the samples. Points (1) - (9) are the samples from test wells and (a) - (j) are from springs and shallow wells.

Most of the points are distributed in the areas with high (Ca+Mg) and (CO_3+HCO_3) concentration. The points of the test well samples have higher (CO_3+HCO_3) concentration in comparison with the points of samples taken from spring water. The difference is mainly attributable to water origin, that is, water from the lower aquifer has existed for a period longer than water from the upper aquifer, thereby consisting of different chemical properties due to geological activities.

7.2.4 Inventory of Wells and Springs

Surveys were conducted on the present condition of the shallow wells and springs located in the vicinity of the proposed boreholes. The following items were surveyed by area.

- Number of shallow wells and springs in the vicinity of the proposed boreholes
- Water right and utilization of the above shallow wells and springs
- Hydrogeological conditions such as aquifer characteristics, water level and water quality of the above shallow wells and springs

The results are summarized in Table 7.2.7. As shown in this table, there are many shallow wells and springs in the area, which are used for domestic and agricultural purposes. However, no impact is presumed on the utilization of shallow wells and springs from the construction of deep wells, due to the following hydrogeological condition.

(a) The water of the existing shallow wells and springs in the area is discharged from the shallow (upper) aquifers consisting of alluvial deposits (Qa), pumice sediments (Qp) and weathered upper zone of Tertiary volcanic rocks.

(b) The screen of the deep wells are installed in the lower aquifers which belong to the formation of Tertiary volcanic rocks (Qv). The lower aquifer is the unconfined and/or semi-confined aquifer.

(c) An unsaturated dry zone separates the upper and lower aquifers.

(d) A partial leakage of groundwater will occur from the upper aquifer to the lower aquifer through the unsaturated dry zone, but the artificial leakage can be mostly avoided by cementing.

Table 7.2.1 Existing Well Record

Groundwater Basin	Aquifer	Discharge (Q=ℓ/s) Average	Maximum	Minimum	Number of Wells	Remarks : Sc(m³/day/m) of Existing Data
Rio Platanos Basin ①	Tv : Tertiary Volcanics	4.44	9.46	0.76	4	
Rio Acuacapa Basin ②	Tv : Tertiary Volcanics	0.95	0.95	0.95	1	Sc(m³/day/m): 1.34
Rio Las Vacas & Lago de Amatitlan Basin ③	Qa : Alluvial Sediments	31.62	61.00	20.50	5	Sc(m³/day/m):233.05—483.84
	Qp : Pleistocene Volcanics	14.23	22.67	1.58	26	Sc(m³/day/m): 2.18—893.95
	Tv : Tertiary Volcanics	13.39	36.09	1.73	10	Sc(m³/day/m): 11.41-4980.00
	Qp/Tv:Ple./Tertiary Volcanics	14.27	28.01	5.80	12	Sc(m³/day/m): 4.24—357.89
	Br : Basement Rocks	3.41	3.41	3.41	1	Sc(m³/day/m): 3.00
Rio Pixcaya Basin ④	Tv : Tertiary Volcanics	7.52	15.14	0.32	7	
	Qp/Tv:Ple./Tertiary Volcanics	8.53	15.77	1.89	9	Sc(m³/day/m): 4.87— 78.52
Rio Guacalate Basin ⑤	Qa : Alluvial Sediments	14.24	31.55	6.62	9	Sc(m³/day/m): 55.78—544.89
	Qv : Holocene Volcanics	13.81	31.54	6.00	7	Sc(m³/day/m): 27.39— 88.09
	Tv : Tertiary Volcanics	7.89	15.14	1.70	6	Sc(m³/day/m): 2.57—817.34
	Qp/Tv:Ple./Tertiary Volcanics	9.84	17.70	3.78	4	Sc(m³/day/m): 54.11—490.32
Lago de Atitlan Basin ⑦	Qa : Alluvial Sediments	27.13	27.13	27.13	1	Sc(m³/day/m):200.34
Rio Samala Basin ⑨	Qp : Pleistocene Volcanics	20.86	68.81	3.15	32	Sc(m³/day/m): 25.18—726.91
Others	Tv : Tertiary Volcanics	7.89	17.41	1.89	7	
	Qv : Holocene Volcanics	9.27	9.27	9.27	1	
	Qp : Pleistocene Volcanics	14.51	14.51	14.51	1	
	Br : Basement Rocks	4.20	10.09	1.13	3	

Table 7.2.2 Result of Hydrogeological Survey by Municipality (1)
(Probability of New Water Sources Development)

Hydrogeological Conditions

GUATEMALA

No.	Munichipality	Water Sources (l/s)			Water Quality		Hydrogeological Conditions				Class
		N	P	R	PH	Ec (25°C)	Productivity of Existing Well (l/s)		Lithofacies	Geological Structure	
1	Santa Catarina Pinula	8.67	20.51	-	6.0	140	11.04	a	a(Qp)>b	a	A
2	San Jose Pinula	-	17.78	-	6.2	92	5.68	b	b>a(Qp)	c	B
3	San Jose del Golfo	0.31	5.46	-	6.2	320	5.93	b	b·c	b	B
4	Palencia										
5	Chinautla	0.05	1.72	-	7.0	410			a(Qp)>b	a	A
6	San Pedro Ayampuc	2.03	5.18	-	7.6	587	2.59	c	b	b·c	B
7	Mixco	5.79	30.75	-	7.0	180	7.69	b	b>a(Qp)	b·c	B
8	San Pedro Sacatepequez	4.24	3.40	-	6.3	149	3.40	c	b>a(Qp)	b·c	B
9	San Juan Sacatepequez	10.00	12.00	-	7.0	509	12.00	a	b>a(Qp)	b·c	A
10	San Raymundo	-	22.08	-	7.5	305	11.04	a	a(Qp)·b·c	a·b	A
11	Chuarrancho	0.01	-	11.11	6.5	550			c	c	C
12	Fraijanes										
13	Amatitlan										
14	Villa Nueva	4.98	61.51	-	7.0	308	12.30	a	a(Qp)>b	a	A
15	Villa Canales	45.00	128.70	-	7.0	265	64.35	a	a(Qa>Qp)	a	A
16	San Miguel Petapa										

Hydrogeological Conditions

SACATEPEQUEZ

No.	Munichipality	Water Sources (l/s)			Water Quality		Hydrogeological Conditions				Class
		N	P	R	PH	Ec (25°C)	Productivity of Existing Well (l/s)		Lithofacies	Geological Structure	
1	Antigua Guatemala										
2	Jocotenango	-	39.40	-	6.5	284	13.13	a	a(Qa)	a	A
3	Pastores										
4	Sumpango										
5	Sto. Domingo Xenacoj										
6	Santiago Sacatepequez										
7	San Bartolome M. Altas	0.40	13.00	-	7.0	143	6.50	b	b	b	B
8	San Lucas Sacatepequez										
9	Santa Lucia M. Altas	-	8.00	-	6.5	238	4.00	c	b>a(Qp)	c	C
10	Magdalena Milpas Altas	0.81	9.40	-	6.5	173	9.40	b	b>a(Qp)	b	B
11	Santa Maria de Jesus	1.50	6.00	-	7.0	328	6.00	b	a(Qa·Qv)	c	B
12	Ciudad Vieja	0.55	40.12	-	6.5	270	13.37	a	a(Qv)	a	A
13	San Miguel Duenas										
14	San Juan Alotenango										
15	San Antonio Aguas Cal.	8.45	1.70	-			1.70	c	b>a(Qa)	b·c	B
16	Santa Catarina Barahona	17.58	-	-					b>a(Qa)	b·c	B

1. Productivity of Existing Well
   a: More than 10 l/sec
   b: 5-10 l/sec
   c: Less than 5 l/sec

2. Lithofacies
   a: Upper Aquifer (Qa·Qp·Qv)
   b: Lower Aquifer (Tv)
   c: Basement Rocks

3. Geological Structure
   a: Basin Structure
   b: Fractured Zone
      Deep Weathered Zone
   c: Local Basin / Weathering

4. Class: Availability of Groundwater in Terms of Quantity/Quality
   A: High
   B: Medium
   C: Low

Table 7.2.2 Result of Hydrogeological Survey by Municipality (2)
(Probability of New Water Sources Development)

Hydrogeological Conditions

CHIMALTENANGO

No.	Munichipality	Water Sources (l/s)			Water Quality		Hydrogeological Conditions				Class
		N	P	R	PH	Ec (25°C)	Productivity of Existing Well (l/s)		Lithofacies	Geological Structure	
1	Chimaltenango										
2	San Jose Poaquil	0.93	-	2.15	6.3	91			b·c(Lim)	b	B
3	San Martin Jilotepeque	-	18.90	-	7.0	167	18.90	a	a(Qp)>b	a	A
4	San Juan Comalapa	34.00	5.80	-	6.3	140	5.80	b	a(Qp)·b	c	B
5	Santa Apolonia										
6	Tecpan Guatemala										
7	Patzun	16.90	-	-	6.5	511			a(Qp)·b	c	B
8	San Miguel Pochuta										
9	Patzicia	8.58	(10.00)	-	6.5	149			b>a(Qp)	b·c	B
10	Santa Cruz Balanya										
11	Acatenango										
12	San Pedro Yepocapa										
13	San Andres Itzapa										
14	Parramos										
15	Zaragoza	10.42	3.15	-	6.0	155	3.15	c	b>a(Qp)	b·c	B
16	El Tejar	-	30.70	-	6.5	223	10.23	a	a(Qp)·b	a	A

Hydrogeological Conditions

SOLOLA

No.	Munichipality	Water Sources (l/s)			Water Quality		Hydrogeological Conditions				Class
		N	P	R	PH	Ec (25°C)	Productivity of Existing Well (l/s)		Lithofacies	Geological Structure	
1	Solola	30.4	-	-	6.0	106			a(Qp)·b	b·c	B
2	San Jose Chacaya										
3	Santa Maria Visitacion										
4	Santa Lucia Utatlan	1.88	-	-	6.0	82			b>a(Qp)	b·c	B
5	Nahuala	3.47	-	-	-	-			b·a(Qp)	b·c	B
6	Sta.Catarina Ixtahuacan	7.29	-	-	6.5	125			b>a(Qp)	b	B
7	Santa Clara la Laguna										
8	Concepcion										
9	San Andres Semetabaj	0.95	-	-	-	-			b	c	C
10	Panajachel										
11	Sta. Catarina Palopo	3.12	-	-	7.0	238			b>a(Qa)	c	C
12	San Antonio Palopo	0.42	-	-	6.5	181			b>a(Qa)	c	C
13	San Lucas Toliman										
14	Santa Cruz la Laguna										
15	San Pablo la Laguna										
16	San Marcos la Laguna										
17	San Juan la Laguna										
18	San Pedro la Laguna										
19	Santiago Atitlan										

1. Productivity of Existing Well
 a:More than 10 l/sec
 b: 5-10 l/sec
 c:Less than 5 l/sec

2. Lithofacies
 a:Upper Aquifer(Qa·Qp·Qv)
 b:Lower Aquifer(Tv)
 c:Basement Rocks

3. Geological Structure
 a:Basin Structure
 b:Fractured Zone
 Deep Weathered Zone
 c:Local Basin / Weathering

4. Class:Availability of Groundwater in Terms of Quantity/Quality
 A:High
 B:Medium
 C:Low

Table 7.2.2 Result of Hydrogeological Survey by Municipality (3)
(Probability of New Water Sources Development)

Hydrogeological Conditions
TOTONICAPAN

No.	Munichipality	Water Sources (l/s)			Water Quality		Hydrogeological Conditions				Class
		N	P	R	PH	Ec (25°C)	Productivity of Existing Well (l/s)		Lithofacies	Geological Structure	
1	Totonicapan										
2	San Cristobal Totonic.										
3	San Francisco el Alto	6.7	-	-	6.5	68			b>a(Qa)	b	C
4	San Andres Xecul	2.3	-	-	6.0	104			b·a(Qp)	a	A
5	Momostenango	14.2	-	-	6.5	94			b	b	B
6	Santa Maria Chiquimula										
7	Santa Lucia la Reforma										
8	San Bartolo Aguas Cal.										

Hydrogeological Conditions
QUETZALTENANGO

No.	Munichipality	Water Sources (l/s)			Water Quality		Hydrogeological Conditions				Class
		N	P	R	PH	Ec (25°C)	Productivity of Existing Well (l/s)		Lithofacies	Geological Structure	
1	Quetzaltenango										
2	Salcaja										
3	Olintepeque	0.94	11.13	-	6.5	207	11.13	a	a(Qp)	a·b	A
4	San Carlos Sija	2.80	-	-	6.2	100			b>a(Qp)	b·c	B
5	Sibilia										
6	Cabrican										
7	Cajola	1.84	-	-	6.0	62			a(Qa)·b	a	A
8	San Miguel Siguila										
9	San Juan Ostuncalco										
10	San Mateo										
11	Cpcion. Chiquirichapa	11.57	-	-	6.0	220			b>a(Qp)	b·c	B
12	San M. Sacatepequez	3.15	-	-					a(Qv)·b	a	A
13	Almolonga	23.87	36.90	-	6.5	356	12.30	a	b>a(Qa·Qv)	a	A
14	Cantel										
15	Huitan	0.91	-	-	-	-			b>c	c	C
16	Zunil										
17	Colomba								a(Qv)	a	A
18	San Francisco la Union	0.59	-	-	6.5	127			a(Qp)b	b·c	B
19	El Palmar										
20	Coatepeque										
21	Genova	3.03	-	-	6.0	89			a(Qv)	c	B
22	Flores Costa Cuca	2.25	(9.27)	-	6.5	98	9.27	b	a(Qv)	c	B
23	La Esperanza										
24	Palestina	-	13.89	-	6.5	146	13.89	a	b	b	B

1. Productivity of Existing Well
   a:More than 10 l/sec
   b: 5-10 l/sec
   c:Less than 5 l/sec

2. Lithofacies
   a:Upper Aquifer(Qa·Qp·Qv)
   b:Lower Aquifer(Tv)
   c:Basement Rocks

3. Geological Structure
   a:Basin Structure
   b:Fractured Zone
   Deep Weathered Zone
   c:Local Basin / Weathering

4. Class:Availability of Groundwater in Terms of Quantity/Quality
   A:High
   B:Medium
   C:Low

Table 7.2.3 Result of Electrical Resistivity Sounding (carried out in Phase I)

No.	Municipality	Number & Depth of E/R Sounding		Main Aquifer Characteristics			Recommended Site & Depth for Test Well		Productivity of existing Well
		Number	Depth	Lithofacies	Aparent Resistivity	Thickness	Site	Depth	
		(points)	(GL-m)		(Ωm)	(m)		(m)	(l/sec)
Gu 2	San José Pinula	5	180~300	Upper rhyolitic welded tuff with thin lava flows (Tv)	32~312	120	About 300ms. South of E-2 (Fig 2.1.2)	150~(200)	5.68
Gu 8	San Pedro Sacatépequez	3	360~380	Pumice sediments (Qp) and pyroclastic rocks with lava flows and waterlain sediments (Tv)	7~140	70~90	Between E-2 and E-3 (Fig 2.1.3)	200	3.40
				Andesitic/Basaltic fractured lava flow (Tv)	532~600	250±			—
Sa11	Santa María de Jesus	8	180~340	Andesitic/Basaltic fractured lava flow with pyroclastic rocks (Qv)	700~1,460	200±	E-3 point (Fig 2.1.4)	150~(200)	6.00
Ch 3	San Martin Jilotepeque	4	260~320	Tuffaceous sandstone/ Sandstone with tuffbreccia and tuff (Miocene)	26~504	70~90	About 100ms. S.W.of E-2 (Fig 2.1.5)	200	18.90
Ch 4	San Juan Comalapa	5	260~320	Dacitic/Andesitic tuffbreccia with lava flows and tuffs(Tv)	116~675	300±	About 140ms. South of E-2 (Fig 2.1.6)	200	5.80
So 1	Sololá	8	260~360	Dacitic/Andesitic/Basaltic fractured lava flow with pyroclastic rocks (Tv)	405~1,125	90~200	E-4 point (Fig 2.1.7)	200	—
So 4	Santa Lucia Utatlan	5	260~360	Dacitic/Andesitic lava flow with pyroclastic rocks (Tv)	410~720	260	Between E-1 and E-3 (Fig 2.1.8)	200	—
To 5	Momostenango	2	300~340	Andesitic/Basaltic fractured lava flow with pyroclastic rocks (Tv)	568~1,530	200±	About 500ms. N.E.of E-1 (Fig 2.1.9)	(200)~250	—
Qu18	San Francisco la Union	6	340~400	Andesitic/Basaltic fractured lava flow with pyroclastic rocks (Tv)	448~1,600	250±	About 350ms. East of E-2 (Fig 2.1.10)	(200)~250	—

Table 7.2.3 Result of Electrical Resistivity Sounding (carried out in Phase II)

No.	Municipality	Number & Depth of E/R Sounding		Main Aquifer Characteristics		Recommended Drilling Depth
		Number	Depth	Lithofacies	Aparent Resistivity	
		(points)	(GL-m)		(Ωm)	(m)
Gu 3	San Jose del Golfo	3	200~240	Pyroclastic rocks with lava flow (Tv)	56~416	150
So 5	Nahuala	3	140~180	Pyroclastic rocks with lava flow (Tv)	23~700	200
Qu 4	San Carlos Sija	3	300	Andesitic lava flow (Tv)	53~700	200
Qu 7	Cajola	3	320~340	Pumice sediments(Qp) and Andesitic lava flow (Tv)	840~1,500	200
Qu21	Génova	3	200~300	Pyroclastic(Volcanicmud) flow (Qv)	20~140	180
Qu22	Flores Costa Cuca	4	140~300	Pyroclastic(Volcanicmud) flow (Qv)	63~344	180
To 5	Momostenango	1	160	Andesitic lava flows with Pyroclastics	68~1,080	150

