REPORT OF IMPLEMENTATION DESIGN SURVEY ON THE JAPANESE TECHNICAL COOPERATION PROJECT FOR THE FORESTRY RESEARCH IN SAO PAULO, BRAZIL

October, 1980

JAPAN INTERNATIONAL COOPERATION AGENCY

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FOREWORD

In sequence to the commencement of the São Paulo Forestry Research Cooperation Project to establish watershed management techniques in the State of São Paulo of the Republic of Brazil, the Japan International Cooperation Agency sent an implementation design team headed by Mr. Ikujiro Osaki, Disaster Inspector, Division of Forestry Conservation, Forestry Agency, in July, 1980.

The implementation design was intended to establish various test programs concerning water regulation and soil conservation necessary for the transfer of watershed management techniques, to design necessary testing facilities and also to conduct survey and study on simple soil conservation methods necessary for the study of water regulation and soil conservation.

This report gives the results of the above-mentioned survey and is expected, hopefully, to serve as an important technical guide for the future development of the project.

Finally, I wish to express my sincere thanks to those officials in both countries who gave generous support during the course of the survey and also to the members of the survey team.

October, 1980

Katsura WATANABE
Director,
Department of Forestry and
Fishery Development Cooperation,
Japan International Cooperation
Agency

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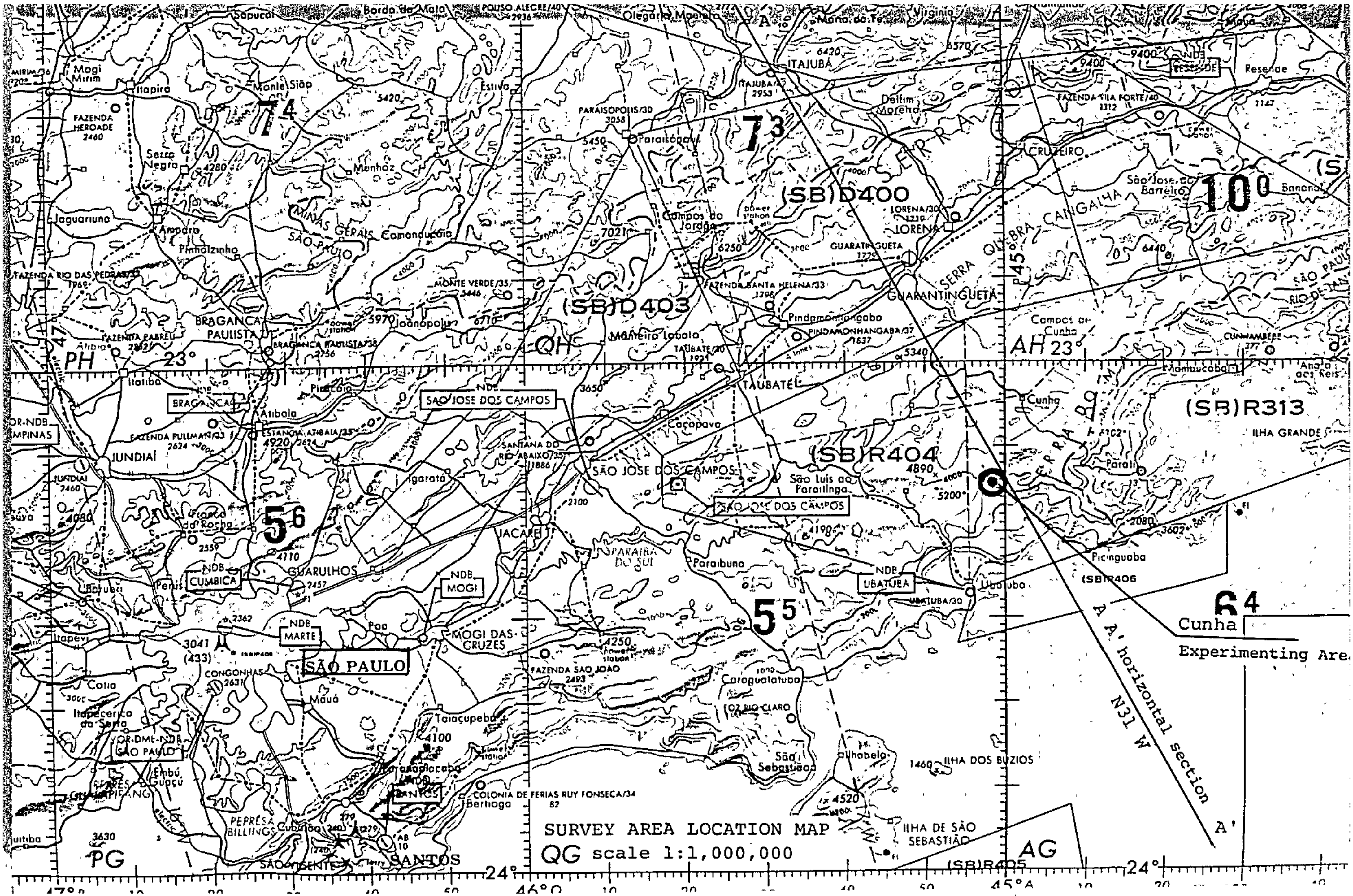
Plan (D area)	1/2,000

Computation details of the traversing on area D.

Computation of structural stability

Located map



SURVEY AREA LOCATION MAP
QG scale 1:1,000,000
A A' horizontal section
N31 W
A'
Cunha
Experimenting Are
(SB)D400
(SB)D403
(SB)R404
(SB)R313
(SB)R406
(SB)R405
SÃO PAULO
SÃO JOSE DOS CAMPOS
TAUBATÉ
GUARATINGUETÁ
LORENA
ITAJUBÁ
JUNDIAÍ
BRAGANÇA PAULISTA
MOGI DAS CRUZES
GUARULHOS
SANTOS
SÃO VICENTE
Caraguatatuba
São Sebastião
Ubatuba
Paraibuna
Cunha
Parati
Resende
Cruzeiro
Campos do Jordão
Pindamonhangaba
Caçapava
Jacareí
Mogi Mirim
Itapira
Amparo
Atibaia
Itatiba
ILHA GRANDE
ILHA DOS BUZIOS
ILHA DE SÃO SEBASTIÃO
SERRA QUEBRA CANGALHA
MINAS GERAIS
SÃO PAULO
RIO DE JANEIRO
NDB CUMBICA
NDB MARTE
NDB MOGI
NDB UBATUBA
NDB SÃO JOSE DOS CAMPOS
VOR-DME-NDB SÃO PAULO
PH
QH
AH
PG
QG
AG
23°
24°
45°
46°
47°

I INTRODUCTION

1. Objectives of the Survey

São Paulo State of Brazil is making rapid progress as an international modern and wide urban area. However, with the progress of agriculture and stock-farming in mountainous districts over the past 2 centuries, the problems of soil conservation, water pollution, etc. arise. To solve the problems, Japan was requested to provide technical cooperation for the research project of São Paulo Forest Institute.

Among the fields of research cooperation on watershed management techniques, logging techniques, remote sensing techniques and smallwood utilization techniques, the present survey was concerned with watershed management techniques. It was thus intended to design annual experiment programs and model facilities necessary for the transfer of methods of research on water regulation and soil conservation and also to study simple soil conservation methods for the recovery and prevention of the devastation in mountainous areas.

2. Composition of the Survey Team

Name	Responsibilities	Current position
OSAKI, Ikujiro	General	Disaster Inspector, Forestry Conservation Division, Guidance Department, Forestry Agency
MIKI, Shuichi	Coordinator	Payroll Division, Personnel Department, JICA
YAMAGUCHI, Iwasuke	Test planning	Technical Adviser, Forestry Engineering Consultants
TAKAGI, Yasuo	Forestry conservation planning	Acting Chief of Forestry Conservation Research, Forestry Engineering Consultants Institute
TATENUMA, Kei	Forestry conservation design	Assistant to the Chief of Forestry Conservation Research, Forestry Engineering Consultants Institute

3. Survey Schedule

Date		Remarks
1980 July 8	Tue.	Leaving Narita. (All members)
9	Wed.	Arriving São Paulo. Briefing with experts on survey items and schedule. (All members)
10	Thu.	Courtesy call on the Japanese Consultate General, São Paulo Office of the JICA and the São Paulo State Forestry Institute; briefing on data. (All members)
11	Fri.	Briefing with the São Paulo Forestry Institute and experts. (All members)
12	Sat.	Collection and arrangement of material on the implementation design survey with experts.
13	Sun.	To continue the above and preparations for the field survey. (All members)
14	Mon.	Field survey of Cuunya area. (All members)
15	Tue.	To continue the above. (Consul General and the Director of the São Paulo State Forestry Institute to inspect Cuunya.) (All members)
16	Wed.	1. Briefing with the São Paulo Forestry Institute and experts; briefing with the Japanese Consultate General. (Osaki, Miki.) 2. Field survey of Cuunya area. (Yamaguchi, Takagi, Tatenuma.)
17	Thu.	1. São Paulo - Brasilia. Briefing with the Japanese Embassy, JICA Brasilia Office, experts, São Paulo State Forestry Institute; courtesy call on the Planning Board, Ministry of Foreign Affairs, Ministry of Agriculture. (Osaki, Miki.) 2. Same as above.
18	Fri.	1. Brasilia - São Paulo. (Osaki, Miki.) Briefing with experts. (All members) 2. Collection of data. (Yamaguchi, Takagi, Tatenuma.)
19	Sat.	1. Leaving São Paulo. (Osaki, Miki.) 2. Arrangement of data. (Yamaguchi, Takagi, Tatenuma.)
20	Sun.	2. Same as above.
21	Mon.	1. Arriving Narita. (Osaki, Miki.)
? August 7	Thu.	2. Field survey and arrangement of its results and data. (Yamaguchi, Takagi, Tatenuma.)
8	Fri.	Briefing with the São Paulo State Forestry Institute and experts. (Yamaguchi, Takagi, Tatenuma.)
9	Sat.	Leaving São Paulo.
11	Mon.	Arriving Narita.

II. SCOPE OF THE SURVEY

1. Introduction

1.1 Outline of the Implementation of the Survey

(1) Discussion with the officials concerned

This survey was executed, based on extensive discussions about survey policies, survey contents, etc. with JICA officials in charge, Mr. Nakano (Director of Disaster Prevention Department of Forest Research Institute), Mr. Endo (Director of Management Department, Hokkaido Branch of FRI) and Mr. Ohsaki (Disaster Inspector of Conservation Division, Forestry Agency) who made a field survey as the members of preliminary survey team, consultation team and experts.

Particularly in the execution of the field survey, close contacts were kept with the officials of São Paulo Forestry Institute, and with Team leader Nakano and chief researcher Kudo dispatched as experts, to be given their guidance and co-operation in the field working, data collection and technical problems.

1.2 Survey Items

(1) Annual experiment programs for watershed control

Annual experiment programs are made on the setting of the experimental watershed, setup of measuring instruments such as water gauges, rain gauges, meteorological instruments or instrument platforms, and evapo-transpirometers in forest land, as well as method of investigation on basic conditions of watershed, hydrology, data arrangement, forest hydrological analysis, devastated land survey and simple soil conservation works etc.

(2) Determination of locations for watershed management models and their design

(A) Water balance facilities (lysimeter)

Purpose: Comparative study on water balance concerning rainfall, infiltration, runoff, transpiration, etc. by type of covering vegetation

Number of installations: 3

Structure: Plane lysimeter
Made of concrete; inner diameter 10m × 10m, Depth 2m
Bottom; gravel 30cm, land fill 150cm, space 20cm
With a head race pipe and a gauge unit (water chamber, 60° V-notch, stage recorder)

(B) Overland flow facilities

Purpose: Comparative study on the overland outflows of water (including interflow) and sediment by type of covering vegetation

Number of installations: 3

Structure: In the maximum gradient direction on a mountainside slope, a 30m long and 20m wide section is surrounded by 1.2m high concrete boarding (1.0m embedded) on the three sides of top and both flanks, and at the bottom are installed a 0.8m high and 1.0m wide sediment chamber, a gauge unit consisting of a head race pipe, water chamber with 60° V-notch, and a stage recorder.

(C) Gauging facilities

Purpose: Study concerning the relation between the types of covering vegetation and water runoff

Number of installations: 4

Structure: Open channel type or weir type, according to the condition of the site. A dam for soil saving and regulation is provided to allow prompt and correct measurement of low flow as well as flood discharge. The open channel is triangular in section, and the weir has double section with V-notch. A stage recorder is installed.

A measuring instrument to obtain a correlation formula between stage and mean velocity is prepared.

(D) Compartment of dividing of experimental watershed and topographic surveying

Purpose: The catchment area of the experimental watershed (area D) is measured to clarify the area, gradient, and condition of torrents.

(3) Study on simple soil conservation works

To study simple soil conservation works functionally and economically applicable to the local conditions, investigations are executed on soil structure, soil type, river water quality, intensity of devastation, vegetation, etc. A study of the simple soil conservation works and a design of standard construction methods as a models are executed.

(A) Survey on river water quality

River water is investigated as to acidity, turbidity, organic matters, salts, etc., to obtain basic data for mountain conservation measures.

(B) Geologic survey

Surface geological survey and survey by soil auger are made to investigate the structure, strengths of compressions, etc. of soil layers, as basic data for planning of simple soil conservation works and designing of watershed management model facilities.

(C) Soil survey

Soil profiles and physico-chemical properties of soils are investigated, to obtain data for considering mountain conservation measures. Main survey items are soil profile, pH, soil hardness, grainning, etc.

(D) Investigation of devastated land area

Typical devastated regions are investigated as to location, area, type, gradient, eroded depth, existence of spring water, geologic structure, etc., to clarify the mechanism of devastation, as data for considering simple soil conservation works.

(E) Study of simple soil conservation works

Simple soil conservation works are studied by type and mechanism, to design models.

1.3 General Conditions of Survey Area

(1) Topographic features, geologic structure and weather conditions

The Serra do Mar and the Serra do Quebra Cangalha lie in parallel to the coastline from east-northeast to west-southwest, forming highland of about 1,000 meters above the sea level.

Parallel, and north of the highland, beyond the Paraiba ravine, there lie the Serra do Manti Queira at about 2,000 meters abvoe the sea level.

The survey area is located at the south end in the center of the highland, occupying the area in the upper stream and on the right side of the Rio Paraibuna.

The Rio Paraibuna flows parallel to the coastline toward the west-southwest, at 20km to 30km from the Atlantic Ocean, and joins the Rio Paraitinga at Paraibuna into the main river, named Rio Paraiba. It irrigates several artificial lakes, and takes a U-turn at about 50km of the east from São Paulo, to proceed to the east-northeast in the Paraiba ravine, accepting large and small tributaries. Then, it passes to the north of Rio de Janeiro at 50km to 100km from the coastline and parallel to it, flowing into the Atlantic Ocean near Campos City. It is a large river with a total length of about 800km, and a watershed area of about 57,000km^2.

(See Fig. 1, Topographic sectional view.)

Since the original flow of the Rio Paraibuna is 1,860m above the sea level, the mean gradient of the entire river is 0.23%, and that of the upper stream is about 0.7%.

As for the geological structure, the mountainous zone of the survey area (to be temporarily called the Paraiba Highland) forms a stratum called Complexo Cristalino-Brasileiro of Precambrian age containing mylonite granites, gneisses, crystalline schists (mica schists, quartz schists), granites and basic diabases intruded in the Mesozoic era partially.

(See Fig. 2, Geologic map.)

In the lowland of the Paraiba ravine (Bacia de Taubate), there is Taubate layer consisting of siltstones and sandstone sedimented in lakes and in the river. In the flood plain along the river, Alluvium is distributed.

Fig. 1 Topographic Sectional View

Pruba ~ survy area ~ Guaratinguetá ~ Itajubá .

