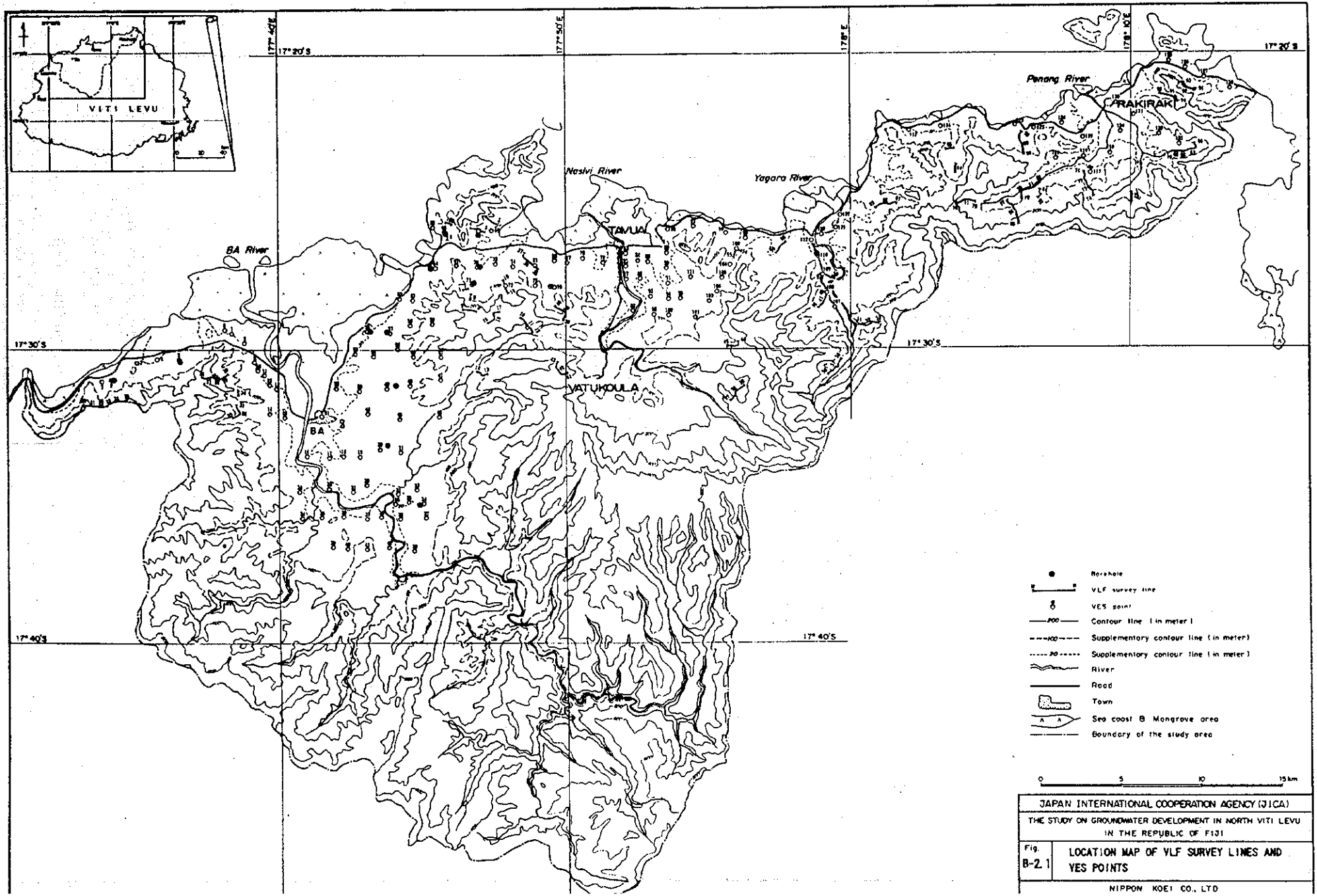
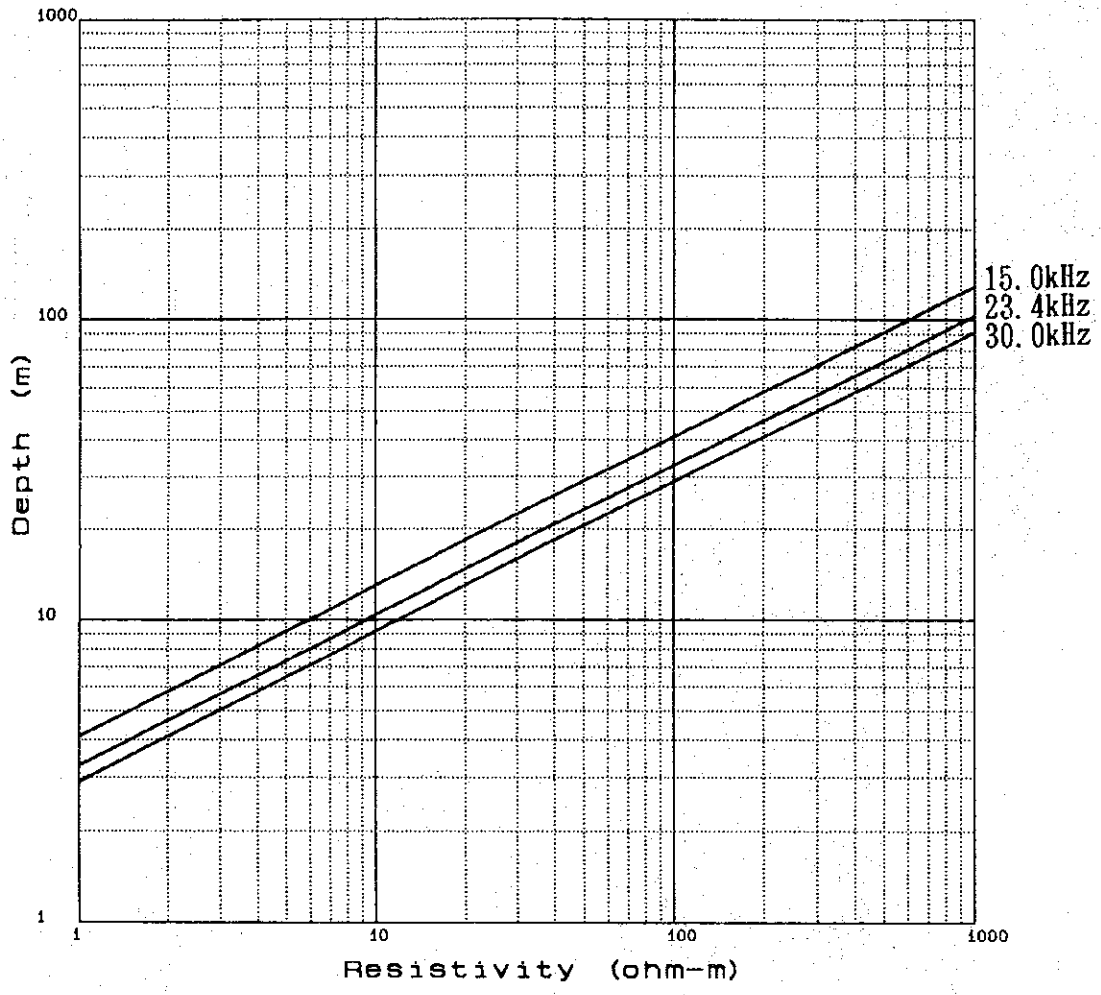
FIGURES


VITI LEVU
17°20'S
17°30'S
17°40'S
177°50'E
178°E
178°10'E
Nasivi River
Yagara River
Penang River
BA River
TAVUA
RAKIRAKI
VATUKOULA
BA
Borehole
VLF survey line
VES point
Contour line (in meter)
Supplementory contour line (in meter)
Supplementory contour line (in meter)
River
Road
Town
Sea coast & Mangrove area
Boundary of the study area
0
5
10
15km
JAPAN INTERNATIONAL COOPERATION AGENCY (JICA)
THE STUDY ON GROUNDWATER DEVELOPMENT IN NORTH VITI LEVU IN THE REPUBLIC OF FIJI
Fig. B-2.1
LOCATION MAP OF VLF SURVEY LINES AND VES POINTS
NIPPON KOEI CO., LTD



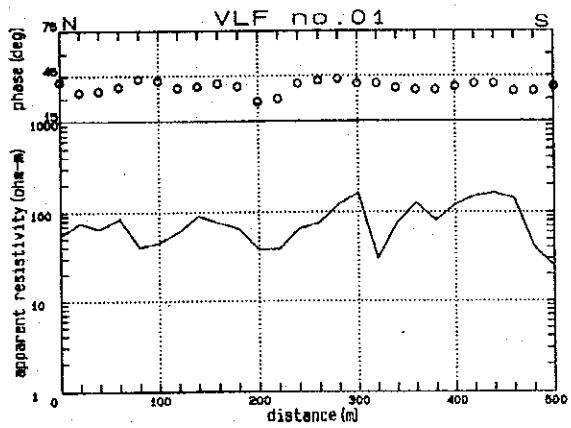
$$D = 503 \sqrt{(\rho / f)}$$

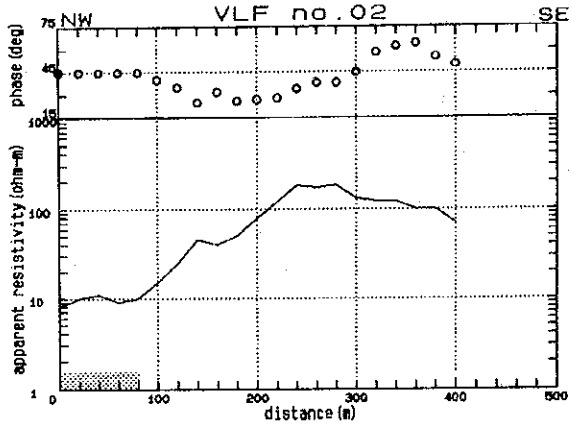
D : skin depth (m)

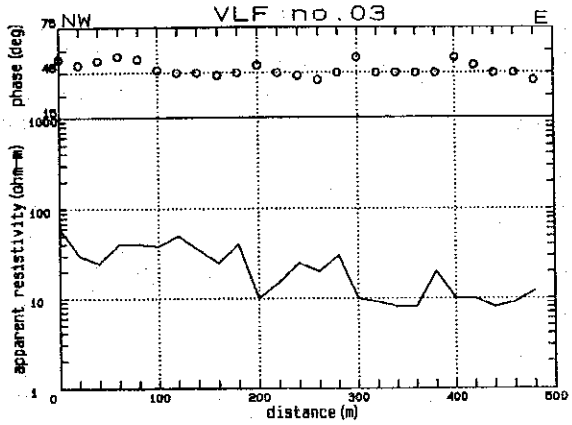
ρ : resistivity (ohm-m)

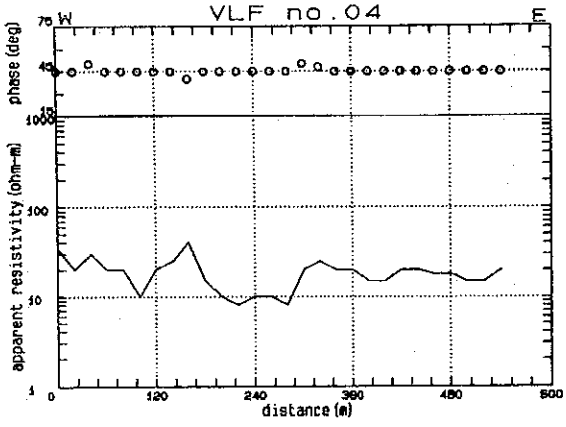
f : frequency (Hz)

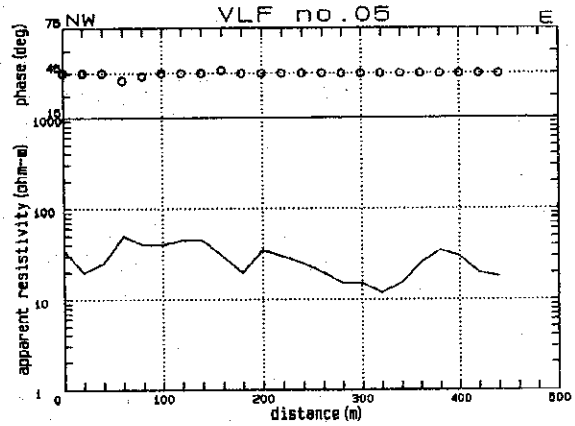
JAPAN INTERNATIONAL COOPERATION AGENCY (JICA)	
THE STUDY ON GROUNDWATER DEVELOPMENT IN NORTH VITI LEVU IN THE REPUBLIC OF FIJI	
Fig. B-2.2	PENETRATION DEPTH
NIPPON KOEI CO., LTD NIKKO EXPLORATION & DEVELOPMENT CO., LTD	

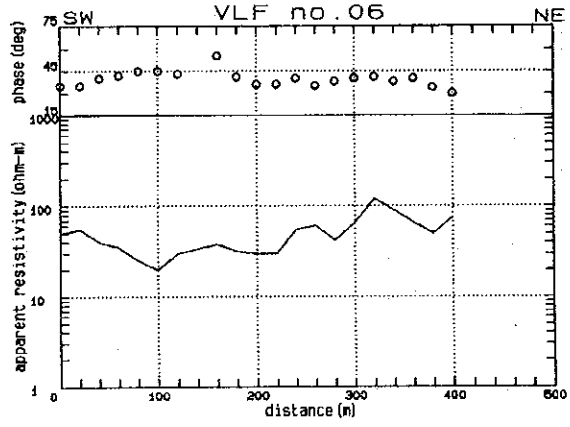


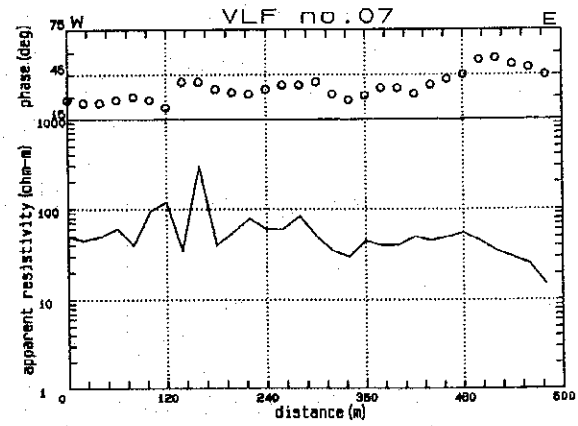


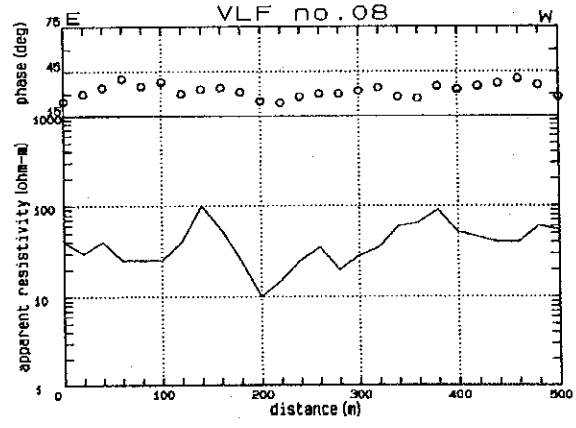












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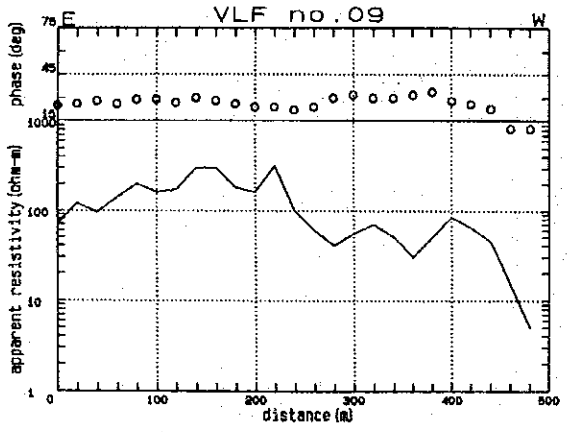
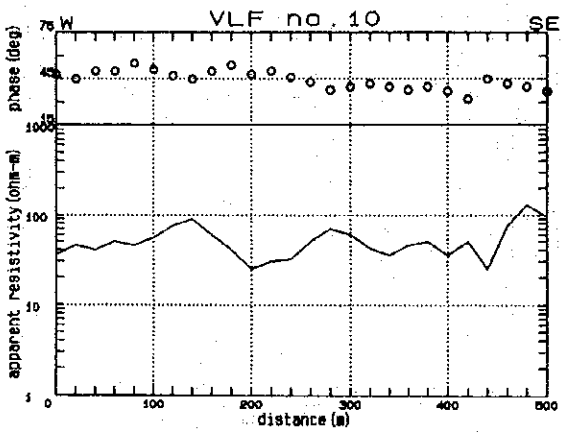
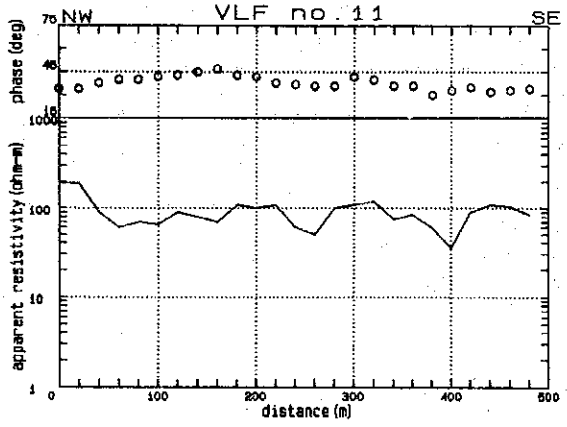
THE STUDY ON GROUNDWATER DEVELOPMENT IN NORTH VITI LEVU IN THE REPUBLIC OF FIJI

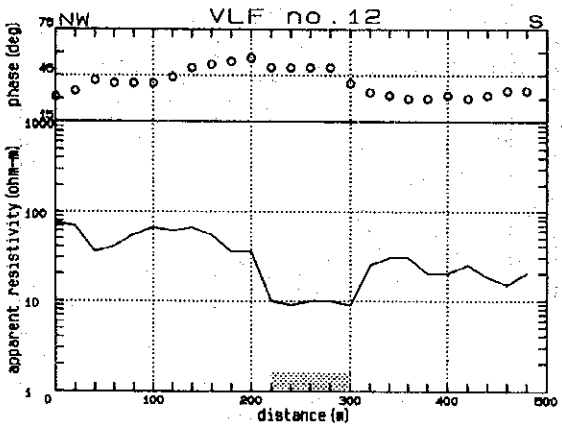
Fig. 8-2.3 VLF RESISTIVITY AND PHASE ANGLE PROFILES (1)

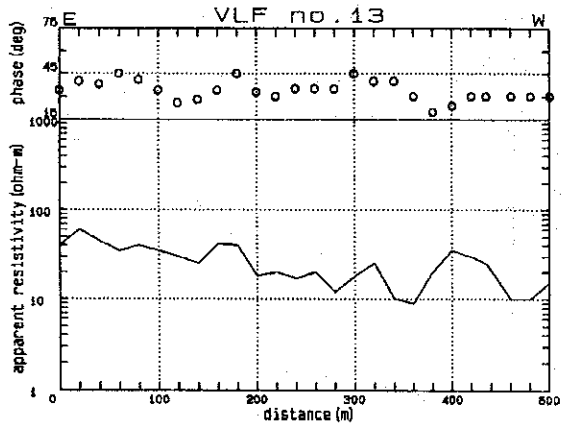
NIPPON KOEI CO., LTD
NIKKO EXPLORATION & DEVELOPMENT CO., LTD

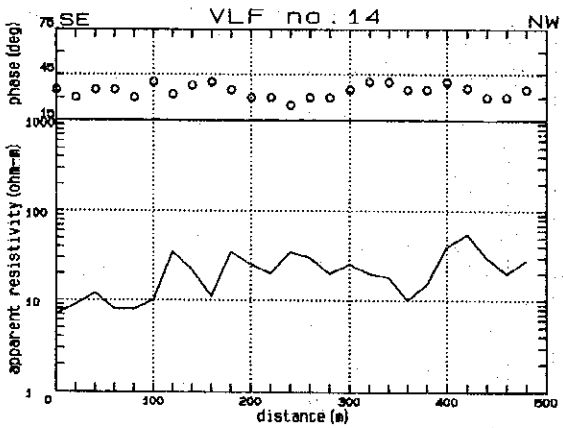


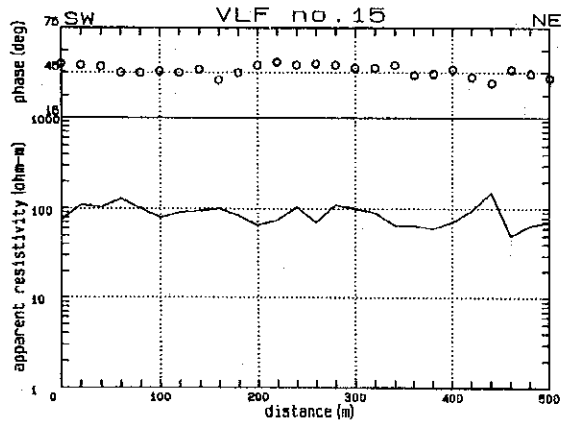


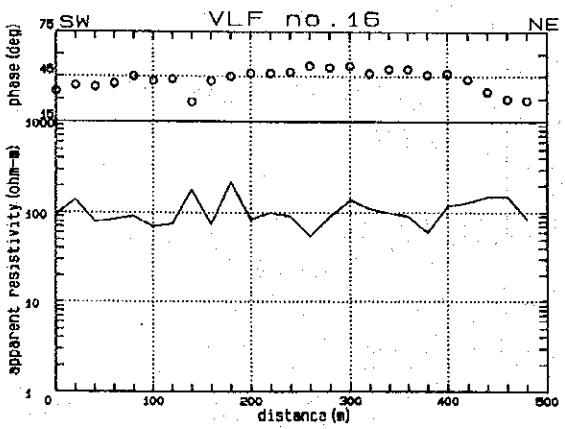










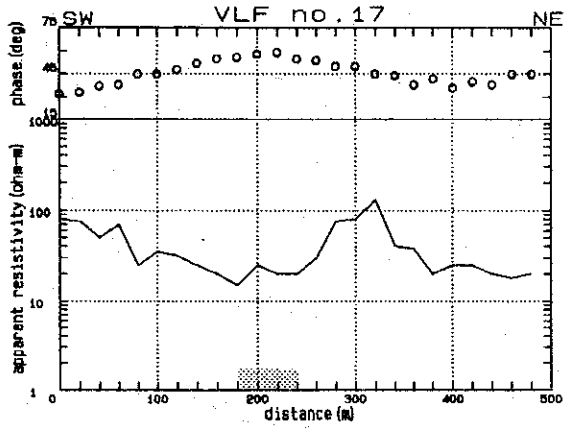


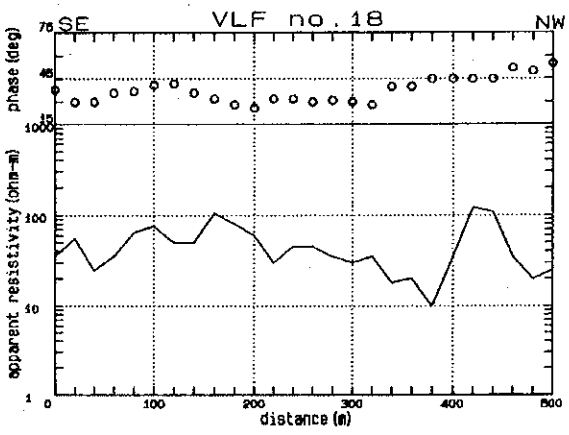
JAPAN INTERNATIONAL COOPERATION AGENCY (JICA)

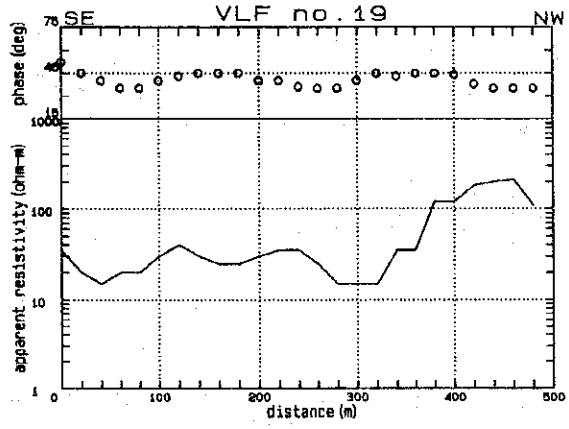
THE STUDY ON GROUNDWATER DEVELOPMENT IN NORTH VITI LEVU IN THE REPUBLIC OF FIJI

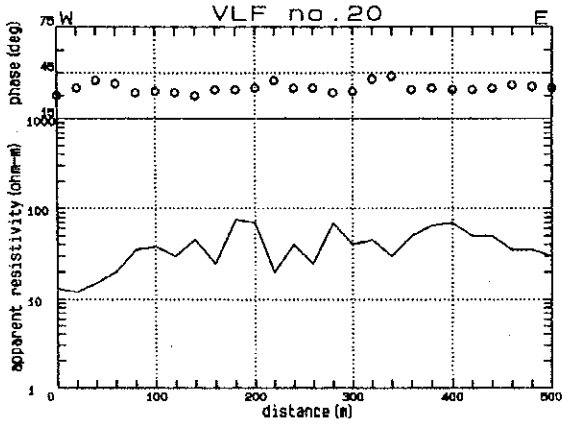
Fig. B-2.3 VLF RESISTIVITY AND PHASE ANGLE PROFILES (2)