Table 7.2.4 Results of Test Well Drilling Works

Nobre de Pozo (Well Name)	San Jose Pinula	San Pedoro Sacatepequez	Santa Maria de Jesus	San Martin Jilotepeque	San Juan Comalapa	Solola	Santa Lucia Utatlan	Momostenaogo	San Fransisco la Union	Genova
1. Profundidad (Well depth) (m)	180	250	212	196	215	170	199	183	190	152
2. Latitud(North Latitude) Longitud(West Longitude)	14° 32′ 29″ 90° 25′ 10″	14° 41″ 05″ 90° 39′ 08″	14°29′10″ 90°41′45″	14° 47′ 05″ 90° 47′ 10″	14° 44′ 44″ 90° 53′ 14″	14° 47′ 35″ 91° 10′ 58″	14° 46′ 40″ 91° 16′ 40″	15° 02′ 49″ 91° 25′ 20″	14° 55′ 15″ 91° 32′ 37″	14° 37′ 17″ 91° 49′ 58″
3. Elevacion (Elevation) (m)	1728	2090	1880	1760	2090	2370	2408	2216	2714	360
4. Diametro del ademe (Diameter of Casing Pipes)	8″	8″	8″	8″	8″	8″	8″	8″	8″	8″
5. Perforado por (Drilled by)	JICA Study Team									
6. Fecha de inic.y final de la perfor (Biginning and Completion Date of Drilling)	Aug.24 ~Sep.30 1994	Aug.22 ~ Sep.22 1994	Sep. 3 ~Oct.11 1994	Sep. 1 ~Oct. 3 1994	Oct.16 ~Nov.20 1994	Oct.13 ~Nov. 9 1994	Oct.16 ~Nov.12 1994	Nov.18 ~Dec. 4 1994	Nov.14 ~Dec.16 1994	Nov.15 ~Dec. 4 1994
7. Tiempo que tomo (Spent days)	38	38	39	33	36	28	28	17	33	20
8. Posicion de rejilla(Screen Position) 1) Tipo Puente(Bridge Type) (Nivel de tierra : -m) (Ground Level : -m)	33.5~ 39.6 42.7~ 54.9 91.4~ 97.5 103.6~109.7 140.2~146.3	182.0~189.0 213.4~219.5 231.6~237.7	140.2~146.3 182.9~189.0 201.2~207.3	115.8~121.9 134.1~146.3 164.6~182.9	109.7~121.9 128.0~140.2 152.4~158.5 176.8~189.0	152.4~170.2	115.8~121.9 152.4~164.6 182.9~190.2	85.3~103.6 126.5~132.6 134.1~140.2 146.3~158.5	79.2~103.6 115.8~152.4	103.6~121.9 134.1~146.3
2) Tipo Johnson(Johnson Type)	21.3~ 27.4 79.3~ 85.4 115.8~121.9	164.6~182.9	152.4~164.6	88.4~ 91.5 103.6~109.7 146.3~152.4	164.6~170.7		170.7~182.9	164.6~170.7 176.8~179.8	103.61~15.82 152.41~76.78 182.91~85.9	91.4~103.6 146.4~149.4
3) Ranurado(Slot Type)	97.5~103.6 125.0~131.1 134.1~140.2 158.5~164.6	109.7~115.8 121.9~128.0 195.1~201.2 237.7~244.7	82.3~ 94.5 137.2~142.6 146.3~152.4 164.6~167.6 170.7~182.9 189.0~201.1	97.5~103.6 121.9~134.1 152.4~164.6	30.4~36.6 73.1~85.3 91.4~103.6 146.3~152.4 189.0~201.2 210.3~213.4	109.7~131.1 140.2~143.3 149.4~152.4	146.3~152.4			85.4~91.5
9. Longitud de rejilla(Screen Length) 1) Tipo Puente(Bridge Type) (m) 2) Tipo Johnson(Johnson Type)(m) 3) Ranurado(Slot Type) (m)	36.6 18.3 21.3	18.3 18.3 18.3	18.3 12.2 48.6	36.6 15.2 30.5	42.7 6.1 51.9	17.8 0 27.5	25.6 12.2 6.1	42.7 9.1 0	61.0 39.6 0	30.5 15.1 6.1
10. Componente quimico de Agua (Water quality) ① pH ② Temperratura de agua : ℃) (Temperrature of Water : ℃) ③ Conductividad (μs/cm) (Conductivity : μs/cm)	7.0 20.0 263.0	6.8 23.4 198.3	7.0 19.8 298.0	7.2 20.3 563.0	6.7 19.8 92.0	7.2 21.2 191.2	7.0 16.6 154.7	7.0 20.0 53.0	- - -	8.0 21.5 182.0

Tabie 7.2.5 Results of Pumping Test

Nobre de Pozo (Well Name)	San Jose Pinula	S.P.Saca-tepequez	S.Maria de Jesus	S.M.Jilo-tepeque	San Joan Comalapa	Solola	Santa Lu. Utatlan	Momoste-naogo	S.F.la Union	Genova
1. Profundidad (Well depth) (m)	180	250	212	196	215	170	199	183	190	152
2. Longitud de rejilla (Total Screen Length) (m)	79.27	60.97	81.68	82.32	100.6	48.78	43.91	59.9	100.5	51.82
3. Formation del Aquifero principal (Formation of Main Aquifer)	Tv	Tv	Qv	Tv	Tv	Tv	Tv	Tv	Tv	Qv
4. Fecha de Bombeo (Pumping Test Date)	Oct. 5 1994	Oct. 7 1994	Nov. 2 1994	Oct.28 1994	Nov.30 1994	Nov.19 1994	Nov.25 1994	Dec. 8 1994	—	Dec.11 1994
5. Nivel estatico de Agua (Static Water Level) (G.L.-m)	6.84	43.71	163.16	80.35	28.94	71.63	131.54	53.50	—	29.85
6. Caudal (GPM)	495	320	282	401	250	390	162	200		201
(Pumping Rate) (m^3/day)	2698	1744	1537	2185	1363	2125	883	1090		1096
7. Descenso (Drawdown) (m)	11.9	67.29	3.53	9.63	156.4	54.86	9.13	70.3	—	88.36
8. Capacidad Especifica : C.F. (Specific Capacity : Sc)(m^3/day/m)	227	26	435	227	8.7	39.7	96.7	15.5	—	12.4
9. Transmisibilidad (Transmissivity) (m^3/day) a. Theis	299	33	150	510	5.51	25.22	228	15.43	—	10.74
b. Jacob	180	37	612	333	5.31	25.09	359	7.12	—	9.55
c. Recuperacion (Recovery)	190	68	937	834	7.34	35.35	538	8.67	—	15.42
Promedio(Average)	223	46	567	559	6.05	28.55	375	10.41	—	11.99

Table 7.2.6 Results of Ion Component Analysis

Location	Ca	Mg	Na	K	Cl	SO4	Alcalinity pH 8.3	pH 4
TEST DRILLING WELLS								
1 S.P.SACATEPEQUEZ	16.29	6.94	21.8	8.67	8.37	0	0	97.7
2 S.J.PINULA	52.12	24.5	11.36	12.12	18.83	0	0	146.55
3 S.M. DE JESUS	44.79	20.33	17.11	6.18	9.76	0	0	140.91
4 S.M.JILOTEPEQUE	22.8	9.82	17.1	7.92	8.37	0	0	112.73
5 S.J.COMALAPA	14.66	6.35	9.16	3.11	7.67	0	0	74.09
6 SOLOLA	16.29	7.93	16.23	7.21	8.37	0	0	111.13
7 S.L.UTITLAN	20.36	8.43	12.32	4.16	6.28	0	0	76.15
8 MOMOSTENANGO	13.03	2.28	7.92	5.66	4.88	0	0	53.51
9 S.F. LA UNION								
10 GENOVA	19.55	12.6	22.36	16.11	13.25	0	12.35	158.47
OTHERS								
S.J.PINULA								
SPRING NO.1	13.03	5.75	5.13	0.86	8.37	0	0	48.85
SPRING NO.2	42.35	20.44	15.1	11.03	36.26	0	0	84.55
SPRING NO.3	19.55	8.63	12	12.3	22.32	0	0	46.97
SPRING NO.4	16.29	8.43	11.1	1.35	11.16	0	0	56.36
DUG WELL	50.49	31.81	18.7	3.9	65.55	0	0	92.06
COMALAPA								
SPRING NO.1	17.92	8.53	6.46	4.58	9.07	0	0	61.74
SPRING NO.2	13.85	5.06	13.7	4.92	10.46	0	0	74.09
SOLOLA								
EXISTING TANK	30.95	1.88	6.74	3.11	9.76	0	0	59.68
WATER FALL	30.95	11.11	16.6	5.11	9.76	36.92	0	92.61
S.P. SACATEPEQUEZ								
SPRING	21.28	13.69	5.97	2.31	22.32	0	0	100.84

Table 7.2.7 Existing Shallow wells and Springs

Municipality	Shallow wells						Springs			
	Number	W/Level (GL-m)	Well depth (m)	W/Quality	W/Right	Water Use	Number	W/Quality	W/Right	Water Use
S. J. Pinula	3	3-25	-	Poor	Private	Agriculture-1 Bathing and washig-2	8	Poor	Public	Bathing & washing
S. P. Sacatepéquez	10	1-10	2.6-9	Good	Private	Agriculture-2 Domestic use-8	10	Good-7 Poor-3	Public-5 Private-5	W/S for city-5 Agriculture-3 Domestic use-2
S. M. de Jesús	0	-	-	-	-	-	0 *-1	-	-	-
S. M. Jilotepeque	3	3-20	6-22	Good-2 Poor-1	Private	Domestic use-2 Stand by-1	5	Good	Public-4 Private-1	Domestic use
S. J. Comalapa	26	3.6-10	4-12	Quite-good	Private	Agriculture-2 Domestic use-24	1	Quite-good	Public & private	Washing Drinking & domestic use
Sololá	3 *-3	0.6-26	1.6-28	Quite-good	Private	Aguriculture-1 Drinking & domestic use-1 Washing, bathing & cleaning-1	3	Quite-good	Public-3	Drinking & domestic use Agriculture
S. L. Utatlán	4	8.5-14.5	10-17	Good-1 *-4 Quite-good-3	Private	Drinking & domestic use-4	2	Good-2	Public-1 Private-1	Drinking Washing & domestic use
Momostenango	15<	3-16	6.5-18	Good & quite-good	Private	Drinking & domestic use	1	Quite-good	Public	Drinking
S. F. la Unión	8	5-18	9-22	Quite-good	Private-8 Public-1	Drinking & domestic use Only drinking	2	Quite-good	Public	Drinking, washing & domestic use
Génova	200	5-10	7-15	Quite-good	Private	Drinking & domestic use	0	-	-	-

*-1: One spring existed, but it has already dried.
*-2: People drink raw water - good, boiled water - quite-good and do not use for drinking - poor
*-3: One was used until 1993, but it has alredy dried.
*-4: However, 2 % of population have stomach problems every month, and ca. 25 children/month have diarrhea.

