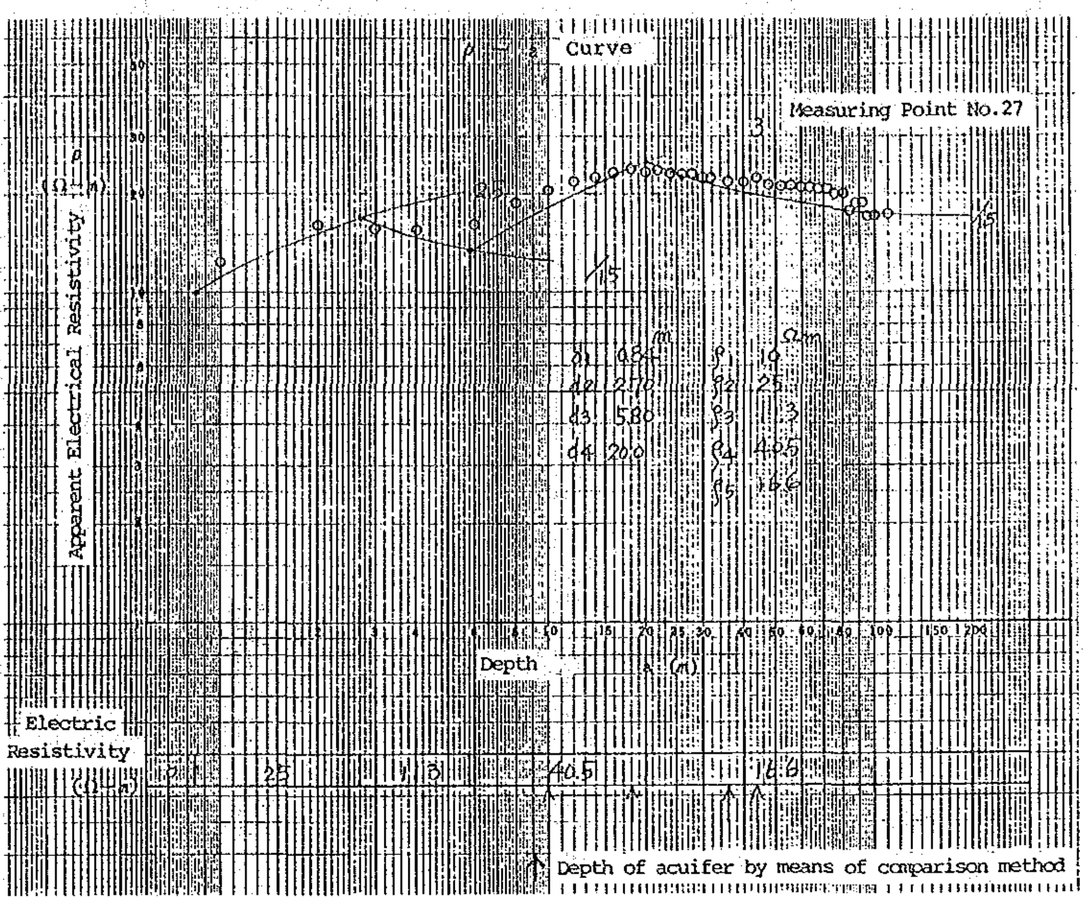


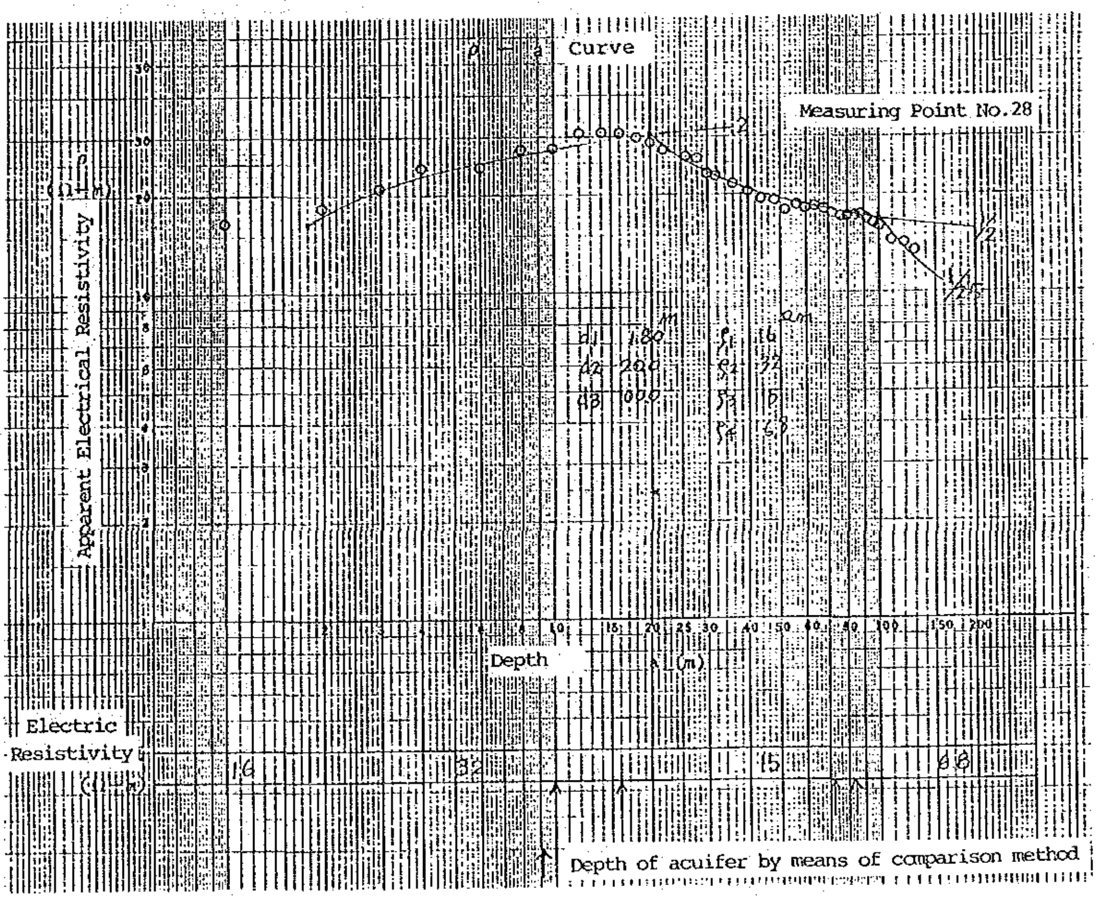
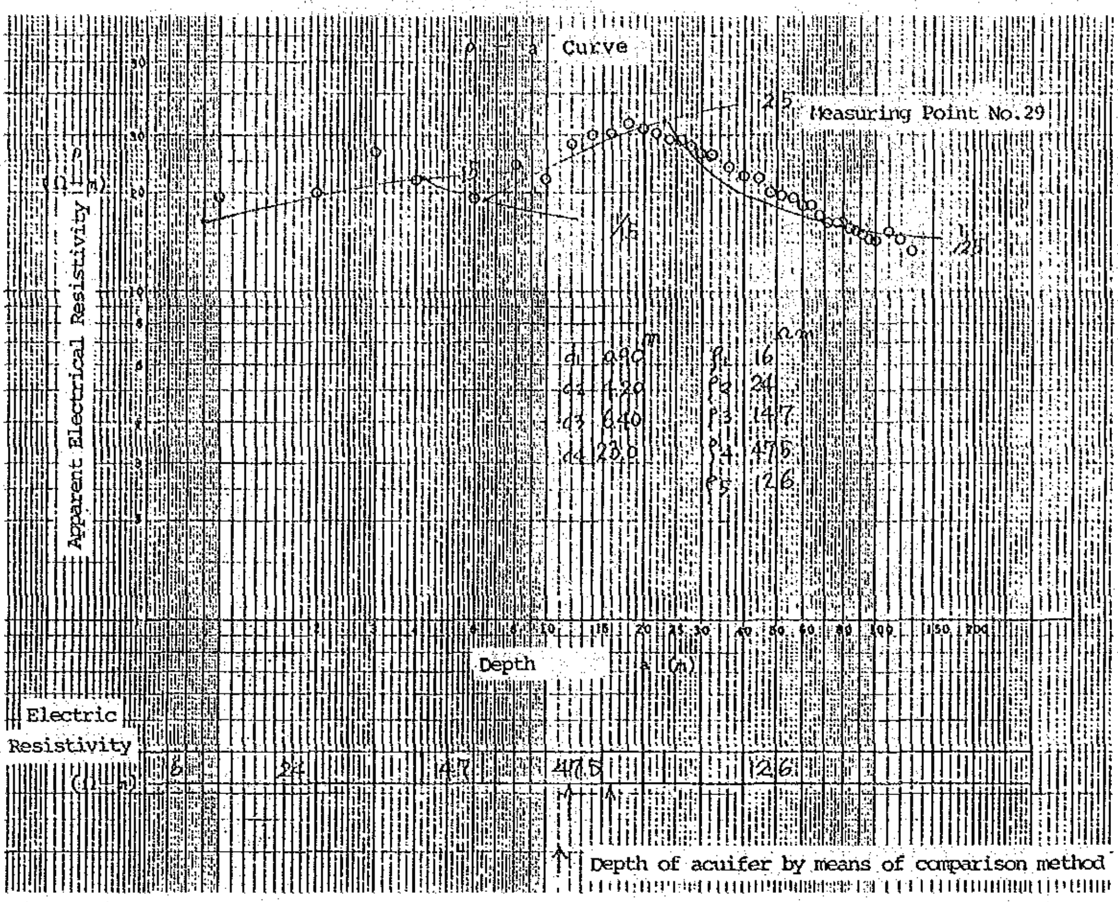
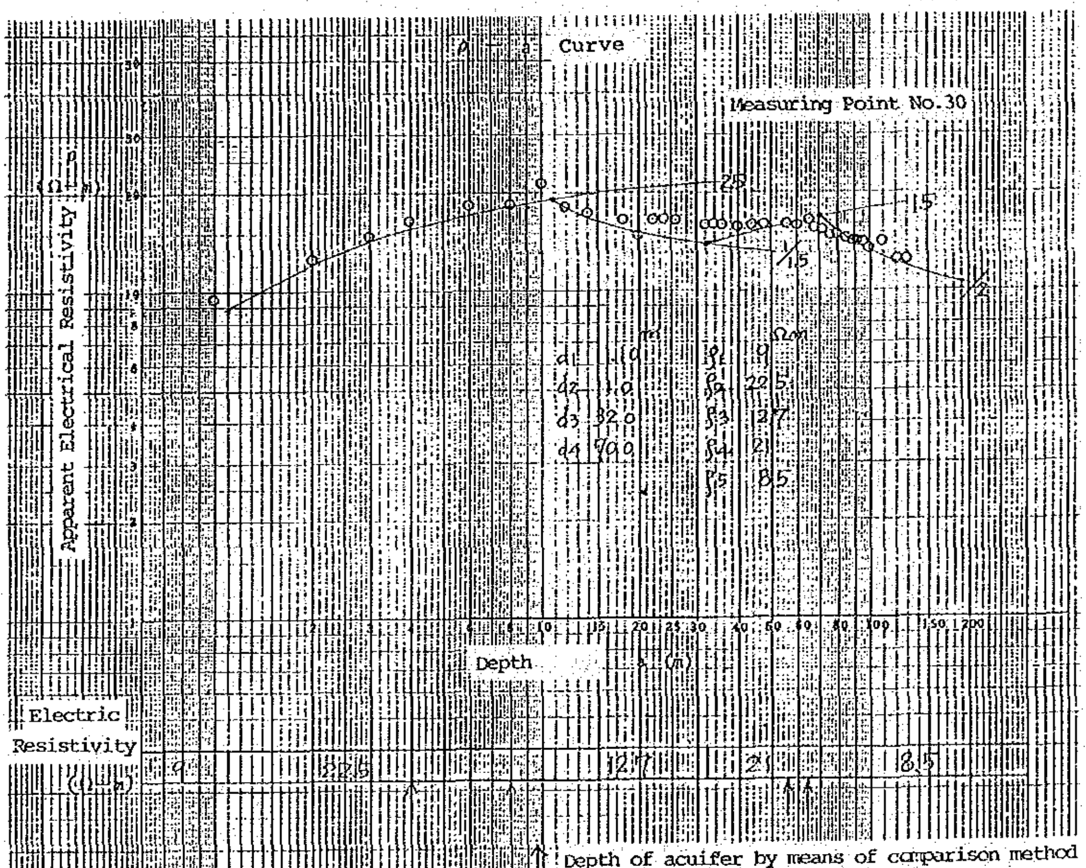


Fig.A.3.2.4-6 ρ -a Curve (14/21)





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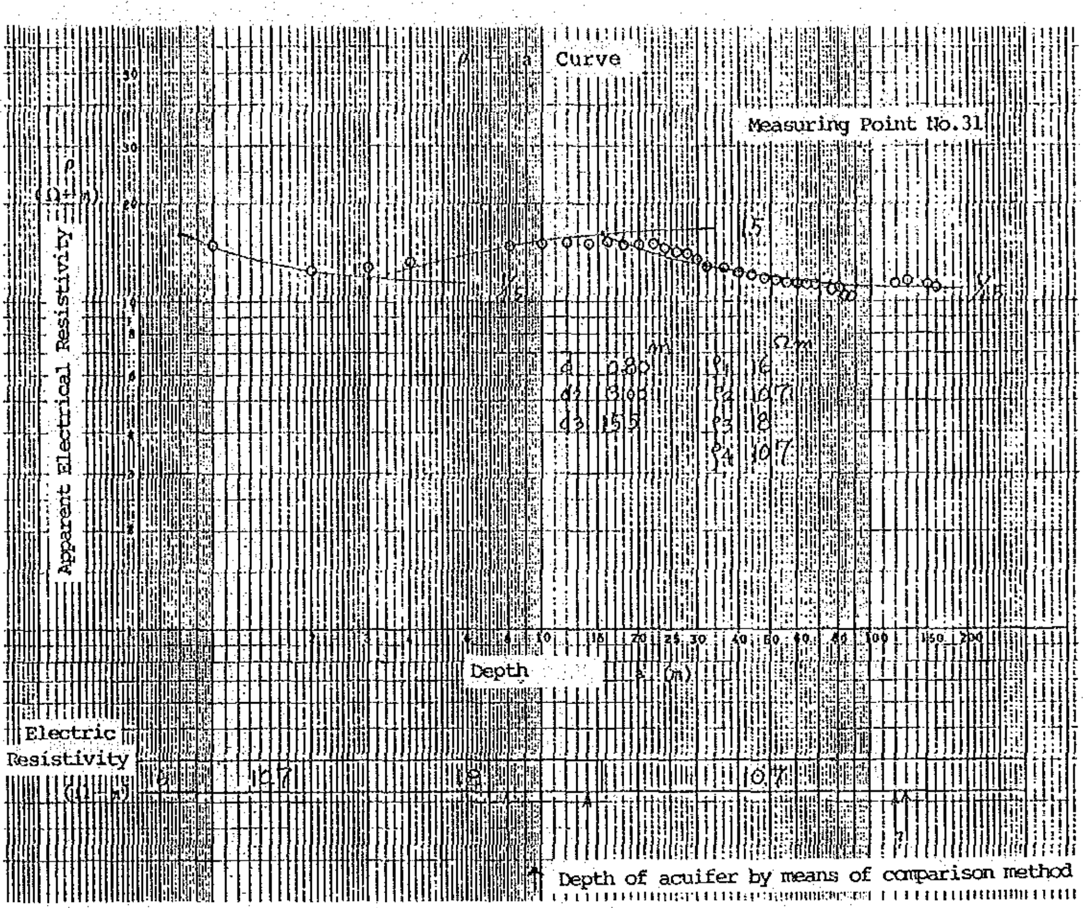


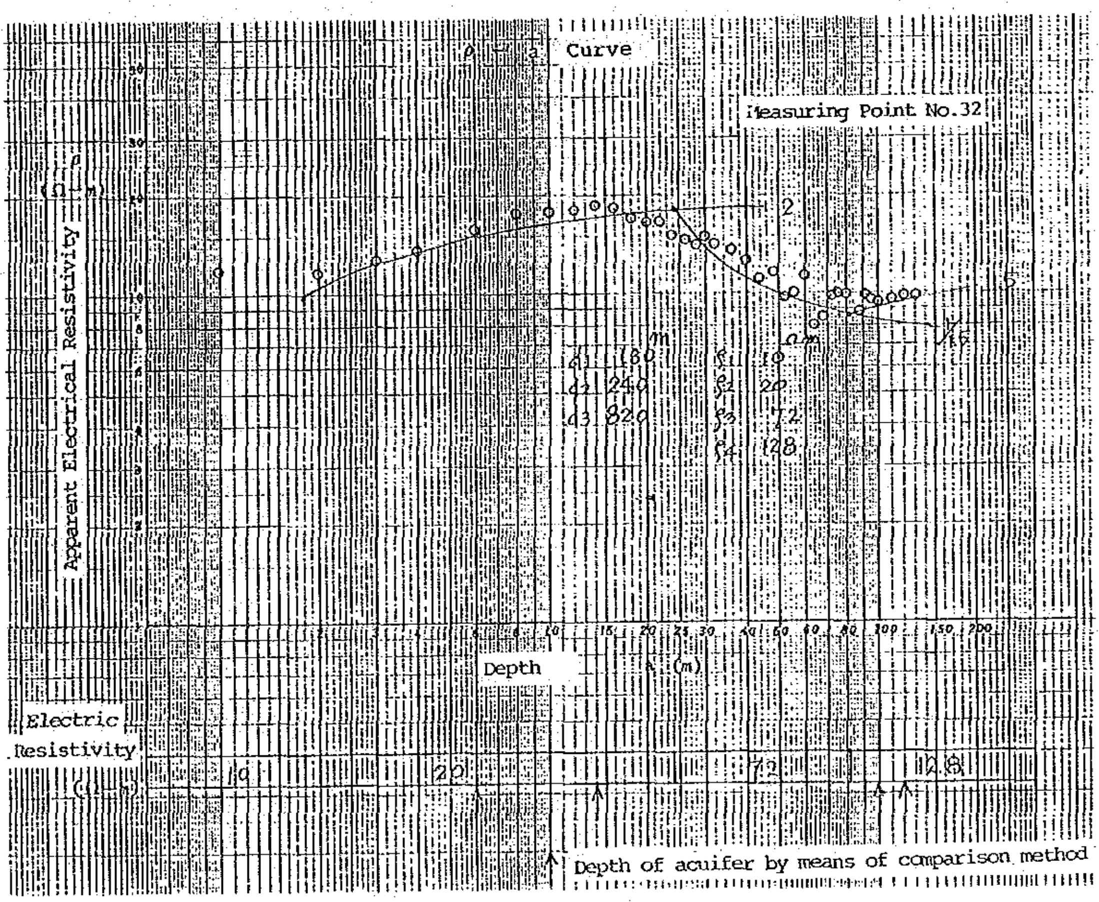
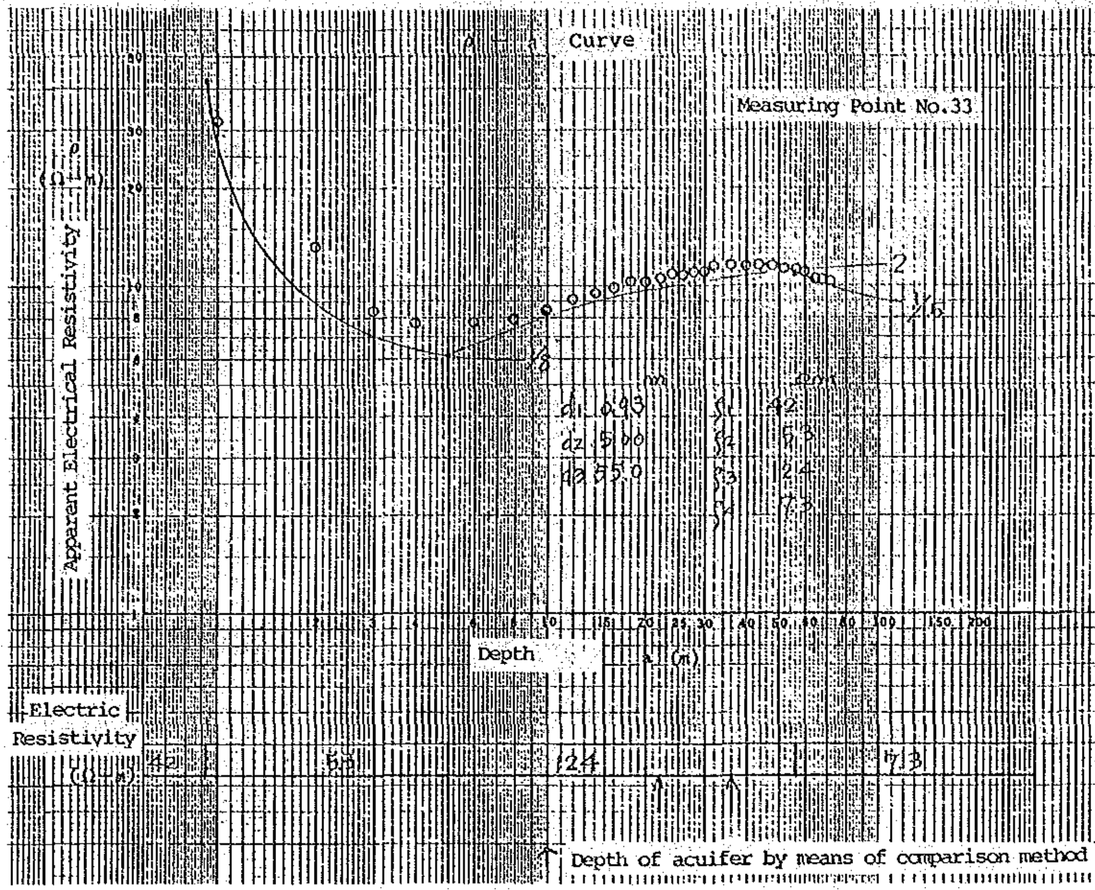


Fig.A.3.2.4-6 ρ -a Curve (16 /21)



