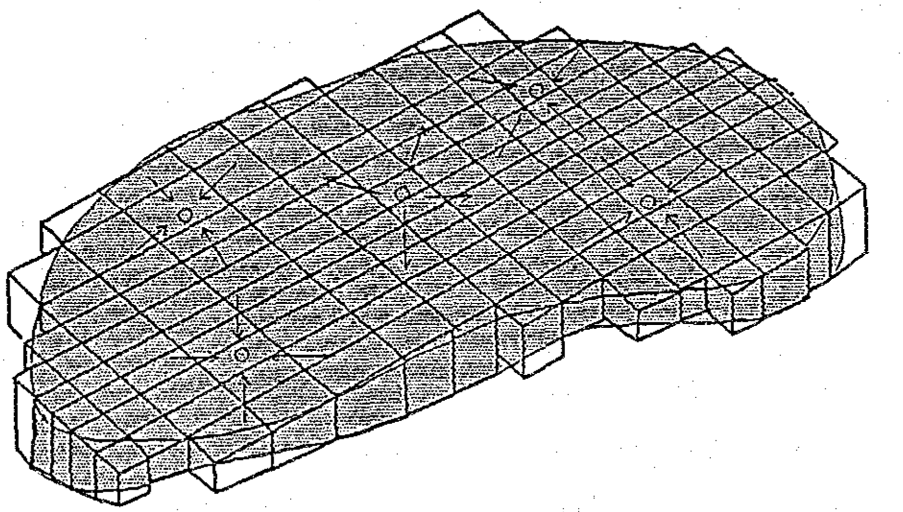


Fig. A-2 Gridding for Irregular Boundary Shape

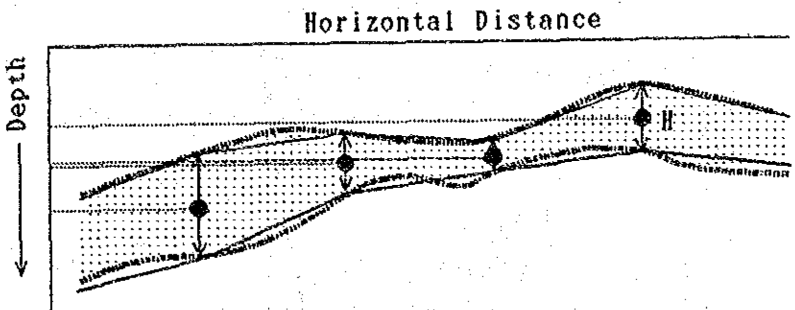
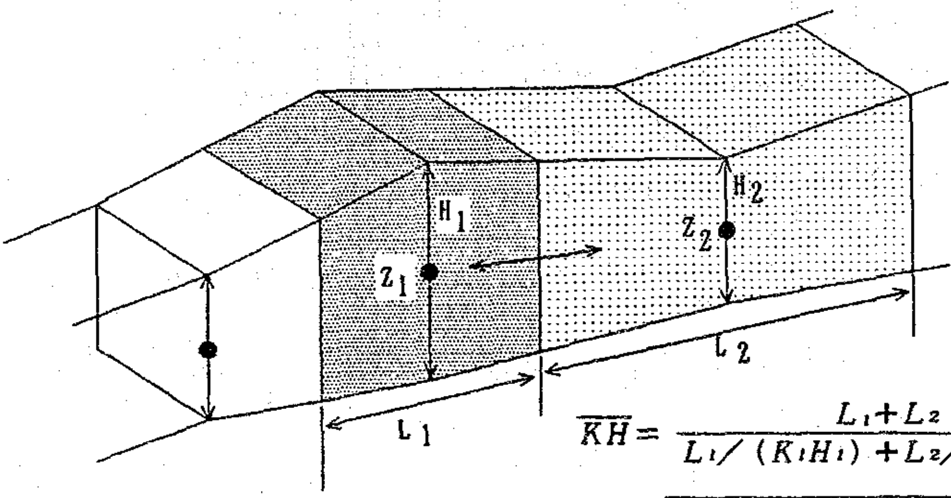


Fig. A-3 Modeling of Geological Structure



$$\overline{KH} = \frac{L_1+L_2}{L_1/(K_1H_1)+L_2/(K_2H_2)}$$

$$\overline{KH}_{cor} = \overline{KH}\sqrt{\frac{0.25(L_1+L_2)^2}{0.25(L_1+L_2)^2+(Z_1-Z_2)^2}}$$