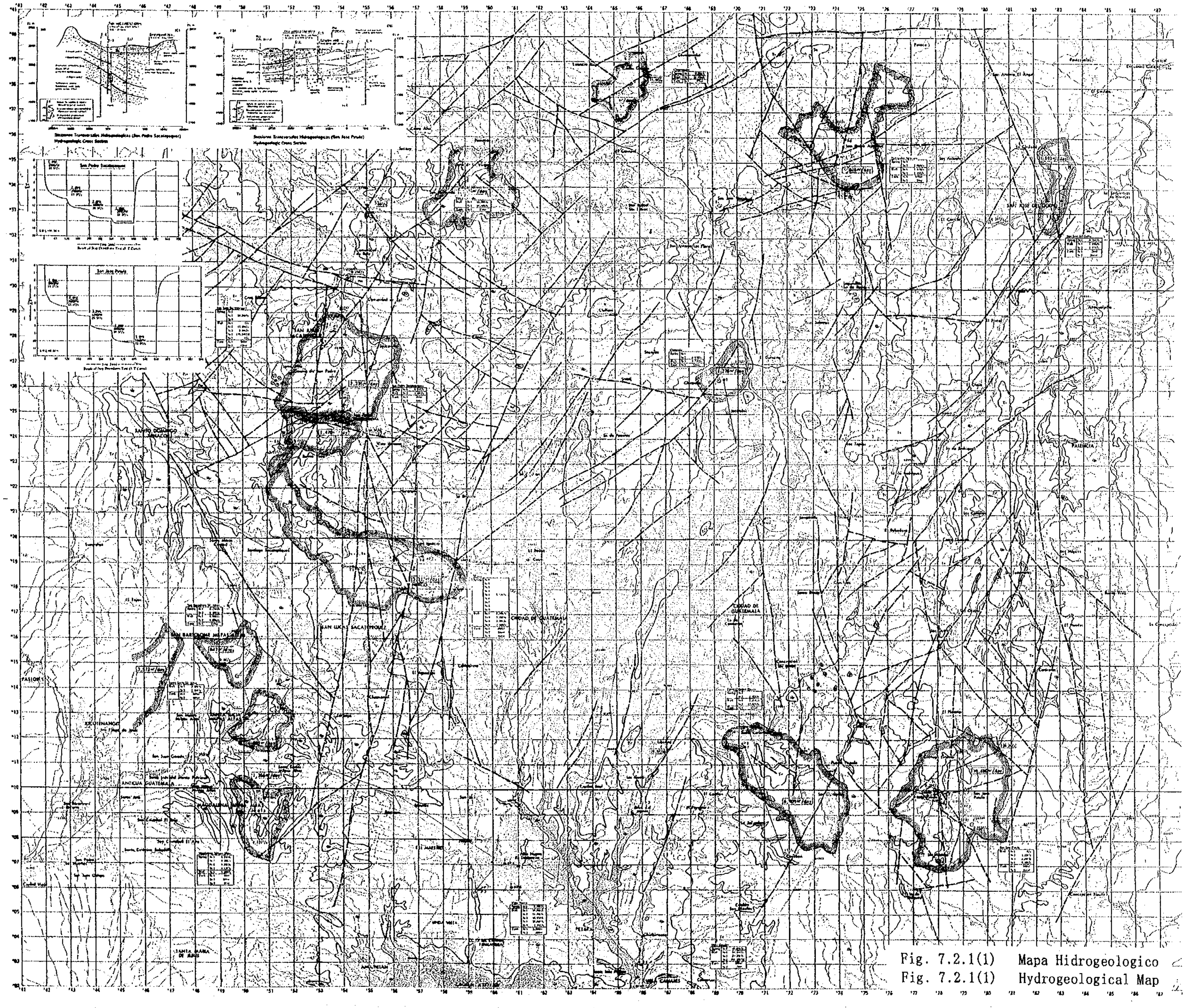


Fig. 7.2.1(1) Mapa Hidrogeologico
Fig. 7.2.1(1) Hydrogeological Map

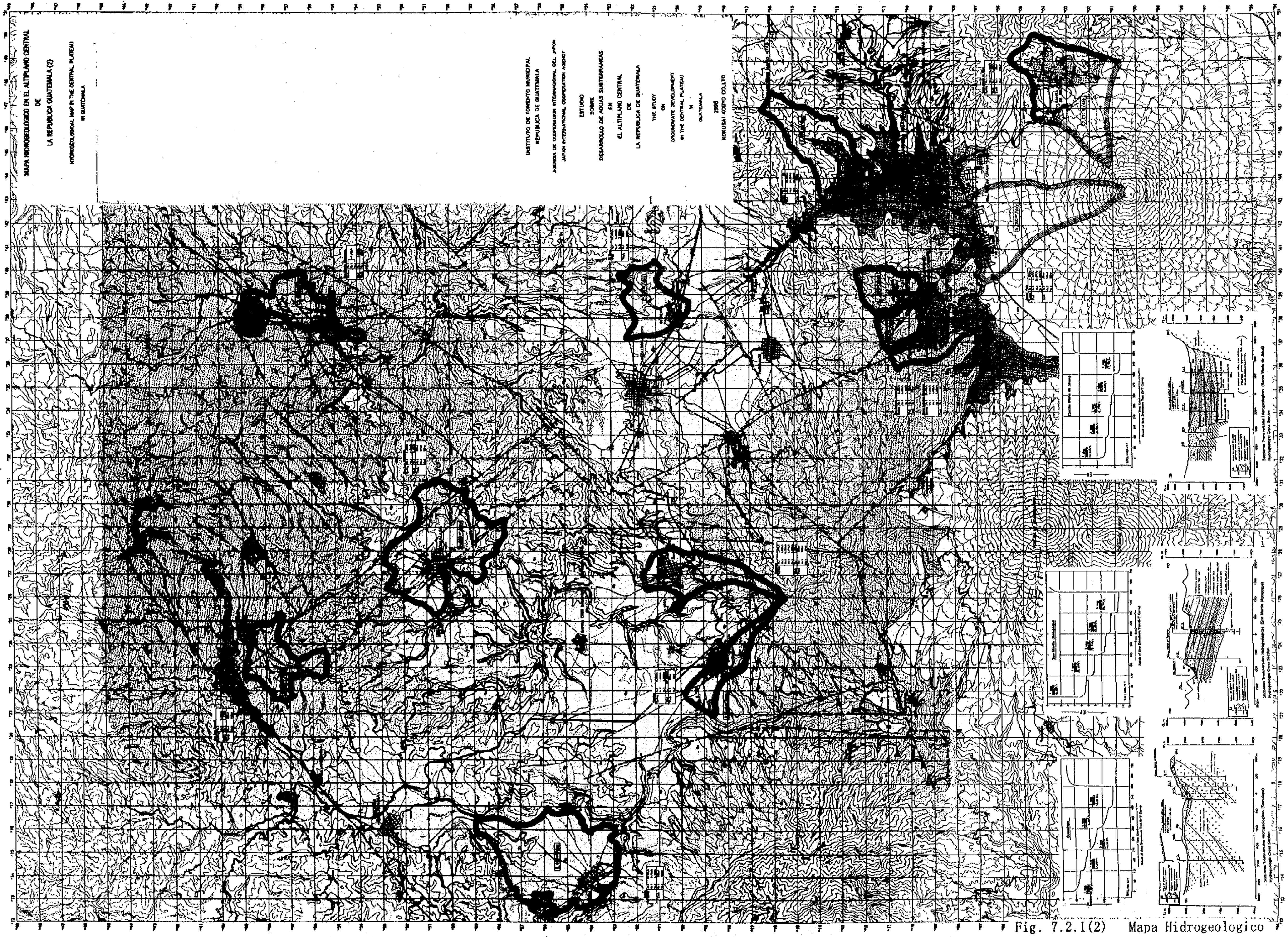


Fig. 7.2.1(2) Mapa Hidrogeologico

Fig. 7.2.1(2) Hydrogeological Map

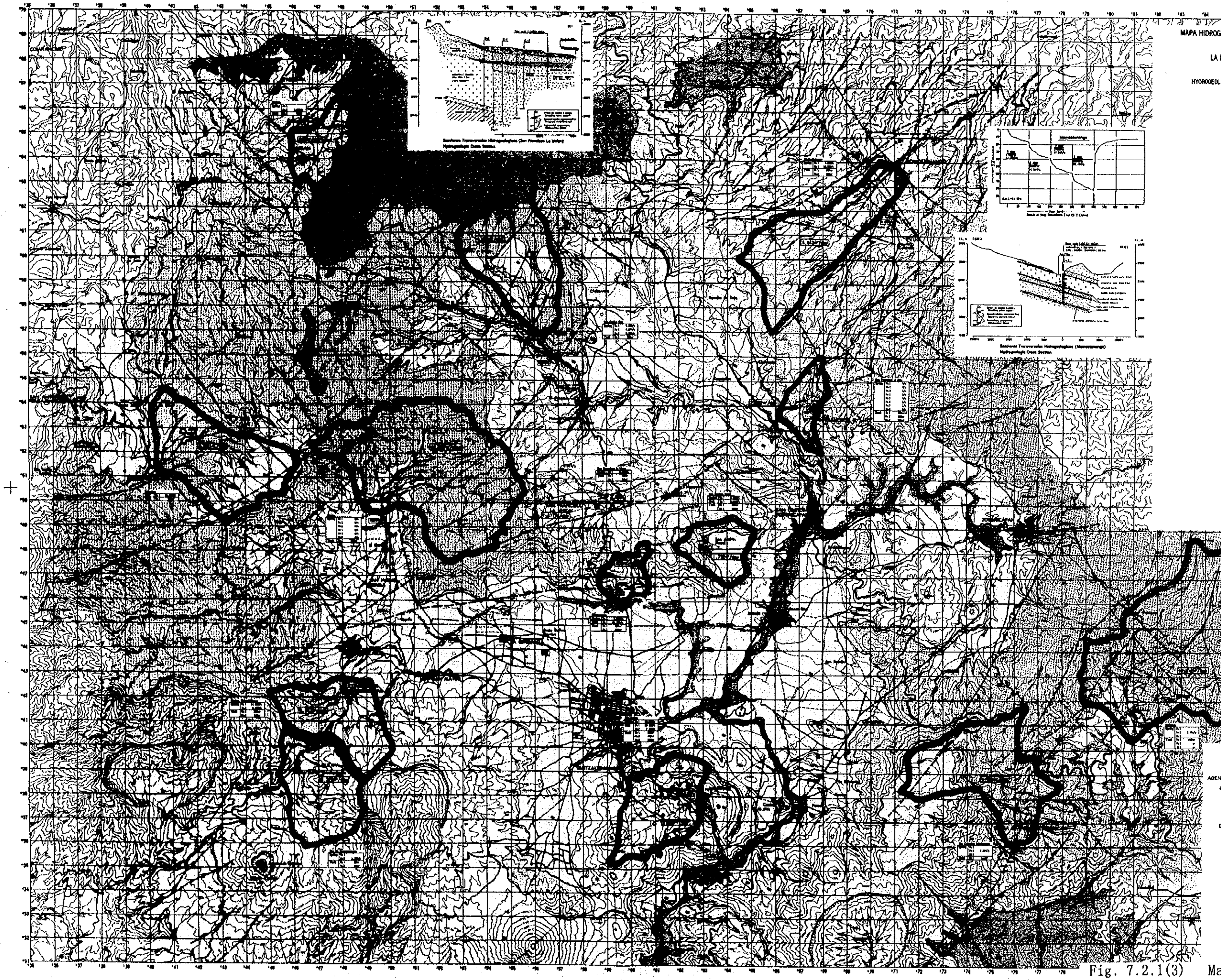


Fig. 7.2.1(3) Mapa Hidrogeologico

Fig. 7.2.1(3) Hydrogeological Map

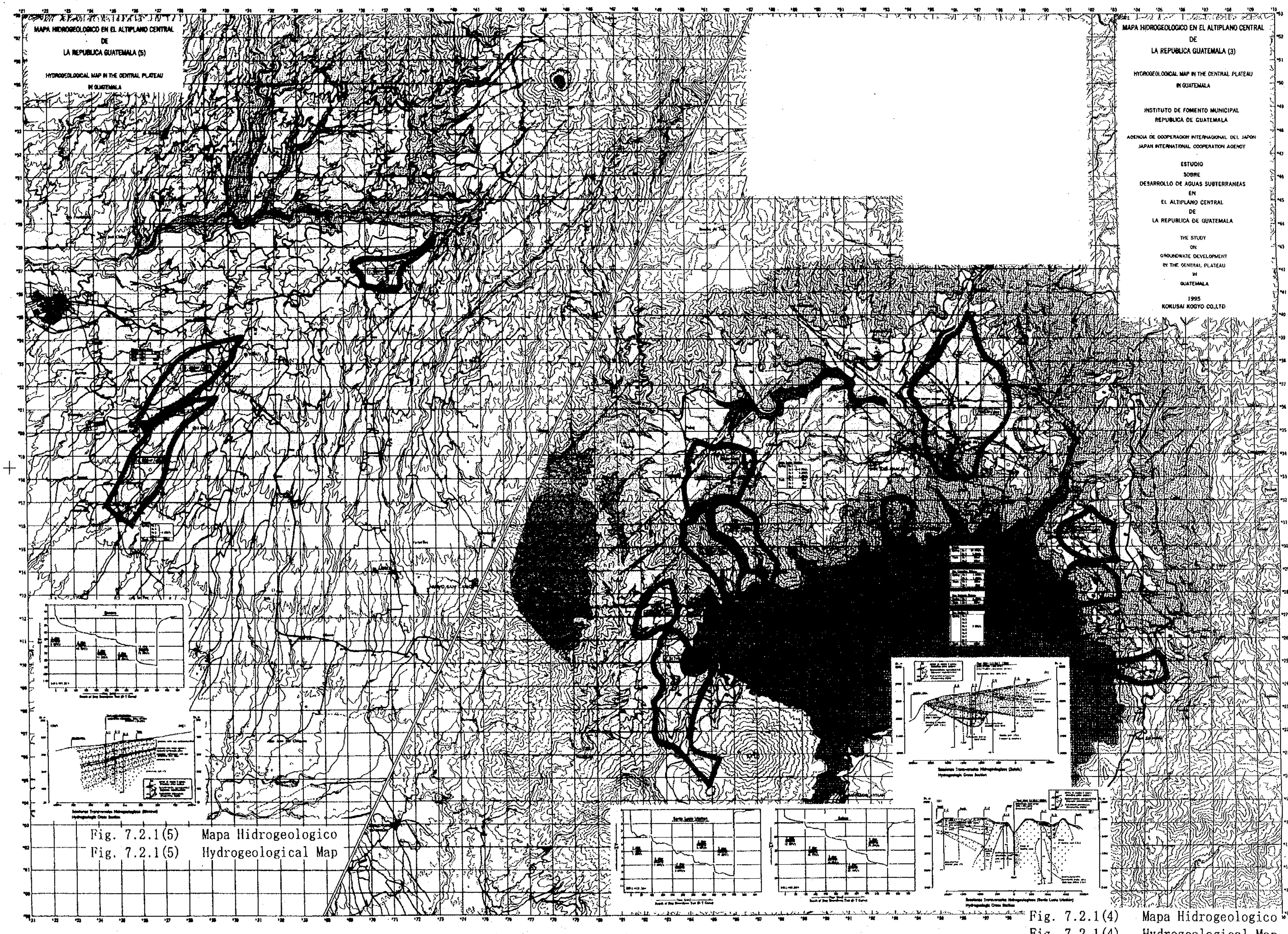


Fig. 7.2.1(5) Mapa Hidrogeologico
Fig. 7.2.1(5) Hydrogeological Map

Fig. 7.2.1(4) Mapa Hidrogeologico
Fig. 7.2.1(4) Hydrogeological Map

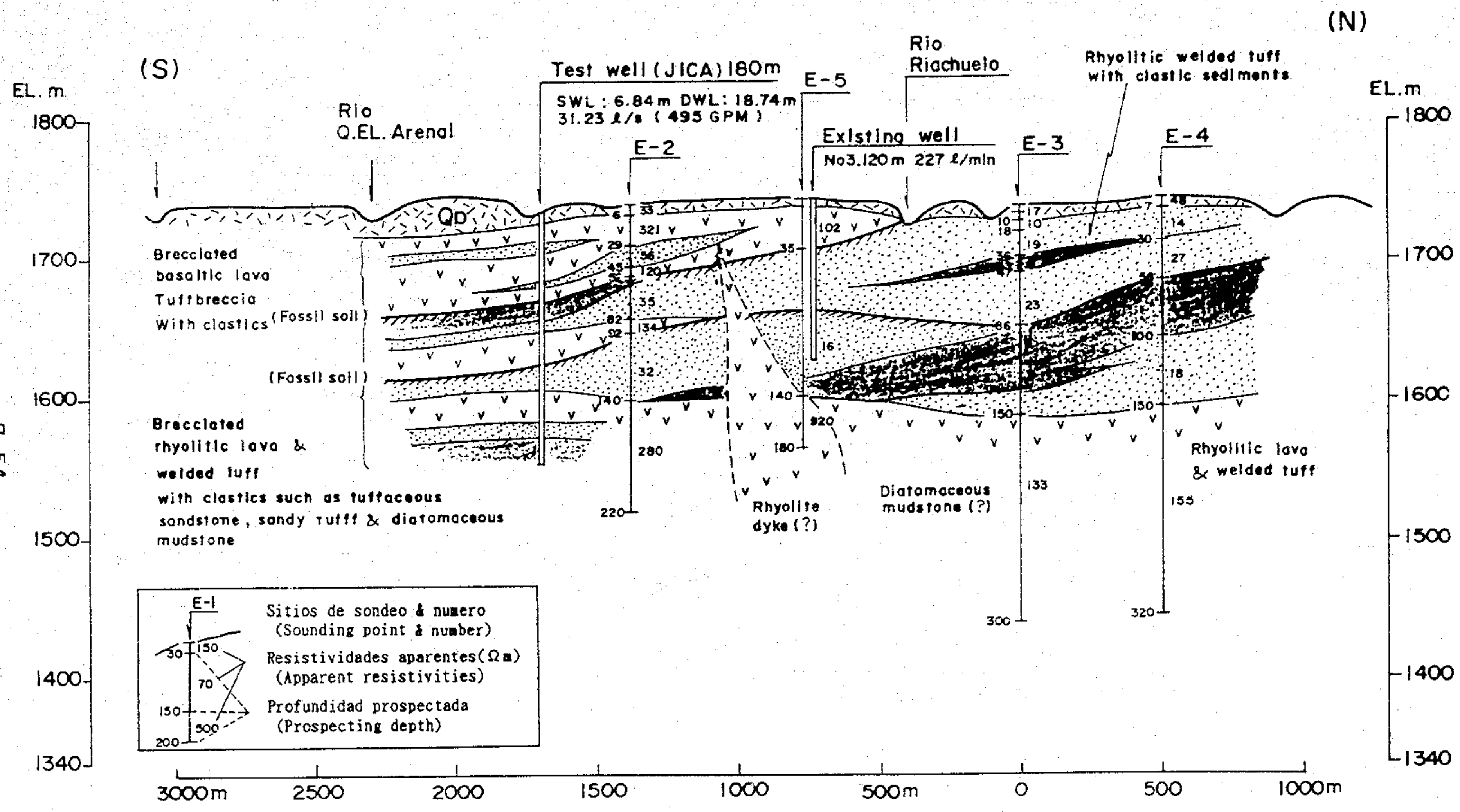


Fig. 7.2.2 Hydrogeologic Cross Section (San José Pinula)

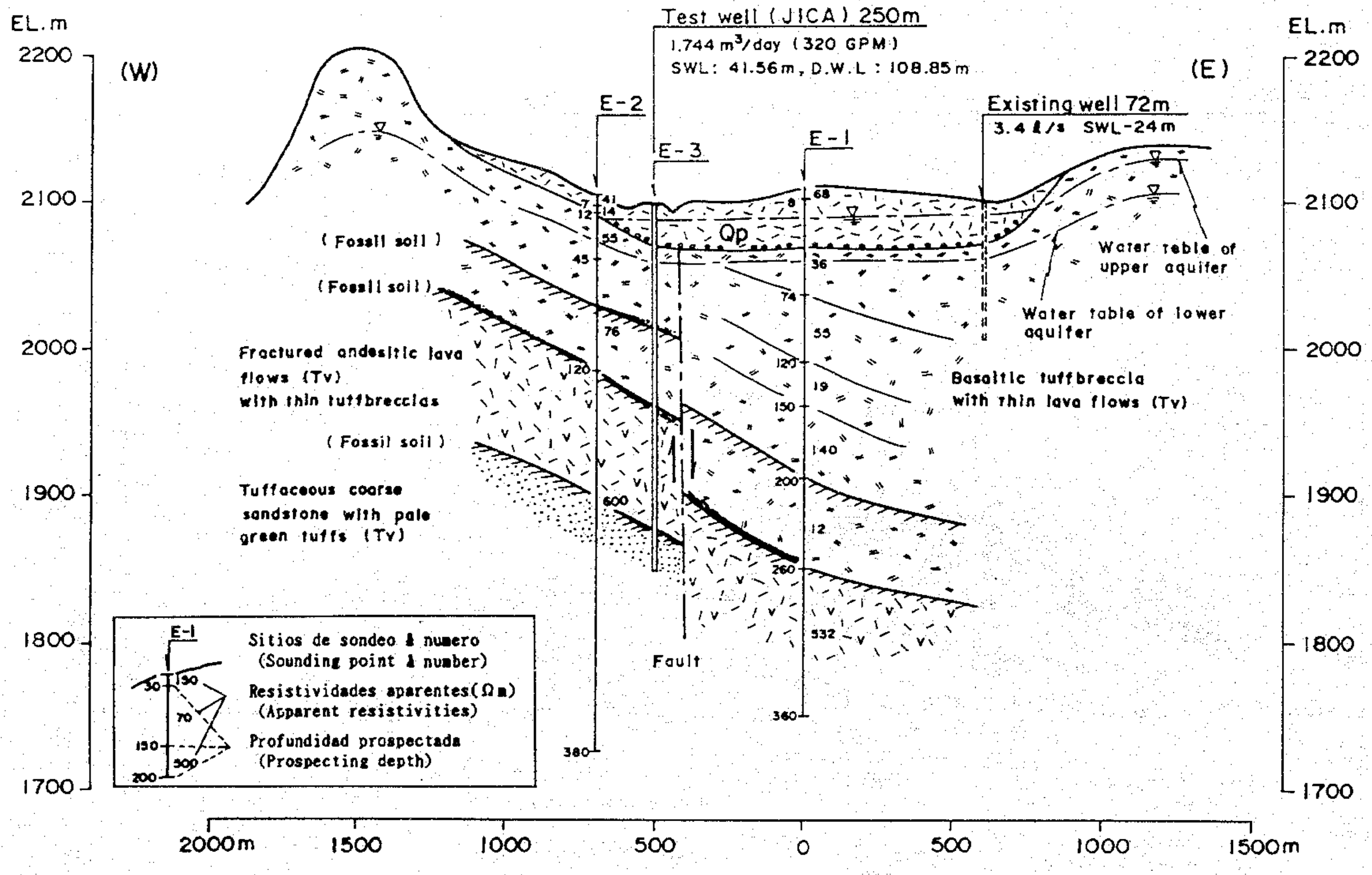


Fig. 7.2.3 Hydrogeologic Cross Section (San Pedro Sacatepéquez)

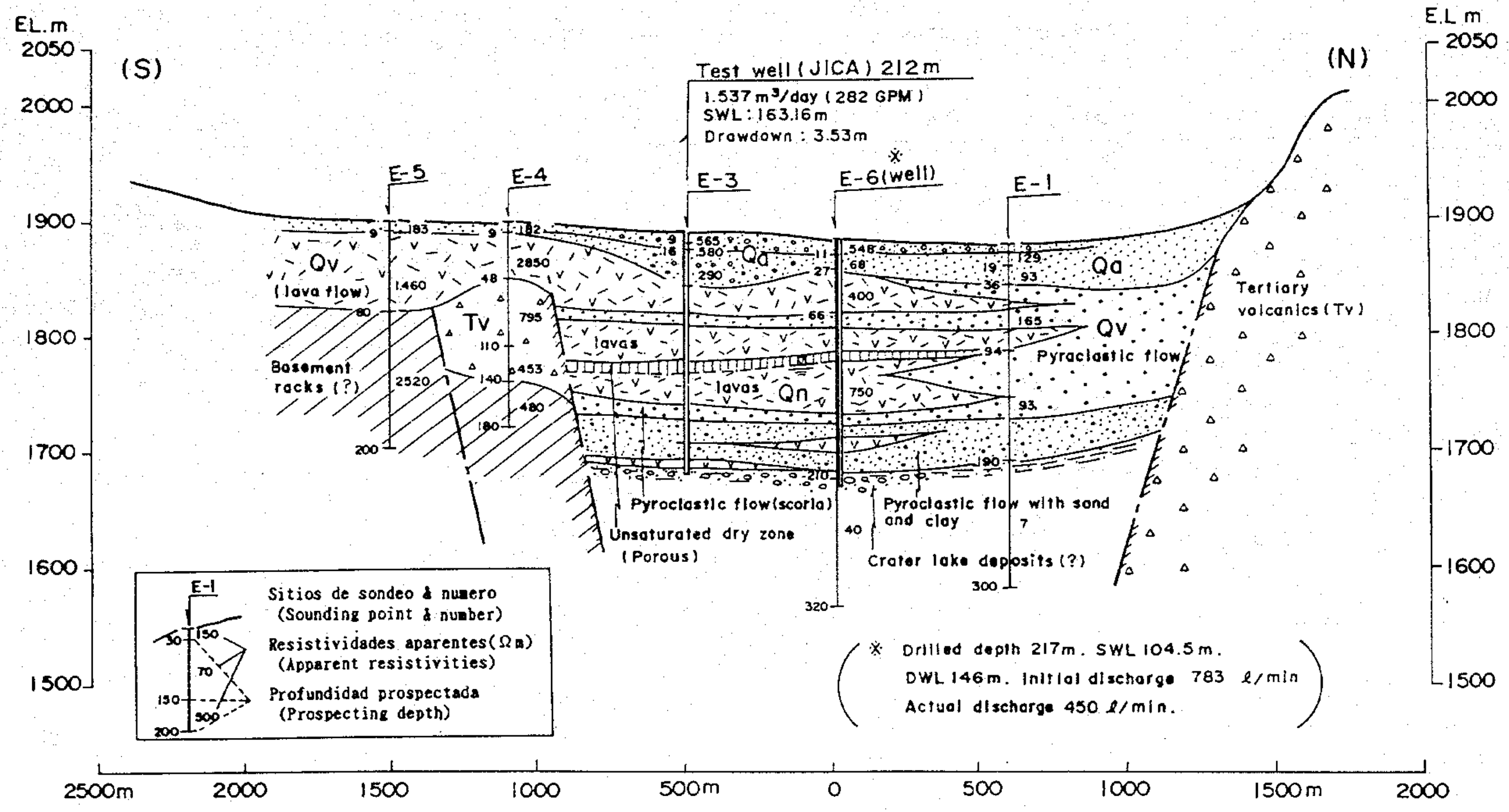


Fig. 7.2.4 Hydrogeologic Cross Section (Santa Maria de Jesús)