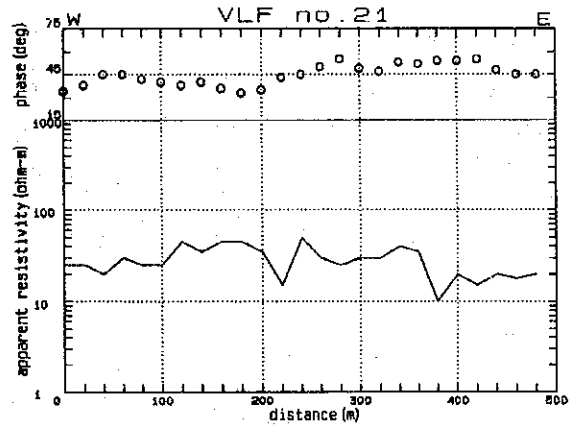
NIPPON KOEI CO., LTD
NIKKO EXPLORATION & DEVELOPMENT CO., LTD

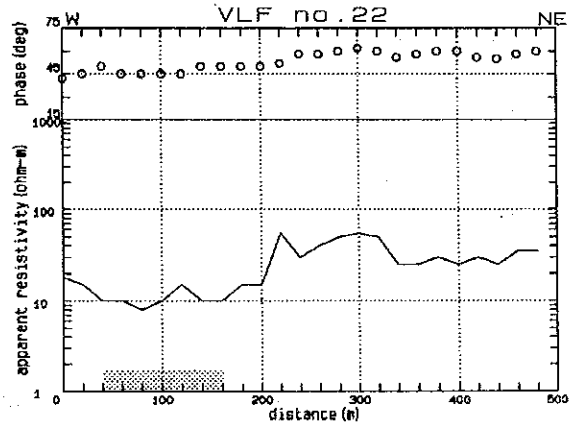


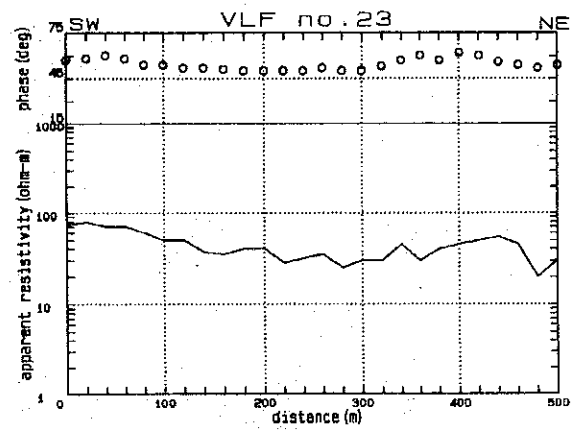


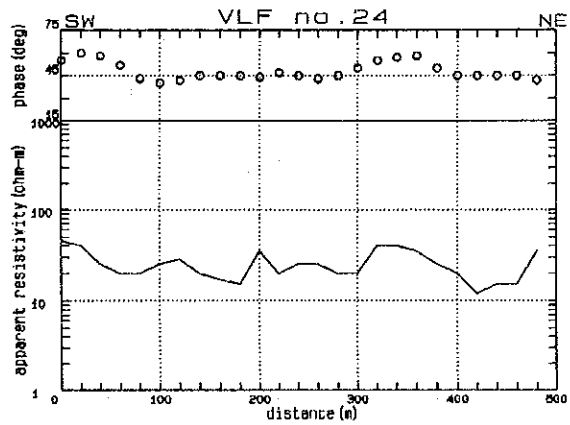










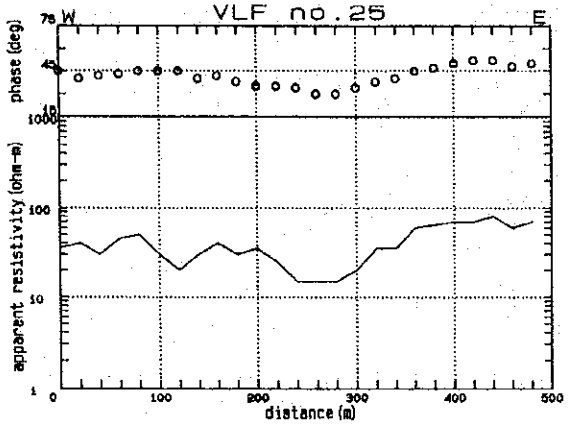


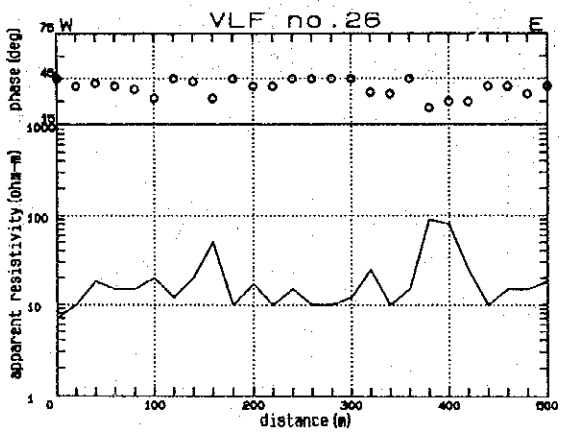
JAPAN INTERNATIONAL COOPERATION AGENCY (JICA)

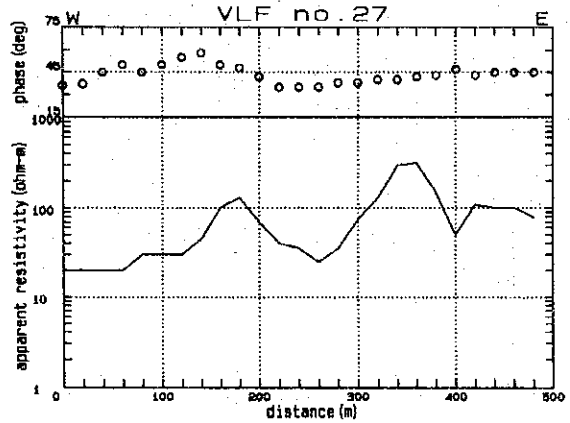
THE STUDY ON GROUNDWATER DEVELOPMENT IN NORTH VITI LEVU IN THE REPUBLIC OF FIJI

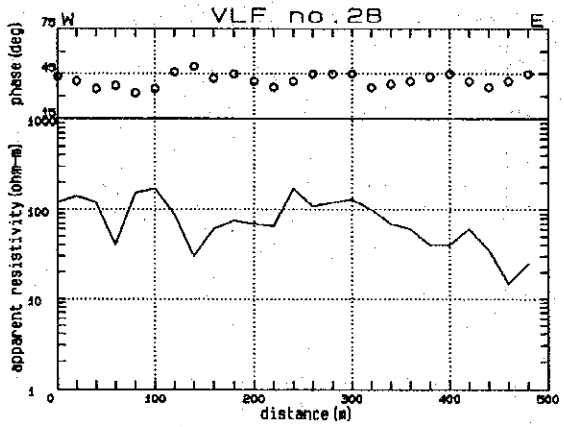
Fig. B-2.3 VLF RESISTIVITY AND PHASE ANGLE PROFILES (3)

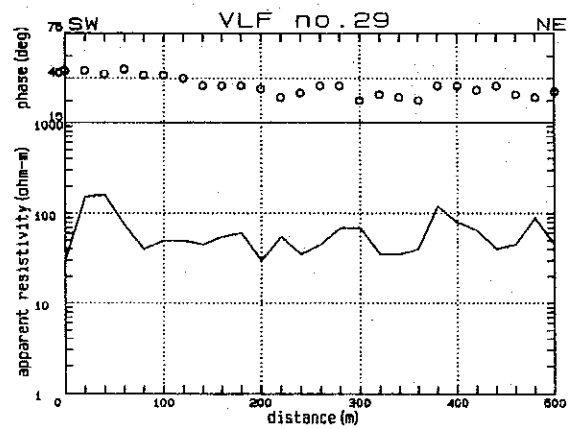
NIPPON KOEI CO., LTD
NIKKO EXPLORATION & DEVELOPMENT CO., LTD

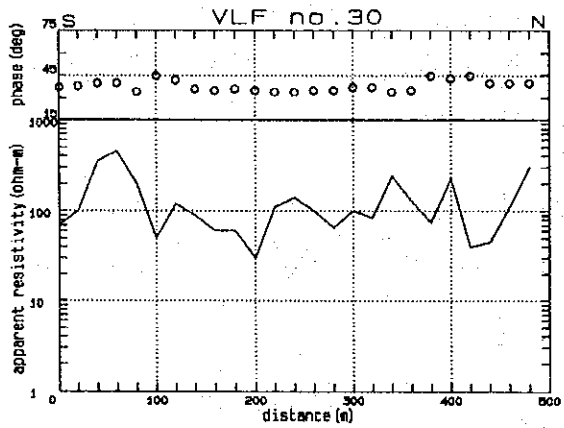


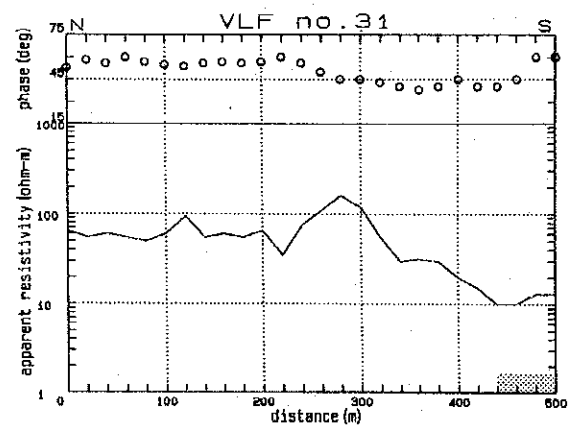


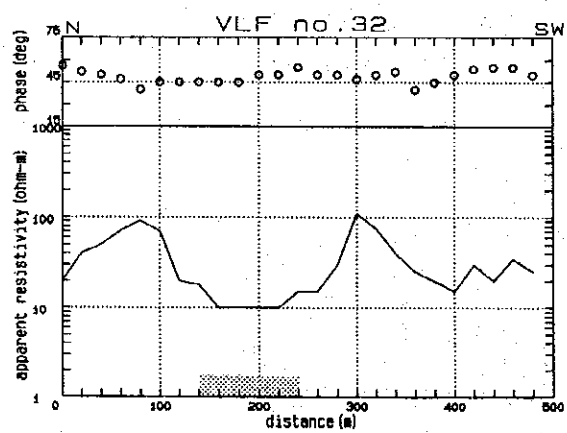










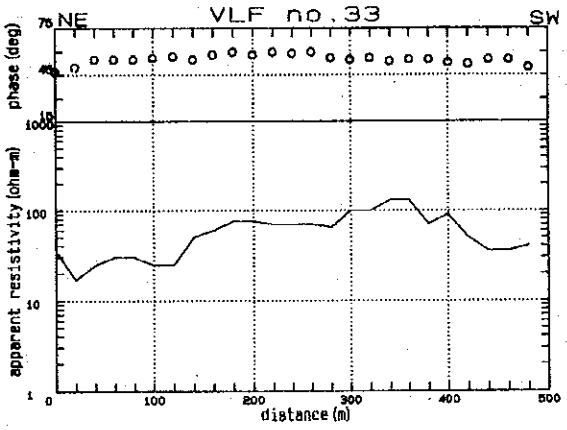


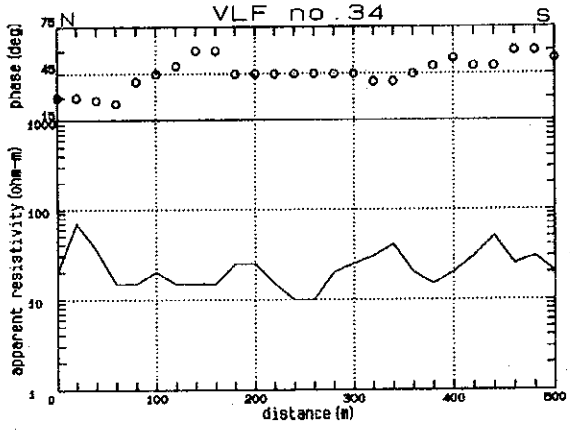
JAPAN INTERNATIONAL COOPERATION AGENCY (JICA)

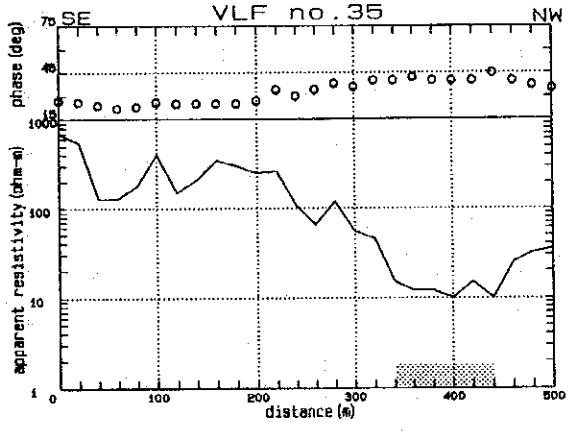
THE STUDY ON GROUNDWATER DEVELOPMENT IN NORTH VITI LEVU IN THE REPUBLIC OF FIJI

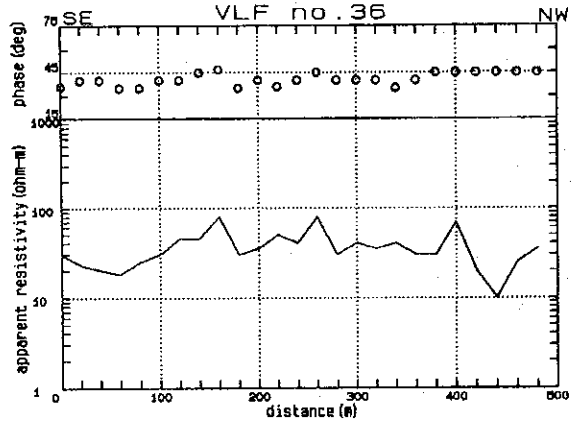
Fig. B-2.3 VLF RESISTIVITY AND PHASE ANGLE PROFILES (4)

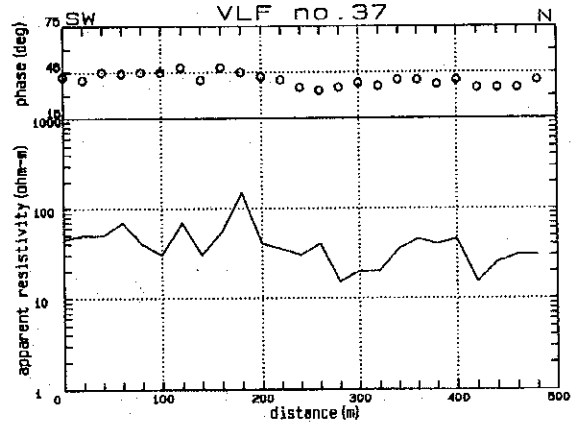
NIPPON KOEI CO., LTD
NIKKO EXPLORATION & DEVELOPMENT CO., LTD

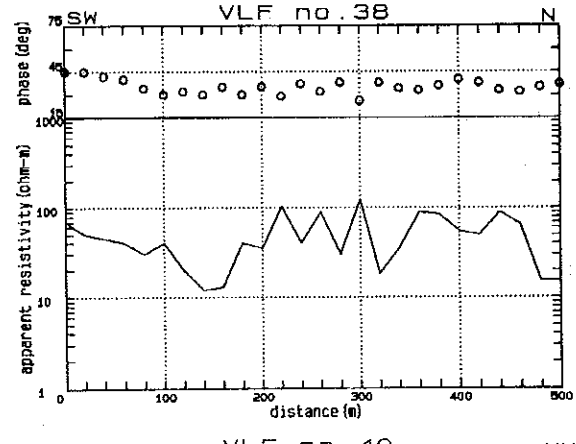


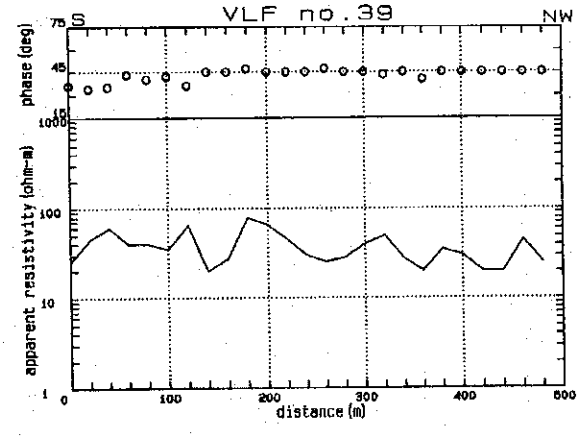


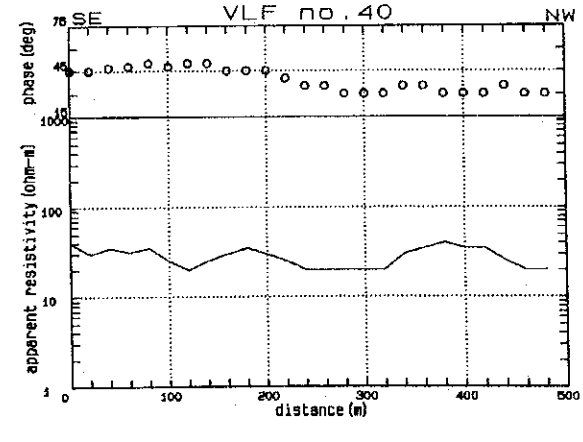










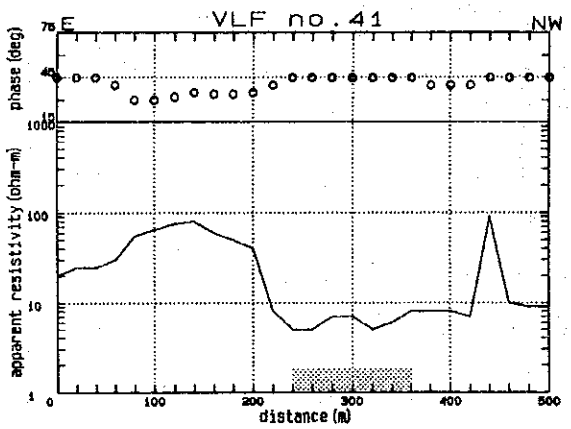


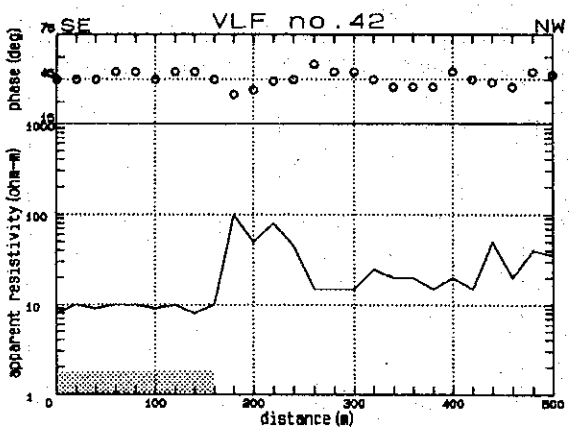
JAPAN INTERNATIONAL COOPERATION AGENCY (JICA)

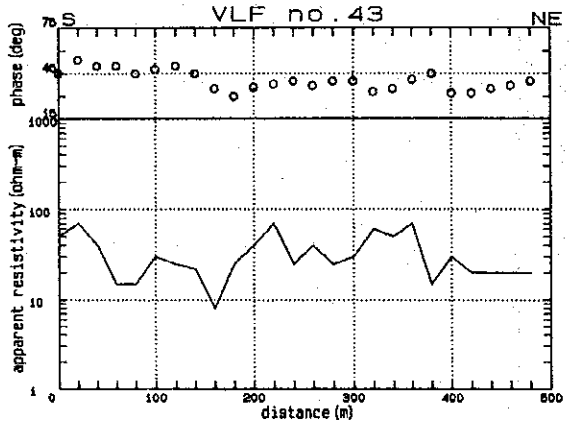
THE STUDY ON GROUNDWATER DEVELOPMENT IN NORTH VITI LEVU IN THE REPUBLIC OF FIJI

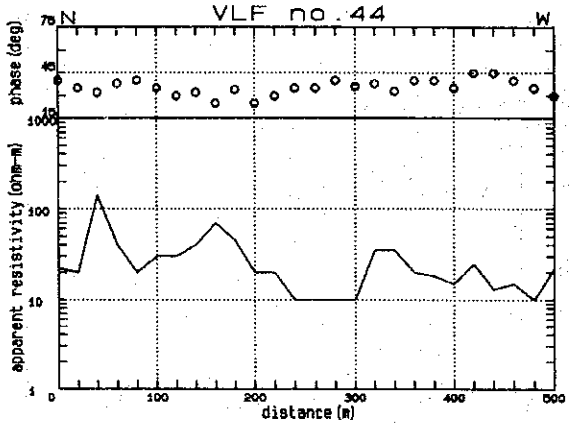
Fig. B-2.3 VLF RESISTIVITY AND PHASE ANGLE PROFILES (5)

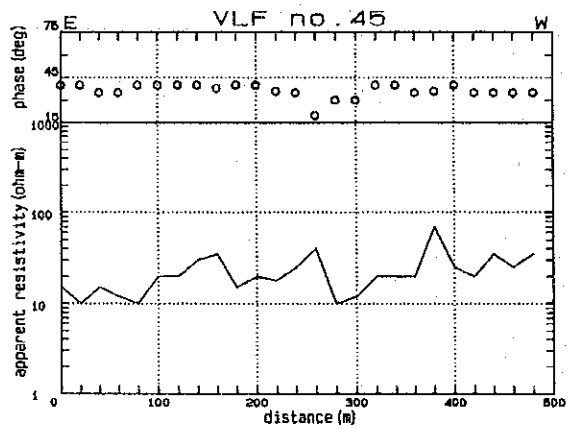
NIPPON KOEI CO., LTD
NIKKO EXPLORATION & DEVELOPMENT CO., LTD

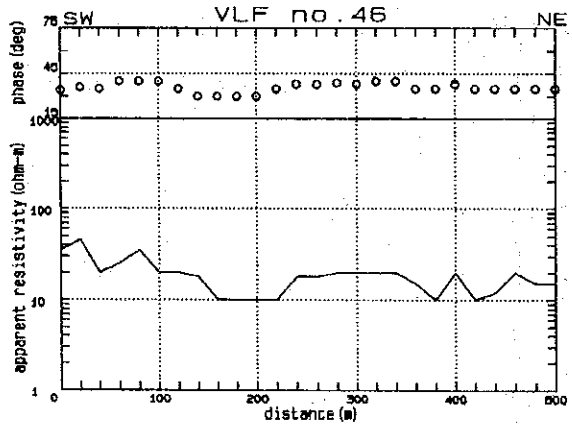


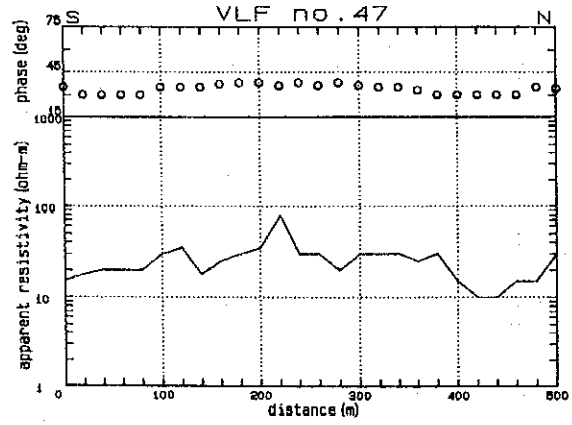


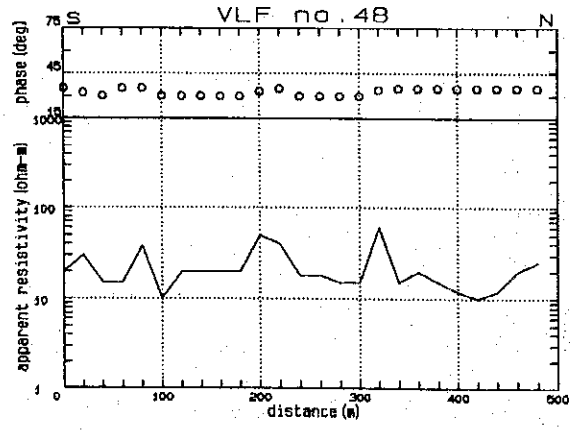










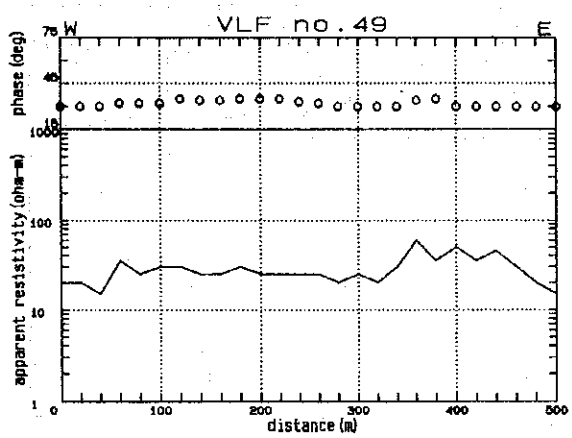


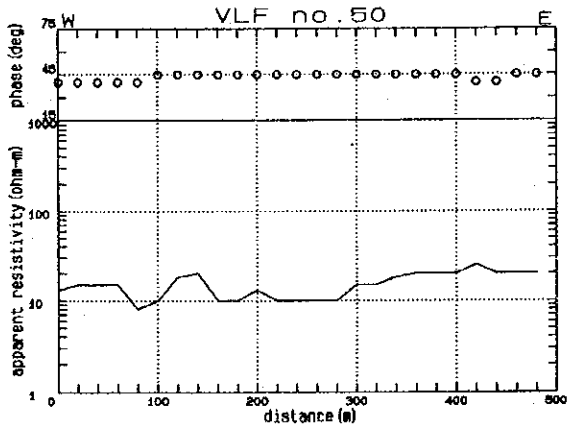
JAPAN INTERNATIONAL COOPERATION AGENCY (JICA)