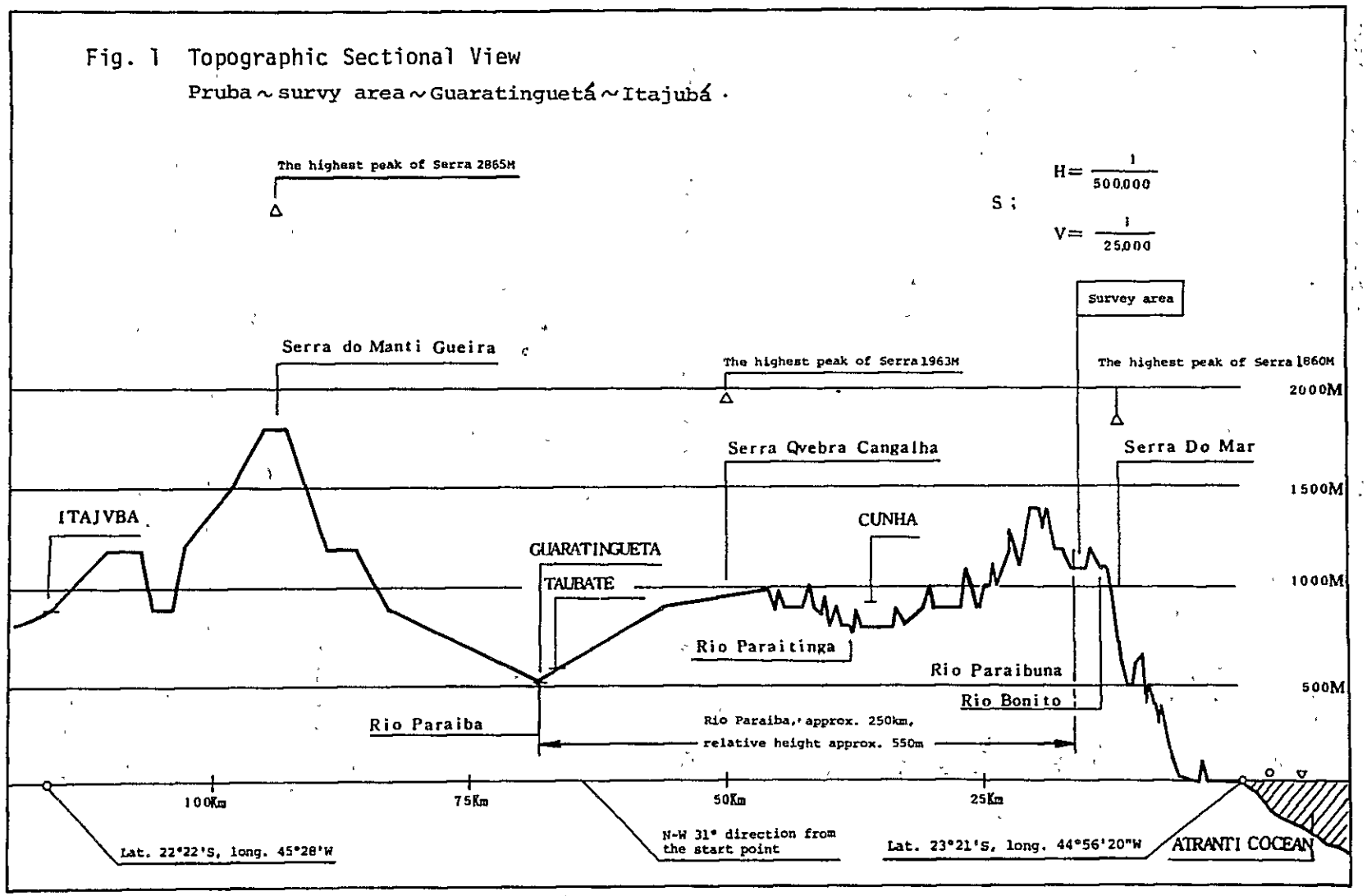
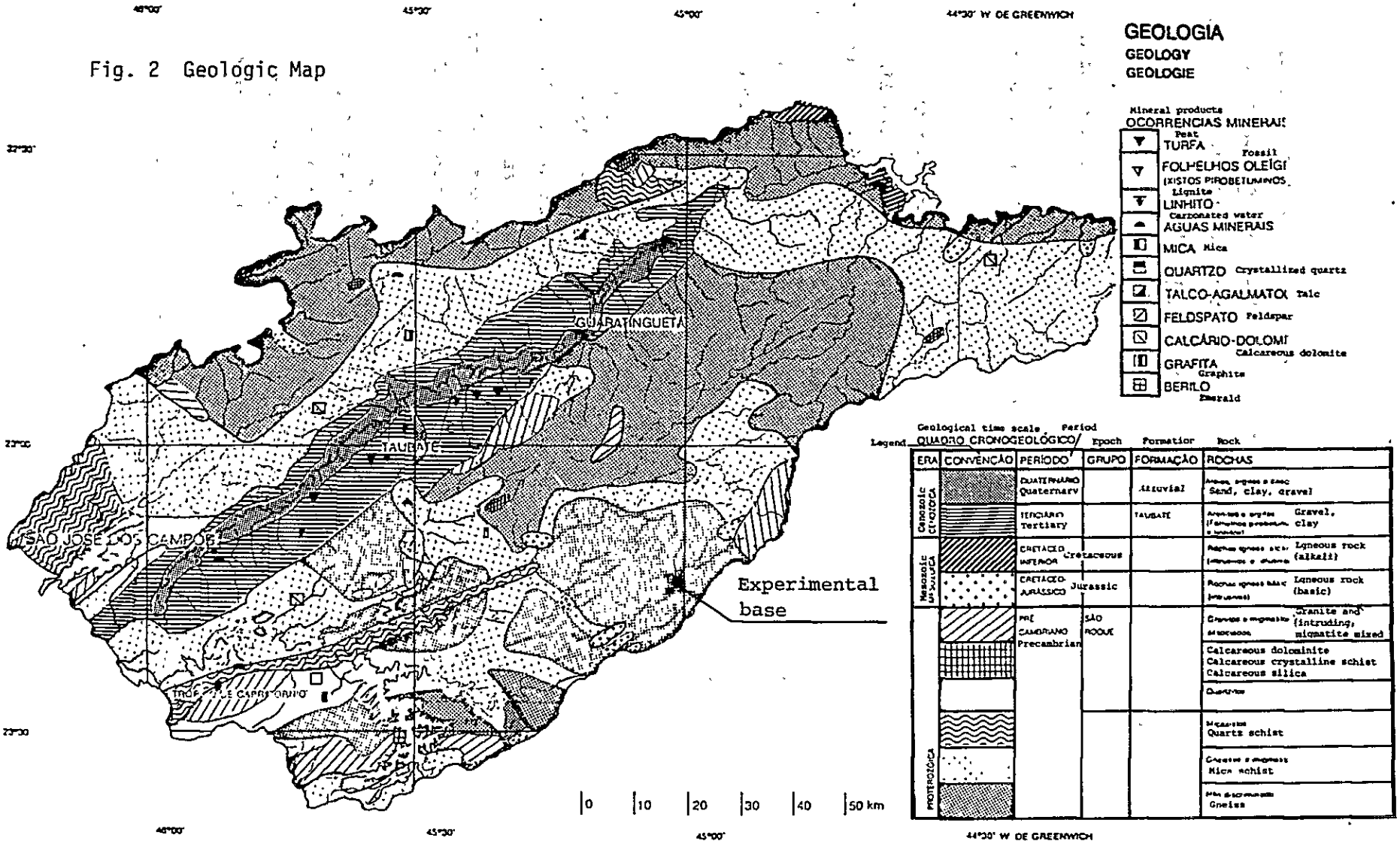


Fig. 2 Geologic Map



Rivers are generally so-called ravines flowing parallel to the mountains. Falls with rocks of exposed gneisses are observed at intervals of a few kilometers, mainly at the curves of the main river. The tributaries have several falls in the upper reaches and at the inlet to the main river.

These falls, acting as ideal natural dams, together with the peculiar regime of making a 180-degree U-turn, effectively suppress the progress of topographic dissection of the water-shed area.

As for the topographic features of the Paraiba Highland, they comprise low mountains partially with steep cliffs like camel's humps at the top. On the middle slopes and at the feet, the slopes descend mostly at low gradient of about 10 to 20 degrees. The drainage density is low, and the land features are like peneplains. On the middle slopes of the mountains, saprolite is thickly sedimented.

As for the topographic features of area D (tributary) where model facilities will be installed, the stream gradient are 0.8 to 1.5% in the lower stream, 10% in the middle stream (5%, if the falls with exposed rocks are excluded), and 10% in the upper stream (about 1% in the swampy zone), and the mountainside gradient are 10 to 15 degrees at the feet, 15 to 25 degrees on the middle slopes, and 30 to 45 degrees at the top with protrusions like camel's humps.

The natural environment in the entire São Paulo State is as shown in Table 1. The monthly mean highest temperature is 25.6°C, while the lowest one is 16.1°C, maximum temperature is 32.8°C, while minimum is 6.9°C. It is a land of everlasting summer in the north of the subtropical zone.

The annual mean precipitation is 1,453mm, and the highest rainfall is 103mm. The rainfall concentrates in a peirod from September to April, and the dry season period is from May to the end of August, with about 10 to 40mm of rain per month.

According to Koeppen's climatic chart, the area near the seashore belongs to temperate humid climate, the inland to temperate summer rain climate, and the northern seashore to tropical rain forest climate.

Since the Paraiba Highland are affected by the Serra do Mar, the annual mean rainfall changes heavily between 3,000 and 1,300mm from the south to the north.

(See Fig. 3, Rainfall-distribution diagram.)

The survey area belongs to a zone with a rainfall of 1,450mm. According to our observation from July to August, the sea wind coming from the southeast brings dense fog and long-continued rain from the mountain tops every day in the afternoon, blowing down to the foot of the mountains, the fog disappearing like a Foehn phenomenon. Depending on the elevation above the sea level and the topographic features, the precipitation is expected to vary extremely.

According to Koeppen's climate classification, the Paraiba Highland are judged to belong to temperate humid climate at heights above 1,400m above sea level, and to tropical rain forest climate in the land lower than 1,400m.

(2) Soil texture, soil type, forest type, water quality, etc.

In the cut faces of the roads in and around the survey area, yellowish brown to reddish brown weathered soils containing crumbly scorias of white quartz are observed to continue for more than 20m.

Table 1 Natural Environment of São Paulo

6-Principais observações meteorologicas das estações localizadas nos Municipios das Capitais-1977

MESES	PRESSAO ATMOSFERICA ATMOSPHERIC PRESSURE (mb)	TEMPERATURE DO AR TEMPERATURE (°C)							UMIDADE RELATIVA HUMIDITY (%)	NEBULOSIDADE FOG (0-10)	PRECIPITACAO PLUVIOMETRICA PRECIPITATION			EVAPORACAL TOTAL EVAPORATION	INSOLACAO TOTAL SUNSHINE (horas e decimos)
		Media das maximas	Media das minimas	Maxima absoluta		Minima absoluta		Media compensada			Altura total Ahura	Maxima em 24 horas			
				Graus	Data	Graus	Data					Ahura	Data		
Janeio		27.6		31.4	12						95.2	103.5	19		159.2
Fevereiro	927,3	30.8	19.3	32.6	10	17.5	20	24.2	71	4.7	53.6	48.4	8	121.8	230.1
Marco	925.5	28.3	19.1	32.6	13	16.9	27	22.6	78	7.3	55.7	38.4	25	118.7	193.6
Abol	927.5	23.7	16.4	30.1	15	13.9	26	19.3	83	7.8	93.3	34.2	10	80.6	
	928.7	23.2	13.7	26.8	10	6.9	17	17.7	80	6.6	39.5	22.4	17	94.8	153.9
	929.8	22.2	13.9	26.9	19	11.1	13	17.3	83	7.0	40.4	14.2	5e25	77.3	135.7
Julho	928.8	25.2	14.2	29.0	28	12.0	9	19.0	67	3.8	6.8	3.7	25	162.3	230.6
Agosto	927.9	25.0	14.9	30.2	13	10.8	19	18.8	73	7.2	10.1	5.0	30	149.5	176.4
Setembio	928.5	24.8	14.8	31.6	15	10.3	2	18.9	78	6.4	102.5	28.8	7	114.7	161.9
Ovut				32.8	25	14.2	9			6.8	141.8	41.3	2	111.1	162.4
	924.0	25.7	17.6	31.3	27	13.5	7	20.6	82	8.6	184.0	57.6	29	103.2	119.6
	925.4	25.0	16.8	30.5	31	14.0	29	20.0	83	7.0	230.0	59 0	22	101.3	153.8
Jant to Dezmbro	(3)927.3	(4)25.6	(3)16.1	32.1	25.10	6.1	17.5	(3)19.1	(3)78	(4)6.7	1,452.9	103.5	19-1	-(111,235.3	(111,876.2

SÃO PAULO

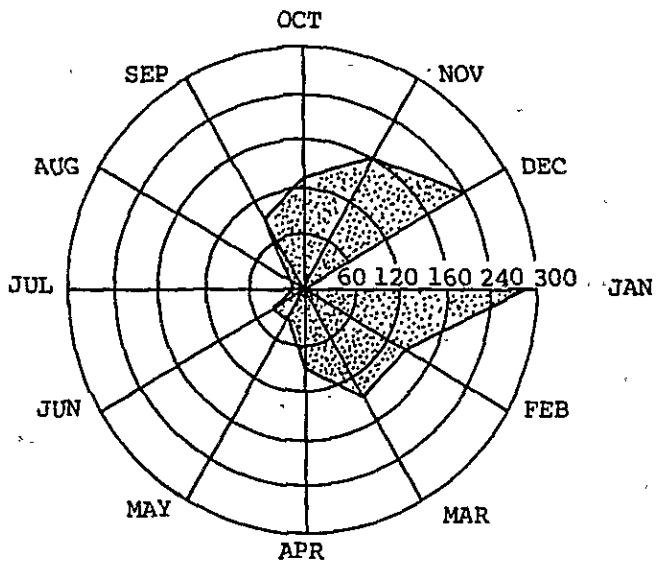
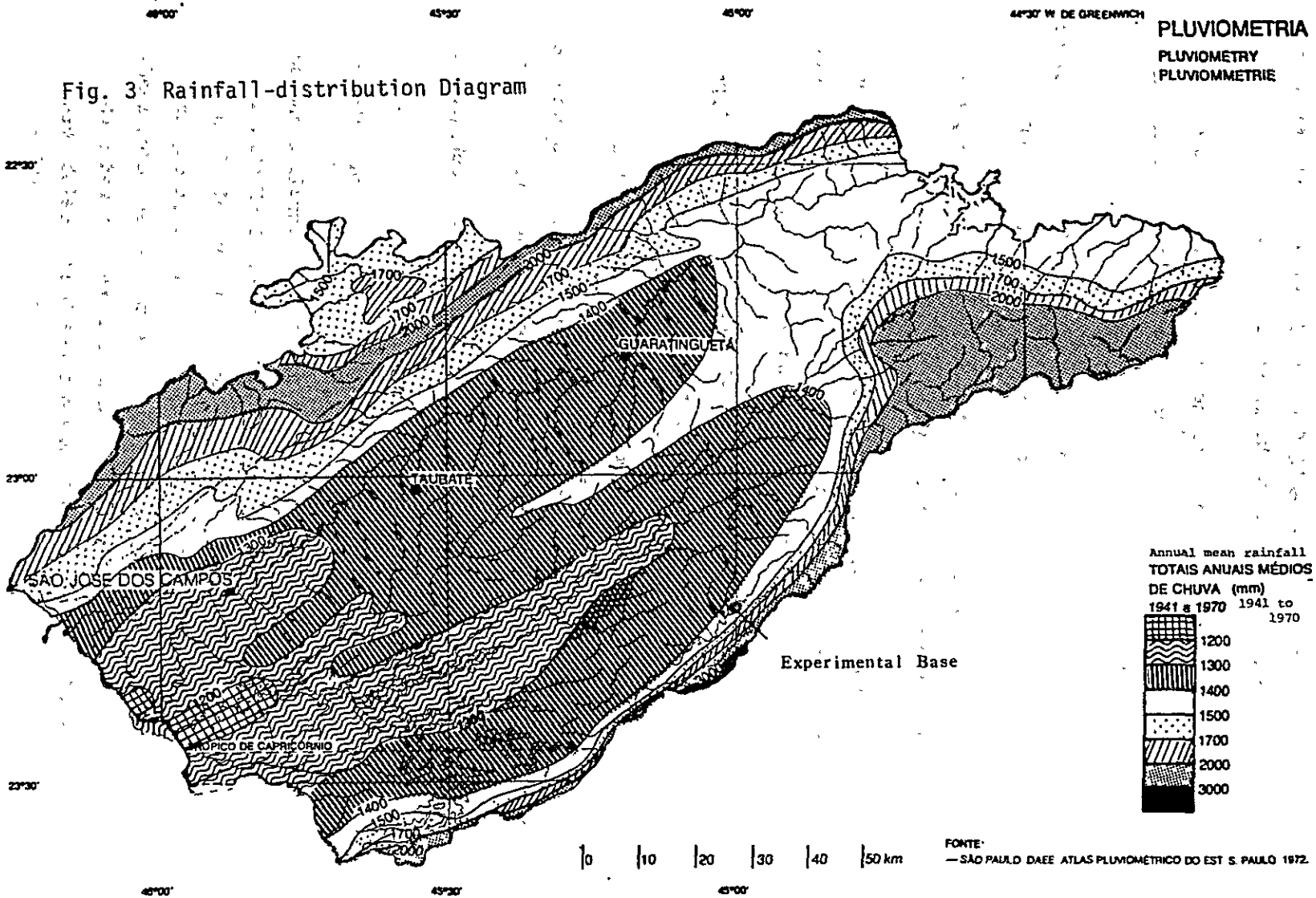


Fig. 3 Rainfall-distribution Diagram



This is saprolite which contains structures and textures of granites or gneisses as the parent materials.