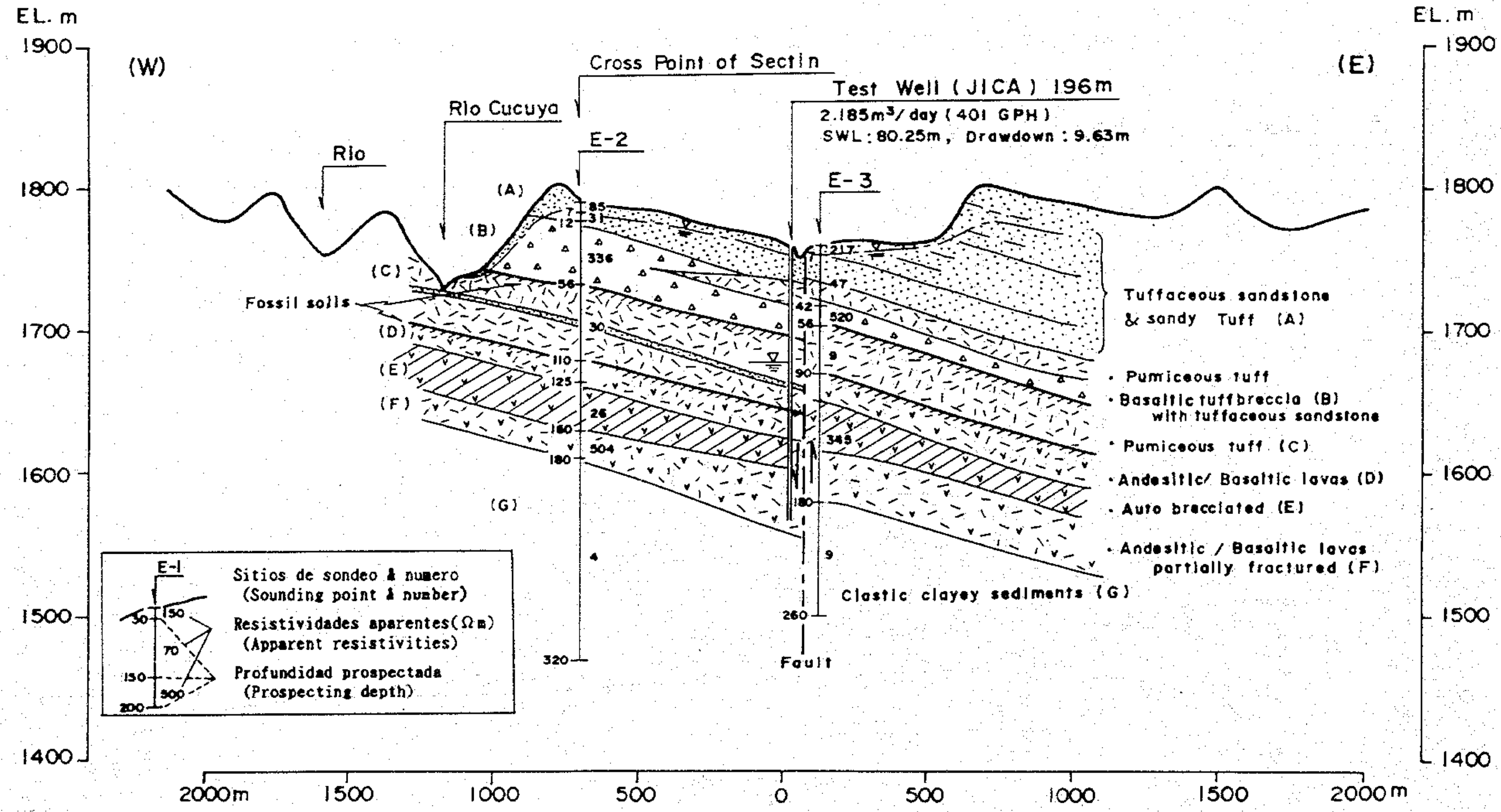


Fig. 7.2.5 Hydrogeologic Cross Section (San Martin Jilotepeque)

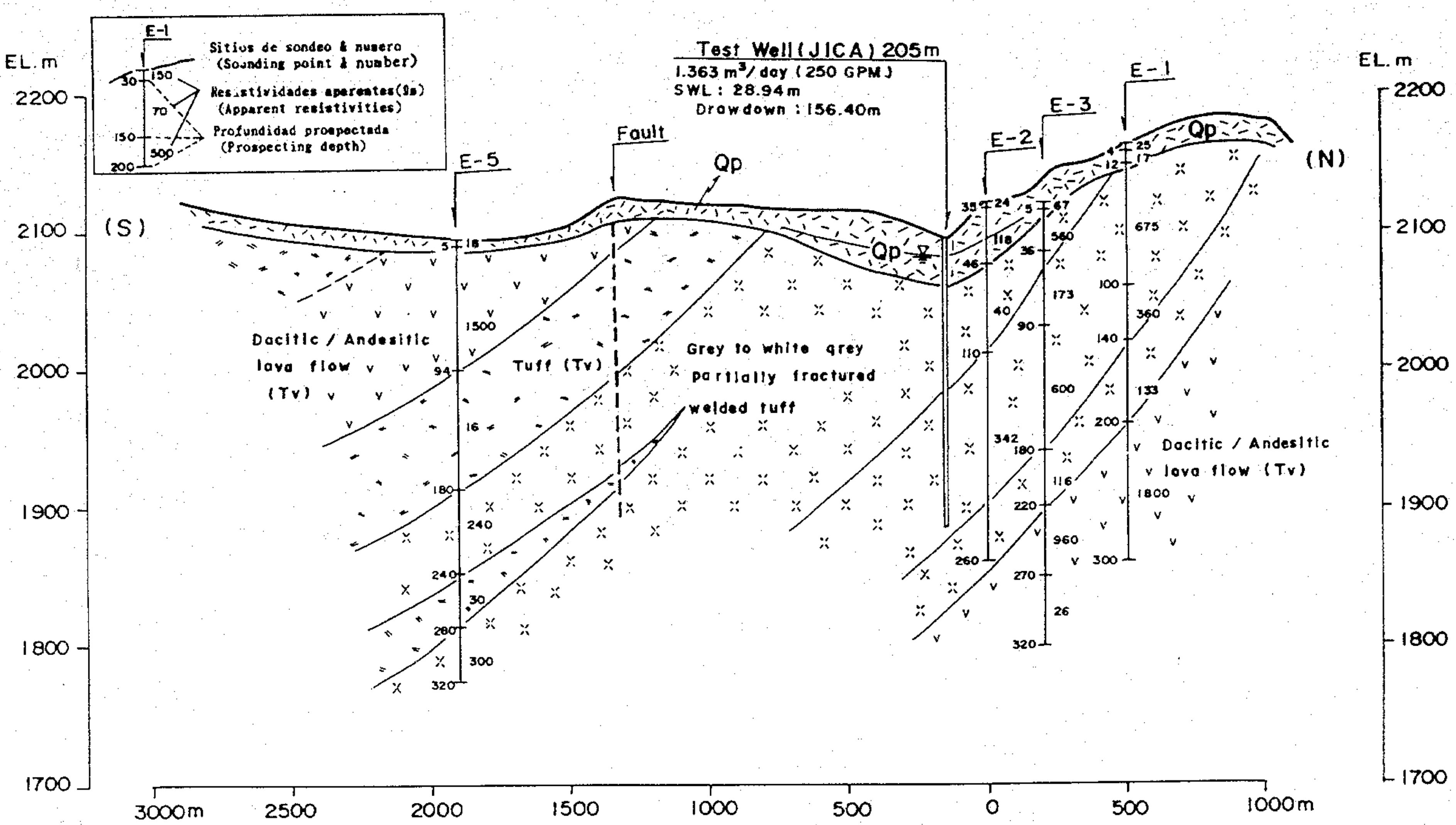


Fig. 7.2.6 Hydrogeologic Cross Section (San Juan Comalapa)

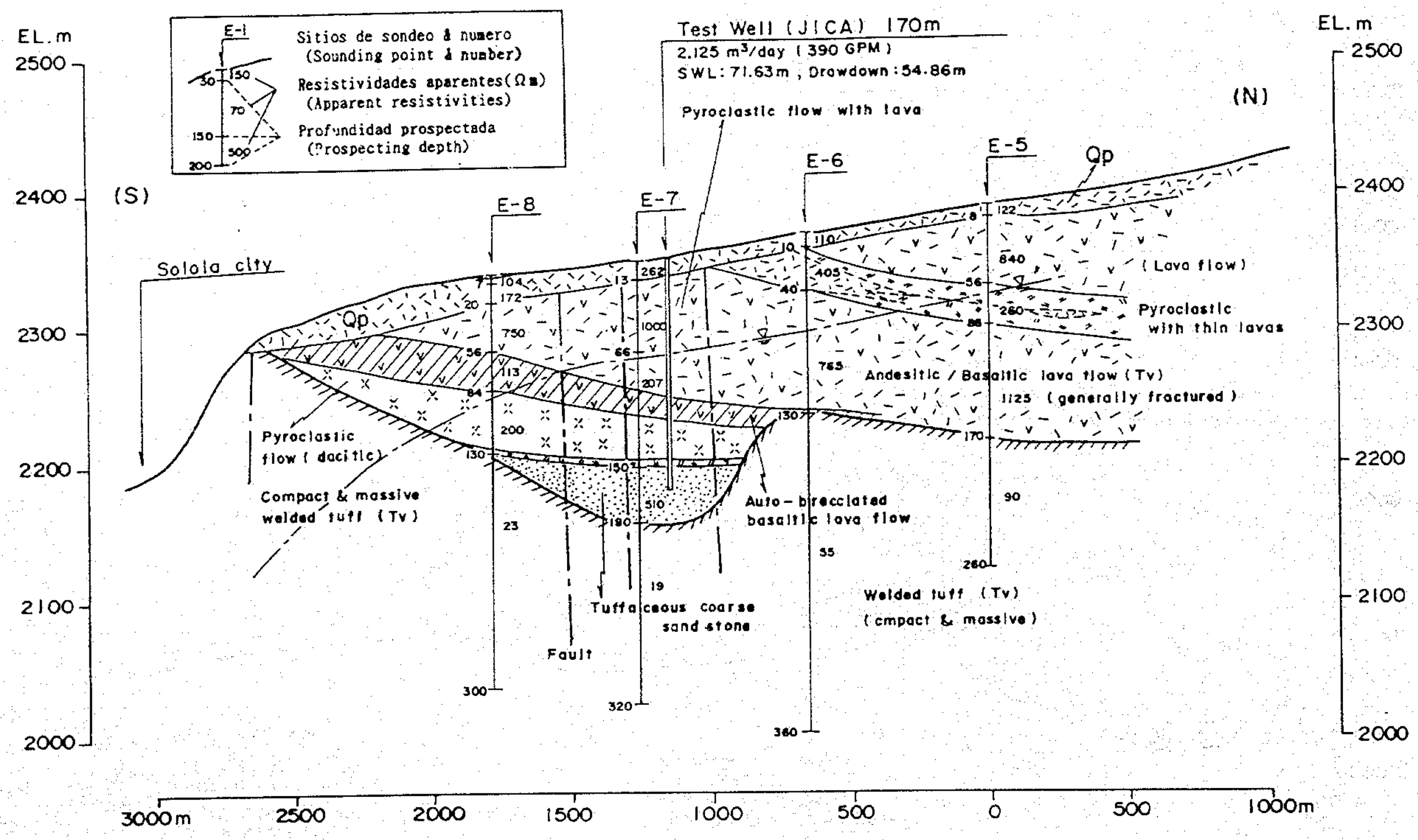


Fig. 7.2.7 Hydrogeologic Cross Section (Sololá)

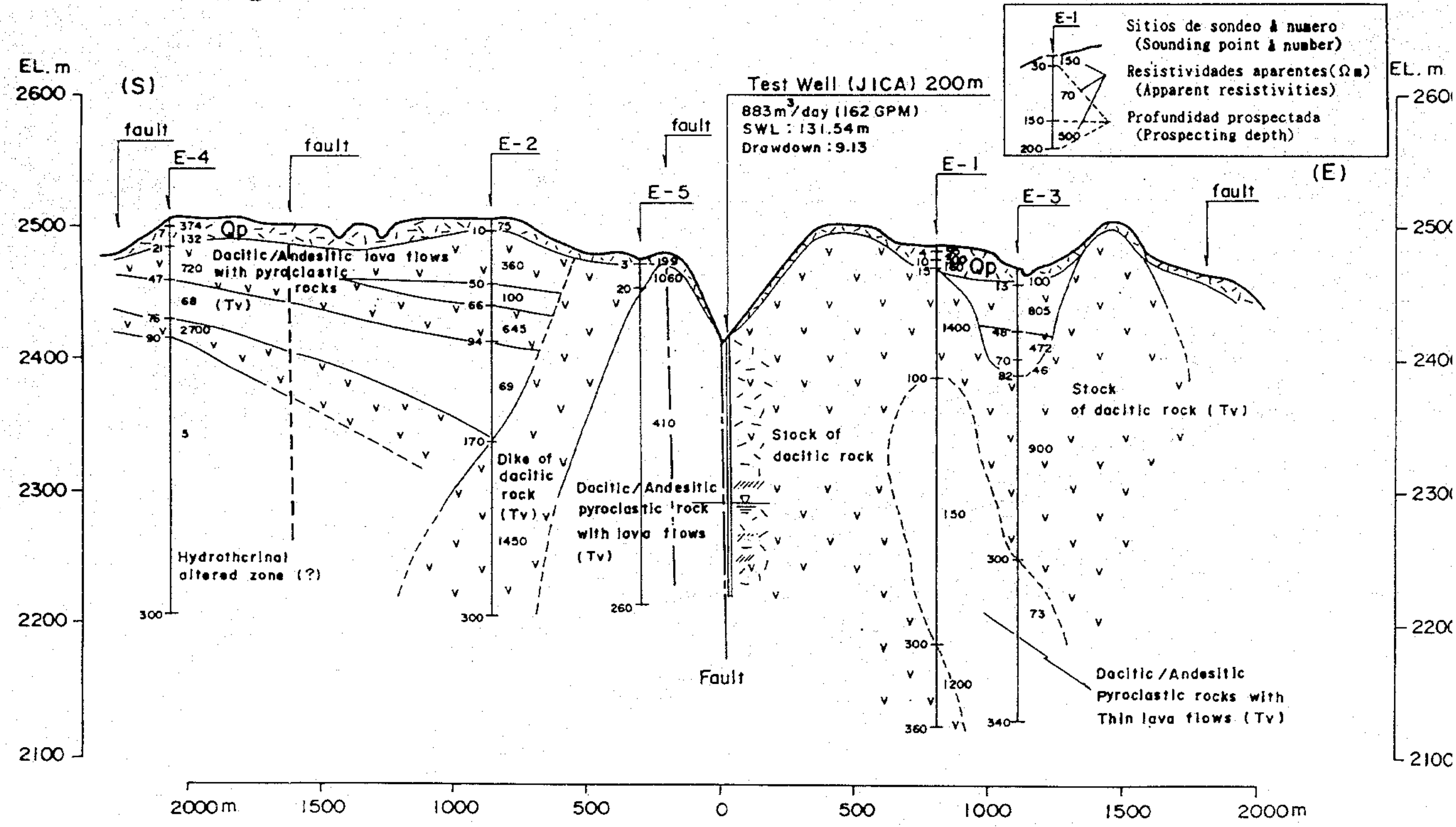


Fig. 7.2.8 Hydrogeologic Cross Section (Santa Lucia Utatlán)

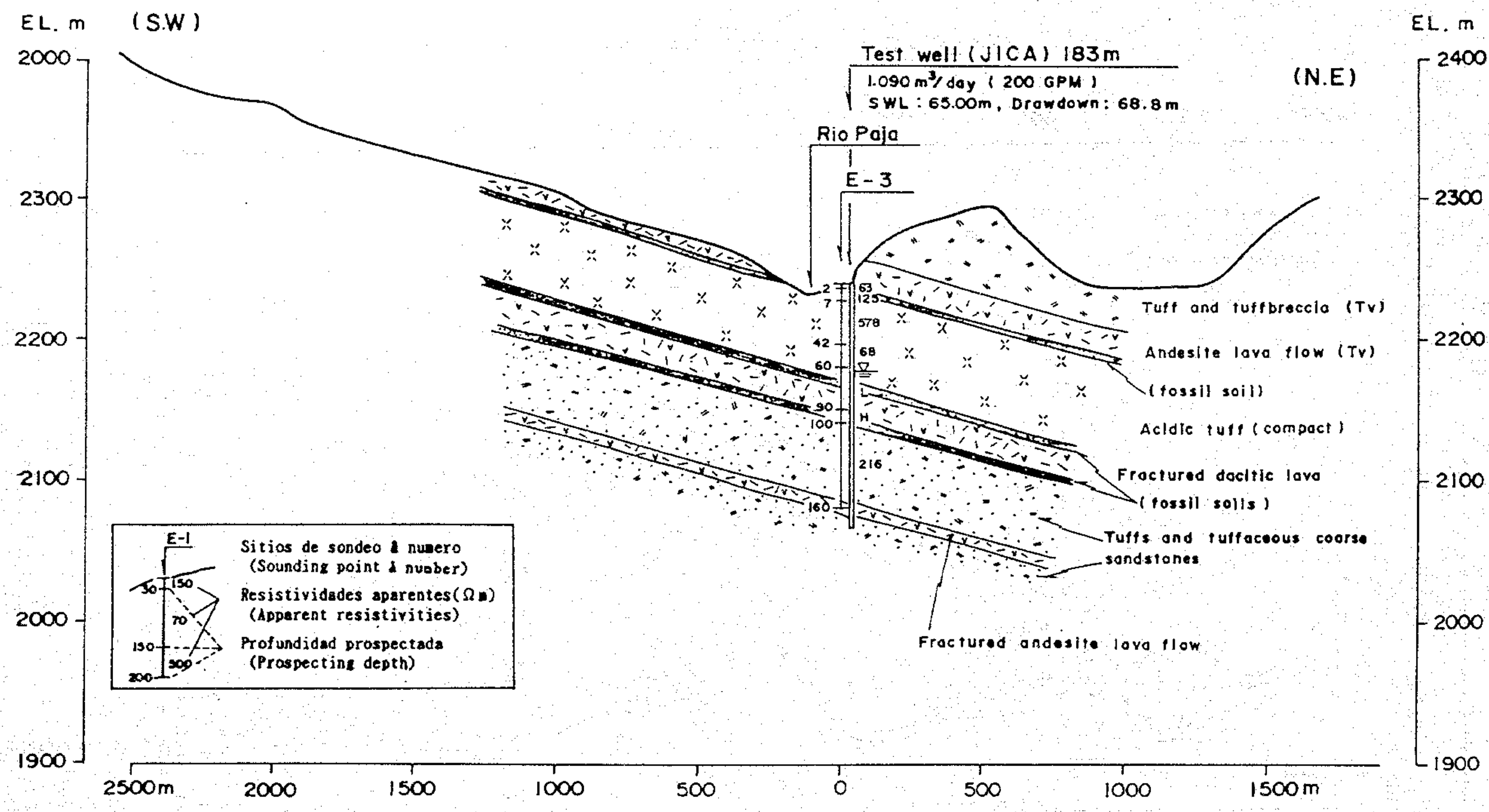


Fig. 7.2.9 Hydrogeologic Cross Section (Momostenango)