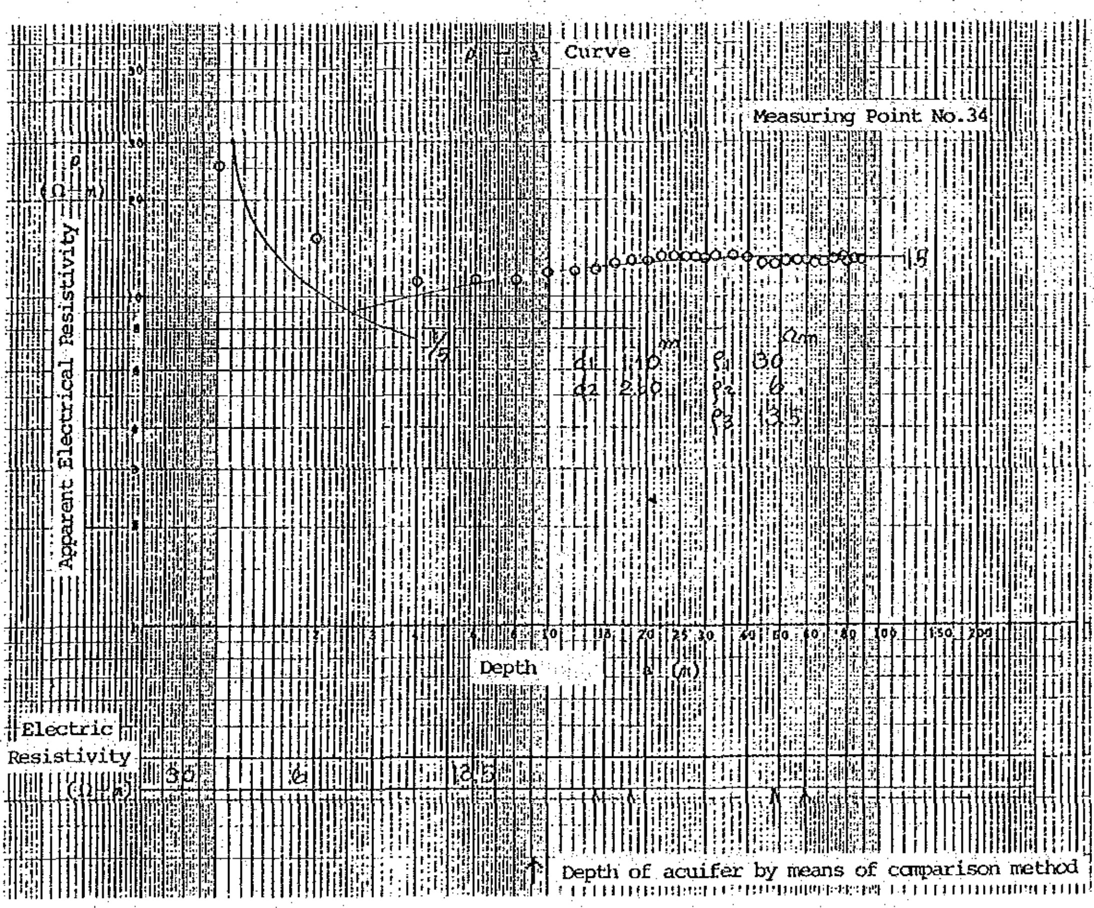
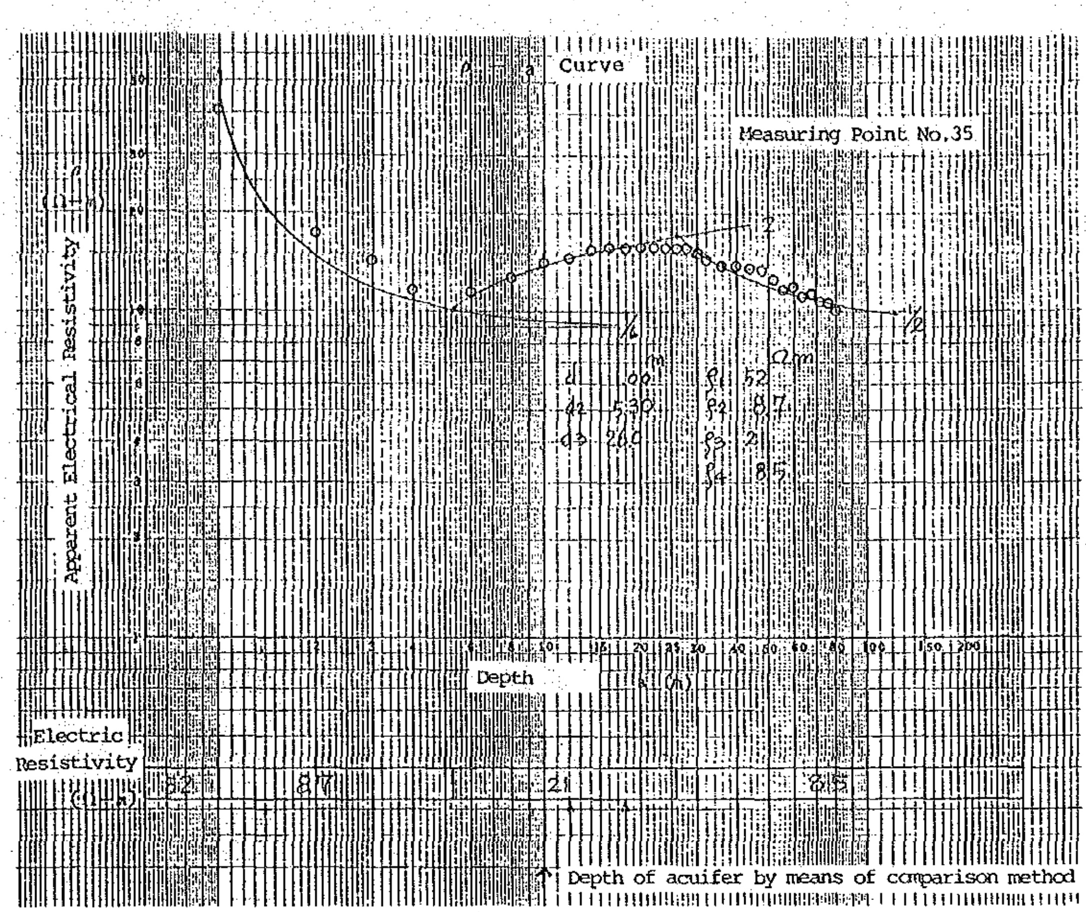
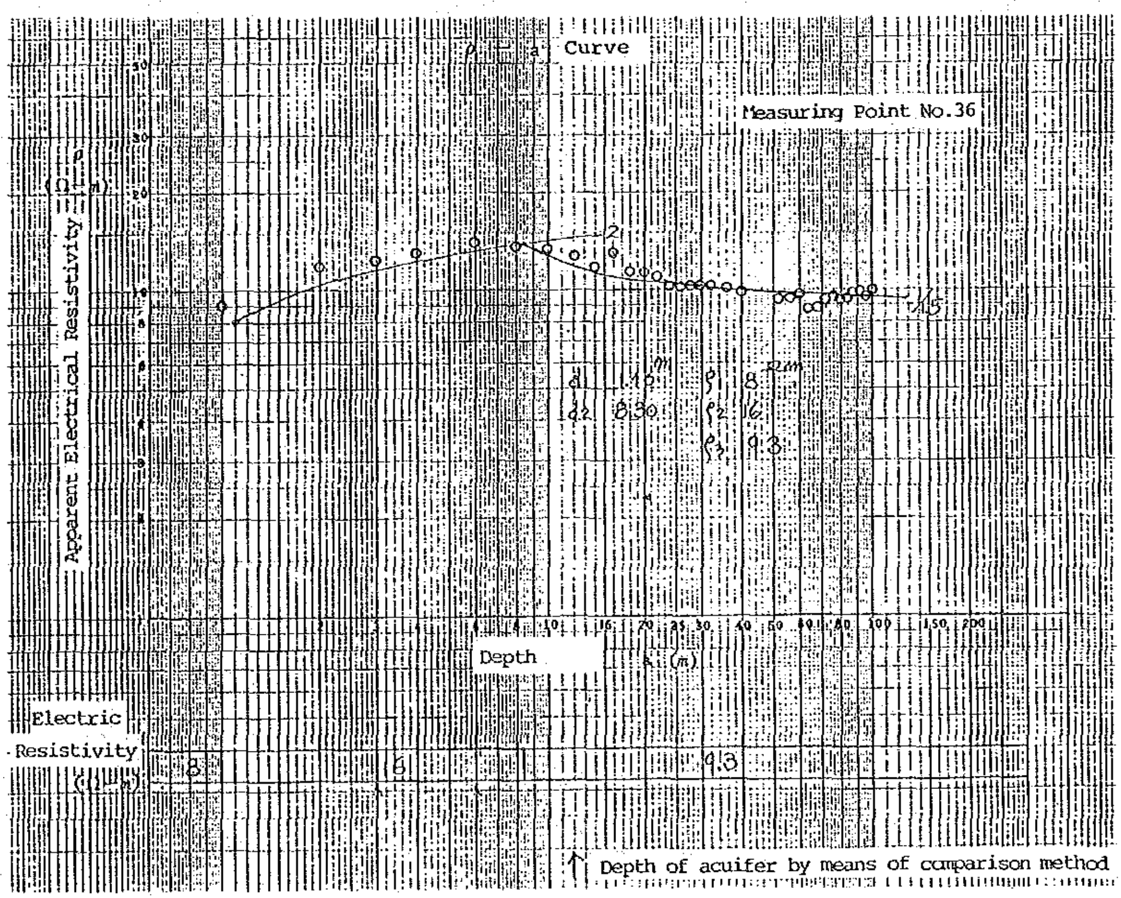


Fig.A.3.2.4-6 ρ-a Curve (17/21)





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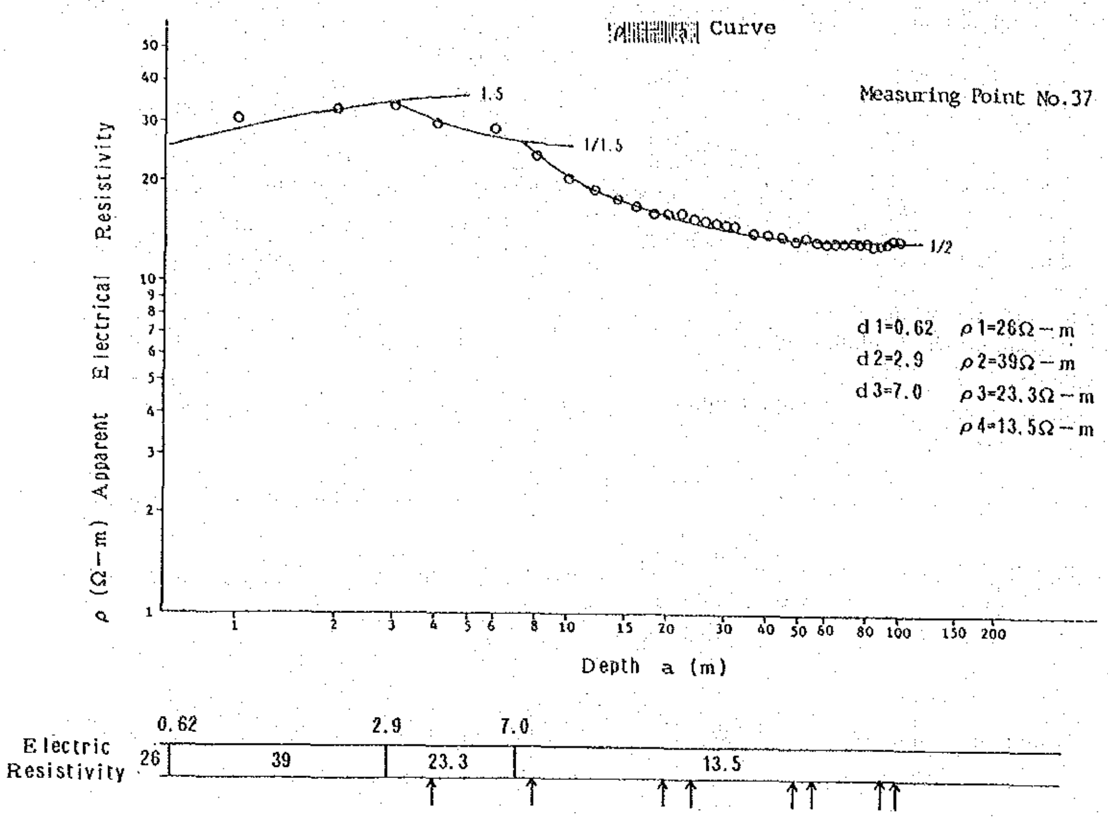


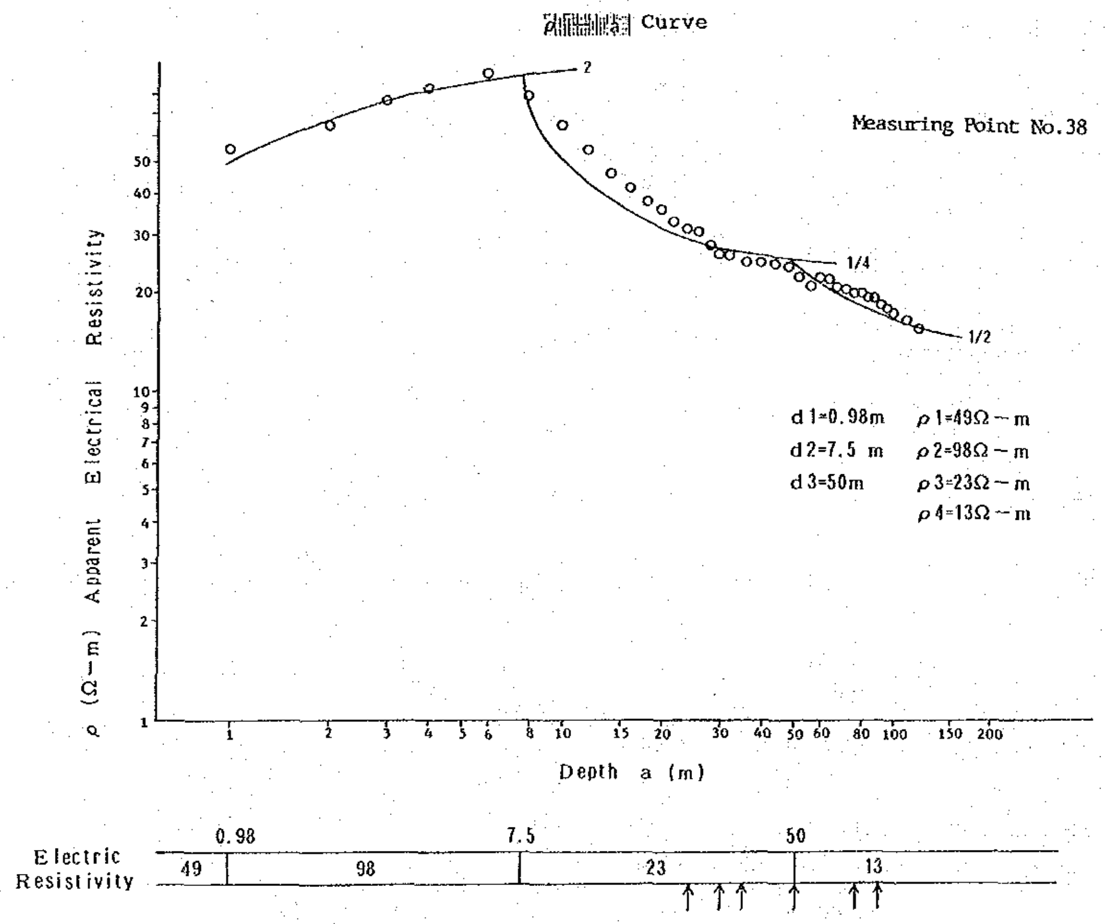
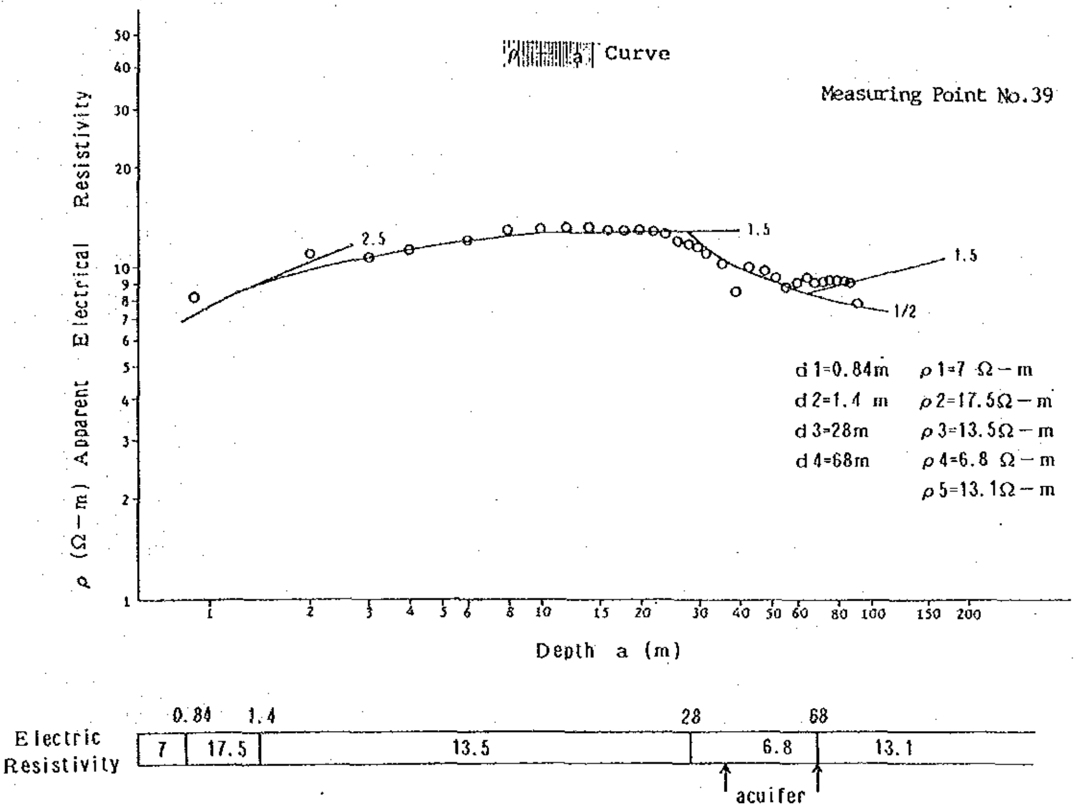


Fig.A.3.2.4-6 ρ-a Curve (19/21)



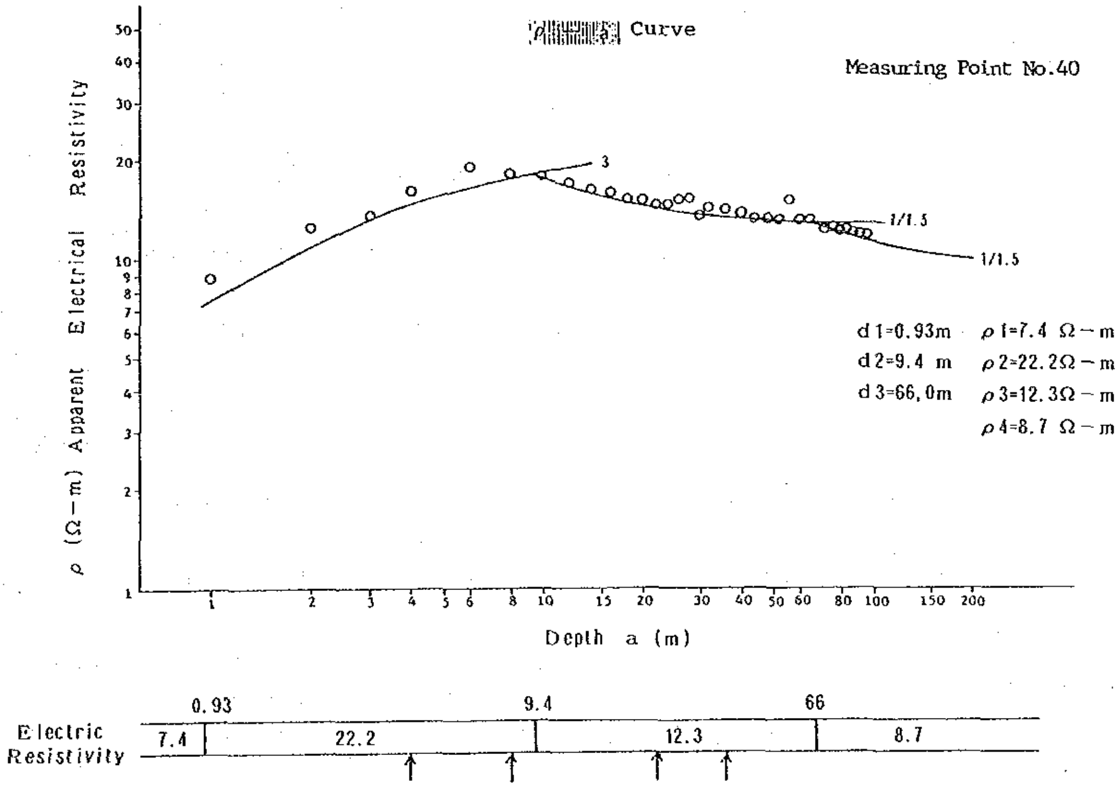
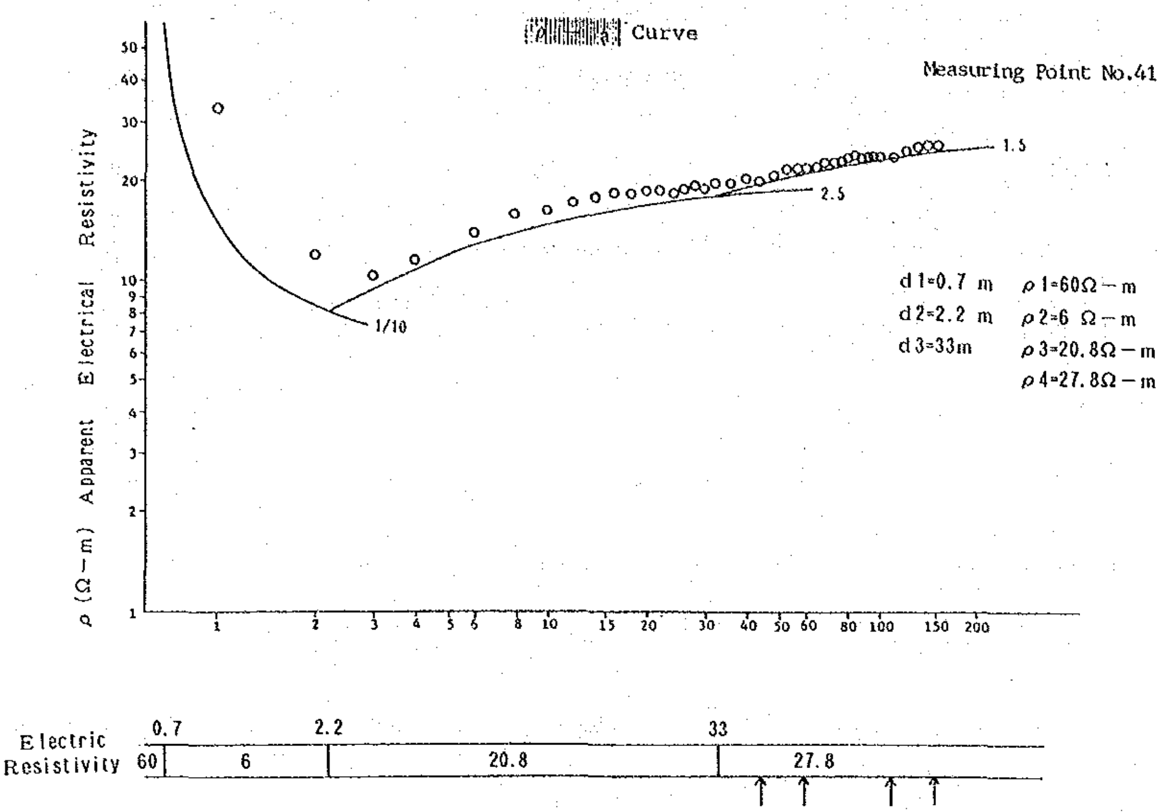


Fig.A.3.2.4-6 ρ-a Curve (20/21)



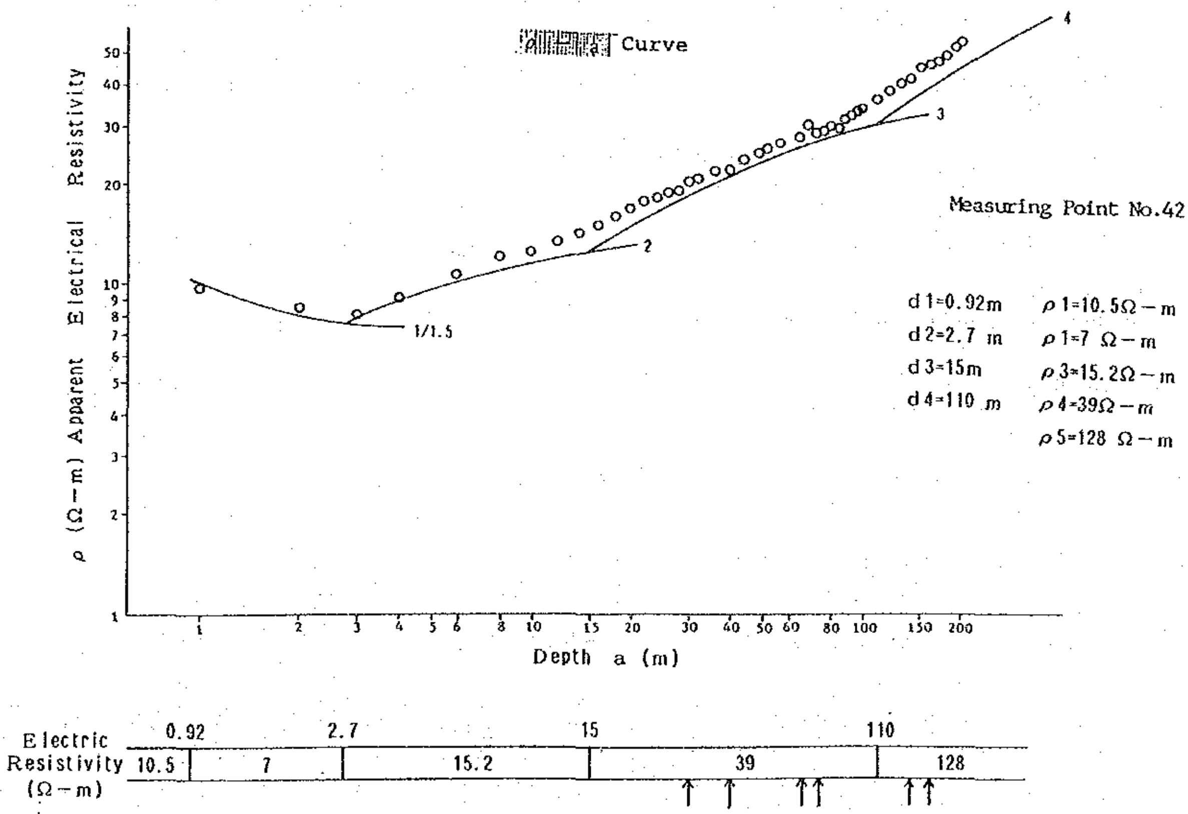


Fig. A.3.2.4-6 ρ - a Curve (21 /21)

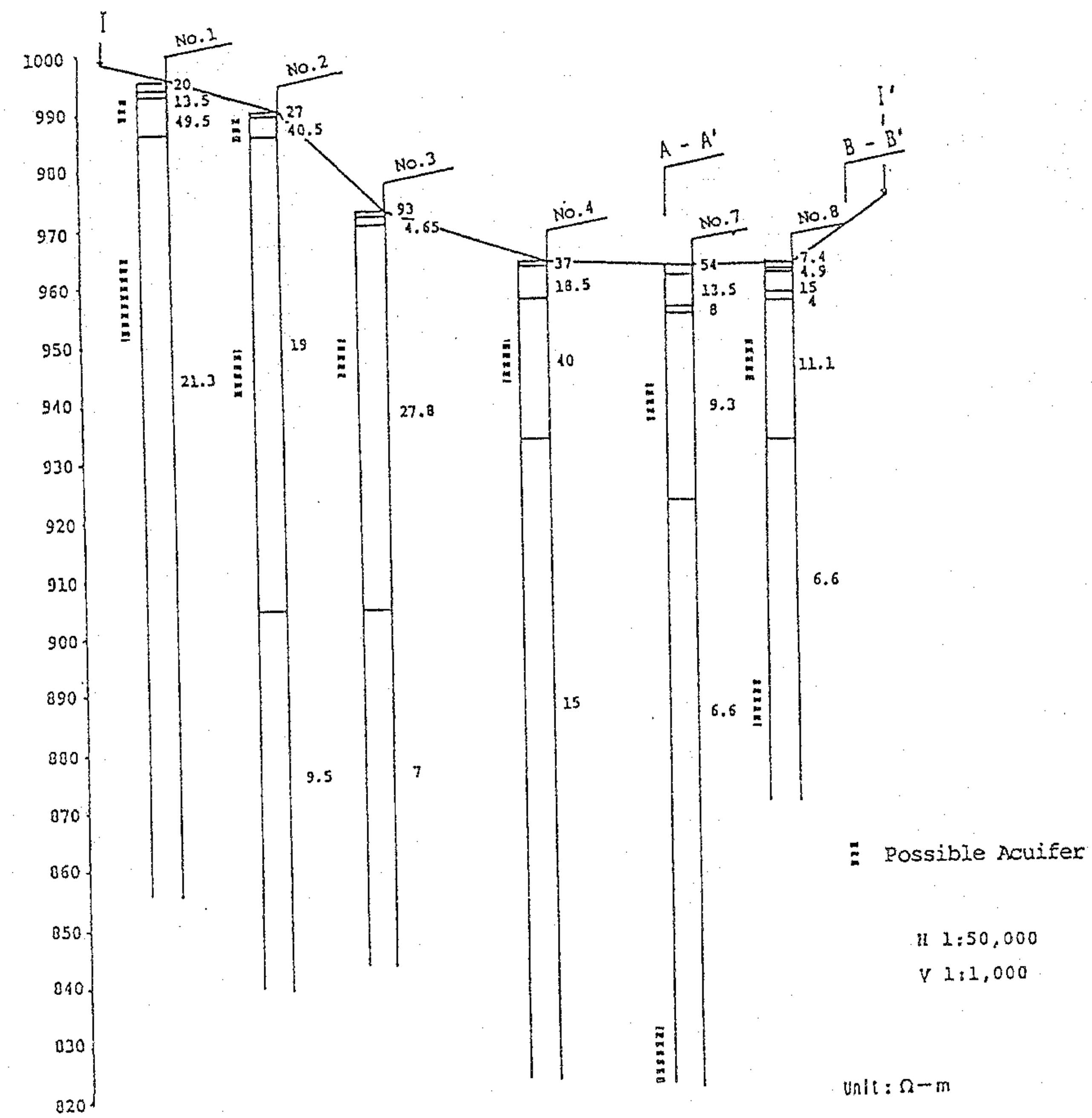


Fig.A.3.2.4-7 Electric Prospecting Profile (1/5)