Fig. A-4 Calculation of Interblock Permeability

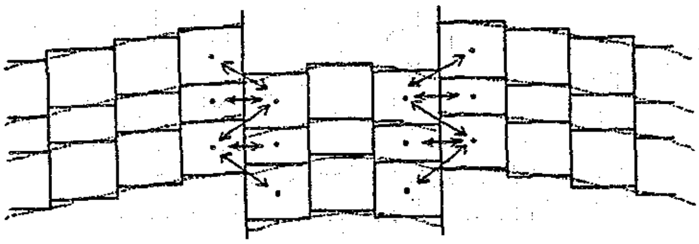


Fig. A-5 Non-neighboring Connections around Faults

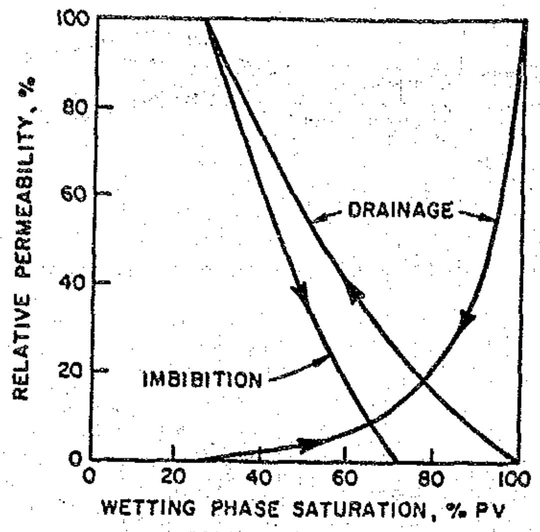


Fig. A-6 Typical Relative Permeability Curves

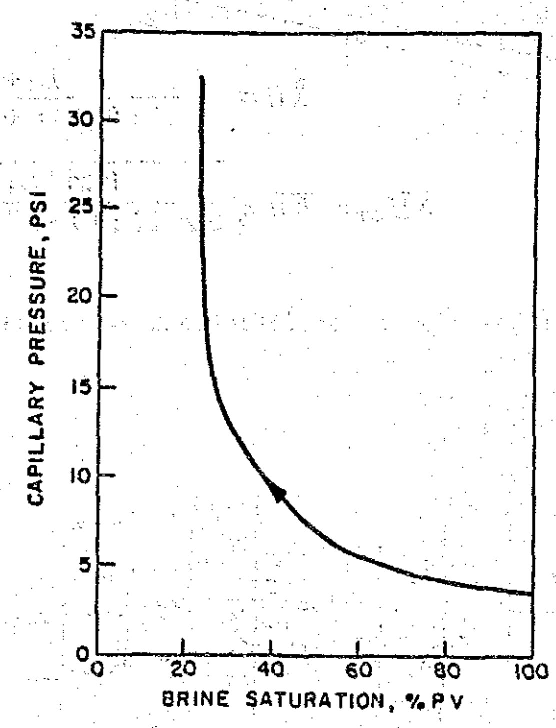
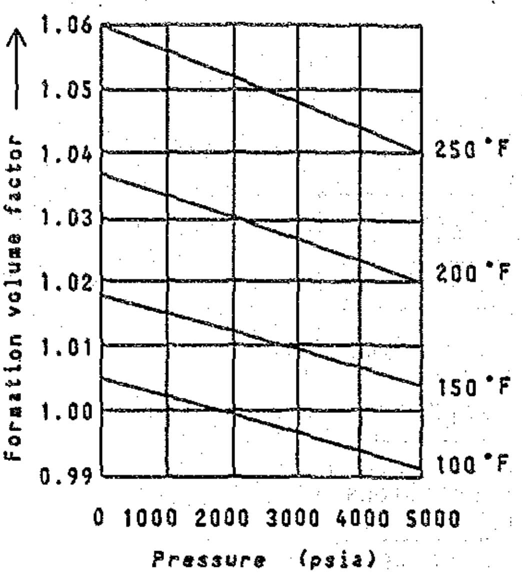
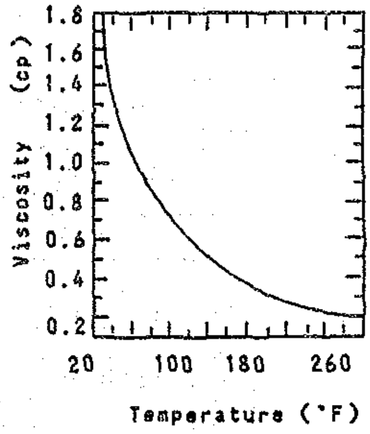


Fig. A-7 Typical Capillary Pressure Curve



(a) Formation volume factor of water

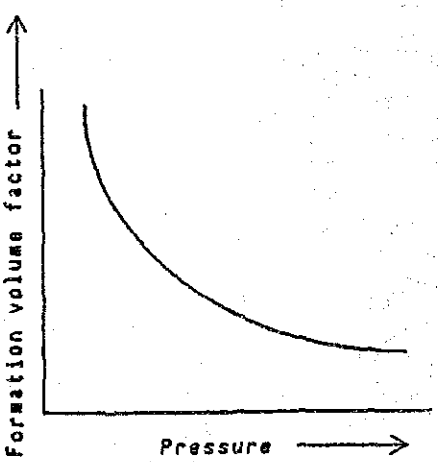
(from Properties of Petroelum Reservoir Fluids by Emil J. Burcik.)



