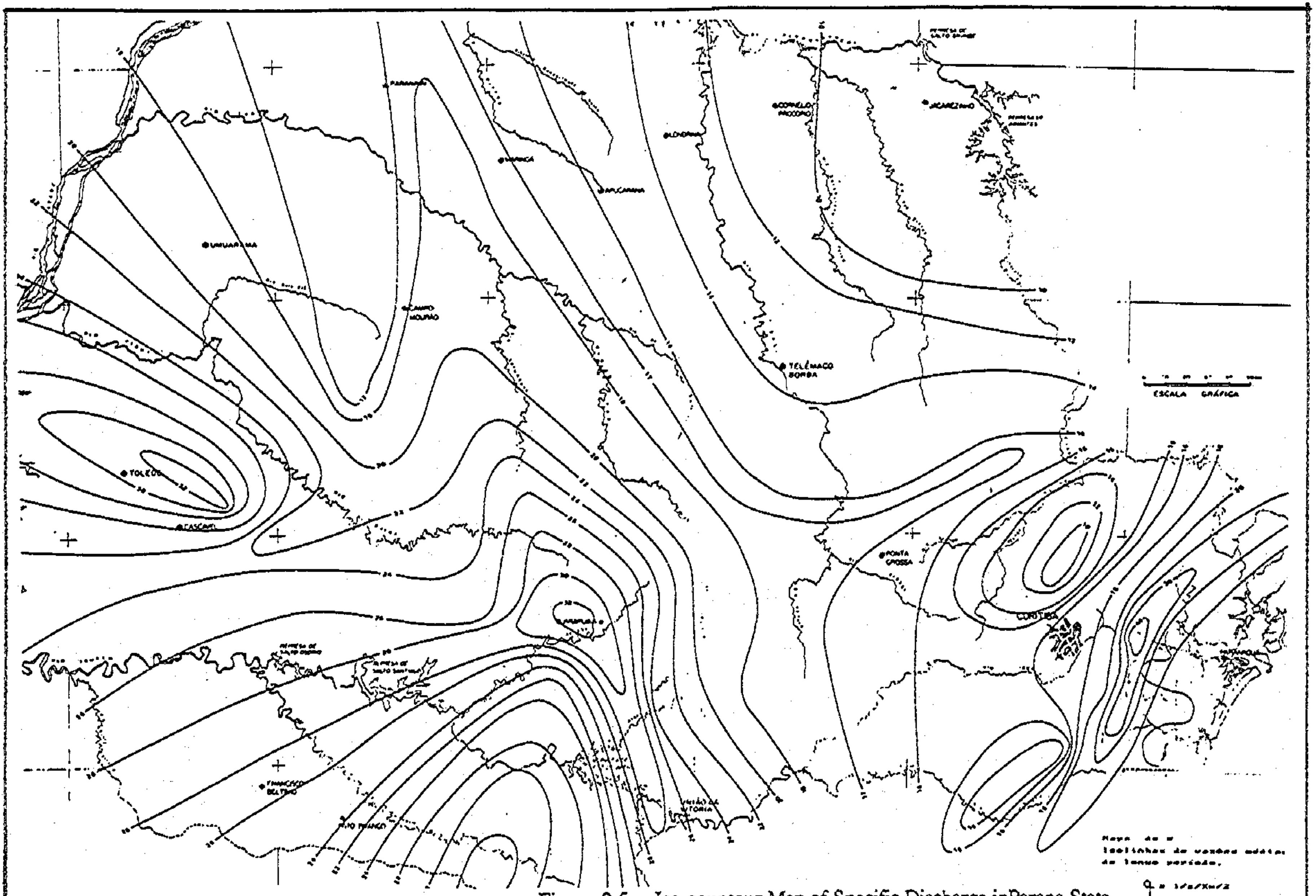


Figure-2.5 Iso-countour Map of Specific Discharge inParana State

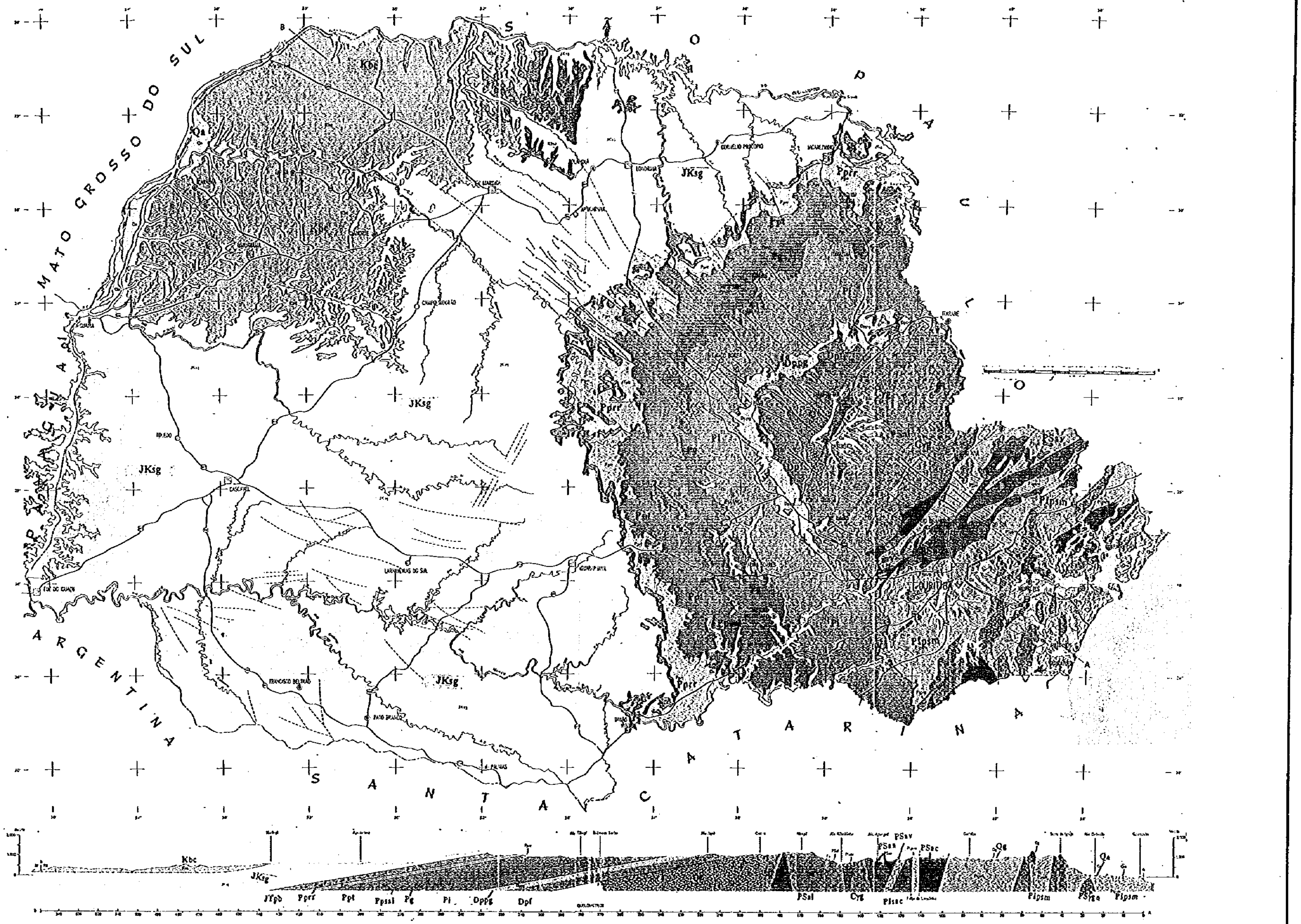


Figure-3.1 Geological Map of Parana State
(MINEROPAL:1986)

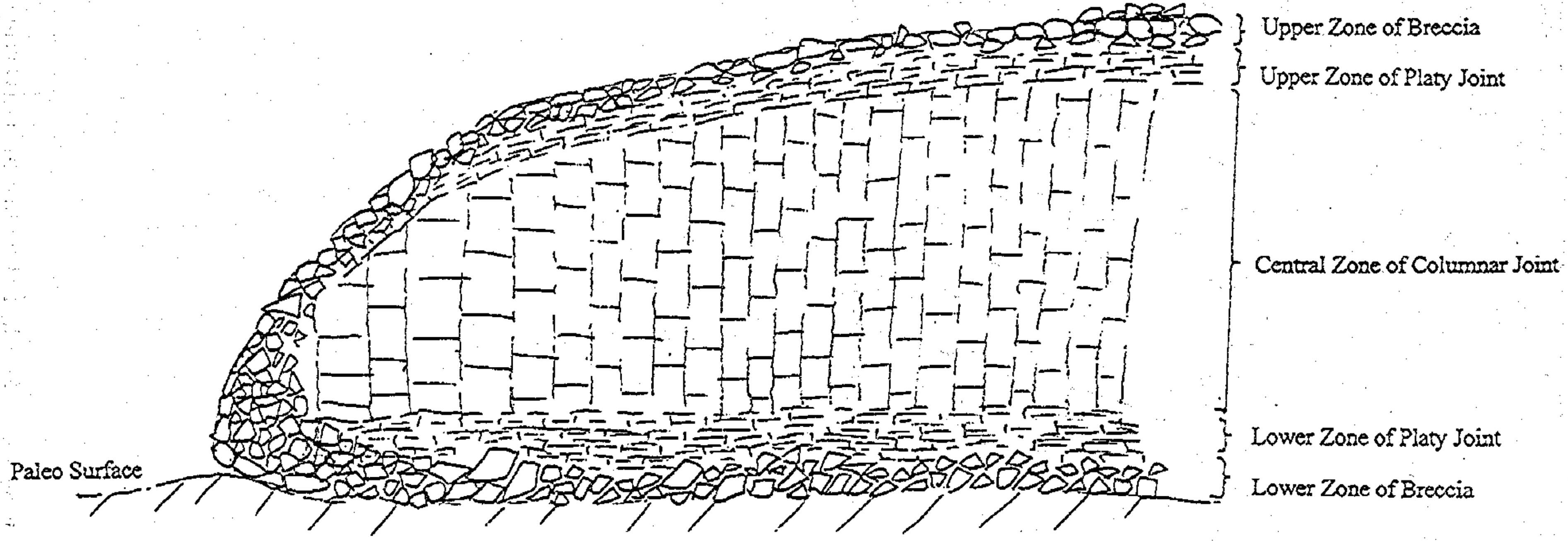


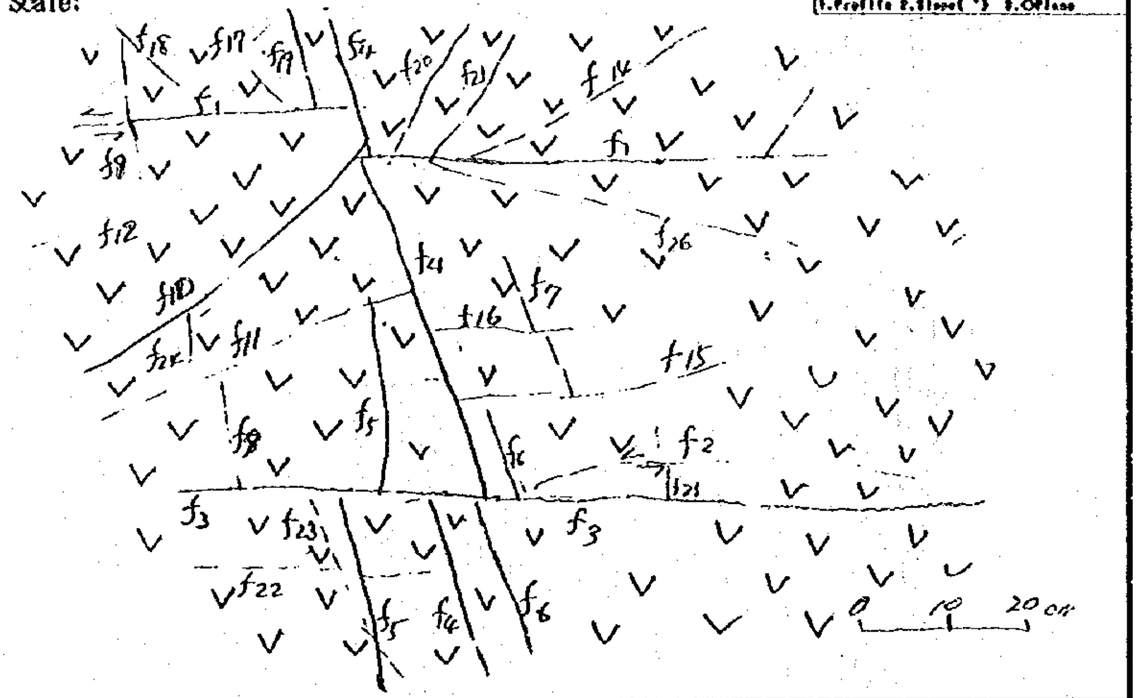
Figure-3.2 Typical Occurrence of Basalt Lava in Serra Geral Formation

CARD OF FRACTURE OBSERVATION

Outcrop No.	1	Site	Rio Bezerra en Cascavel	Unit No		Sample No		Obsever	K, Nakano
Strike & Dip /Bedding		Rock & Discription	Rock Name:	Basalto por Centro Mayor, Form. Serra Geral brownish weathered & demagnetized hypocrstalline basalt					

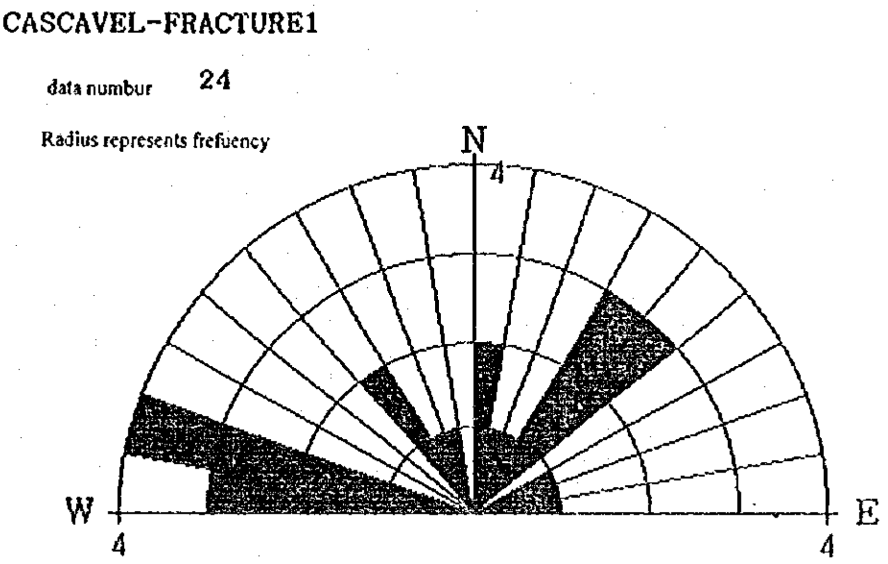
SKETCH Scale:

1. Profile 2. Slope(°) 3. Plane

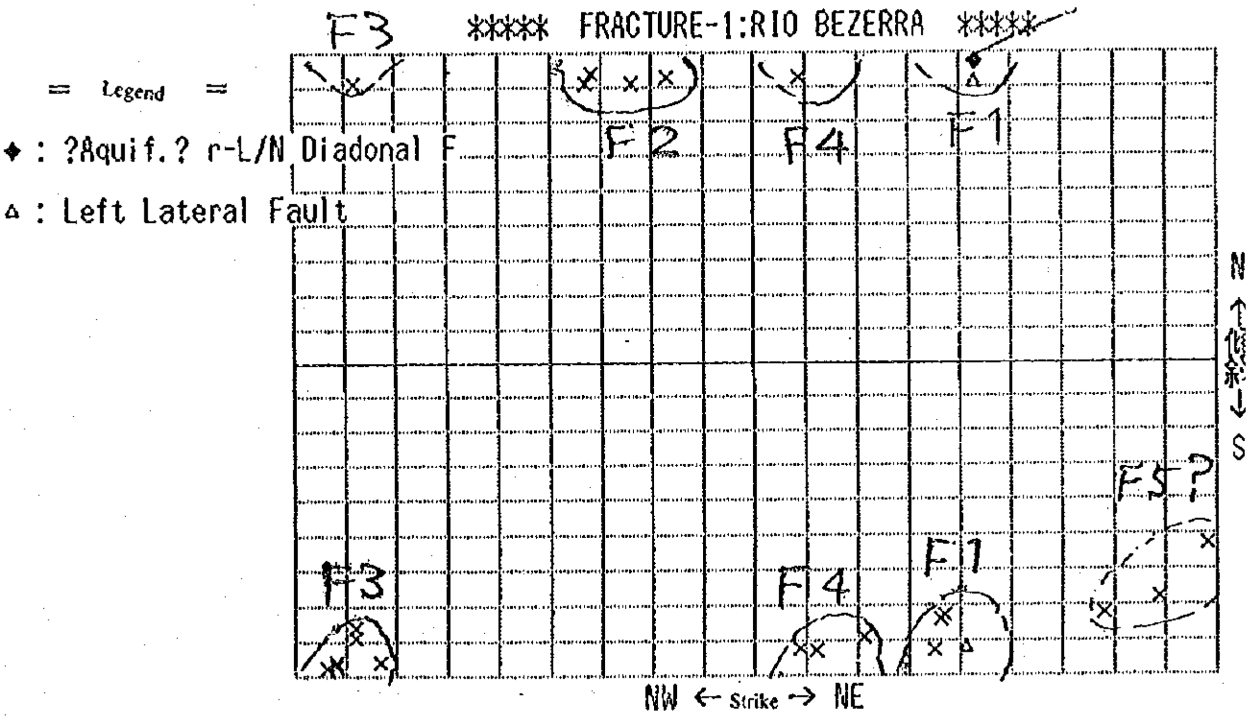


Serial No	Frac No	Strike	Dip	Shape	Widness	Consolidation	Material/Fra	Exist/ Fracturing	Trans (mm)	Old/New of Frac	Slickenside & Striation	Direction /Striation	Sense /Move	Conj. Set	Relation/ Neighbors	Indication /Boring	Conceal
1	f-1	N43E	81N	str	4	con	lm	-	6	f9, f19	O⁻	-	l-	-	-	—	
2	f-2	N41E	82N	gc	1	con	lm	-	4	f25	O⁻	-	l-	-	-	—	
3	f-3	N43E	87N	str	2	con	lm	-	60	f5, f4, f	OO	169	r	-	-	file·FeOx(OH	open space
4	f-4	N82W	87W	gc	2	con	cl-lm	-	40	f7	OO	129	rN-D	-	-	—	
5	f-5	N78W	79S	c	2	con	-	-	-	-	O⁻	-	-	-	-	—	
6	f-6	N82W	86S	gc	1	con	-	-	-	-	O⁻	-	-	-	-	—	
7	f-7	N88E	53S	gc	1	con	-	-	-	-	O⁻	-	-	-	-	—	
8	f-8	N84W	88S	gc	1	con	-	-	-	-	O⁻	-	-	-	-	—	
9	f-9	N73W	86S	gc	2	con	-	-	-	-	O⁻	-	-	-	-	—	
10	f-10	N9E	87E	gc	1	con											
11	f-11	N21E	79E	gc	1	con											
12	f-12	N12E	83E	gc	1	con											
13	f-13																
14	f-14	N9E	83W	gc	1	con											
15	f-15	N35E	83E	gc	1	con											
16	f-16	N36E	74E	gc	1	con											
17	f-17	N32W	84E	gc	1	con											
18	f-18	N68E	72S	gc	1	con											
19	f-19	N79E	68S	gc	1	con											
20	f-20	N33W	81N	gc	1	con											
21	f-21	N24W	81N	gc	1	con											
22	f-22	N37E	73E	gc	1	con					O⁻						
23	f-23	N78W	76S	gc	1	con					O⁻						
24	f-24	N78W	81N	gc	1	con					O⁻						
25	f-25	N17W	83N	gc	1	con					--						

Figure-3.3 Sketch of Micro-fractures in a Outcrop of Cascavel

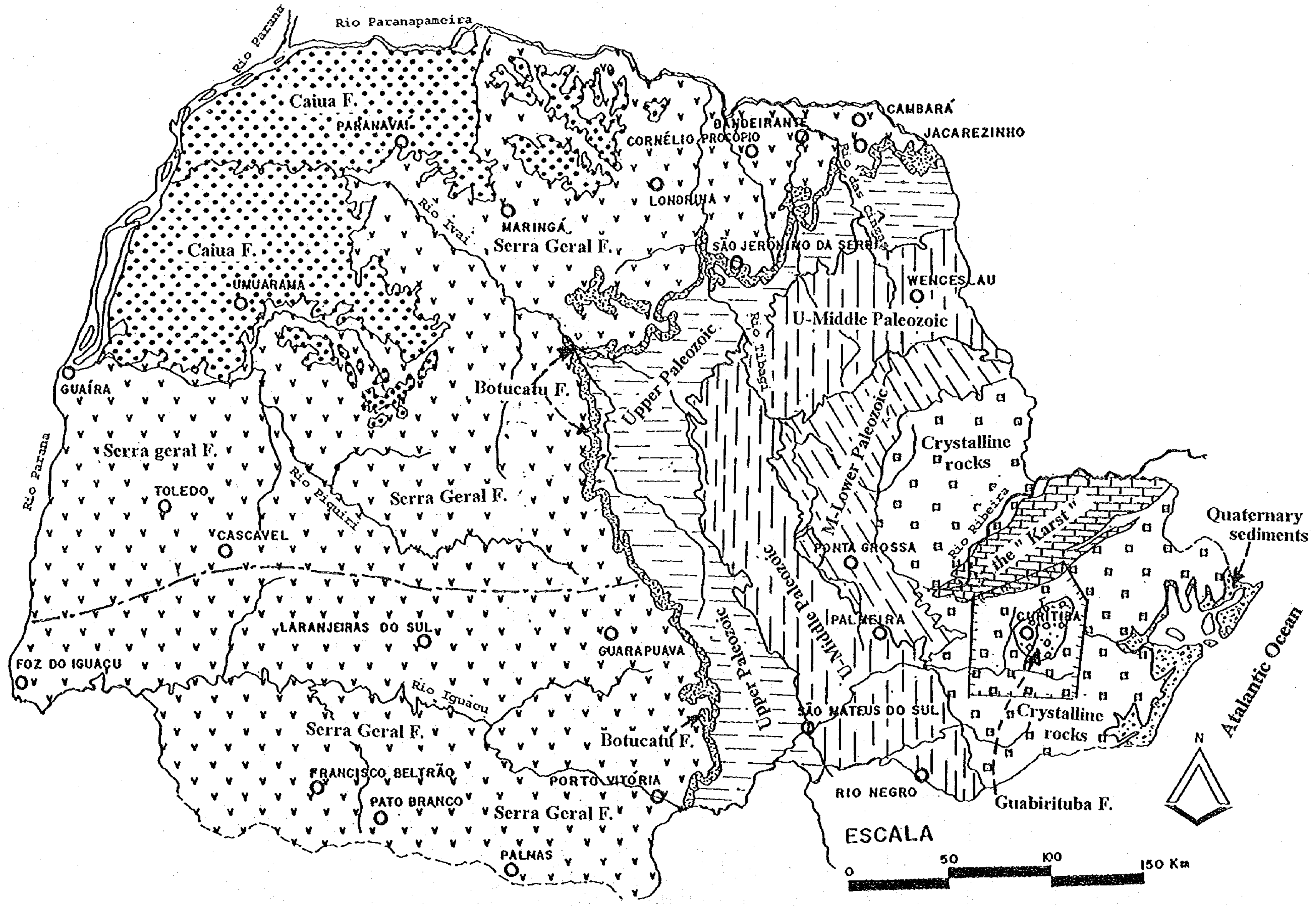


ROSE DIAGRAM



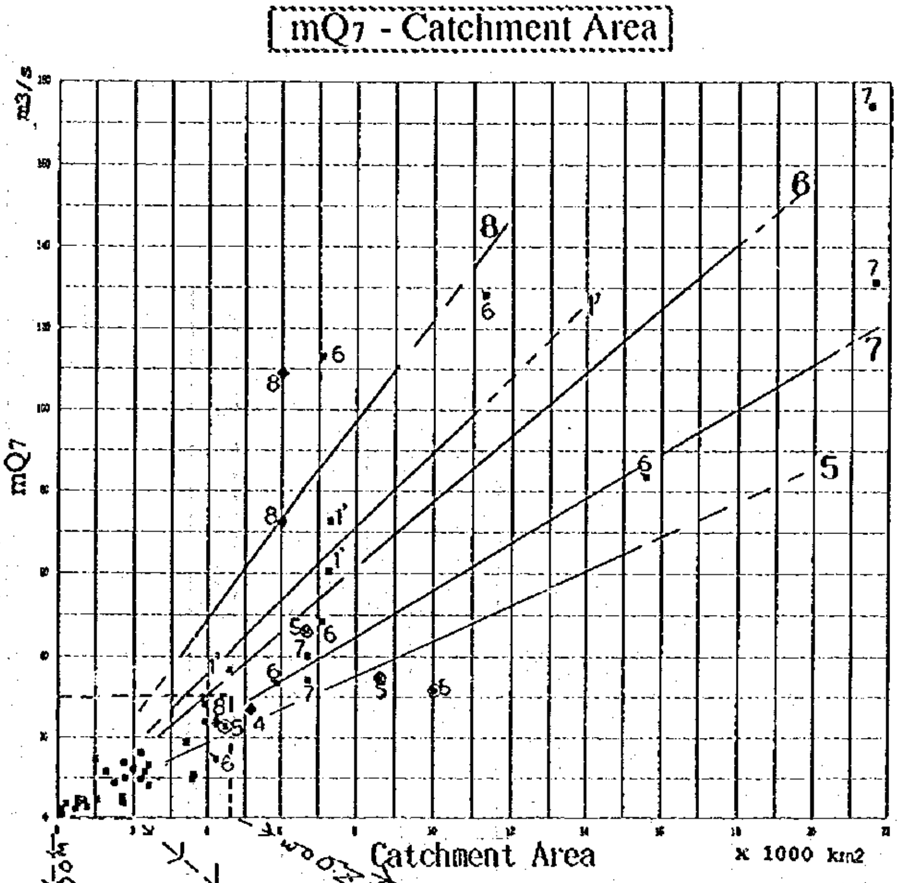
FRACTURE GROUPINO METHD (NAKANO:1988)

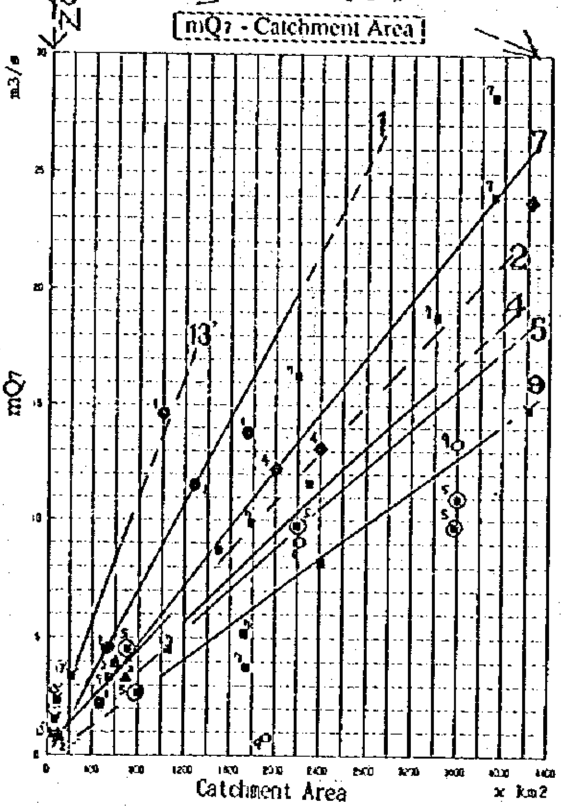
Figure-3.4 Analysis Result of Micro-fractures in Outcrop



(from Geological map of MINEROPAR (1986), figure of Dr. Fraga (1993))

Figure-5.1 Aquifer Distribution of Parana State





No	Aquifer	Low Discharge
1: ●	the Karast in Acungui & Setuva G.	785 m3/d/km2 9.09 l/s/km2
2: ▲	the Granitios in Pre-Ordovicien	550 m3/d/km2 6.37 l/s/km2
4: ◆	Mid-Late Paleozoio Itarete/Guata G.	405 m3/d/km2 4.69 l/s/km2
5: ◉	Late Paleozoic Passa dois G.	403 m3/d/km2 4.66 l/s/km2
6: ■	Northern part of Botucatu & Serra Geral F.	672 m3/d/km2 7.78 l/s/km2
7: ■ ◆	Southern part of Botucatu & Serra Geral F.	460 m3/d/km2 5.56 l/s/km2
8: ◆	Caiua Formation	1056 m3/d/km2 12.22 l/s/km2
9: ○	(Metropolitan Curitiba Area :)	305 m3/d/km2 3.53 l/s/km2
13': ■	the Crystalline rocks in the Coarstal Range	1166 m3/d/km2 13.5 l/s/km2
1': ●	(RIBEIRA BASIN : the Karst and Granitics)	778 m3/d/km2 9 l/s/km2