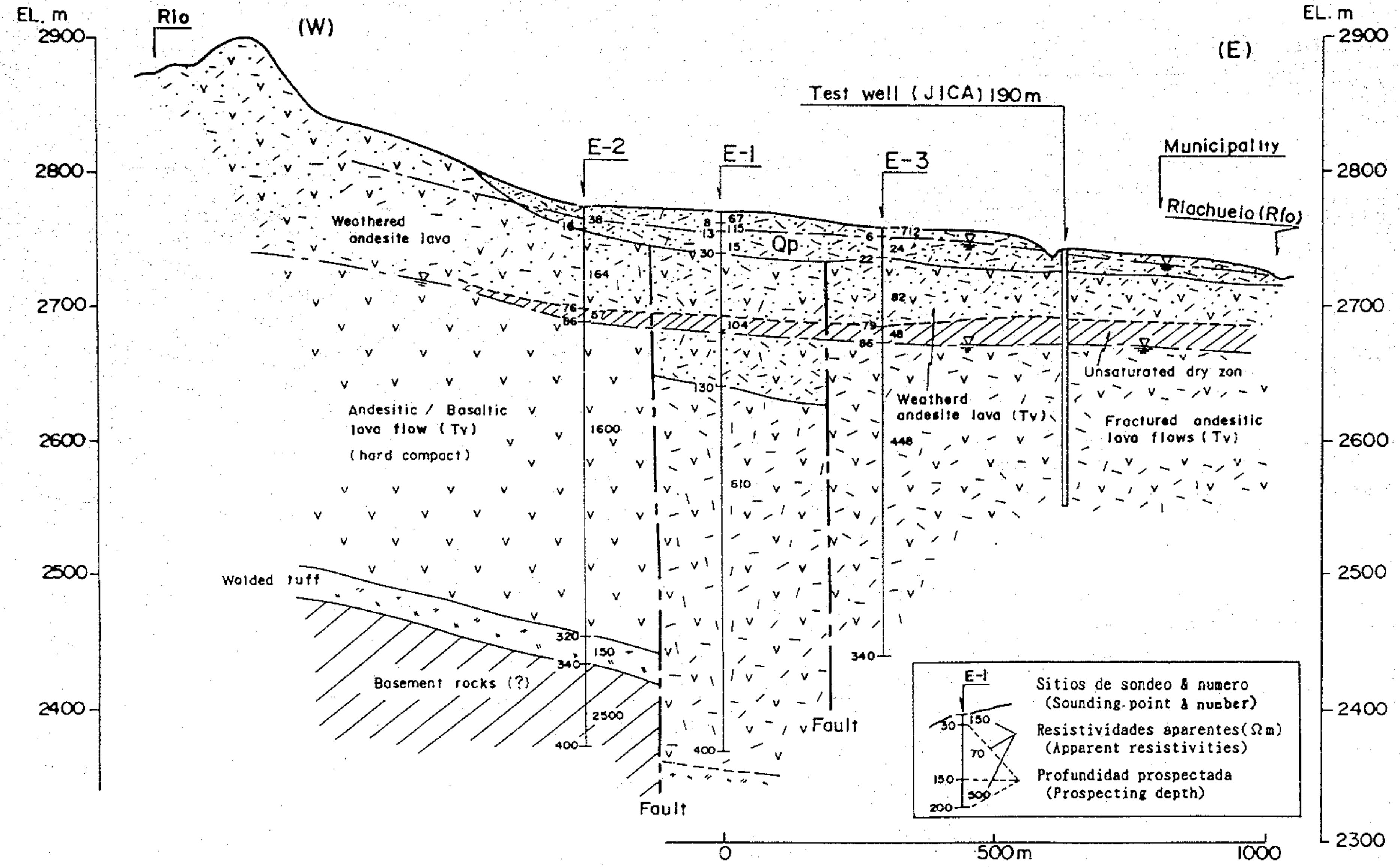


Fig. 7.2.10(1) Hydrogeologic Cross Section (San Francisco la Unión)

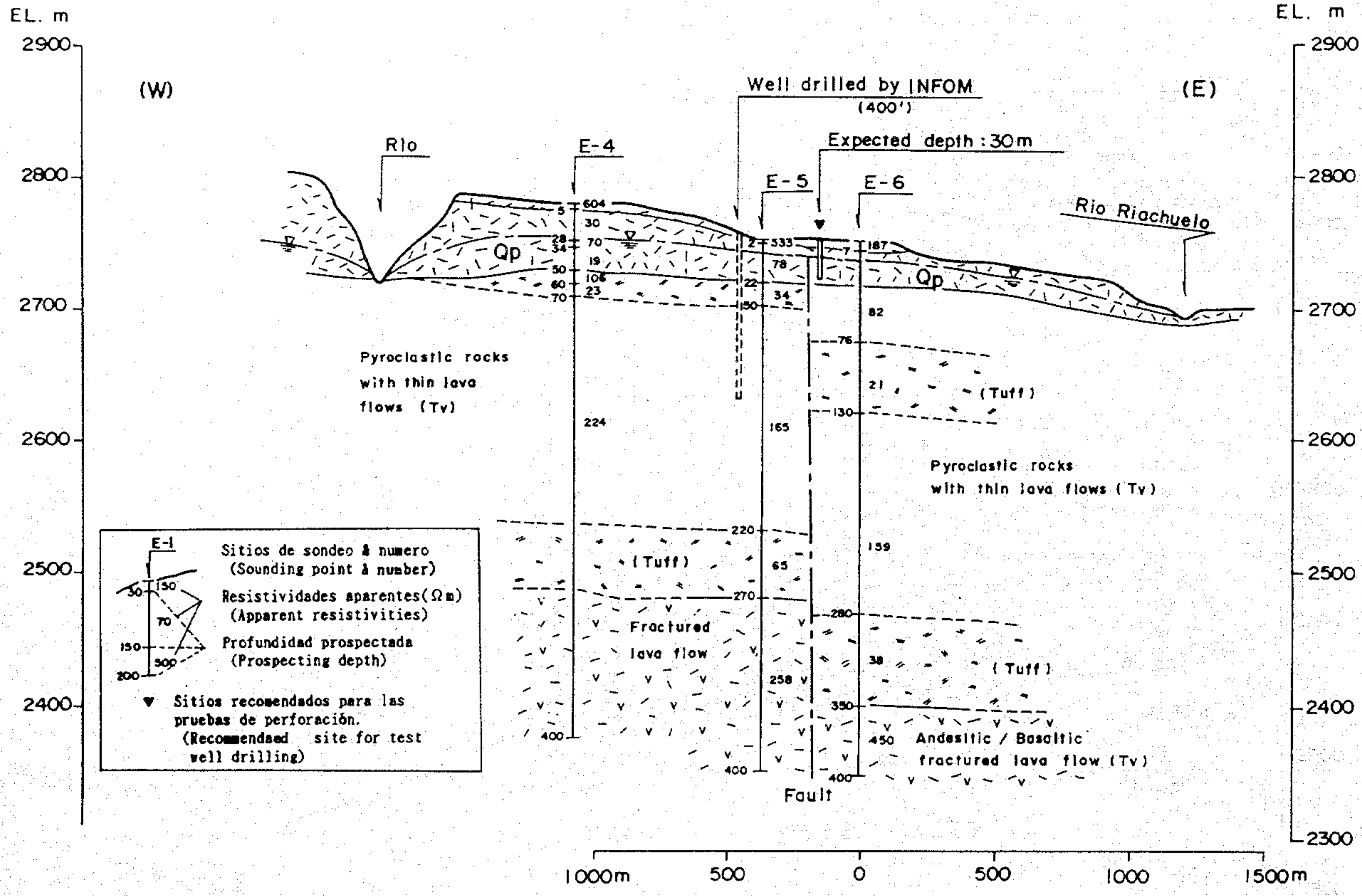


Fig. 7.2.10(2) Hydrogeologic Cross Section (San Francisco la Unión)

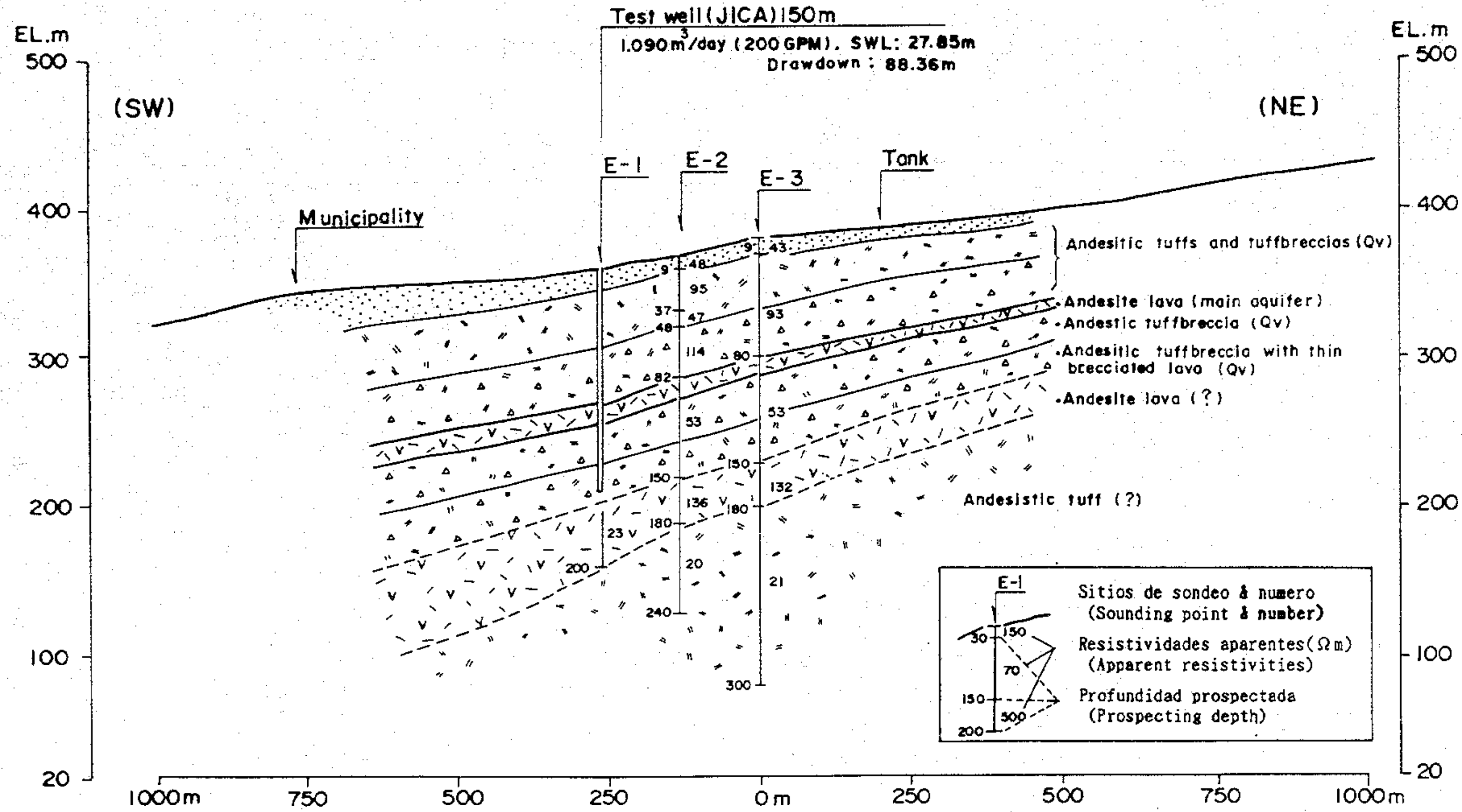


Fig. 7.2.11 Hydrogeologic Cross Section (Genova)

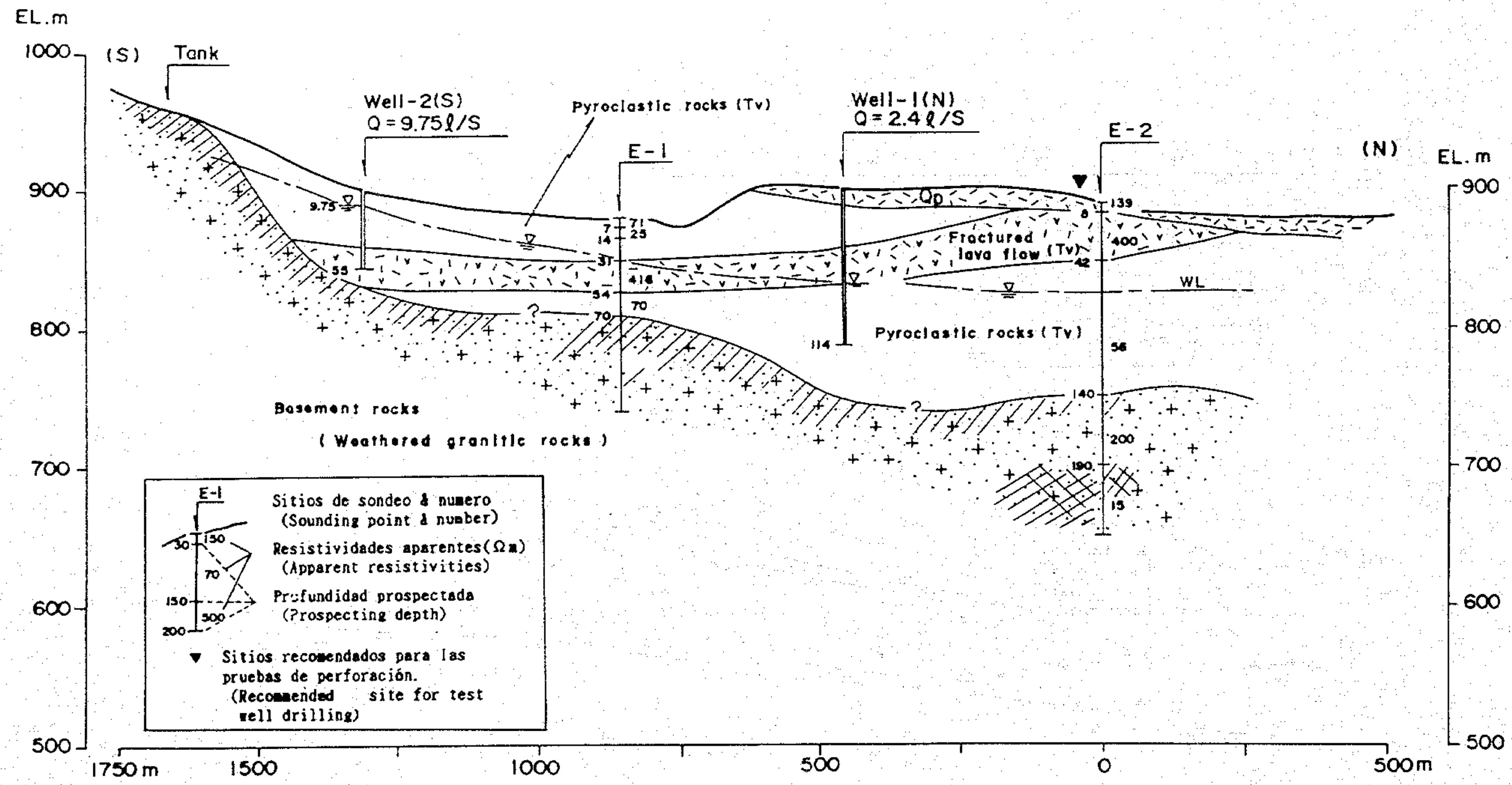


Fig. 7.2.12 Hydrogeologic Cross Section (San José del Golfo)

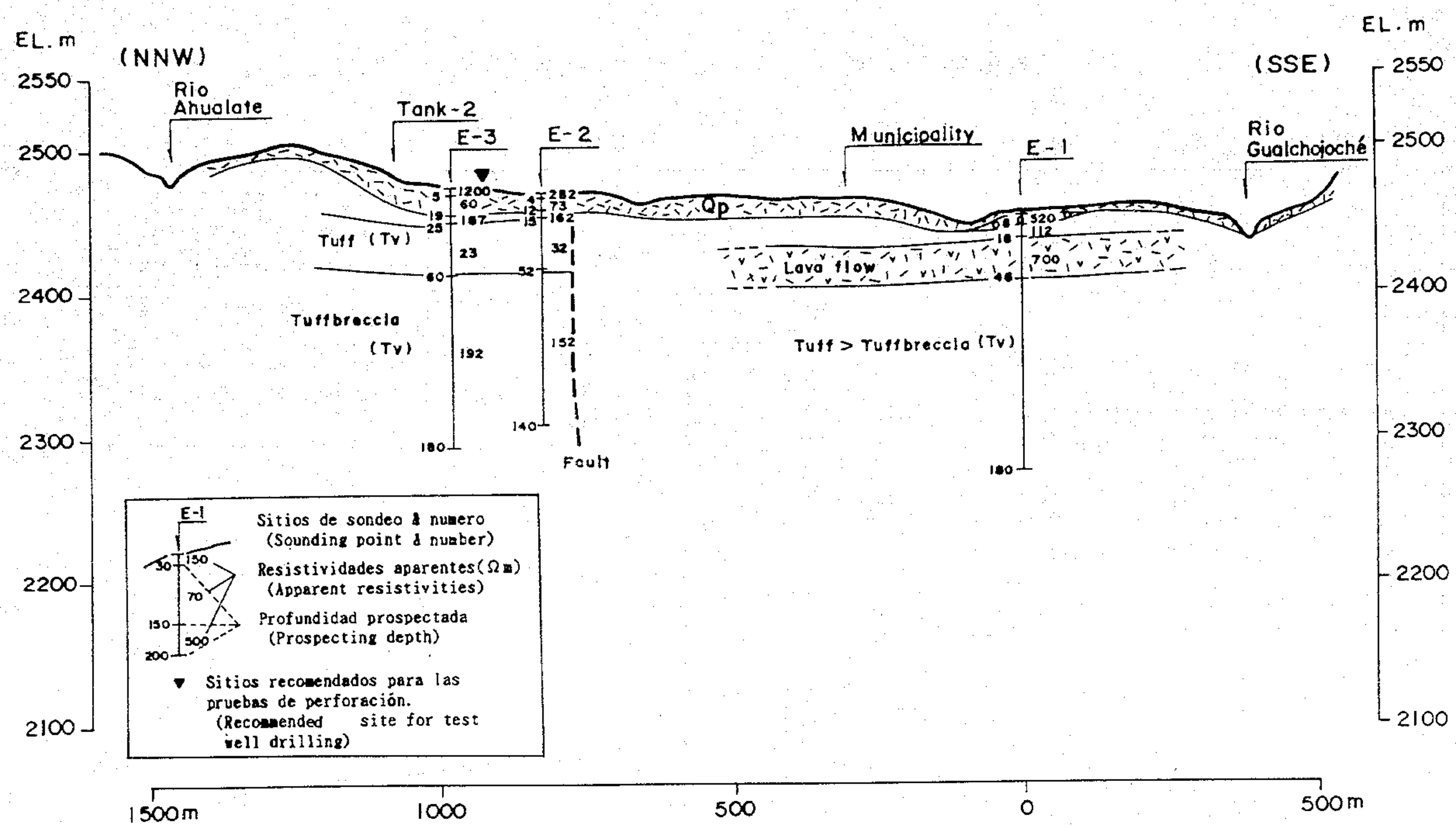


Fig. 7.2.13 Hydrogeologic Cross Section (Nahualá)