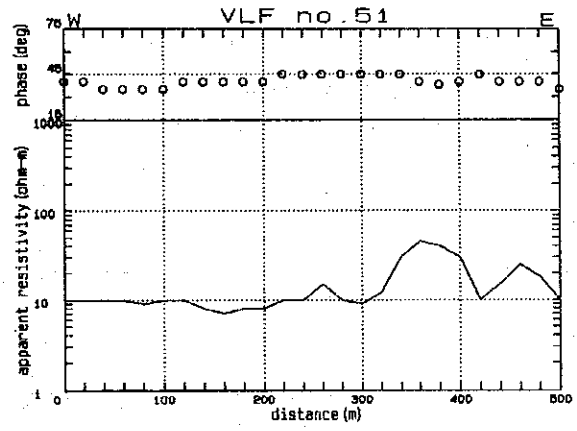
THE STUDY ON GROUNDWATER DEVELOPMENT IN NORTH VITI LEVU IN THE REPUBLIC OF FIJI

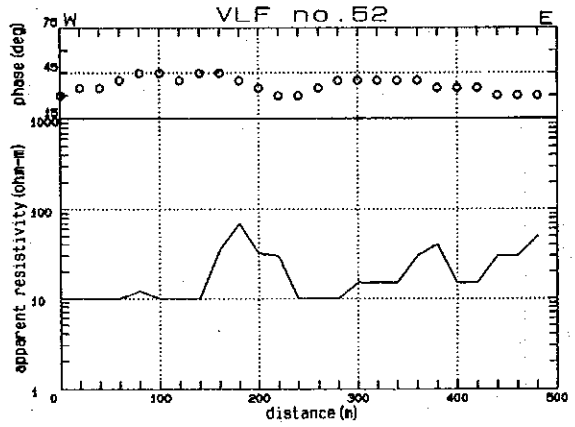
Fig. B-2.3 VLF RESISTIVITY AND PHASE ANGLE PROFILES (6)

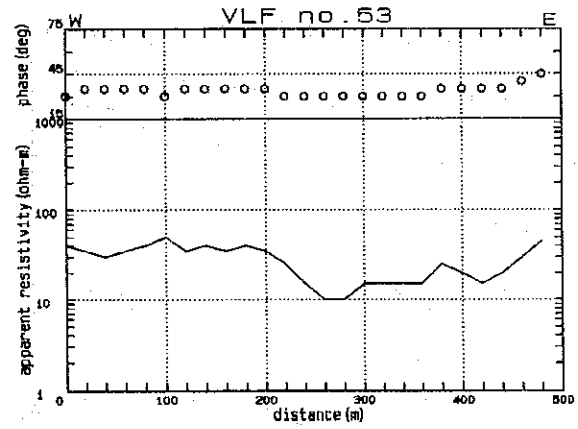
NIPPON KOEI CO., LTD.
NIKKO EXPLORATION & DEVELOPMENT CO., LTD

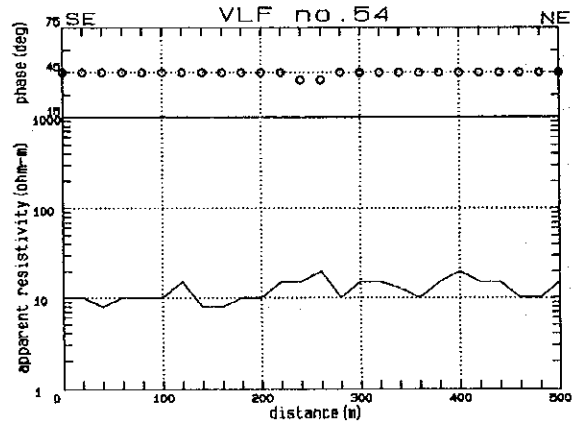


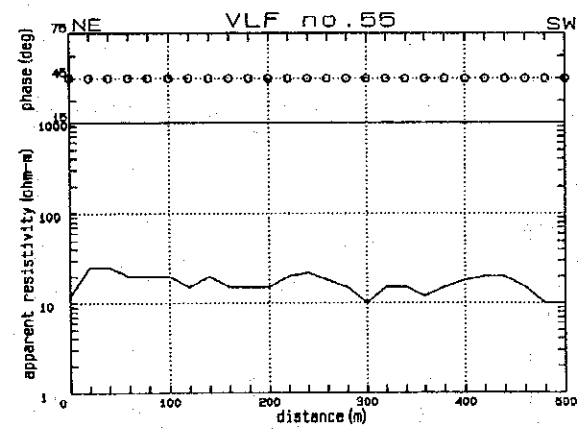


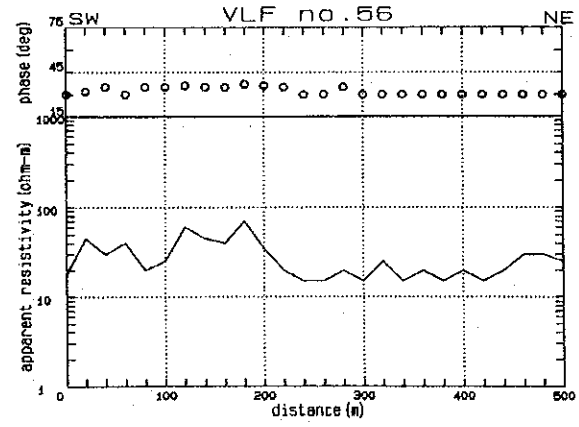










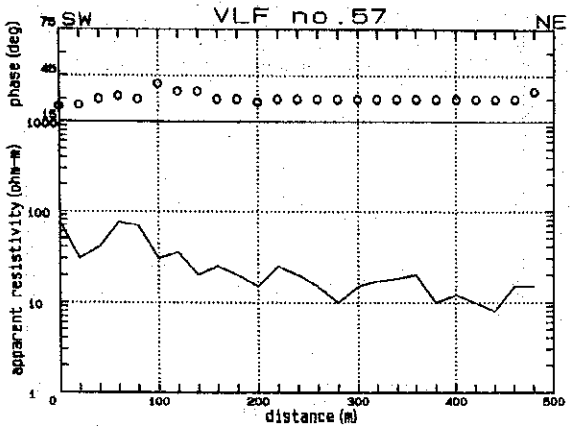


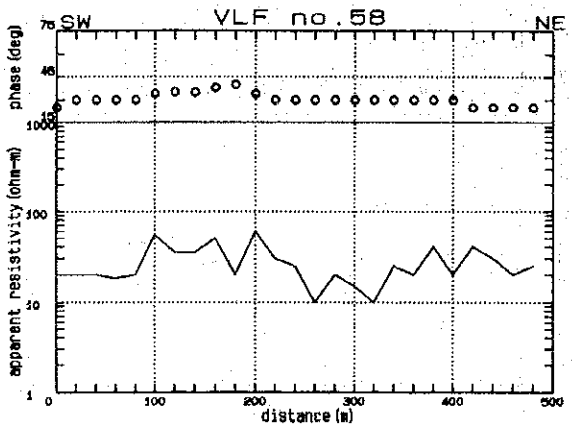
JAPAN INTERNATIONAL COOPERATION AGENCY (JICA)

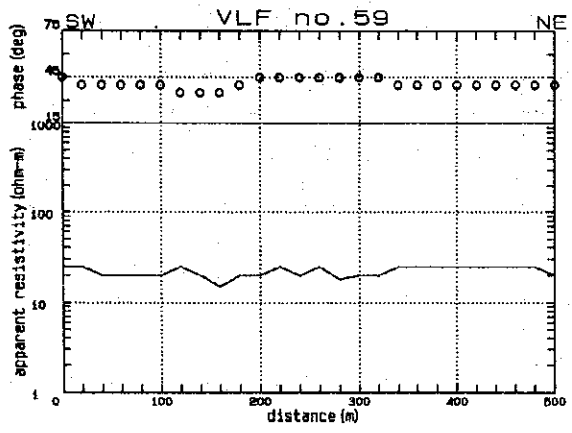
THE STUDY ON GROUNDWATER DEVELOPMENT IN NORTH VITI LEVU IN THE REPUBLIC OF FIJI

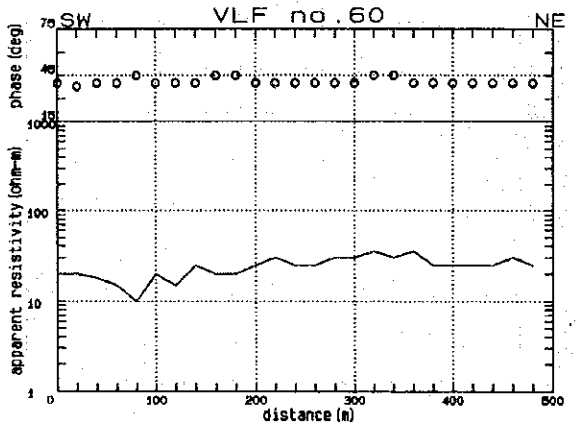
Fig. B-2.3 VLF RESISTIVITY AND PHASE ANGLE PROFILES (7)

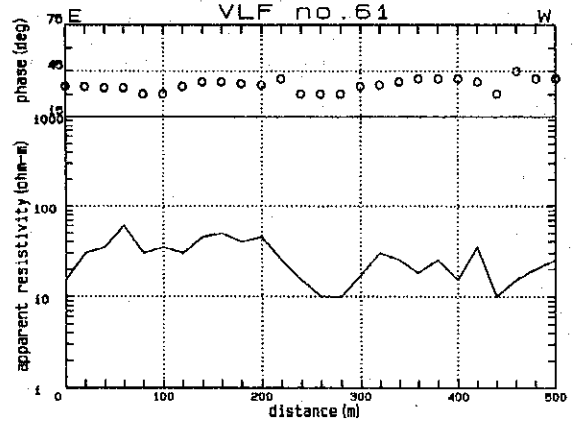
NIPPON KOEI CO., LTD
NIKKO EXPLORATION & DEVELOPMENT CO., LTD

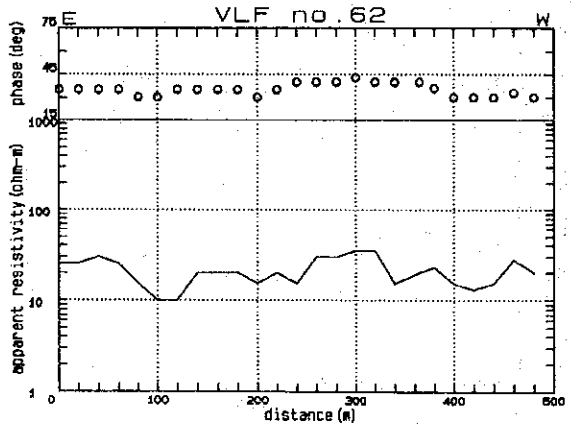


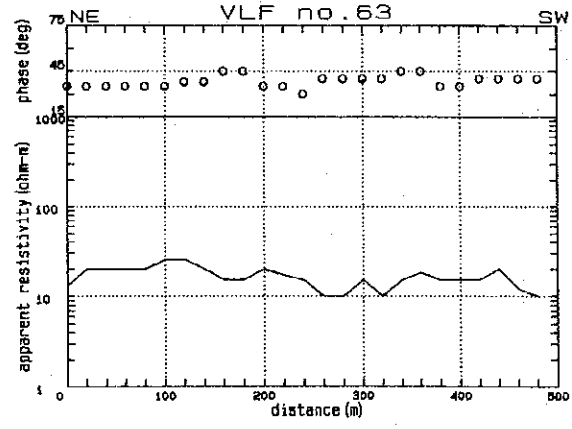


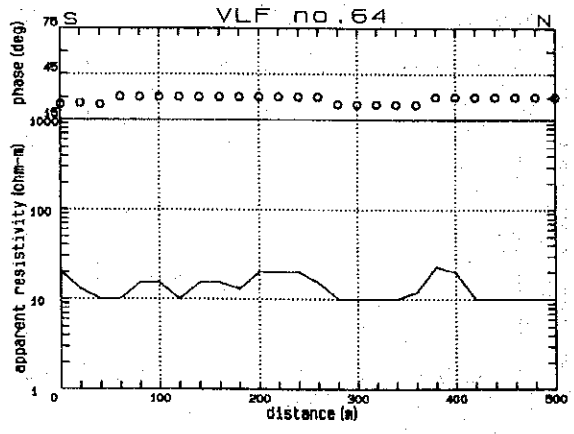










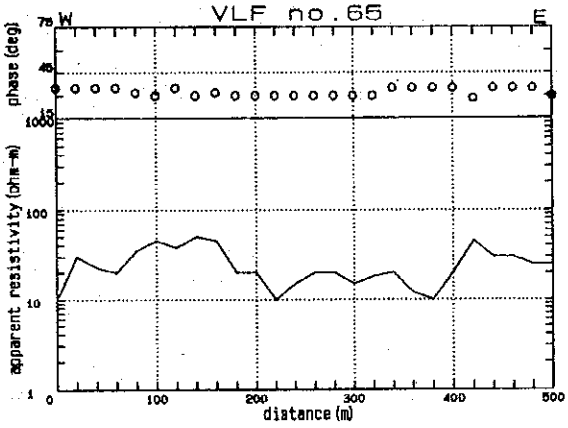


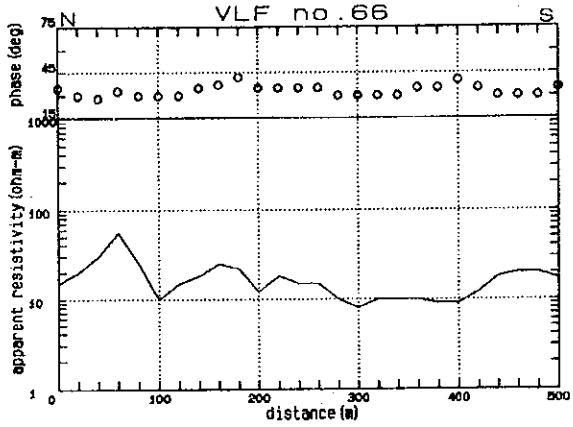
JAPAN INTERNATIONAL COOPERATION AGENCY (JICA)

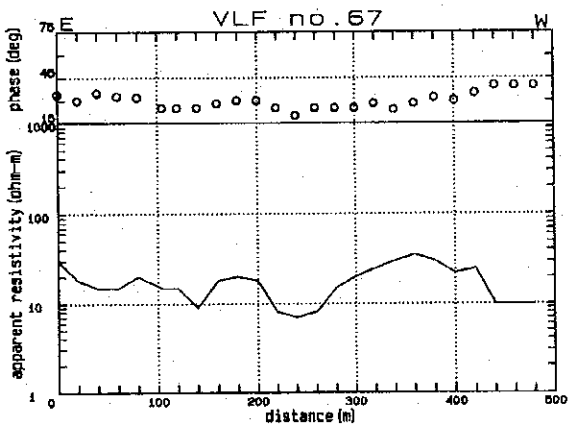
THE STUDY ON GROUNDWATER DEVELOPMENT IN NORTH VITI LEVU IN THE REPUBLIC OF FIJI

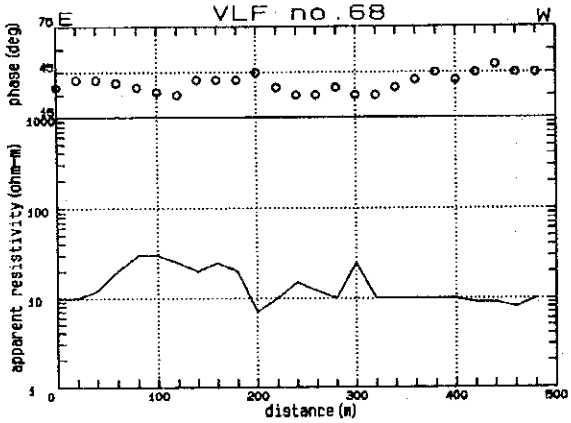
Fig. B-2.3 VLF RESISTIVITY AND PHASE ANGLE PROFILES (8)

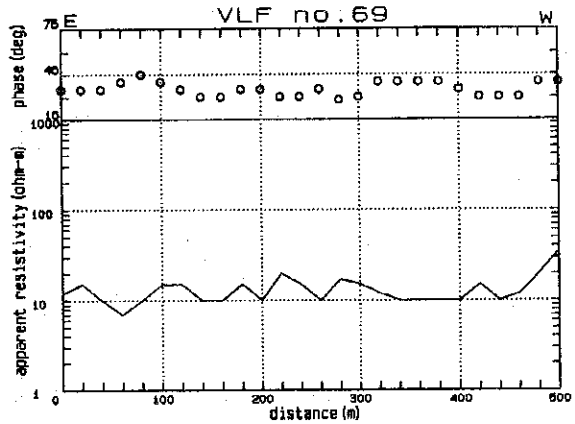
NIPPON KOEI CO., LTD
NIKKO EXPLORATION & DEVELOPMENT CO., LTD.

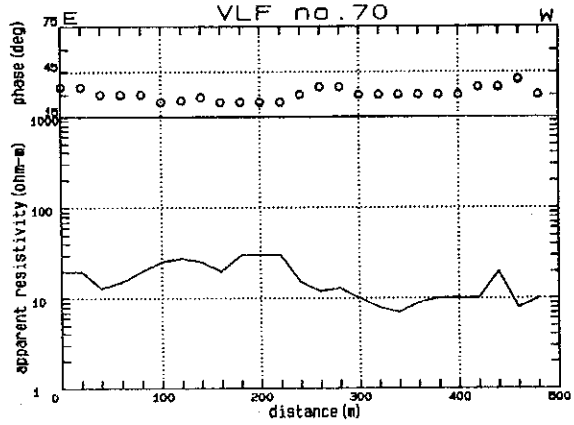


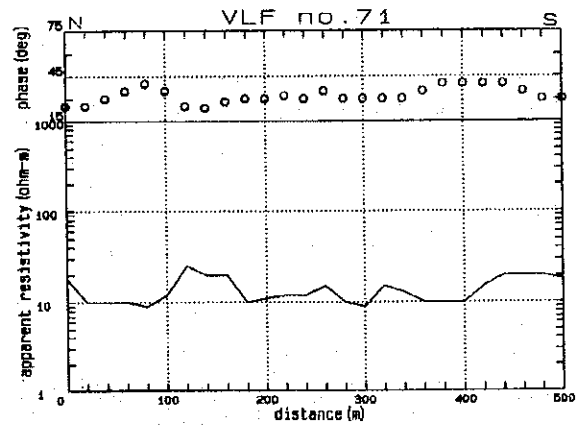


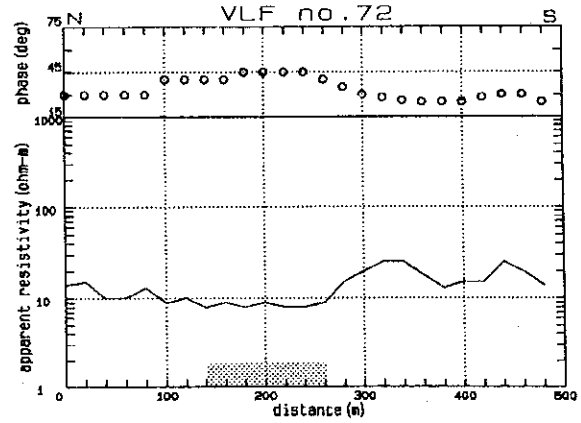










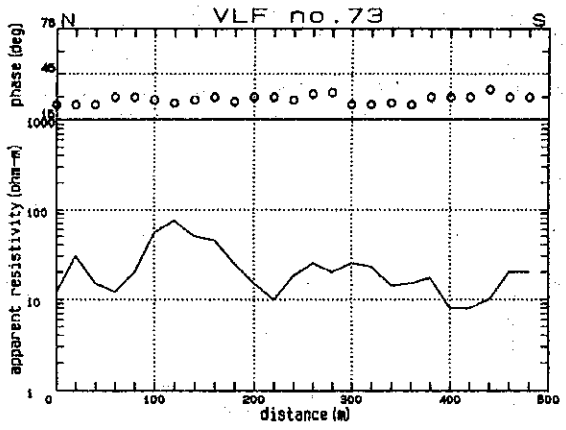


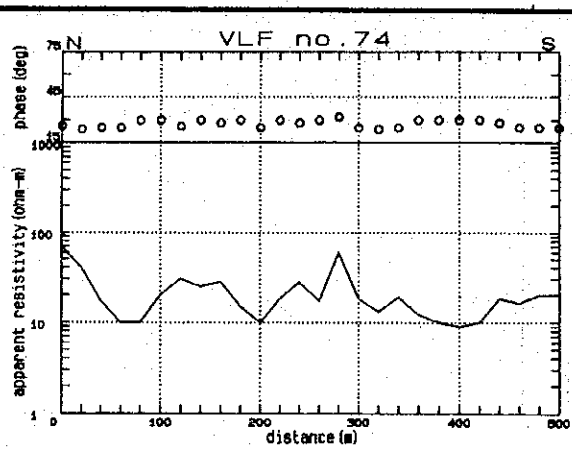
JAPAN INTERNATIONAL COOPERATION AGENCY (JICA)

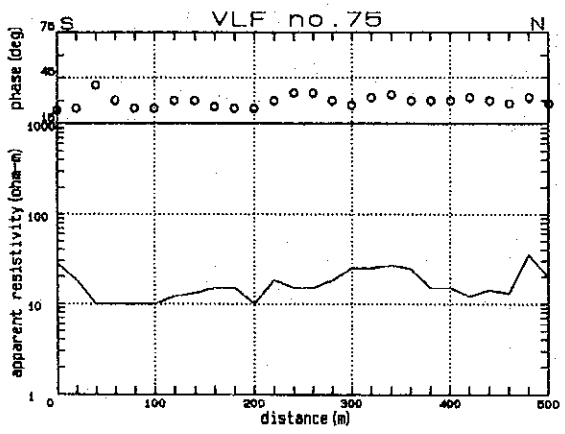
THE STUDY ON GROUNDWATER DEVELOPMENT IN NORTH VITI LEVU IN THE REPUBLIC OF FIJI

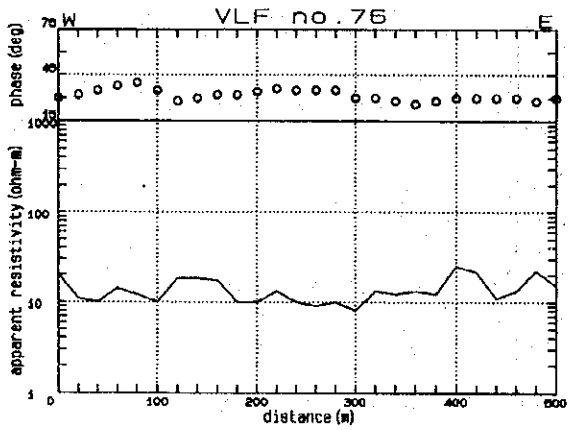
Fig. B-2.3 VLF RESISTIVITY AND PHASE ANGLE PROFILES (9)

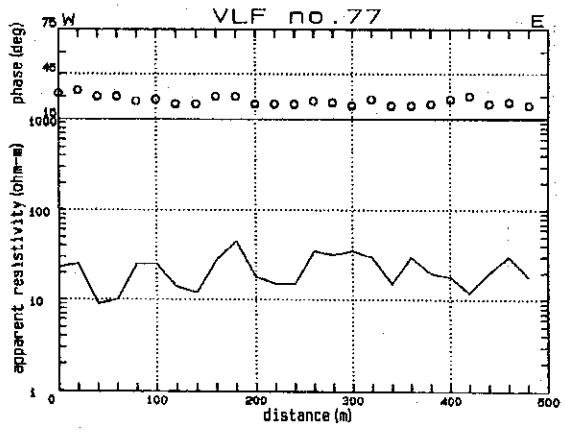
NIPPON KOEI CO., LTD
NIKKO EXPLORATION & DEVELOPMENT CO., LTD

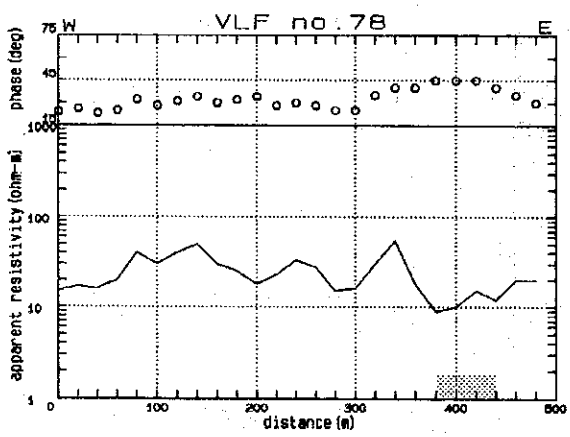


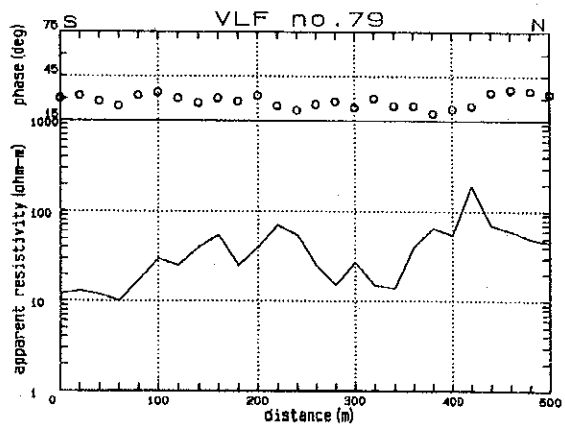


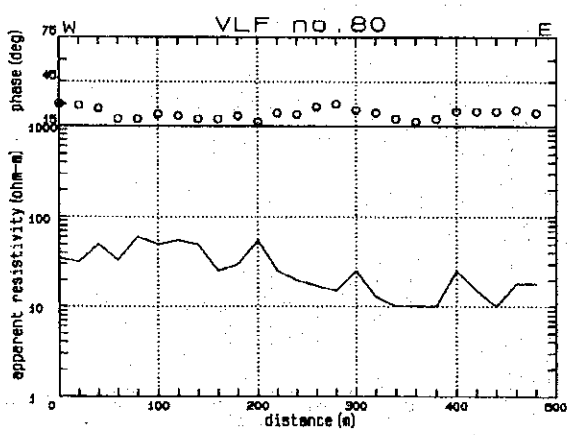










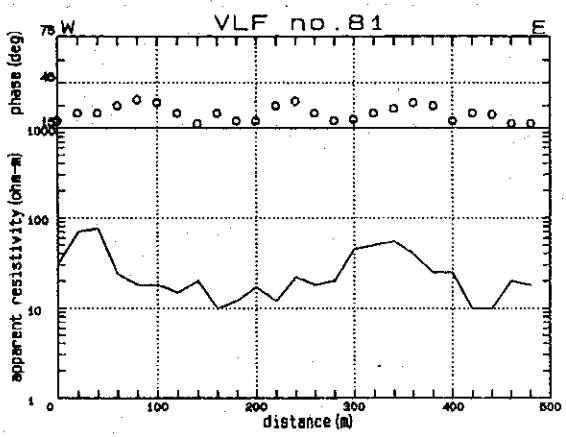


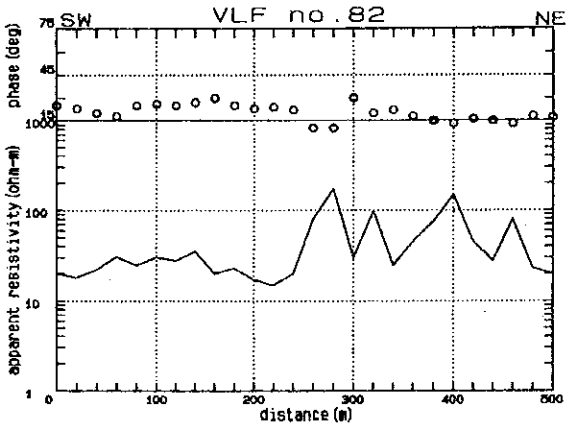
JAPAN INTERNATIONAL COOPERATION AGENCY (JICA)