Saprolite is a product of geochemical weathering of minerals through the main action being leaching by water, and oxidation by atmosphere.

Granites and gneisses mainly comprise silicate and alumina. Silicate is slightly soluble in the natural range of pH.

Alumina is soluble in acid and alkaline solutions, but is not soluble near neutrality.

At the initial weathering, silicate moves partially and seepage water reacts with the surface of feldspars, eliminating cations partially from feldspars and mafic rocks.

Then, feldspars are altered to kaolinite and mica type clay minerals.

Mafic rocks are oxidized losing FeO, forming Fe_2O_3.

In succession, saprolite on the surface layer is affected by strong leaching, to start the production of soil.

In soils, the removal of silicate continues, but quartz is insoluble and accumulated.

Ferric oxide (Fe_2O_3) is accumulated in the stratum like podsol.

The above is the production process of saprolite and soil. The very thick saprolite stratum in the Paraiba Highland has been caused by the warm and humid subtropical climate, causing such chemical actions as leaching, oxidation, and reduction. The reasons why this stratum has been preserved, without being eroded, are the area has been covered with jungle of evergreen broad leaved trees which resist forest

fires, wind damage and insects damage, since the geological age under the warm and humid climate as well as a topographic feature.

(Forests of this district are said to have been axed 150 years ago.)

With respect to the problem of soils, soils are said to be formed by five factors: (i) climate, (ii) country rocks, (iii) biological activities, (iv) topographical features and (v) time.

Of the above, what we can control in the light of watershed management is limited to biological activities.

The pH (H^+) of water concerning the decision of soil type has close relation with the humic substances of soils. The humic substances supply nitrogen indispensable to the growth of plants, concentrate mineral particles, making them into crumbs of organic minerals, secure better aeration, and improve the circulation of water. Thus, the growth of bacteria and other microorganisms in the soil is promoted, making possible the luxuriant growth of vegetation as a supply source of humus.

The fact that a certain specific type of vegetation is maintained for a long time means that the type of vegetation is adapted for the environmental conditions of the land, and that the coarse organic matters such as dead branches and leaves and the temperature, humidity, shade condition, etc. which participate in their humic decomposition are fitted to the type of vegetation. At the same time a certain balance in the cycle of the production and consumption or disappearance of humus is enough to keep.

This balance can be improved into a more preferable state (soil morphology) or on the contrary to the cycle of deterioration, by the alternation of vegetation (change of species of

plants, and change of forest types or stand ages), tending, fertilization, etc.

The soils of the survey area belong to Massape-soil association, being an intermediate type between acidic Latosols and Red-Yellow Podzols. It seems that in high mountainous districts with much precipitation (more than about 1,400m), the Red-Yellow Podzols are dominant, and in lowland, the Latosols are dominant.

The results of the soil survey made this time, soil profiles and the results of mechanical analysis of soils are shown in Tables 2 to 4 and in photos attached. The outline is as follows.

The A horizon is 25 to 30cm thick, rich in humus, dark brown, sandy loam, containing adequate moisture, swollen and soft, weakly acid at pH 5.5 to 6.0, and a little strongly acid at the ridges.

The B horizon is 70 to 200cm thick, yellowish brown, containing a small amount of breccias. The content of clay and silt is 25 to 40% at the foot of mountains, 10 to 20% at the ridges, and the other substances are coarse or fine sand. The foot area can be said to have sandy clay, and the ridges, clayey sand.

The pH value is 6.5 at the foot area on the average, being a little acid, and neutral 6.8 to 7.0 at the ridges.

In the modestly moist condition, the soils are relatively soft, but when exposed to the air and dried, the clay content is concreted, being changed to acid of about pH 5.5.

Except A horizon, the distinction of the soil horizons is difficult. The boundary between B and C horizons is not

clear, and the deposition layer of colored minerals is regarded only as a part of colluvial soils.

The root systems of trees reach about 1m in depth, but do not show a trend of concentration in a certain layer. This must have been caused by it that because of unclear differentiation of soil layers, seepage water infiltrates uniformly into a deep layer through the saprolite layer, and that groundwater is very deep or that there is no layer limiting the groundwater (acquiclude).

Therefore, since the B and C horizons are originally good in permeability as far as there are favorable forest soils (in this case, A horizon of crumbled structure rich in humus), the mountainous area has a very high function of water source conservation.

The locations where samples for the mechanical analysis of soils were taken are as shown in the location map, and E-1 indicates latosolic clay of the Taubate layer (sediment of the Tertiary) near Guaratingueta, containing more than 50% of clay.

The analytical values (mean values) of Massape-soils are as shown in Table 5.

Forest types in the Paraiba Highland are as shown in Fig. 4.

Virgin forests of miscellaneous broad-leaved trees (including needle-leaved trees, araucaria in the highland of more than about 1,200m) called Mata and natural secondary stand (Capoeira) are dominant, being followed by low forests (Cerrado) and planted forests (Reflorestamento).

Forest is only generally dotted as complexes of about 5 to 10km^2, except the mountainous regions, provincial forests, natural parks, etc. and the most of the watershed (about 80%) is occupied by pasture treated extensively.

In this area, from the beginning of the previous century, virgin forests were hewn down, to cultivate coffee, and as a result of uncontrolled cultivation, the land productivity has dropped during these 80 years, and does not allow even coffee cultivation. Therefore the land has been changed to grass land.

After that, the cultivation of coffee moved to the calcareous and fertile terra rossa zone of inland.

According to Koeppen's climate classification, the land higher than about 1,400m in altitude belongs to temperate humid climate, and the land lower than that, belongs to tropical rain forest climate, as mentioned before. Among the evergreen broad-leaved trees of Mata and Capoeira, family of ananas and usneas are observed to exist densely as epiphytes, suggesting the mountainous climate of dense fog.

In the highland above 1,200 to 1,400m in altitude, araucaria, a sole indigenous conifer tree in Brazil similar to Chinese firs are observed. Around villages these trees are conserved to obtain nuts and also to provide shade for cattle and horses.

Also to araucaria, usneas adhere densely.

The water quality of torrents in and around the survey area was analyzed, and the results are as shown in Table 7. The pH values are 6.4 to 6.9, being weakly acid, and contents of iron and phosphoric acid are a little high, in the main river of Paraibuna and in all the areas A, B, C and D. The high turbidity (colloid content) in Area A and the high nitrogen

content in Area D with pastures in the watershed are characteristic.

When water samples were taken (July 31), the season was dry with low turbidity.

It is necessary to examine the water quality continuously about once a month in the future, for studying the relationship between the change of soils caused by the seasonal change of various factors and by the change of forest type on one hand and the change of water quality on the other hand, and so on over a long period of time.

(3) Situations of land use

The changes of land use in the area of the Paraiba Heights were described before. About 80% of the total area is occupied by extensive pasture, and of the other 20% forest land, more than about 10% is man-made forest, consisting mainly of eucalyptus spp., Pinus Elliottii and Pinus taeda.

The planted trees grow well, Eucalyptus spp. stands have been clear cut at intervals of 5 to 10 years, and reproductive sprouting seems to be done twice. However, on sandy slopes, not to repeat the failure of coffee plantations in reducing soil productivity, it is required to carry out pedeological and biological studies with the aim of maintaining soil productivity.

With regard to pasture, compared with Australia, New Zealand, etc., management is generally extensive, involving many problems for watershed management.

Table 2 Results of Soil Survey (1)

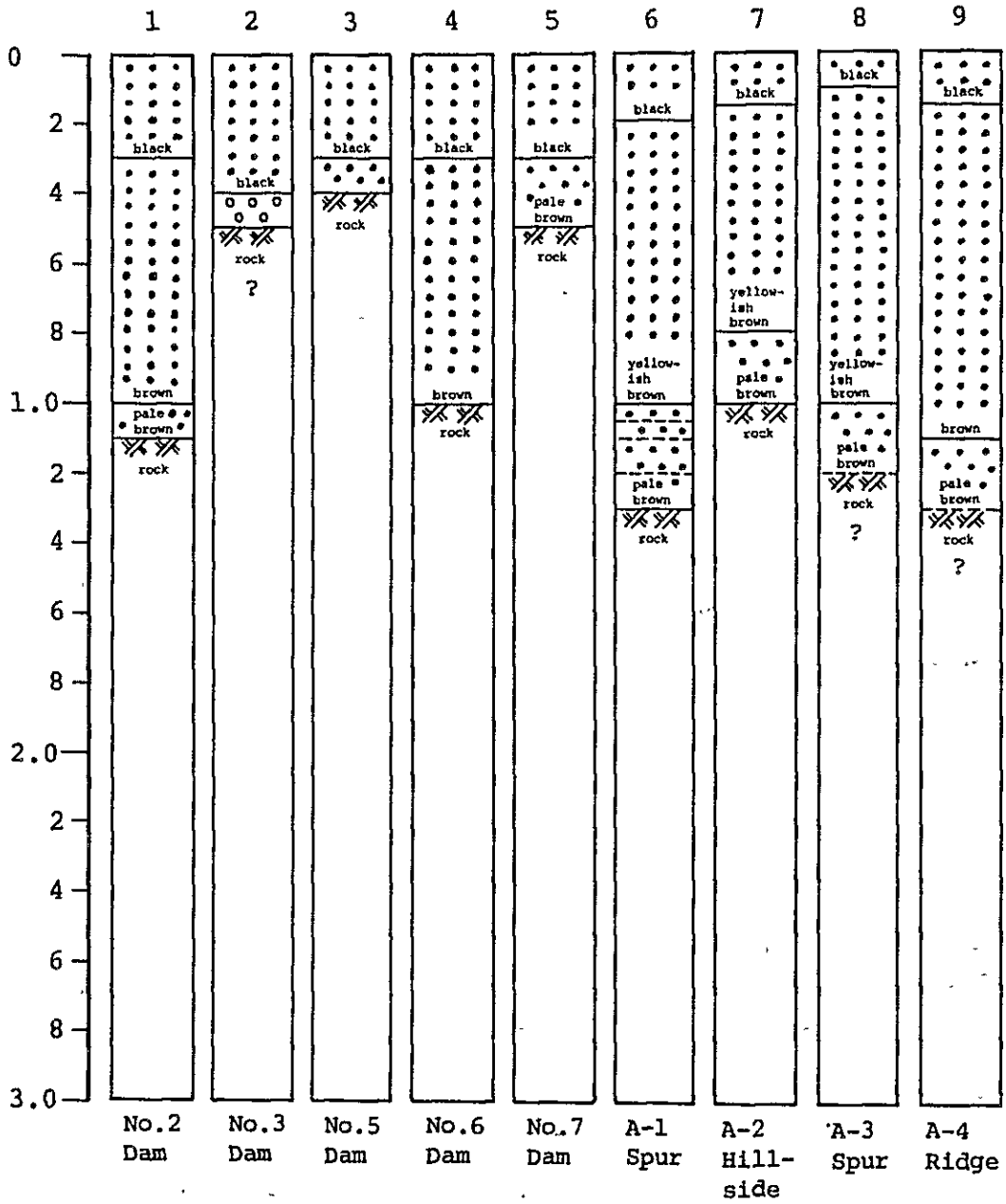
Area		Area A				Area B			
Survey location No.		1	2	3	4	1	3	4	5
Condition of horizons — General condition of respective location	Location	Mountain foot	Middle slope	Middle slope	Ridge	Mountain foot	Middle slope	Middle slope	Ridge
	Altitude	1020	1025	1025	1040	1040	1040	1050	1060
	Direction	E	N	E	E	NE	E	E	N
	Gradient	15°	30°	10°	10°	10°	15°	15°	12°
	Sedimentary type	Eluvium	Eluvium	Eluvium	Eluvium	Colluvium	Eluvium	Eluvium	Eluvium
	Surface geologic, parent materials	Granites	Granites	Granites	Granites	Granites	Granites	Granites	Granites
	Land classification	Forest	Forest	Forest	Forest	Forest	Forest	Forest	Forest
	Situations	Broad leave, natural forest	Broad leave, natural forest	Broad leave, natural forest	Broad leave, natural forest	Broad leave, natural forest	Broad leave, natural forest	Broad leave, natural forest	Broad leave, natural forest
	Average height of upper story trees	10 ~ 20m	20 ~ 20m	15 ~ 20m	15 ~ 20m	5 ~ 15m	10 ~ 15m	15 ~ 20m	15 ~ 20m
A° horizon	Thickness of horizons	5cm	5cm	5cm	5cm	5cm	3cm	4cm	2cm
	Depth from surface	5cm	5cm	5cm	5cm	5cm	3cm	4cm	2cm
	Color	Dark brown	Dark brown	Dark brown	Dark brown	Dark brown	Dark brown	Dark brown	Dark brown
	Humus	Ample	Ample	Ample	Ample	Ample	Ample	Ample	Ample
	Invasion of root	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
A horizon	Thickness of horizons	20cm	15cm	10cm	15cm	30cm	30cm	15cm	14cm
	Depth from surface	25cm	20cm	15cm	20cm	35cm	33cm	19cm	16cm
	Color	Blackish brown	Blackish brown	Blackish brown	Blackish brown	Blackish brown	Blackish brown	Blackish brown	Blackish brown
	P H	5.5	6.0	6.0	6.2			6.2	6.4
	Humus	Ample	Ample	Ample	Ample	Ample	Ample	Very ample	Very ample
	Soil structure	Sandy loam	Sandy loam	Sandy loam	Sandy loam	Sandy loam	Sandy loam	Sandy loam	Sandy loam
	Gravel	Nil	Nil	Nil	Containing breccias	Nil	Nil	Nil	Nil
	Hardness		5kg/cm²	10	5	8	8	10	5
	Consistency	Soft	Soft	Soft	Soft	Soft	Soft	Hard	Soft
	Invasion of root	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
B horizon	Thickness of horizons	80cm or more	65cm	90cm	95cm	70cm	120cm	85cm or more	84cm
	Depth from surface	105cm or more	85cm	105cm	115cm	105cm	153cm	104cm or more	100cm
	Color	Yellowish brown	Yellowish brown	Yellowish brown	Brown	Yellowish white to yellowish brown	Yellowish brown	Yellowish brown	Yellowish brown
	P H	6.3	6.5	6.5	6.8	5.5 ~ 6.4		6.8	6.8
	Humus	Contained	Contained	Contained	Contained	Contained	Contained	Contained	Ample
	Soil structure	Sandy loam	Sandy loam	Sandy loam	Sandy loam	Sandy loam	Sandy loam	Sandy loam	Sandy loam
	Gravel	Containing a little breccias	Containing a little breccias	Containing a little breccias	Containing a little breccias	Containing a little breccias	Nil	Nil	Nil
	Hardness		8kg/cm²	10	20	10	18	18	10
	Consistency	Soft	Soft	Soft	Hard	Soft	Soft	Soft	Soft
	Invasion of root	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Remarks	Deepest reach of root	100cm	80cm	95cm	105cm	60cm	120cm	90cm	70cm
	Deposited layer of iron, etc.	Nil	Nil	Nil	Nil	95cm from surface	Nil	Nil	Nil
	Others	Containing silt	Decomposed granites or underlying rocks exist below B horizon.	C horizon comprises decomposed granites.	C horizon comprises brownish white decomposed granites.	B horizon can be classified further into 3 sub-layers.	C horizon comprises decomposed granites containing 10 to 20cm breccias.		C horizon comprises yellowish white sandy soils.