Figure-4.1 Relationship Between mQ7 and Catchment Area

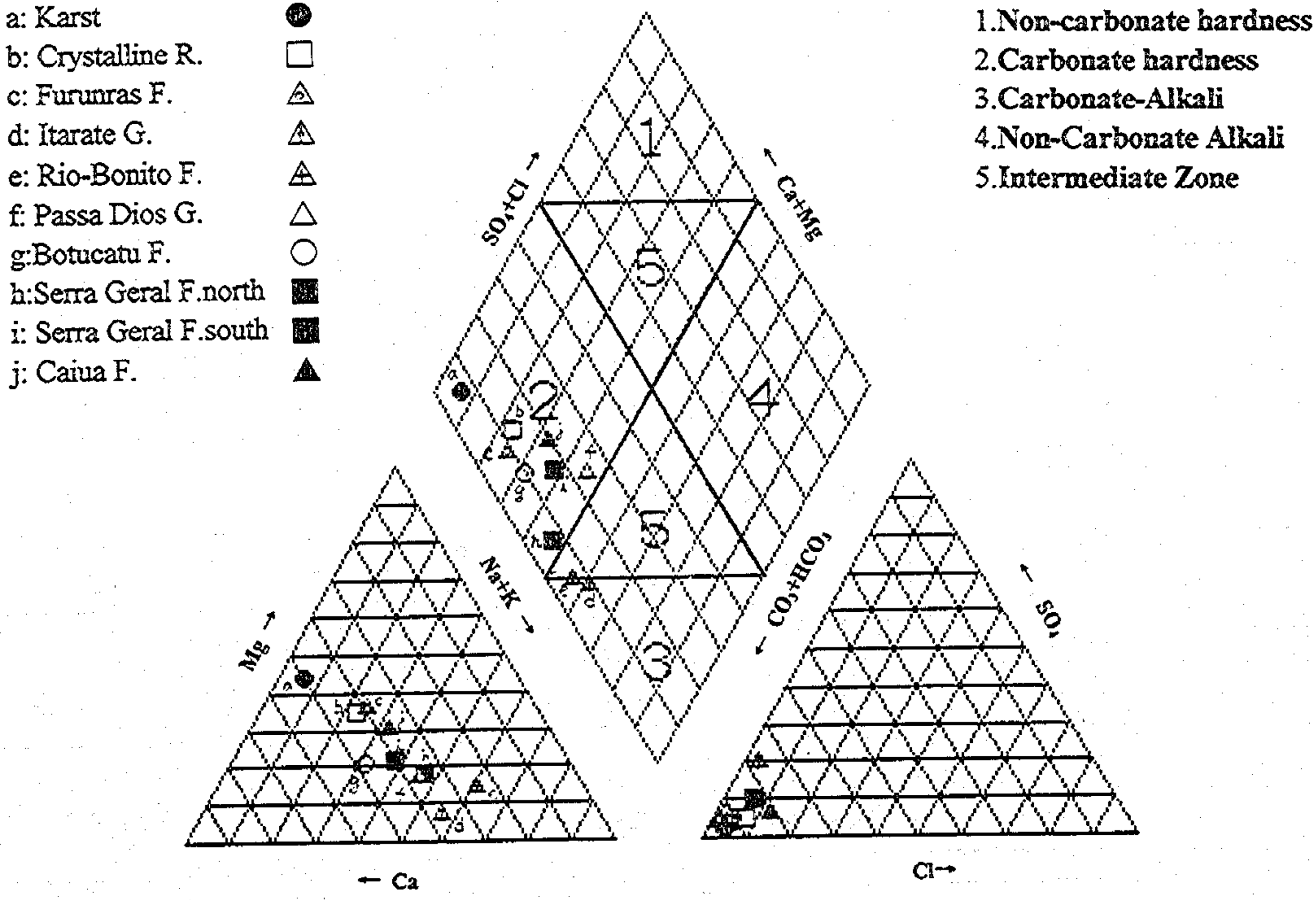


Figure-5.2 Trilinear Diagram for Principal Aquifers

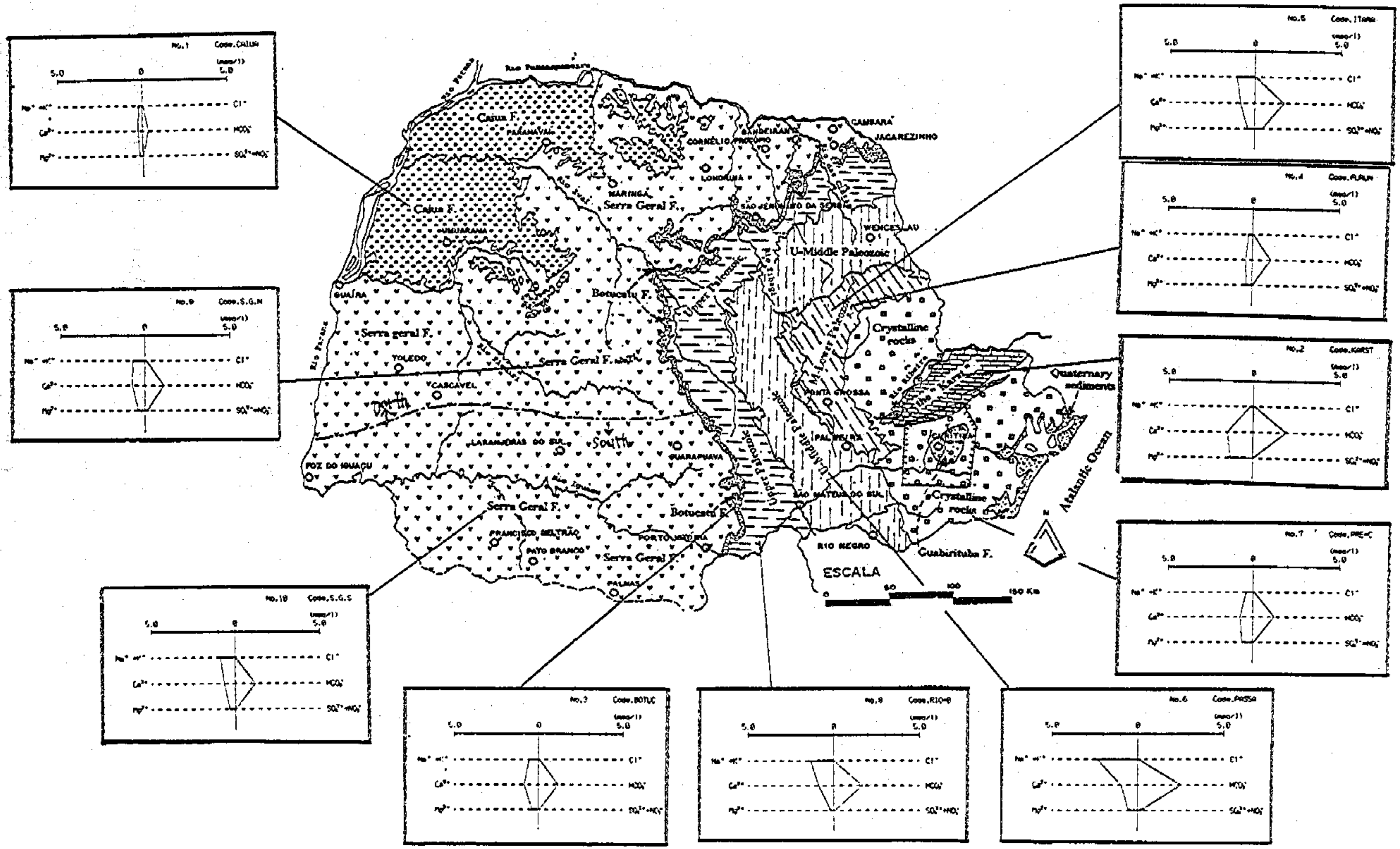
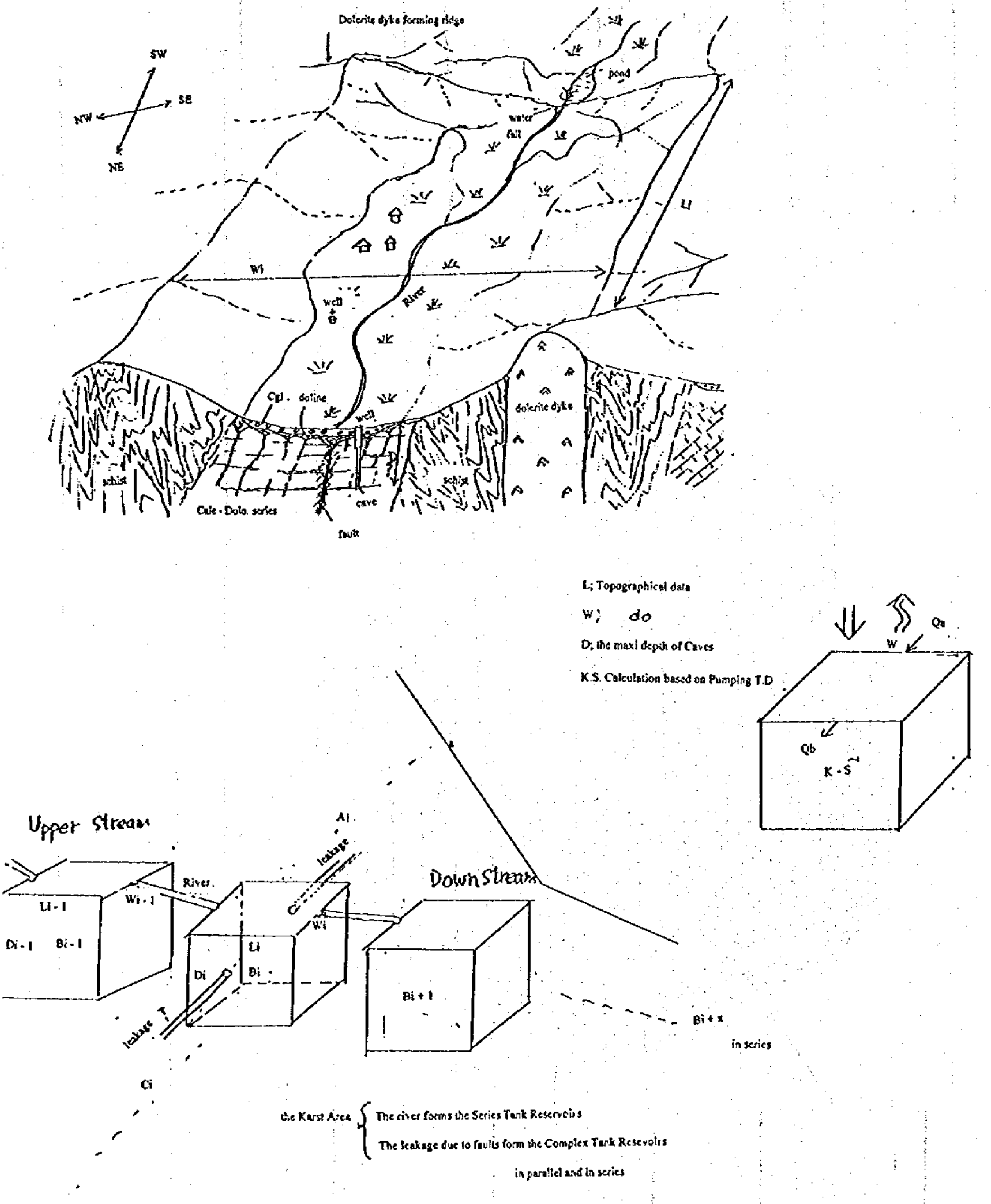


Figure-5.3 Pattern Diagrams of Respective Aquifers



L; Topographical data

W; do

D; the maxi depth of Caves

K.S. Calculation based on Pumping T.D

the Karst Area { The river forms the Series Tank Reservoirs
The leakage due to faults form the Complex Tank Resevoirs in parallel and in series

Figure-5.4 Aquifer Model of "Karst" Area

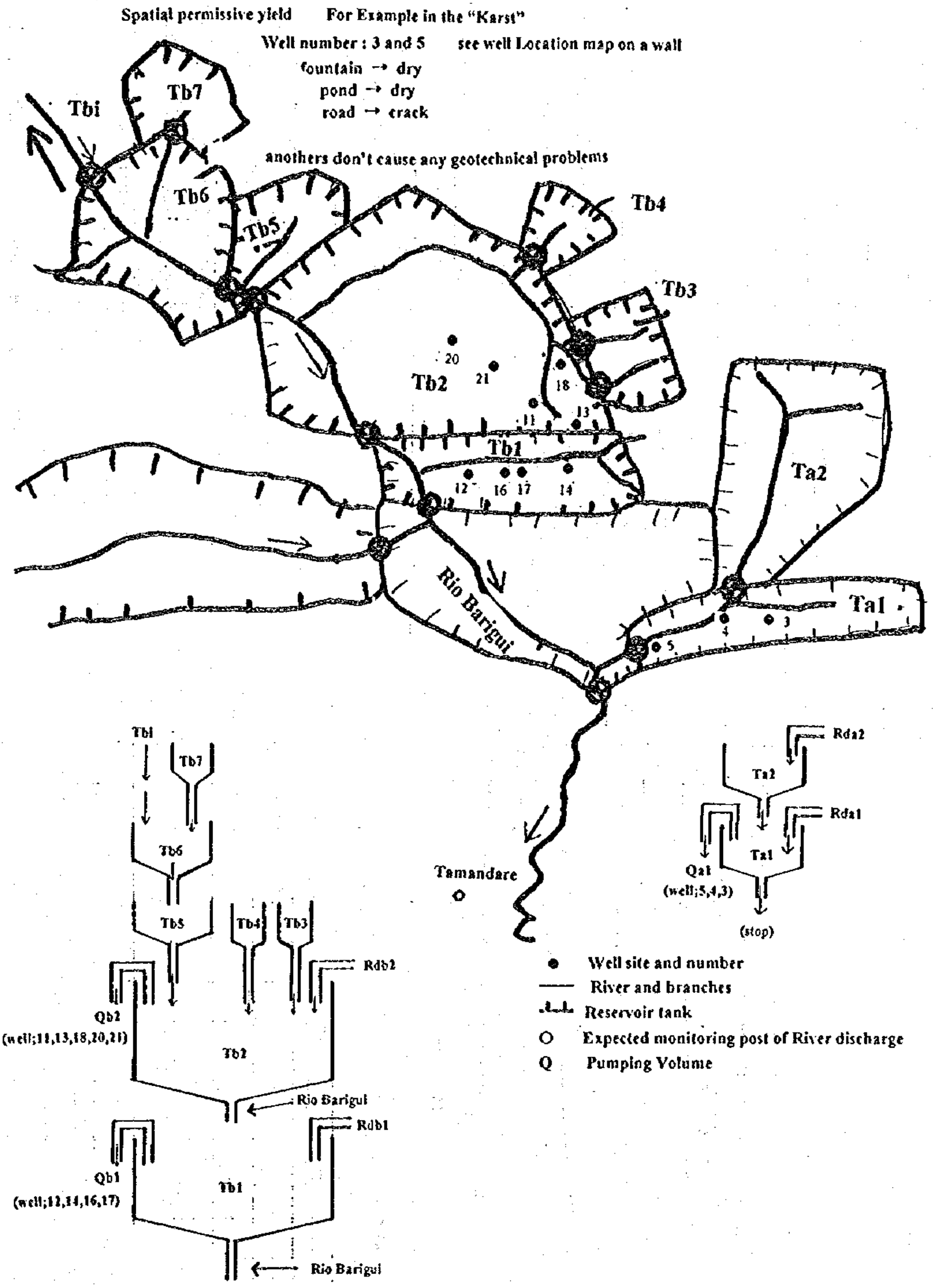
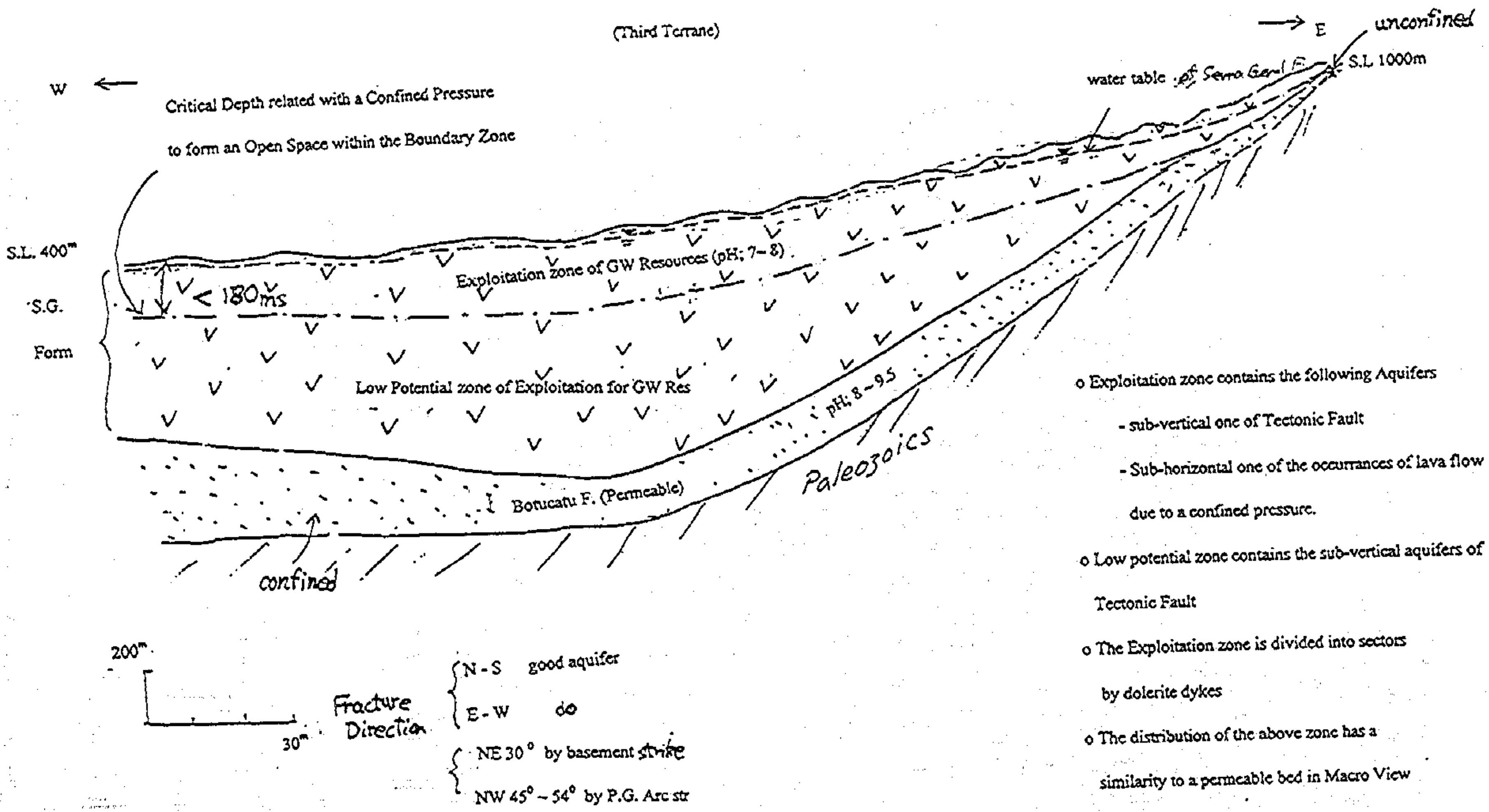
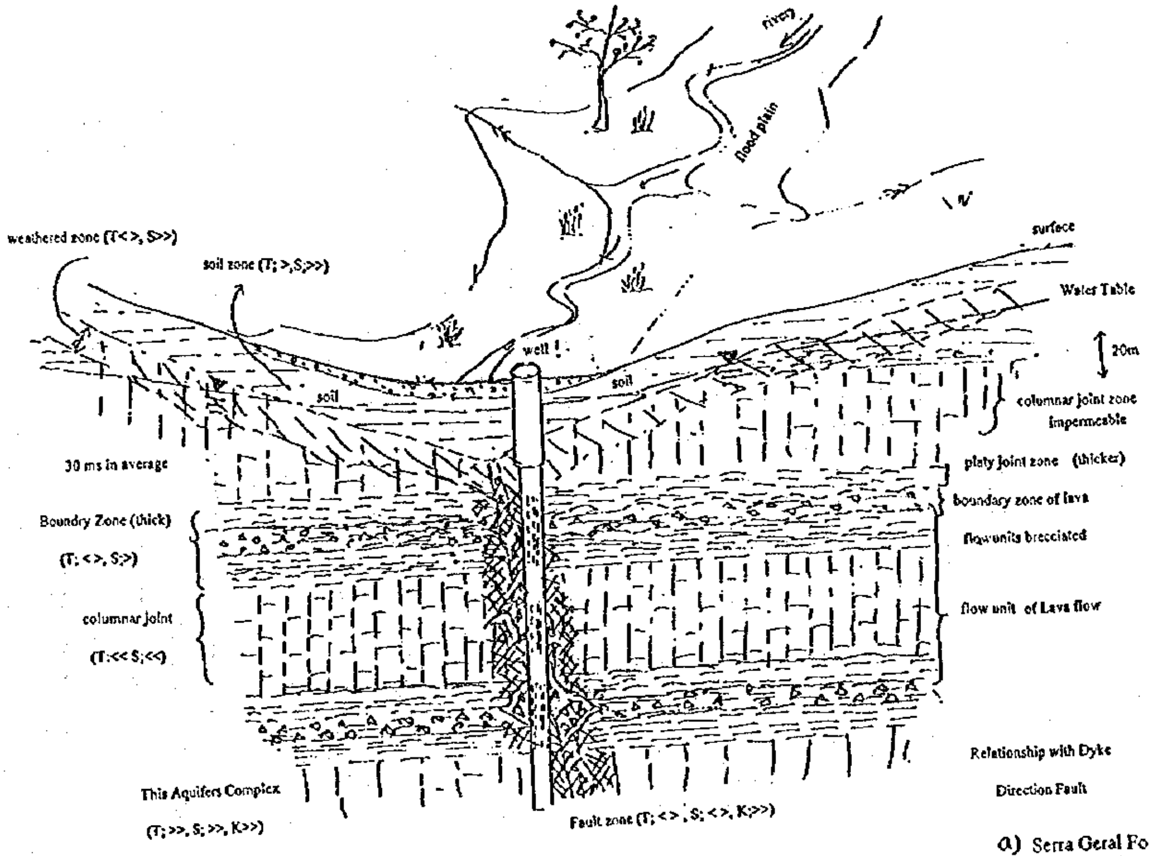