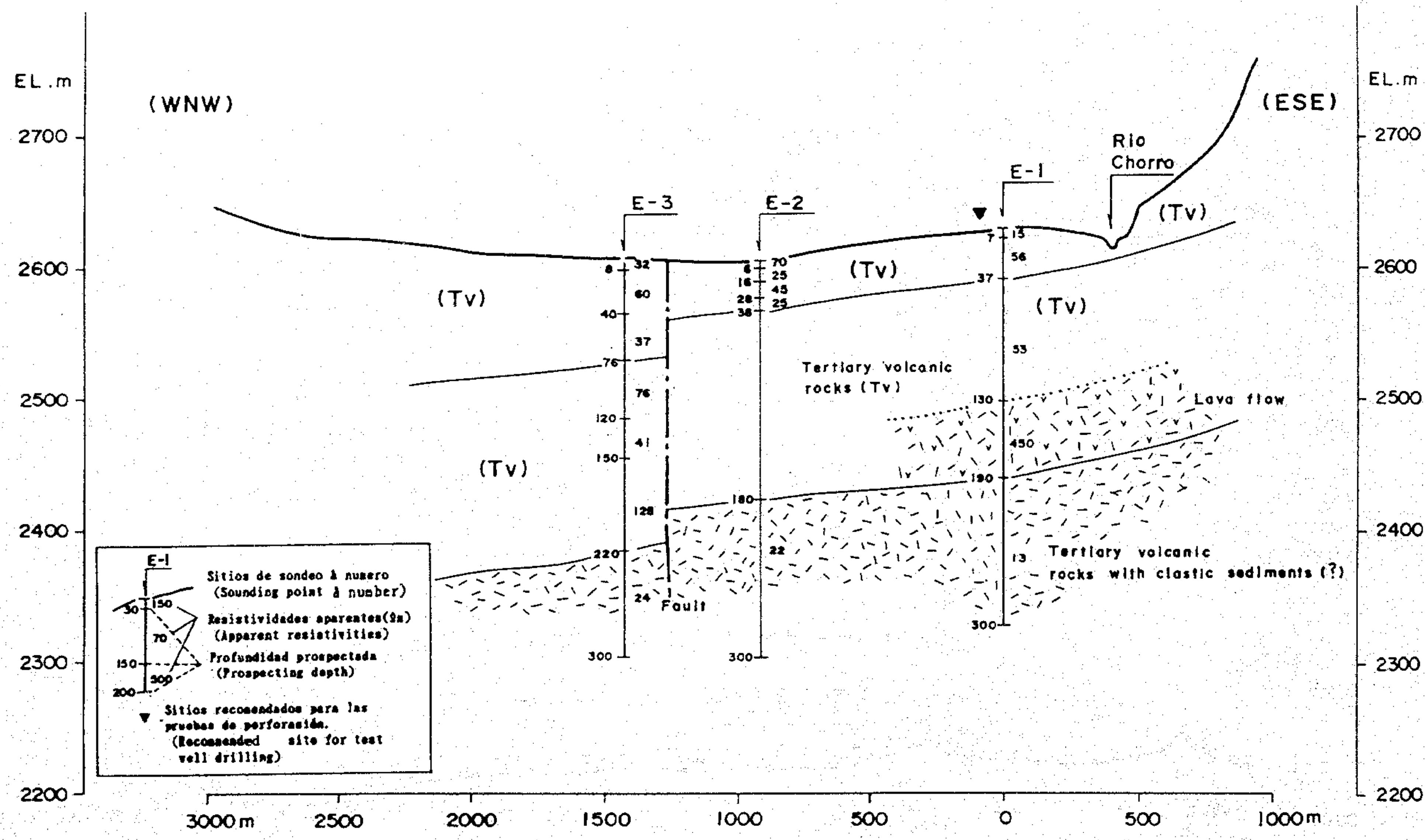


Fig. 7.2.14 Hydrogeologic Cross Section (San Carlos Sija)

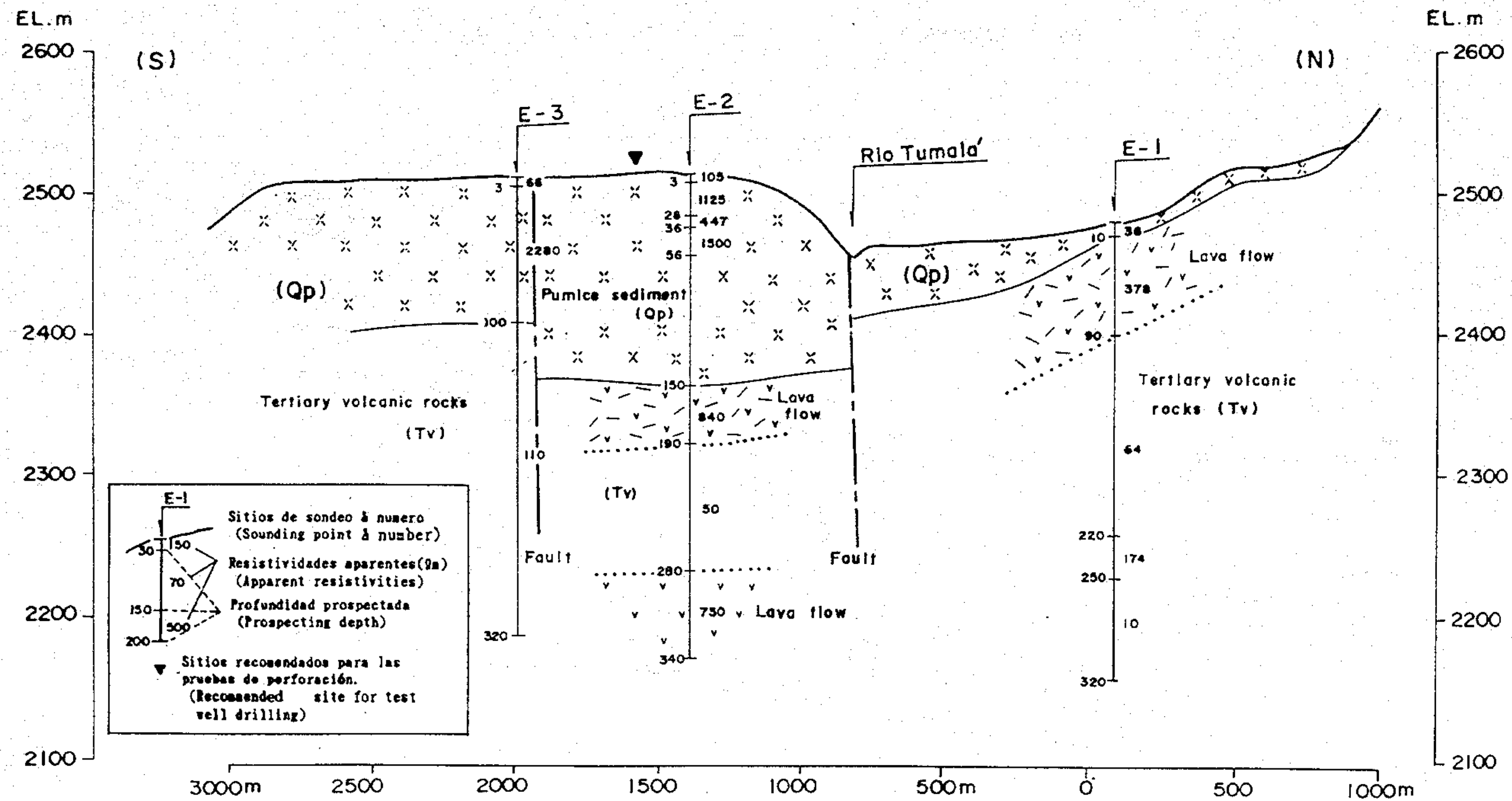


Fig. 7.2.15 Hydrogeologic Cross Section (Cajola)

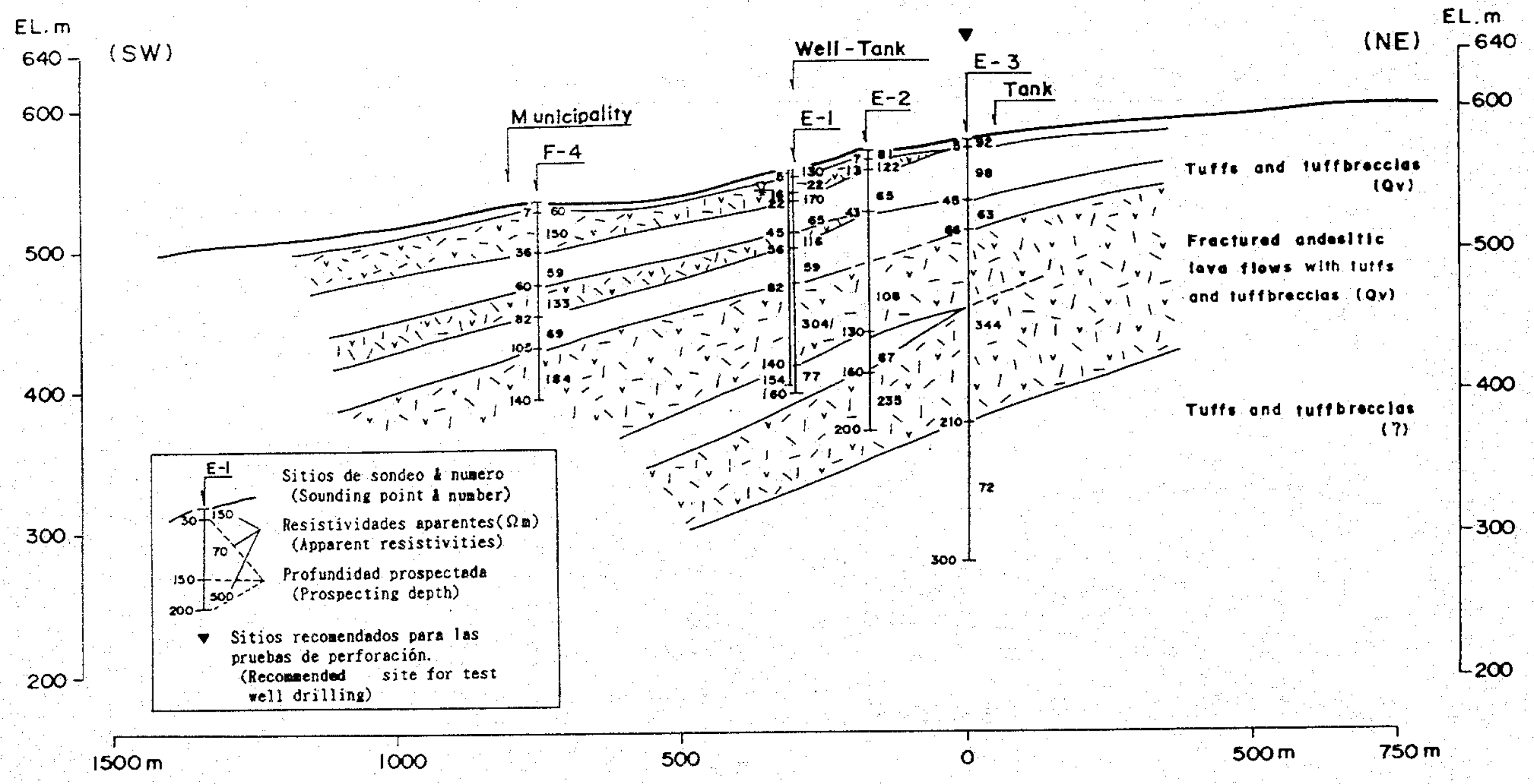


Fig. 7.2.16 Hydrogeologic Cross Section (Flores Costa Cuca)

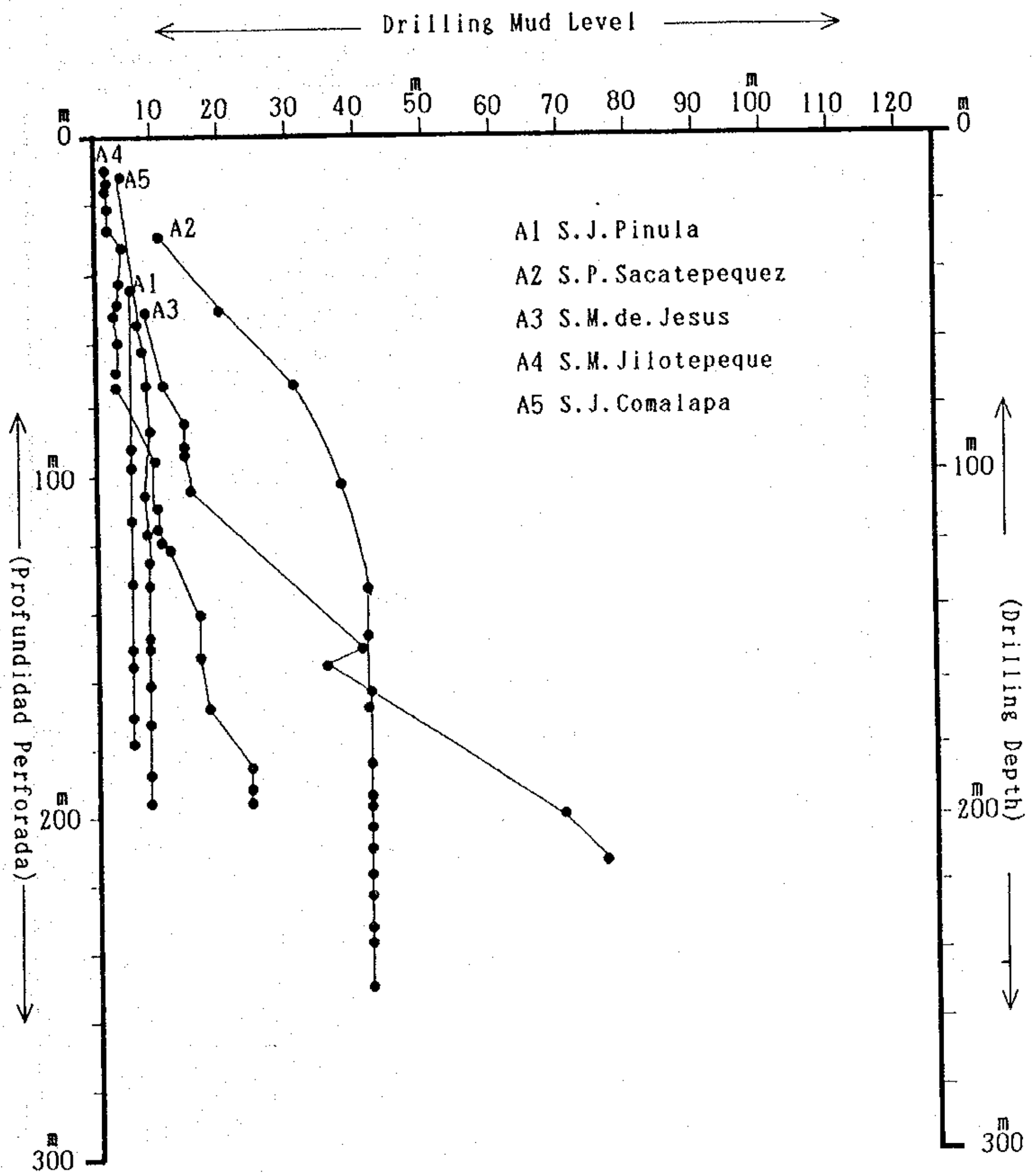


Fig. 7.2.17(1) Fluctuations of Drilling Mud Level

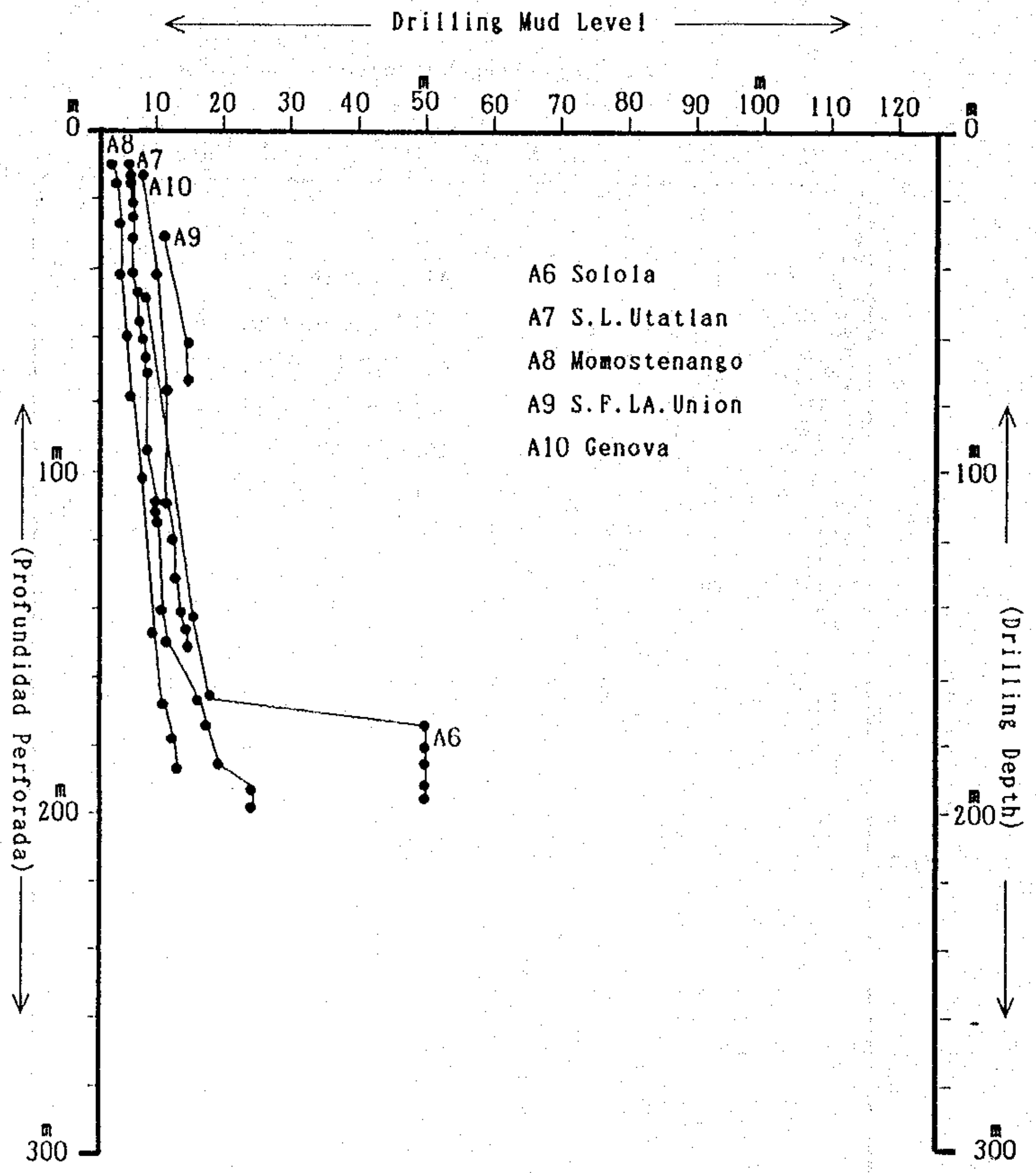
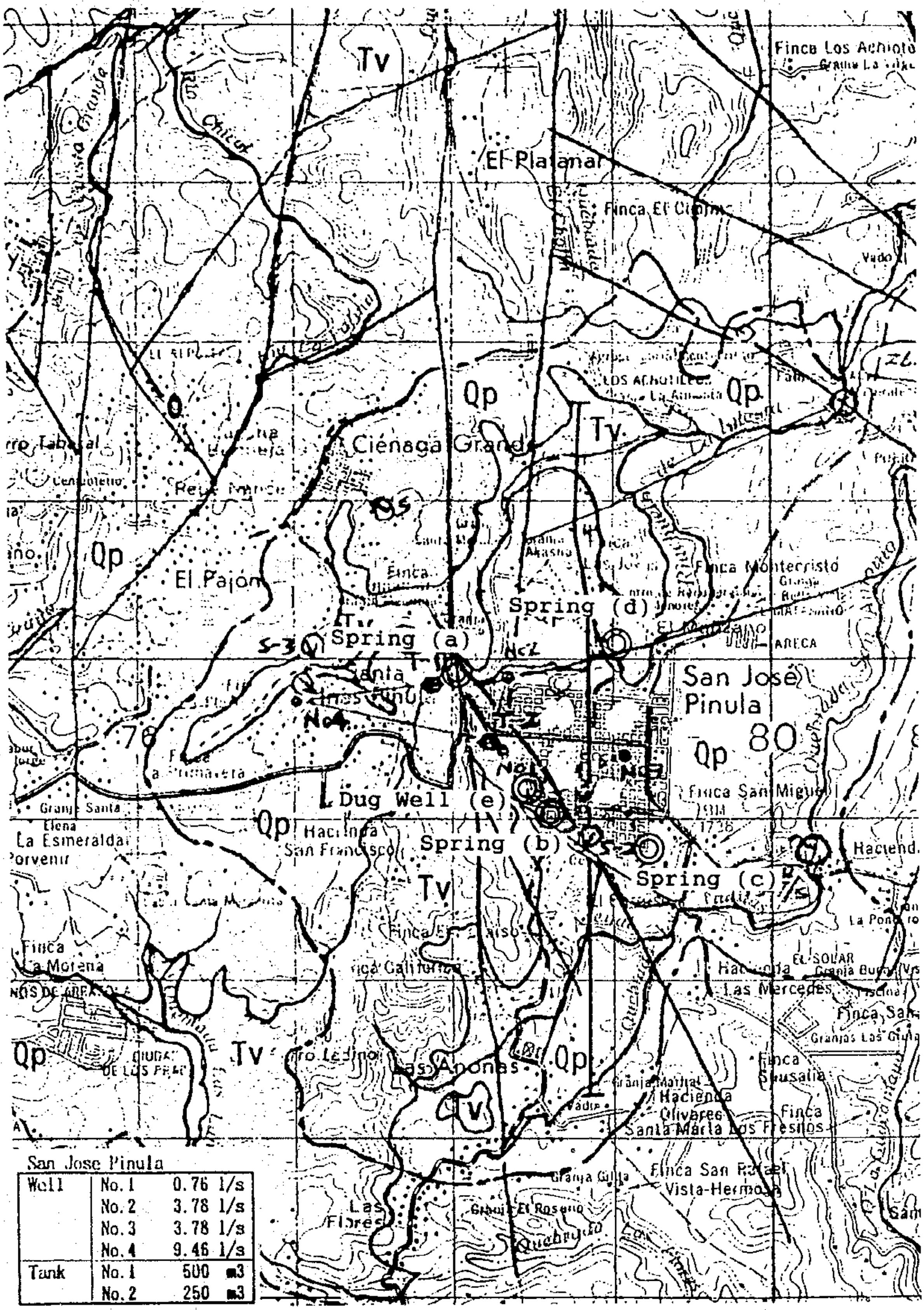