Table 2 Results of Soil Survey (2)

Area		Area C				Area D			
Survey location No.		1	2	3	4	1	2	3	4
Conditions of horizons — General conditions of respective location	Location	Mountain foot	Middle slope	Middle slope	Ridge	Mountain foot	Middle slope	Middle slope	Ridge
	Altitude	1050	1060	1065	1075	1040	1060	1075	1150
	Direction	NE	NE	NW	N	E	E	N	W
	Gradient	8°	10°	15°	20°	10°	25°	13°	25°
	Sedimentary type	Eluvium	Eluvium	Eluvium	Eluvium	Colluvium	Colluvium	Colluvium	Eluvium
	Surface geologic, parent materials	Granites	Granites	Granites	Granites	Granites	Granites	Granites	Granites
	Land classification	Forest	Forest	Forest	Forest	Pasture	Pasture	Pasture	Forest
	Situations	Broad leave, natural forest	Broad leave, natural forest	Broad leave, natural forest	Broad leave, natural forest	Grass land	Grass land	Grass land	Broad leave, natural forest
	Average height of upper story trees	15 ∿ 20m	10 ∿ 20m	10 ∿ 20m	10 ∿ 15m	—	—	—	10 ∿ 20m
A° horizon	Thickness of horizons	2cm	3cm	3cm	4cm	5cm	2cm	3cm	4cm
	Depth from surface	2cm	3cm	3cm	4cm	5cm	2cm	3cm	4cm
	Color	Dark brown	Dark brown	Dark brown	Dark brown	Dark brown	Dark brown	Dark brown	Dark brown
	Humus	Ample	Ample	Ample	Ample	Ample	Ample	Ample	Ample
	Invasion of root	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
A horizon	Thickness of horizons	18cm	25cm	20cm	25cm	25cm	13cm	10cm	18cm
	Depth from surface	20cm	28cm	23cm	29cm	30cm	15cm	13cm	22cm
	Color	Blackish brown	Blackish brown	Blackish brown	Blackish brown	Blackish brown	Blackish brown	Blackish brown	Blackish brown
	P H	5.2	5.8	5.7	6.0	4.9	6.0	5.2	
	Humus	Very ample	Ample	Ample	Ample	Contained	Contained	Contained	Ample
	Soil structure	Sandy loam	Sandy loam	Sandy loam	Sandy loam	Clay loam	Clay loam	Clay loam	Sandy loam
	Gravel	Nil	Nil	Nil	Nil	Nil	Nil	Nil	Nil
	Hardness	5kg/cm²	4	4	2	8	7	10	4
	Consistency	Soft	Soft	Soft	Soft	Soft	Hard	Soft	Soft
	Invasion of root	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
B horizon	Thickness of horizons	75cm	100cm or more	77cm or more	71cm	65cm	185cm	187cm	62cm
	Depth from surface	95cm	128cm or more	100cm or more	100cm	95cm	200cm	200cm	90cm
	Color	Yellowish brown	Yellowish brown	Yellowish brown	Yellowish white	Yellowish brown	Reddish brown	Reddish brown	Yellowish brown
	P H	6.6	6.8	6.6	6.8	6 9	6.9	7.0	
	Humus	Ample	Contained	Contained	Contained	Cotained a little	Contained a little	Contained a little	Contained a little
	Soil structure	Sandy loam	Sandy loam	Sandy loam	Sandy loam	Clay loam	Clay loam	Clay loam	Sandy loam
	Gravel	Nil	Nil	Nil	Nil	Nil	Nil	Nil	Containing a little breccias
	Hardness	14kg/cm²	10	12	10	10	17	18	20
	Consistency	Hard	Hard	Hard	Hard	Soft	Hard	Hard	Rather hard
	Invasion of root	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Remarks	Deepest reach of root	80cm	120cm	100cm	80cm	50cm	60cm	55cm	100cm
	Deposited layer of iron, etc.	Nil	Nil	Nil	100-110cm from surface	Nil	Nil	Nil	Nil
	Others	C horizon comprises decomposed grantes containing breccias.	C horizon comprises decomposed granites with underlying rocks.	C horizon comprises decomposed granites.	Deposited layer belongs to C horizon.	Much clay in the soil.	C horizon comprises red soil.	Soils are deep.	Underlying rocks are shallow