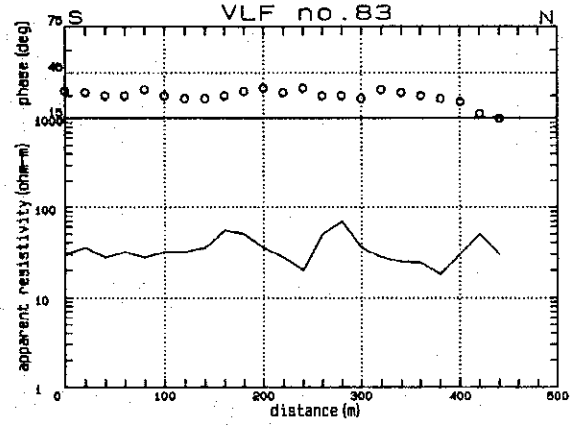
THE STUDY ON GROUNDWATER DEVELOPMENT IN NORTH VITI LEVU IN THE REPUBLIC OF FIJI

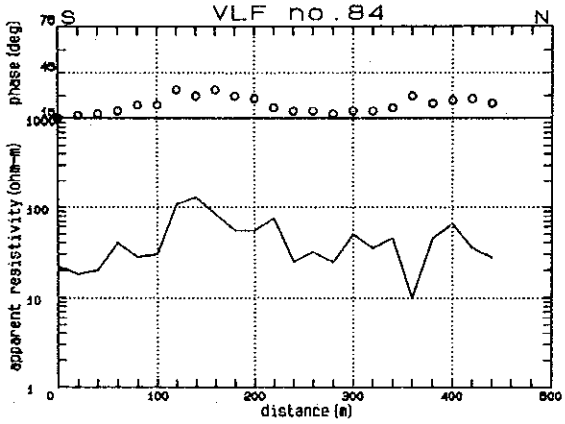
Fig. B-2.3 VLF RESISTIVITY AND PHASE ANGLE PROFILES (10)

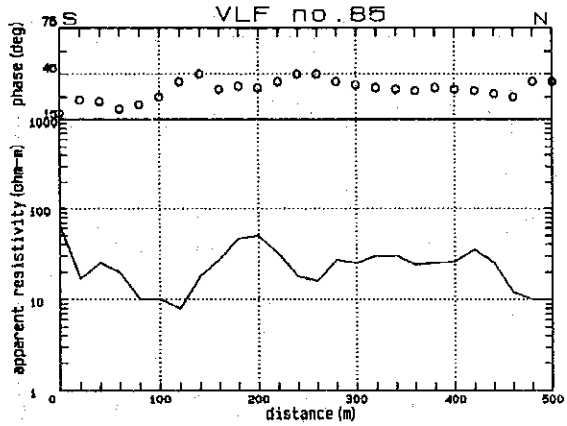
NIPPON KOEI CO., LTD
NIKKO EXPLORATION & DEVELOPMENT CO., LTD

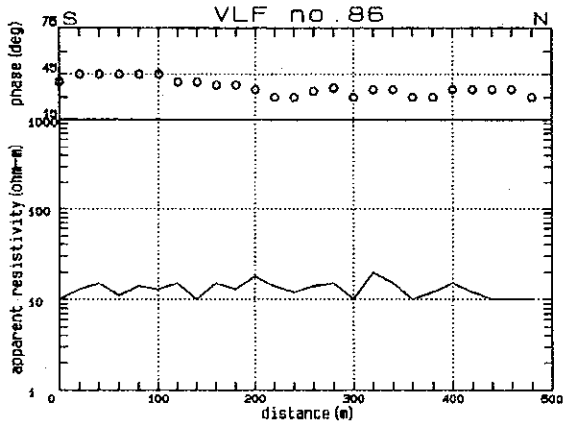


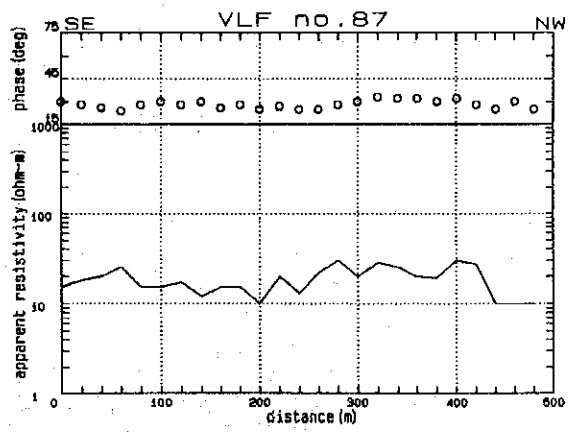


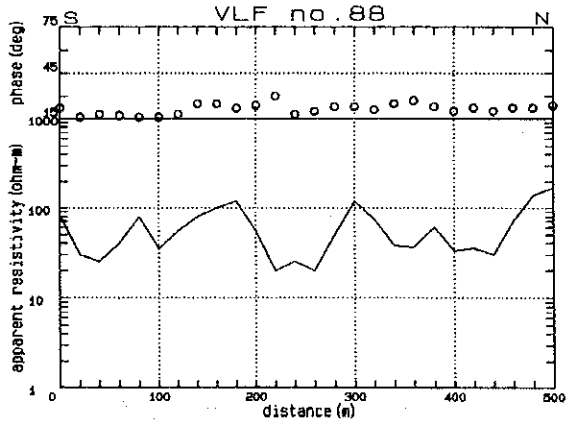










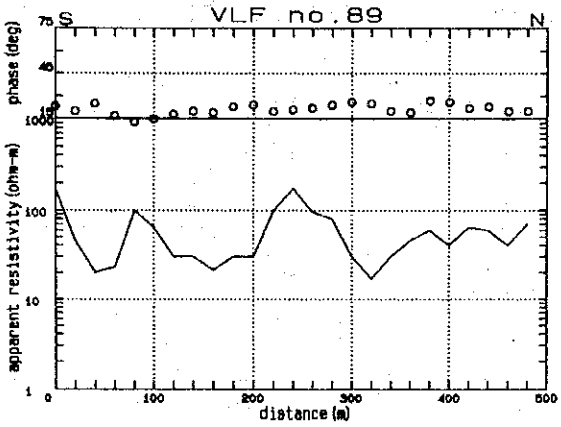


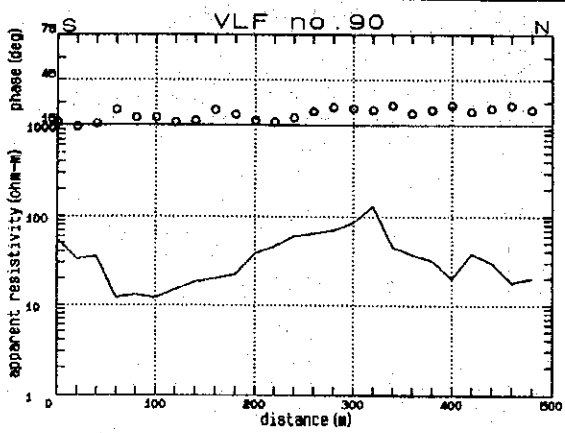
JAPAN INTERNATIONAL COOPERATION AGENCY (JICA)

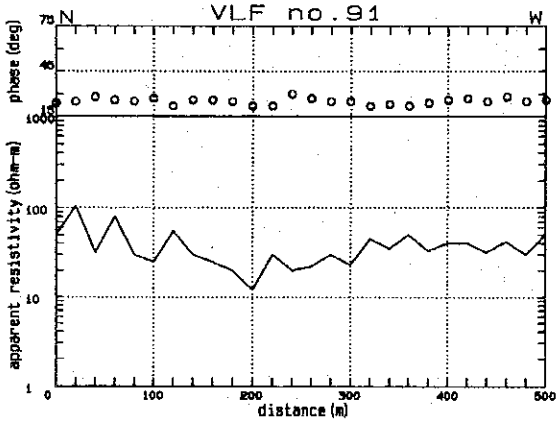
THE STUDY ON GROUNDWATER DEVELOPMENT IN NORTH VITI LEVU IN THE REPUBLIC OF FIJI

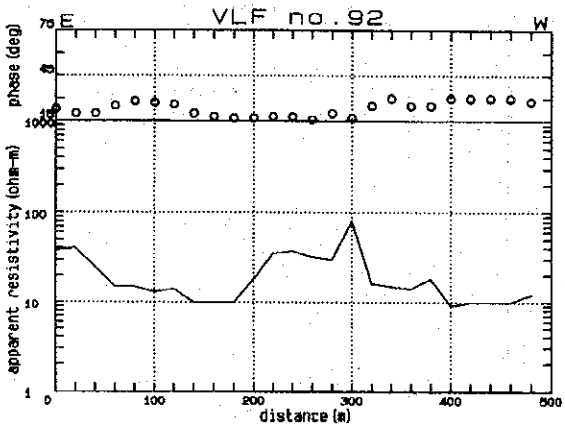
Fig. B-2.3 VLF RESISTIVITY AND PHASE ANGLE PROFILES (11)

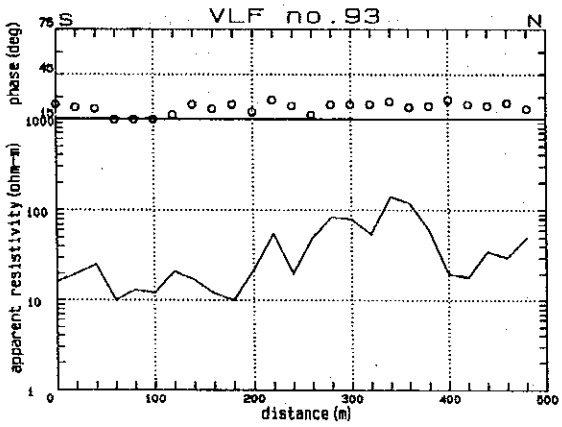
NIPPON KOEI CO., LTD
NIKKO EXPLORATION & DEVELOPMENT CO., LTD

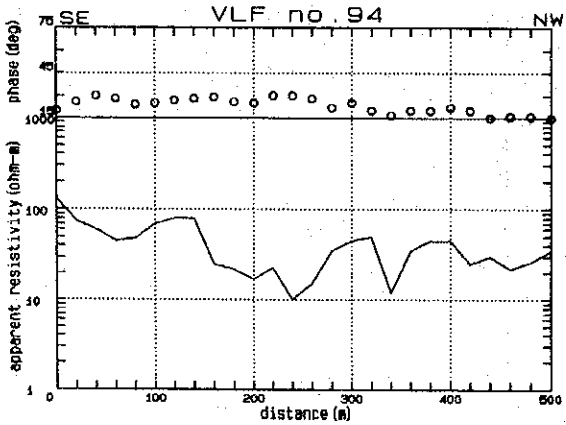


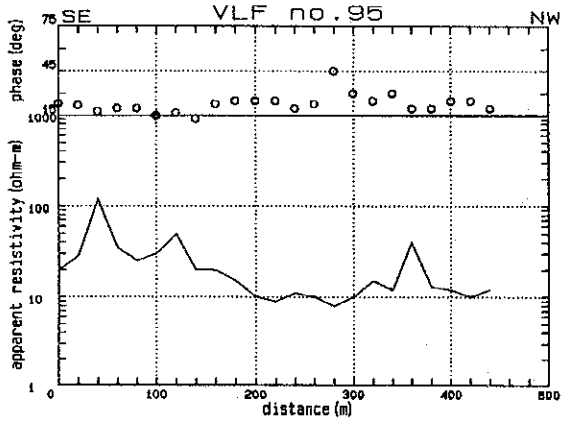


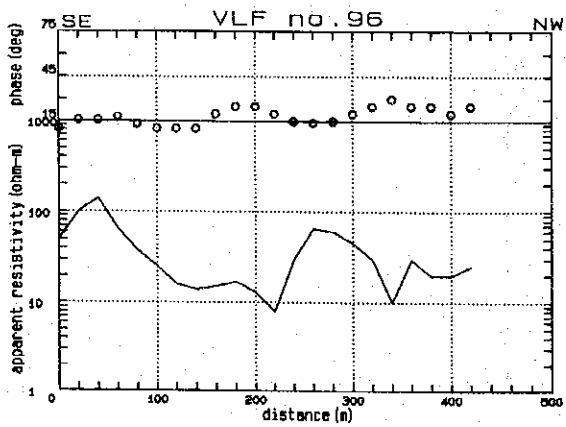










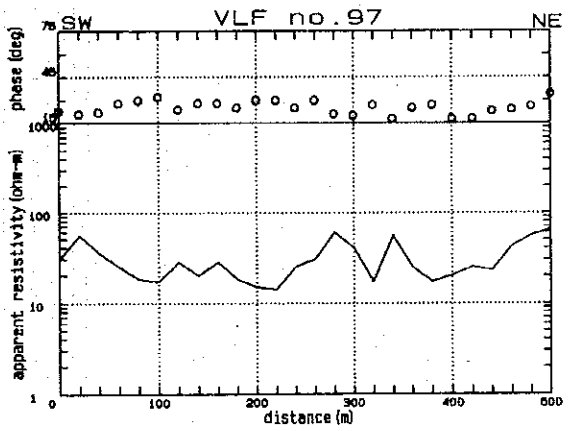


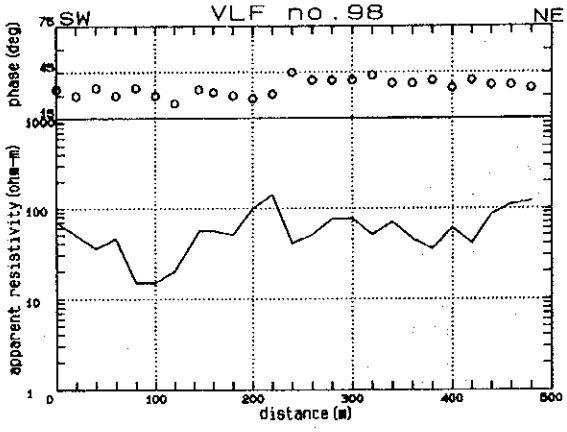
JAPAN INTERNATIONAL COOPERATION AGENCY (JICA)

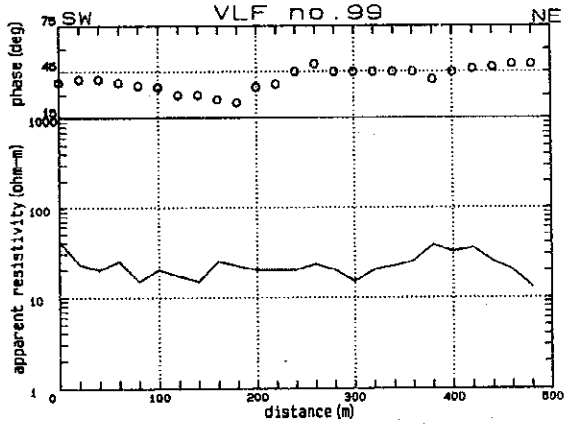
THE STUDY ON GROUNDWATER DEVELOPMENT IN NORTH VITI LEVU IN THE REPUBLIC OF FIJI

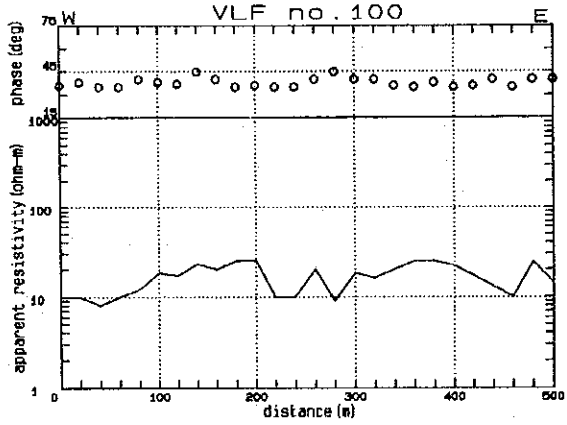
Fig.	
B-2.3	VLF RESISTIVITY AND PHASE ANGLE PROFILES (12)

NIPPON KOEI CO., LTD
NIKKO EXPLORATION & DEVELOPMENT CO., LTD

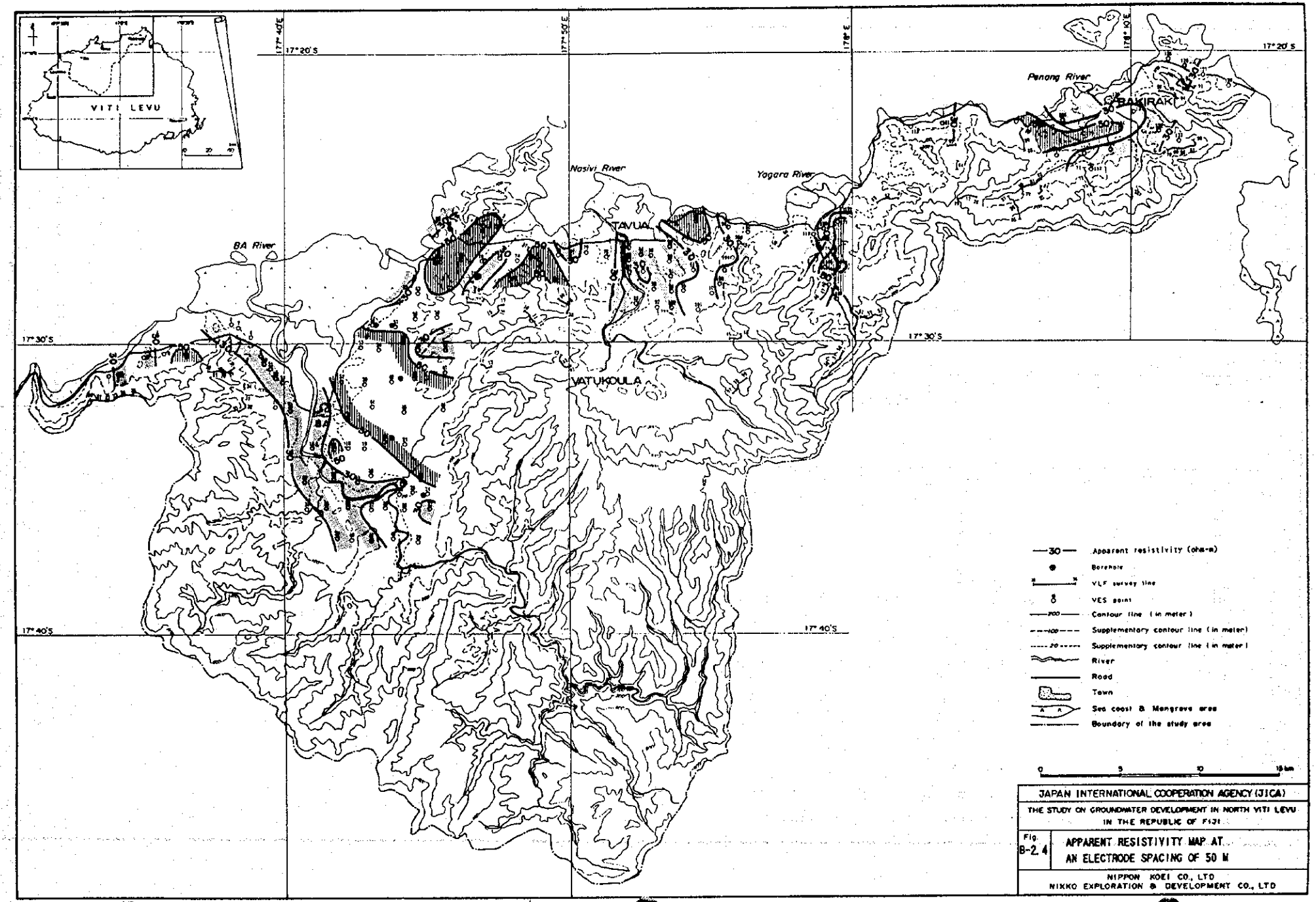


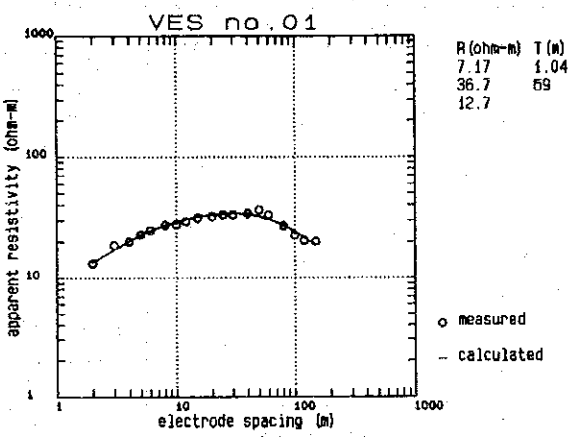


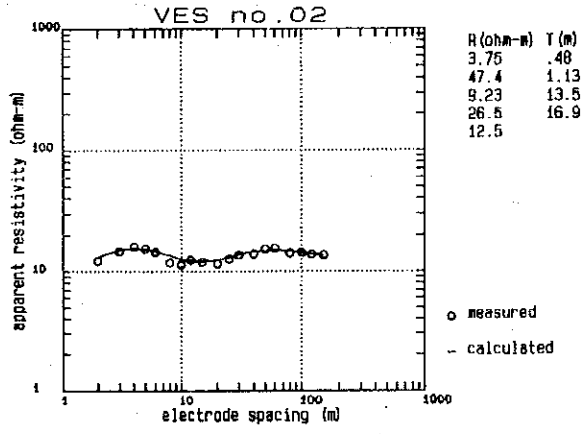


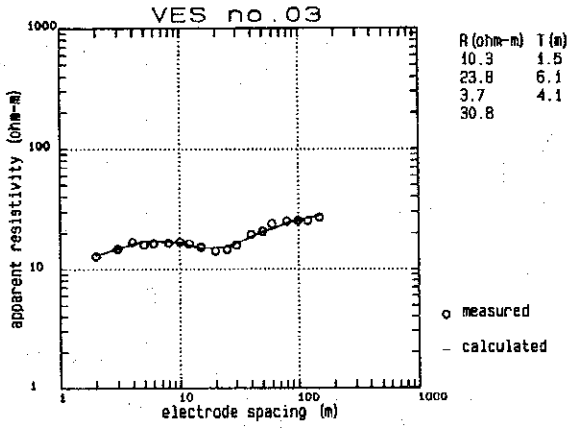


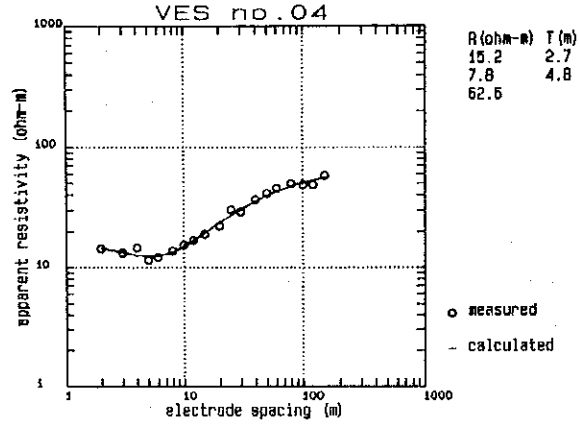
JAPAN INTERNATIONAL COOPERATION AGENCY (JICA)	
THE STUDY ON GROUNDWATER DEVELOPMENT IN NORTH VITI LEVU IN THE REPUBLIC OF FIJI	
Fig. B-2.3	VLF RESISTIVITY AND PHASE ANGLE PROFILES (13)
NIPPON KOEI CO., LTD NIKKO EXPLORATION & DEVELOPMENT CO., LTD	

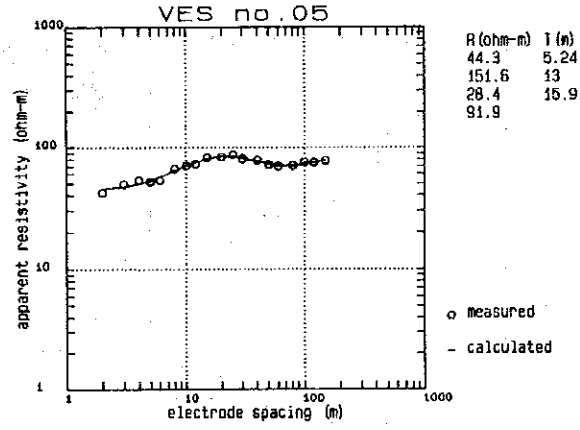

VITI LEVU
177°40'E
177°50'E
178°E
178°10'E
17°20'S
17°30'S
17°40'S
Penang River
BAKIRAKI
Nasivi River
Yagara River
TAVUA
BA River
VATUKOULA
—30— Apparent resistivity (ohm-m)
Borehole
VLF survey line
VES point
—200— Contour line (in meter)
---100--- Supplementary contour line (in meter)
----20---- Supplementary contour line (in meter)
River
Road
Town
Sea coast & Mangrove area
Boundary of the study area
0 5 10 15km
JAPAN INTERNATIONAL COOPERATION AGENCY (JICA)
THE STUDY ON GROUNDWATER DEVELOPMENT IN NORTH VITI LEVU IN THE REPUBLIC OF FIJI
Fig. B-2.4
APPARENT RESISTIVITY MAP AT AN ELECTRODE SPACING OF 50 M
NIPPON KOEI CO., LTD
NIKKO EXPLORATION & DEVELOPMENT CO., LTD