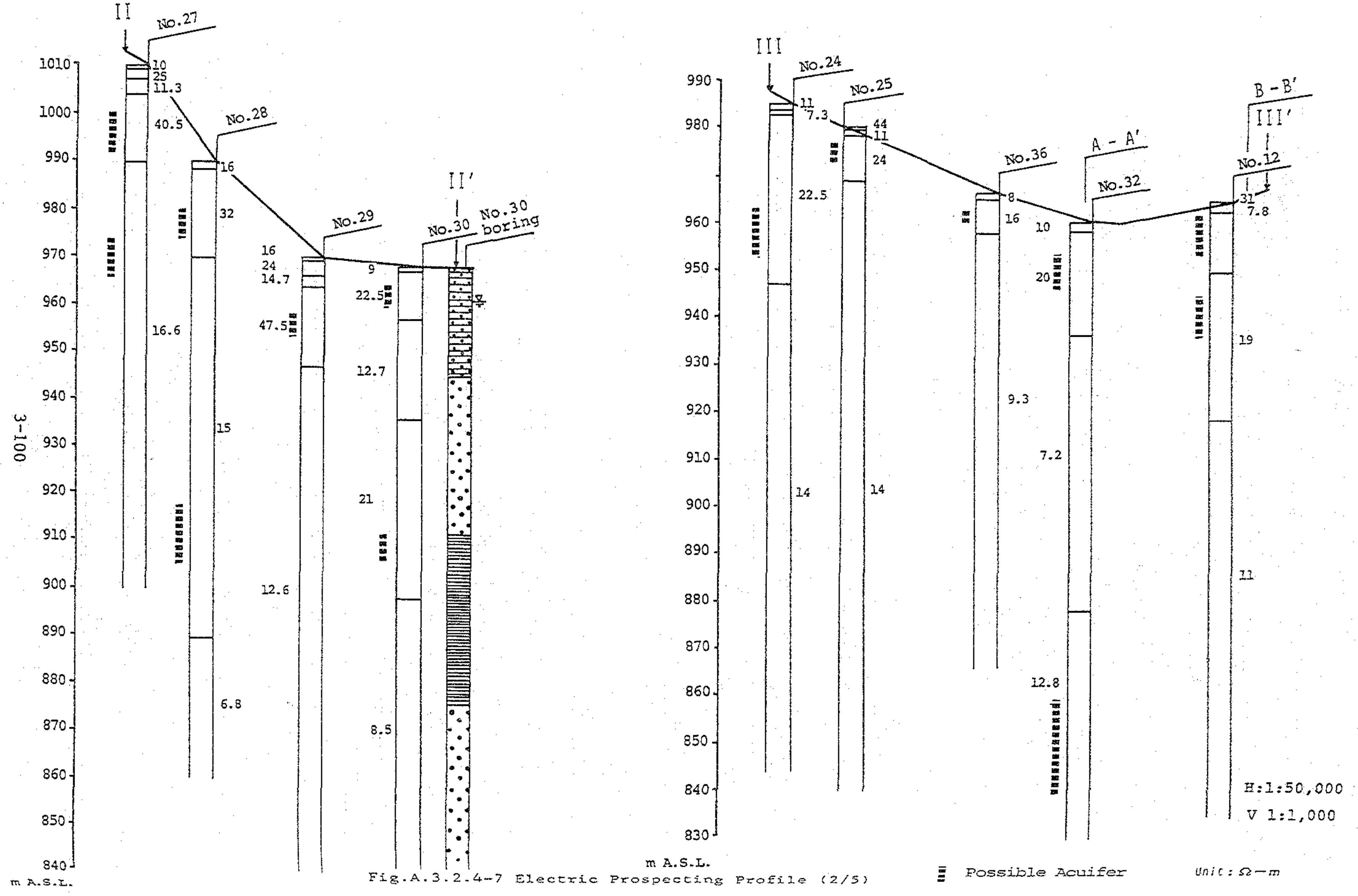


Fig.A.3.2.4-7 Electric Prospecting Profile (2/5)

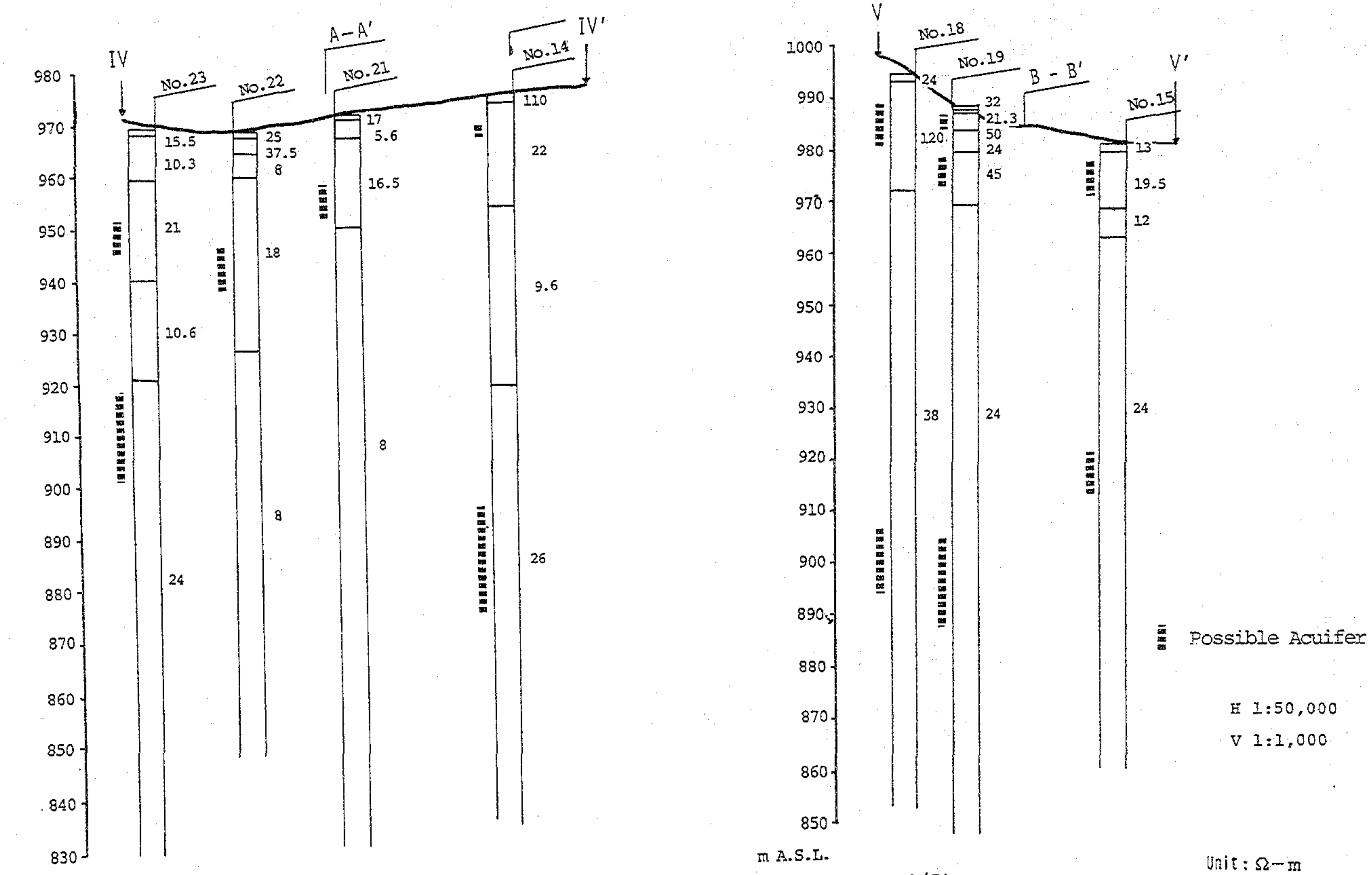


Fig.A.3.2.4-7 Electric Prospecting Profile (3/5)

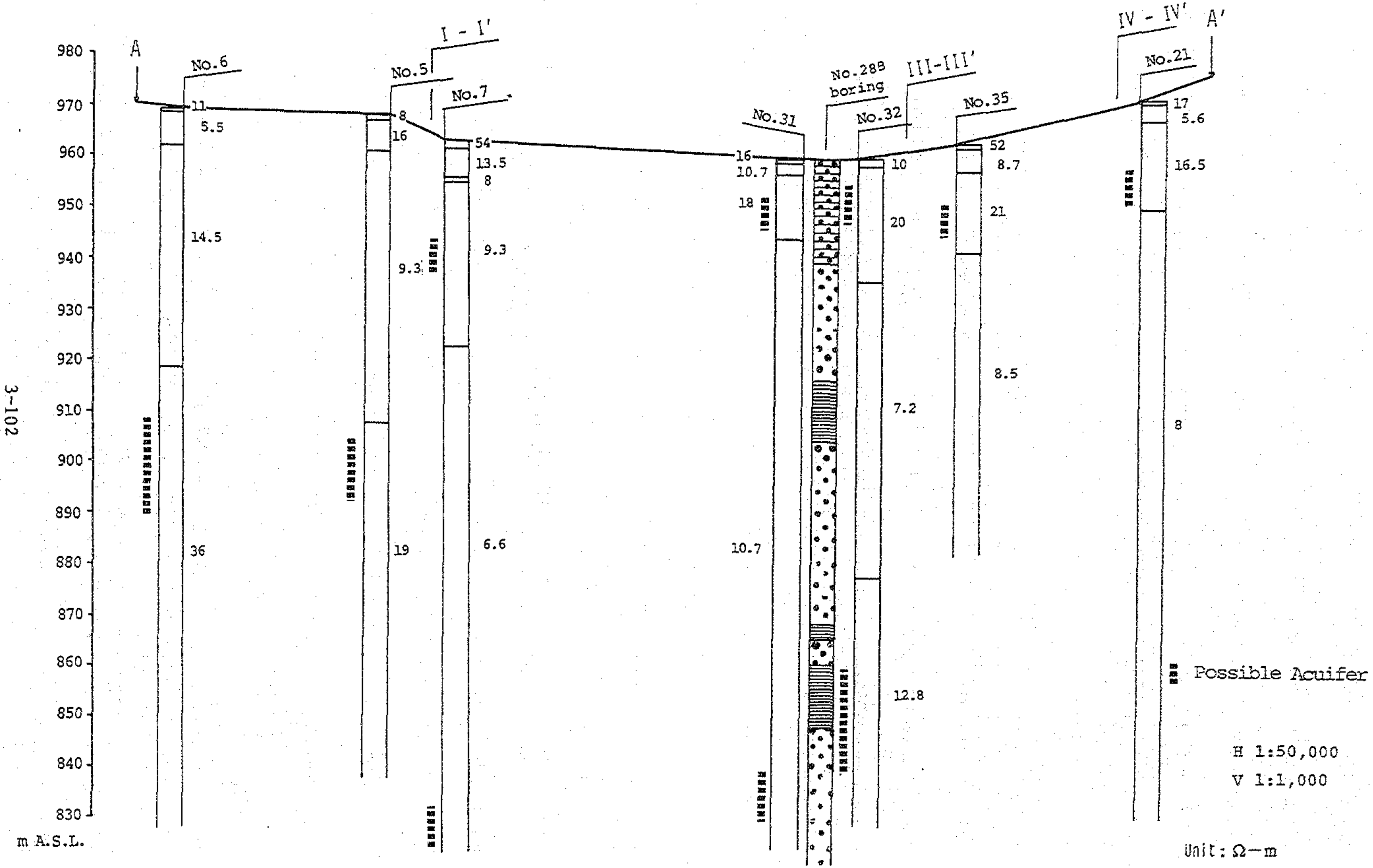


Fig.A.3.2.4-7 Electric Prospecting Profile (4/5)

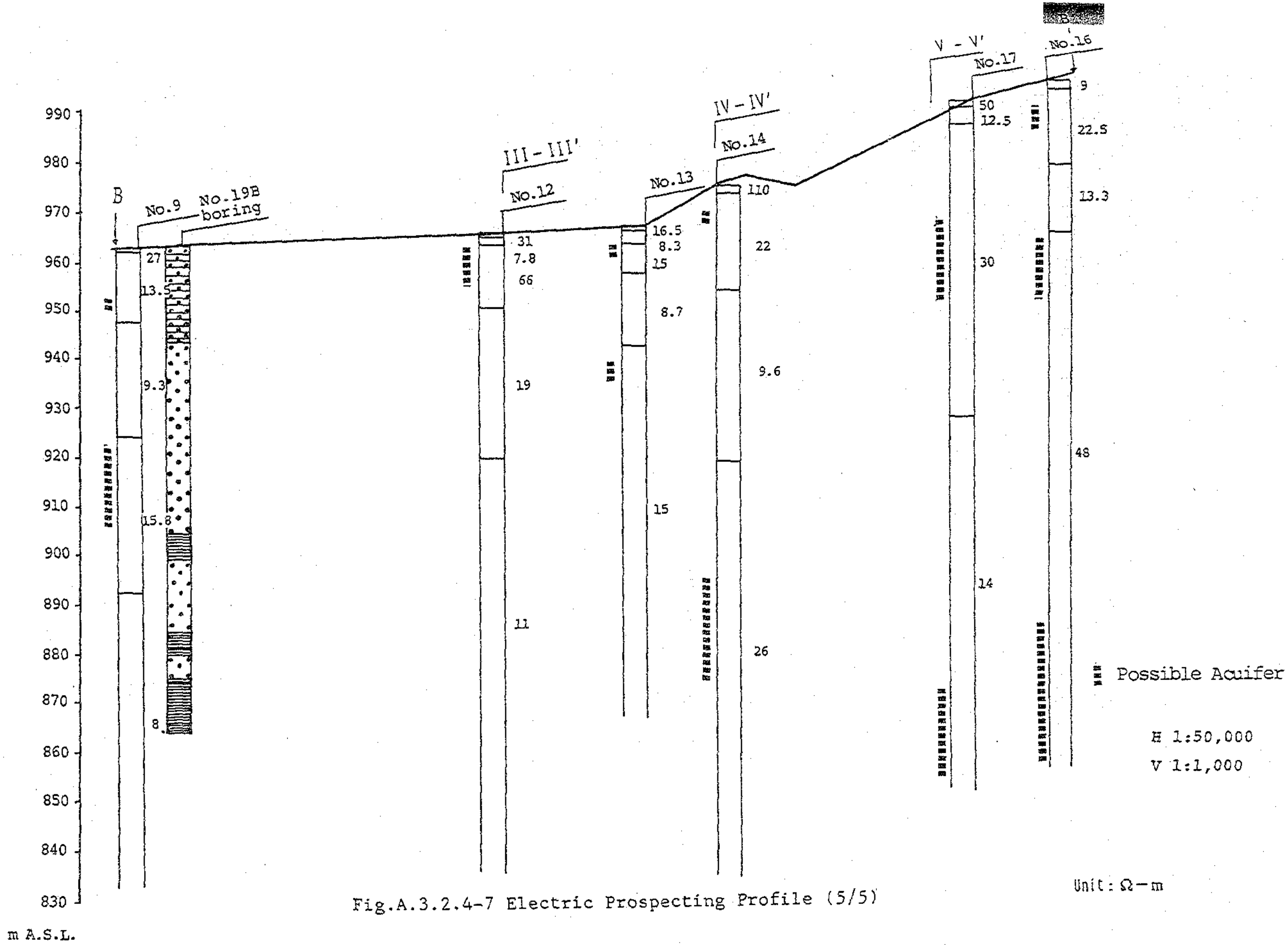


Fig.A.3.2.4-7 Electric Prospecting Profile (5/5)

(3) Pumping test

For the purpose of determining the hydrogeological coefficient of aquifers, the pumping test was performed at a well selected from each of Mojarritas sector and San Pedro sector, both of which are major ground water development areas. The pumping test employed 2 methods: one is the Jacob's method, which pumps a certain volume of water from a single well continuously until the water level is stabilized, to measure changes in water levels during pumping, and the other is the recovery method, which observes the recovery condition of the level in a well after stopping to pump water.

Table A.3.2.4-1to3 summarizes observation data of the pumping test, and Fig A.3.2.4-8 to 10 is the analysis diagram. The analysis result is obtained in the following equation, as shown below. Symbols used in the equation have meanings stated below.

Q : Pumping Discharge (m^3/sec)
r : Well Radius (m)
T : Transmissivity (m^2/h)
K : Permeability Coefficient
S : Storage Coefficient
t : Measured Time
t': Time after Stop of Pumping (sec)
t_o: Basal Time obtained from Figure (sec)
s: Drawdown (m)
h: Screen Length (m)

a. Mojarritas Sector (No. 19B well)

i. Jacob's Method

$Q = 1.65 \times 10^{-2}\ m^3/sec$

$s = 41.5\ m$

$r = 0.10\ m$

$t_o = 22\ sec$

$h = 64\ m$

$$T = \frac{2.3Q}{4\ S} = \frac{0.183Q}{S}$$

$$= \frac{0.183 \times 1.65 \times 10^{-2}}{41.5} = 7.28 \times 10^{-5} (m^2/sec)$$

$$S = \frac{2.25T\ to}{r^2}$$

$$= \frac{2.25 \times 7.28 \times 10^{-5} \times 22}{0.1^2} = 3.6 \times 10^{-1}$$

$$K = \frac{T}{h} \quad \frac{7.28 \times 10^{-5}}{64} = 1.14 \times 10^{-6}\ m/sec$$

ii. Recovery Method

$$T = \frac{0.183Q}{\Delta S'}$$

$$= \frac{0.183 \times 1.65 \times 10^{-2}}{7} = 4.3 \times 10^{-4} (m^2/sec)$$

$$K = \frac{T}{\Delta h} = \frac{4.3 \times 10^{-4}}{64} = 6.72 \times 10^{-6}\ m/sec$$

With respect to the permeability coefficient thus obtained, both Jacob's method and recovery methods, show values in almost the same order. Generally, fine sand, silt, and silty sand have the same permeability and order, and show somewhat worse value of transmissivity than the gravel layer or sandy gravel layer. The value of the storage coefficient is considerably greater than values (0.005 to 0.00005) in the pressured aquifer and approximates to values (0.05 to 0.4) in the no-pressure aquifer. Therefore, it is probable that the aquifer targeted by the well is a no-pressure aquifer.

b. San Pedro Sector (No. 29 well)

i. Jacob's Method

$Q = 1.5 \times 10^{-2}\ m^3/sec$

$\Delta S = 2.2$ m

$r = 0.10$ m

$t_o = 3.6$ sec

$h = 65.5$ mm

$$T = \frac{0.183Q}{S}$$

$$= \frac{0.183 \times 1.5 \times 10^{-2}}{2.2} = 1.2 \times 10^{-3}\ (m^2/sec)$$

$$S = \frac{2.25T\ to}{r^2}$$

$$= \frac{2.25 \times 1.2 \times 10^{-3} \times 3.6}{0.1^2} = 9.7 \times 10^{-1}$$

$$K = \frac{T}{\Delta h} = \frac{1.2 \times 10^{-3}}{65.5} = 1.8 \times 10^{-5}\ (m/sec)$$

This test well exhibited instantaneous water level recovery and prevented the test by the recovery method. The permeability coefficient obtained here is in the same order as that of medium- and fine-sand, and silty sand.

Table A.3.2.4-1 Continuous Pumping Test at Deep

Measured Time	Time t (Sec)	Water Level (m)	Drawdowns (m)	Note
12 : 05	0	10.67	0	Pumping Discharge $1.65 \times 10^{-2} m^3$ /Sec
: 06	60	29.26	18.59	
: 07	120	41.15	30.48	
: 08	180	49.07	38.40	
: 09	240	51.82	41.15	
: 10	300	57.61	46.94	
: 11	360	60.96	50.29	
: 12	420	63.70	53.03	
: 13	480	65.23	54.56	
: 14	540	67.97	57.30	
: 15	600	70.71	60.04	
: 20	900	72.85	62.18	
: 30	1.500	72.24	61.57	
: 40	2.100	72.24	61.57	
: 50	2.700	77.11	66.44	
13 : 00	3.300	78.64	67.97	
: 10	3.900	78.64	67.97	
: 20	4.500	78.64	67.97	
: 30	5.100	78.64	67.97	
: 40	5.700	78.64	67.97	
: 50	6.300	78.64	67.97	
14 : 00	6.900	78.64	67.97	
: 30	8.700	78.64	67.97	
15 : 00	10.500	78.64	67.97	
: 20	11.700	78.64	67.97	

Table A.3.2.4-2 Recovery Test at Deep Well (No. 19B) in Mojaritas Sector

Measured Time	Time t (Sec)	Time t'	t / t'	Water Level (m)	Drawdown s (cm)	Note
15 : 20	11,700	0	—	78.84	67.97	Pumping Stop
: 21	11,760	60	196	51.82	41.15	
: 22	11,820	120	98.5	29.26	18.59	
: 23	11,880	180	66	20.73	10.06	
: 24	11,940	240	49.75	16.75	6.09	
: 25	12,000	300	40	15.85	5.18	
: 26	12,060	360	33.5	15.24	4.57	
: 27	12,120	420	28.86	14.63	3.96	
: 28	12,180	480	25.38	14.63	3.96	
: 29	12,240	540	22.67	14.63	3.96	
: 30	12,300	600	20.5	13.73	3.05	
: 32	12,420	720	17.25	13.11	2.44	
: 34	12,540	840	14.93	13.11	2.44	
: 36	12,660	960	13.19	11.58	0.91	
: 38	12,780	1,080	11.83	10.67	0	

Table A.3.2.4-3 Continuous Pumping Test at Deep Well (No. 29) in San Pedro Sector

Measured Time	Time t (Sec)	Water Level (m)	Drawdown s (m)	Note
8 : 40	0	14.33		Pumping Discharge $1.5 \times 10^{-2} m^3 / Sec$
: 41	60	17.39	3.60	
: 42	120	17.66	3.33	
: 43	180	17.98	3.65	
: 44	240	18.27	3.94	
: 45	300	18.44	4.11	
: 47	420	18.77	4.44	
: 49	540	19.03	4.70	
: 51	660	19.21	4.88	
: 54	840	19.45	5.12	
: 57	1,020	19.63	5.31	
9 : 00	1,200	19.83	5.50	
: 10	1,800	20.18	5.85	
: 20	2,400	20.47	6.14	
: 30	3,000	20.64	6.31	
: 40	3,600	20.85	6.52	
: 50	4,200	20.95	6.62	
10 : 00	4,800	20.98	6.65	
: 30	6,600	21.03	6.70	
11 : 00	8,400	21.07	6.74	
: 30	10,200	21.14	6.81	
12 : 00	12,000	21.16	6.83	
13 : 00	15,600	20.83	6.50	