Table 3.1

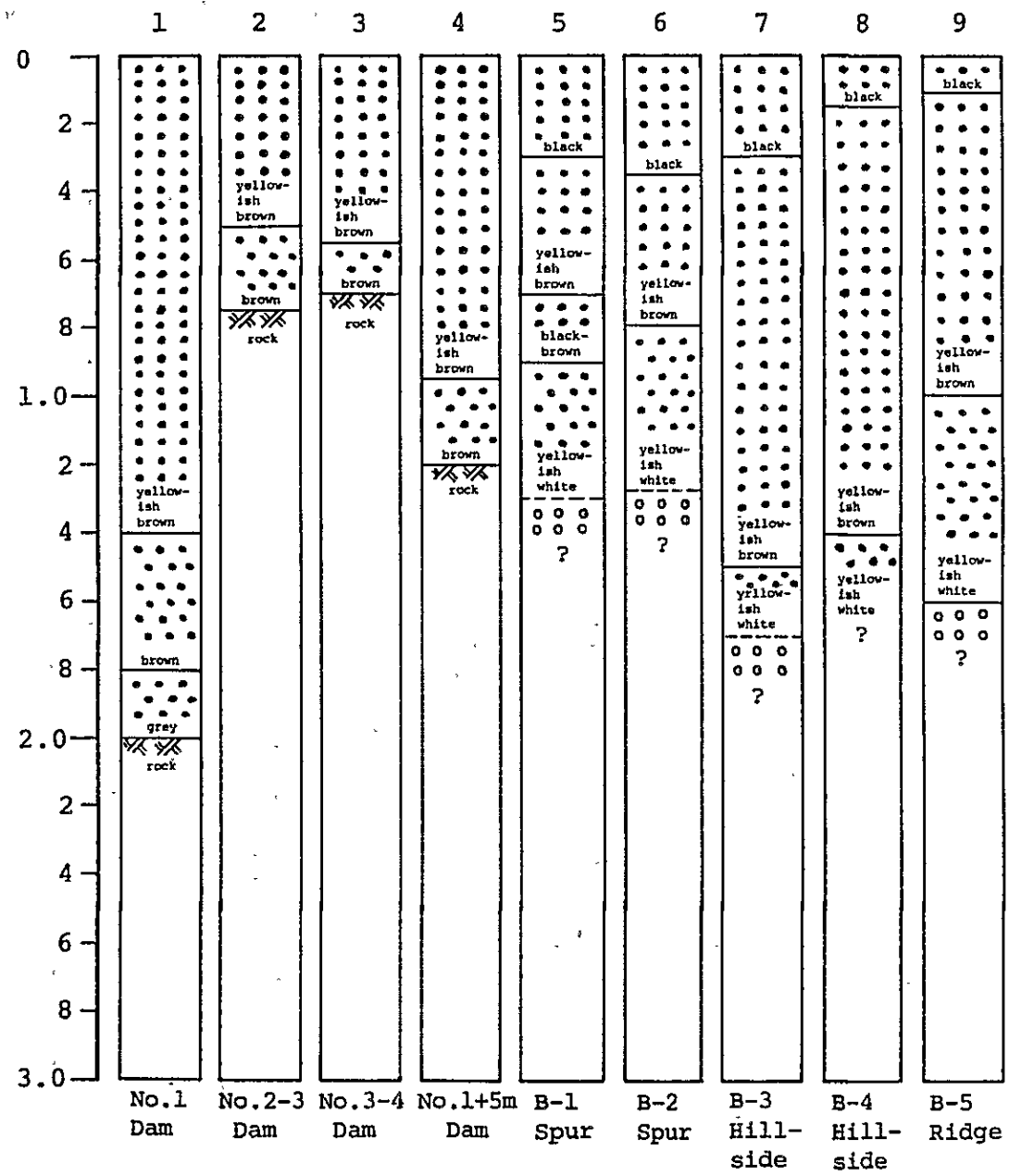
A Area Soil Profil



Classification	Organic soil	Clay	Silt	Sandy soil	Gravel soil	Sand	Gravel
Mark							

Table 3.2

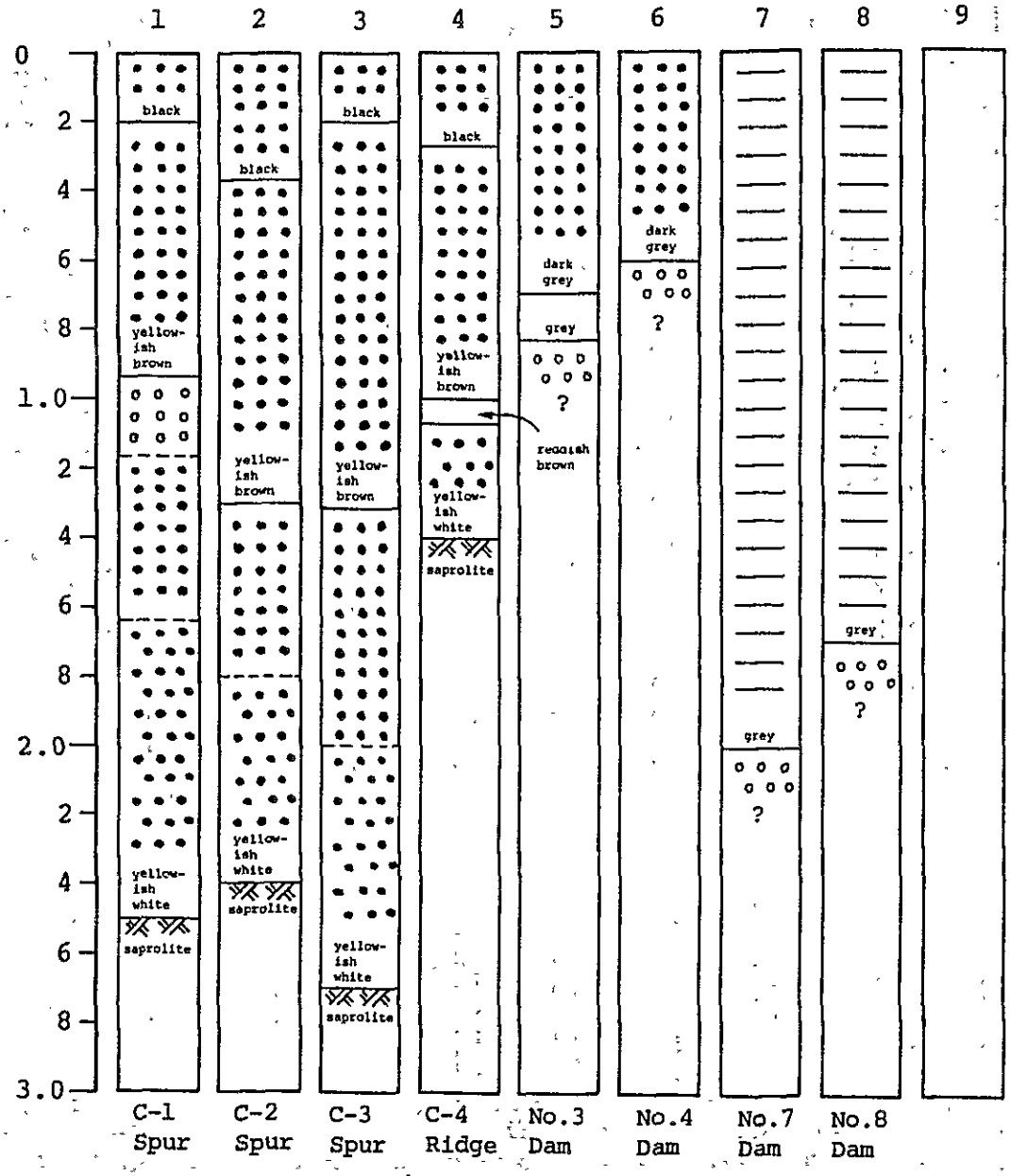
B Area Soil Profil



Classification	Organic soil	Clay	Silt	Sandy soil	Gravel soil	Sand	Gravel
Mark							

Table 3.3

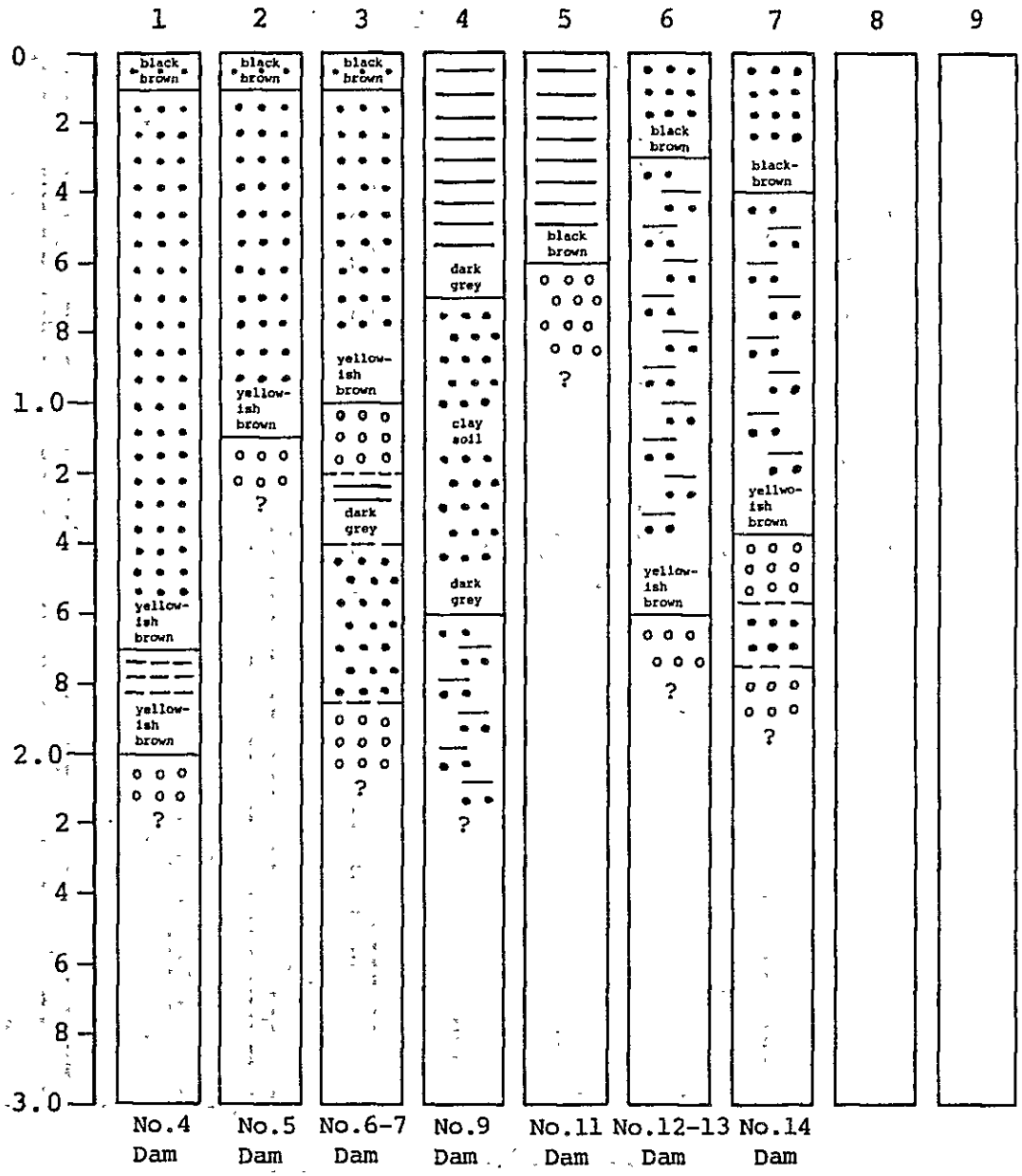
C Area Soil Profil



Classification	Organic soil	Clay	Silt	Sandy soil	Gravel soil	Sand	Gravel
Mark							

Table 3.4

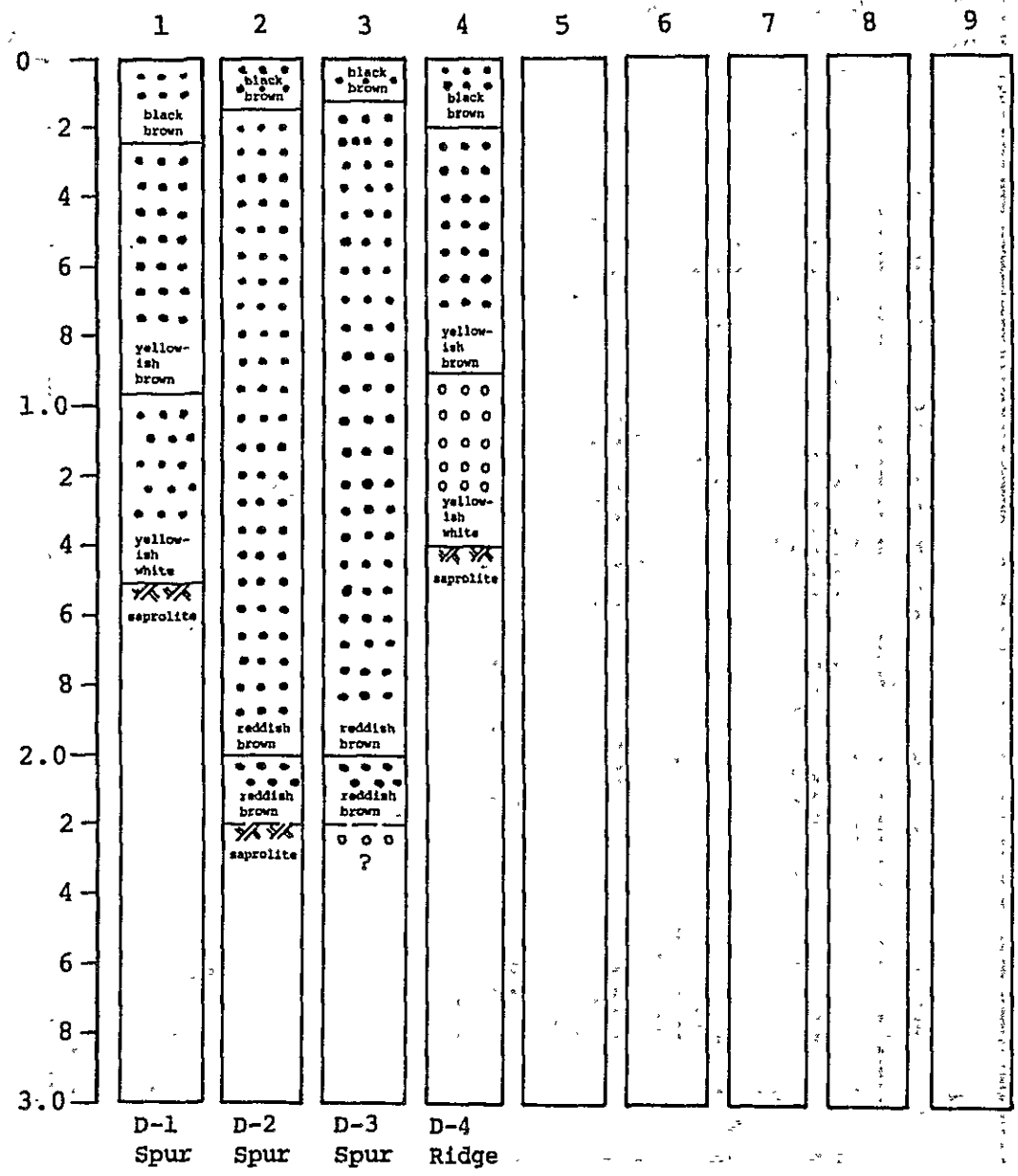
D-I Area Soil Profil



Classification	Organic soil	Clay	Silt	Sandy soil	Gravel soil	Sand	Gravel
Mark							

Table 3-5

D-II Area Soil Profil



Classification	Organic soil	Clay	Silt	Sandy soil	Gravel soil	Sand	Gravel
Mark							

Table 4

Rem: INSTITUTO FLORESTAL SP. Cx. Postal 1322- Cep. 01000 SP.

Int: Instituto Florestal

Ass: Análise Granulométrica de amostras de Solo

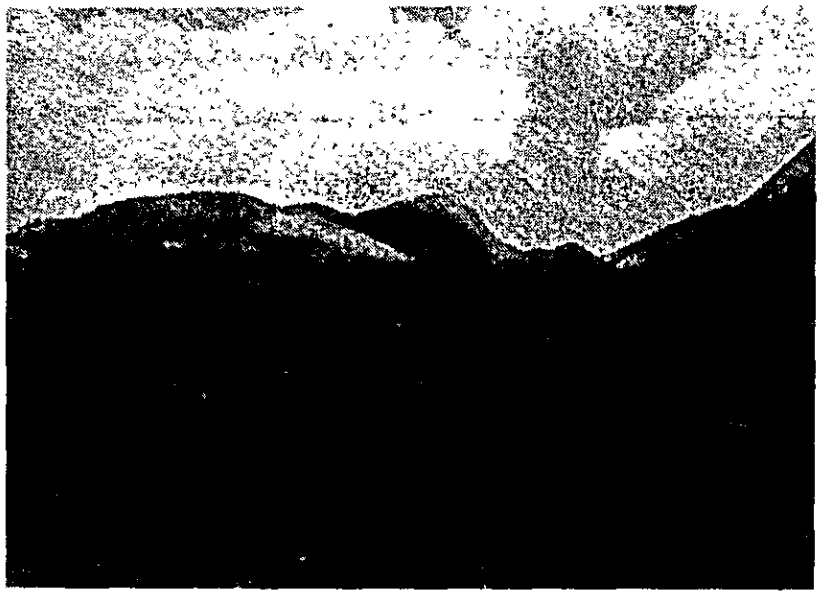
Reg:_____ Proc:_____ Anal: RHD

ANALISE GRANULOMÉTRICA DO SOLO
GRANULAR ANALYSIS

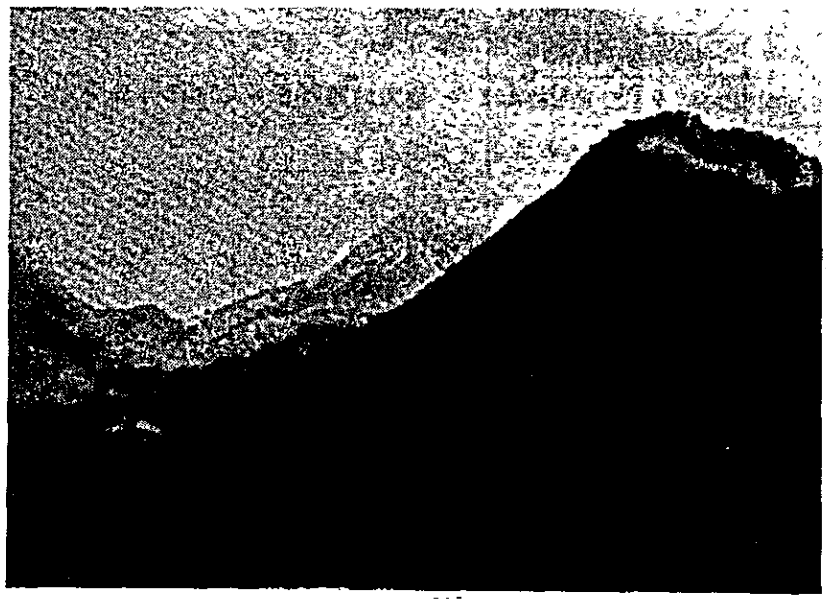
NO DE AMOSTRA SAMPLE NUMBER		ARGILA CLAY %	LIMO MINUTE %	AREIA FINA FINE %	AREIA GROSSA COARSE %	CLASSIFICAÇÃO CLASSIFICATION
SEÇÃO	INTER.					
844	B-1	22	4	22	52	fr. arg. ar
845	B-2	24	5	20	51	fr. arg. ar
846	B-3	19	10	22	49	fr. ar
847	B-4	7	3	18	72	ar. fr
848	A-1	32	5	20	43	fr. arg. ar
849	A-2	34	6	18	42	fr. arg. ar
850	A-3	24	7	24	45	fr. arg. ar
851	A-4	24	5	22	49	fr. arg. ar
852	C-1	25	7	19	49	fr. arg. ar
853	C-2	30	9	20	41	fr. arg. ar
854	C-3	21	11	30	38	fr. arg. ar
855	C-4	12	7	26	55	fr. ar
856	D-1	31	8	16	45	fr. arg. ar
857	D-2	40	9	12	39	fr. arg.
858	D-3	16	10	44	30	fr. ar
859	D-4	15	6	39	40	fr. ar
860	E-1	52	3	12	33	arg.
861	E-1	50	1	14	35	arg. ar

Table 5 Results of Soil Analysis: Massapé Sao Moros

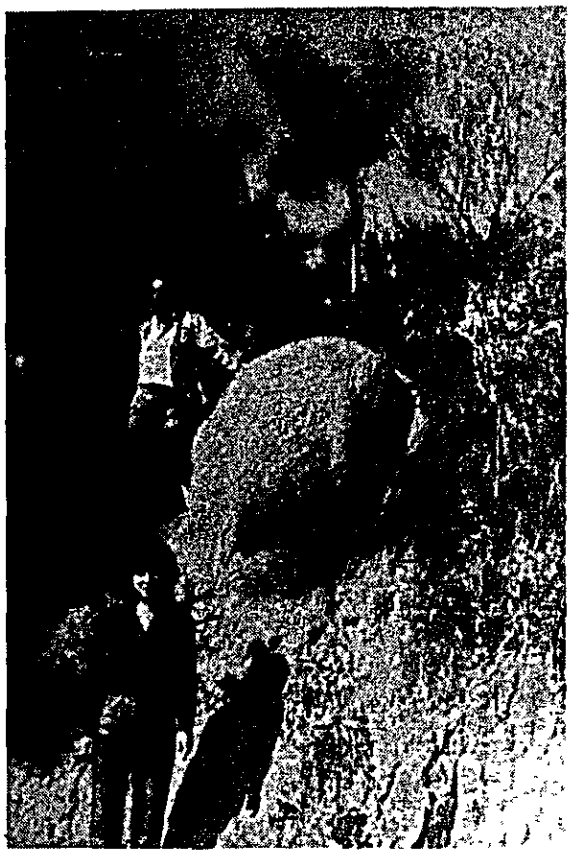
Strata	Moisture %	PH	C%	N%	K_{ml}	Ca_{ml}	Mg_{ml}	P_2O_5 ml	Saturation dégree
0∿ 40	14.3	5.8	1.3	0.02	0.18	2.50	0.70	0.60	35
40∿ 80	16.3	5.5	0.5	0.05	0.12	1.50	0.70	0.50	31
80∿150	16.8	5.5	0.3	0.02	0.12	0.50	0.60	0.40	19



Coastal mountain range (Serra do Mar),
looking north from Ubatuba
Soil: gneiss

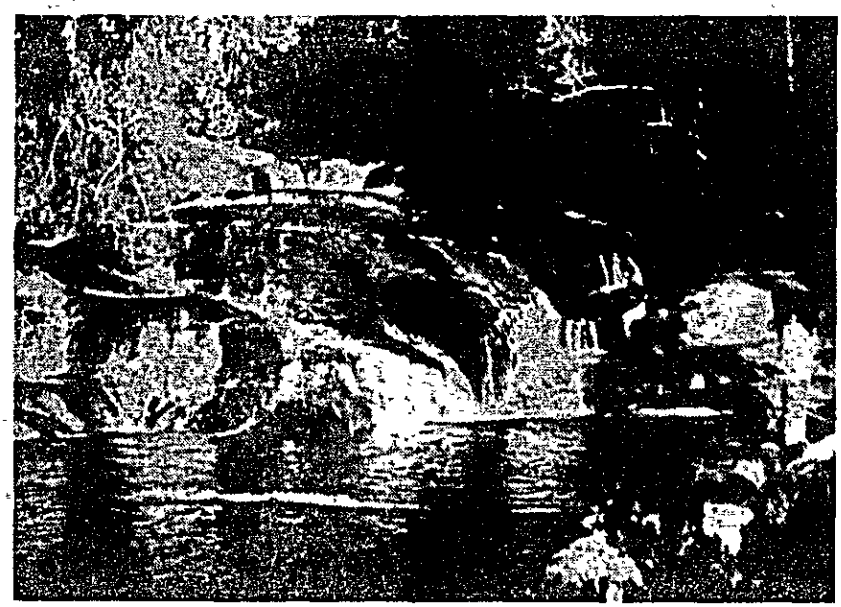


Same as above.