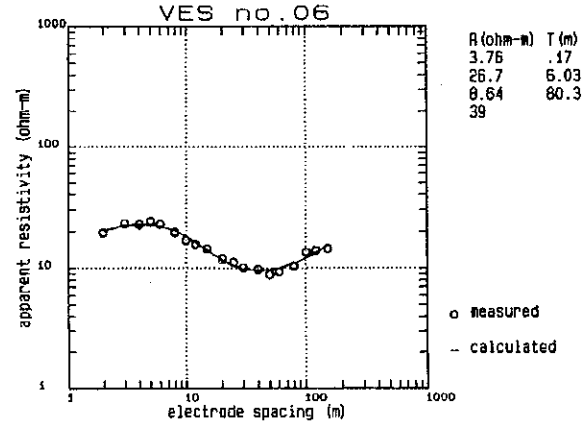


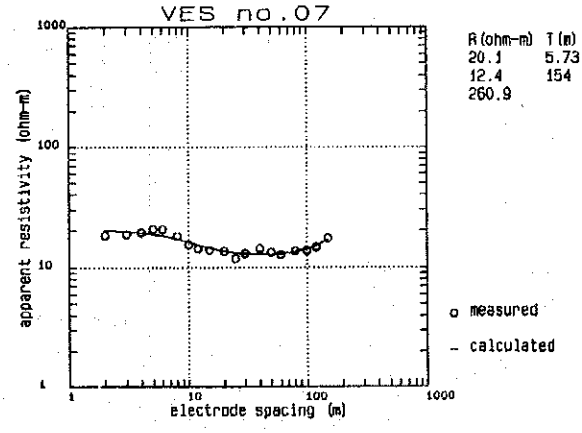


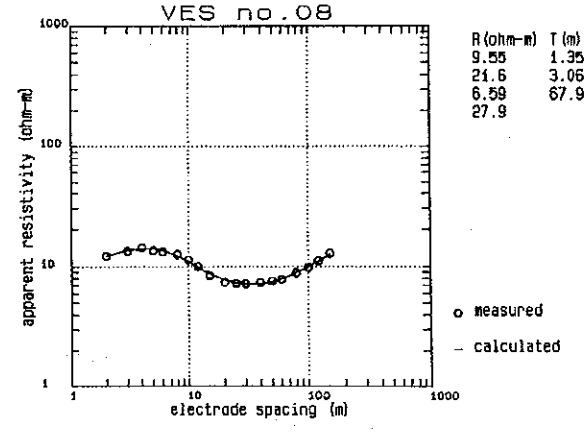










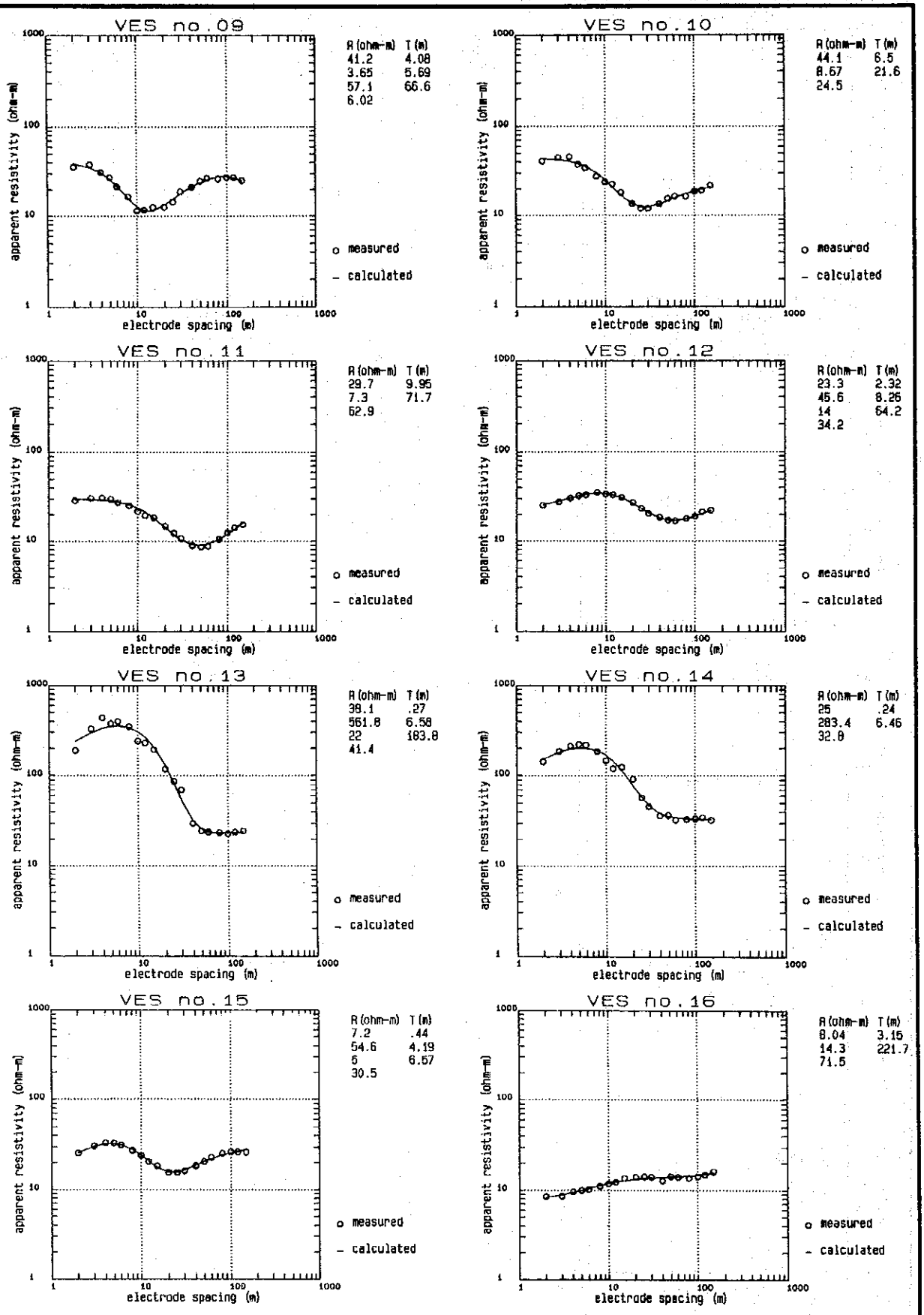


JAPAN INTERNATIONAL COOPERATION AGENCY (JICA)

THE STUDY ON GROUNDWATER DEVELOPMENT IN NORTH VITI LEVU IN THE REPUBLIC OF FIJI

Fig. B-2.5 VERTICAL ELECTRIC SOUNDING CURVES (1)

NIPPON KOEI CO., LTD
NIKKO EXPLORATION & DEVELOPMENT CO., LTD

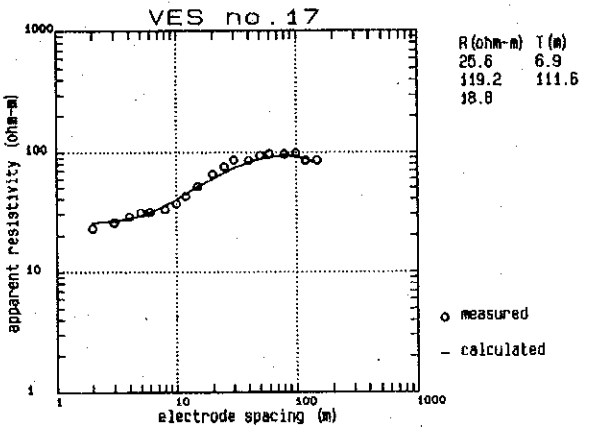


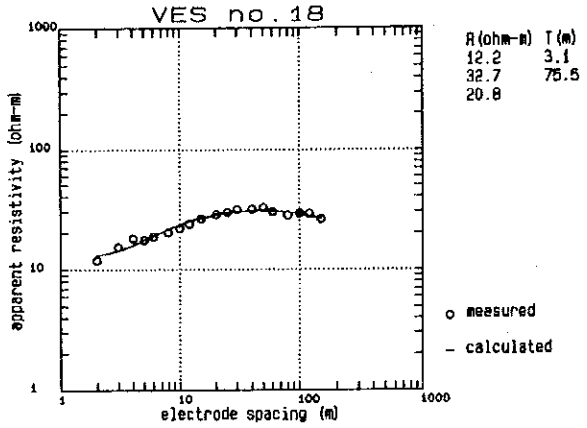
JAPAN INTERNATIONAL COOPERATION AGENCY (JICA)

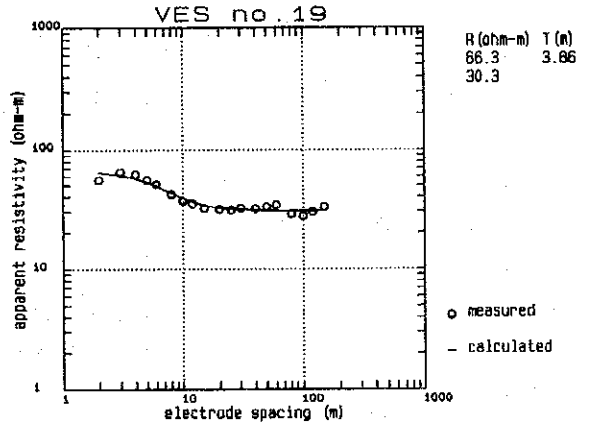
THE STUDY ON GROUNDWATER DEVELOPMENT IN NORTH VITI LEVU IN THE REPUBLIC OF FIJI

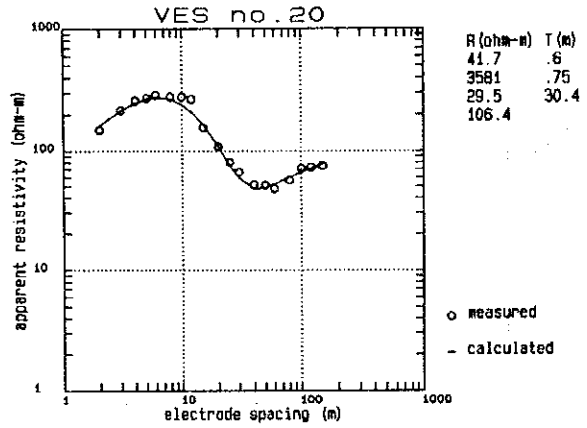
Fig. B-2.5 VERTICAL ELECTRIC SOUNDING CURVES (2)

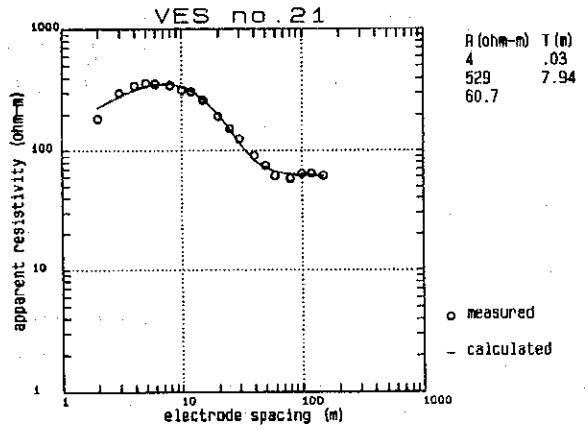
NIPPON KOEI CO., LTD
NIKKO EXPLORATION & DEVELOPMENT CO., LTD

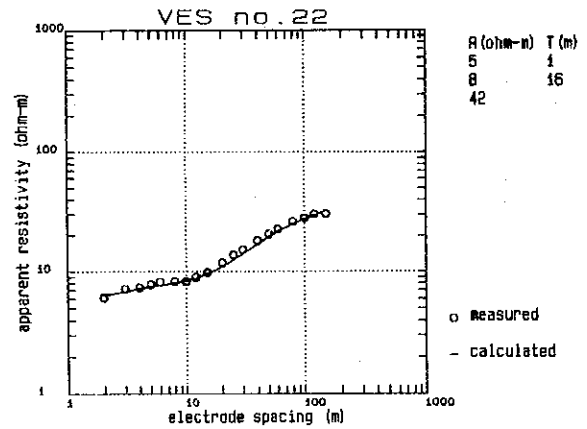


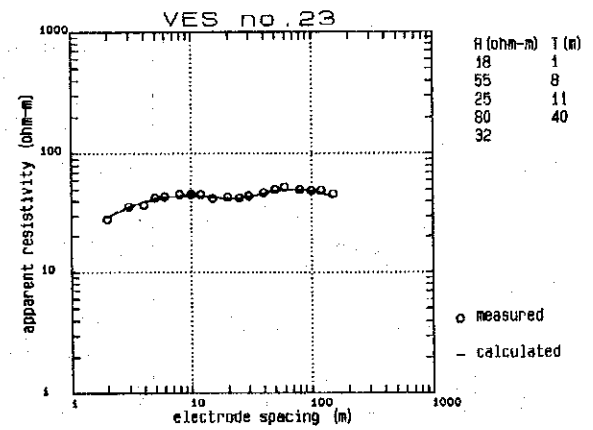


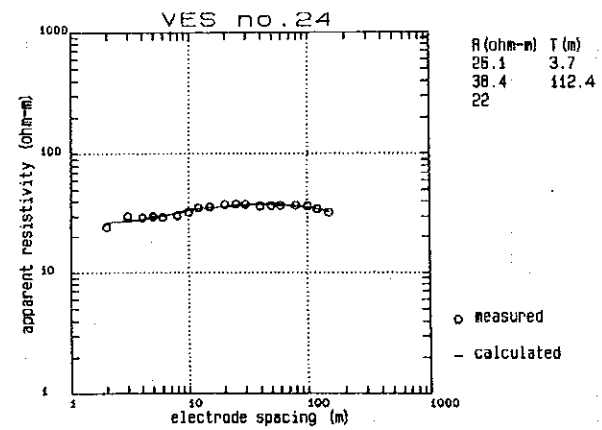












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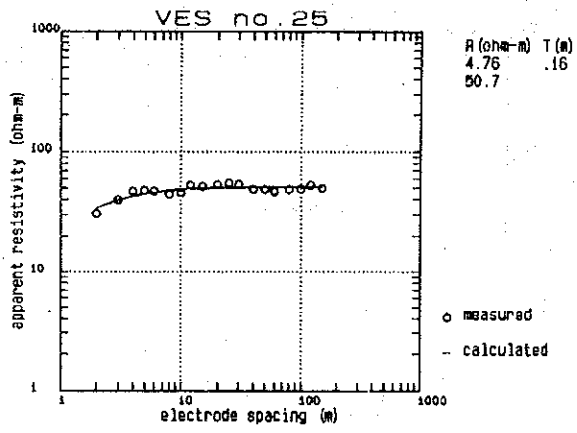
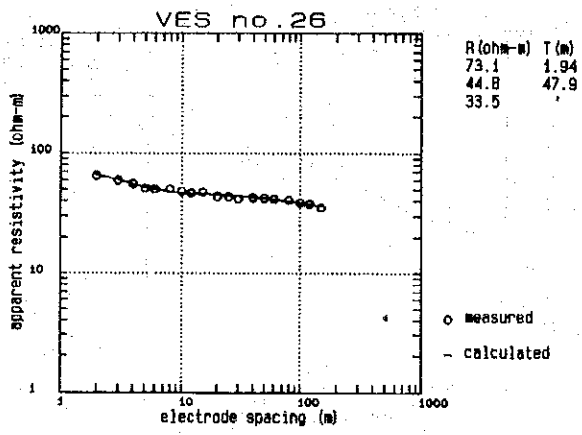
THE STUDY ON GROUNDWATER DEVELOPMENT IN NORTH VITI LEVU IN THE REPUBLIC OF FIJI

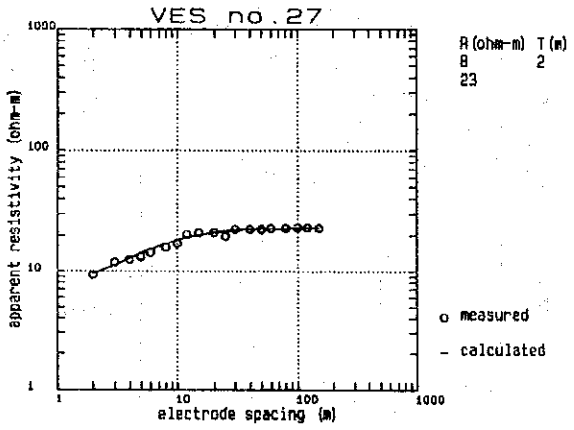
Fig. B-2.5

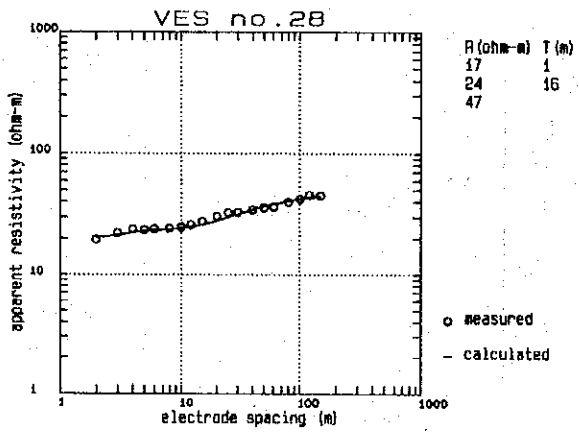
VERTICAL ELECTRIC SOUNDING CURVES (3)

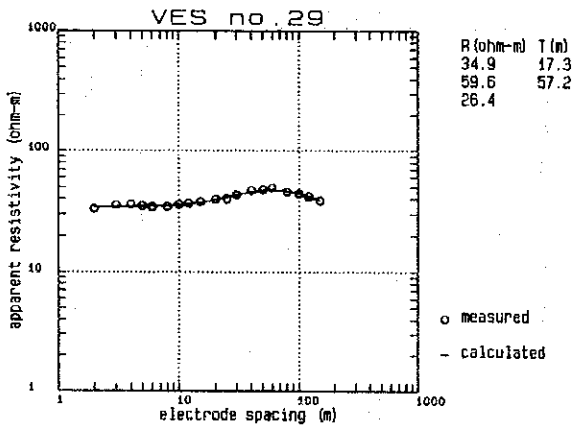
NIPPON KOEI CO., LTD
NIKKO EXPLORATION & DEVELOPMENT CO., LTD

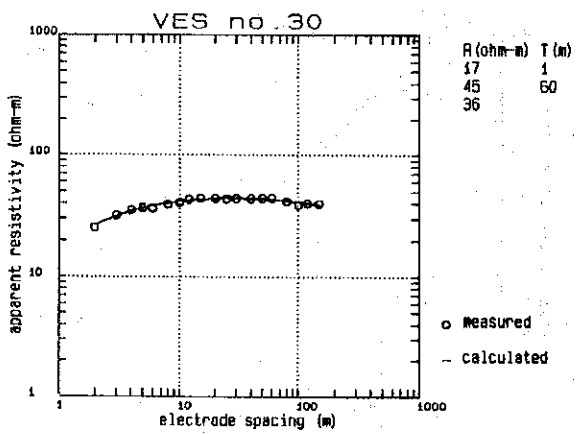


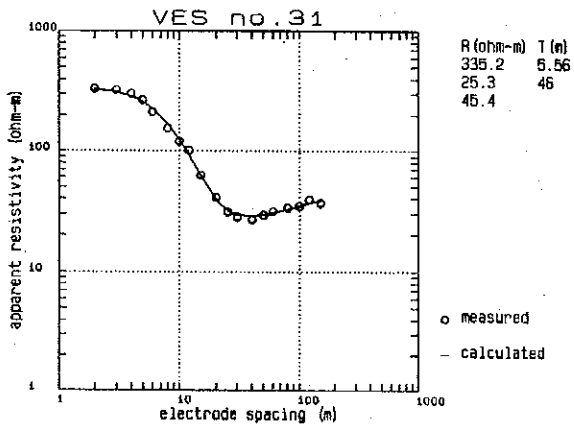


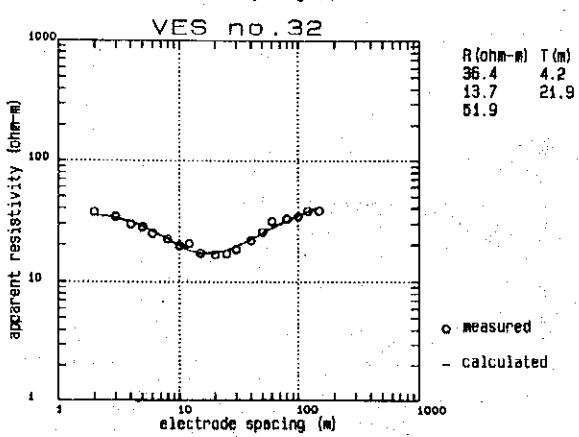












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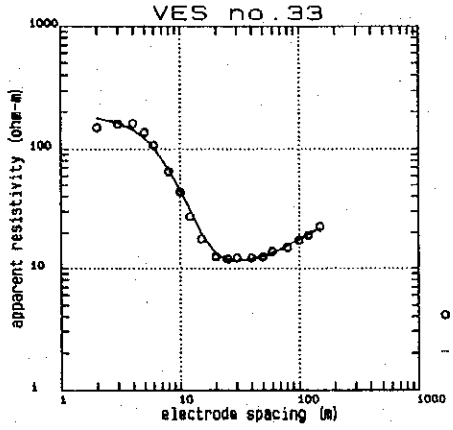
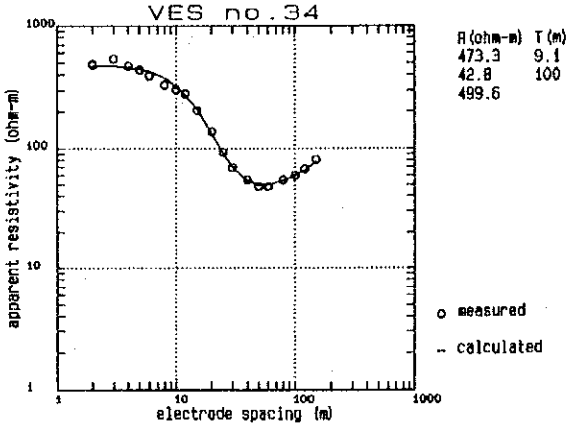
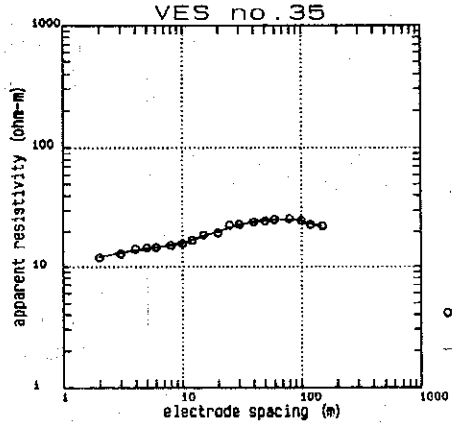
THE STUDY ON GROUNDWATER DEVELOPMENT IN NORTH VITI LEVU IN THE REPUBLIC OF FIJI

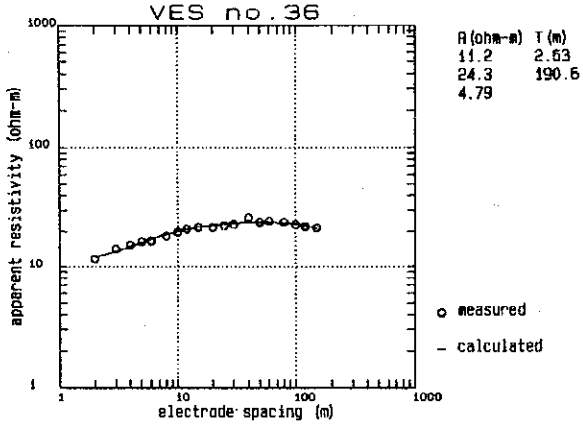
Fig. B-2.5 VERTICAL ELECTRIC SOUNDING CURVES (4)

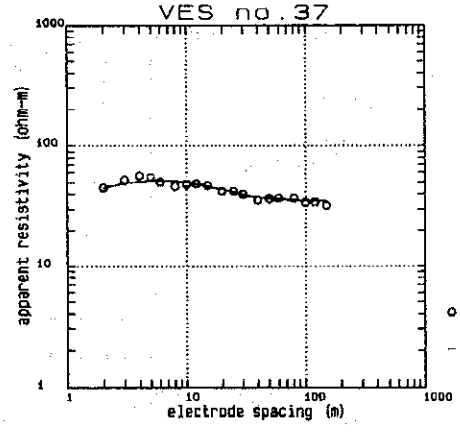
NIPPON KOEI CO., LTD
NIKKO EXPLORATION & DEVELOPMENT CO., LTD

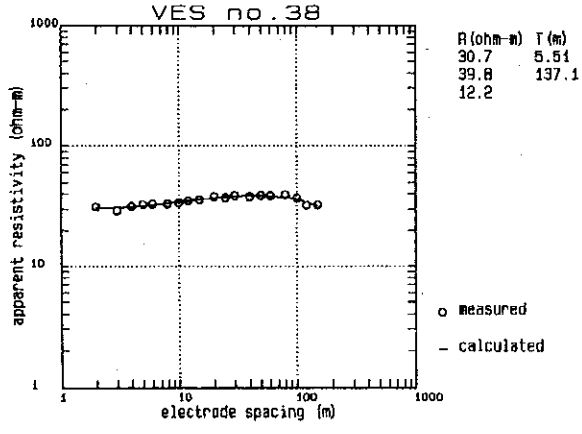


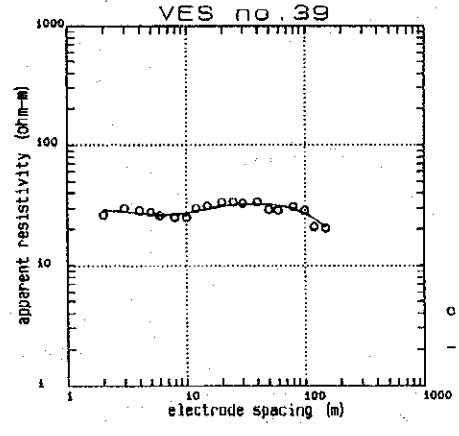


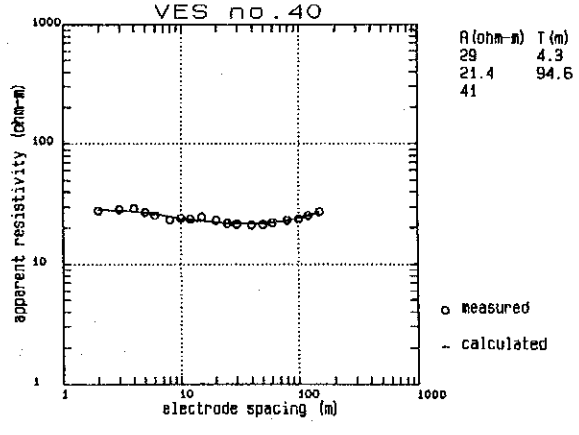










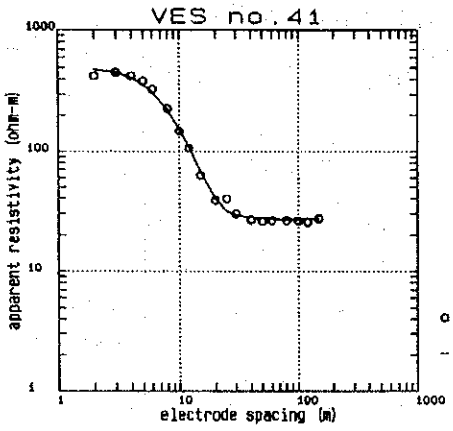


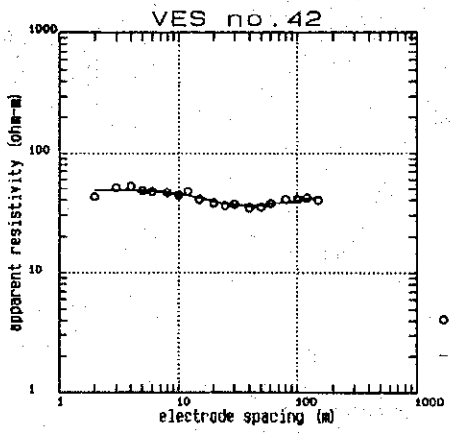
JAPAN INTERNATIONAL COOPERATION AGENCY (JICA)