(a) Jacob's Method

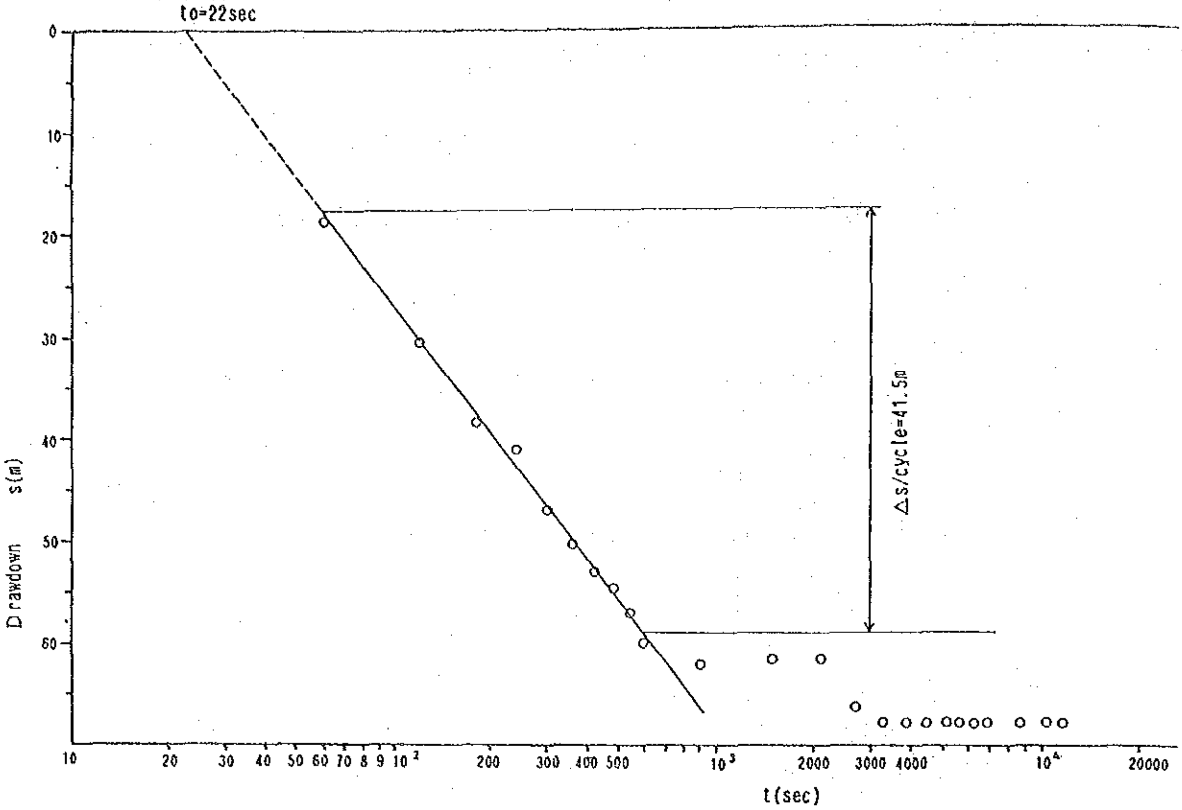


Fig. A.3.2.4-8 Analysis of Pumping Test

(b) Recovery Method

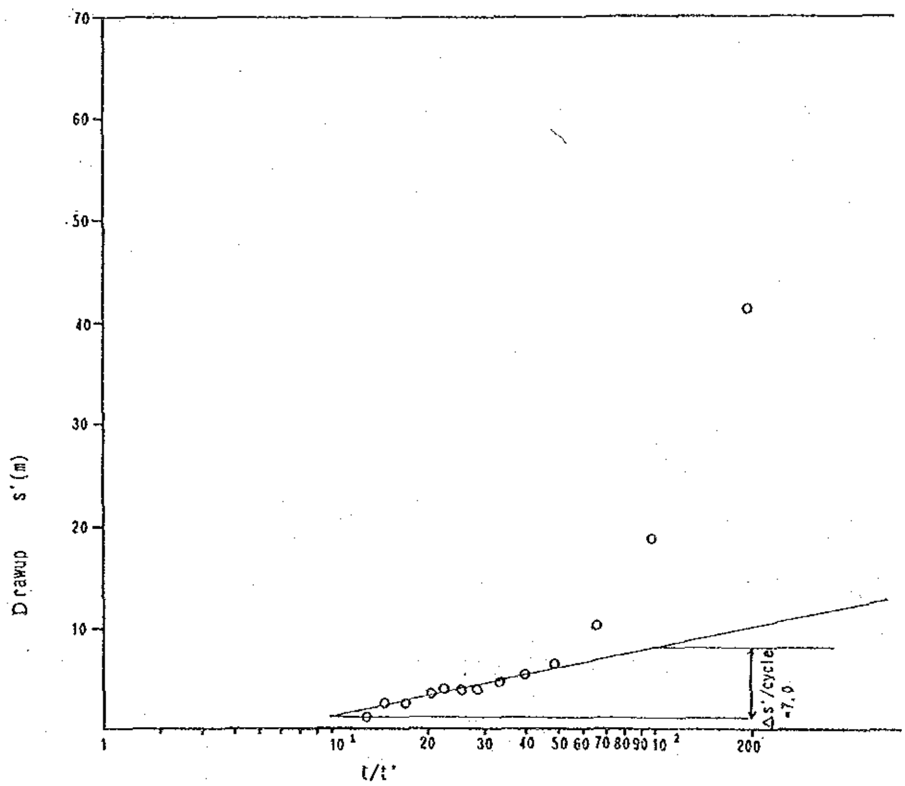


Fig. A.3.2.4-9 Analysis of Pumping Test

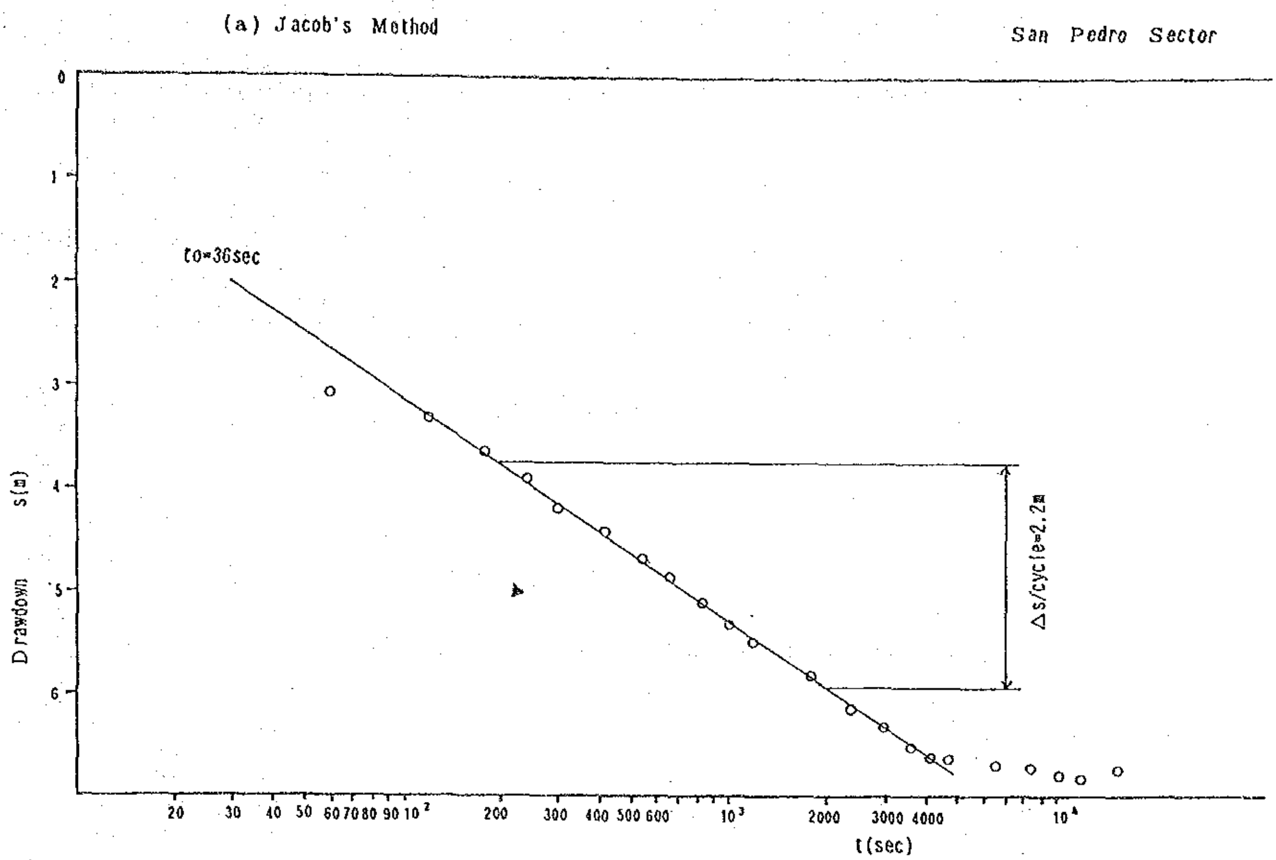


Fig. A.3.2.4-10 Analysis of Pumping Test

4) Groundwater Flow Condition

Using the groundwater table of 113 wells measured August, October and December 1987, a regional groundwater table map is drawn to understand the groundwater flow (Fig. A.3.2.4-11).

The groundwater tables generally show higher than GL-20m in the area and higher than GL-10m in the plain area. The areas with groundwater table being higher than GL-1m are identified in two sectors. The areas with higher than GL-0.5m very closely coincide with unusable land with clay soild.

The groundwater table gradually deepen toward hills and mountain areas from plain area. But the table rises up near of volcanic impermeable layers.

In the areas of existing main river courses and piedment, the hydraulic gradient is steep (1/3 - 1/240), but in the plain area it becomes gentle (1/125 - 1/600). The change of the gradient is relatively abrupt in the boundaries between piedment and plain area. The changing zones roughly coincide with changes in geological components, granulometry of detrieval materials and ground slope.

In Fig. A.3.2.4-12 is presented the monthly variation of groundwater tables between February 1985 and July 1987. In general speaking, the annual variation of tables has not been detected, but the sectorial monthly fluctuation can be classified into 3 types as follow:

(a) Area with increment of groundwater table during the rainy season;
(b) Area with increment of groundwater table during the dry season; and
(c) Area with stable groundwater table all the year round.

The area (a) coincide with surrounding limits between mountains and piedments, terraces, and surrounding areas of deep wells and principal river courses. The area (b) is detected in the central part of the basin. The area (c) is distributed in hill, sub-basin of the tributaries and surrounding area of type (b).

On the basis of the above analysis, the variation of groundwater tables can be interpreted as following manner: The supply from rainfall presents the rapid elevation of groundwater tables during rainy season, but the rapid drawdown during dry season. On the other hand, the elevation of groundwater tables is found during dry season in the central part of the basin due to slow appearance of the effect produced by the rainfall of wet season.

According to the hearing, the stable groundwater levels of deeps wells do not show clear variation all the year round and delay some minutes to recover the groundwater level before pumping.

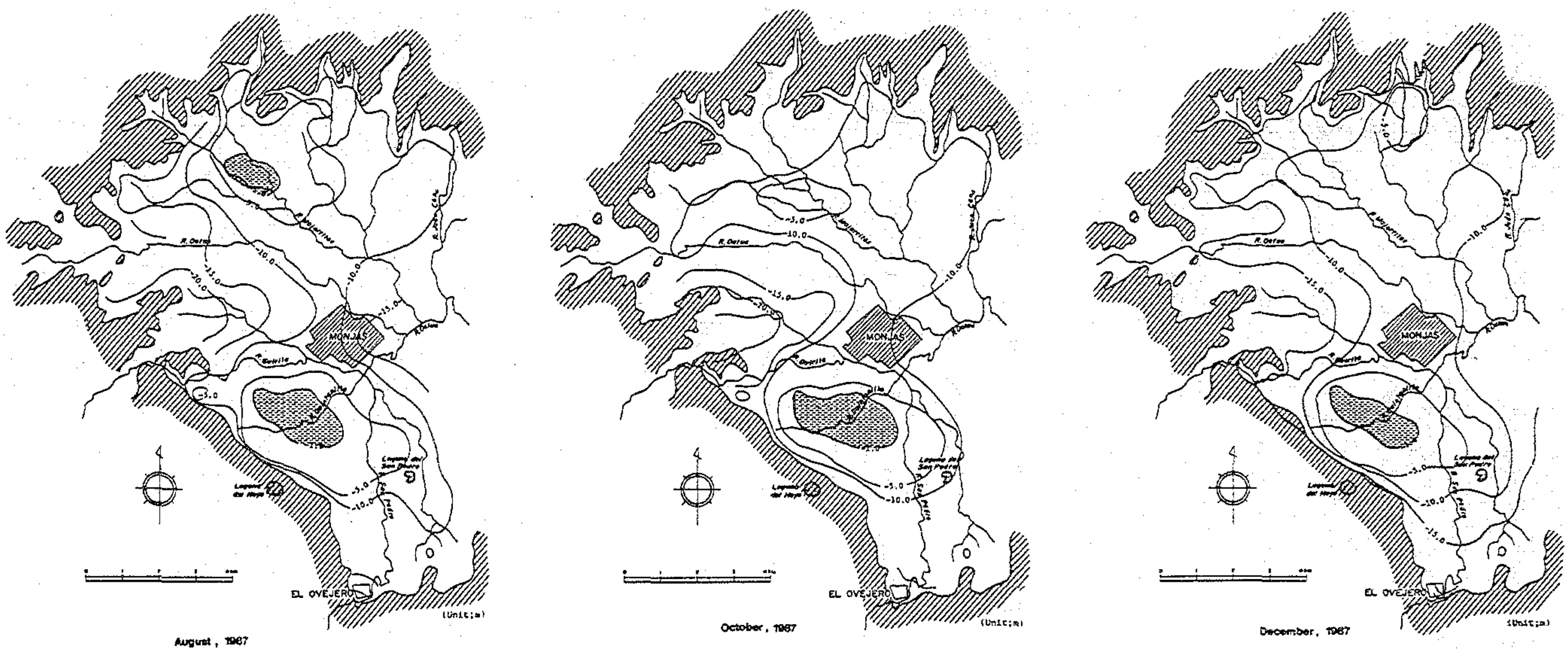


Fig. A.3.2.4-11 Isobath Map of Shallow Wells

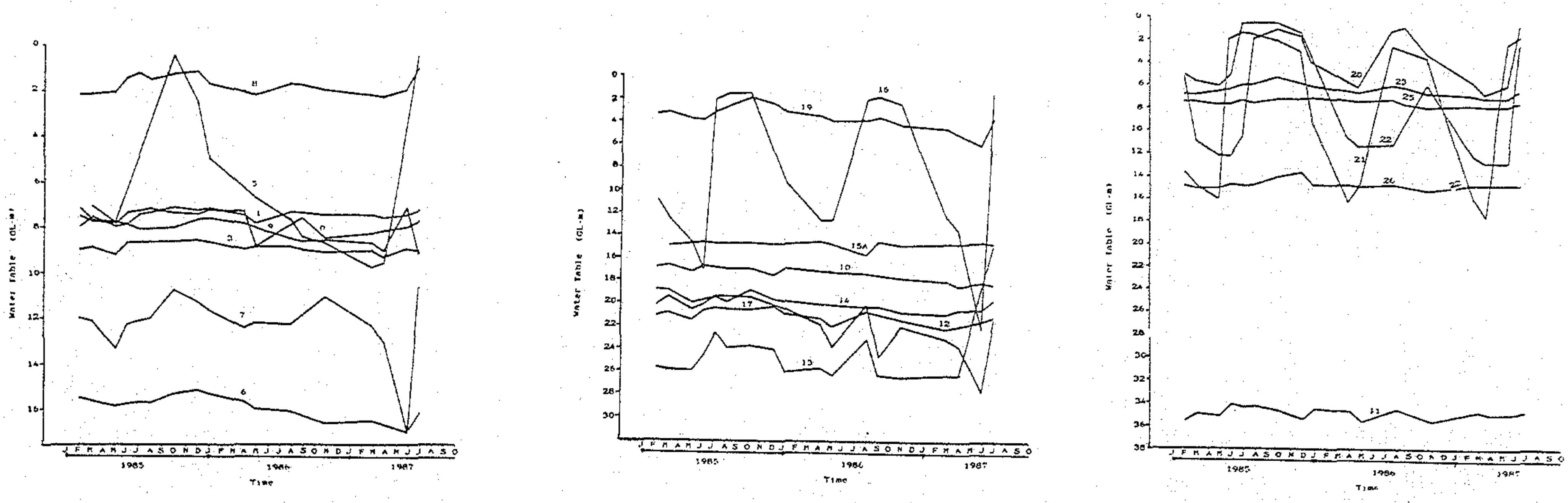


Fig. A.3.2.4-12 Monthly Variation of Groundwater Table of Shallow Wells

5) Ground water quality

In 1985 DIRYA analyzed 25 samples of ground water from shallow wells in the study area. In the present study 3 samples from deep wells in Mojarritas Sector and San Pedro Sector were analyzed. Table A.3.2.4-4 shows the analysis result. The analysis result is also shown in the form of Trilinear Diagram and Classification of Irrigation Water (Fig. A.3.2.4-13, 14).

6) Utilization of ground water

Utilization of ground water in the study area may be classified into irrigation water and household water. Irrigation water is obtained from deep wells while household water from shallow wells. In the study area Monjas Sector and Los Terrones-Llano Grande Sector are thoroughly provided with water supply. The former depends for the water source on a spring near Agua Tibia while the latter on neighbor small rivers.

This subparagraph describes utilization of ground water from deep wells. Utilization of ground water in each Sector stated above is as outlined below (Table A.3.2.4-5).

Table A.3.2.4-5 Summary of Groundwater Utilization

	Number of Well	Irrigation Area (ha)	Total Pumping Discharge (m^3)
Mojarritas Sector	22 (20) (*1)	260	Approximately 4.0 MCM
San Pedro Sector	4 (4) (*1)	68	Approximately 0.9 MCM
Other Sector	11 (7) (*1)	120 (136)	Approximately 1.5 MCM
Total	37 (31) (*1)	448 (464) (*2)	6.5 MCM

*1 Number of working wells

*2 Including non-steady utilization

Table A.3.2.4-4 Groundwater Quality

(Sampling Date:January, 1985)

No. of Well	1	2	3	6	8	9	13	17	19	20	21	22	23	26
pH	8.13	7.46	7.08	7.03	7.12	7.44	7.30	7.62	7.45	7.20	6.83	7.12	7.39	7.48
EC(ms/cm at 25° c)	314	549	276	235	128	275	571	301	432	203	103	314	605	447
SS(ppm)	266	438	244	216	170	226	294	274	484	162	228	216	404	260
Ca^{++}	0.96	1.60	0.96	1.17	0.32	0.96	1.07	0.96	0.96	0.96	0.53	1.49	2.13	1.17
Mg^{++}	0.89	1.49	0.69	0.79	0.50	1.10	1.71	0.69	0.69	0.69	0.29	1.19	2.19	3.46
Na^{+}	1.55	1.95	1.40	0.43	0.40	0.83	1.40	1.40	2.15	0.43	0.23	0.60	1.40	0.95
K^{+}	0.22	0.34	0.13	0.09	0.11	0.13	0.13	0.19	0.38	0.14	0.10	0.06	0.33	0.23
Co_3^{--}	0.76	0.00	0.51	0.00	0.00	0.51	0.86	0.46	0.30	0.00	0.00	0.51	0.96	0.76
Hco_3^{-}	3.16	2.41	2.42	2.17	1.40	2.62	3.40	2.55	2.06	1.98	1.17	2.64	4.29	3.20
Cl^{-}	0.20	2.16	4.49	0.01	0.15	0.25	0.12	0.21	0.99	0.29	0.06	0.35	0.73	0.06
So_4^{--}	0.13	0.15	0.10	0.00	0.00	0.02	0.03	0.12	0.34	0.33	0.16	0.15	0.13	0.00
Na%	42.82	36.25	44.03	17.34	30.08	22.03	32.48	43.21	51.44	19.37	20.00	17.96	23.14	16.35
SAR	1.61	1.57	1.54	0.43	0.62	1.62	1.19	4.54	2.15	0.43	0.36	0.52	0.95	0.62
Na_2Co_3 RES	2.07	0.00	1.28	0.21	0.58	1.07	1.48	1.36	0.71	0.33	0.35	0.47	0.93	0.00

(Sampling Date:March, 1985) (Sampling Date:December, 1987)

No. of Well	2	5	7	13	14	16	21	22	24	25	26	23*	258*	29*
pH	7.00	7.34	7.00	8.08	7.10	6.10	7.60	7.10	6.60	6.90	7.57	6.65	6.79	6.50
EC(ms/cm at 25° c)	548	412	393	308	367	70	141	340	209	255	268	392	401	189
SS(ppm)	418	264	342	244	314	—	190	230	360	216	212	312	330	194
Ca^{++}	1.83	2.37	1.83	0.97	1.51	0.11	0.65	1.83	0.75	1.08	0.97	1.56	1.68	0.92
Mg^{++}	1.08	1.06	1.08	0.69	1.09	0.20	0.28	0.87	0.29	0.69	0.80	1.10	1.02	0.41
Na^{+}	1.90	0.73	0.62	1.15	1.40	0.24	0.27	0.61	0.83	0.63	0.63	1.55	1.40	0.44
K^{+}	0.35	0.07	0.16	0.10	0.14	0.16	0.12	0.07	0.23	0.19	0.17	0.28	0.22	0.14
Co_3^{--}	0.21	0.28	0.29	0.00	1.20	0.00	0.00	0.62	0.00	0.37	0.32	0.00	0.00	0.00
Hco_3^{-}	1.98	3.48	1.71	2.61	2.60	0.68	1.17	1.96	1.24	2.28	2.24	4.05	4.09	1.44
Cl^{-}	1.38	0.32	0.54	0.30	0.06	0.06	0.02	0.46	0.02	0.02	0.06	0.06	0.14	0.14
So_4^{--}	0.06	0.35	0.10	0.14	0.00	0.00	0.00	0.14	0.30	0.00	0.03	—	—	—
Na%	36.82	17.26	16.80	39.52	33.82	33.80	20.45	18.05	39.52	24.32	24.51	34.52	32.41	23.04
SAR	1.58	0.56	0.51	1.26	1.23	0.61	0.39	0.53	1.15	0.67	0.67	1.34	1.20	0.54
Na_2Co_3 RES	0	0.33	0	0.95	1.20	0.37	0.25	0	0.20	0.88	0.79	1.39	1.39	0.11

Note:NaX = Na/Na+Ca+Mg, SAR = Na/ (Ca+Mg)/2
* = Deep Well

(Source:DIRYA and Study Team)

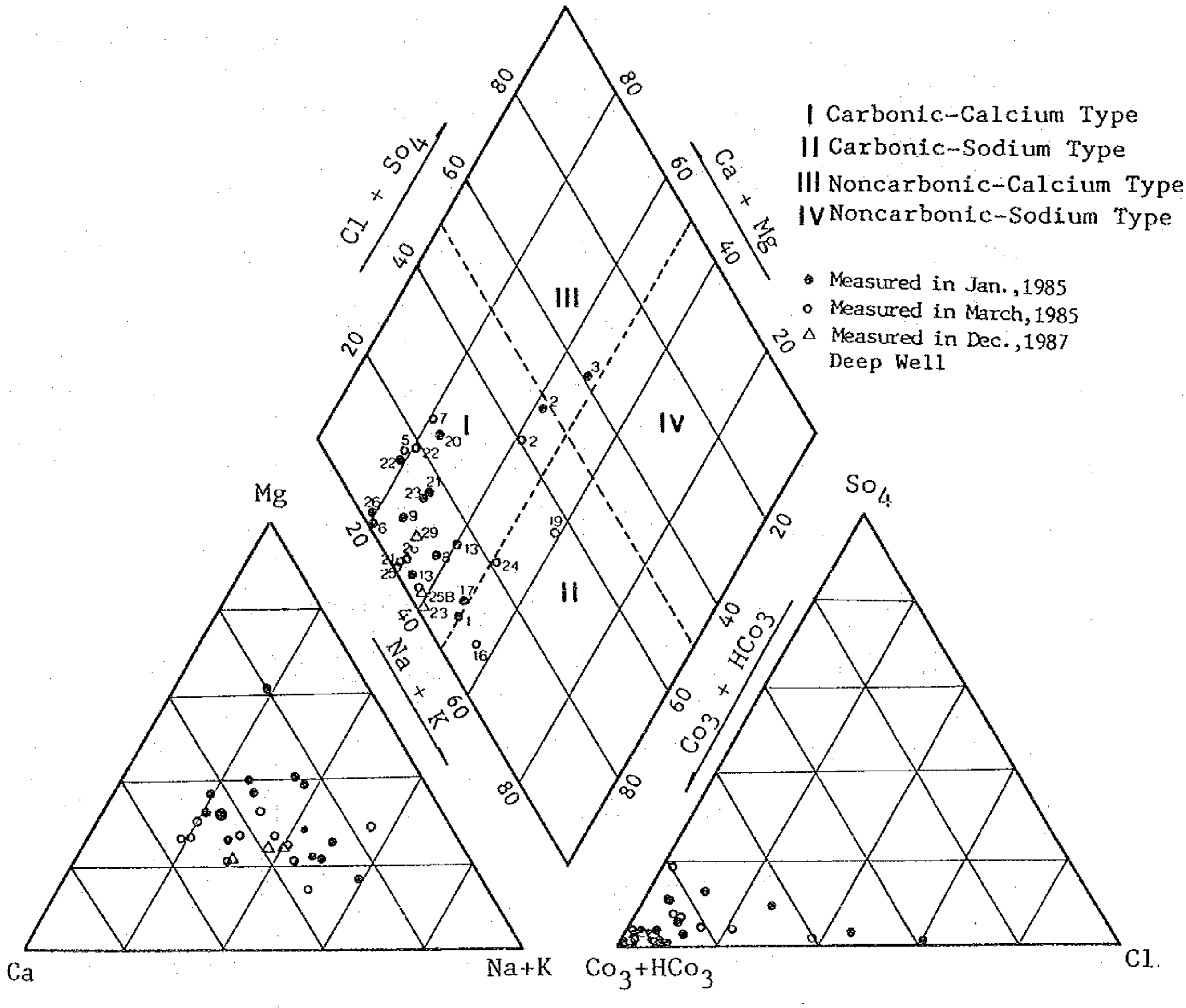
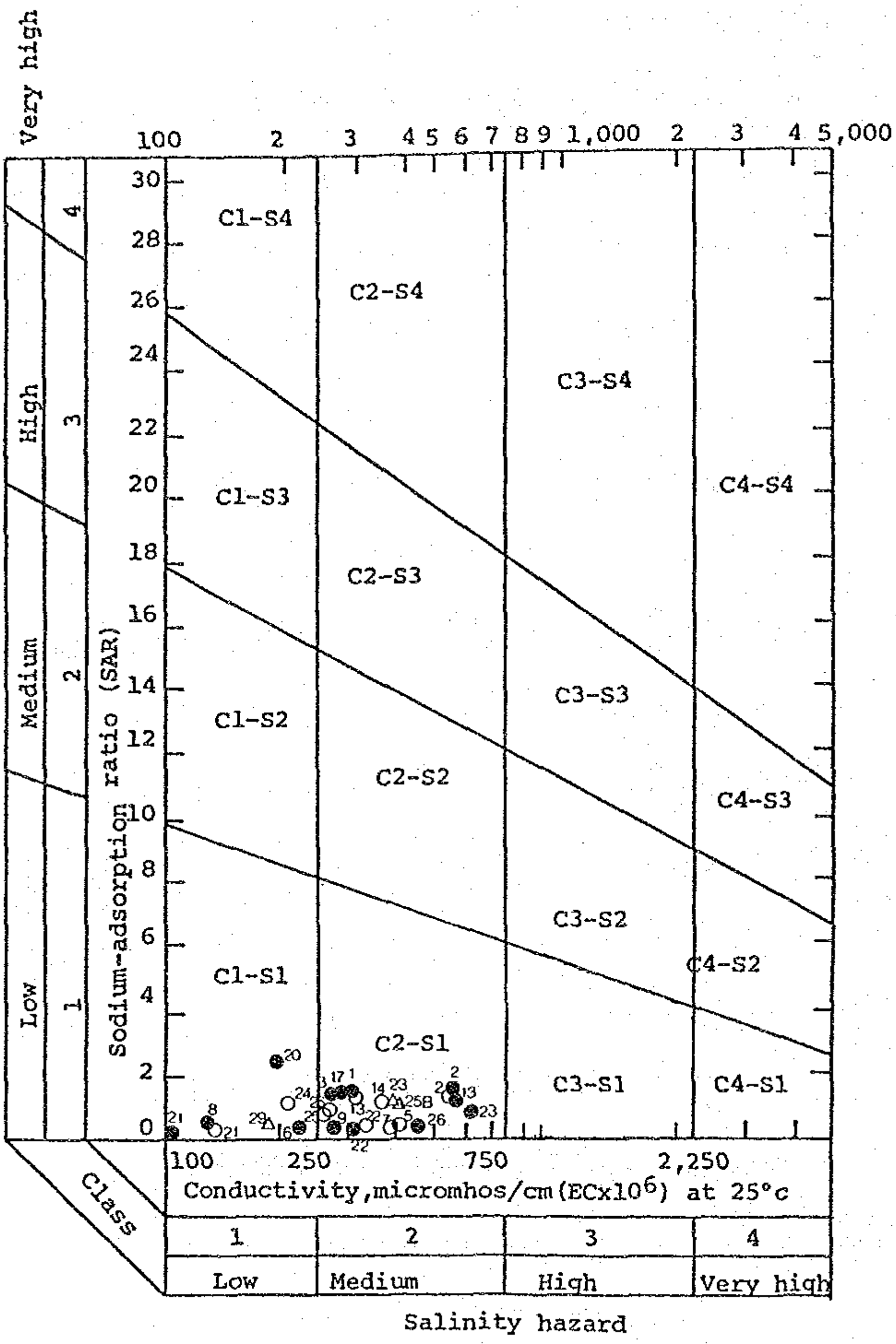


Fig. A.3.2.4-13 Trilinear Diagram



Source : USAD Salinity Lab. Handbook 60

Fig. A.3.2.4-14 Classification for Irrigation Water

Table A.3.2.4-6 shows electric charges and pumping output estimated on the basis of fact-finding hearing study on water utilization performed in the above 3 sectors. Table A.3.2.4-7 shows fixed cost (such as well digging cost and pump expenses) and variable charge (electric charges) relevant to ground water development in October, 1987.