Ant-hill in the headwaters of
the Paraibuna

Waterfall in the upper reaches
of the Paraibuna

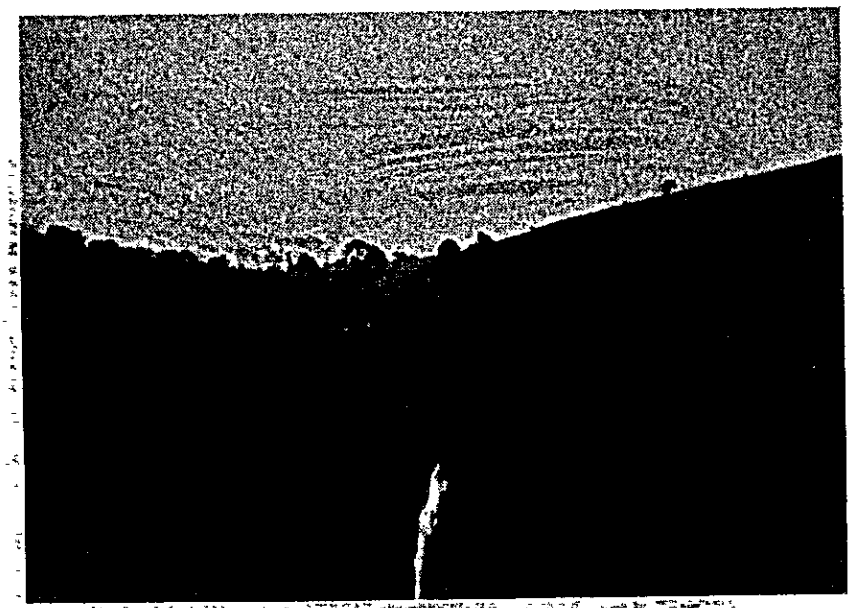


Waterfall in the lower reaches
of the Paraibuna
Penetation of diabase

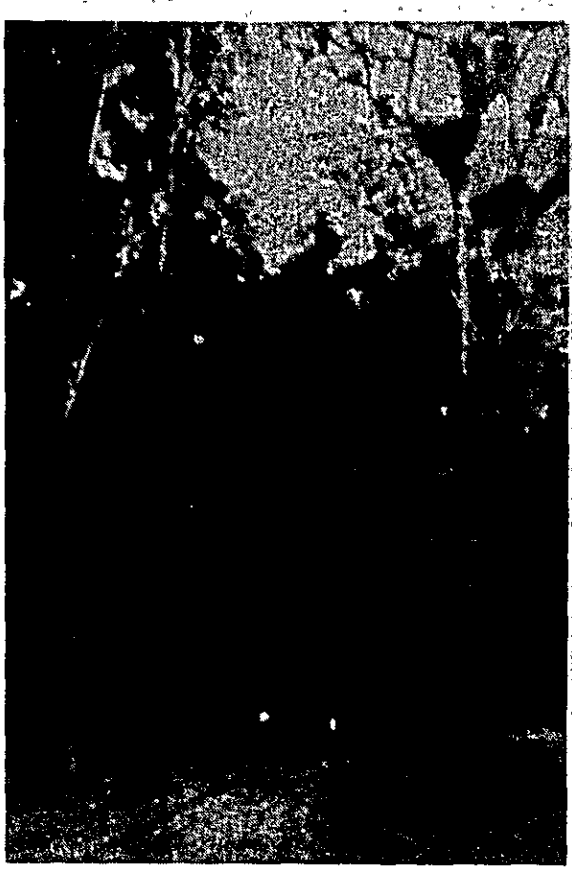
Riverbed in the lower reaches
of the Paraibuna
Gneiss joint

Upper reaches of the Paraibuna;
Slack waters above the waterfall

Waterfall across the river from Point D
Gneiss joint extends ENE-WSW in parallel
to the coastal mountain range



Uppermost reaches of the Riveira, a branch
of the Paraibuna. Exposed diabase



Middle reaches of the Paraibuna, Forest type of a natural stand

Same as left Insertion of numerous Ananas

Same as above
Araucalia can be seen

Upper reaches of the Paraibuna Ranch with Araucalia

Araucalia has pasture and young growth as symbions

Fig. 4 Forest Type Map

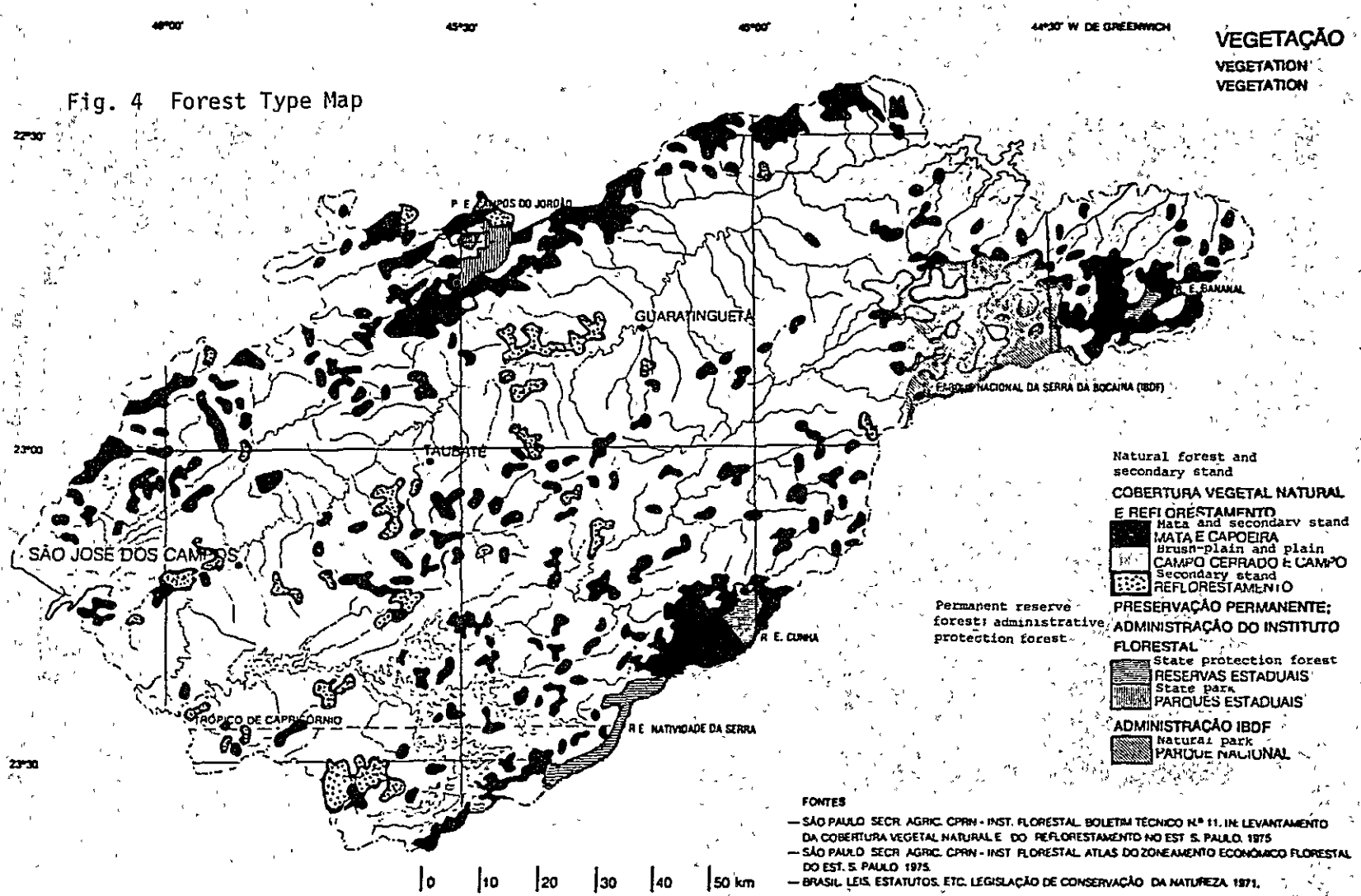


Table 6.1

SECRETARIA DE ESTADO DA SAÚDE
COORDENADORIA DE SERVIÇOS TÉCNICOS ESPECIALIZADOS

INSTITUTO ADOLFO LUTZ

Nº 23717

DIVISÃO DE BROMATOLOGIA E QUÍMICA — TL-BQ.

O Instituto Adolfo Lutz certifica que foi o seguinte o resultado da ANÁLISE Orientação
n.º ____ TL n.º OR - 4996/80 Talão OR - 09 procedida no
Produto Água Natural de Corrego
Mar
~~Fabricado~~ Remetido por Ringyo Doboku Konsal
em ____ à rua do Horto n.º 01
Município São Paulo Estado São Paulo
~~Vendidos ou em depósito por~~ Localizado em Fazenda - Projeto Jica em Cunha
à rua ____ n.º ____ Estado São Paulo
~~Colhido por~~ Entregue pelo interessado
~~Remetido pelo~~ Solicitado pelo interessado
com o requerimento de n.º 4315 de 30 de julho de 19 80
Entrada nesta Diretoria em 31 de julho de 19 80

RESULTADOS

pH		6,70	
Sólidos em suspensão	Turbidity in suspension (floating partides)	abaixo de 2,0 mg/l	→less than 2.0mg/l
Ferro	Ferrous	0,13 mg/l em Fe	
Nitrogênio nitrico	Nitrogen	0,10 mg/l em N	
Fosfatos	Phosphorus	0,20 mg/l em P	
Turbidez	Turbidity	11,7	

OBSERVAÇÕES: Os dados analiticos acima referem-se à amostra entregue pelo interessado, identificada com o codigo H-1

São Paulo, 6 de agosto de 19 80

Table 6.2

SECRETARIA DE ESTADO DA SAÚDE
COORDENADORIA DE SERVIÇOS TÉCNICOS ESPECIALIZADOS

Nº23713

INSTITUTO ADOLFO LUTZ

DIVISÃO DE BROMATOLOGIA E QUÍMICA — TL-BQ.

O Instituto Adolfo Lutz certifica que foi o seguinte o resultado da ANALISE Orientação
n.º ____ TL n.º OR - 4992/80 Talão OR - 09 procedida no
Produto Água Natural de Corrego
Marca ____
Remetido ~~Fabricado~~ por Ringyo Doboku Konsal
em ____ à rua do Horto n.º 01
Município São Paulo Estado São Paulo
~~Vendidos ou em depósito por~~ Localizado em Fazenda - Projeto Jica em Cunha
à rua ____ n.º ____ Estado São Paulo
~~Colhido por~~ Entregue pelo interessado
~~Remetido pelo~~ Solicitado pelo interessado
com o requerimento de n.º 4315 de 30 de julho de 19 80
Entrada nesta Diretoria em 31 de julho de 19 80

RESULTADOS

pH		6,90
Sólidos em suspensão	Turbidity in suspension (floating partides)	38,50 mg/l
Ferro	Ferrous	0,12 mg/l em Fe
Nitrogênio nitrico	Nitrogen	0,10 mg/l em N
Fosfatos	Phosphorus	0,20 mg/l em P
Turbidez	Turbidity	8,0

OBSERVAÇÕES: Os dados analíticos acima referem-se à amostra entregue pelo interessado, identificada com o código - amostra A-1

São Paulo, 6 de agosto de 19 80

Table 6.3

SECRETARIA DE ESTADO DA SAÚDE
COORDENADORIA DE SERVIÇOS TÉCNICOS ESPECIALIZADOS Nº23714

INSTITUTO ADOLFO LUTZ

DIVISÃO DE BROMATOLOGIA E QUÍMICA — TL-BQ.

O Instituto Adolfo Lutz certifica que foi o seguinte o resultado da ANALISE Orientação
n.º TL n.º OR - 4993/80 Talão OR - 09 procedida no
Produto Água Natural de Corrego
Marca
Enviado ~~Fabricado~~ por Ringyo Doboku Konsal
em à rua do Horto n.º 01
Município São Paulo Estado São Paulo
~~Vendidos ou em depósito por~~ Localizada em Fazenda - Projeto Jica em Cunha
à rua n.º Estado São Paulo
~~Colhido por~~ Entregue Pelo interessado
~~Remetido pelo~~ Solicitado pelo interessado
com o requerimento de n.º 4315 de 30 de julho de 19 80
Entrada nesta Diretoria em 31 de julho de 19 80

RESULTADOS

pH		6,60
Sólidos em suspensão	Turbidity in suspension (floating partides)	5,00 mg/l
Ferro	Ferrous	0,38 mg/l em Fe
Nitrogênio nitrico	Nitrogen	não encontramos
Fosfatos	Phosphorus	0,35 mg/l em P
Turbidez	Turbidity	5,00

OBSERVAÇÕES: Os dados analiticos acima referem-se à amostra entregue pelo interessado, identificada com o codigo B-1

São Paulo, 6 de agosto de 19 80

Table 6.4

SECRETARIA DE ESTADO DA SAÚDE
COORDENADORIA DE SERVIÇOS TÉCNICOS ESPECIALIZADOS

Nº 23715

INSTITUTO ADOLFO LUTZ

DIVISÃO DE BROMATOLOGIA E QUÍMICA — TL-BQ.

O Instituto Adolfo Lutz certifica que foi o seguinte o resultado da ANALISE Orientação
n.º _____ TL n.º OR - 4994/80 Talão OR - 09 procedida no
Produto Água Natural de Corrego _____
_____ Marca _____
~~Fabricado~~ Remetido por Ringyo Doboku Konsal
em _____ à rua do Horto n.º 01
Município São Paulo Estado São Paulo
~~Vendidos ou em depósito por~~ Localizado em Fazenda - Projeto Jica em Cunha
à rua _____ n.º _____ Estado São Paulo
~~Colhido por~~ Entregue pelo interessado
~~Remetido pelo~~ Solicitado pelo interessado
com o requerimento de n.º 4315 de 30 de julho de 19 80
Entrada nesta Diretoria em 31 de julho de 19 80

RESULTADOS

pH			6,60
Sólidos em suspensão	Turbidity in suspension (floating partides)		9,00 mg/l
Ferro	Ferrous		0,14 mg/l em Fe
Nitrogênio nitrico	Nitrogen		não encontramos
Fosfatos	Phosphorus	abaixo de	0,10 mg/l em P → less than 0.10mg/l
Turbidez	Turbidity		5,90

OBSERVAÇÕES: Os dados analiticos acima referem-se à amostra entregue pelo interessado, identificada com o código C-1

São Paulo, 6 de agosto de 19 80

Table 6.5

SECRETARIA DE ESTADO DA SAÚDE
COORDENADORIA DE SERVIÇOS TÉCNICOS ESPECIALIZADOS

INSTITUTO ADOLFO LUTZ

Nº23716

DIVISÃO DE BROMATOLOGIA E QUÍMICA — TL-BQ.

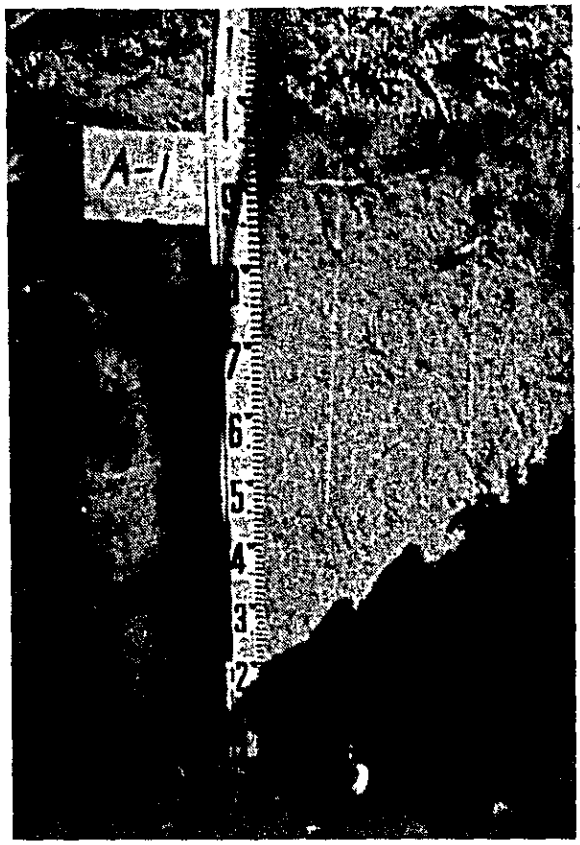
O Instituto Adolfo Lutz certifica que foi o seguinte o resultado da ANALISE Orientação
n.º ____ TL n.º OR - 4995/80 Talão OR - 09 procedida no
Produto Água Natural de Corrego
Marca ____
~~Remetido~~ ~~Fabricado~~ por Ringyo Doboku Konsal
em ____ à rua do Horto n.º 01
Município São Paulo Estado São Paulo
~~Vendidos ou em depósito por~~ Localizado em Fazenda - Projeto Jica em Cunha
à rua ____ n.º ____ Estado São Paulo
~~Colhido por~~ Entregue pelo interessado
~~Remetido pelo~~ Solicitado pelo interessado
com o requerimento de n.º 4315 de 30 de julho de 19 80
Entrada nesta Diretoria em 31 de julho de 19 80