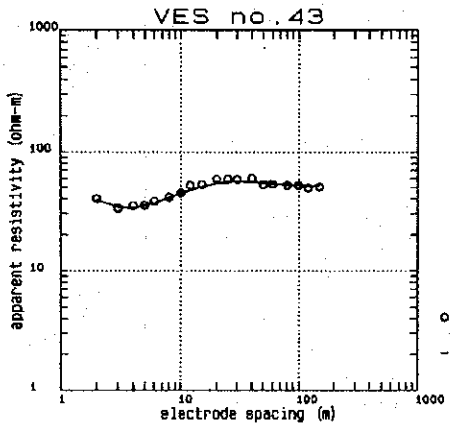
THE STUDY ON GROUNDWATER DEVELOPMENT IN NORTH VITI LEVU IN THE REPUBLIC OF FIJI

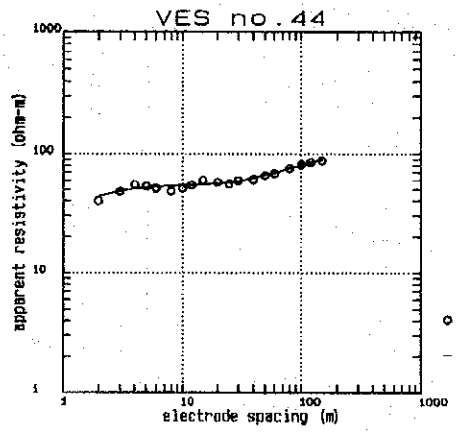
Fig. B-2.5 VERTICAL ELECTRIC SOUNDING CURVES (5)

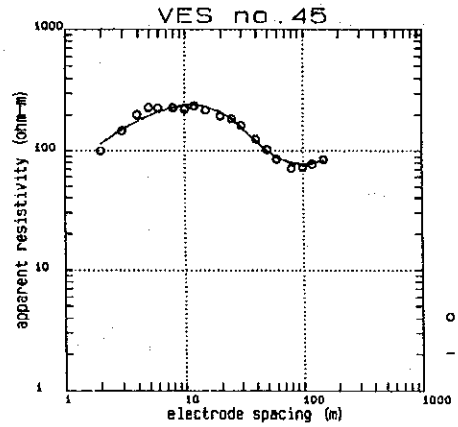
NIPPON KOEI CO., LTD
NIKKO EXPLORATION & DEVELOPMENT CO., LTD

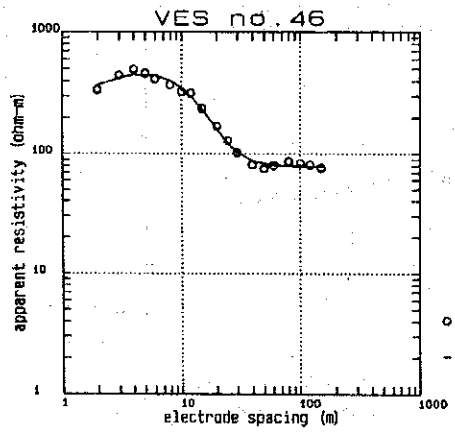


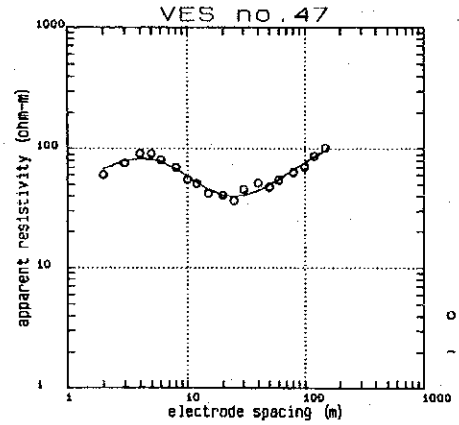


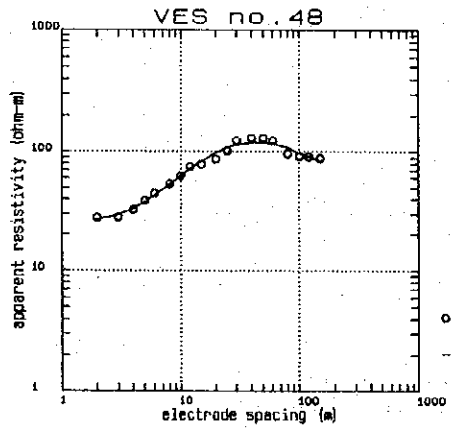










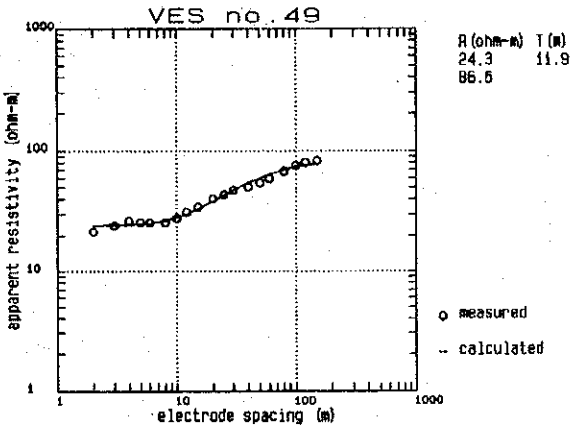


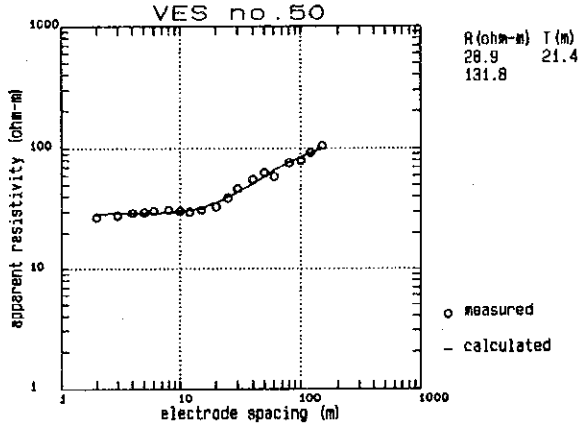
JAPAN INTERNATIONAL COOPERATION AGENCY (JICA)

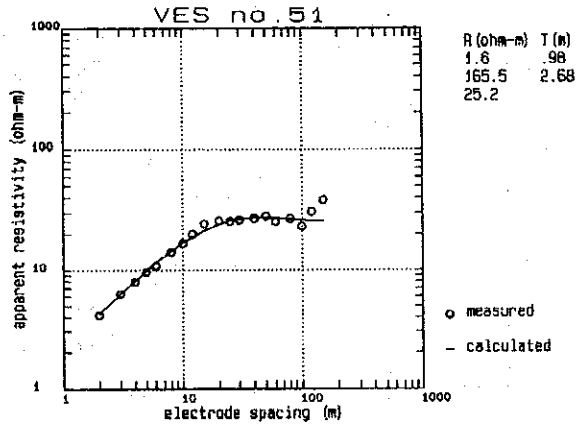
THE STUDY ON GROUNDWATER DEVELOPMENT IN NORTH VITI LEVU IN THE REPUBLIC OF FIJI

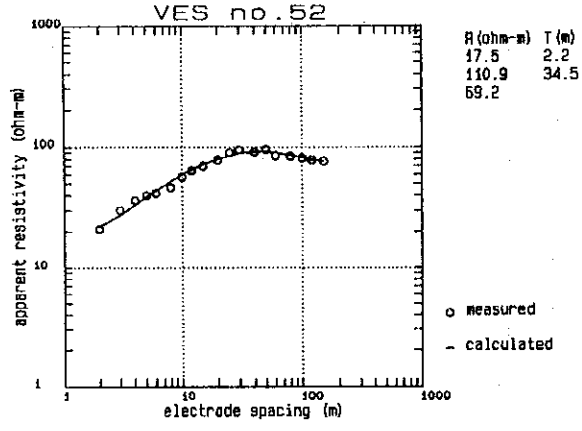
Fig. B-2.5 VERTICAL ELECTRIC SOUNDING CURVES (6)

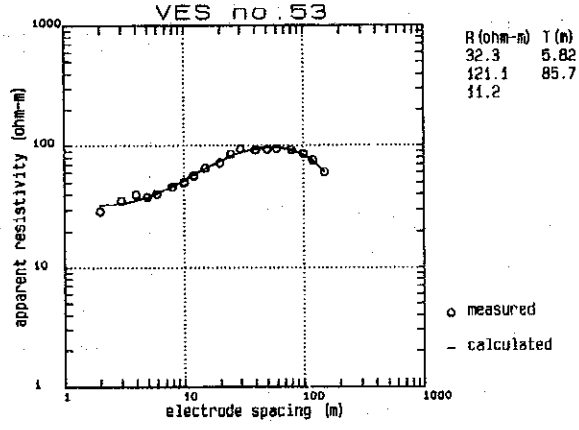
NIPPON KOEI CO., LTD
NIKKO EXPLORATION & DEVELOPMENT CO., LTD

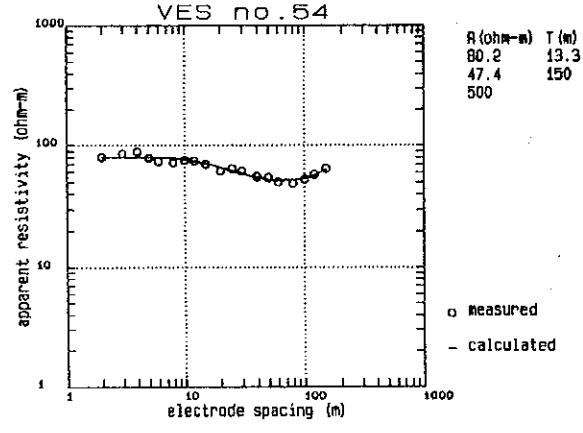


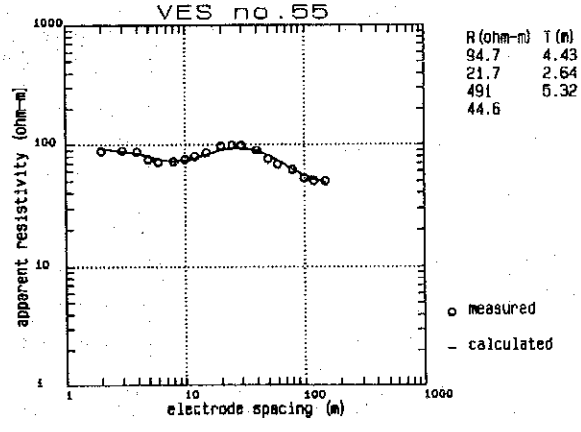


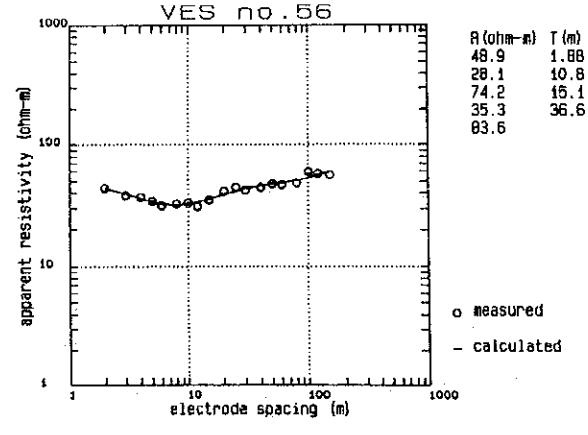










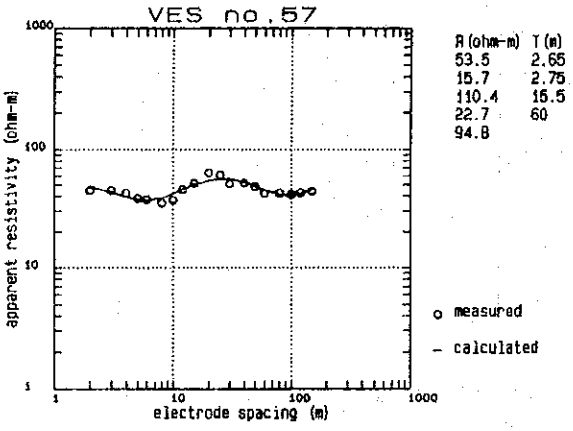


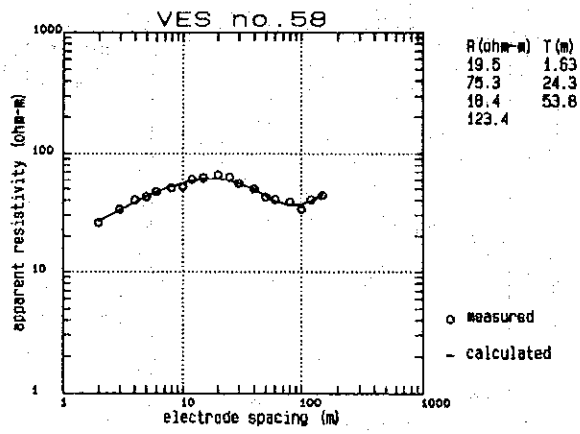
JAPAN INTERNATIONAL COOPERATION AGENCY (JICA)

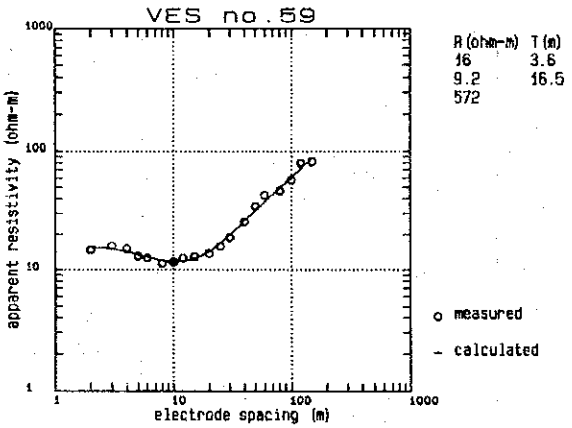
THE STUDY ON GROUNDWATER DEVELOPMENT IN NORTH VITI LEVU IN THE REPUBLIC OF FIJI

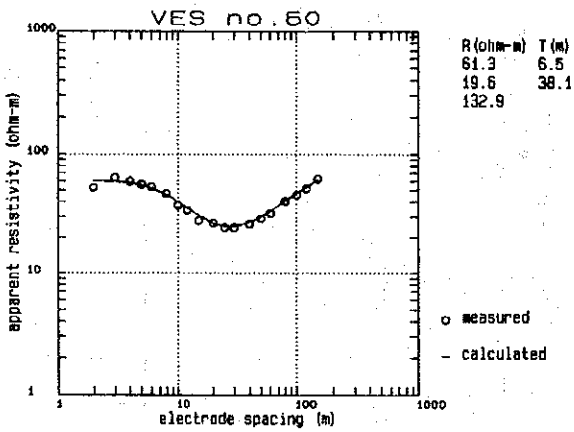
Fig. 8-2.5 VERTICAL ELECTRIC SOUNDING CURVES (7)

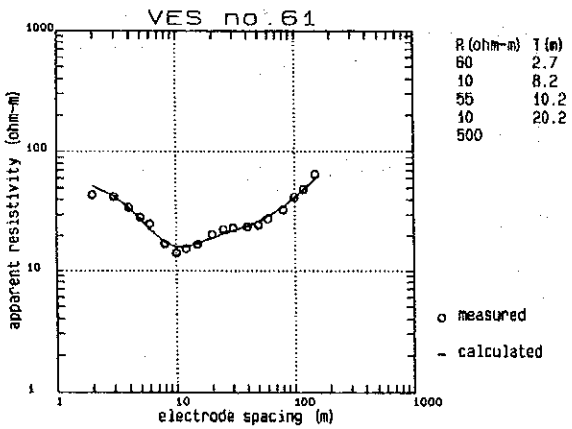
NIPPON KOEI CO., LTD
NIKKO EXPLORATION & DEVELOPMENT CO., LTD

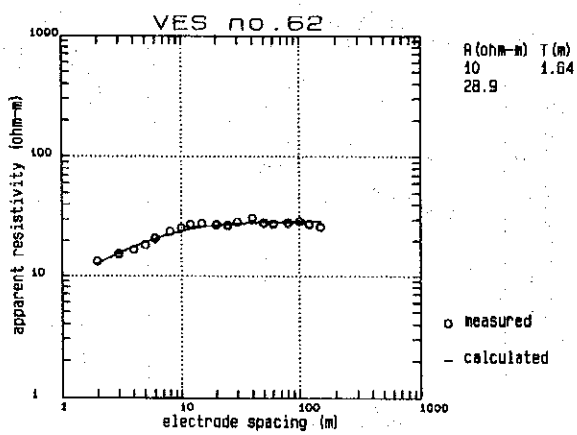


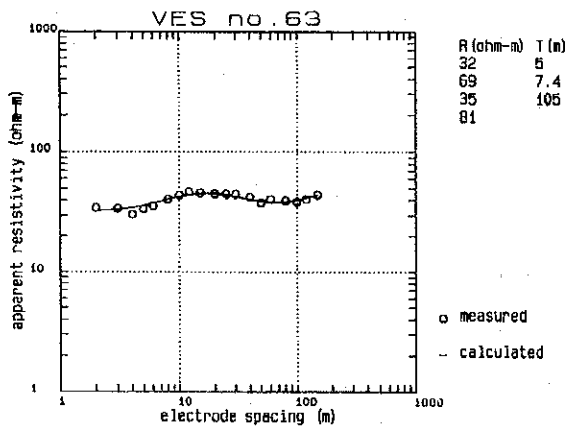


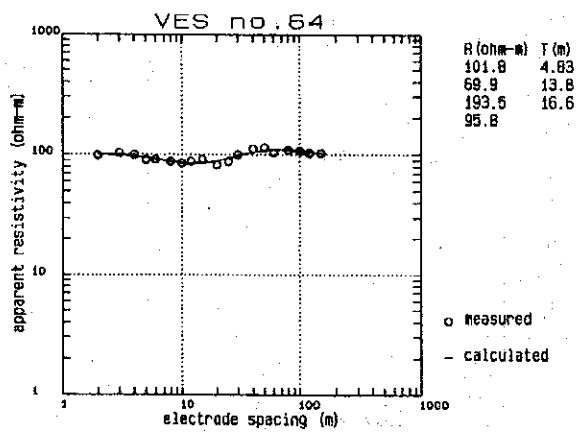












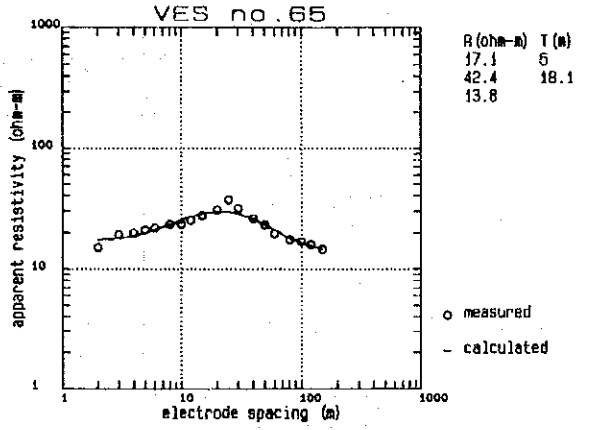
JAPAN INTERNATIONAL COOPERATION AGENCY (JICA)

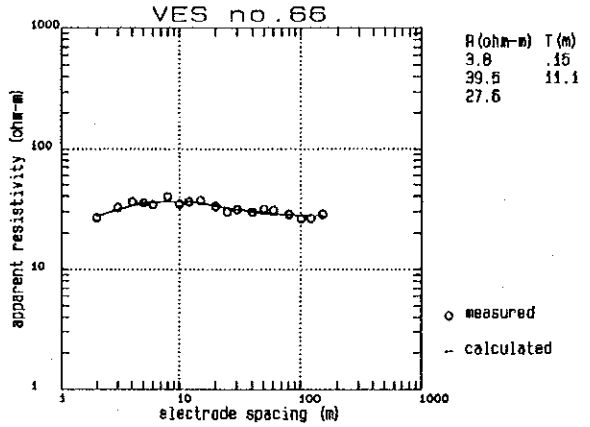
THE STUDY ON GROUNDWATER DEVELOPMENT IN NORTH VITI LEVU IN THE REPUBLIC OF FIJI

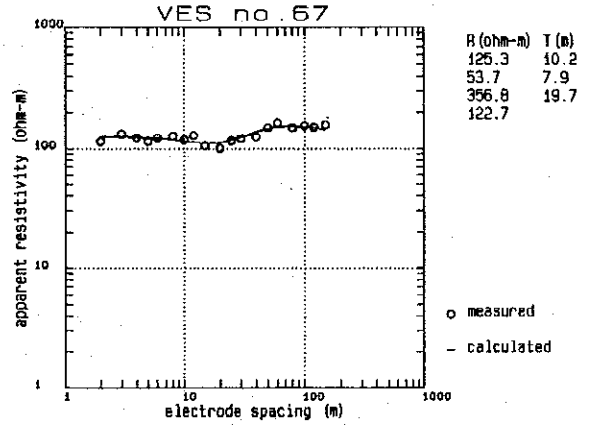
Fig. B-2.5

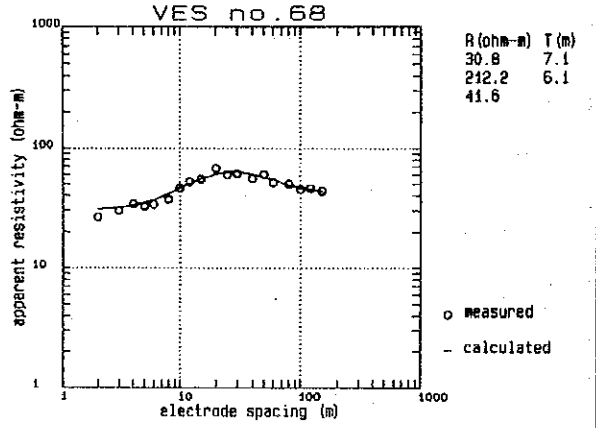
VERTICAL ELECTRIC SOUNDING CURVES (8)