Figure-5.5 Tank Model of Transitional Groundwater Resources of "Karst"

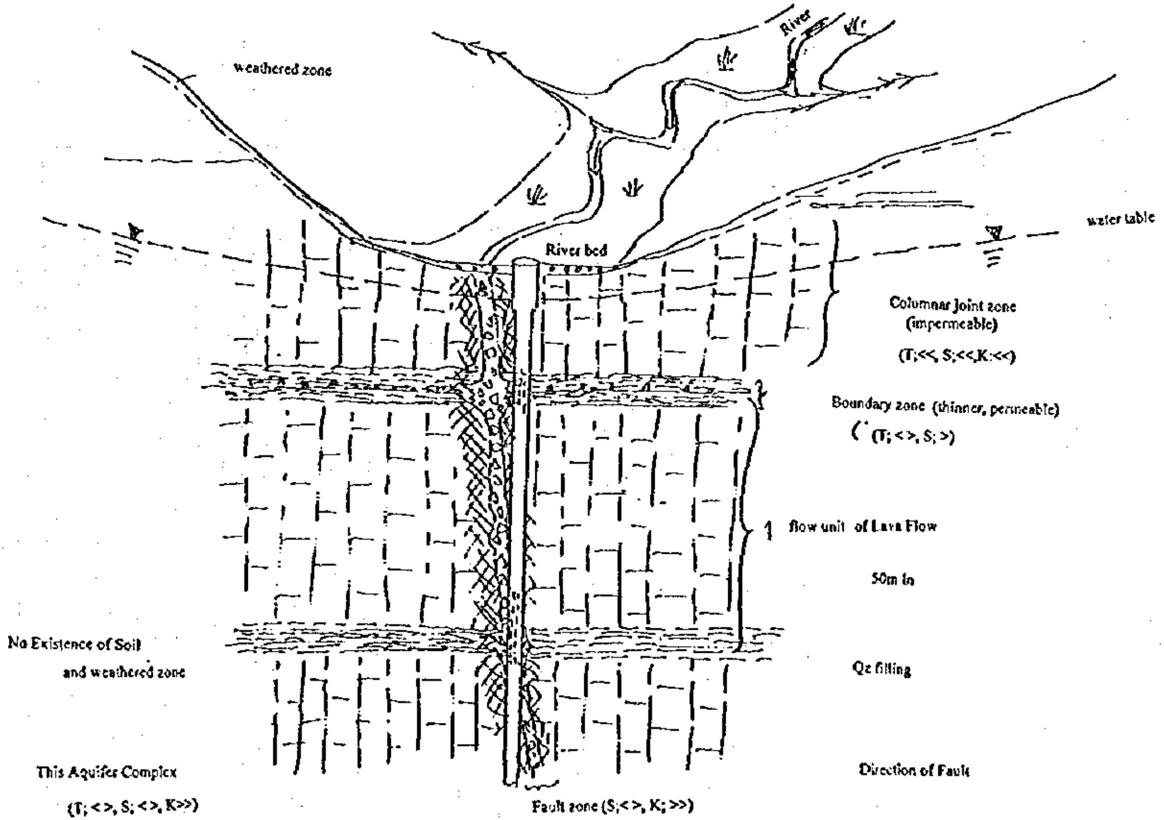


- o Exploitation zone contains the following Aquifers
  - sub-vertical one of Tectonic Fault
  - Sub-horizontal one of the occurrances of lava flow due to a confined pressure.
- o Low potential zone contains the sub-vertical aquifers of Tectonic Fault
- o The Exploitation zone is divided into sectors by dolerite dykes
- o The distribution of the above zone has a similarity to a permeable bed in Macro View
- o In Macro view, the North area and the South area look similar in layering of the aquifer and Tectonic fault, except soil and weathered zone
- o Hydrogeological

Figure-5.6 Reservoir models of Botucatu Formation

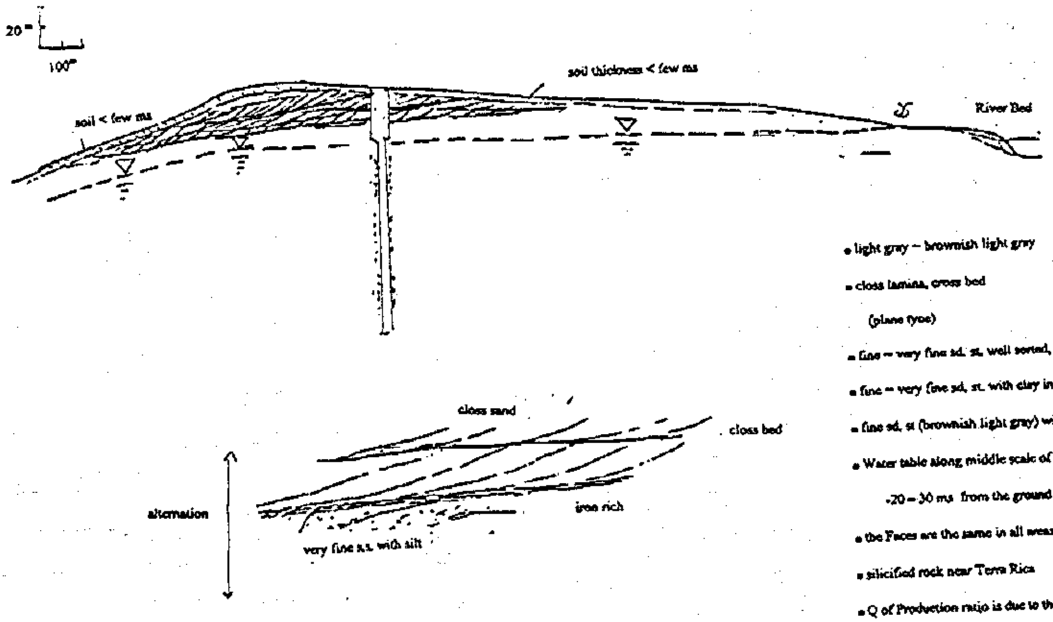


a) Serra Geral Form. (Norte)
(Drilling Site)



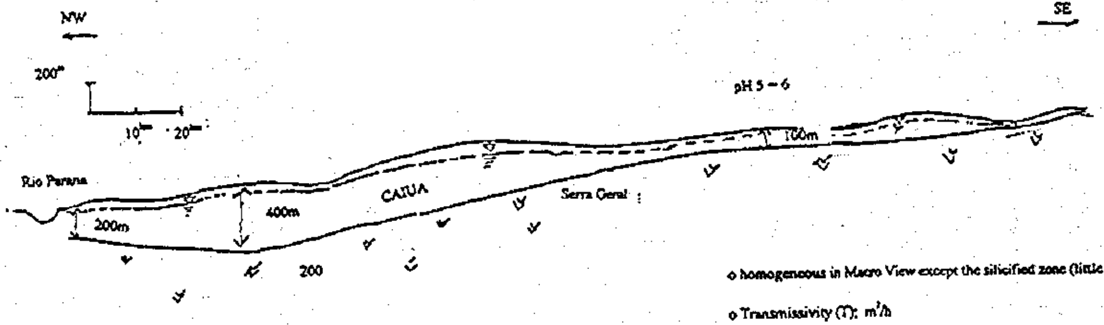
b) Serra Geral Form. (S'!: ˉ)

Figure-5.7 Aquifer Model of Northern Area and Southern Area in Serra Geral Formation



- light gray – brownish light gray
- closs lamina, cross bed
  (plane type)
- fine – very fine sd. st. well sorted, intercalated below; Aquifers
- fine – very fine sd, st. with clay in the matrix ; no
- fine sd, st (brownish light gray) with much magnetite ; no
- Water table along middle scale of Topography
  -20 – 30 ms from the ground surface
- the Faces are the same in all areas
- silicified rock near Terra Rica
- Q of Production ratio is due to the well depth in the saturated zone

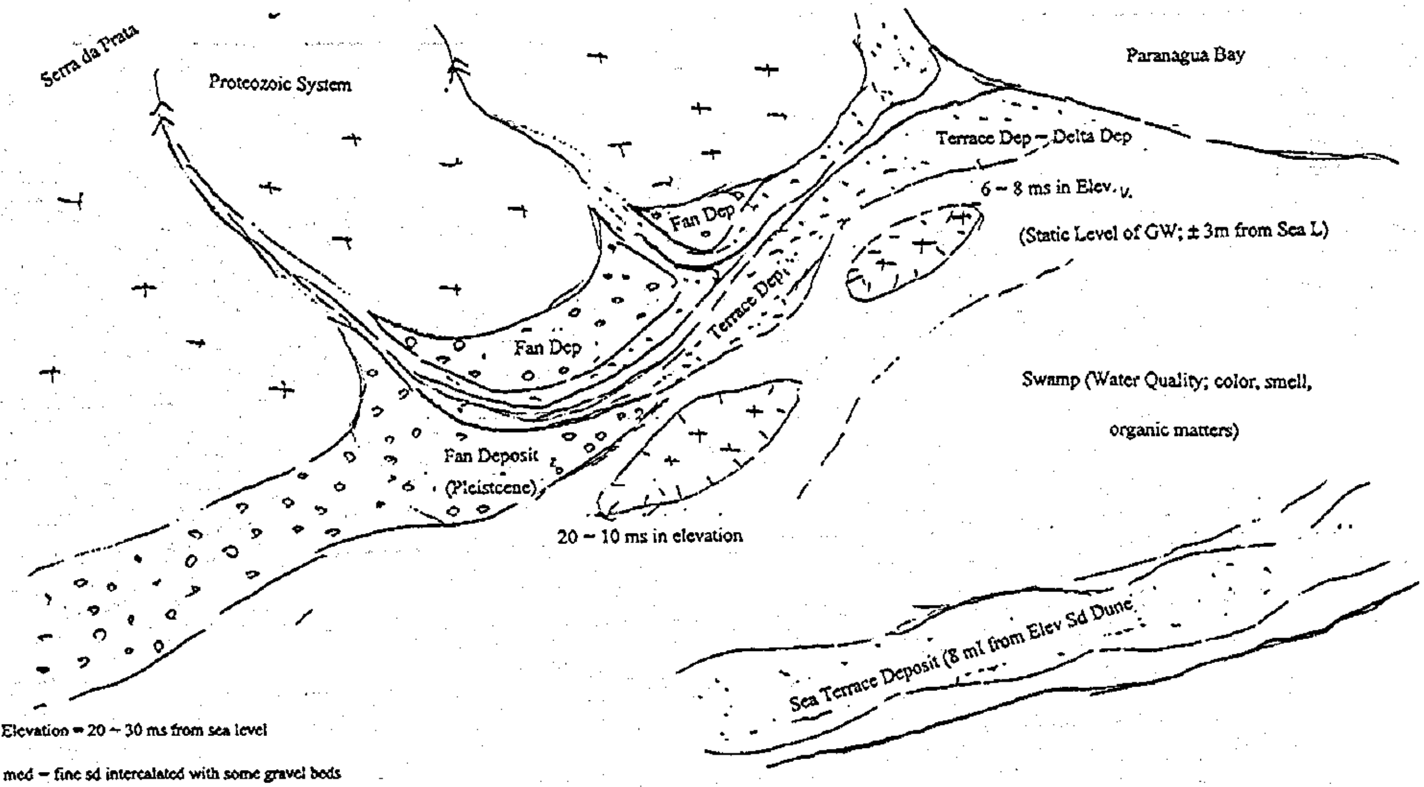
Fig. 2-4 Aquifer Model of CAJUA Formation



- o Static water table
- o Thickness of Caiua Formation (profiles)

- o homogeneous in Macro View except the silicified zone (little exposure)
- o Transmissivity (T): m^3/h
- o Specific Capacity (Sc); $m^3/h,m$
- o Storativity (S);
- o Coefficient of permeability (K); m/h

Figure-5.8 Aquifer Model of Caiua Formation



o Fan Dep 1) Elevation = 20 ~ 30 ms from sea level

2) med ~ fine sd intercalated with some gravel beds

3) high permeability (RZ $10^{-10\,cm/sec}$)

4) Pleistocene ~ Pliocene (?)

o Terrace Dep 1) Elevation = 15 ~ 8 ms. from S.L.

2) fine sd (~ med) intercalated silty matrix sd. and granule ~ pebble gravel beds.

3) good permeability (10^{-1} ZR Z$10^{-3cm/sec}$)

4) Late Pleistocene (?)

o Sd. Dune 1) Elevation < 8 ms. I from S.L.

2) fine sd intercalated with some gray clay layers deposited in lagoon enviroment

3) moderate permeability (R=10^{-2} ± cm/sec)

4) Late Pleistocene

Figure-5.9 Aquifer Model of Quaternary Fan Deposits

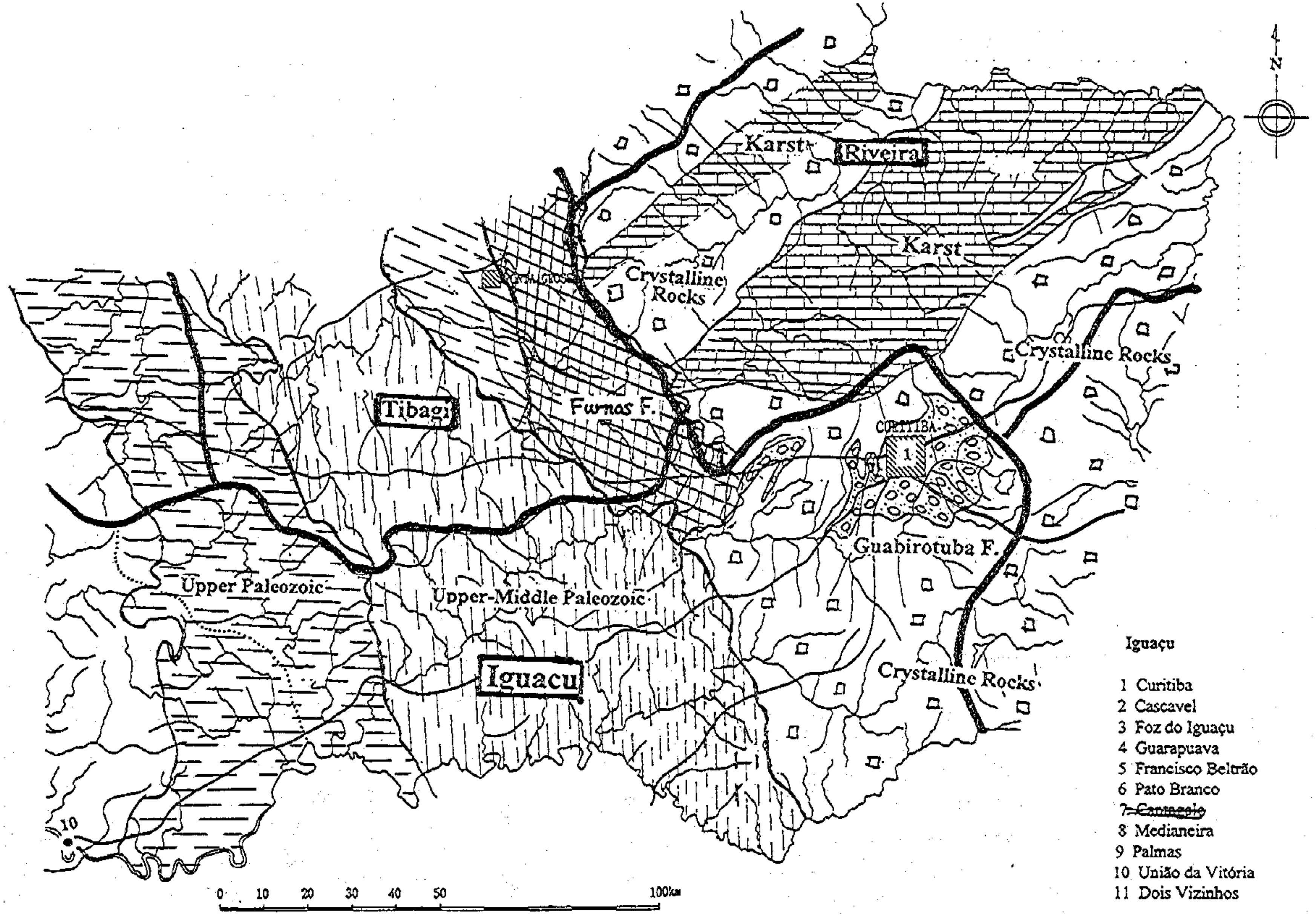


Figure-6.1 Aquifer Distribution in Iguacu Pilot Basin (1/3)