RESULTADOS

pH		6,40
Sólidos em suspensão	Turbidity in suspension (floating partides)	5,00 mg/l
Ferro	Ferrous	0,38 mg/l em Fe
Nitrogênio nitrico	Nitrogen	0,20 mg/l em N
Fosfatos	Phosphorus	0,18 mg/l em P
Turbidez	Turbidity	4,50

OBSERVAÇÕES: Os dados analiticos acima referem-se à amostra entregue pelo interessado, identificada em o codigo D—1

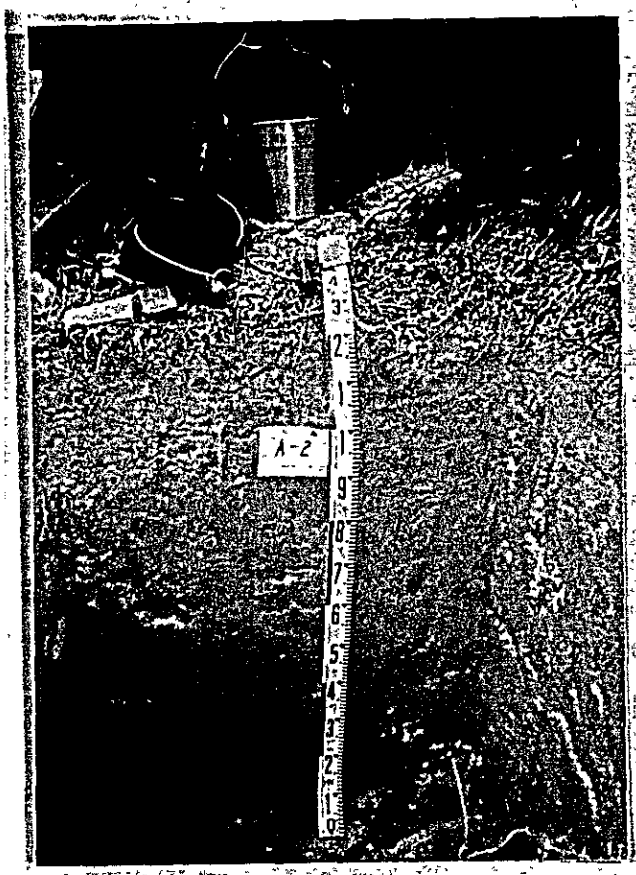
São Paulo, 6 de agosto de 19 80

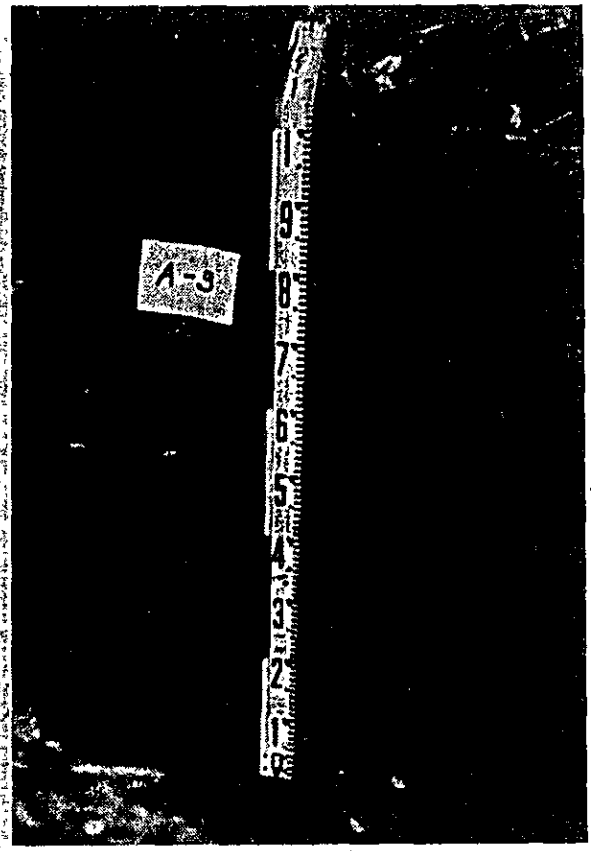


Soil profile

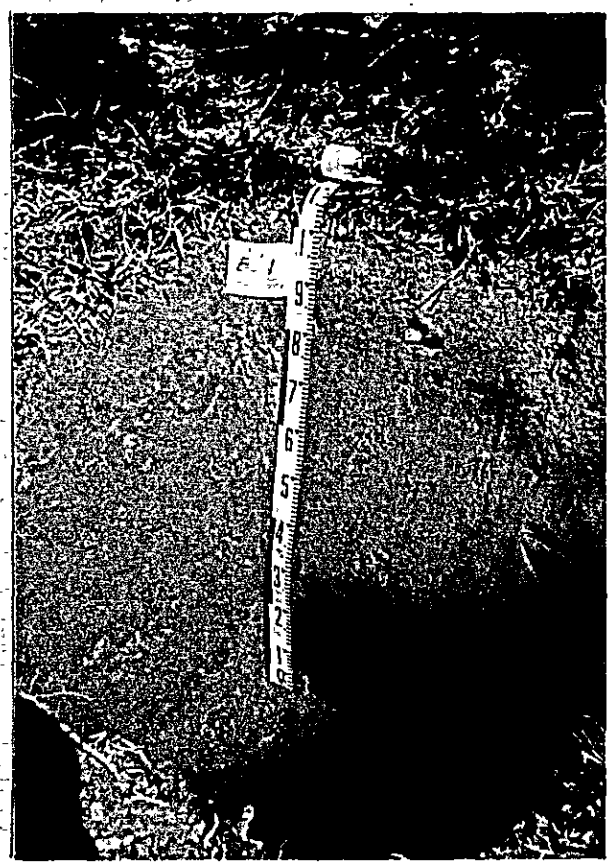
Sounding by soil auger

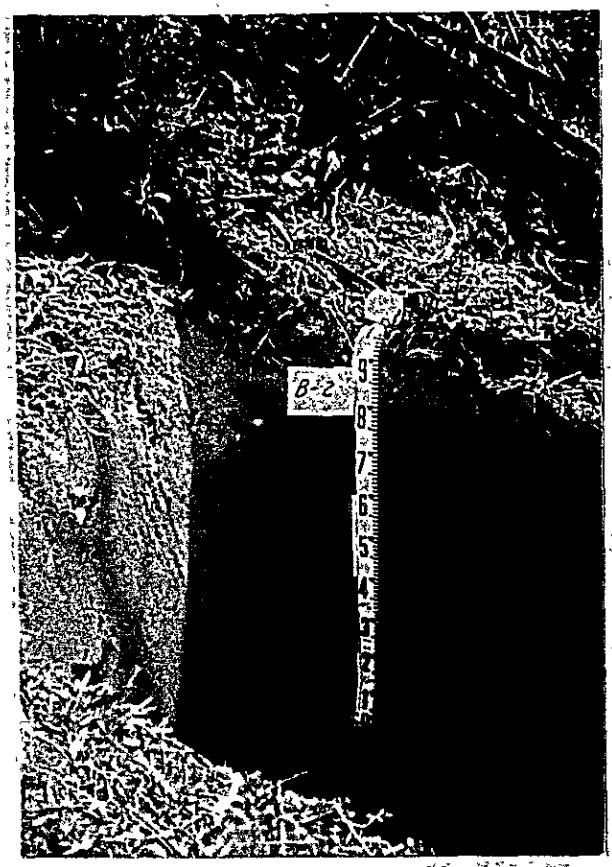
Soil acidity measurement

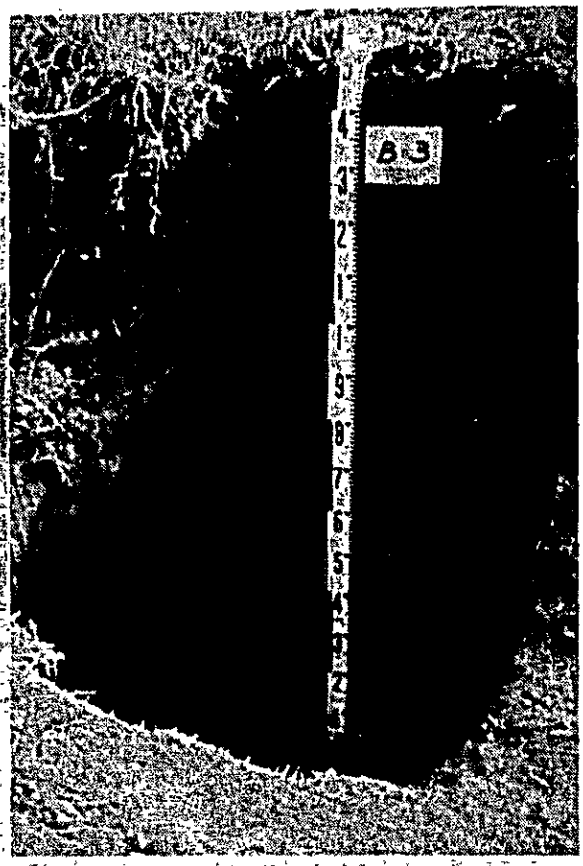

A-2


A-3

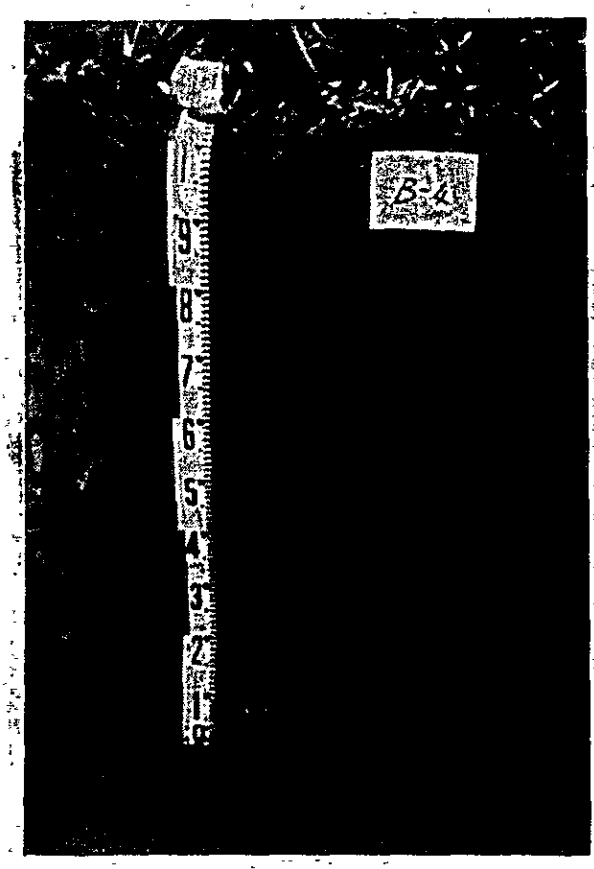

A-4

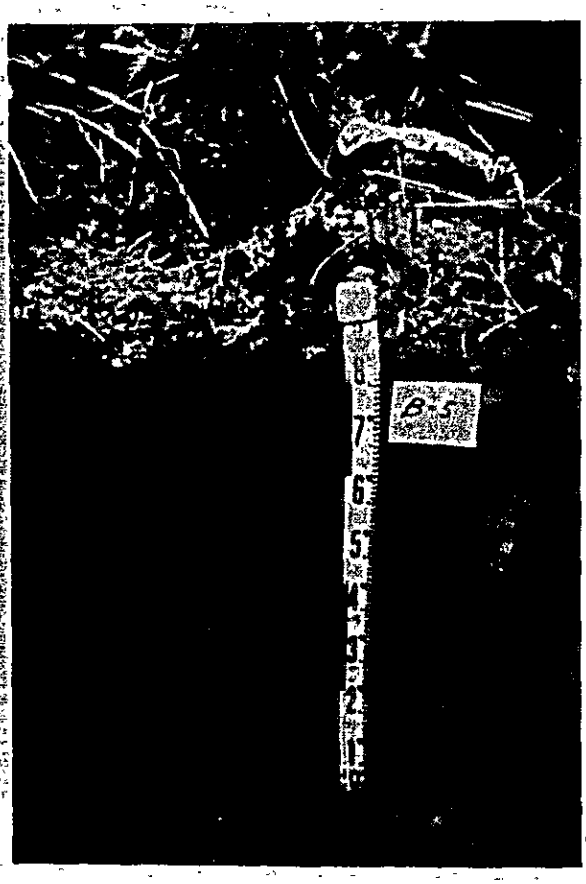