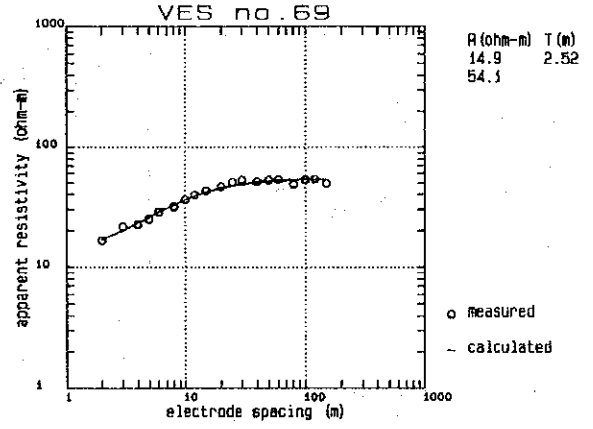
NIPPON KOEI CO., LTD
NIKKO EXPLORATION & DEVELOPMENT CO., LTD

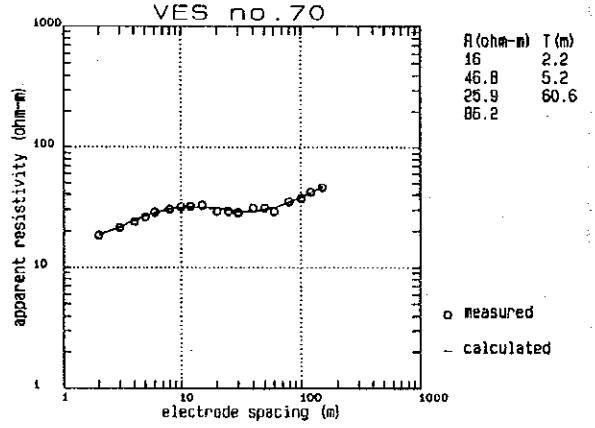


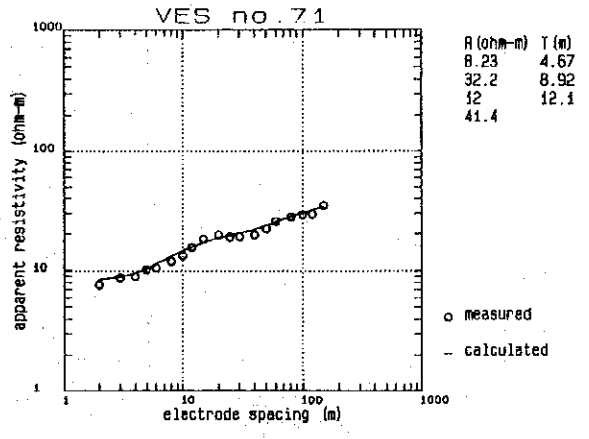


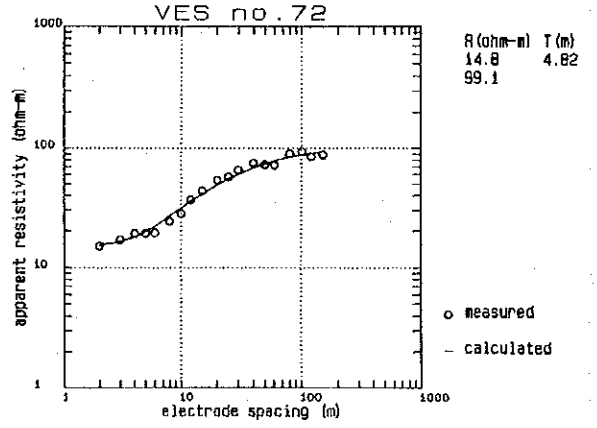










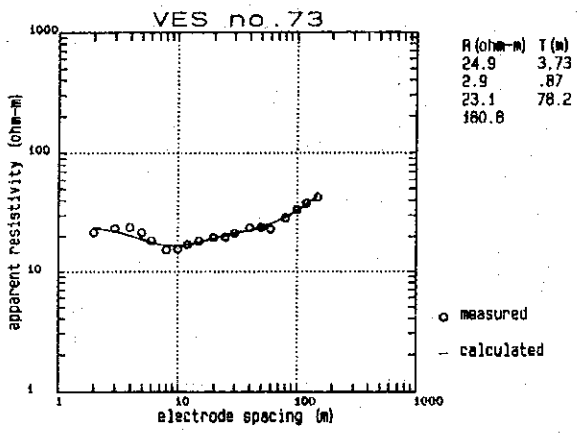


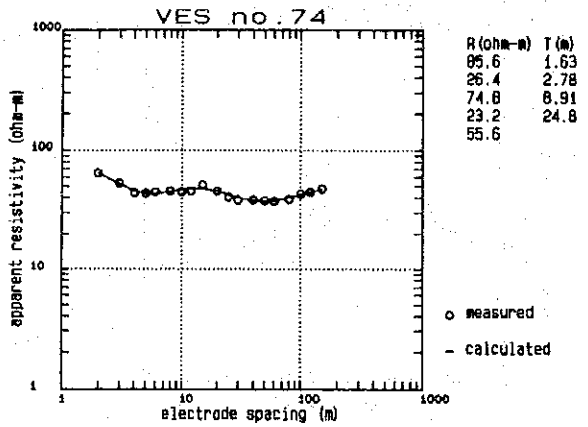
JAPAN INTERNATIONAL COOPERATION AGENCY (JICA)

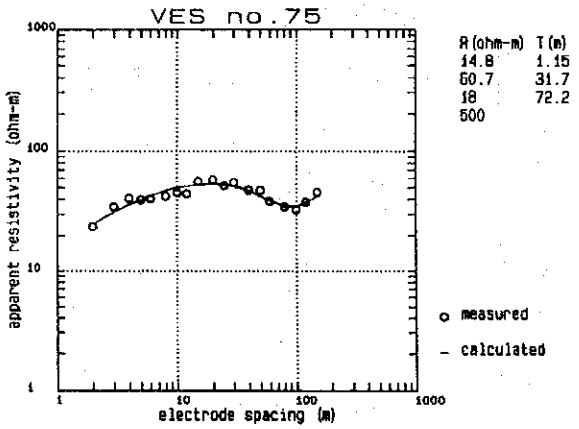
THE STUDY ON GROUNDWATER DEVELOPMENT IN NORTH VITI LEVU IN THE REPUBLIC OF FIJI

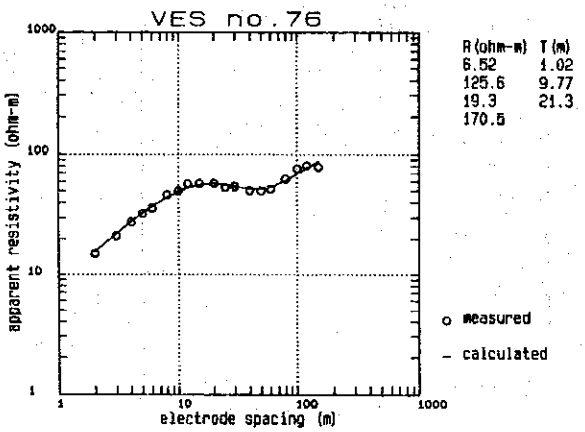
Fig. B-2.5 VERTICAL ELECTRIC SOUNDING CURVES (9)

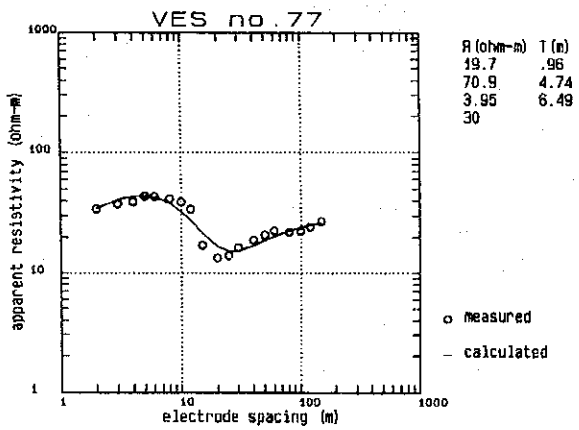
NIPPON KOEI CO., LTD
NIKKO EXPLORATION & DEVELOPMENT CO., LTD

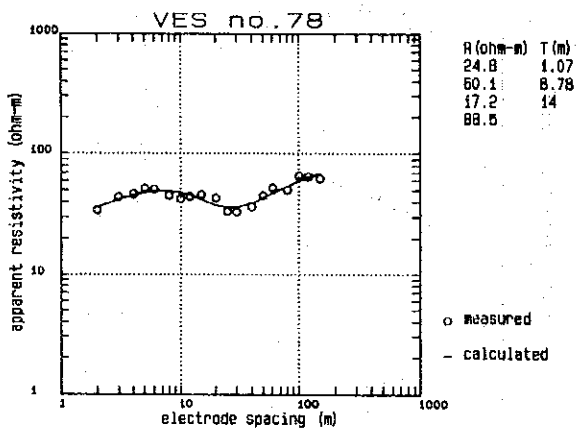


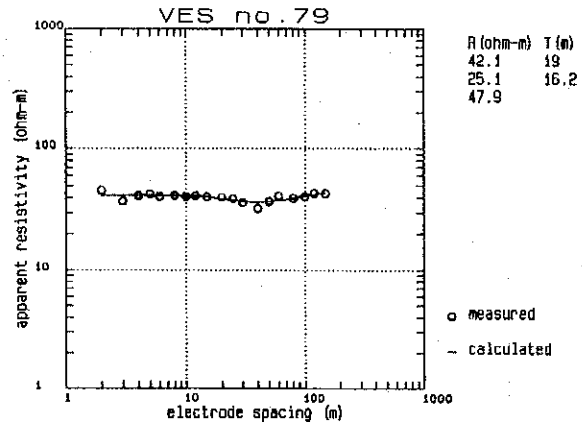


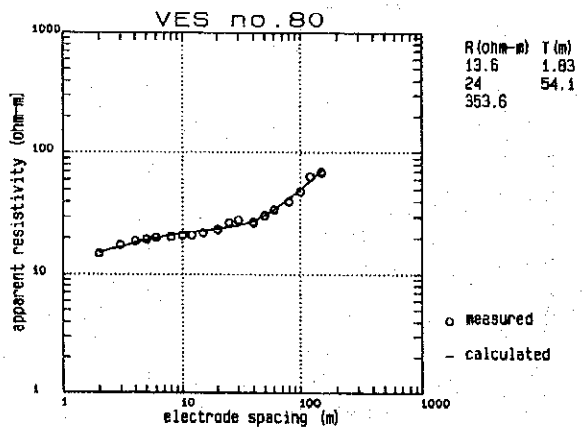










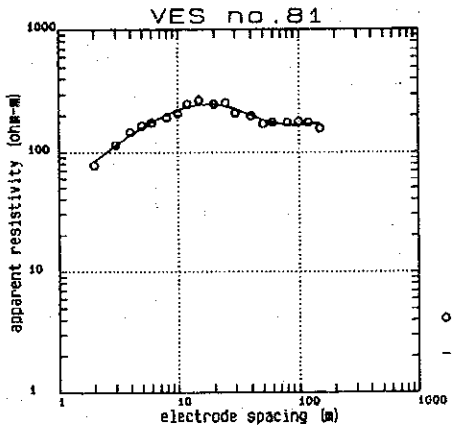


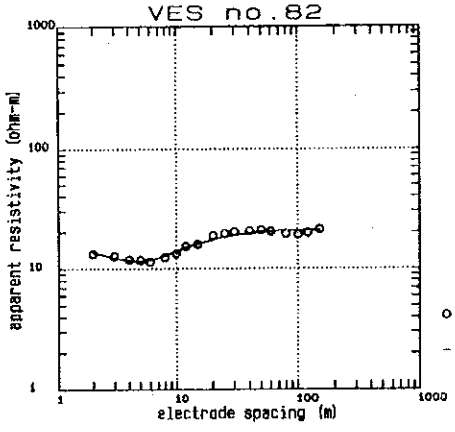
JAPAN INTERNATIONAL COOPERATION AGENCY (JICA)

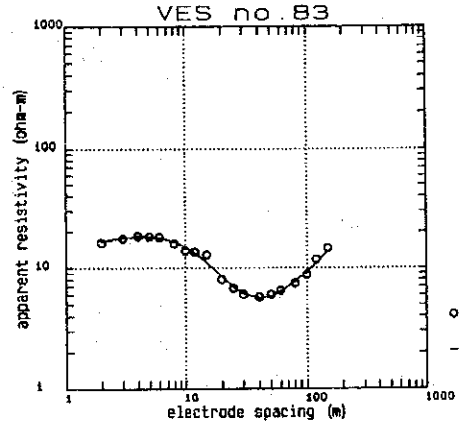
THE STUDY ON GROUNDWATER DEVELOPMENT IN NORTH VITI LEVU IN THE REPUBLIC OF FIJI

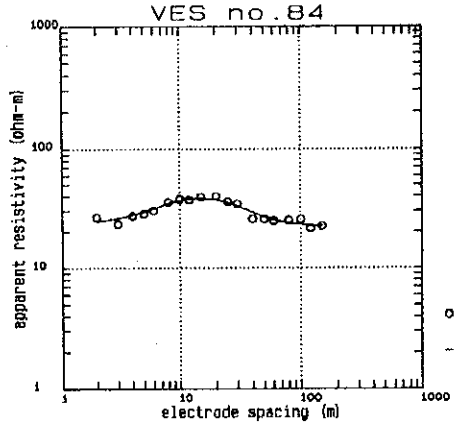
Fig. B-2.5 VERTICAL ELECTRIC SOUNDING CURVES (10)

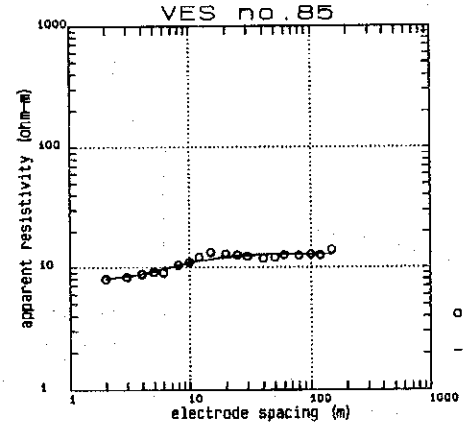
NIPPON KOEI CO., LTD
NIKKO EXPLORATION & DEVELOPMENT CO., LTD

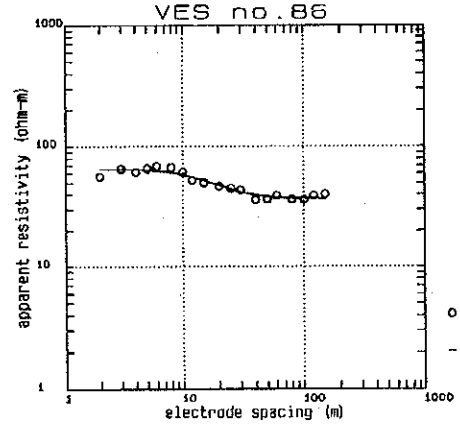


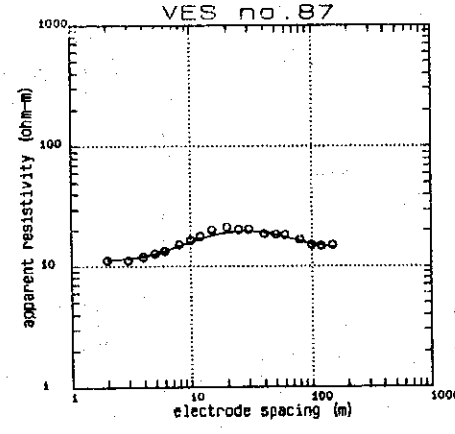


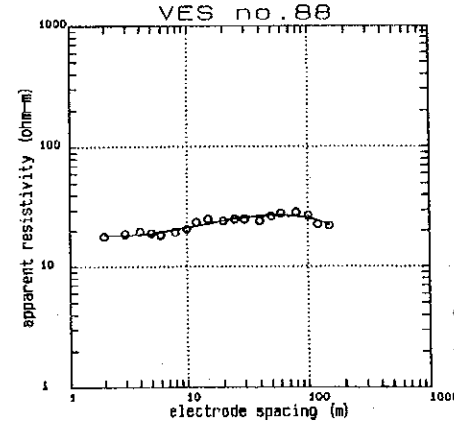










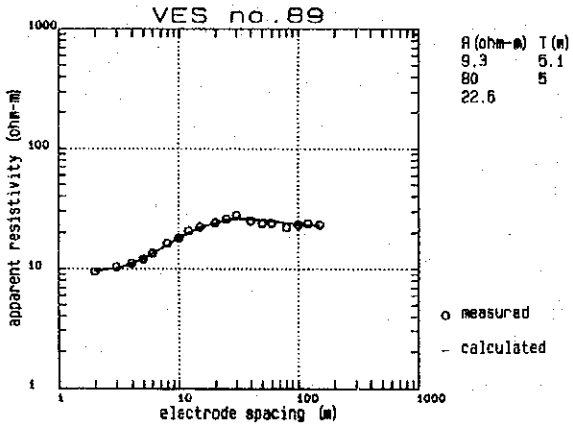


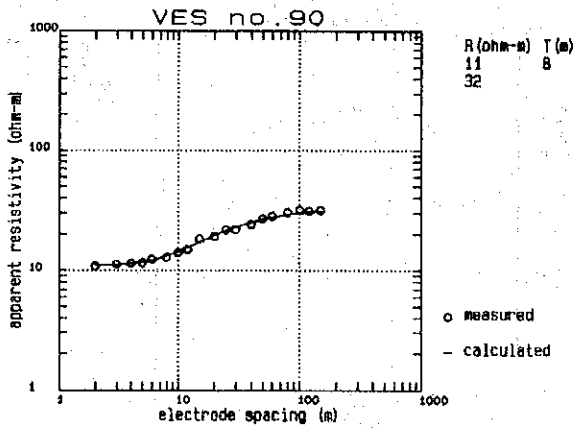
JAPAN INTERNATIONAL COOPERATION AGENCY (JICA)

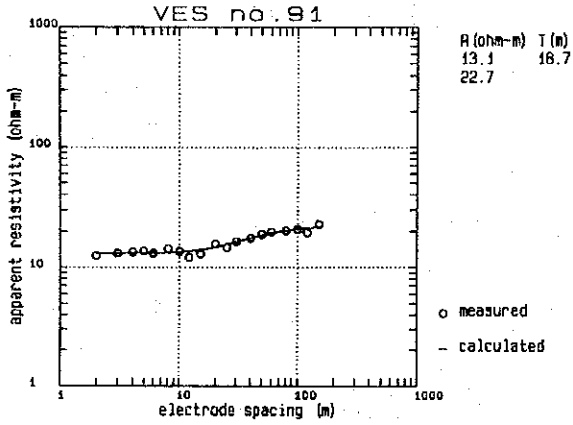
THE STUDY ON GROUNDWATER DEVELOPMENT IN NORTH VITI LEVU IN THE REPUBLIC OF FIJI

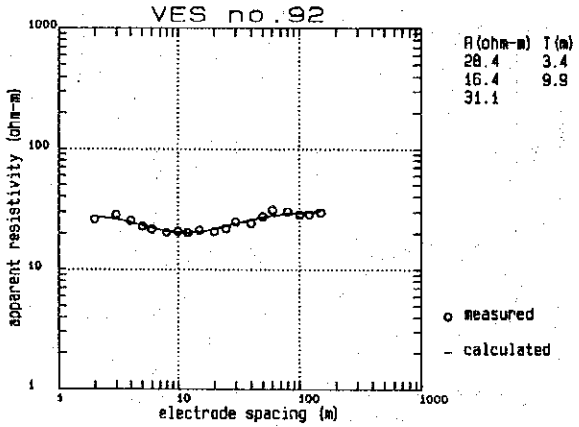
Fig. B-2.5 VERTICAL ELECTRIC SOUNDING CURVES (11)

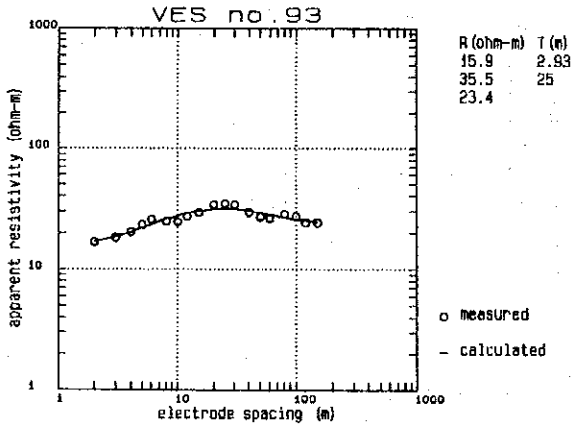
NIPPON KOEI CO., LTD
NIKKO EXPLORATION & DEVELOPMENT CO., LTD

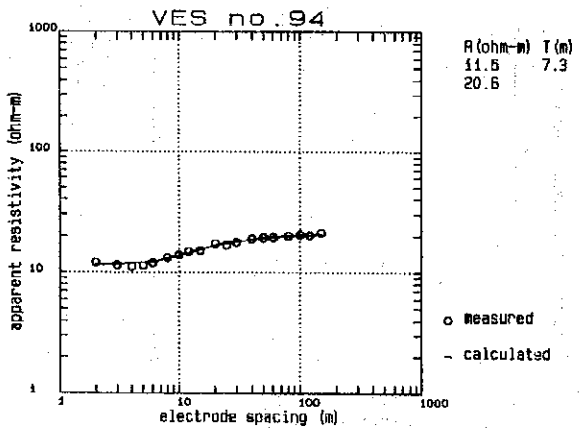


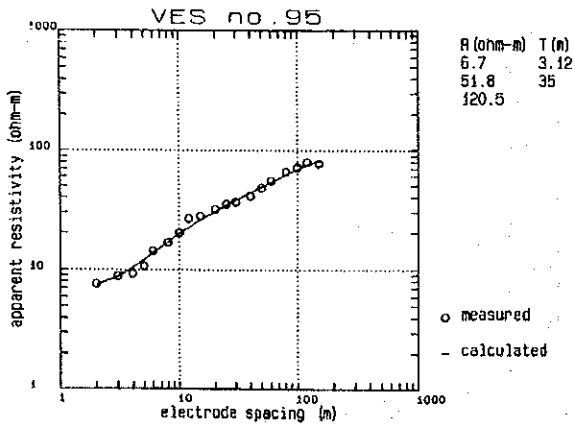


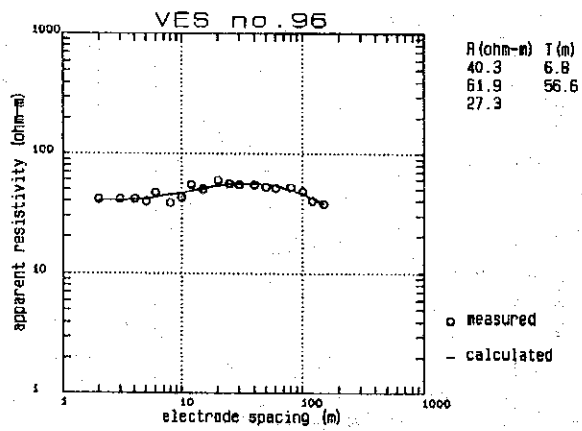










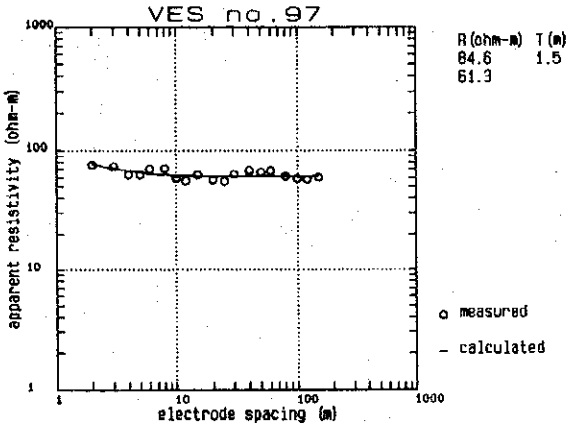


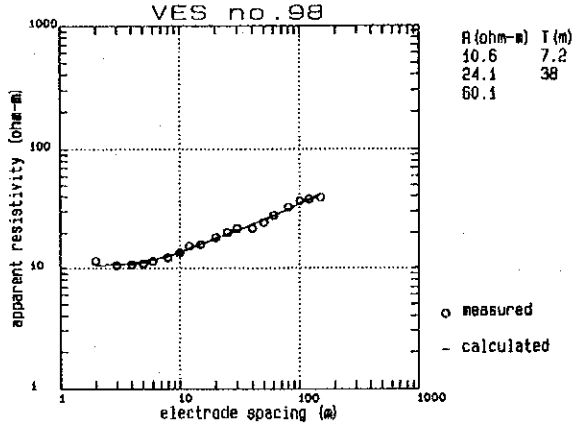
JAPAN INTERNATIONAL COOPERATION AGENCY (JICA)

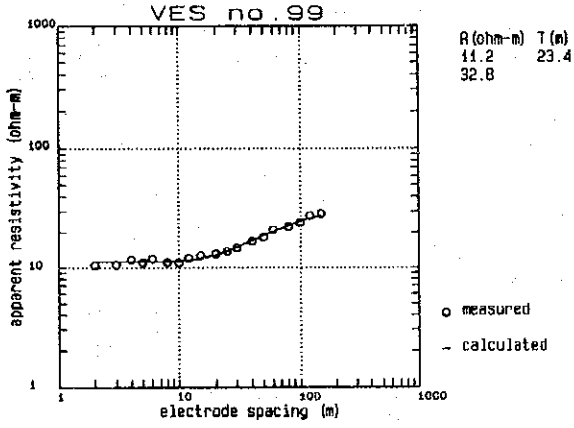
THE STUDY ON GROUNDWATER DEVELOPMENT IN NORTH VITI LEVU IN THE REPUBLIC OF FIJI

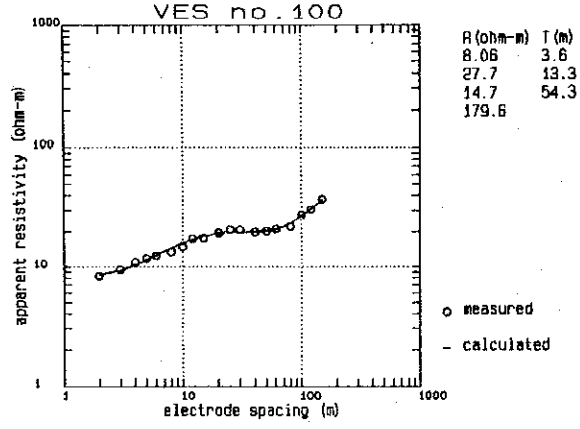
Fig. B-2.5 VERTICAL ELECTRIC SOUNDING CURVES (12)