Table A.3.2.4-6 Deep Well Groundwater Utilization

	Mojarritas Sector	San Pedro Sector	Other Sector
No. of well	21 B	29	9
Irrigated Area (ha)	21	9.8	14
Irrigtated Period	Nov./Apr. (everyday)	Nov./Mar. (time/2days)	Dic Mar (every day)
Irrigated Hour	181/days×16hr/d=2.896 hrs	106/days×14hr/d=1.484 hrs	121days ×19hrs/d =2.299 hrs
	(=10.425.600sec)	(=5.342.400sec)	(=8.276.400sec)
Pump Power	11.2kW	11.2kW	7.5kW
Consumed Electricity	32.435 kWh	16.620kWh	17.243kWh
Basic Charge	Q 2.96×11.2kW=	Q 2.96×11.2kW=	Q 2.96×7.5kW =
	Q 33.15	Q 33.15	Q 22.2
Consumption Charge	Q 0.134 ×100kWh×11.2+	Q 0.134 ×100kWh×11.2+	Q 0.134 ×100kWh×7.5 +
	Q 0.128 ×100kWh×11.2+	Q 0.128 ×100kWh×11.2+	Q 0.128 ×100kWh×7.5 +
	Q 0.108 ×32.235kWh =	Q 0.108 ×16.420kWh =	Q 0.108 ×17.043kWh =
	Q 3.774.82	Q 2.066.80	Q 2.037.14
Sub Total	Q 3.807.97	Q 2.099.95	Q 2.059.34
Combustible Adjustment (10%) + IVA (7%)	Q 647.35	Q 356.99	Q 350.09
Grand - Total	Q 4.455.32	Q 2.456.94	Q 2.409.43
Electric Charge per ha	Q 221.16	Q 250.71	Q 172.10
Pumping Discharge	15.8ℓ /S ×10.425.600 sec	17.5ℓ /S ×5.342.400sec	5.0ℓ /S ×8.276.400sec
	=164.724 m^3	=93.492m^3	=41.382m^3

(Source : Field Survey)

Table A.3.2.4-7 Actual Cost for Groundwater Development

Item	Unit price (Q)	Quantity	Price (Q)	Note
Preparation Work		Unit	2,500	Transportation, installation of machine & equipment
Boring	200	70 m	14,000	10"
Well Facility		Unit	29,000	Tube, casing, screen, etc.
Well Prospecting Test		Unit	1,700	Pumping test, electric prospecting (SP).
Pump		Unit	11,000	Submergible pump, 11 kW, including installation cost.
Electric Facilities			10,000	Cable (300 m), transformer, including installation cost
Conducting pipe	14	250 m	3,500	4", VU pipe
Electric Charge		31,680 KWh	4,350	16 hr/day x 180 days
Annual Instal-ment Rate	0.080 (i=5%), 0.1175 (i=10%) Durable period: 20 years			
Annual Pumping Discharge	800 m^3/day x 180 days = 144,000 m^3			

The following calculation shows groundwater cost necessary for obtaining a pump discharge per unit;an example is taken from this well to be developed.

<u>Case of annual interest of 5%</u>

$$\text{Groundwater cost} = \frac{(2.5+14.0+29.0+1.7+11.0+10.0+3.5)\times10^3\times0.0802+4350}{144.0\times10^3}$$

$$= 0.07\ Q/m^3$$

<u>Case of annual interest of 10%</u>

$$\text{Groundwater cost} = \frac{(2.5+14.0+29.0+1.7+11.0+10.0+3.5)\times10^3\times0.1175+4350}{144.0\times10^3}$$

$$= 0.09\ Q/m^3$$

(3) Seismology

Table A.3.2.4-8 Seismographical Record (1978 to 1982)

Cordinate of dam site
Latitude 14°50'
Longitude 90°00'

No.	Date	Epicenter		Magnitude	Distance from dam site	Acceleration
		Latitude	Longitude			
1	Jul 29,'78	14.613	90.903	5.1	119	1.98
2	Jul 29,'78	14.762	90.008	3.1	35	2.30
3	Jan 12,'79	14.067	91.532	6.0	194	3.06
4	Jan 15,'79	13.373	89.980	4.9	126	1.18
5	Jan 22,'79	13.539	90.166	4.7	113	1.17
6	Sep 10,'79	14.017	90.651	4.7	105	1.59
7	Sep 23,'79	14.150	90.289	4.0	63	2.24
8	Sep 27,'79	14.223	90.268	3.5	57	1.10
9	Oct 9,'79	14.128	90.262	5.0	63	15.33
10	Nov 11,'79	14.203	90.265	4.3	58	5.47
11	Feb 11,'80	14.153	90.205	4.1	56	4.07
12	Mar 6,'80	14.507	89.540	3.1	32	2.67
13	Apr 21,'80	15.108	89.456	4.3	79	1.98
14	May 7,'80	14.996	89.611	3.6	60	1.10
15	Sep 18,'80	13.479	89.874	4.9	130	1.92
16	Feb 21,'81	14.382	89.416	3.5	48	2.01
17	Apr 4,'81	15.162	89.729	4.4	75	3.08
18	Apr 7,'81	14.672	90.044	3.2	30	3.92
19	Jun 8,'81	14.401	89.798	4.0	12	38.43
20	Aug 12,'81	14.614	89.884	4.1	14	38.02
21	Aug 20,'81	14.330	89.884	4.1	26	13.09
22	Aug 29,'81	14.330	89.884	3.8	21	26.13
23	Nov 14,'81	14.340	89.769	3.4	19	13.09
24	Jan 4,'82	14.185	89.696	4.2	38	11.42
25	Jan 9,'82	14.329	90.016	3.1	27	3.97
26	Jun 19,'82	13.215	89.666	6.3	144	17.26
27	Sep 29,'82	14.351	89.158	5.0	56	9.31

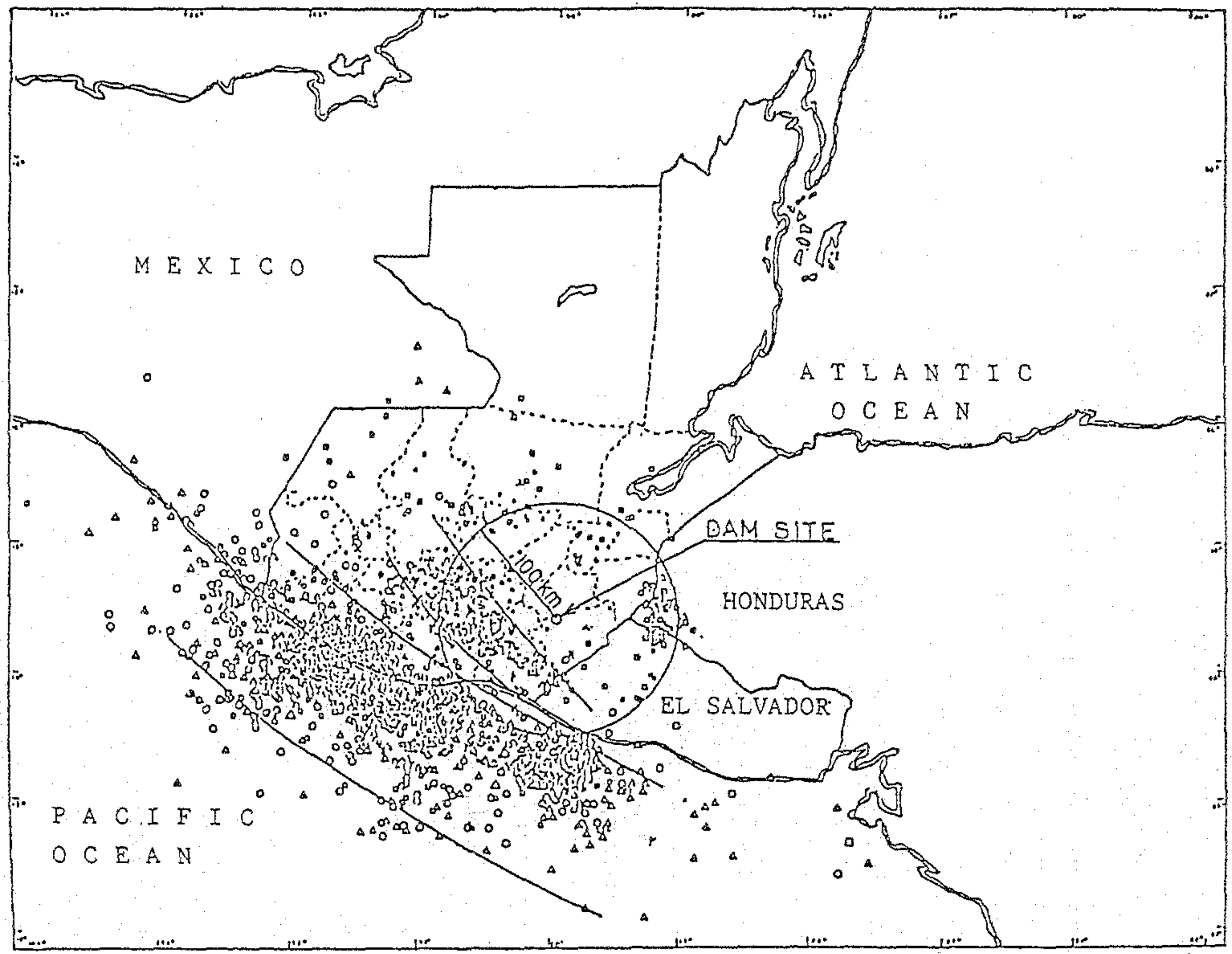
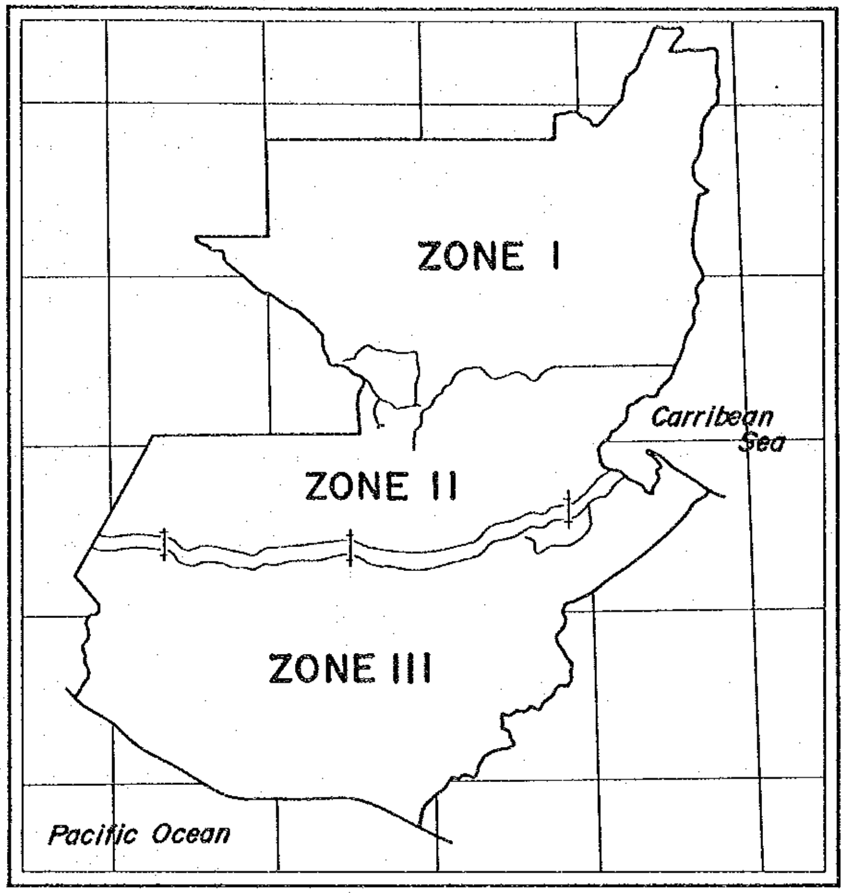


Fig. A.3.2.4-15 Epicentre Map



ZONE I : Minor Damage
ZONE II: Moderate Damage
ZONE III: Major Damage

Use Group 1 : Essential facilities necessary for life care and safety.
Use Group 2: Ordinary commereial, residential public assembly and industrial structures (those that are not included in Use Groups 1 and 3).
Use Group 3: Facilities which are relatively nonessential for public safety.

Fig. A.3.2.4-16 Schematic Intensity Map

3.2.5 Soils and Land Classification

(1) Soils

1) Soil characteristecs

Soil of Monjas basin has so far been surveyed in anticipation of development and promotion of the area. In 1972 DIRYA, ministry of Agriculture, Cattle and Food Resources, played a main role in a large-scale soil survey. More particularly, the profile survey was conducted at about 58 test pits newly dug, followed by detailed physical and chemical analysis of soils sampled from the test pits. In 1987 additional soil survey followed that 15 test pits were provided in the main area for the purpose of soil classification.

A huge amount of survey data were collected and used for land classification, and the land classification map with a scale of 1/20,000 was completed. However, a soil map is not yet available.

At this point, soils in the area are classified as shown below on the basis of the existing survey result and the present survey.

In terms of the soil order, soils are roughly divided into 3 categories : Vertisol, Inceptisol, and Alfisol. Vertisol is subdivided into 2 categories according to soil color : Cromusterts with color intensity of 1.5 or more and Pellusterts with less than 1.5. In terms of the sub-order, Inceptisol is subdivided into Tropepts and Ochrepts with less organic content, both of which are widely distributed in the tropical and sub-tropical zones. In terms of the great-group, Inceptisol is subdivided into Durustalf and Ustropepte ; the farmer contains Duripan in its layer within 1 meter from the ground level while the latter no Duripan. In terms of the great-group, Alfisol is subdivided into Rhodustalfs with Duripan in its layer within 1 meter from the ground level and Haplustalfs with no Duripan.

The present survey provided 16 test pits in the Study area to observe the soil profile and sample test soil (Fig. A.3.2.5-1, and 2). Table A.3.2.5-1 shows a relationship between the soil order and soil color.

2) Physical properties of soil

Table A.3.2.5-2 shows the result of analyzing soil in each layer for physical properties. Fig. A.3.2.5-4 illustrates distribution of clay content for each soil layer.

Vertisol has clay content progressively increased as the cultivated surface layer lowers to the lower layer. Some Vertisol contains clay that accounts for more than 70% of the whole soil. On the other hand, Inceptisol and Alfisol generally contain, less clay content (Fig. A.3.2.5-4).

Fig. A.3.2.5-5 shows available moisture for each soil order, which is obtained as a difference between the above mentioned field capacity and the moisture content at the wilting point.

Vertisol with high clay content tends to have high available moisture content, while Inceptisol and Alfisol tend to have less moisture content.

Fig. A.3.2.5-6 shows bulk density by soil order.

Most soils have the apparent specific gravity distributed within a range from 1.1 to 1.5. Many soils show slightly higher values in the lower layes with less humus content, but a difference between soils is unknown.

3) Chemical properties of soil

Table A.3.2.5-3 shows the analysis result of chemical properties of soil. Fig. A.3.2.5-7 shows a change in humus content depending on soil layers for each soil.

Surface soil has high humus content while lower layer soil less. However, a difference of humus content among soil orders is unknown.

Vertisol has not so high humus content as suggested by its black soil color.

Fig. A.3.5.2-8 shows a change in the pH by soil order. Most soils show pH of 5.0 -6.0 in the cultivated layer. Vertisol and Alfisol tend to show high values in the lower layer.

Figs. A.3.2.5-9, -10, and -11 show content of exchangeable calcium, magnesium and potassium for each soil layer.

These figures indicate that most soils have a little less exchangeable potassium as soil lowers from the surface layer to the lower layer.

Fig. A.3.2.5-13 shows exchangeable sodium content and the ratio of sodium content to exchangeable sodium content of 1 meq or less. Generally, the lower the layer, the higher the sodium content, in many soils.

As to the ratio of exchangeable sodium to the substitute capacity, most soil shows as low a value as 5% or less.

Figs. A.3.2.5-14 and 15 show total cation base content and base saturation for each layer, respectively.

Some soils have slightly less base content in the surface while most soils show high content of 25 meq or more in the lower layer.

Any soil has high base saturation, for example, some Vertisol has base saturation of more than 100% in the lower layer. Presumably, this is because soil is affected by the mottle of calcium carbonate, etc. found in the lower layer.

Surface soil has the base substituting capacity varied in a wide range of 10 - 40 meq. Most soils show high values of 25 - 50 meq in the lower layer. Most of Inceptisol show less CEC.

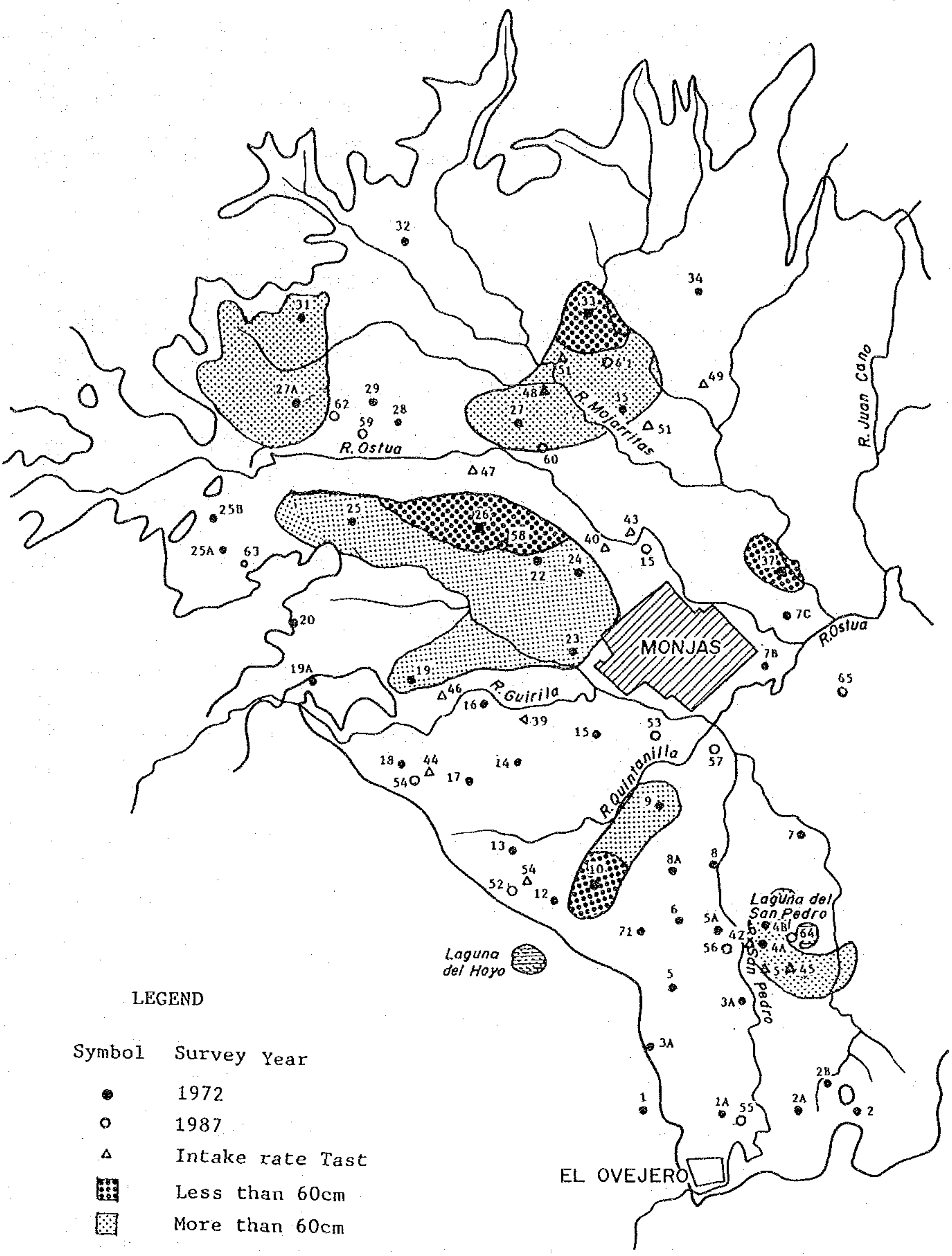


Fig. A.3.2.5-1 Survey Points and Duripan Distribution

Table A.3.2.5-1 Soil Color

DEPTH / SOIL ORDER	I HORIZON	II HORIZON	III HORIZON	IV HORIZON	V HORIZON
VERTISOL	7.5yR 2/0 (Black) 7.5yR 3/2 (Black Brown) 10yR 2/1 (Black) 10yR 3/2 (Black Brown)	7.5yR 1.7/1 (Black) 7.5yR 4/2 (Red Gray) 10yR 2/1 (Black) 10yR 1.7/1 (Black)	10yR 2/1 (Black) 10yR 4/2 (Gray yellow Brown)	10yR 3/1 (Black Brown) 10yR 5/2 (Gray yellow Brown)	10yR 2/1 (Black)
INCEPTISOL	10yR 3/2 (Black Brown) 7.5yR 2/2 (Black Brown)	7.5yR 2/2 (Black Brown) 10yR 2/1 (Black) 10yR 3/1 (Black Brown)	7.5yR 3/3 (Dark Brown) 10yR 4/2 (Gray yellow Brown)	10yR 5/2 (Gray yellow Brown) 7.5yR 5/2 (Gray Brown) 7.5yR 3/3 (Dark Brown)	
ALFISOL	7.5yR 3/2 (Black Brown) 7.5yR 3/3 (Dark Brown)	5yR 2/3 (Dark Red Brown) 5yR 3/3 (Dark Red Brown)	10yR 4/3 (Dark Yellow Brown) 10yR 4/4 (Brown)	10yR 4/3 (Yellow Brown) 10yR 4/6 (Brown)	

Table A.3.2.5-2 Physical Properties (1)

Pit No.	Depth cm	Clay %	Silt %	Sand %	Field Capacity1/3	Wilting Point 15	Bulk Density
52	0~ 20	53.4	20.3	26.3	44.8	29.2	1.29
	20~ 45	69.2	11.6	19.2	59.2	37.4	1.17
	45~ 70	68.1	13.5	18.4	59.9	38.2	1.19
	70~100	—					
53	0~ 30	51.8	26.8	21.5	43.0	27.8	1.17
	30~ 56	67.3	17.3	15.5	55.0	32.7	1.29
	56~ 75	71.8	16.9	11.3	60.2	34.0	1.26
	75~100	76.5	13.8	9.8	62.8	36.0	1.24
38	0~ 12	22.8	43.7	33.5	27.7	14.5	1.15
	12~ 30	65.5	20.8	13.7	54.5	35.2	1.20
	30~ 58	76.3	8.7	15.0	62.3	40.8	1.21
	58~	78.8	9.1	12.1	62.4	44.3	1.20
46	0~ 10	18.4	36.1	35.6	16.1	9.7	1.14
	10~ 28	54.6	19.1	26.3	47.4	27.8	1.22
	28~ 54	51.2	19.7	29.1	41.1	24.8	1.28
	54~ 65	48.0	22.3	29.7	36.8	23.2	1.35
47	0~ 13	39.0	24.0	37.0	31.9	19.8	1.33
	13~ 41	52.5	17.7	29.7	39.5	24.3	1.23
	41~ 62	52.1	17.3	30.7	43.7	25.8	1.18
	62~ 77	49.4	19.4	31.2	41.0	24.7	1.24
40	0~ 10	37.4	26.0	36.6	36.6	23.6	1.30
	10~ 23	55.8	15.5	28.7	45.2	29.3	1.31
	23~ 38	51.3	17.7	31.0	43.2	27.3	1.24
	38~ 53	52.5	21.1	26.4	48.2	31.8	1.28
41	0~ 15	42.3	24.2	33.4	33.8	24.8	1.25
	15~ 26	47.1	26.2	26.8	42.9	29.3	1.16
	26~ 43	47.0	27.2	25.8	42.2	28.9	1.15
	43~ 63	51.9	28.3	19.8	45.1	31.2	1.14
	63~	52.1	27.9	20.1	42.3	29.7	1.13
48	0~ 11	27.1	22.4	50.5	29.0	13.8	1.38
	11~ 26	65.7	9.1	25.3	53.8	31.5	1.14
	26~ 47	61.8	11.1	27.1	51.4	30.1	1.10
	47~ 64	48.4	15.3	36.3	37.9	24.4	1.35
	64~ 73	42.9	17.2	40.0	35.3	22.5	1.38

Table A.3.2.5-2 Physical Properties (2)

Pit No.	Depth cm	Clay %	Silt %	Sand %	Field Capacity1/3	Wilting Point 15	Bulk Density
58	0~ 25	32.3	29.5	38.2	30.0	17.3	1.25
	25~ 52	58.7	17.4	24.0	45.4	26.4	1.31
	52~ 74	55.3	20.4	24.3	45.2	26.3	1.31
	74~ 87	44.8	31.8	33.4	40.4	25.5	1.25
59	0~ 16	40.8	13.8	45.4	30.4	19.3	1.46
	16~ 52	40.7	15.4	43.8	26.6	17.4	1.48
	52~ 71	29.8	20.8	49.2	22.2	13.6	1.44
61	0~ 20	34.8	20.1	41.1	33.3	19.6	1.29
	20~ 40	59.4	22.2	18.4	49.5	30.8	1.31
	40~ 74	–	–	–	57.5	34.5	1.22
	74~100	–	–	–	52.5	32.4	1.26
63	0~ 13	23.3	23.2	53.5	21.6	13.0	1.46
	13~ 33	56.6	15.9	27.5	46.0	31.3	1.22
	33~ 60	55.7	19.4	25.0	44.5	29.7	1.21
	60~ 80	51.3	22.0	26.8	42.8	29.2	1.25
65	0~ 16	41.7	40.7	17.6	36.4	21.5	1.12
	16~ 38	53.4	31.8	14.8	37.7	25.7	1.24
	38~ 69	56.5	27.9	15.6	39.3	26.8	1.32
	69~100	70.5	20.3	9.2	54.2	39.2	1.28
51	0~ 11	44.4	26.0	29.7	41.2	27.7	1.45
	11~ 32	53.3	20.9	25.8	44.8	30.3	1.25
	32~ 55	54.9	17.4	27.7	45.9	30.3	1.21
	55~ 76	62.0	18.9	19.1	51.7	37.0	1.17
57	0~ 15	28.1	45.2	26.7	29.0	16.6	1.29
	15~ 43	36.1	41.2	22.7	32.0	20.3	1.22
	43~ 68	42.4	33.2	24.4	40.0	26.1	1.24
	68~ 89	61.7	26.3	11.4	46.6	33.5	1.19
	89~	35.1	38.1	26.8	38.5	21.9	1.12
55	0~ 16	28.6	31.8	39.6	28.8	14.8	1.29
	16~ 42	38.3	28.1	33.6	32.7	19.9	1.23
	42~ 65	32.7	27.6	39.8	27.6	19.2	1.36
	65~ 90	50.0	24.4	25.6	36.3	26.0	1.34
	90~	49.9	24.9	25.2	38.3	26.9	1.35