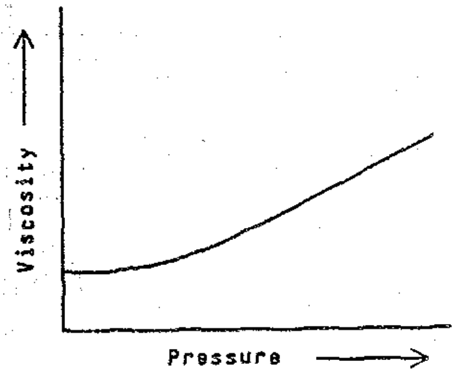
(b) Change in viscosity of water along temperature

(from Frick, T.C. ed.: Petroleum Production Handbook.)

Fig. A-8 Water Properties



(a)



(b)

Fig. A-9 General Tendency of Gas Properties

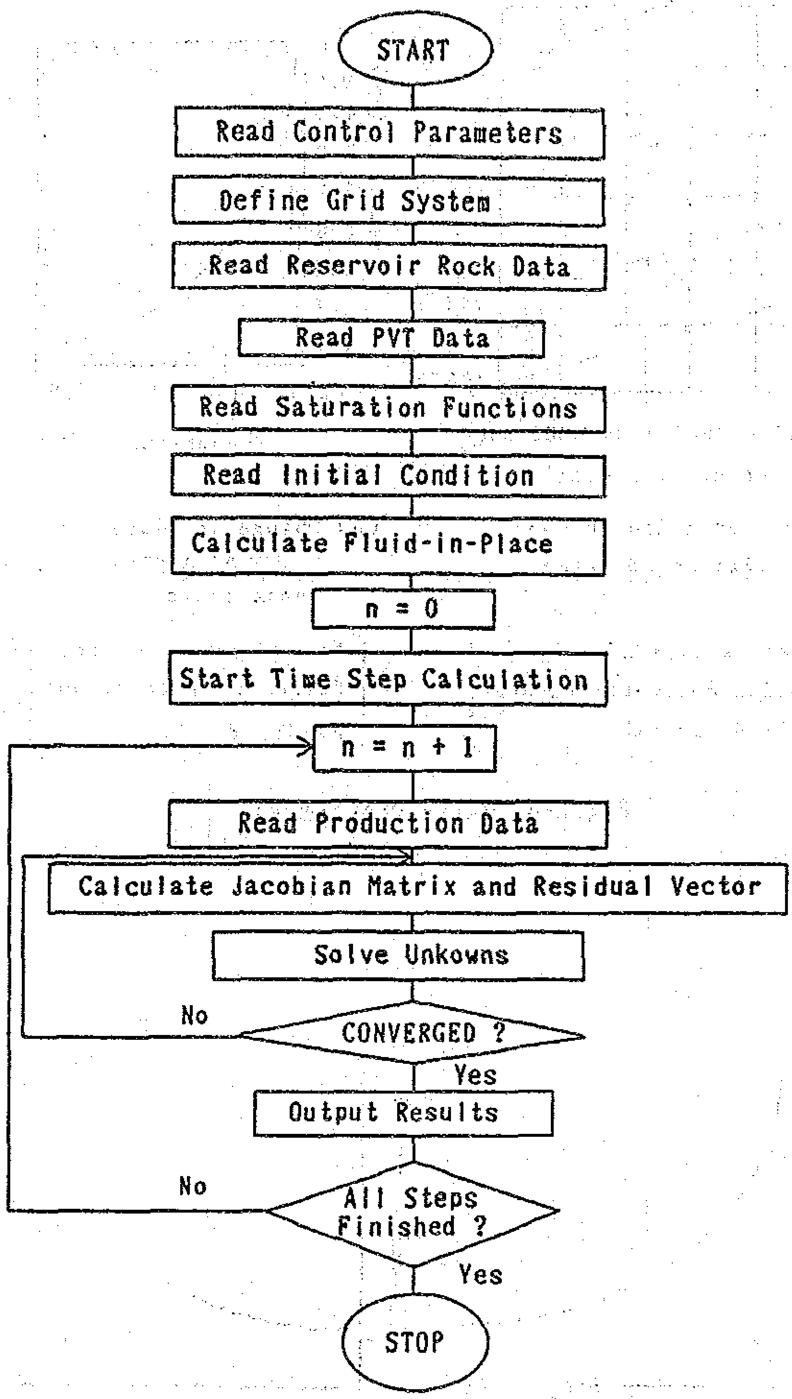


Fig. A-10 A Flow Chart of GWS3D2P

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