Fig. 7.2.17(2) Fluctuations of Drilling Mud Level



Well	No. 1	0.76 l/s
	No. 2	3.78 l/s
	No. 3	3.78 l/s
	No. 4	9.46 l/s
Tank	No. 1	500 m3
	No. 2	250 m3

Fig. 7.2.18 Sampling Points of Water Quality Analysis

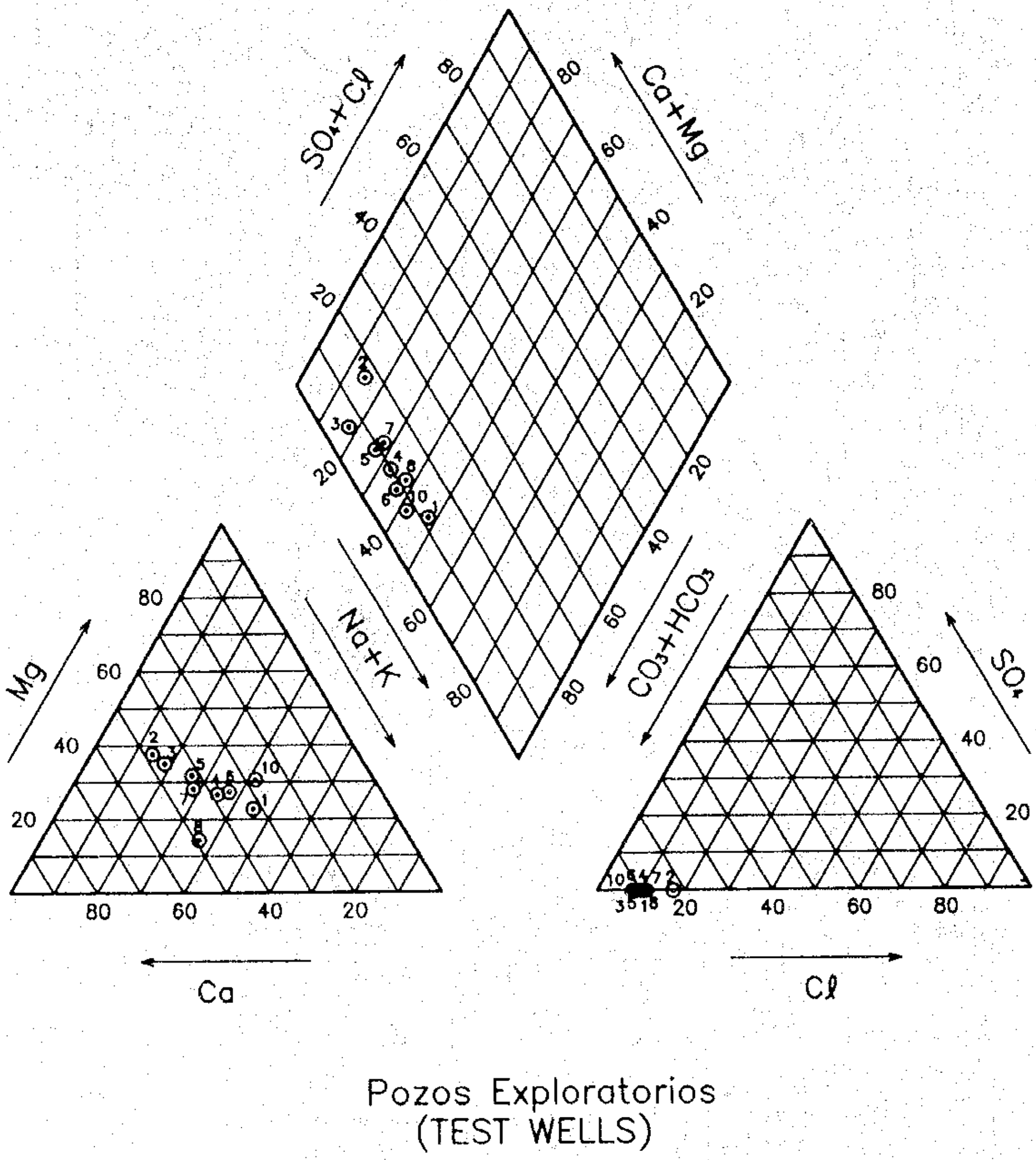


Fig. 7.2.19 (1) Diagrama Tri-lineal

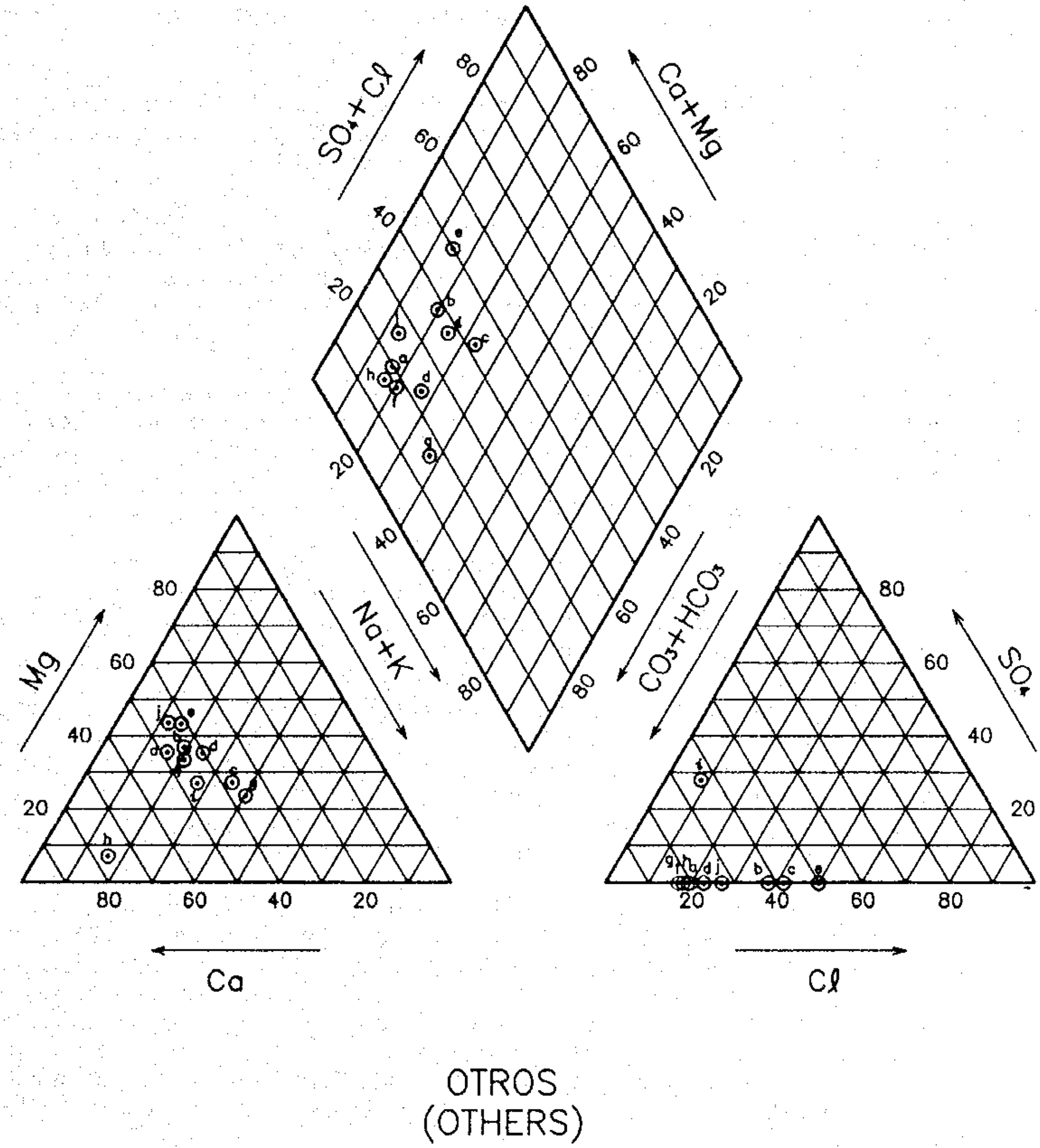


Fig. 7.2.19 (2) Diagrama Tri-lineal

7.3 Groundwater Development Potential

7.3.1 Estimation of Groundwater Development Potential

Little experience has been accumulated on the groundwater development in the Study Area. Hence, insufficient data on hydrogeological information like drilling logs, results of pumping tests and continuous monitoring of the groundwater level and rainfall preclude detailed evaluation of the development scale.

Groundwater development in the Study Area will be based on the upper and lower aquifers in the Pleistocene volcanic and the Tertiary volcanic rocks, respectively.

The aquifer in the Pleistocene volcanic is expected to be especially productive, but its thickness is insufficient for a stable extraction. Therefore, the Tertiary volcanic will be the principal target for future water source development.

For tentative potential evaluation, two methods were applied: the assumed infiltration ratio into the aquifer by geological condition, and the base flow in the dry season.

(1) Estimation of infiltration ratio

Annual rainfall in the municipalities was estimated from the rainfall record. When the municipality did not have a rainfall station, a neighboring station was chosen and its records were adopted for analysis.

Each recharge area was demarcated on the topographic map with a scale of 1:50,000. This area was used for the calculation of groundwater potential. The river basin is basically used as recharge area, however, when the river basin is very big like Villa Canales and Villa Nueva, 50 km2 was applied as the upper bound.

Infiltration factor was applied in the calculation of the groundwater potential. This factor is the ratio of the rainfall that has infiltrated into the aquifer. Adopted to represent this factor is the value indicated in the report "Plan Maestro de Riego y Drenaje, Caracterización Hidroclimática e Hidrogeología" by Ministerio de Agricultura, Ganadería y Alimentación in 1990. The assumed aquifer recharge from the annual rainfall by geology is as follows.

- Basement Rock	2%
- Tertiary Volcanic Rocks (Tv)	10%
- Pleistocene Volcanic (Qp)	15%
- Alluvial Deposit (Qa)	10%
- Holocene Volcanic (Qv)	15%

Therefore, the annual groundwater potential was calculated as follows.

Annual Groundwater Potential	=	Annual Rainfall	x	Recharge Area	x	Infiltration Factor

(2) Estimation by river base flow

The value of a river base flow in the dry season is generally regarded as groundwater recharge. Therefore, the groundwater potential is simply estimated from this value and the recharge area.

From the results of the discharge records during 1960 - 1980 and spot measurements in April - May of 1994, specific discharge of the base flow is estimated at about 5 ℓ/sec/km2 in most of the Study Area which has about 1,000 mm of annual rainfall, and around 10 ℓ/sec/km2 in the southern part of Quetzaltenango which has an annual rainfall of about 3,000 mm.

Annual Groundwater Potential	=	Base Flow	x	Recharge Area

Table 7.3.1 shows the results of both calculations. These values represent a tentative evaluation, and the values calculated by infiltration are shown in the hydrogeological map (Fig.7.2.1). This potential should be revised with the monitoring data indicated in Section 7.3.3.

This potential is calculated for the recharge area of each municipality, and corresponds to the total production in the area.

The yielding capacity of one well is estimated at about 5 ℓ/sec, the same as the value of base flow, because 1 km^2 is generally regarded as the unit of the recharge area for one well, and, this capacity corresponds to the records of existing wells.

However, the test drilling results showed that the capacity of one well is much higher than this value, as described in Section 7.2., because of the peculiar hydrogeological features of the area, specially of the fault system.

Detailed development potential of the 10 municipalities selected for the Feasibility Study is discussed in the next section.

7.3.2 Groundwater Development Strategy for 10 Municipalities

(1) San Jose Pinula

The town is located in the graben-type groundwater basin where the upper aquifer of Pleistocene pumice sediments and the lower aquifer of Tertiary volcanic rocks with clastic sediments are intercalated. Between these aquifers, there is an unsaturated dry zone. Since the upper aquifer is not thick (several meters) and the water table largely fluctuates seasonally, groundwater in this aquifer is unstable and is not therefore utilized as a public supply source.

The lower aquifer, which consists of basaltic to rhyolitic brecciated lavas and gravel beds with quartz sand, is the main aquifer of the basin. The existing water supply source is the groundwater of this lower aquifer pumped through 3 wells with a depth of 120 meters,and daily production of $613.2m^3$. The yielding capacity of the 3 wells ranges from 1.45 to 9.46ℓ/s, averaging 4.68ℓ/s (74.2 GPM).

On the other hand, the yielding capacity of the test well was 31.23ℓ/s (495 GPM) with a drawdown of 11.90 meters. The depth of the test well is 180 meters and the static water level is 6.84 maters B.G.L. The difference in the yielding capacities of the existing wells and the test well may be caused by the following two reasons.

(a) The test well is 60 meters deeper than the existing wells and struck a confined aquifer.

(b) The test well was properly located, focusing on the fault system, based on hydrogeological and geophysical survey.

Whereas the projected water demand of the municipality in the year 2010 is $3,095m^3$/day (26.4ℓ/s), the shortage can be covered by the test well if it is utilized as a production well.

The estimated groundwater potential and water balance of the groundwater sub-basin in the year 2010 are as follows:

- Recharge area	$16km^2$
- Annual rainfall	1,650mm
- Infiltration ratio	14.5 %
- Groundwater potential	$10,488m^3$/day
- Pumping discharge in 2010	$3,095m^3$/day
- Balance	$7,393m^3$

(2) San Pedro Sacatepéquez

The town is situated in a geotectonic intramountain river basin controlled by faults of NW-SE, NS and NE-SW directions. The groundwater bearing layers of the river basin are Pleistocene pumice sediments (upper aquifer) and locally fractured basaltic to andesitic volcanic rocks of the Tertiary (lower aquifer) formation. In general, an unsaturated dry zone separates the upper and lower aquifers which are unconfined and semi-confined aquifers, respectively.

The thickness of the upper aquifer ranges from several meters to 20 meters and many small scale springs, the important water resources in the area for domestic and agricultural use, gush out from this upper aquifer. The total daily discharge from the springs is estimated at more than 400m³, of which 212m³/day is used as municipal water supply.

Groundwater occurrence and the characteristics of the lower aquifer in Tertiary volcanic rocks were unknown, as only the record of one existing well was available. The discharge rate of the existing well is 3.46,49ℓ/s, and the daily production is 97.9m³ for an 8 hour pumping rate. The yielding capacity of the test well is 20.19ℓ/s (320 GPM), with a drawdown of 67.29 meters. The static water level in this well is 41.56 meters B.G.S. in the lower aquifer.

Since the water demand in 2010 is 1,572m³/day and its estimated supply shortage is 1,278m³/day (14.8ℓ/s), the shortage can be covered by this test well.

The estimated groundwater potential and water balance in the area in 2010 are as follows.

- Recharge area	4.0km²
- Annual rainfall	1,032mm
- Infiltration ratio	13.0%
- Groundwater potential	1,470(~1,728)m³/day *1
- Pumping discharge in 2010 (including spring water)	1,760 m³/day *2
- Balance	290(~-32)m³

*1: Groundwater potential estimated by infiltration factor is 1,470m³/day, and 1,728m³/day by base flow flow factor.

*2: Breakdown of pumping discharge (including spring water) in 2010 is as follows:

- Pumping discharge from 2 wells	1,572m³/day
- Spring water for agricultural use	188m³/day

Since the water balance in this area in 2010 will become negative at a value between 290 to 300m³/day, the groundwater monitoring is very important, as described in the next section.

(3) Santa María de Jesús

As shown in Fig. 7.2.1 (2) and 7.2.4, the well is located on a flat plain (Sabana Grande) surrounded by steep mountains. The basin is mainly filled up with Quaternary volcanic rocks originating from Volcan de Agua, and the basement is formed by slightly permeable Tertiary volcanic rocks.

This basin has two aquifers, the upper and lower aquifers, which are separated by an unsaturated dry zone. The water table is 16 meters B.G.S. in the upper aquifer, and 163 meters B.G.S. in the lower aquifer.