Table A.3.2.5-2 Physical Properties (3)

Pit No.	Depth cm	Clay %	Silt %	Sand %	Field Capacity1/3	Wilting Point 15	Bulk Density
56	0~ 20	27.1	34.4	38.5	33.1	18.8	1.20
	20~ 46	37.8	30.7	31.5	35.3	23.5	1.15
	46~ 72	37.0	30.1	32.9	33.1	22.4	1.29
	72~100	36.5	26.3	37.2	33.7	22.7	1.34
60	0~ 18	30.8	35.2	34.0	25.9	14.0	1.22
	18~ 40	23.9	17.9	58.3	19.9	11.6	1.41
	40~ 65	24.5	16.0	59.1	19.6	11.7	1.53
	65~100	42.5	8.9	48.6	29.2	20.0	1.33
62	0~ 18	17.5	23.4	50.0	22.0	13.0	1.25
	18~ 33	23.4	24.4	52.3	26.1	16.6	1.22
	33~ 53	23.9	21.3	54.8	24.8	15.8	1.28
	53~ 72	30.0	22.6	47.4	30.5	18.7	1.21
	72~107	20.8	21.6	57.6	23.8	14.8	1.24
66	0~ 20	31.9	26.6	41.5	28.8	18.3	1.28
	20~ 50	29.3	26.1	44.5	25.3	16.7	1.23
	50~100	23.3	30.8	45.9	22.9	13.7	1.27
42	0~ 10	13.0	18.9	68.1	16.0	5.8	1.59
	10~ 17	16.5	18.8	64.7	18.7	10.5	1.52
39	0~ 12	20.6	27.1	52.3	23.6	12.8	1.31
	12~ 26	25.8	28.3	45.9	23.8	13.3	1.42
	26~ 50	28.3	29.8	41.9	23.5	14.3	1.31
	50~ 66	28.4	22.6	49.0	22.3	11.7	1.44
	66~	28.3	19.9	51.8	22.4	15.1	1.44
43	0~ 11	17.6	33.6	48.3	25.7	15.5	1.29
	11~ 22	43.0	25.5	31.5	37.0	25.7	1.27
64	0~ 18	40.3	22.7	37.0	30.1	21.0	1.31
	18~ 55	26.9	26.2	46.9	39.0	25.5	1.08
	55~ 80	20.3	36.0	43.8	40.9	24.1	1.08
	80~100	13.0	29.4	57.5	29.2	15.8	1.29
44	0~ 14	21.2	41.5	37.3	27.4	11.3	1.20
	14~ 21	25.4	39.5	35.1	29.2	12.6	1.15
	21~ 54	46.1	20.8	33.1	28.5	20.6	1.42

Table A.3.2.5-2 Physical Properties (4)

Pit No.	Depth cm	Clay %	Silt %	Sand %	Field Capacity1/3	Wilting Point 15	Bulk Density
45	0~ 11	46.1	29.3	24.7	34.7	21.6	1.31
	11~ 17	59.3	24.5	16.2	34.3	26.7	1.24
	17~ 31	35.4	25.0	39.6	39.3	26.6	1.08
	31~ 72	32.9	28.7	38.4	45.0	27.8	1.04
54	0~ 27	26.6	23.8	50.5	24.3	13.4	1.41
	27~ 56	44.4	17.6	37.9	28.6	18.9	1.37
	56~ 83	44.9	23.8	31.3	30.6	18.7	1.34
	83~100	36.3	20.6	43.1	29.0	17.7	1.41

Table A.3.2.5-3 Chemical Properties (1)

Pit No.	Depth	Organic-Matter	PH	Exchange, meq/100 Ca	Mg	K	Na	CEC meq/100	Base Saturation	Total Base meq/100	Na/CEC
52	0~ 20	2.9	5.82	17.3	9.0	0.7	0.5	42.6	64.7	27.6	1.17
	20~ 45	1.9	5.90	22.3	11.5	0.3	0.8	38.2	91.3	34.9	2.09
	45~ 70	—	5.96	23.0	11.7	0.3	1.1	49.9	72.2	36.0	2.20
	70~100	—	—	24.5	12.1	0.2	1.0	44.8	84.3	37.8	2.23
53	0~ 30	3.3	6.19	18.5	7.3	0.9	1.4	34.3	81.7	28.0	5.76
	30~ 56	1.8	6.99	21.7	10.9	0.5	3.1	41.8	86.4	36.1	7.41
	56~ 75	—	7.48	19.7	12.2	0.5	4.3	33.8	> 100	36.6	12.72
	75~100	—	7.77	20.3	14.3	0.6	6.2	27.4	> 100	41.4	0.72
38	0~ 12	0.5	5.89	3.8	8.3	0.6	0.8	16.0	83.3	13.4	5.00
	12~ 30	1.4	6.83	23.2	9.5	0.5	4.2	46.4	80.9	37.5	9.05
	30~ 58	1.3	7.43	25.5	12.3	0.5	6.0	51.8	85.6	49.8	11.58
	58~	1.0	7.66	28.6	13.9	0.6	6.7	55.4	90.0	49.8	12.09
46	0~ 10		5.04	5.0	1.1	0.1	0.4	9.7	68.8	6.7	4.12
	10~ 28		5.44	18.3	4.8	0.2	1.2	33.9	72.4	24.5	3.54
	28~ 54		6.10	18.4	4.3	0.2	1.4	30.8	78.7	24.2	4.55
	54~ 65		6.53	13.9	3.3	0.2	1.2	26.5	69.6	18.5	4.53
47	0~ 13		5.21	13.9	4.1	0.5	0.5	25.2	75.1	19.0	1.98
	13~ 41		5.10	20.1	5.9	0.3	0.8	33.7	80.0	27.0	2.37
	41~ 62		5.71	22.7	6.1	0.3	1.1	36.5	82.5	30.1	3.01
	62~ 77		5.51	23.0	6.5	0.3	1.2	32.1	96.5	31.0	3.74
40	0~ 10	3.5	6.07	13.5	4.9	0.6	0.3	26.0	74.1	19.3	1.15
	10~ 23	1.3	5.59	15.3	6.1	0.4	1.1	38.7	59.0	22.9	2.84
	23~ 38	1.2	6.17	15.8	6.1	0.4	1.2	35.1	66.9	23.4	3.42
	38~ 53	1.2	6.87	18.1	7.1	0.6	1.7	39.8	69.2	27.5	4.27
41	0~ 15	2.8	5.76	14.6	7.7	0.7	0.2	30.8	75.3	23.2	0.65
	15~ 26	3.8	5.97	17.4	9.4	0.4	0.3	37.7	72.5	27.4	0.80
	26~ 43	2.0	6.06	15.4	9.4	0.3	0.3	36.0	70.7	25.4	0.83
	43~ 63	2.1	6.12	15.8	10.7	0.6	0.3	47.7	57.4	27.4	0.63
	63~	1.8	6.17	14.4	10.4	0.6	0.3	44.4	57.9	25.7	0.68
48	0~ 11		5.70	7.8	1.9	0.5	0.5	14.9	72.2	10.7	3.36
	11~ 26		5.95	20.6	5.7	0.5	1.1	37.3	74.9	27.9	2.95
	26~ 47		6.67	21.0	5.5	0.3	1.3	39.1	71.9	28.1	3.32
	47~ 64		6.87	19.3	5.1	0.3	1.5	27.8	94.1	26.1	5.40
	64~ 73		6.23	0.9	0.3	0.2	1.3	23.9	11.0	2.9	5.44

Table A.3.2.5-3 Chemical Properties (2)

Pit No.	Depth	Organic-Matter	PH	Exchange. meq/100				CEC meq/100	Base Satura-tion	Total Base meq/100	Na/CEC
				Ca	Mg	K	Na				
58	0~ 25	2.3	5.85	10.8	3.0	0.5	0.5	20.3	73.6	14.9	2.46
	25~ 52	1.3	5.65	22.3	5.4	0.2	1.6	27.9	> 100	29.5	5.73
	52~ 74	−	5.60	22.3	4.8	0.2	2.0	35.7	82.0	29.3	5.60
	74~ 87	−	6.55	11.0	4.8	0.3	3.0	34.9	54.6	19.1	8.60
59	0~ 16	1.7	7.17	12.2	2.3	0.2	2.0	19.5	85.4	16.7	10.26
	16~ 52	1.1	5.88	8.3	2.9	0.2	1.3	19.4	64.9	12.6	6.70
	52~ 71	−	4.74	5.3	2.1	0.4	0.6	14.2	58.4	8.3	4.23
61	0~ 20	2.7	5.80	12.3	5.3	0.9	0.8	24.6	78.3	19.2	3.25
	20~ 40	1.2	6.25	21.2	10.5	0.6	1.2	42.2	79.3	33.5	2.84
	40~ 74	−	7.36	32.1	14.9	0.6	1.3	45.8	> 100	49.0	2.84
	74~100	−	7.72	34.6	14.1	0.6	1.3	44.4	> 100	50.6	2.93
63	0~ 13	1.8	4.87	6.8	2.6	1.4	0.2	14.7	74.5	11.0	1.36
	13~ 33	1.5	5.18	19.3	6.6	3.1	0.9	40.7	73.5	29.9	2.21
	33~ 60	−	5.71	21.0	15.0	3.5	1.3	38.4	> 100	40.8	3.39
	60~ 80	−	6.25	24.8	8.8	5.9	2.0	46.7	88.3	41.2	4.28
65	0~ 16	2.8	5.27	12.8	4.3	0.8	0.2	25.4	71.5	18.1	0.79
	16~ 38	2.1	5.61	16.1	5.3	0.5	0.5	27.4	81.6	22.4	1.82
	38~ 69	−	6.01	15.6	4.8	0.5	0.4	26.6	80.0	21.3	1.50
	69~100	−	6.82	22.1	10.3	0.7	0.5	43.3	77.7	33.6	1.15
51	0~ 11		5.49	20.4	6.7	1.7	0.4	34.4	84.6	29.1	1.14
	11~ 32		5.69	21.2	8.4	1.4	0.5	41.3	76.3	31.5	1.21
	32~ 55		6.27	26.2	10.2	0.9	0.6	39.7	95.2	37.9	1.51
	55~ 76		7.07	26.5	11.3	0.8	1.0	44.1	89.6	39.6	2.27
57	0~ 15	4.7	5.30	10.8	3.1	0.8	0.3	16.4	91.0	14.9	1.83
	15~ 43	2.3	5.58	14.1	3.4	0.5	0.4	24.6	74.7	18.4	1.63
	43~ 68	−	5.59	13.0	3.7	0.3	0.5	47.0	37.4	17.6	1.06
	68~ 89	−	5.69	19.6	4.5	0.5	0.5	35.5	70.5	25.0	1.41
	89~	−	5.70	12.4	3.5	0.4	0.4	23.1	72.5	16.7	1.73
55	0~ 16	2.3	4.87	7.6	2.2	0.9	0.1	12.4	86.8	10.8	0.81
	16~ 42	2.3	4.57	8.3	2.6	0.3	0.3	23.3	48.8	11.4	1.29
	42~ 65	−	4.71	7.1	1.9	0.3	0.3	18.8	50.8	9.6	1.60
	65~ 90	−	4.73	9.6	3.9	0.3	0.5	33.0	43.1	14.3	1.52
	90~	−	4.72	9.6	4.3	0.4	0.5	27.9	52.6	14.7	1.79

Table A.3.2.5-3 Chemical Properties (3)

Pit No.	Depth	Organic-Matter	PH	Exchange, meq/100				CEC meq/100	Base Satura-tion	Total Base meq/100	Na/CEC
				Ca	Mg	K	Na				
56	0~ 20	3.5	5.35	10.4	2.9	1.4	0.2	19.8	75.5	14.9	1.01
	25~ 46	2.0	4.90	12.3	3.5	0.5	0.3	26.3	63.0	16.6	1.14
	46~ 72	–	4.99	13.0	3.9	0.4	0.4	25.9	68.2	17.7	1.54
	72~100	–	5.26	13.4	3.9	0.4	0.4	24.5	73.6	18.0	1.63
60	0~ 18	2.8	5.80	7.2	2.2	1.3	0.5	14.1	78.4	11.1	3.55
	18~ 40	1.8	4.80	3.7	0.9	0.8	0.5	12.2	47.6	5.8	4.10
	40~ 65	–	4.42	3.4	0.9	0.6	0.5	12.9	42.0	5.4	3.88
	65~100	–	4.80	6.4	2.0	0.6	0.6	14.9	63.0	9.4	4.03
62	0~ 18	2.4	5.08	6.3	0.9	0.6	0.2	13.9	57.5	8.0	1.44
	18~ 33	1.8	5.09	9.3	2.2	0.5	0.3	15.2	80.5	12.2	1.97
	33~ 53	–	5.35	9.9	2.1	0.4	0.4	18.4	69.6	12.8	2.17
	53~ 72	–	5.44	10.7	3.8	0.5	0.4	19.9	77.2	15.4	2.01
	72~107	–	5.50	7.6	2.5	0.5	0.3	13.5	81.1	10.9	2.22
66	0~ 20	1.0	5.89	11.2	1.3	1.0	0.4	19.3	71.5	13.8	2.07
	20~ 50	1.0	5.81	11.4	1.1	0.7	0.4	19.1	71.1	13.6	2.09
	50~100	–	5.56	11.7	1.2	1.0	0.3	18.3	77.6	14.2	1.64
42	0~ 10	0.5	5.15	3.1	1.5	0.6	0.7	7.5	77.3	5.8	9.33
	10~ 17	0.9	5.26	3.2	1.5	1.2	0.6	9.9	65.1	6.4	6.06
39	0~ 12	2.2	5.20	5.5	1.9	0.8	0.6	9.6	92.0	8.8	6.25
	12~ 26	2.1	4.82	5.2	2.3	0.6	0.6	11.4	75.4	8.6	5.26
	26~ 50	1.3	5.21	6.1	3.2	0.4	0.6	11.1	93.1	10.3	5.40
	50~ 66	1.0	5.24	5.1	2.4	0.3	0.6	11.5	73.6	8.5	5.21
	66~	1.0	5.61	5.0	4.3	0.4	0.7	11.5	90.3	10.4	6.09
43	0~ 11	3.2	5.56	11.7	2.7	0.8	0.6	20.7	75.9	15.7	2.90
	11~ 22	1.9	5.59	17.1	2.9	0.5	1.0	29.3	73.6	21.5	3.41
64	0~ 18	3.0	5.24	8.4	7.9	0.8	0.2	32.1	53.9	17.3	0.62
	18~ 55	0.8	5.88	9.9	12.5	1.2	0.4	44.4	54.1	24.0	0.90
	55~ 80	–	6.06	11.3	13.5	0.9	0.4	41.6	62.8	26.1	1.53
	80~100	–	6.10	9.4	7.2	0.6	0.4	28.3	62.2	17.6	1.41
44	0~ 14	2.6	5.18	4.0	2.2	0.2	0.6	8.3	83.8	7.0	1.23
	14~ 21	1.8	4.96	4.9	1.8	0.2	0.6	11.1	68.5	7.5	5.45
	21~ 54	2.0	6.09	9.2	4.1	0.3	1.8	20.3	76.0	15.4	8.87

Table A.3.2.5-3 Chemical Properties (4)

Pit No.	Depth	Organic-Matter	PH	Exchange, meq/100				CEC meq/100	Base Saturation	Total Base meq/100	Na/CEC
				Ca	Mg	K	Na				
45	0~ 11	3.9	5.19	9.6	7.7	1.2	0.6	45.2	42.2	19.1	1.33
	11~ 17	3.8	5.23	11.0	8.5	0.7	0.6	38.3	54.0	20.7	1.57
	17~ 31	2.1	5.36	10.6	12.3	0.3	0.6	39.4	60.3	23.8	1.52
	31~ 72	0.9	5.54	8.0	11.7	0.3	0.8	78.1	26.7	20.8	1.02
54	0~ 27	2.3	5.30	5.1	1.8	1.3	0.1	8.9	94.2	8.4	1.12
	27~ 56	1.3	4.44	5.2	1.7	0.6	0.2	14.8	52.0	7.7	1.35
	56~ 83	—	4.58	6.8	2.4	0.4	0.2	15.0	65.1	9.8	1.33
	83~100	—	4.70	6.5	2.6	0.4	0.2	16.0	59.8	9.7	1.25

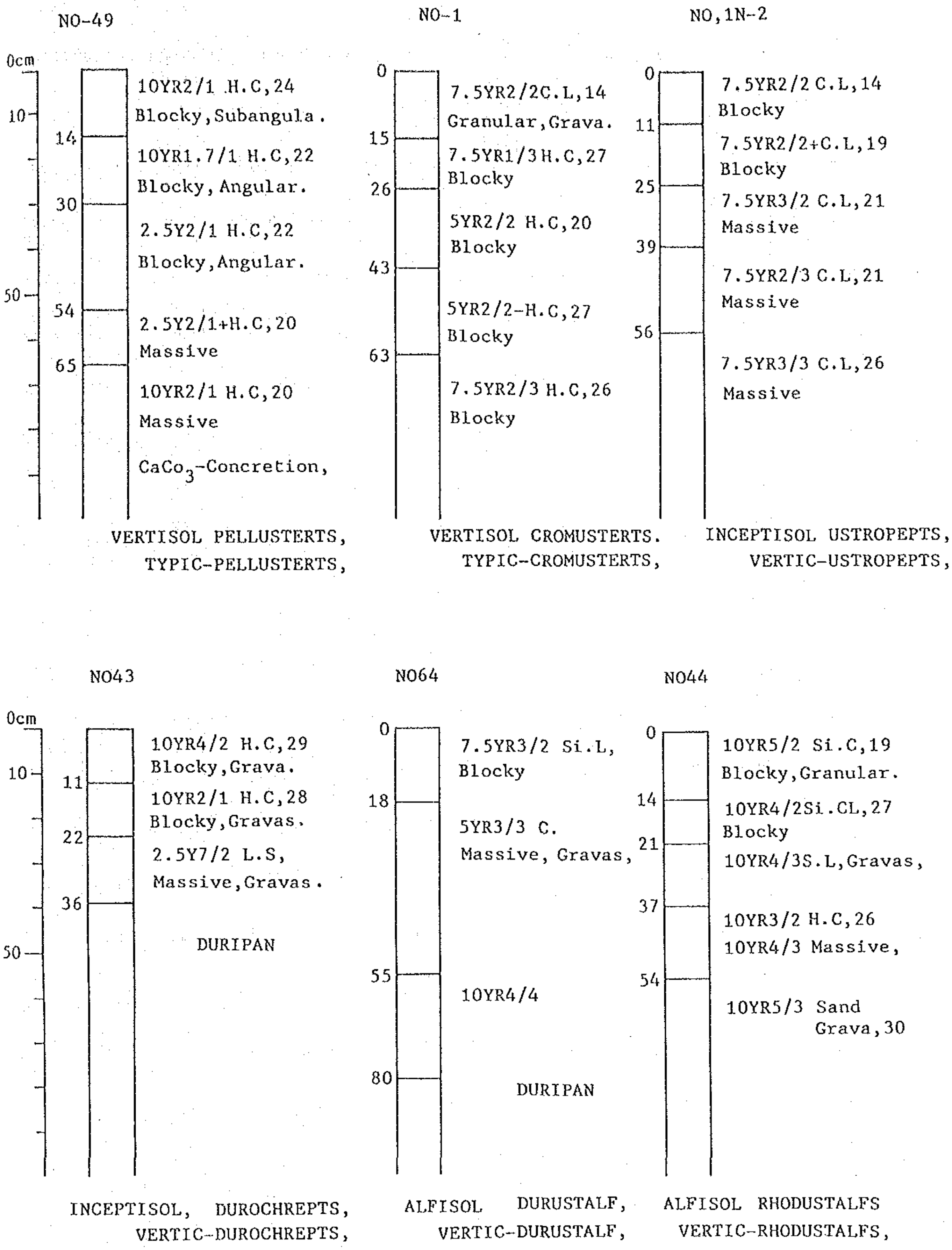


Fig. A.3.2.5-2 Profiles of Representative Soil

Table A.3.2.5-4 Result of Soil Analysis at Point of Intake Rate Test

No.	Depth	Soil Texture	Clay (%)	Silt (%)	Sand (%)	Soil Moisture 1/3 ATM	Soil Moisture 15 ATM	Organic Matter (%)	D.A.	pH
1.	0 - 20	Clay	53.43	20.32	26.25	44.83	29.15	2.86	1.2928	5.82
	20 - 45	Clay	69.15	11.64	19.21	59.23	37.92	1.87	1.1693	5.90
	45 - 70	Clay	68.08	13.50	18.42	59.91	38.17	-	1.1920	5.96
	70 - 100									
2.	0 - 16	Clay Loam	28.56	31.81	39.63	28.82	14.83	2.28	1.2858	4.87
	16 - 42	Clay Loam	38.29	28.11	33.60	32.68	19.94	2.30	1.2279	4.57
	42 - 65	Clay Loam	32.68	27.55	39.77	27.58	19.19	-	1.3600	4.71
	65 - 90	Clay	50.02	24.35	25.63	36.30	25.95	-	1.3350	4.73
	90 - 1	Clay	49.90	24.87	25.23	38.29	26.92	-	1.3451	4.72
3.	0 - 18	Clay	40.34	22.66	37.00	30.14	20.95	3.00	1.3099	5.24
	18 - 55	Clay Loam	26.89	26.21	46.90	39.00	25.46	0.77	1.0798	5.88
	55 - 80	Loam	20.28	35.97	43.75	40.85	24.06		1.0824	6.06
	80 - 100	Sandy Loam	13.02	29.44	57.54	29.16	15.82		1.2931	6.10
4.	0 - 27	Sandy Clay Loam	26.62	23.84	50.54	24.25	13.38	2.26	1.4166	5.30
	27 - 56	Clay	44.44	17.62	37.94	28.63	18.90	1.29	1.3658	4.44
	56 - 83	Clay	44.91	23.75	31.34	30.55	18.74	-	1.3385	4.58
	83 - 100	Clay Loam	36.31	20.61	43.08	29.01	17.70	-	1.4118	4.70
5.	0 - 18	Sandy Loam	17.55	23.42	59.03	22.00	12.97	2.39	1.2508	5.08
	18 - 33	Sandy Clay Loam	23.35	24.39	52.26	26.05	16.58	1.78	1.2190	5.09
	33 - 53	Sandy Clay Loam	23.92	21.27	54.81	24.81	15.79		1.2755	5.35
	53 - 72	Sandy Clay Loam	30.00	22.59	47.41	30.48	18.71		1.2129	5.44
	72 - 107	Sandy Clay Loam	20.78	21.60	57.62	23.76	14.76		1.2439	5.50
6.	0 - 25	Clay Loam	32.28	29.54	38.18	30.04	17.31	2.26	1.2525	5.85
	25 - 52	Clay	58.68	17.36	23.96	45.38	26.36	1.26	1.3136	5.65
	52 - 74	Clay	55.33	20.41	24.26	45.24	26.29	-	1.3063	5.60
	74 - 87	Clay	44.83	31.76	33.41	40.37	25.46	-	1.2548	6.55
7.	0 - 15	Clay Loam	28.11	45.17	26.72	29.04	16.63	4.70	1.2917	5.30
	15 - 43	Clay Loam	36.06	41.20	22.74	31.96	20.26	2.31	1.2162	5.58
	43 - 68	Clay	42.39	33.22	24.39	39.95	26.13	-	1.2418	5.59
	68 - 89	Clay	61.74	26.87	11.39	44.63	33.47	-	1.1889	5.69
	89 - 7	Clay Loam	35.09	38.12	26.79	38.46	21.85	-	1.1203	5.70
8.	0 - 20	Clay Loam	34.83	24.08	41.09	33.27	19.57	2.67	1.2861	5.80
	20 - 40	Clay	59.41	22.15	18.44	49.46	30.82	1.24	1.3086	6.25
	40 - 74	Clay	-	-	-	57.48	34.51	-	1.2163	7.36
	74 - 100	Clay	-	-	-	52.45	32.43	-	1.2554	7.72
9.	0 - 12	Loam	22.80	43.71	33.49	27.73	14.47	0.48	1.1467	5.89
	12 - 30	Clay	65.48	20.81	13.71	54.45	35.15	1.40	1.1950	6.83
	30 - 58	Clay	76.33	8.66	15.01	62.34	40.76	1.28	1.2070	7.43
	58 -	Clay	78.75	9.12	12.13	62.41	44.31	0.99	1.2043	7.66

° Observation and Sampling; Aug - Dec 1987
° D.A; apparent specific gravity

PROFILE-NO	52	LOCATION	CAMPAMENTO	SLOPE	2%
LAND-USE	MAIZE, TOMATO	SOIL	VERTISOL PELLUSTERT.		

Depth	TEXTURE	ORGANIC-MAT.	SOIL COLOR WET.	SOIL COLOR DRY	GRAVEL	MOTTLING, CONCRETION.	STRUCTURE		ROOT
0	Si.C		7.5yR 2/0		NO	NO	BLOCKY		FINE, SMAL
20	Li.C		7.5yR 3/0		〃	〃	〃		〃
45	Li.C		10yR 2/1		〃	〃	〃		〃
70	Li.C		10yR 3/2		〃	NO	MASSIVE		NO

PROFILE-NO	53	LOCATION		SLOPE	1.5%
LAND-USE		SOIL	VERTISOL PELLUST.		

Depth	TEXTURE	SOIL COLOR WET.	SOIL COLOR DRY	GRAVEL	MOTTLING, CONCRETION.	STRUCTURE	DRY, WET.	ROOT
	C	10yR 2/0		NO	NO	MIDDLE BLOCKY	DRY	FINE, SMALL
30	C	2.5yR 2/0		〃	〃	〃	〃	〃
56	C	10yR 4/1		〃	〃	〃	〃	〃
75	C	10yR 4/1		〃	〃	MASSIVE	HALF WET	—

Fig. A.3.2.5-3 Profile of Soils (1)

PROFILE-NO	38	LOCATION	QUINTANILLA	SLOPE	1%
LAND-USE	MAIZE	SOIL	VERTISOL CROMUST.		