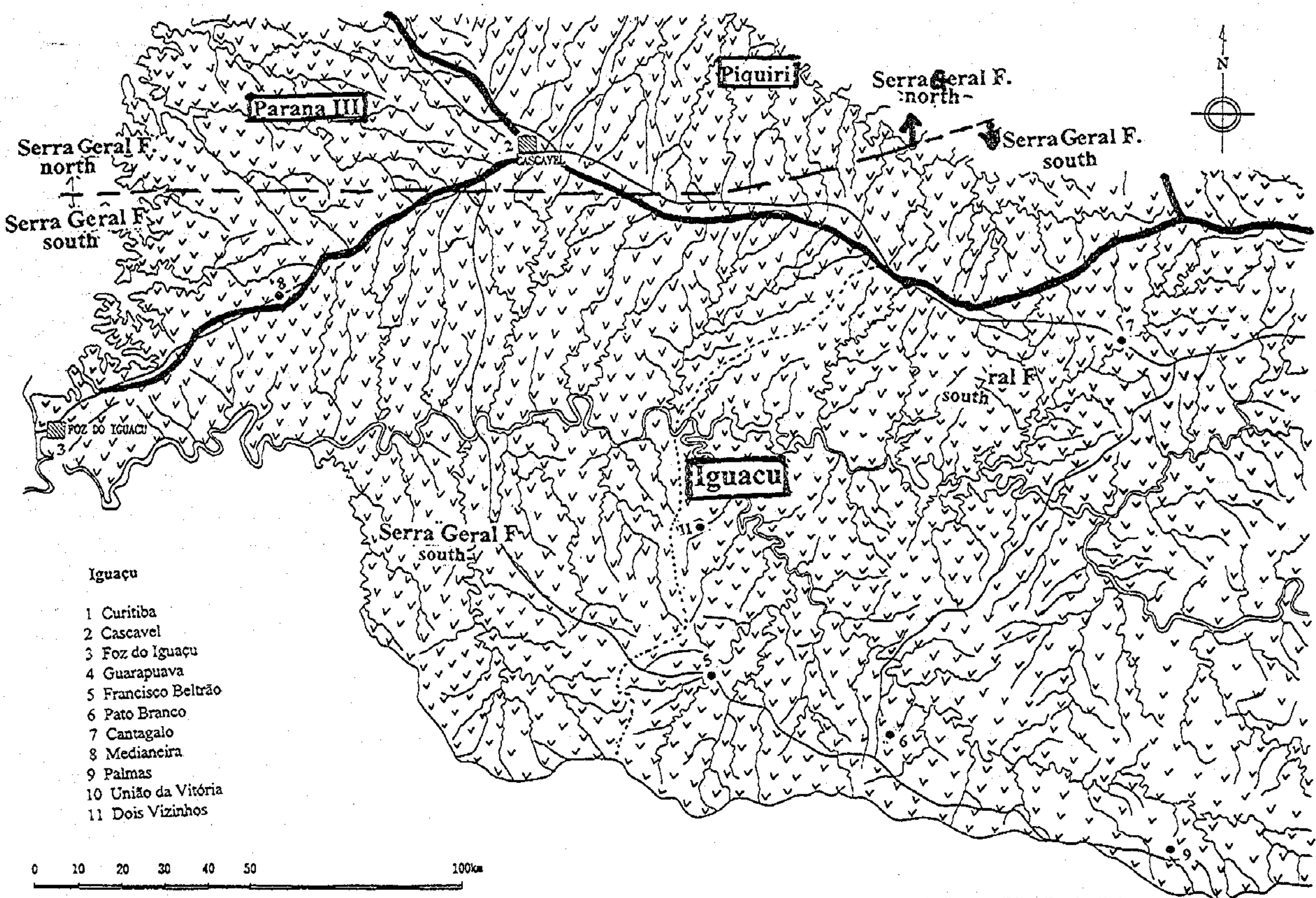


Figure-6.1 Aquifer Distribution in Iguacu Pilot Basin (2/3)

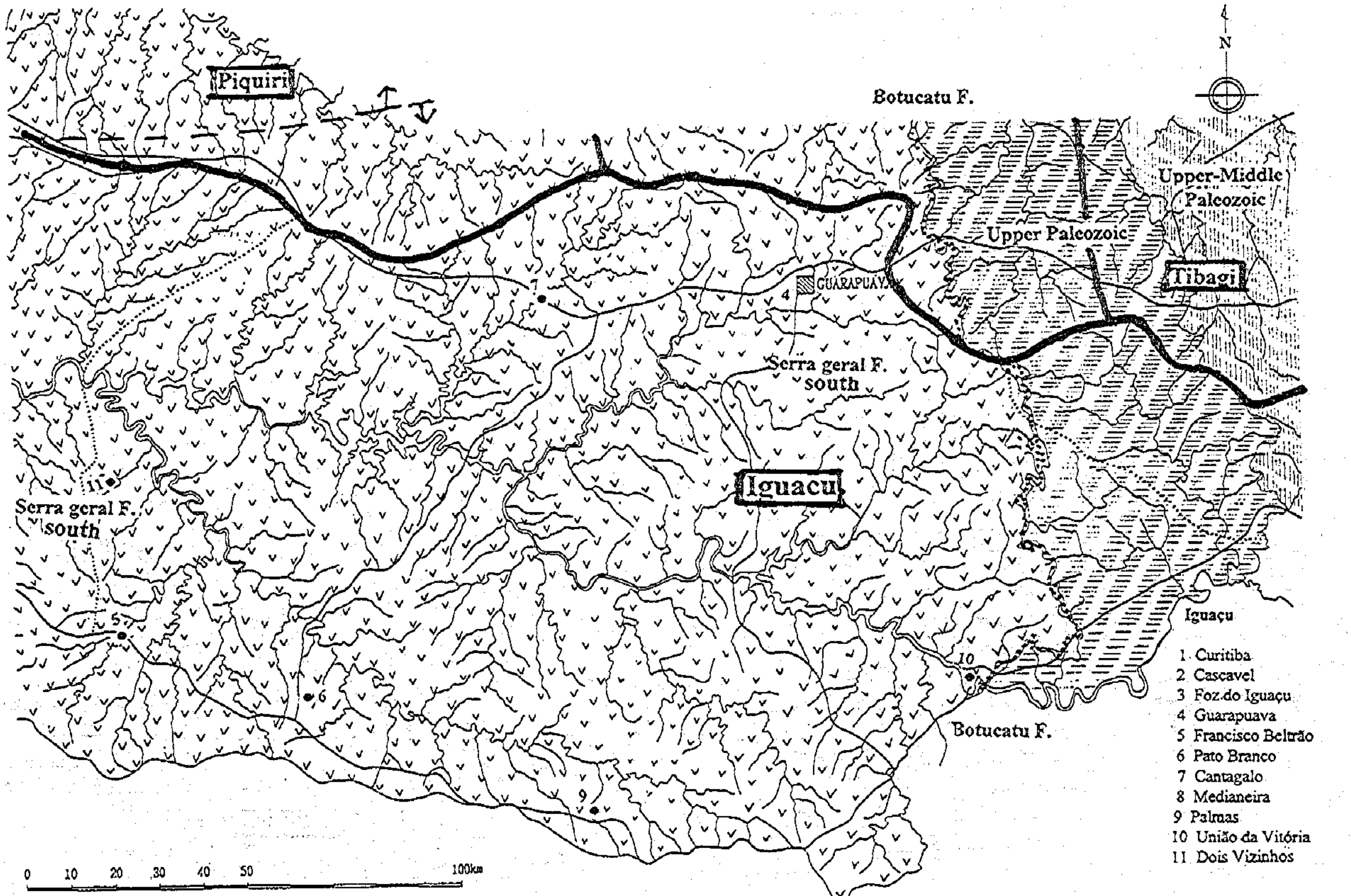


Figure-6.1 Aquifer Distribution in Iguacu Pilot Basin (3/3)