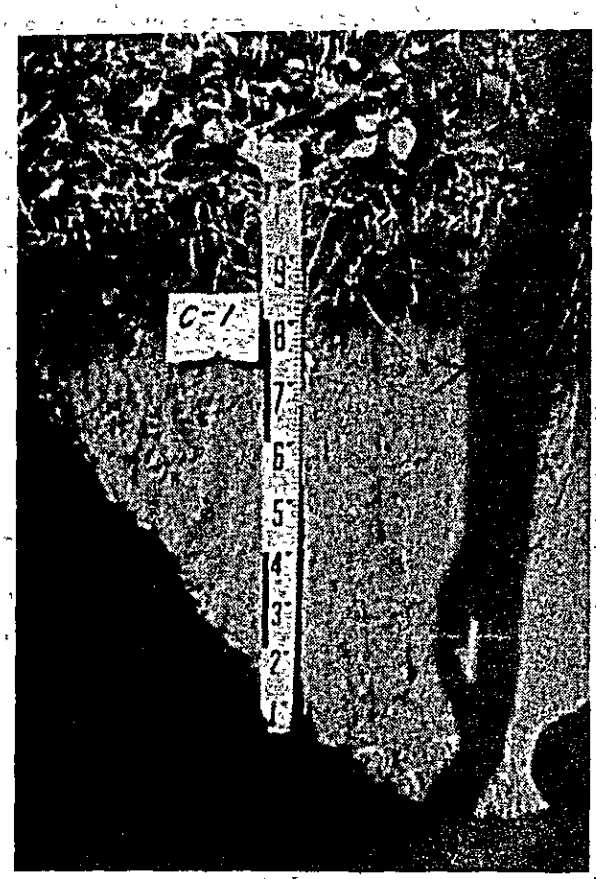


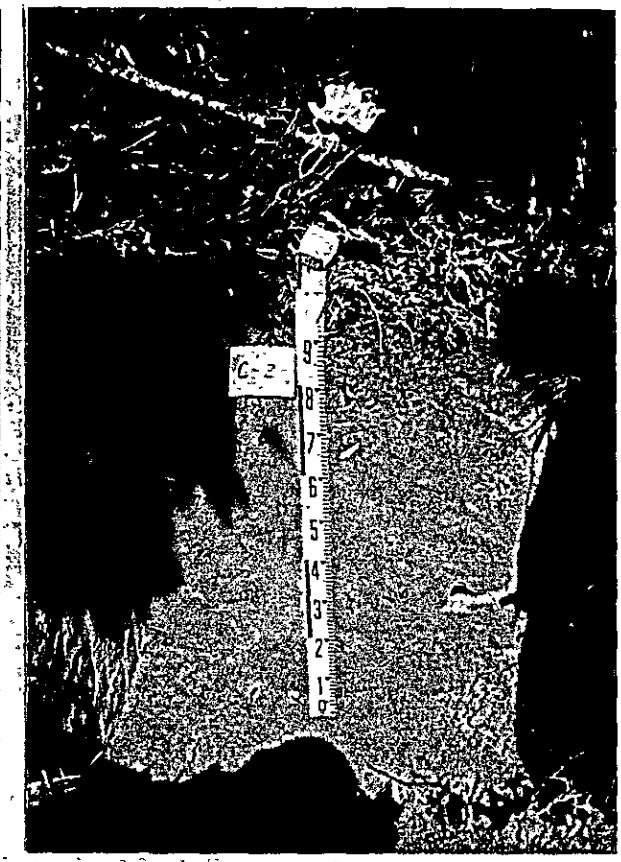


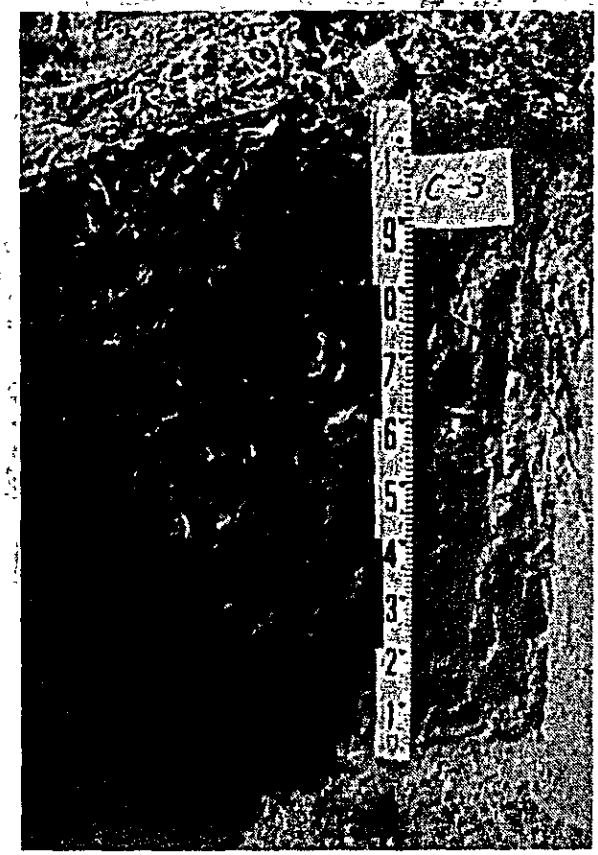
Ferro deposit at 90cm in depth

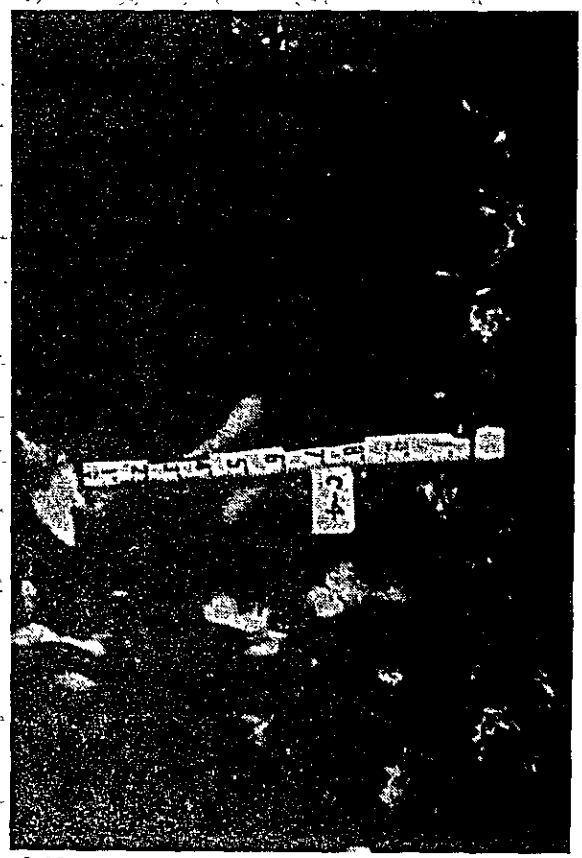


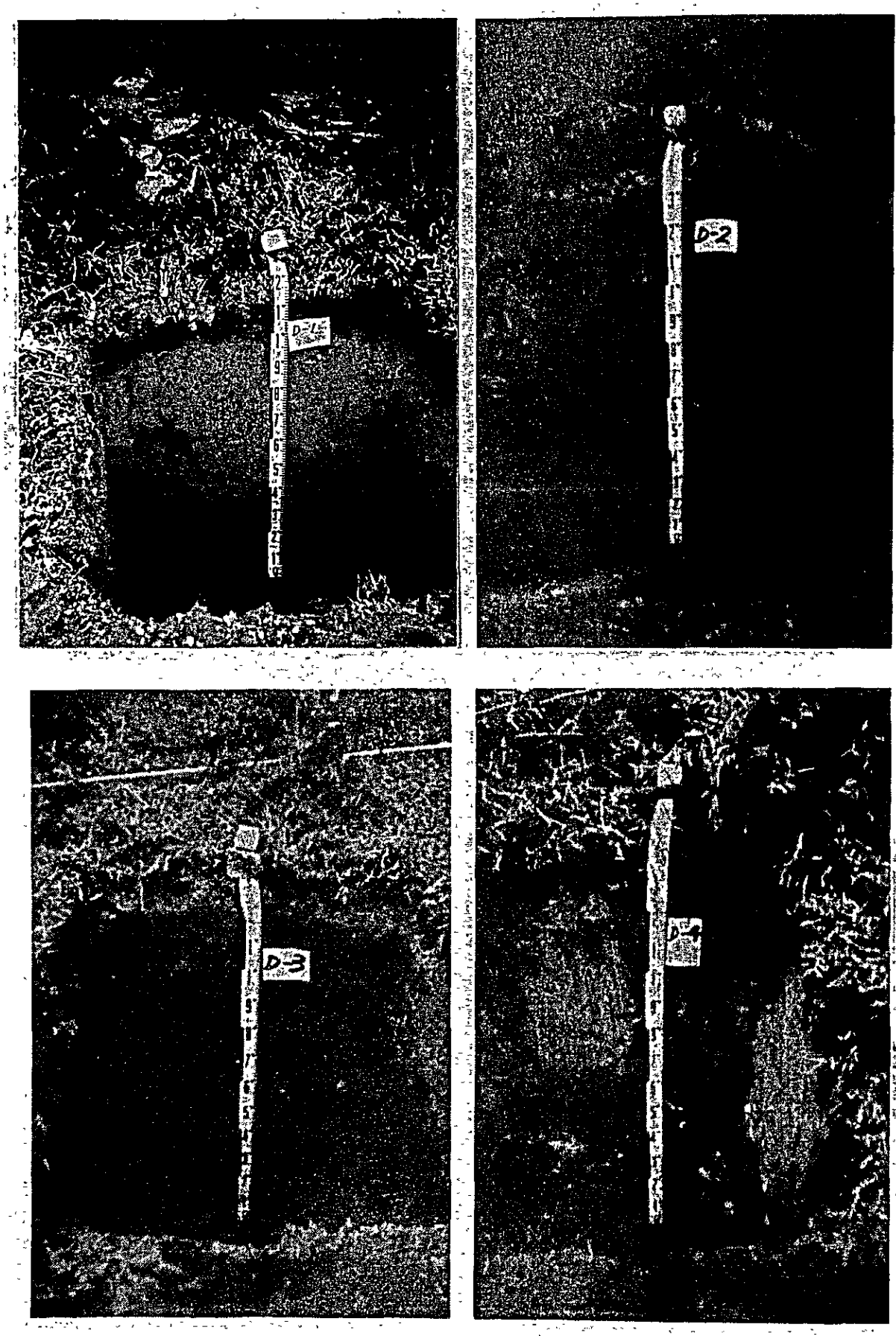


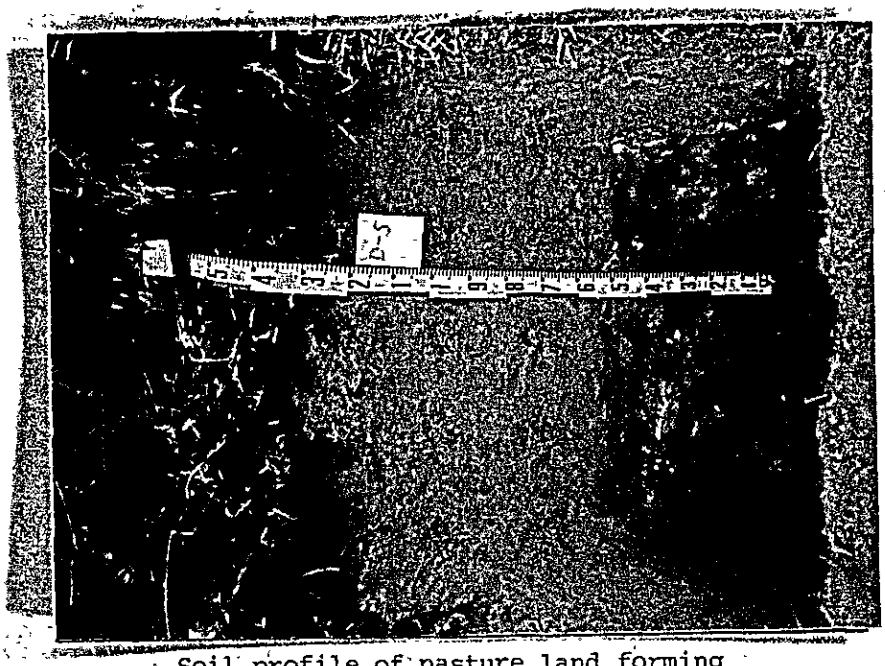

C-1


C-2

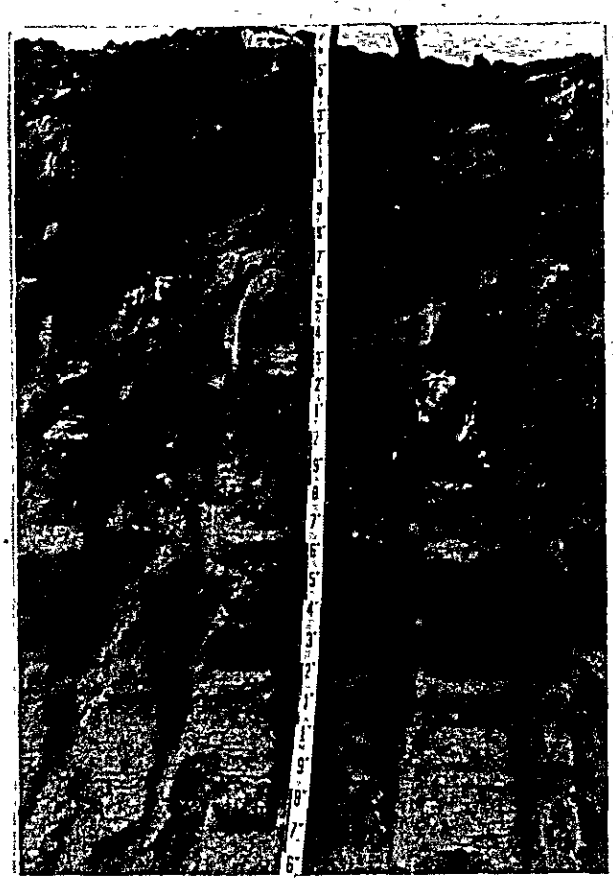

C-3



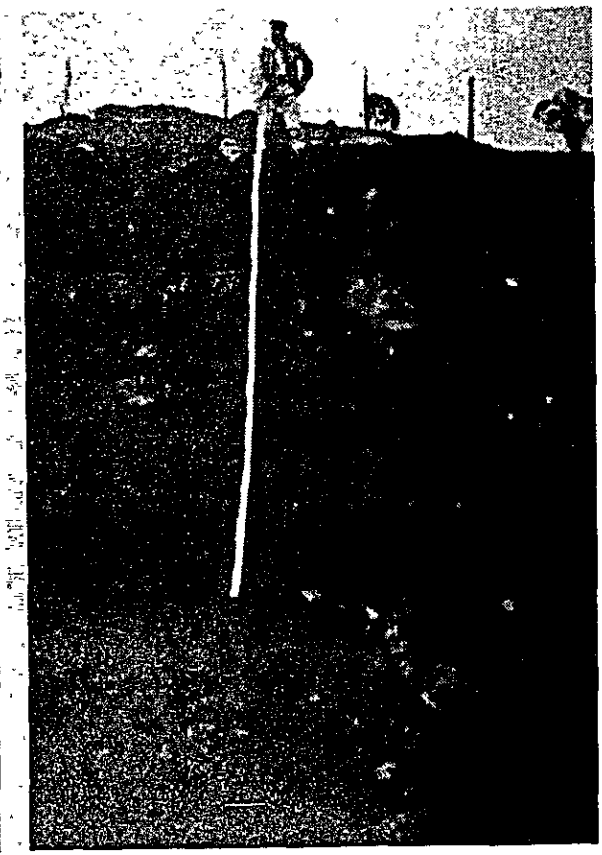

D-2
D-3



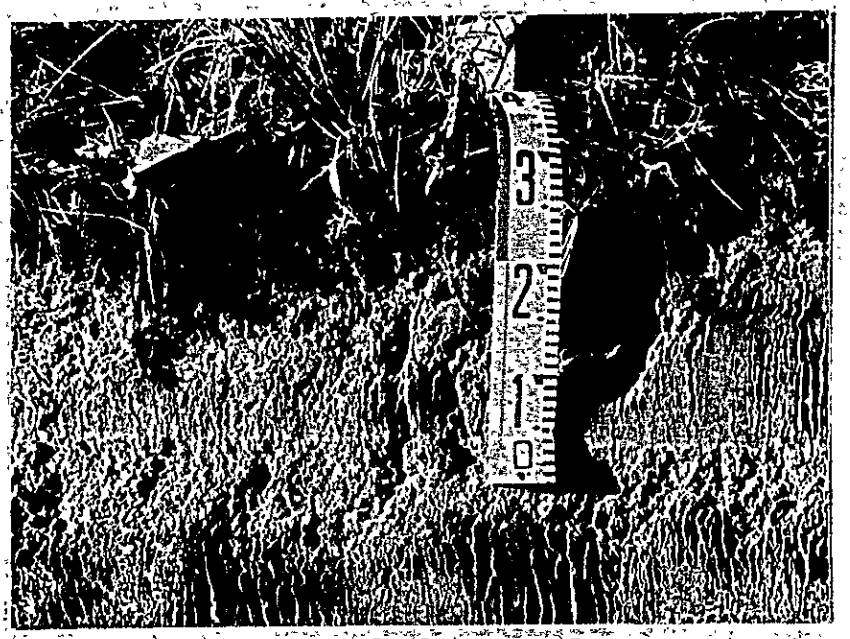
Soil profile of pasture land forming the foot of mountain in Area D



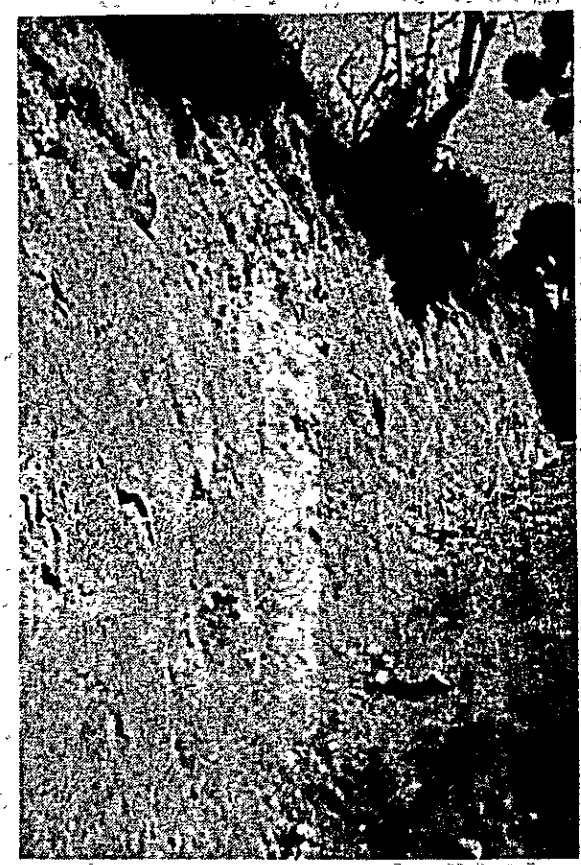
Same as above; predominantly breccia



Same as above; thick saprolite



Soil of pasture land in Area D:
A horizon is 10cm; B horizon dried and solidified with 5.5 is P.H



Upper reaches of the Paraibuna; thick saprolite