Depth (cm)	TEXTURE	ORGANIC-MAT.	SOIL COLOR WET.	SOIL COLOR DRY	GRAVEL	MOTTLING, CONCRETION.	STRUCTURE	HARDNESS	DRY, WET.	ROOT
0–12	Li.C	3	7.5yR 3/2		SMALL GRAVEL	—	SMALL BLOCKY	21	DRY	SMALL FINE
12–30	HC	4	7.5yR 1.7/1		NO	—	SMALL MIDDLE BLOCKY	20	HALF DRY	FINE SMALL
30–58	HC	4	7.5yR 2/1		〃	—	〃	18	HALF WET	〃
58–	HC	2	7.5yR 1.7/1		〃	—	〃	24	〃	〃

PROFILE-NO	40	LOCATION	VIVERO	SLOPE	1%
LAND-USE	MAIZE	SOIL	VERTISOL CROMUST.		

Depth (cm)	TEXTURE	ORGANIC-MAT.	SOIL COLOR WET.	SOIL COLOR DRY	GRAVEL	MOTTLING, CONCRETION.	STRUCTURE	HARDNESS	DRY, WET.	ROOT
0–11	HC	4	10yR 3/2		FINE GRAVEL	NO	BLOCKY, SUB ANGULAR	25	HALF DRY	SMALL FINE
11–23	HC	5	10yR 2/3		NO	〃	BLOCKY ANGULAR	23	〃	SMALL FINE
23–38	HC	6	10yR 2/1		〃	〃	MASSIVE	17	HALF WET	SMALL FINE
38–53	HC	3	10yR 2/1 × 10yR 5/2		〃	〃	〃	20	〃	—

DURIPAN

Fig. A.3.2.5-3 Profile of Soils (2)

PROFILE-NO	41	LOCATION	LAGUNA	SLOPE	1%
LAND-USE	MAIZE		SOIL	VERTISOL CROMUST.	

Depth (cm)	TEXTURE	ORGANIC MAT.	SOIL COLOR WET.	SOIL COLOR DRY	GRAVEL	MOTTLING, CONCRETION.	STRUCTURE	HARDNESS	DRY, WET.	ROOT
0–15	CL	4	7.5yR 2/2		SMALL GRAVEL	NO	GRANULAR	14	HALF DRY	FINE, SMALL
15–26	HC	5	7.5yR 1/3		NO	〃	MASSIVE	24	〃	〃
26–43	HC	4	5yR 2/2		〃	〃	〃	20	〃	〃
43–63	HC	3	5yR 2/2		〃	〃	〃	27	HALF WET	〃
63–	HC	1	2.5yR 2/3		〃	〃	〃	26	〃	

PROFILE-NO	46	LOCATION	FINCA LOS MARIAS	SLOPE	1～2%
LAND-USE	PASTURE		SOIL	VERTISOL CROMUST.	

Depth (cm)	TEXTURE	ORGANIC MAT.	SOIL COLOR WET.	SOIL COLOR DRY	GRAVEL	MOTTLING, CONCRETION.	STRUCTURE	HARDNESS	DRY, WET.	ROOT
0–10	Li.C	1	10yR 3/2		NO	NO	GRANULAR, BLOCKY	33	DRY	FINE, SMALL
10–28	HC	5	7.5yR 1.7/1		〃	〃	SMALL MIDDLE, BLOCKY, SUB ANGULAR.	34	HALF WET	〃
28–54	HC	5	10yR 1.7/1		〃	〃	BLOCKY ANGULAR	32	〃	〃
54–65	HC	3	10yR 3/1 ×10yR 4/2		FINE, SMALL GRAVEL	Fe,Mn CONCRETION	ANGULAR	32	〃	

DURIPAN

Fig. A.3.2.5-3 Profile of Soils (3)

PROFILE-NO	47	LOCATION	LA BASA	SLOPE	0~ 1%
LAND-USE	MAIZE	SOIL	VERTISOL CROMUST.		

Depth (cm)	TEXTURE	ORGANIC-MAT.	SOIL COLOR WET.	SOIL COLOR DRY	GRAVEL	MOTTLING, CONCRETION.	STRUCTURE	HARDNESS	DRY, WET.	ROOT
0–13	Li.C	2	10yR 2/3		—	—	BLOCKY ANGULAR	19	DRY	MIDDLE FINE
13–41	HC	2.5	7.5yR 1.7/1		—	—	MASSIVE	25	HALF DRY	SMALL FINE
41–62	HC	3	10yR 1.7/1 ×10yR 4/2		—	—	〃	21	〃	MIDDLE FINE
62–77	HC	2	10yR 5/3 ×10yR 2/1		—	—	SMALL BLOCKY	22	〃	〃

DURIPAN

PROFILE-NO	48	LOCATION	LA ESTANCIA	SLOPE	0~ 1%
LAND-USE	MAIZE	SOIL	VERTISOL CROMUST.		

Depth (cm)	TEXTURE	ORGANIC-MAT.	SOIL COLOR WET.	SOIL COLOR DRY	GRAVEL	MOTTLING, CONCRETION.	STRUCTURE	HARDNESS	DRY, WET.	ROOT
0–11	Li.C	2	7.5yR 3/2		—	—	BLOCKY SUBANGULAR	30	DRY	SMALL FINE
11–26	HC	4	5yR 1.7/1		—	—	SMALL BLOCKY	33	HALF DRY	〃
26–47	HC	4	A1 1.5/0		—	—	MASSIVE	28	〃	〃
47–64	HC	3	7.5yR 1.7/1 ×10yR 6/2		—	—	〃	26	〃	—
64–73	HC	1	10yR 4/2 ×10yR 5/8		—	—	〃	28	〃	—

DURIPAN

Fig. A.3.2.5-3 Profile of Soils (4)

PROFILE-NO	49	LOCATION	SALANO	SLOPE	0~ 1%
LAND-USE	MAIZE TOMATO		SOIL	VERTISOL CROMUST.	

Depth (cm)	TEXTURE	ORGANIC-MAT.	SOIL COLOR WET.	SOIL COLOR DRY	GRAVEL	MOTTLING, CONCRETION.	STRUCTURE	HARDNESS	DRY, WET.	ROOT
0–14	HC	4	10yR 2/2			NO	SMALL BLOCKY	24	HALF DRY	SMALL FINE
14–30	HC	4	10yR 1.7/1			〃	BLOCKY, ANGULAR	22	〃	〃
30–54	HC	4	2.5y 2/1			〃	BLOCKY, ANGULAR	22	〃	FINE
54–65	HC	3	2.5y 2/1			$CaCo_3$ CONCRETION	MASSIVE	20	HALF WET	FINE
65–	HC	2	10yR 2/1			〃	〃	20	〃	

DURIPAN

PROFILE-NO	51	LOCATION	MOJARRITA	SLOPE	0~ 1%
LAND-USE	MAIZE KIONEY BEAN		SOIL	VERTISOL CROMUST.	

Depth (cm)	TEXTURE	ORGANIC-MAT.	SOIL COLOR WET.	SOIL COLOR DRY	GRAVEL	MOTTLING, CONCRETION.	STRUCTURE	HARDNESS	DRY, WET.	ROOT
0–11	HC	3	10yR 2/2		NO	NO	BLOCKY, ANGULAR	30	HALF DRY	FINE, SMALL
11–32	HC	4	7.5yR 2/1		〃	〃	SMALL BLOCKY	20	〃	〃
32–55	HC	3	7.5y 2/2		〃	〃	BLOCKY, SUB ANGULAR	22	HALF WET	〃
55–76	Li.C	2	5yR 2/2		〃	〃	SMALL BLOCKY GRANULAR	23	〃	〃
76–	Si.C	2	7.5yR 2/2		〃	CONCRETION	〃	24	〃	

DURIPAN

Fig. A.3.2.5-3 Profile of Soils (5)

PROFILE-NO	57	LOCATION		SLOPE	1%
LAND-USE		SOIL	VERTISOL CROMUST.		

Depth	TEXTURE	SOIL COLOR WET.	SOIL COLOR DRY	GRAVEL	MOTTLING, CONCRETION.	STRUCTURE	DRY. WET.	ROOT
0–15	Si.C	10yR 3/2		NO	NO	MIDDLE BLOCKY	DRY	FINE. MIDDLE
15–43	C	10yR 2/1		〃	〃	〃	〃	〃
43–68	C	5yR 2/2		〃	〃	〃	〃	〃
68–89	C	10yR 3/1		〃	〃	〃	〃	—
89–	C	10yR 5/2		〃	〃	MASSIVE	HALF WET	—

PROFILE-NO	58	LOCATION	AREN MORAJAM	SLOPE	1%
LAND-USE	MAIZE, KIDNEY BEAN, TABACCO	SOIL	VERTISOL CROMUST.		

Depth	TEXTURE	ORGANIC-MAT.	SOIL COLOR WET.	SOIL COLOR DRY	GRAVEL	MOTTLING, CONCRETION.	STRUCTURE	ROOT
0–25	Si.C		10yR 4/2		NO	NO	MIDDLE BLOCKY	SMALL FINE
25–52	C		10yR 2/1		〃	〃	〃	〃
52–74	C		10yR 3/1		〃	〃	〃	〃
74–87	C		10yR 5/2		〃	〃	MASSIVE	
87–		FRAJIDAN						

Fig. A.3.2.5-3 Profile of Soils (6)

PROFILE-NO	59	LOCATION		SLOPE	1.5%
LAND-USE		SOIL	VERTISOL CROMUST.		

Depth	TEXTURE	SOIL COLOR WET.	SOIL COLOR DRY	GRAVEL	MOTTLING, CONCRETION.	STRUCTURE	DRY. WET.	ROOT
	C	7.5yR 3/2		NO	NO	MIDDLE BLOCKY	DRY	SMALL FINE
16	C	7.5yR 4/2		〃	〃	〃	〃	〃
52	C	10yR 4/2		〃	〃	〃	〃	〃
71								

PROFILE-NO	61	LOCATION	SANJUAN	SLOPE	1%
LAND-USE	MAIZE	SOIL	VERTISOL CROMUST.		

Depth	TEXTURE	ORGANIC MAT.	SOIL COLOR WET.	SOIL COLOR DRY	GRAVEL	MOTTLING, CONCRETION.	STRUCTURE		ROOT
0	Si.C		10yR 4/2		NO	NO	BLOCKY		SMALL FINE
20	C		10yR 2/1		〃	〃	〃		〃
40	C		10yR 3/1		〃	〃	〃		〃
74	C		10yR 4/1		〃	〃	〃		

Fig. A.3.2.5-3 Profile of Soils (7)

PROFILE-NO	63	LOCATION		SLOPE	3%
LAND-USE		SOIL	VERTISOL CROMUST.		

Depth	TEXTURE	SOIL COLOR WET.	SOIL COLOR DRY	GRAVEL	MOTTLING, CONCRETION.	STRUCTURE	DRY, WET.	ROOT
	C	10yR 5/2		NO	NO	MIDDLE BLOCKY	DRY	SMALL FINE
13	C	10yR 4/1		〃	〃	〃	〃	〃
33	C	2.5y 2/0		〃	〃	〃	〃	〃
60	C	2.5y 4/2		〃	〃	MASSIVE	HALF WET	—

PROFILE-NO	65	LOCATION	SAN PEDRO	SLOPE	1%
LAND-USE	TABACCO, KIDNEY BEAN	SOIL	VERTISOL CROMUST.		

Depth	TEXTURE	ORGANIC MAT.	SOIL COLOR WET.	SOIL COLOR DRY	GRAVEL	MOTTLING, CONCRETION.	STRUCTURE		ROOT
0	Si.C		10yR 3/1		NO	NO	BLOCKY		FINE, SMALL
16	Si.C		10yR 2/2		〃	〃	〃		〃
38	C		10yR 4/2		〃	D.RED	MASSIVE		〃
69	C		10yR 5/1		〃	NO	〃		

Fig. A.3.2.5-3 Profile of Soils (8)

PROFILE-NO	39	LOCATION	LAS PALMAS	SLOPE	1~ 2%
LAND-USE	MAIZE		SOIL	INCEPTISOL, USTROP.	

DEPTH	TEXTU-RE	ORGA-NIC-MAT.	SOIL COLOR WET.	SOIL COLOR DRY	GRAVEL	MOTTLING, CONCRE-TION.	STRUCTURE	HARD-NESS	DRY, WET.	ROOT
0–12	CL	3	10yR 3/4		—	—	GRANULAR SMALL BLOCKY	19	DRY	FINE SMALL
12–26	CL	2	7.5yR 4/2		—		BLOCKY	26	HALF DRY	〃
26–50	CL	1	7.5yR 4/4 × 7.5yR 4/6		—	SMALL MOTTLING	〃	26	〃	FINE
50–66	CL	1	10yR 5/4 × 7.5yR 4/6 × 10yR 5/6		—	〃	BLOCKY, SUBANGULAR	24	HALF WET	
66–	CL	1	10yR 5/2		—		MASSIVE	23	〃	

PROFILE-NO	42	LOCATION	OVEJERO	SLOPE	1.5%
LAND-USE			SOIL	INCEPTISOL USTROP.	

DEPTH (cm)	TEXTU-RE	ORGA-NIC-MAT.	SOIL COLOR WET.	SOIL COLOR DRY	GRAVEL	MOTTLING, CONCRE-TION.	STRUCTURE	HARD-NESS	DRY, WET.	ROOT
0–10	S.L	2	10yR 4/4		SMALL GRAVEL	—	GRANULAR ,	16	HALF DRY	FINE SMALL
10–17	CL	3	5yR 3/3		SMALL FINE GRAVEL	—	BLOCKY	29	〃	〃
17–	GRAV									

Fig. A.3.2.5-3 Profile of Soils (9)

PROFILE-NO	IN-1	LOCATION	LA LAGUNA	SLOPE	1~2 %
LAND-USE	MAIZE	SOIL	INCEPTISOL. USTRO.		

cm	TEXTU-RE	ORGA-NIC-MAT.	SOIL COLOR		GRAVEL	MOTTLING. CONCRE-TION.	STRUCTURE	HARD-NESS	DRY. WET.	ROOT
			WET.	DRY						
0	CL	4	7.5yR 2/2		NO	NO	BLOCKY SUB ANGULAR	11	DRY	SMALL FINE
12	CL	4	7.5yR 2/2		〃	〃	〃	15	HALF DRY	〃
24	Li.C	3.5	7.5y 2/3		〃	〃	〃	26	〃	〃
44	Li.C	2	7.5yR 2/2		〃	〃	SMALL MIDDLE BLOCKY SUB ANGULAR	25	〃	〃
70	Li.C	2	7.5yR 2/2		〃	〃	〃	21	〃	〃

PROFILE-NO	IN-2	LOCATION	FINCA LA ENVIDO	SLOPE	0~ 1%
LAND-USE	MAIZE	SOIL	INCEPTISOL. USTROP.		

cm	TEXTU-RE	ORGA-NIC MAT.	SOIL COLOR		GRAVEL	MOTTLING. CONCRE-TION.	STRUCTURE	HARD-NESS	DRY. WET.	ROOT
			WET.	DRY						
0	SL	3	7.5yR 2/2		SMALL MIDDLE GRAVEL	–	BLOCKY	14	HALF WET	SMALL FINE
11	CL	4	7.5yR 2/2		SMAL. FINE GRAVEL	–	MASSIVE	19	〃	〃
25	CL	3	7.5y 2/3		〃	–	〃	21	〃	〃
39	CL	2	7.5yR 3/2		NO	–	〃	26	〃	NO
56	CL	1	7.5yR 3/3		〃	–	〃	28	〃	〃

Fig. A.3.2.5-3 Profile of Soils (10)

PROFILE-NO	55	LOCATION	EL OVEJERO	SLOPE	1.5%
LAND-USE	MAIZE, KIDNEY BEAN		SOIL	INCEPTISOL USTROP.	

	TEXTURE	ORGANIC-MAT.	SOIL COLOR		GRAVEL	MOTTLING, CONCRETION.	STRUCTURE	ROOT			
			WET.	DRY							
0	Si.C		10yR 3/2		NO	NO	MIDDLE BLOCKY	MIDDLE. FINE.			
16	Si.C		7.5yR 3/2		〃	〃	〃	〃			
42	C		10yR 4/3		〃	〃	BLOCKY	〃			
65	C		10yR 4/2		〃	RED.BLACK CONCRETION	〃	〃			
95	C		7.5yR 5/2		〃	〃	MASSIVE	〃			

PROFILE-NO	56	LOCATION		SLOPE	1%
LAND-USE			SOIL	INCEPTISOL IUSTRO.	

	TEXTURE	SOIL COLOR		GRAVEL	MOTTLING, CONCRETION.	STRUCTURE	DRY. WET.	ROOT		
		WET.	DRY							
cm	C.L	10yR 3/2		NO	NO	MIDDLE , SUBANGULAR	DRY	FINE		
20	Si.C	10yR 2/1		〃	〃	MIDDLE. BLOCKY.	〃	〃		
46	Si.C	10yR 4/2		〃	〃	〃	〃	〃		
72	C	2.5yR 3/2		〃	〃	MASSIVE	HALF WET	–		

Fig. A.3.2.5-3 Profile of Soils (11)

PROFILE-NO	60	LOCATION		SLOPE	2%
LAND-USE		SOIL	INCEPTISOL USTRO.		

Depth (cm)	TEXTURE	SOIL COLOR WET.	SOIL COLOR DRY	GRAVEL	MOTTLING, CONCRETION.	STRUCTURE	DRY, WET.	ROOT
0–18	C.L	10yR 3/2		NO	NO	MIDDLE. ANGULAR.	DRY	FINE SMALL
18–40	Si.C	10yR 3/1		〃	〃	MIDDLE. BLOCKY.	〃	〃
40–65	Si.C	5yR 3/2		〃	〃	〃	〃	〃
65–	C	5yR 3/4		〃	〃	MASSIVE	HALF WET	–

PROFILE-NO	62	LOCATION	AGUA CALIENTE	SLOPE	1.5%
LAND-USE	MAIZE PASTURE	SOIL	INCEPTISOL USTROP.		

Depth (cm)	TEXTURE	ORGANIC-MAT.	SOIL COLOR WET.	SOIL COLOR DRY	GRAVEL	MOTTLING, CONCRETION.	STRUCTURE	DRY, WET.	ROOT
0–18	Li.C		10yR 3/2		NO	NO	SUBANGULAR	DRY	FINE, SMALL
18–33	Li.CL		10yR 3/1		〃	〃	〃	〃	〃
33–53	Li.C		10yR 2/1		〃	〃	〃	HALF DRY	〃
53–72	C		10yR 4/1		〃	〃	ANGULAR	〃	
72–	CL		10yR 5/2		〃	D.R.B. CONCRETION	SUBANGULAR		

Fig. A.3.2.5-3 Profile of Soils (12)

PROFILE-NO	66	LOCATION		SLOPE	1.5%
LAND-USE		SOIL	INCEPTISOL USTRO.		

cm	TEXTU-RE	SOIL COLOR WET.	SOIL COLOR DRY	GRAVEL	MOTTLING, CONCRE-TION.	STRUCTURE	DRY, WET.	ROOT		
	C.L	10yR 2/1		NO	NO	MIDDLE, BLOCKY	DRY	FINE SMAL		
20	Si.C	10yR 3/2		〃	〃	〃	〃	〃		
50	C	10yR 4/2		〃	〃	〃	〃	—		

PROFILE-NO	43	LOCATION	BOELO NALA PADA	SLOPE	1%
LAND-USE		SOIL	INCEPTISOL DUROCH.		

cm	TEXTU-RE	ORGA-NIC-MAT.	SOIL COLOR WET.	SOIL COLOR DRY	GRAVEL	MOTTLING, CONCRE-TION.	STRUCTURE	HARD-NESS	DRY, WET.	ROOT
0	HC	3	10yR 4/2		NO	NO	BLOCKY ANGULAR	29	HALF DRY	FINE, SMALL
11	HC	4	10yR 2/1		SMALL FINE GRAVEL	〃	〃	28	〃	〃
22	SAND GRAVEL		2.5y 7/2		NO	〃	—	0	〃	
36			DURIPAN							

Fig. A.3.2.5-3 Profile of Soils (13)

PROFILE-NO	45	LOCATION	LAG.SAN PEDRO	SLOPE	1.5%
LAND-USE		SOIL	ALFISOL DURUST.		

Depth (cm)	TEXTURE	ORGANIC-MAT.	SOIL COLOR WET.	SOIL COLOR DRY	GRAVEL	MOTTLING, CONCRETION.	STRUCTURE	HARDNESS	DRY, WET.	ROOT
0–11	SCL	3	7.5yR 3/3		SMALL GRAVEL	NO	GRANULAR, SMALL-BLOCKY	18	DRY	SMALL FINE
11–17	CL	4	7.5yR 2/3		NO	〃	SUBANGULAR	25	HALF DRY	〃
17–31	L	2	2.5yR 4/8		〃	〃	〃	25	HALF WET	* FINE
31–55	CL	1	10yR 4/6		〃	2.5yR 6/3 MOTTLING	MASSIVE	30	〃	—
55–72	CL	1	10yR 4/4 × 2.5yR 3/6		〃	〃	〃	26	〃	—

PROFILE-NO	64	LOCATION		SLOP	4%
LAND-USE		SOIL	ALFISOL DURUSTALF.		

Depth (cm)	TEXTURE	SOIL COLOR WET.	SOIL COLOR DRY	GRAVEL	MOTTLING, CONCRETION.	STRUCTURE	DRY, WET.	ROOT
0–18	Si.C	7.5yR 3/2		NO	NO	MIDDLE BLOCKY	DRY	FINE, SMALL
18–55	C	5yR 3/3		SUB GRAVEL	〃	MASSIVE	HALF WET	〃
55–80		10yR 4/4		NO	〃	DURIPAN	〃	〃
80–		10yR 3/3		〃	〃		〃	〃

Fig. A.3.2.5-3 Profile of Soils (14)

PROFILE-NO	44	LOCATION	LAS PALMAS	SLOPE	1%
LAND-USE	MAIZE	SOIL	ALFISOL HAPLUSTALFS.		

Depth (cm)	TEXTURE	ORGANIC-MAT.	SOIL COLOR WET.	SOIL COLOR DRY	GRAVEL	MOTTLING, CONCRETION.	STRUCTURE	HARDNESS	DRY, WET.	ROOT
0–14	Si.C	2	10yR 5/2		NO	NO	SMALL BLOCKY .	19	DRY	FINE, SMALL
14–21	Si.CL	2	10yR 4/2		〃	〃	〃	27	〃	SMALL
21–37	S.GRAVEL	3	10yR 4/3		SUB-GRAVEL	〃	–	–	HALF DRY	SMALL
37–54	CL	3	10yR 3/1 × 10yR 4/3		NO	〃	–	26	〃	〃
54–	CL	1	10yR 5/3		MIDDLE, FINE GRAVEL	〃		30	〃	

PROFILE-NO	54	LOCATION	VACA EN CANAL	SLOPE	1.5%
LAND-USE		SOIL	ALFISOL HAPALUSTALFS.		