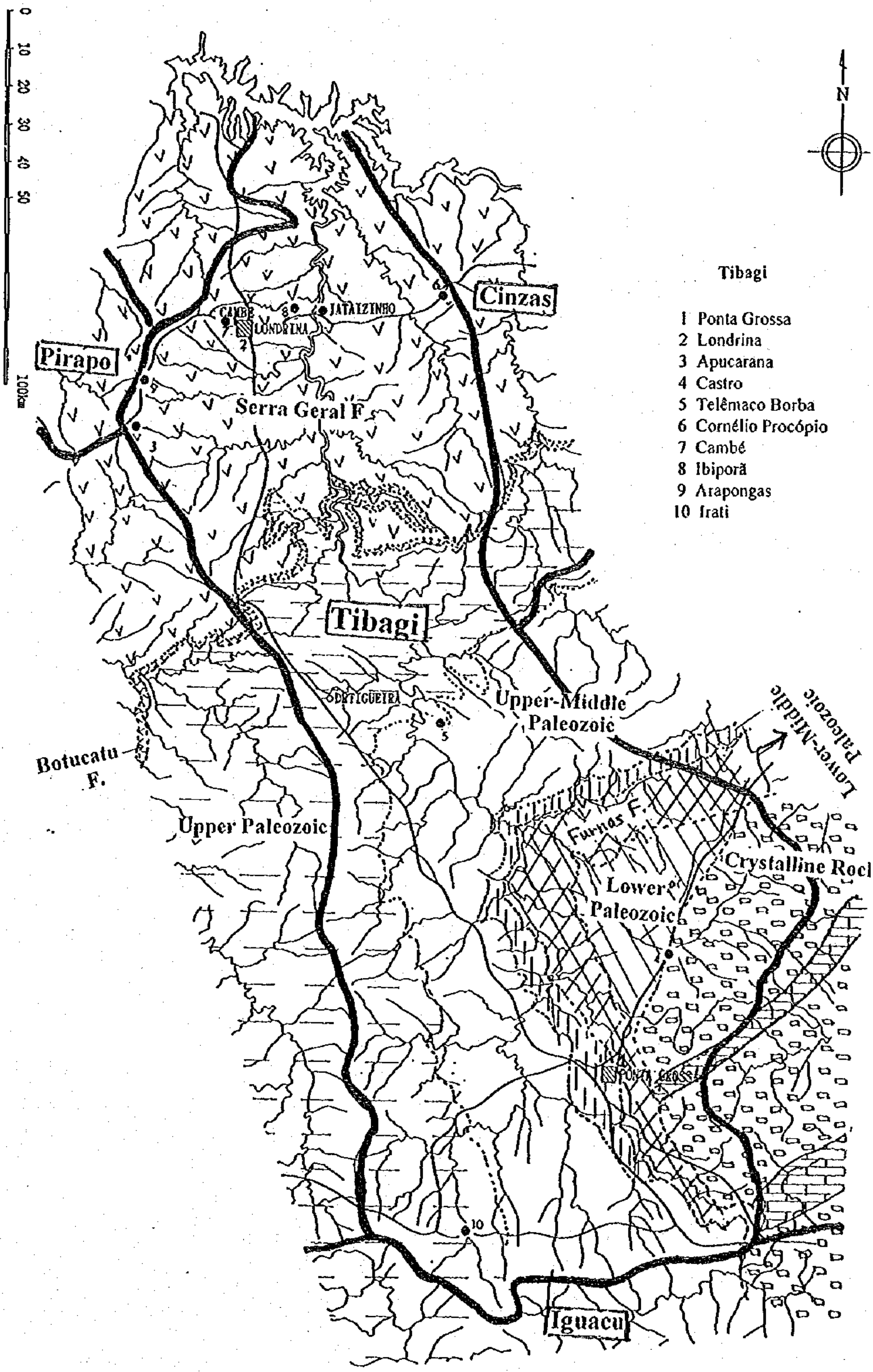


Figure-6.2 Aquifer Distribution in Tibagi Pilot Basi

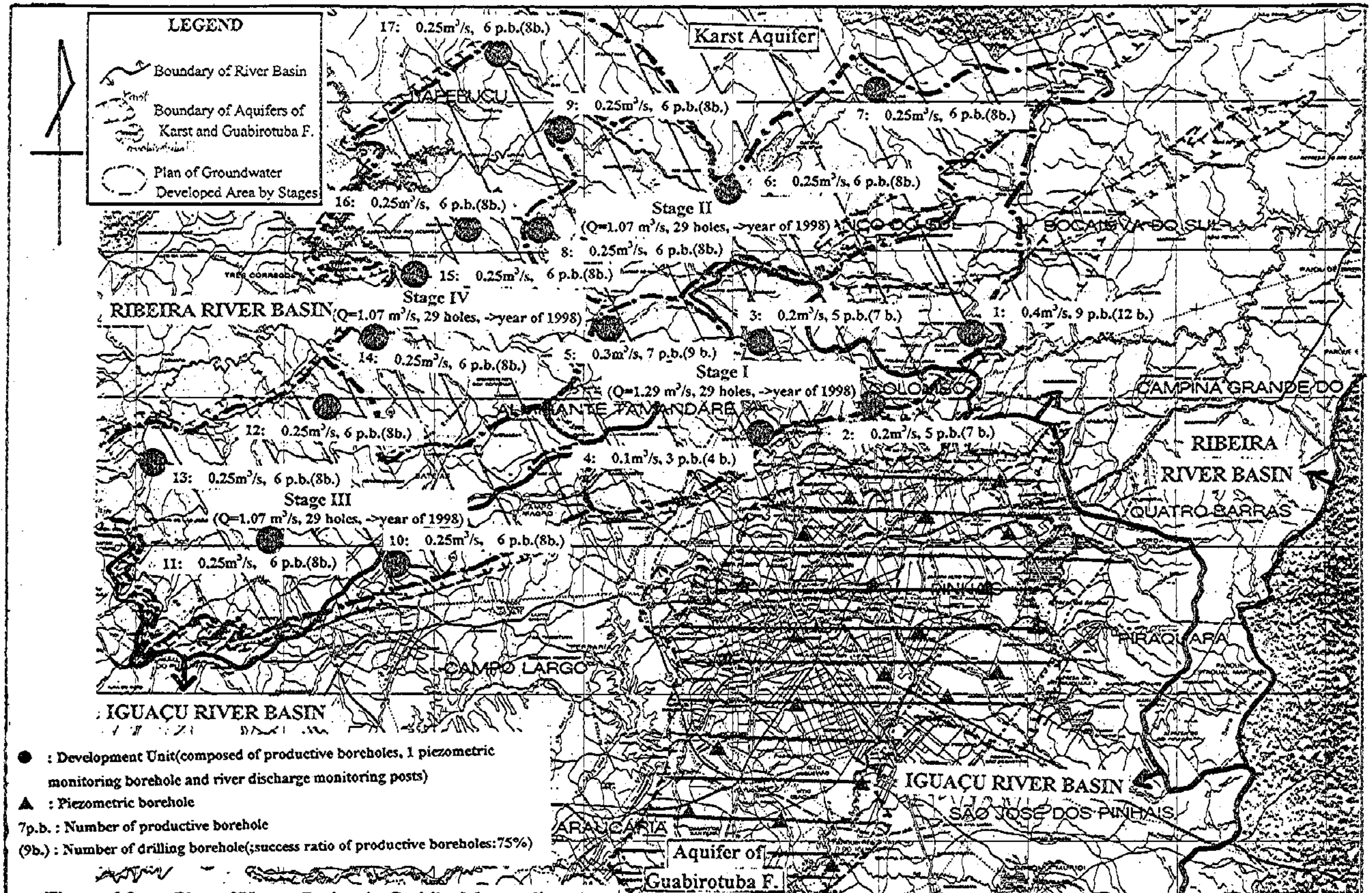


Figure-6.3 Plan of Urgent Project in Curitiba Metropolitan Area

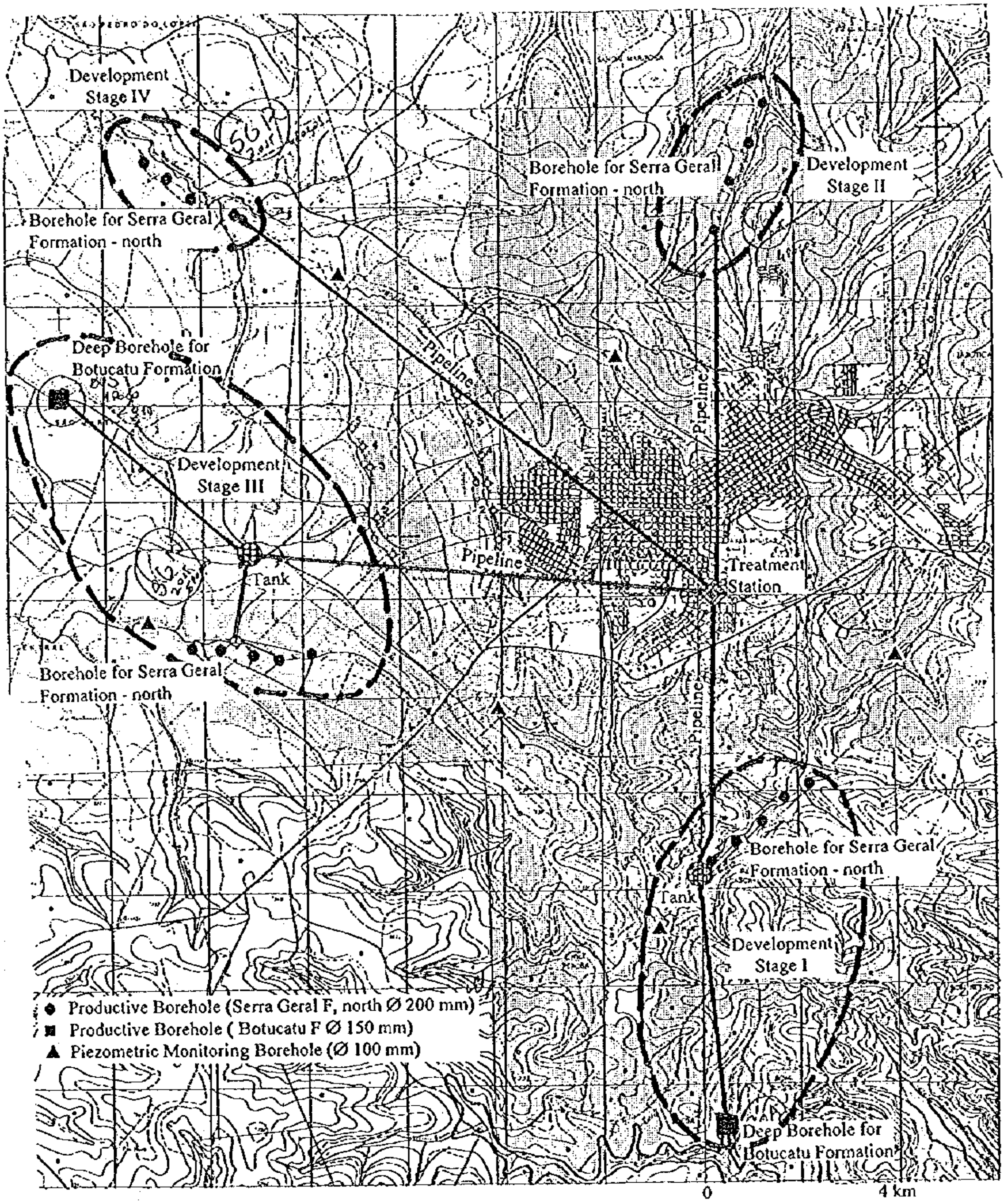


Figure-6.4 Groundwater Development Plan with Piezometric Monitoring Borehole for Cascavel

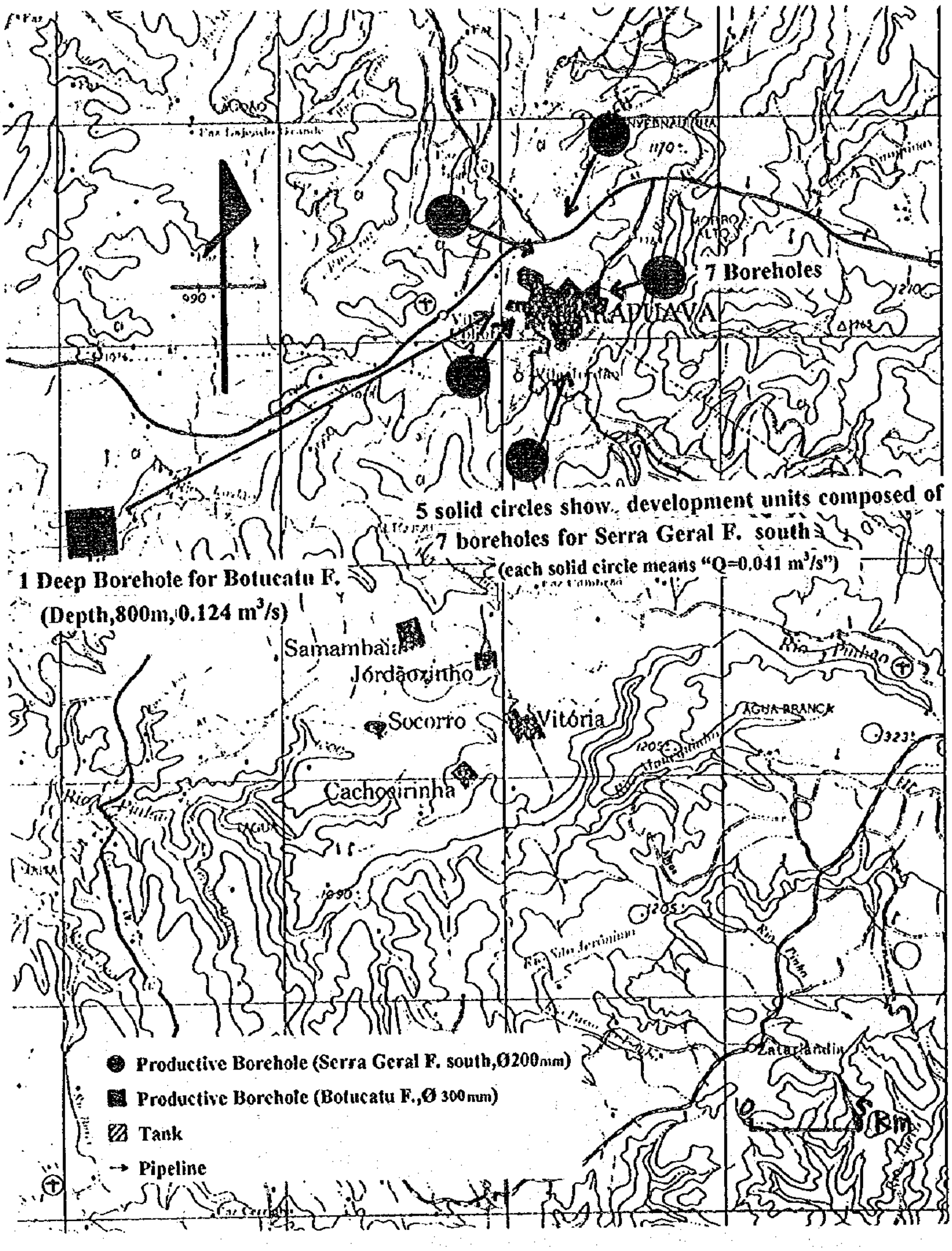


Figure-6.5 Groundwater Development Plan with Piezometric Monitoring Borehole for Guarapuava

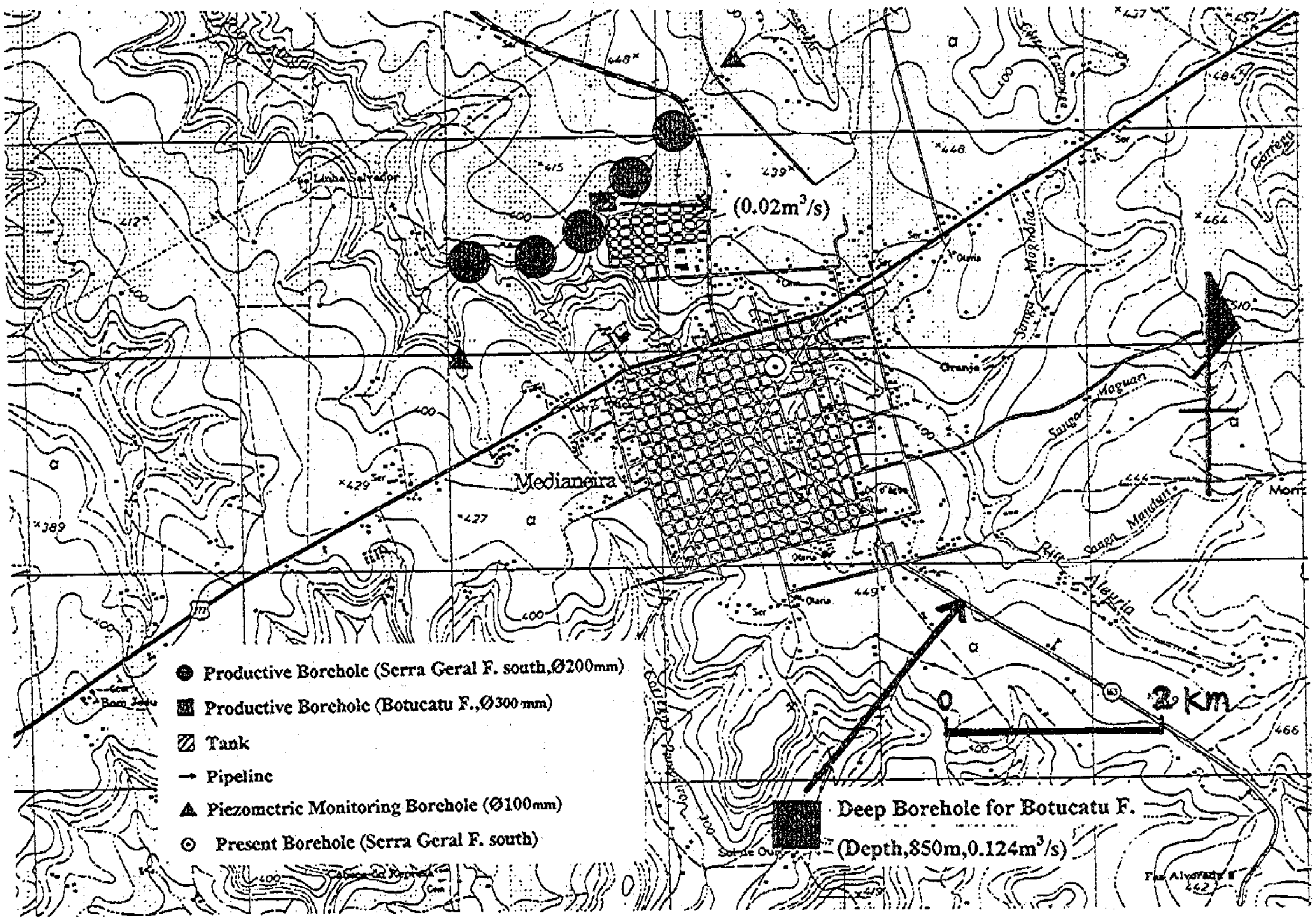


Figure-6.6 Groundwater Development Plan with Piezometric Monitoring Borehole for Medianeire

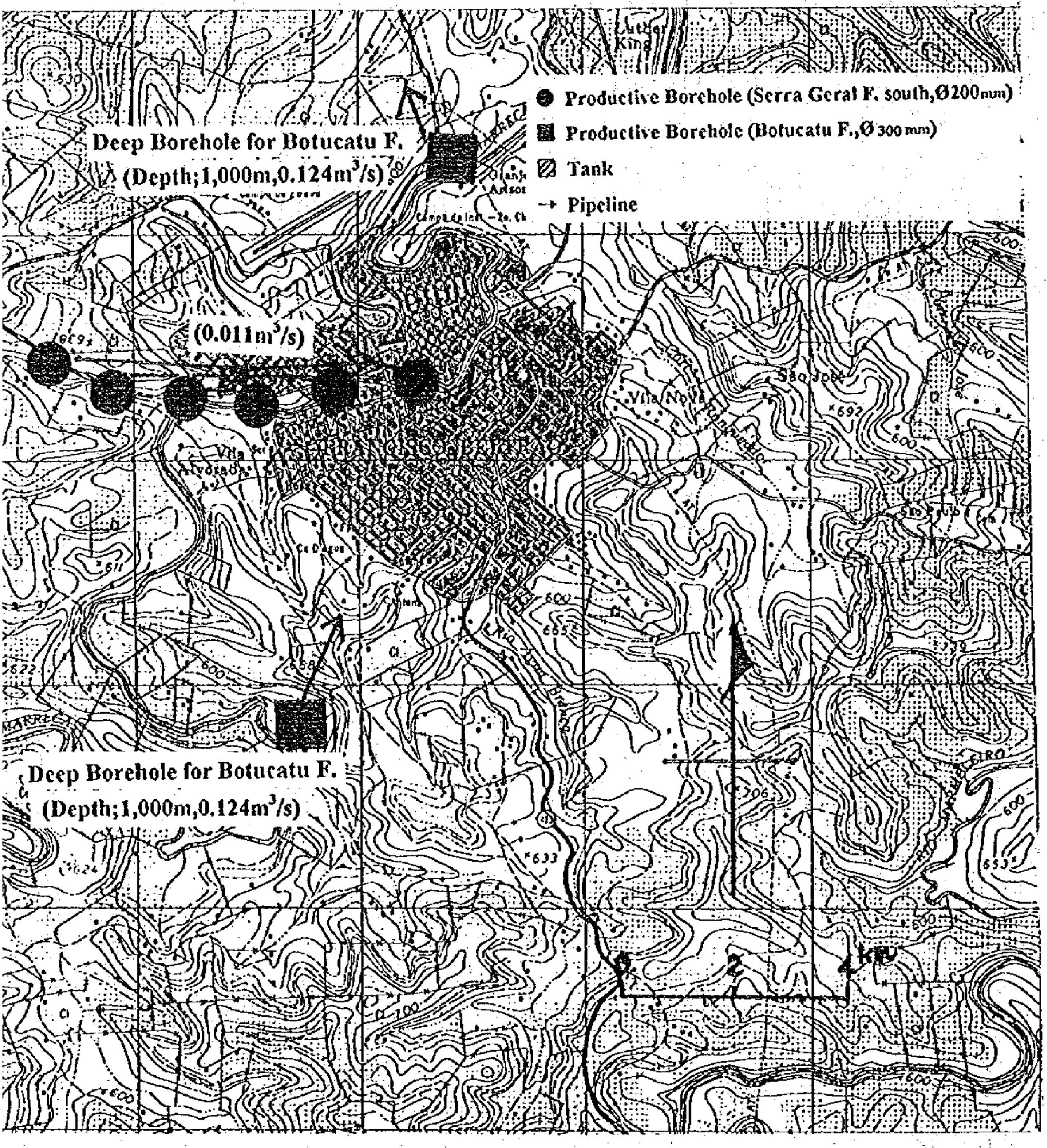


Figure-6.7 Groundwater Development Plan with Piezometric Monitoring Borehole for Francisco Beltrao