The yielding capacity of the lower aquifer, confirmed by test drilling, is 17.79ℓ/s (282 GPM) with a drawdown of 3.53 meters, while the yielding capacity of the existing well is 6.0ℓ/s (95 GPM).

The water demand in 2010 is 2,308m³/day, and the supply shortage of 1,617m³/day (18.7³/s) can be covered by the production from the test well.

The estimated groundwater potential and water balance in the groundwater basin in 2010 are as follows:

- Rechange area	14.0km²
- Annual rainfall	1,229mm
- Infiltration ratio	13.0%
- Groundwater potential	7,071m³/day
- Pumping discharge in 2010	2,308m³/day
- Balance	4,763m³

(4) San Martín Jilotepeque

The municipal area is situated in the intramountain basin of the Pixcayá River basin, consisting mainly of Tertiary volcanic rocks.

The main aquifer of the basin is in a layer of fractured and auto-brecciated andesitic to basaltic lavas of Tertiary volcanic rocks. The yielding capacity of the aquifer confirmed by test drilling is 25.30ℓ/s (400 GPM) with a drawdown of 9.63 meters, and the static water level is 82 meters B.G.S., while the yielding capacity of the existing well is 6.0ℓ/s (95 GPM).

Production from the test well can cover the estimated municipal water supply shortage of 1,032m³/day (11.95ℓ/s) in 2010.

The estimated groundwater potential and water balance of the basin in 2010 are as follows:

- Recharge area	7.0km²
- Annual rainfall	1,272mm
- Infiltration ratio	15.0%
- Groundwater potential	3,659m³/day
- Pumping discharge in 2010	1,550m³/day

- Balance 2,109m³

(5) San Juan Comalapa

The municipal area is located in the intramountain basin of the Pixcayá River system, consisting mainly of Pleistocene pumice sediments (upper aquifer) and Tertiary volcanic rocks (lower aquifer).

The upper aquifer is composed of relatively highly permeable layer of pumice sediments with lake deposits of sandy materials several meters thick. There are many springs gushing out from the upper aquifer, and the estimated total discharge is more than 15ℓ/s.

The lower aquifer is in a layer of partially fractured welded tuffs of the Tertiary. The productivity of the test well drilled down to the lower aquifer is not high at 15.78ℓ/s (1,363m³/day, 250 GPM), with a huge drawdown of 156.4m from the static water level of 28.94 meters B.G.S. For a cost effective pumping, drawdown should be lowered to within 80~90 meters by reducing the pumping rate to 12.0ℓ/s (about 1,000m³/day, 190 GPM). The existing well in this town yields 6.421/s (102 GPM).

Since the supply shortage is estimated at 1,954m³/day in 2010, the development of one more well producing about 1,000m³/day is required in order to meet the demand in 2010.

The point recommended for drilling the additional well is shown in Fig. 9.1.5, based on hydrogeological surveys. However, more detailed surveys should be conducted to determine the proper location and depth of the well prior to undertaking construction work.

The estimated groundwater potential and water balance of the basin in 2010 are as follows:

- Recharge area	16.0km²
- Annual rainfall	1,414mm
- Infiltration ratio	13.0%
- Groundwater potential	8,058m³/day
- Total discharge in 2010	3,793m³/day
(from 3 deep wells)	(2,493m³/day)
(from springs)	(1,300m³/day)
- Balance	4,265m³

(6) Sololá

The area in Sololá for groundwater development is on a flat plateau about 2 kilometers north of the city, where the Tertiary volcanic rocks with clastic sediments (lower aquifer) is unconformably overlain by thin Pleistocene pumice sediments (upper aquifer).

The upper aquifer is only several meters thick in the area, but springs gushing out from the aquifer discharge a total amount of more than 45ℓ/s (3,888m³/day). An unsaturated dry-zone separates the upper and lower aquifers.

The main lithological units of the lower aquifer are auto-brecciated and fractured basaltic to andestic lavas and tuffaceous coarse grained sandstone. The yielding capacity of the lower aquifer, confirmed by test drilling, is 24.59ℓ/s (390 GPM) with a drawdown of 54.86 meters. Static water level is 71.63 meters B.G.S.

If this test well is used as a production well, the pumping rate should be reduced from 24.59ℓ/s to a 13.0~14.0ℓ/s (1,100~1,200m³/day), in order to keep the pumping level at less than 100m B.G.S., for safe pumping (economical pumping).
To cover up the supply shortage of the municipality in 2010 which is estimated at 2,172m³/day (25.14ℓ/s), another well should be constructed in addition to the test well.

The site recommended for the additional well was selected by conducting hydrogeological surveys, and shown in Fig. 9.1.6. However, a more detailed survey is required prior to well construction in order to properly pinpoint the well site and determine well depth.

The estimated groundwater development potential and water balance of the area in 2010 are as follows:

- Recharge area	18.5km²
- Annual rainfall	1,081mm
- Infiltration ratio	14.5%
- Groundwater potential	7,945m³/day
- Total discharge in 2010	6,060m³/day
(from deep wells)	(2,127m³/day)
(from springs)	(3,888m³/day)
- Balance	1,885m³

(7) Santa Lucía Utatlán

The municipal area is located in the intramountain basin of Rio Quiscab, consisting mainly of Tertiary volcanic rocks conformably overlain by thin pumice sediments of the Pleistocene.

The main aquifer is in the fractured portion of the Tertiary volcanic rocks. The test drilling site was selected targeting the fractured zone of auto-brecciated dacitic rocks along the NE-SW lineament, which sharply controls the flow direction of streams. The yielding capacity of the fractured zone, confirmed by test drilling, is 10.22ℓ/s (162 GPM) with a drawdown of 9.13 meters. The static water level is 131.45 meters B.G.S. The supply shortage of the municipality in 2010 which is estimated at 344m³/day (3.98ℓ/s), can be sufficiently covered up by the production of this test well.

The estimated groundwater potential and water balance of the area in 2010 are as follows:

- Recharge area	$5km^2$
- Annual rainfall	1,341mm
- Infiltration ratio	13.5%
- Groundwater potential	$2,480m^3$/day
- Total discharge in 2010	$506m^3$/day
(from deep well)	($344m^3$/day)
(from springs)	($162m^3$/day)
- Balance	$1,974m^3$

(8) Momostenango

The municipal area is located on the mountainous highland of Tertiary volcanic rocks. A hot spring (48.1°c, pH 6.5, EC 94 µs/cm) gushes out from the river bed. Test drilling has revealed the possibility of extracting potable water (20.0°c, pH 7.0, EC 53 µs/cm), even in the geothermal area.

The main aquifers of the area, confirmed by test drilling, are found in layers of the fractured dacitic and andestic lavas and tuffaceous coarse sandstone, and the yielding capacity of the well is 12.62ℓ/s (200 GPM) with a drawdown of 70.3 meters. The static water level is 63.5 meters B.G.S.

One more well should be constructed to cover up the supply shortage of the municipality in 2010 which is estimated at $1,955m^3$/day (22.63ℓ/s). The site recommended for the additional well is shown in Fig. 9.1.8, however the final drilling point and depth shall be determined after conducting further detailed hydrogeological survey.

The estimated groundwater development potential and water balance of the area in 2010 are as follows:

- Recharge area	$18.0km^2$
- Annual rainfall	1,341mm
- Infiltration ratio	10.0%
- Groundwater potential	$6,613m^3$/day
- Total discharge in 2010	$3,182m^3$/day
(from deep wells)	($1,955m^3$/day)
(from springs)	($1,227m^3$/day)
- Balance	$3,431m^3$

(9) San Francisco La Union

The municipal area is situated in the intramountain basin of the Rio Salamá system, consisting of Pleistocene pumice sediments (upper aquifer) and Tertiary volcanic rocks. As described in Section 7.2.2 (3), the test drilling has revealed that this area is very difficult for groundwater development by deep well construction, due to the existence of a very porous unsaturated dry zone between the upper and lower aquifers (see Fig. 7.2.10 (1)).

Therefore, the upper aquifer development by the construction of a large but shallow well is recommended to be more effective and economical. Particularly, since the supply shortage of the municipality in 2010 is estimated to be small at 271m³/day (50 GPM). The site and design recommended for the shallow well are shown in Fig. 7.2.10 (2) and Fig. 9.1.9.

The estimated groundwater potential and water balance of the municipality in 2010 are as follows:

- Recharge area 6km²
- Annual rainfall 843mm
- Infiltration ratio 13.5%
- Groundwater potential 1,871m³/day
- Discharge in 2010 271m³/day
- Balance 1,600m³

(10) Génova

The municipal area is located on the flat plain at the foot of Quaternary volcanoes, consisting of pyroclastic rocks with thin lavas and volcanic mud flow layers.

The main aquifer of the area, confirmed by test drilling, is the fractured layer of andesitic lavas of Quaternary volcanic rocks and the yielding capacity is 12.62ℓ/s (200 GPM) with a drawdown of 88.36 meters. The static water level is 27.85 meter B.G.S.

The supply shortage of the municipality in 2010 which is estimated at 770m³/day (8.92ℓ/s) can be covered up by the production of the test well. The existing spring water source (3.03ℓ/s) should be utilized for agriculture instead.

The estimated groundwater potential and water balance of the area in 2010 are as follows:

- Recharge area 10km²
- Annual rainfall 3,640mm
- Infiltration ratio 15.0%
- Groundwater potential 14,959m³/day
- Pumping discharge 770m³/day
- Balance 14,189m³

7.3.3 Groundwater Level and Monitaring Plan

(1) Objectives of Monitoring

Groundwater resource development in this Study Area is in the initial stage, therefore, no monitoring system has been installed in any of the candidate municipalities.

The objectives of the groundwater monitoring required in the Study Area are summarized below:

- to collect basic hydrological data to analyze water balance in the hydrogeological basin, and to evaluate future groundwater development potential
- to collect basic hydrological and water quality data, as well as their long term variations, for a rational river basin management

(2) Installation of Groundwater Level and Rainfall Recorders

Automatic rainfall and groundwater level recorders were installed at the wells in the 3 municipalities of San José Pinula, San Pedro Sacatepéquez and Comalapa (See Fig. 2.6.1).

The monitoring results so far obtained by December 1994 are described below.

(a) San José Pinula Station

The groundwater level of the existing well in San José Pinula has been periodically measured by use of a handy water level detector from June 1994. This well was drilled by the municipal government to a depth of 213 m, but was abandoned because of low productivity, 0.76 ℓ/sec. The automatic water level recorder was installed at this well and a continuous record has been taken since November 16, 1994.

Fig. 7.3.1 shows the fluctuation in water level in the past 6 months. The groundwater level was around 32.16 m from June to September, and has gradually increased from October.

(b) San Pedro Sacatepéquez

The test drilling well in San Pedro Sacatepéquez was used for water level monitoring. Information on the well is as described in Section 7.2.2.

(c) Comalapa

Monitoring equipment was installed at the test drilling well in Comalapa. Information on the well is as described in Section 7.2.2.

Monitoring will be continued by INFOM, and the results will be utilized for water resources investigation in the future.

Table 7.3.1 Tentative Evaluation of the Groundwater Development Potentiality (1/2)

No.	Department	Municipality	A.RAIN (mm)	P.Area (km2)	Geology Type	Percentage BR	Tv	Qv	Qp	Qa	Potential (m3/day) by filtration	by base flow
1	Guatemala	Chinautla	1135	3	TVQP	10	-	-	90	-	1278	1296
2		Chuarrancho	1063	4	BR	-	-	-	-	-	-	-
3		Mixco	1197	16	TVQP2	-	80	-	20	-	5772	6912
4		San José del Golfo	1063	3.5	BR	40	60	-	-	-	693	1512
5		San José Pinula	1650	16	TVQP2	-	10	-	90	-	10488	6912
6		San Juan Sacatepéquez	1032	14	BR	70	-	-	30	-	2335	6048
7		San Raymundo	1122	7	BR	10	30	-	60	-	2626	3024
8		Santa Catarina Pinula	1343	12	TVQP	-	10	-	90	-	6400	5184
9		Villa Canales	1524	50	TVAL	-	60	-	40	-	25052	21600
10		Villa Nueva	1213	50	TVQP	-	-	-	100	-	24925	21600
11		San Pedro Ayampuc	1063	10	BR	80	20	-	-	-	1048	4320
12		San Pedro Sacatepéquez	1032	4	TVQP2	-	40	-	60	-	1470	1728
13	Sacatepéquez	Ciudad Vieja	992	15	QV	-	30	40	-	40	5300	6480
14		Jocotenango	1031	11.5	TVAL	-	80	-	20	-	3573	4968
15		Magdalena Milpas Altas	1031	4		-	60	-	40	-	1356	1728
16		San Antonio Aguas C.	992	5	TVAL	-	90	-	-	10	1359	2160
17		San Bartolome M. Altas	1031	3	TV	-	100	-	-	-	847	1296
18		Santa Lucía M. Altas	1031	2.5	TVQP2	-	20	-	80	-	989	1080
19		Santa María de Jesus	1229	14	QV	-	-	100	-	-	7071	6048
20		Santa Catarina Barahona	992	3	TVAL	-	70	-	-	30	815	1296
21	Chimaltenango	Comalapa	1414	16	TVQP2	-	40	-	60	-	8058	6912
22		El Tejar	1234	6	TVQP	-	60	-	40	-	2434	2592
23		Patzicia	1283	5.5	TVQP2	-	30	-	70	-	2610	2376
24		Patzun	1283	18	TVQP2	-	-	-	100	-	9491	7776
25		San Jose Poaquil	1272	6.5	TV	-	100	-	-	-	2265	2808
26		San Martín Jilotepeque	1272	7		-	-	-	100	-	3659	3024
27		Zaragoza	1283	7	TVQP2	-	60	-	40	-	2953	3024

Table 7.3.1 Tentative Evaluation of the Groundwater Development Potentiality (2/2)

No.	Department	Municipality	A.RAIN (mm)	P.Area (km2)	Geology Type	Percentage BR	Tv	Qv	Qp	Qa	Potential (m3/day) by filtration	by base flow
28	Sololá	Sololá	1081	18.5	TVQP2	-	10	-	90	-	7945	7992
29		Nahualá	1341	41	TVQP2	-	90	-	10	-	15816	17712
30		San Andres Semetabaj	1010	4	TVQP2	-	50	-	50	-	1384	1728
31		San Antonio Palopo	1010	2.5	TV	-	70	-	30	-	796	1080
32		San Juan la Laguna	1010	13		-	50	-	40	10	4317	5616
33		San Marcos la Laguna	1010	6	TVAL	-	90	-	-	10	1660	2592
34		San Pablo la Laguna	1010	6	TVAL	-	90	-	-	10	1660	2592
35		Santa Catarina Ixtahuaca	1341	16	TV	-	70	-	30	-	6760	6912
36		Santa Catarina Palopo	1010	3.5	TV	-	90	-	10	-	1017	1512
37		Santa Clara la Laguna	1010	3	TVQP2	-	10	-	90	-	1204	1296
38		Santa Cruz la Laguna	1010	2	TVAL	-	5	-	95	-	816	864
39		Santa Lucia Utatlán	1341	5	TVQP2	-	30	-	70	-	2480	2160
40	Totonicapán	Momostenango	1341	18	TV	-	100	-	-	-	6613	7776
41		San Andres Xecul	843	6	TVQP	-	50	-	50	-	1732	2592
42		San Francisco el Alto	1341	4.5	TVQP2	-	50	-	50	-	2067	1944
43	Quetzaltenango	Almolonga	1594	11	TVQP	-	70	-	30	-	5524	4752
44		Colomba	3423	5	QV	-	-	100	-	-	7034	2160
45		Concepcion Chiquirichapa	2100	10.5	TVQP2	-	70	-	30	-	6947	4536
46		Cajola	1057	34	TVQP	-	95	-	5	-	10092	14688
47		Flores Costa Cuca	3640	9	QV	-	-	100	-	-	13463	3888
48		Génova	3640	10	QV	-	-	100	-	-	14959	4320
49		Huitan	936	5.5	BR	50	50	-	-	-	846	2376
50		Olintepeque	843	3.5	TVQP	-	70	-	30	-	930	1512
51		Palestina de los Altos	1027	17	TV	-	70	-	30	-	5501	7344
52		San Carlos Sija	1027	18	TVQP2	30	30	-	40	-	4862	7776
53		San Francisco la Union	843	6	TVQP2	-	30	-	70	-	1871	2592
54		San M. Sacatepéquez	2100	10	TVQP	-	80	-	20	-	6329	4320

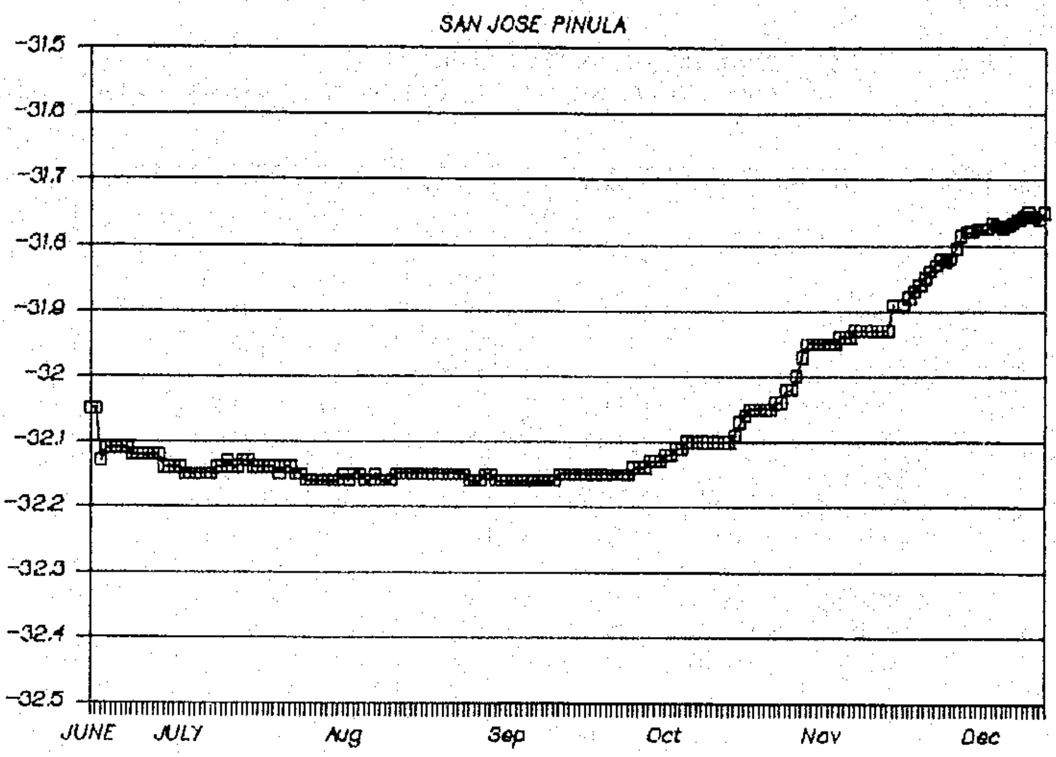


Fig 7.3.1 Daily Groundwater Level in San Jose Pinula