Depth (cm)	TEXTURE	ORGANIC-MAT.	SOIL COLOR WET.	SOIL COLOR DRY	GRAVEL	MOTTLING, CONCRETION.	STRUCTURE	HARDNESS	ROOT
0–27	Li.C		7.5yR 3/2		MIDDLE SMALL GRAVEL	NO	MIDDLE BLOCKY		SMALL FINE
27–56	C		5yR 3/3		〃	〃	MIDDLE BLOCKY		SMALL FINE
56–83	Li.C		5yR 4/4		〃	RED.BLACK MOTTLING	MASSIVE		FINE
83–	Li.C		5yR 3/		〃				

Fig. A.3.2.5-3 Profile of Soils (15)

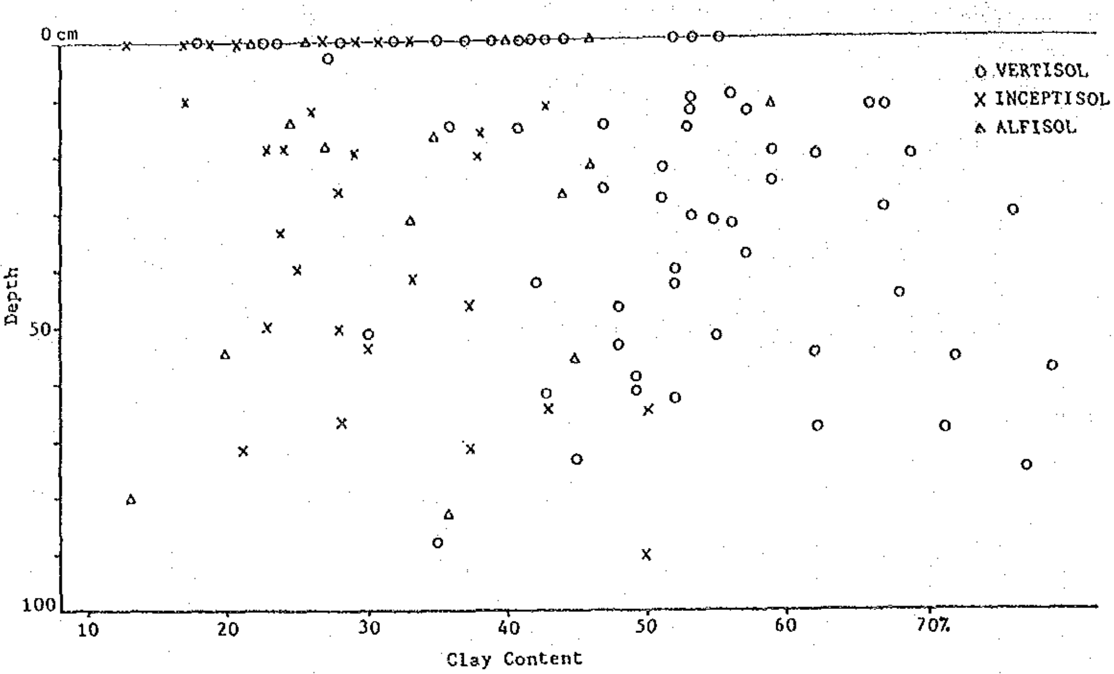


Fig. A.3.2.5-4 Clay Content of Each Soil Order

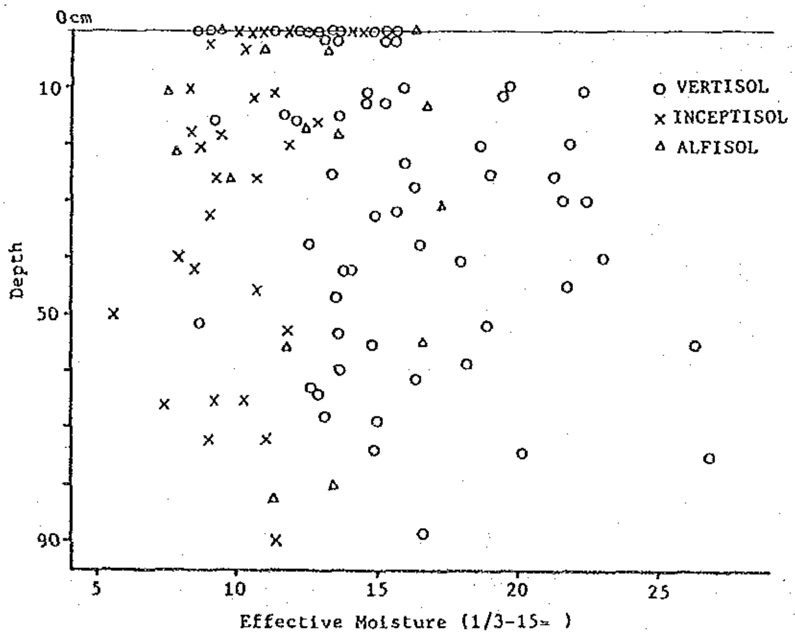


Fig. A.3.2.5-5 Available Moisture of Each Soil Order

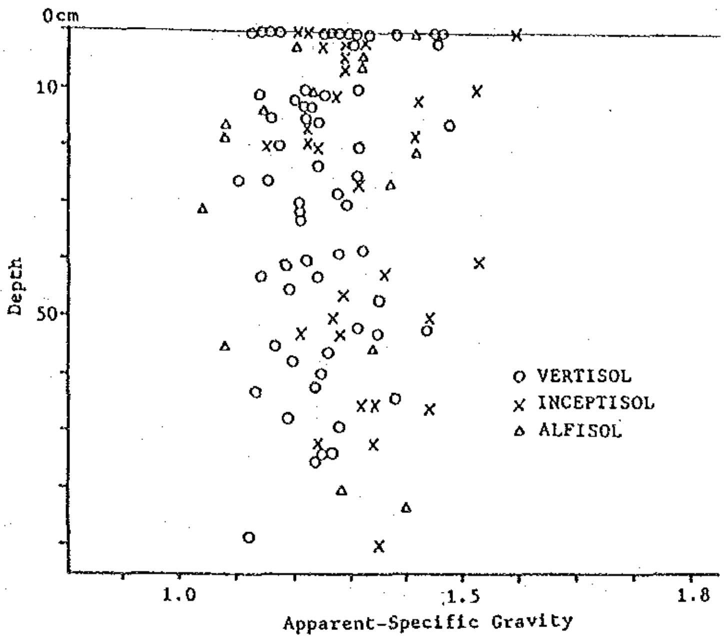


Fig. A.3.2.5-6 Bulk Density of Each Soil Order

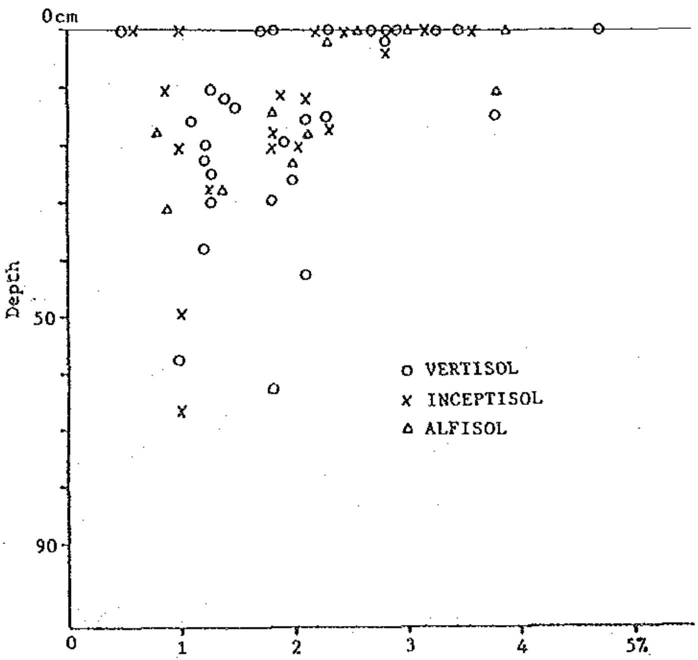


Fig. A.3.2.5-7 Humus Content of Each Soil Order

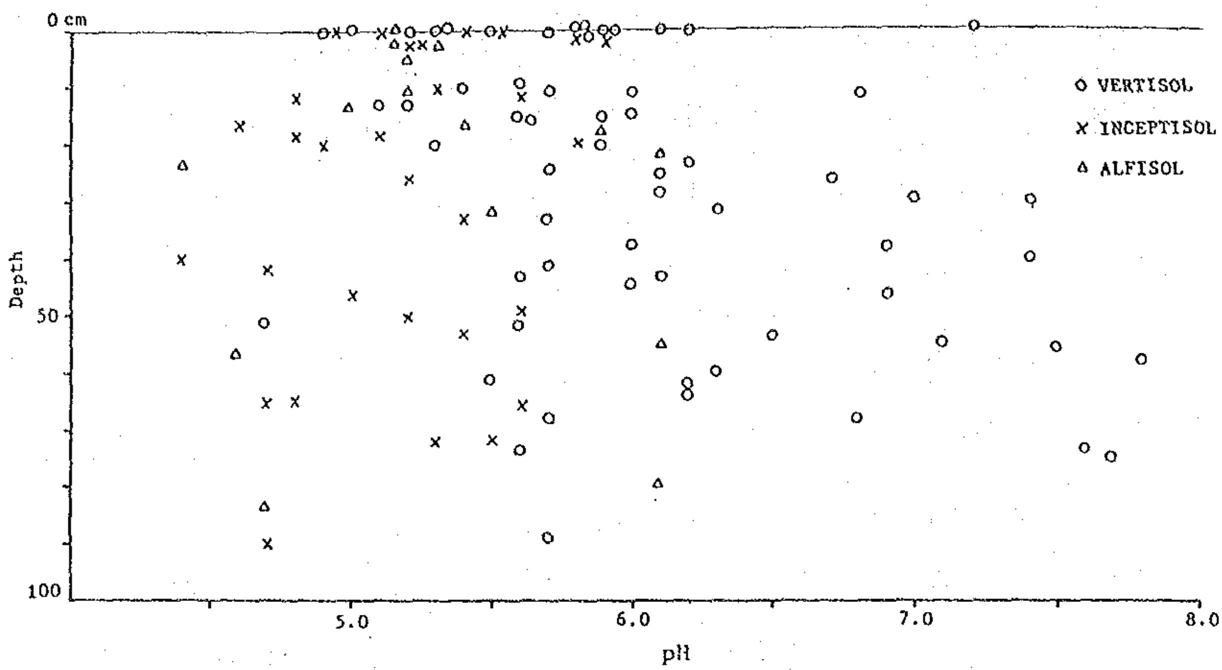


Fig. A.3.2.5-8 pH of Each Soil Order

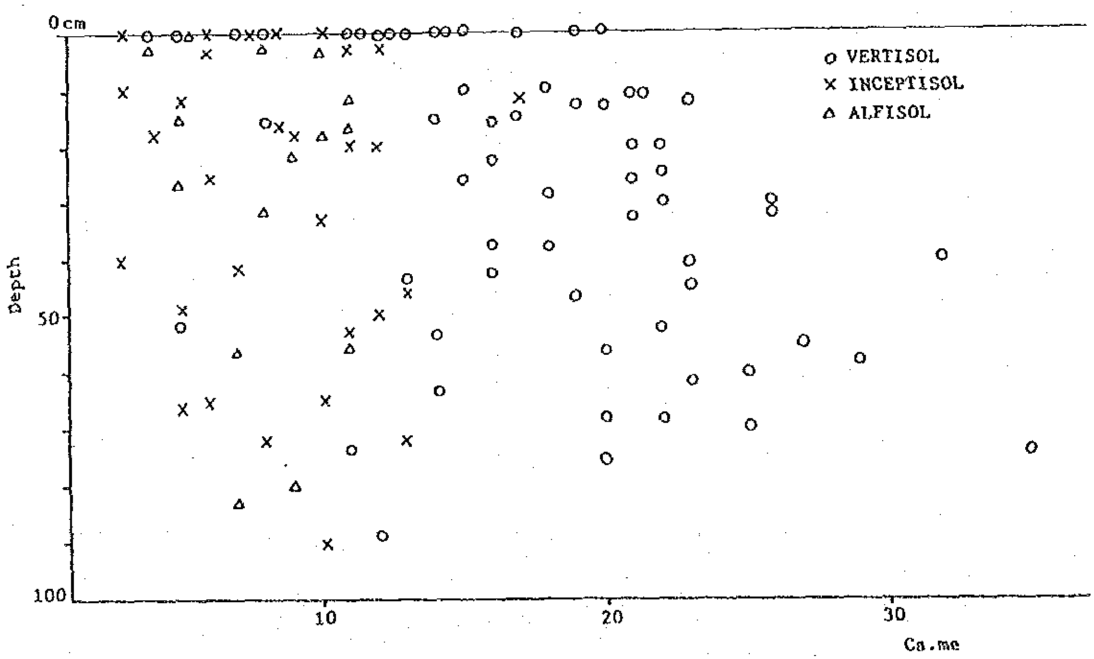


Fig. A.3.2.5-9 Exchangeable Calcium Content of Each Soil Order

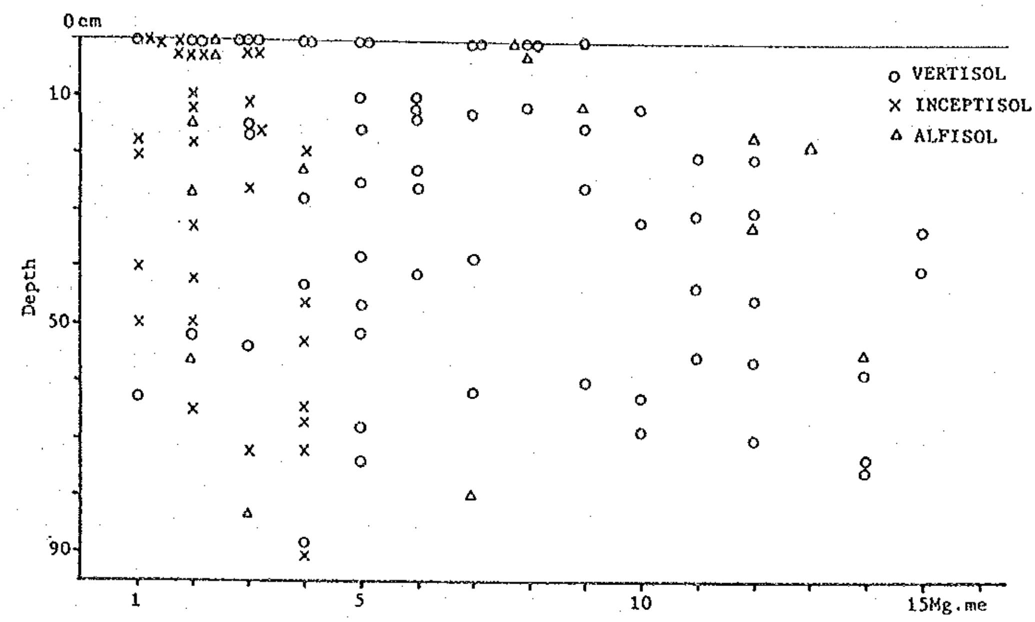


Fig. A.3.2.5-10 Exchangeable Magnesium Content of Each Soil Order

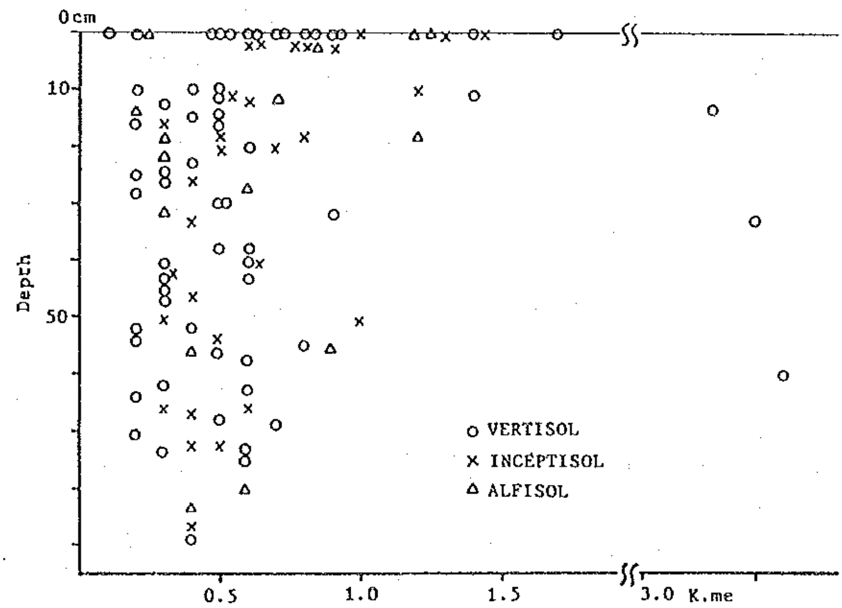


Fig. A.3.2.5-11 Exchangeable Potassium Content of Each Soil Order

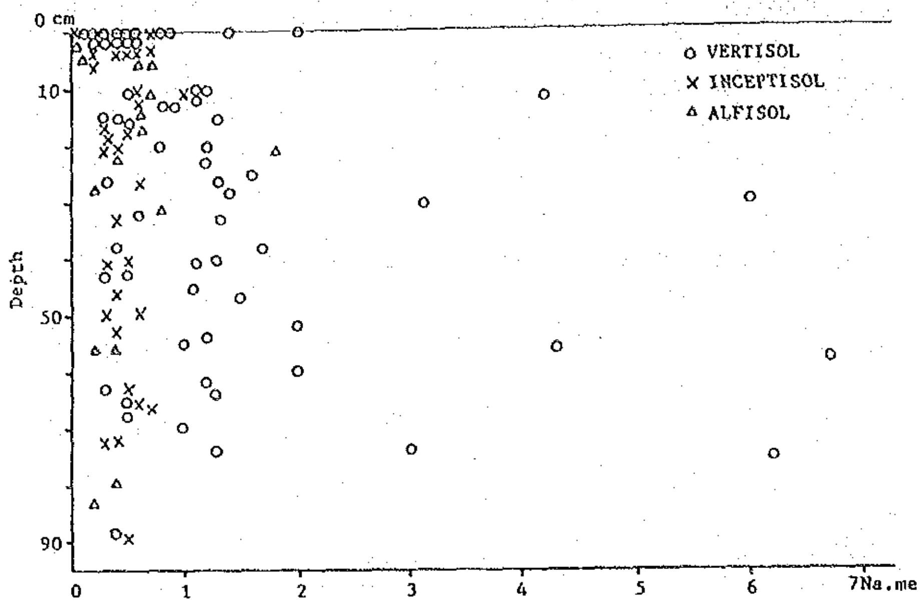


Fig. A.3.2.5-12 Exchangeable Sodium Content of Each Soil Order

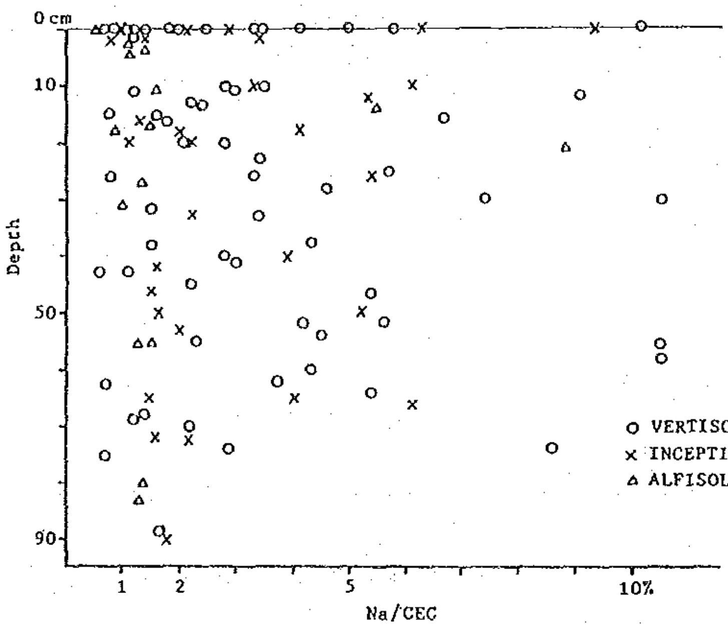


Fig. A.3.2.5-13 Exchangeable Sodium Percentage of Each Soil Order

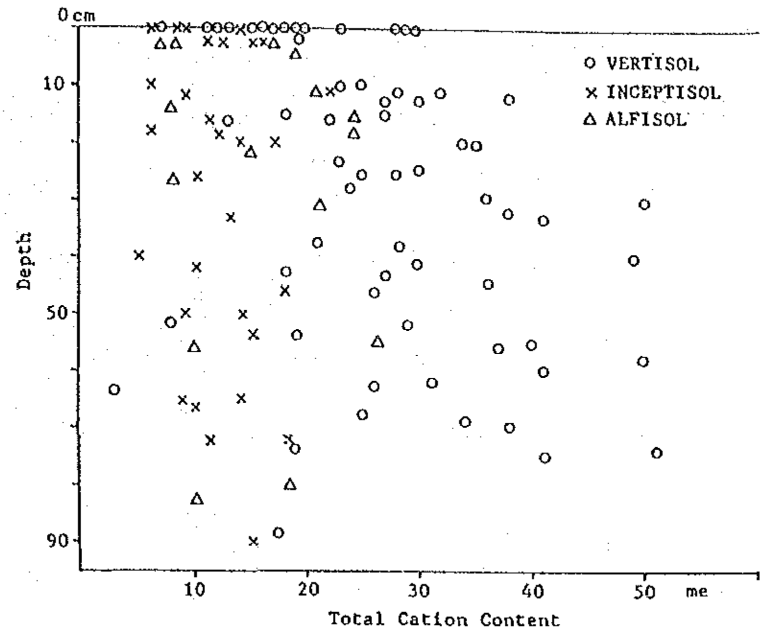


Fig. A.3.2.5-14 Total Cation Content of Each Soil Order

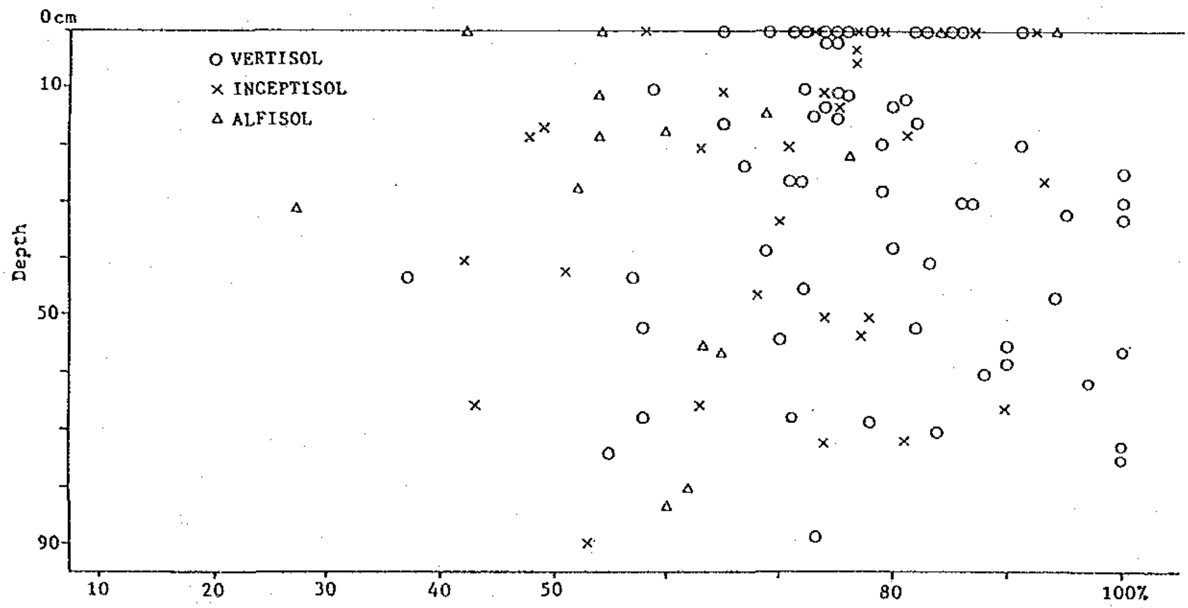


Fig. A.3.2.5-15 Base-saturation of Each Soil Order

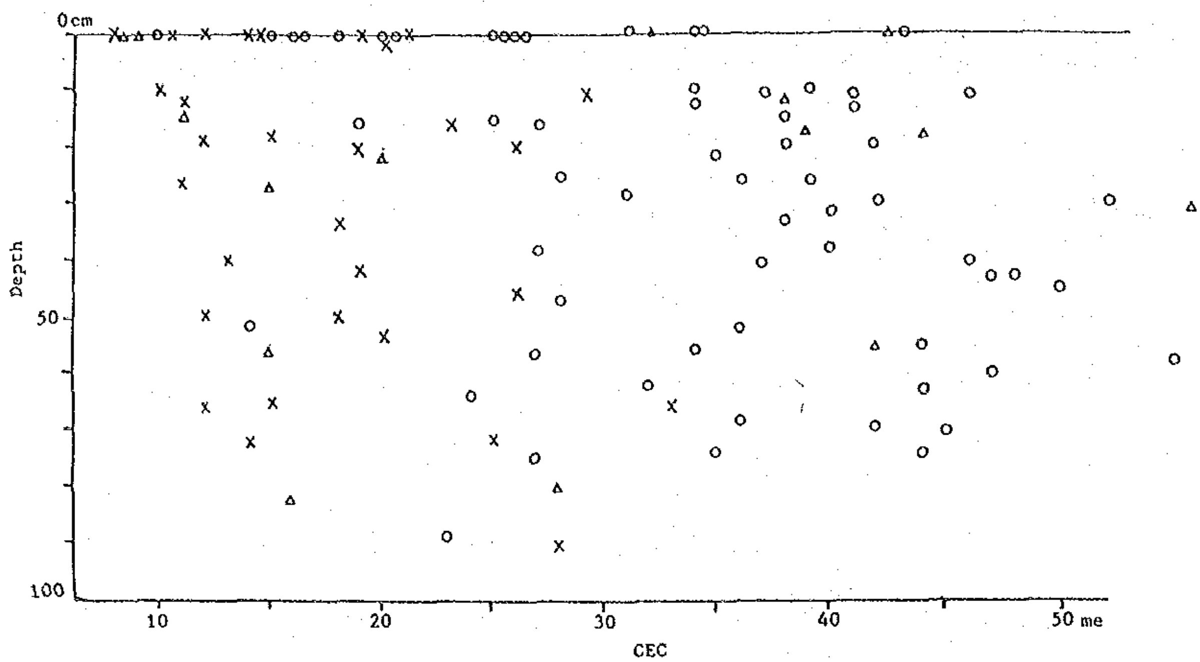


Fig. A.3.2.5-16 Cation-exchange Capacity of Each Soil Order

(2) Land Capability Classification

Soil Characteristics are evaluated according to the soil classification, and the class of the land about the possibility of agricultural use, such as cultivation, is determined in the land capability classification. Criteria are established for evaluation of the factors of the land, and capability class is determined synthesizing the results of the evaluation by the criteria.

In Guatemala the soil survey for land capability classification was initiated in 1976 by "Departamento de Cooperacion Tecnica para el Desarrollo de Nacion Unidas (DCTD)" in cooperation with INAFOR and IGN in imitation of the United States. Soil surveys were conducted for a few agricultural areas and land capability maps on the scale of 1 : 500,000 were completed and their acquisition is charged.

In Monjas area factors adopted in the US system : (1) climate, (2) natural characteristics of soil : slope, texture, drainage, depth of solum, organic matter content, erosion, soil parent material, dominant clay minerals and natural fertility, (3) limit of land use, (4) improvement and management of soil, (5) land suitability, etc. were examined and a land capability map on the scale of 1 : 20,000 was completed. Area of the land grouped into capability classes is shown in Table A.3.3.5-1 and their distribution in Fig. 3.3.5-1.

The almost whole area surveyed is grouped into Class I to III. The land of Class III covers widest area, followed by the land of Class II, and every other land covers area smaller than 5 percent of total area.

The land of Class I is very good for regular cultivation and of few or no limitations (slope lower than 2 percent), and here a high production is expected with rational soil management. This land can be managed without difficulty owing to deep solum, moderate texture, water holding, water permeability and good drainage. The land of this class is distributed along the national road from Monjas to El Ovejero and on the planeland along the rivers and cover small area corresponding to 4 percent of total area.

The land of Class II is good for regular cultivation and of a few limitations. Topography is flat to undulating, slope is not steeper than 3 percent, and evidence of slight erosion is observed. The land of this Class needs moderately intensive management. It is distributed in the southern part of the area and covers about 1,400 ha corresponding to about 20 percent of total area.

The land of class III has more limitations as compared with those of Class II. Topography is flat to undulating and slope is not steeper than 6 percent. It has medium fertility, and the increase in its fertility can be expected by the introduction of fertilization and management technology. It is distributed throughout the area and covers 4,700 ha corresponding to about 67 percent of total area.

The land of Class IV is sloped lands, liable to erosion and not suited for cultivation. It consists mainly of valley and hill growing shrubs and herbs, and has slope steeper than 6 percent. The soils are sandy to gravelly and solum is shallow due to severe erosion. It is distributed around the San Pedro lake, near mountain in the western part of the area and along the rivers, and covers small area corresponding to about 3 percent of total area.

The special land such as monadnock and volcanic cone where rock outcrops are present is divided as Class W in Guatemala. It is not suitable for agriculture. It is distributed in the east side of El Ovejero and in the western part of the area, occupying very small area.

The soils of the lands of Class III consist mainly of Vertisol and Alfisol, and those of Class II Inceptisol.

According to the above results, more than 90 percent of the Study area are occupied by the land suited for cultivation which is classified as land capability class I to III. Therefore, the growth of agricultural production is expected through completion of irrigation facilities in future.