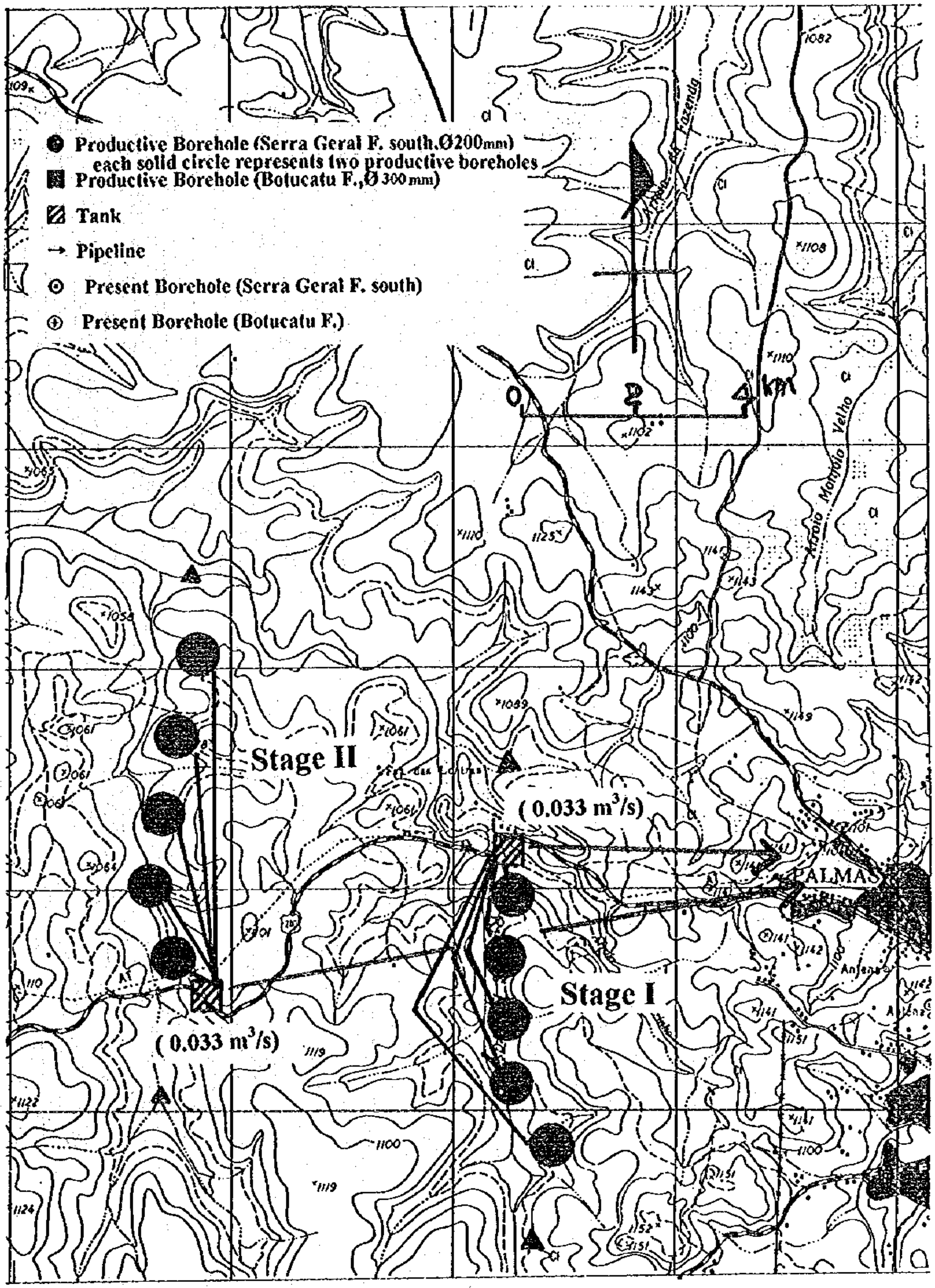


Figure-6.8 Groundwater Development Plan with Piezometric Monitoring Borehole for Palmas

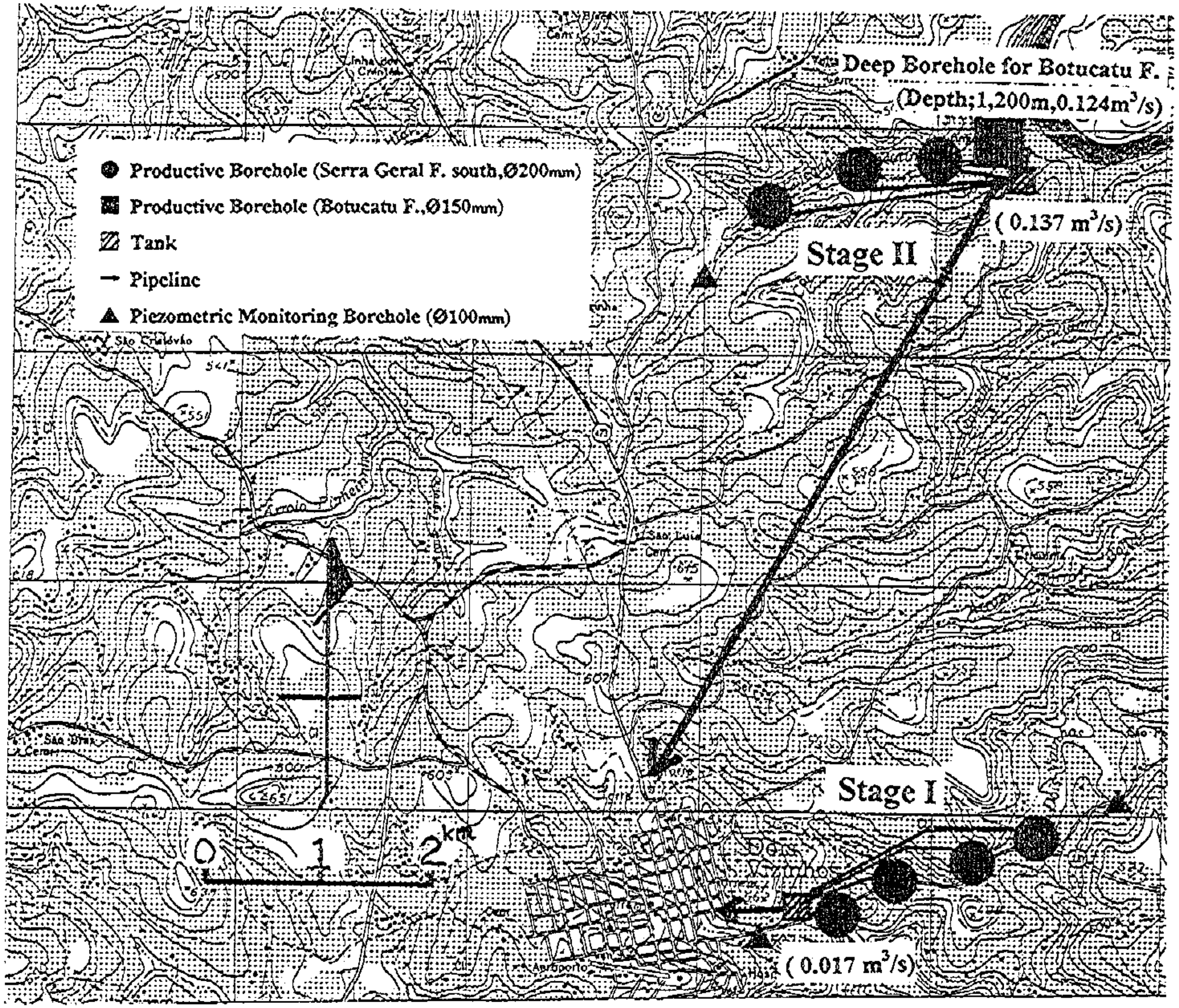


Figure-6.9 Groundwater Development Plan with Piezometric Monitoring Borehole for Dois Vizinhos

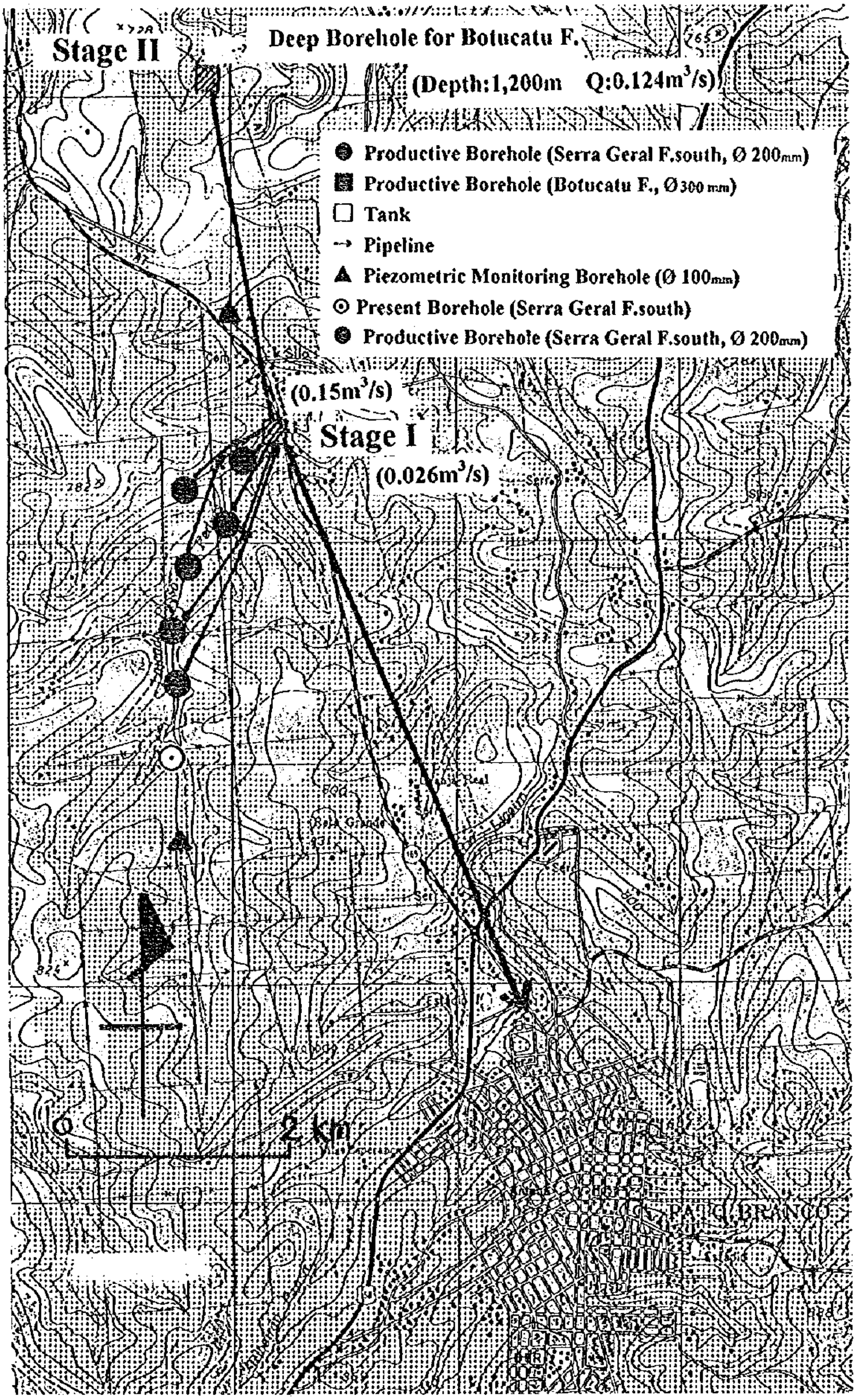


Figure-6.10 Groundwater Development Plan with Piezometric Monitoring Borehole for Pato Branc

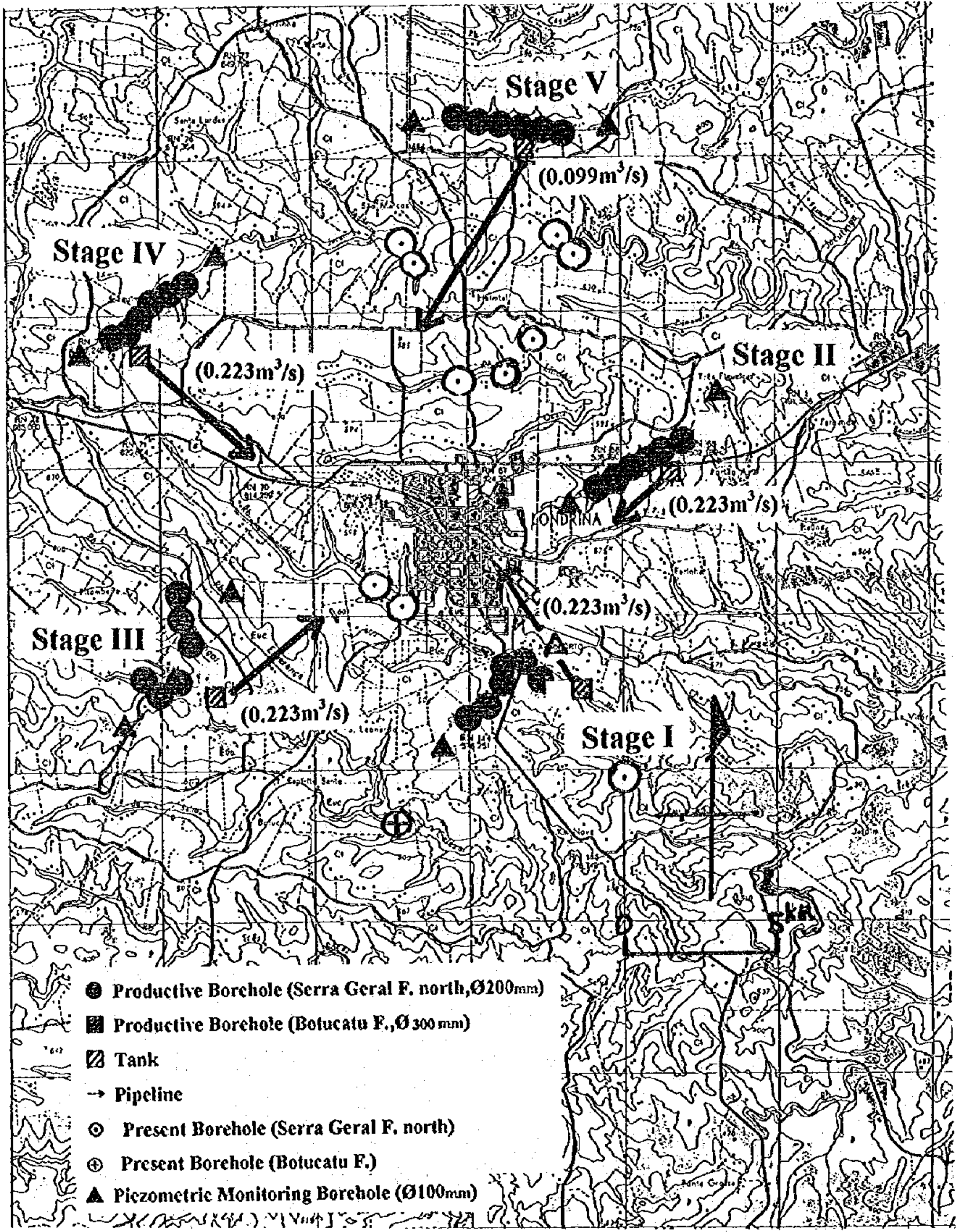


Figure-6.11 Groundwater Development Plan with Piezometric Monitoring Borehole for Londrina

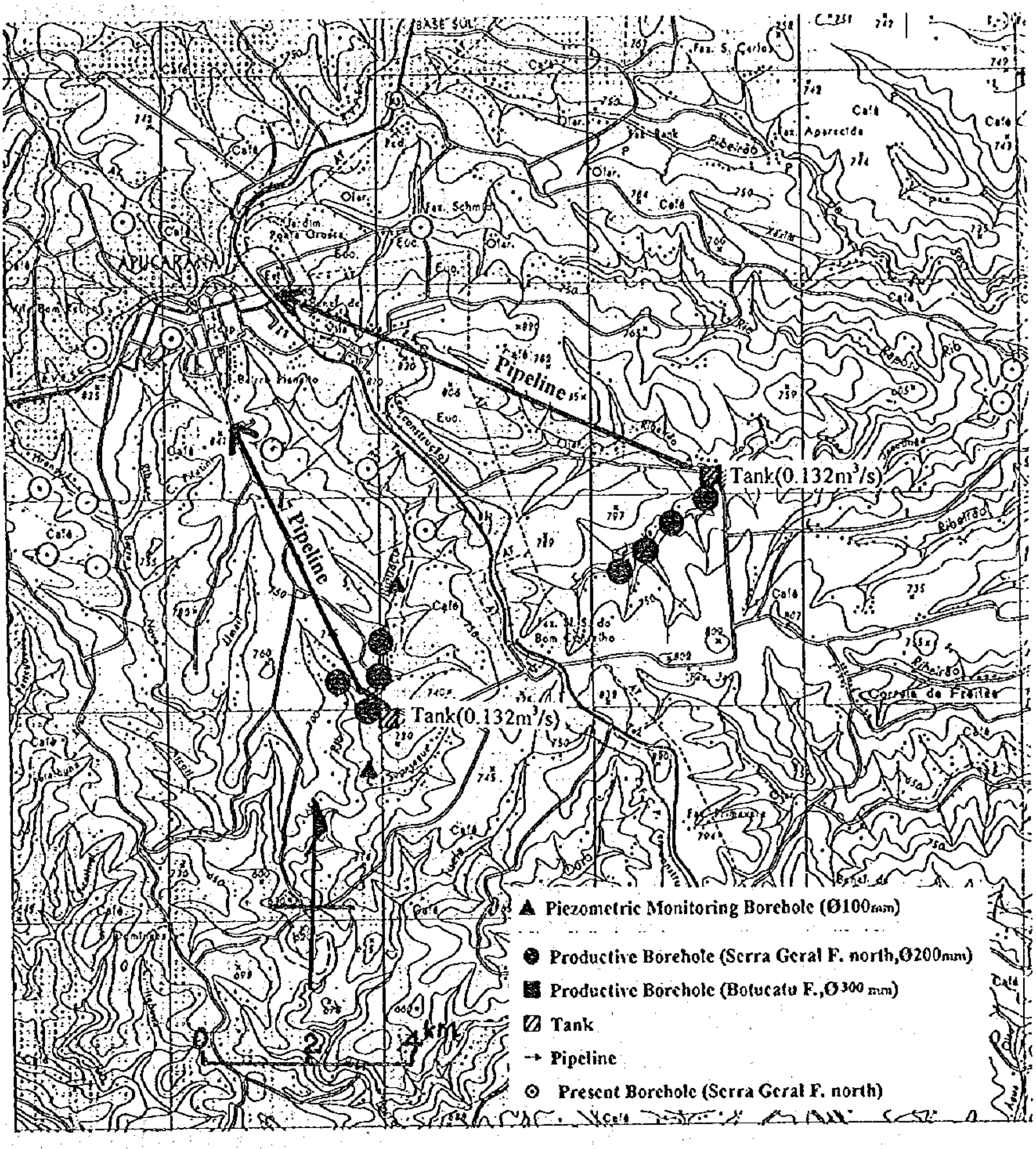


Figure-6.12 Groundwater Development Plan with Piezometric Monitoring Borehole for Apucarana

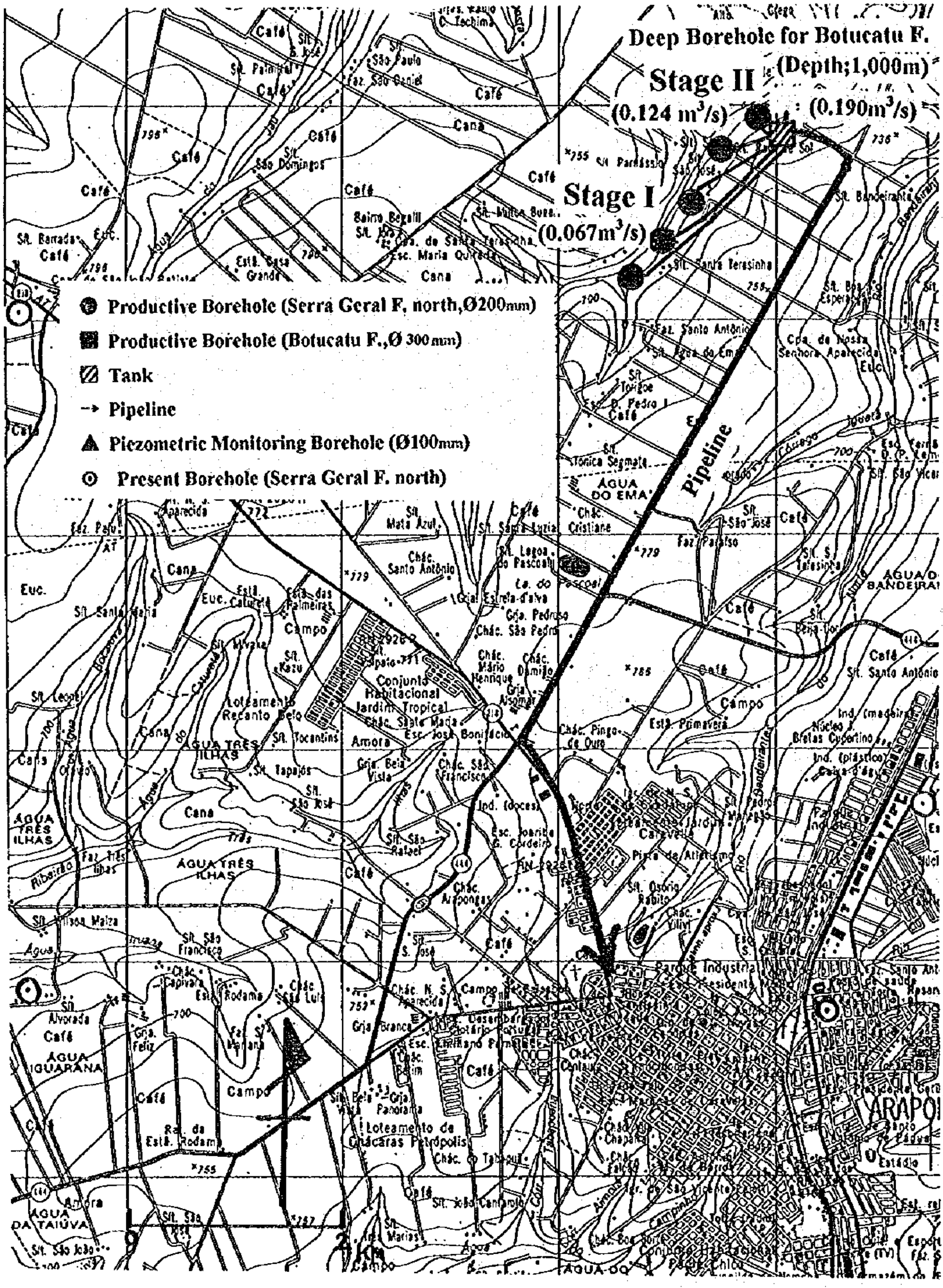


Figure-6.13 Groundwater Development Plan with Piezometric Monitoring Borehole for Arapongas

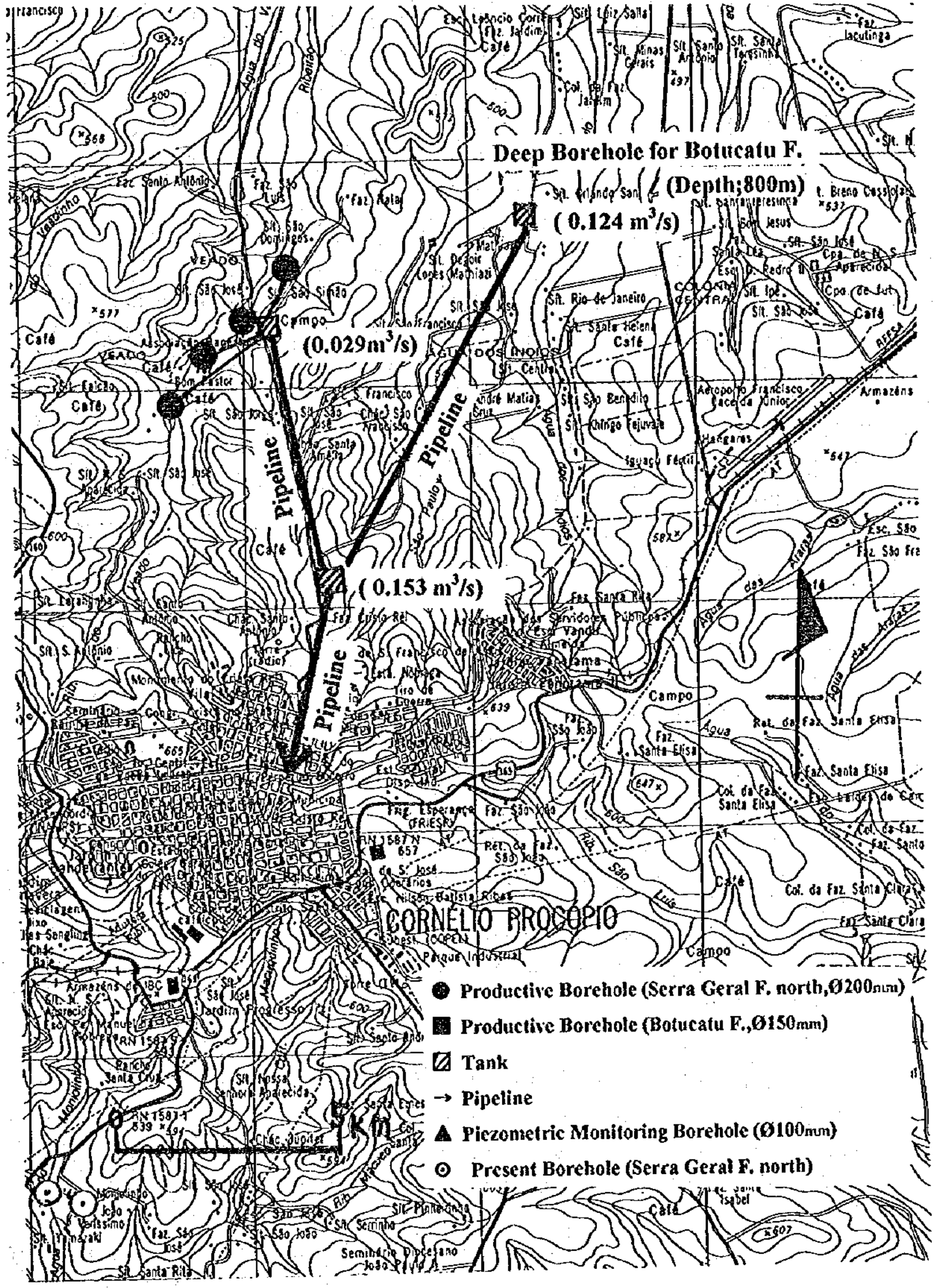


Figure-6.14 Groundwater Development Plan with Piezometric Monitoring Borehole for Cornelio Procopio

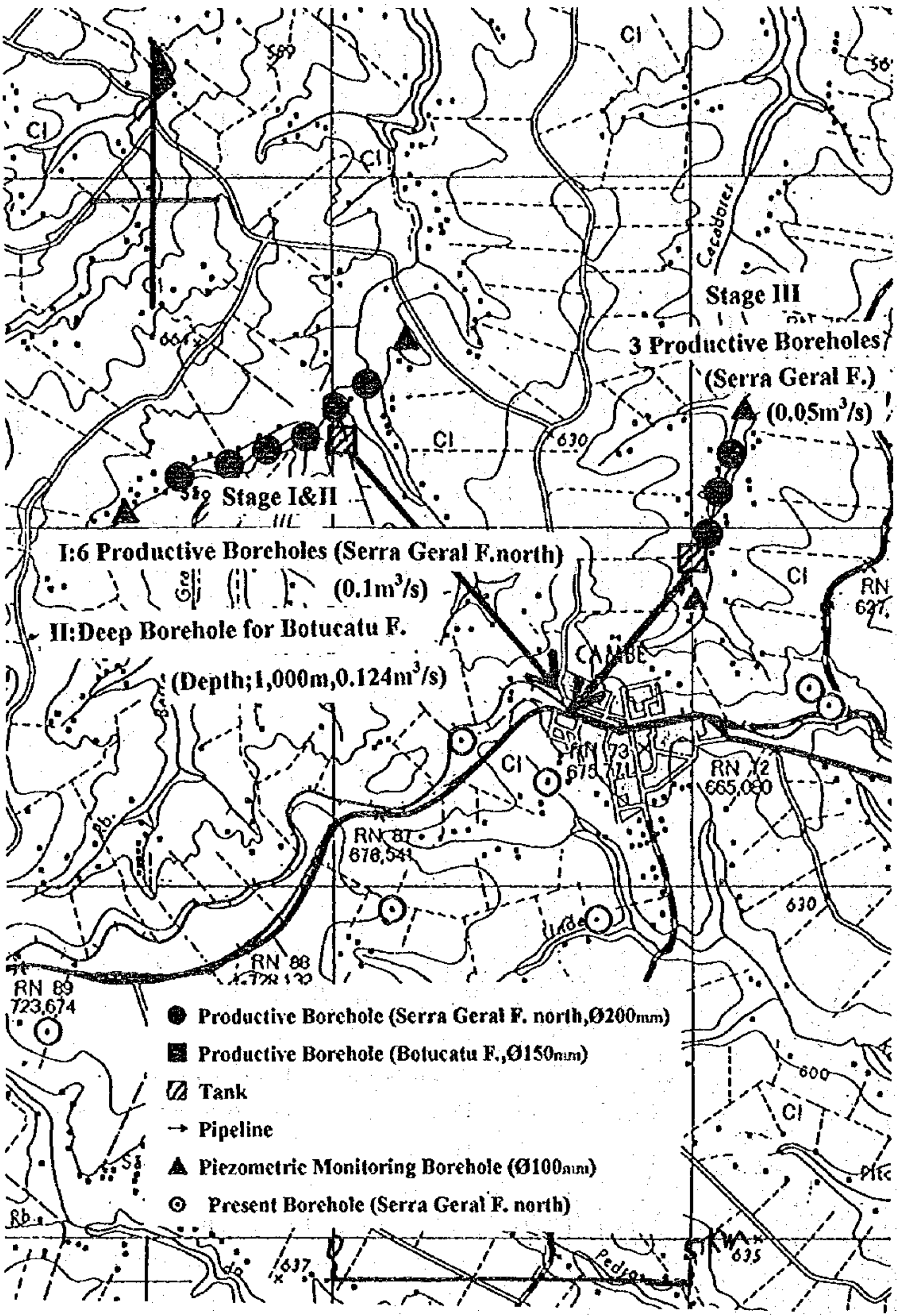


Figure-6.15 Groundwater Development Plan with Piezometric Monitoring Borehole for Cambe

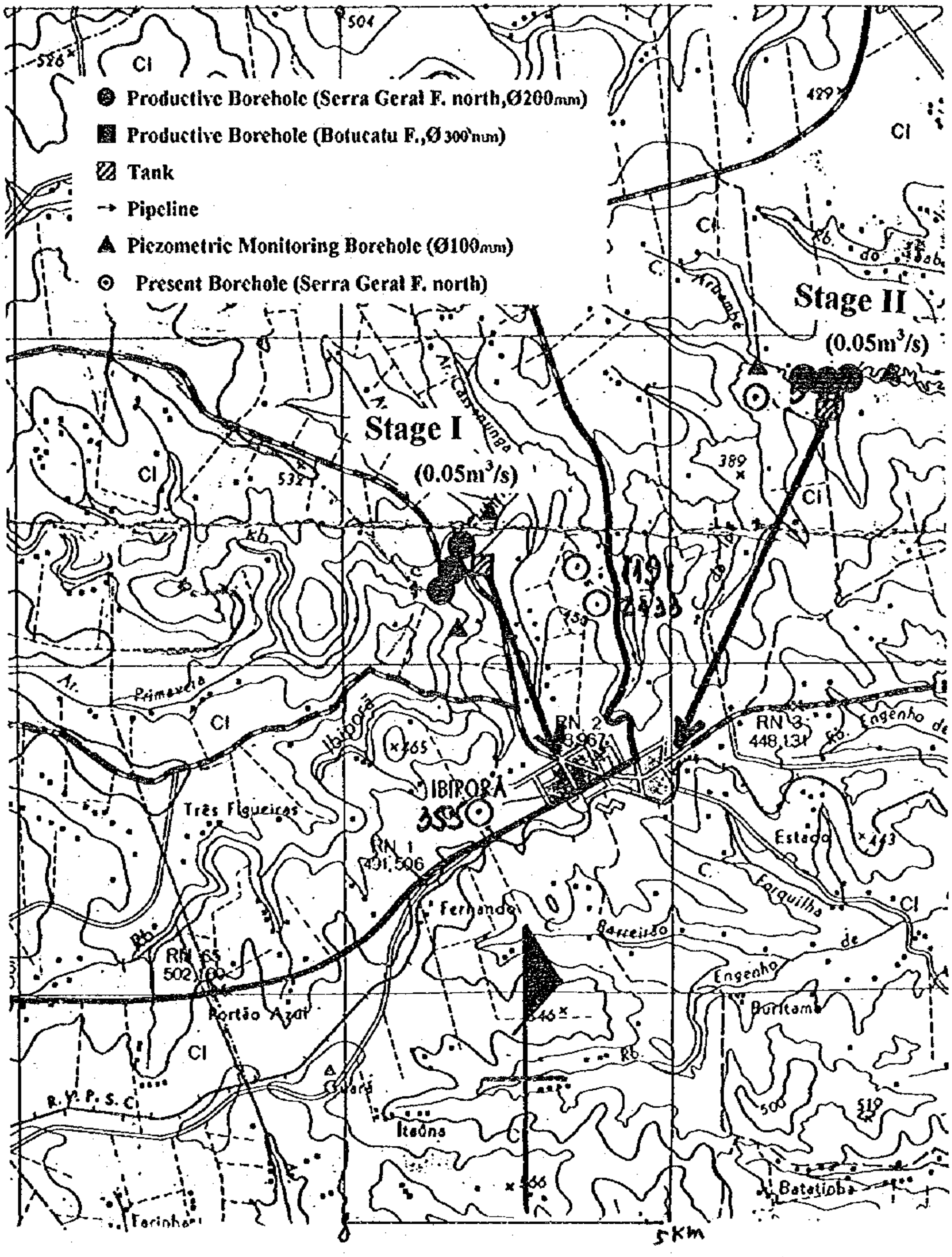


Figure-6.16 Groundwater Development Plan with Piezometric Monitoring Borehole for Ibipor