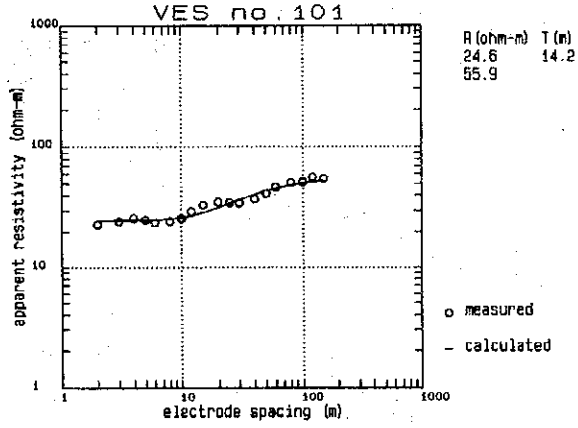
NIPPON KOEI CO., LTD
NIKKO EXPLORATION & DEVELOPMENT CO., LTD

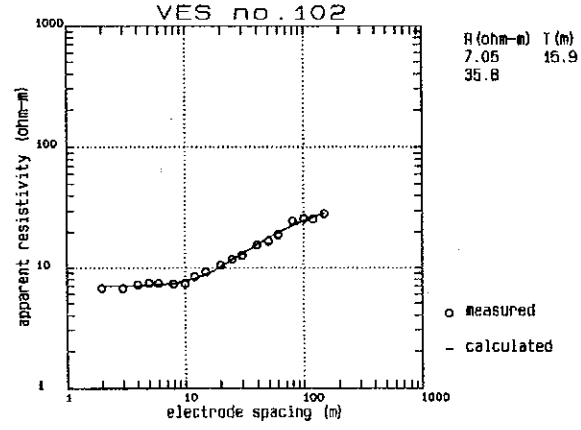


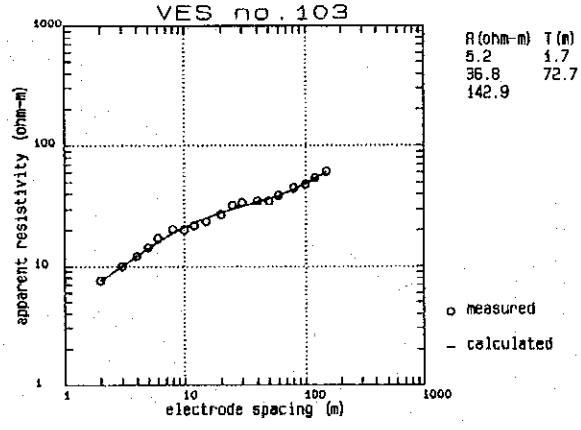


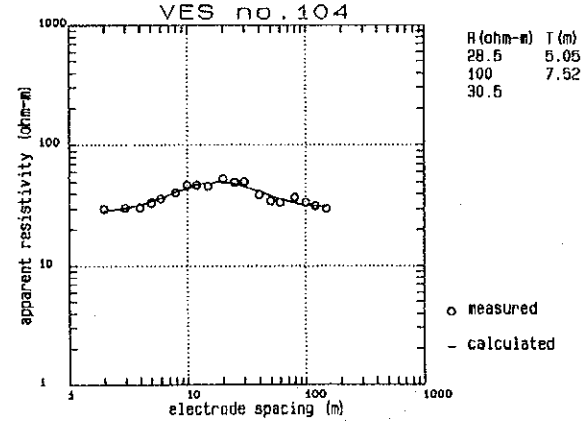










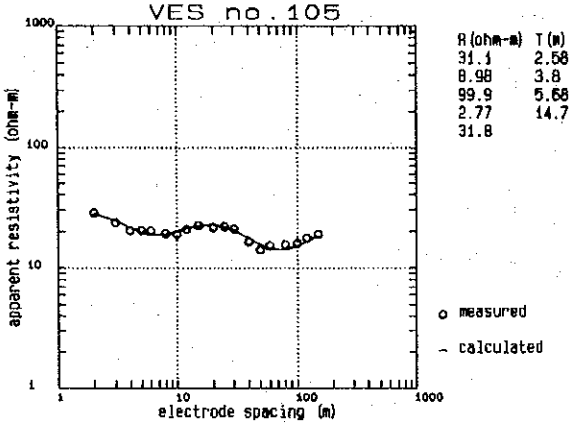


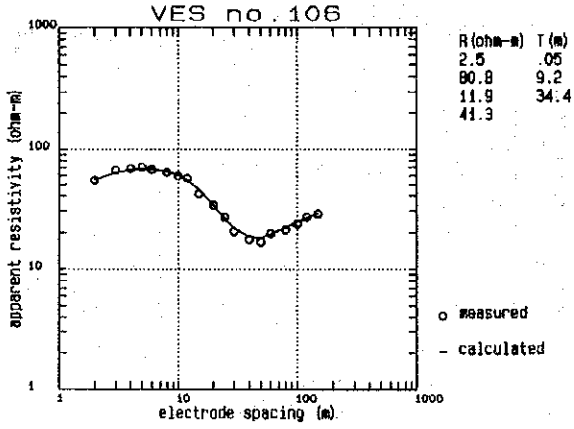
JAPAN INTERNATIONAL COOPERATION AGENCY (JICA)

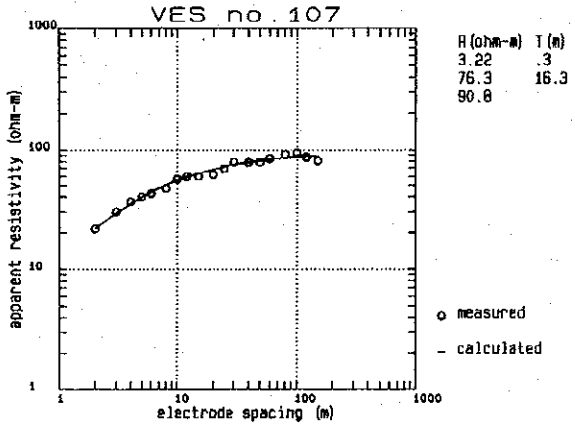
THE STUDY ON GROUNDWATER DEVELOPMENT IN NORTH VITI LEVU IN THE REPUBLIC OF FIJI

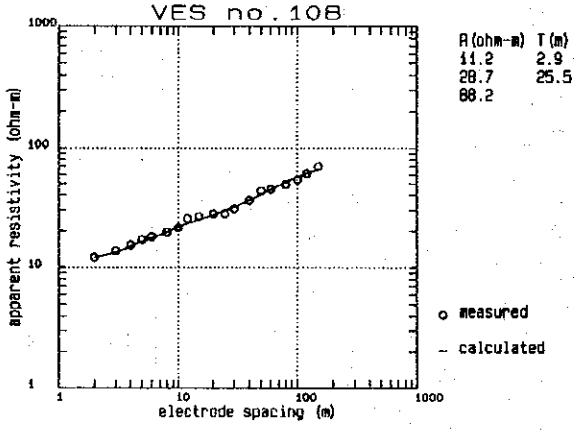
Fig. B-2.5 VERTICAL ELECTRIC SOUNDING CURVES (13)

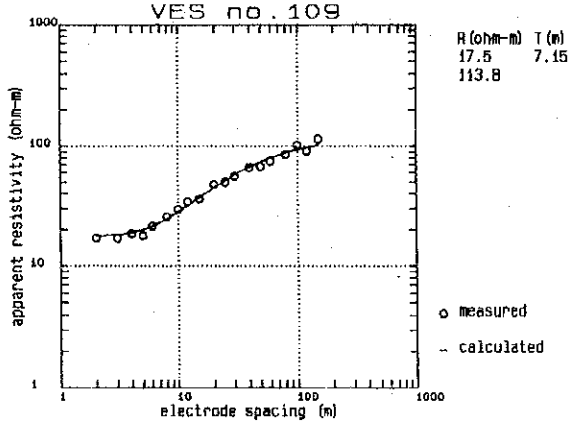
NIPPON KOEI CO., LTD
NIKKO EXPLORATION & DEVELOPMENT CO., LTD

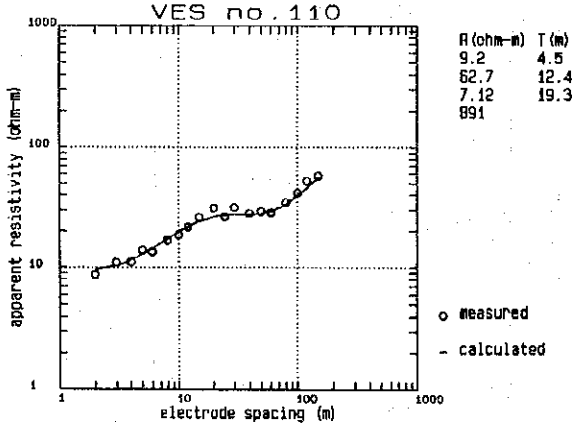


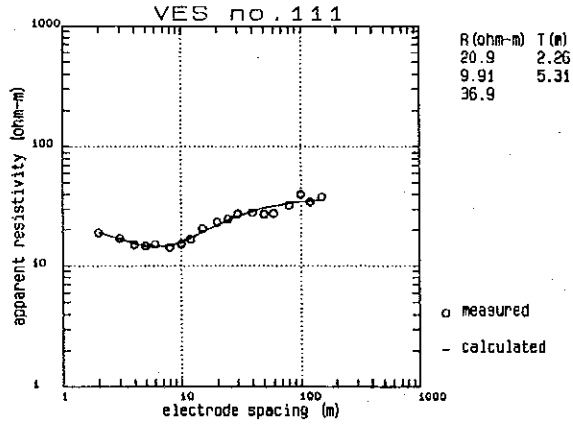


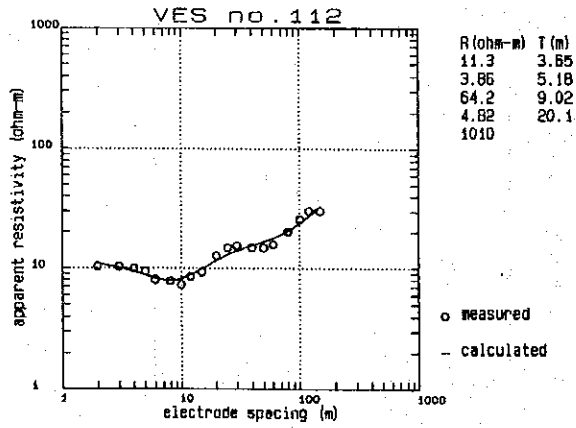










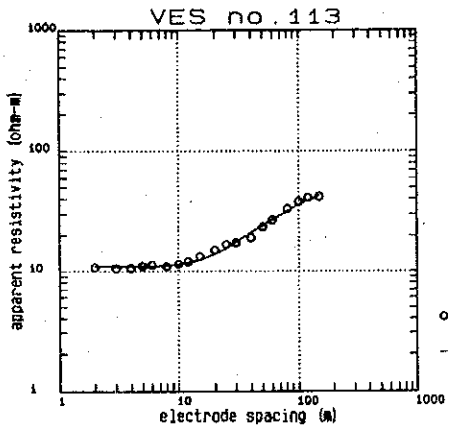


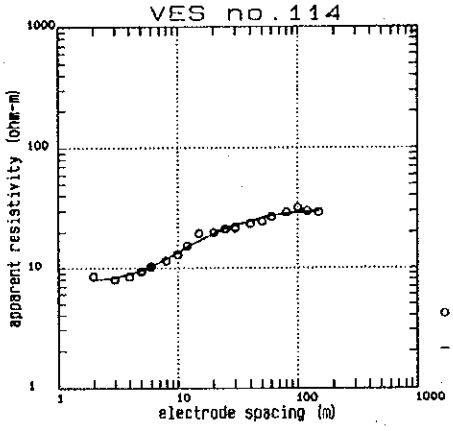
JAPAN INTERNATIONAL COOPERATION AGENCY (JICA)

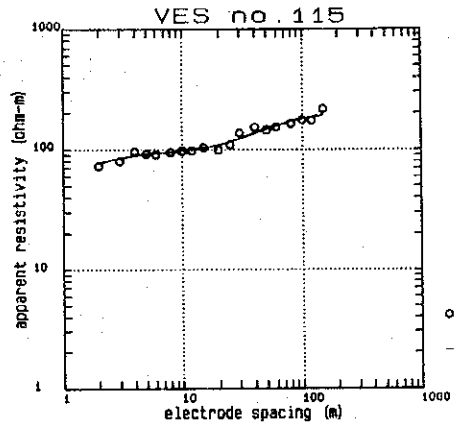
THE STUDY ON GROUNDWATER DEVELOPMENT IN NORTH VITI LEVU IN THE REPUBLIC OF FIJI

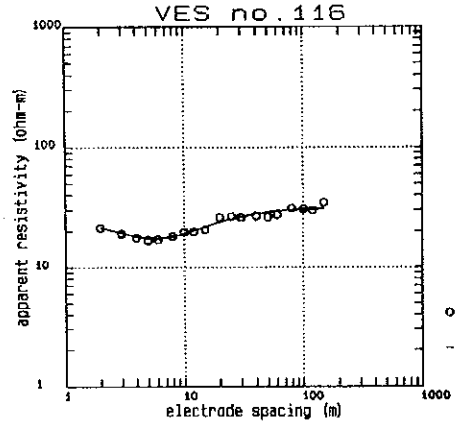
Fig. B-2.5 VERTICAL ELECTRIC SOUNDING CURVES (14)

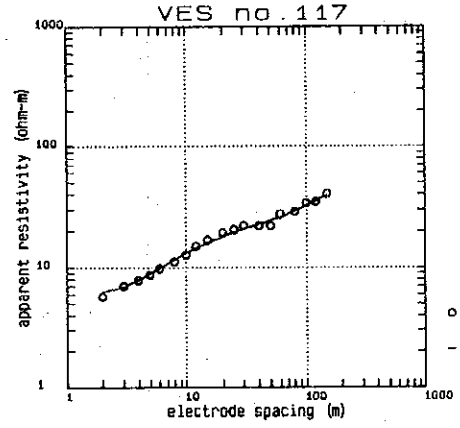
NIPPON KOEI CO., LTD
NIKKO EXPLORATION & DEVELOPMENT CO., LTD

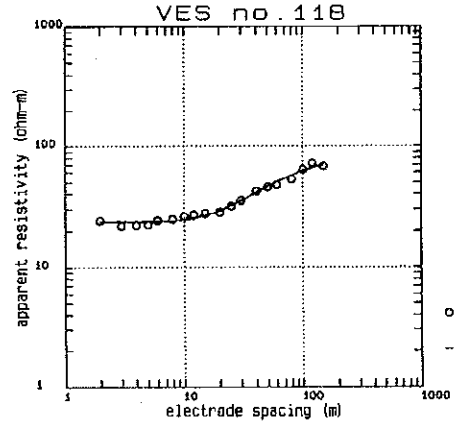


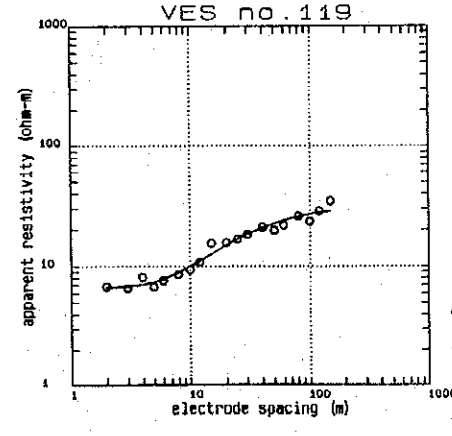


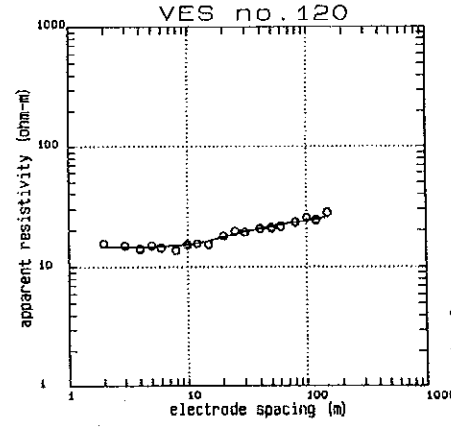










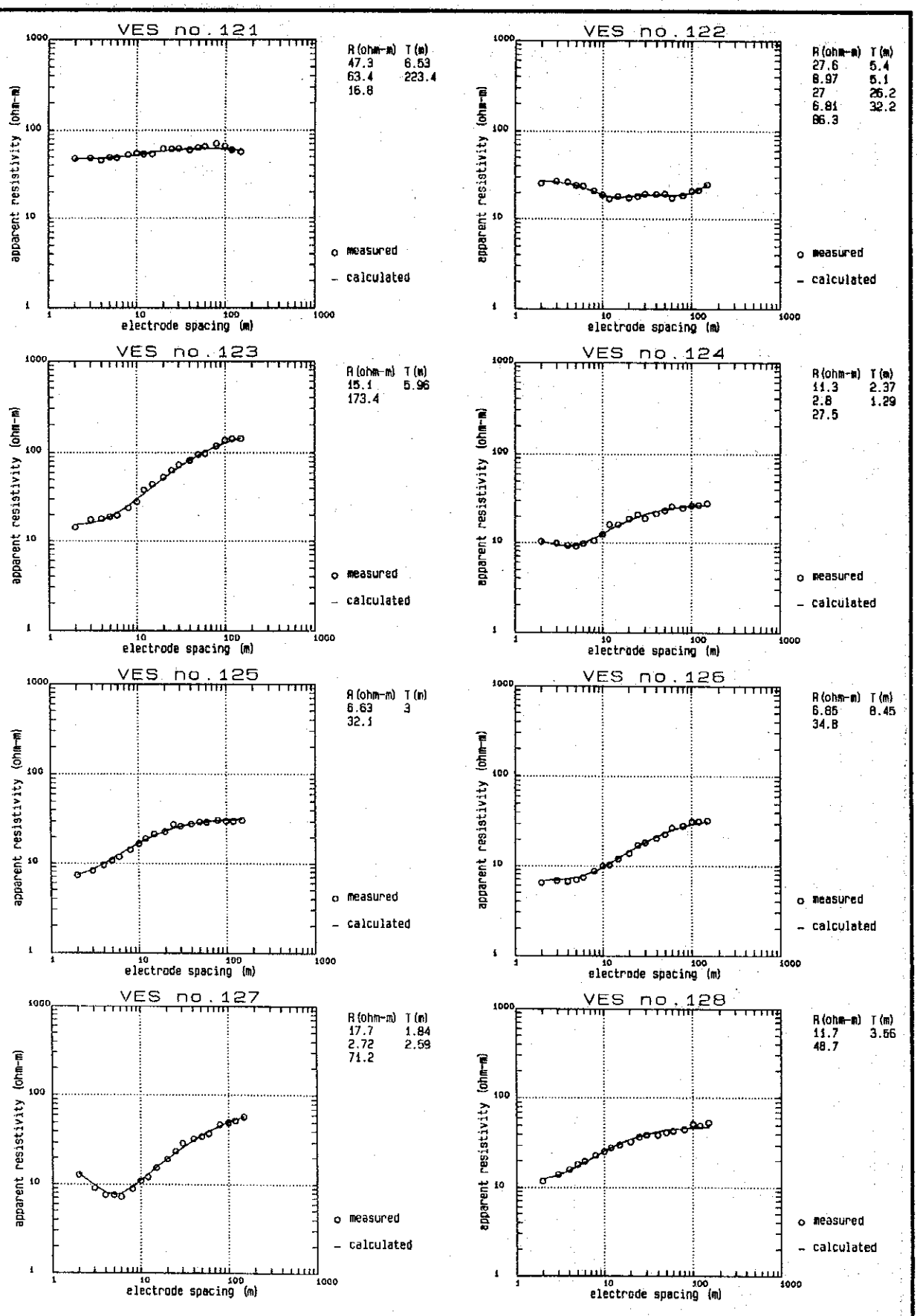


JAPAN INTERNATIONAL COOPERATION AGENCY (JICA)

THE STUDY ON GROUNDWATER DEVELOPMENT IN NORTH VITI LEVU IN THE REPUBLIC OF FIJI

Fig. B-2.5 VERTICAL ELECTRIC SOUNDING CURVES (15)

NIPPON KOEI CO., LTD
NIKKO EXPLORATION & DEVELOPMENT CO., LTD



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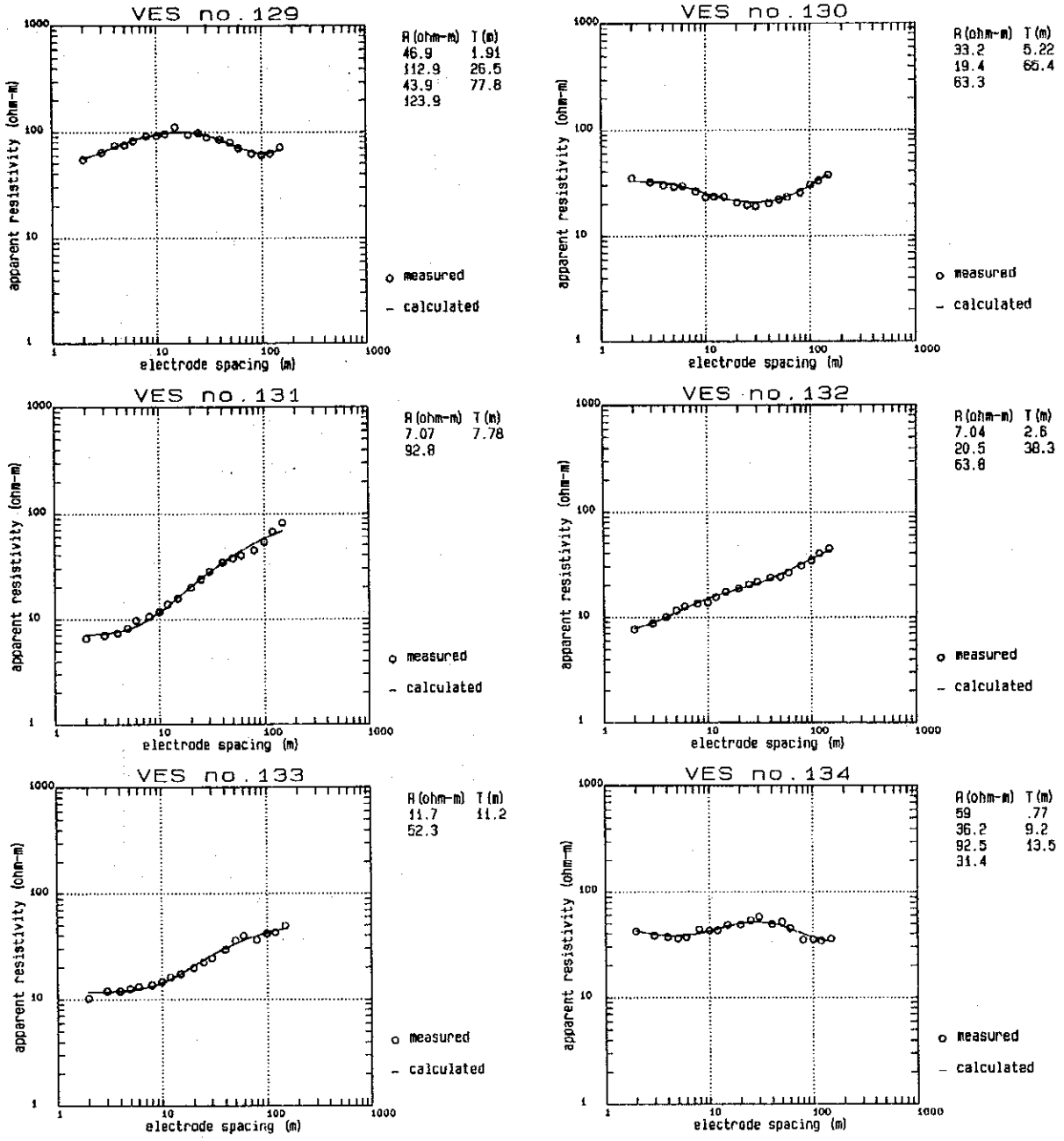
THE STUDY ON GROUNDWATER DEVELOPMENT IN NORTH VITI LEVU IN THE REPUBLIC OF FIJI

Fig. B-2.5 VERTICAL ELECTRIC SOUNDING CURVES (16)

NIPPON KOEI CO., LTD
NIKKO EXPLORATION & DEVELOPMENT CO., LTD

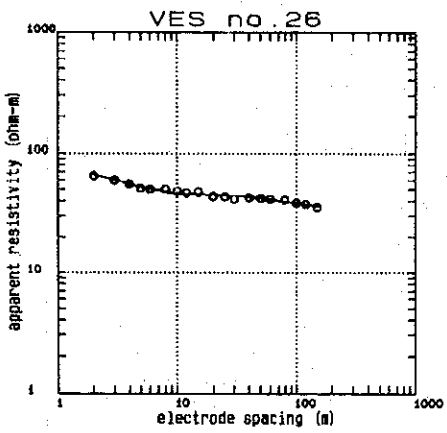


JAPAN INTERNATIONAL COOPERATION AGENCY (JICA)

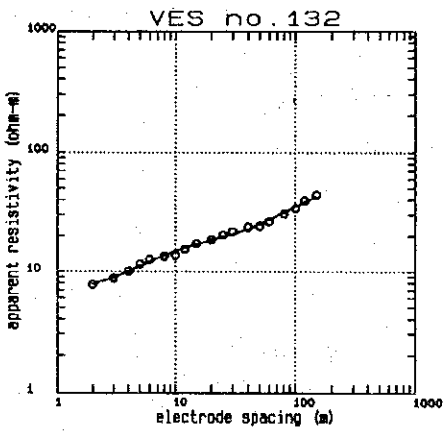
THE STUDY ON GROUNDWATER DEVELOPMENT IN NORTH VITI LEVU IN THE REPUBLIC OF FIJI

Fig. B-2.5 VERTICAL ELECTRIC SOUNDING CURVES (17)

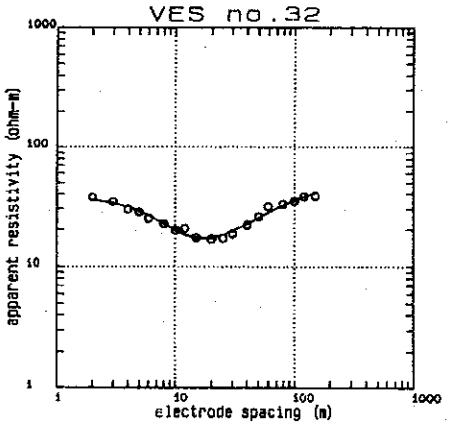
NIPPON KOEI CO., LTD
NIKKO EXPLORATION & DEVELOPMENT CO., LTD



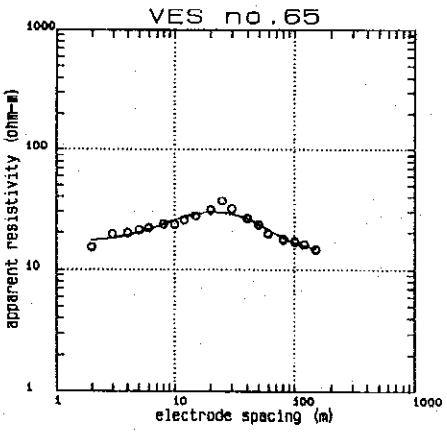
Type A



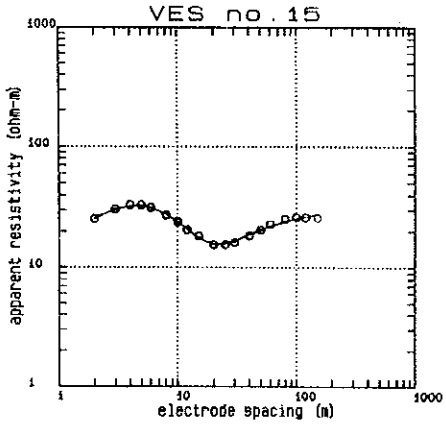
Type B



Type C

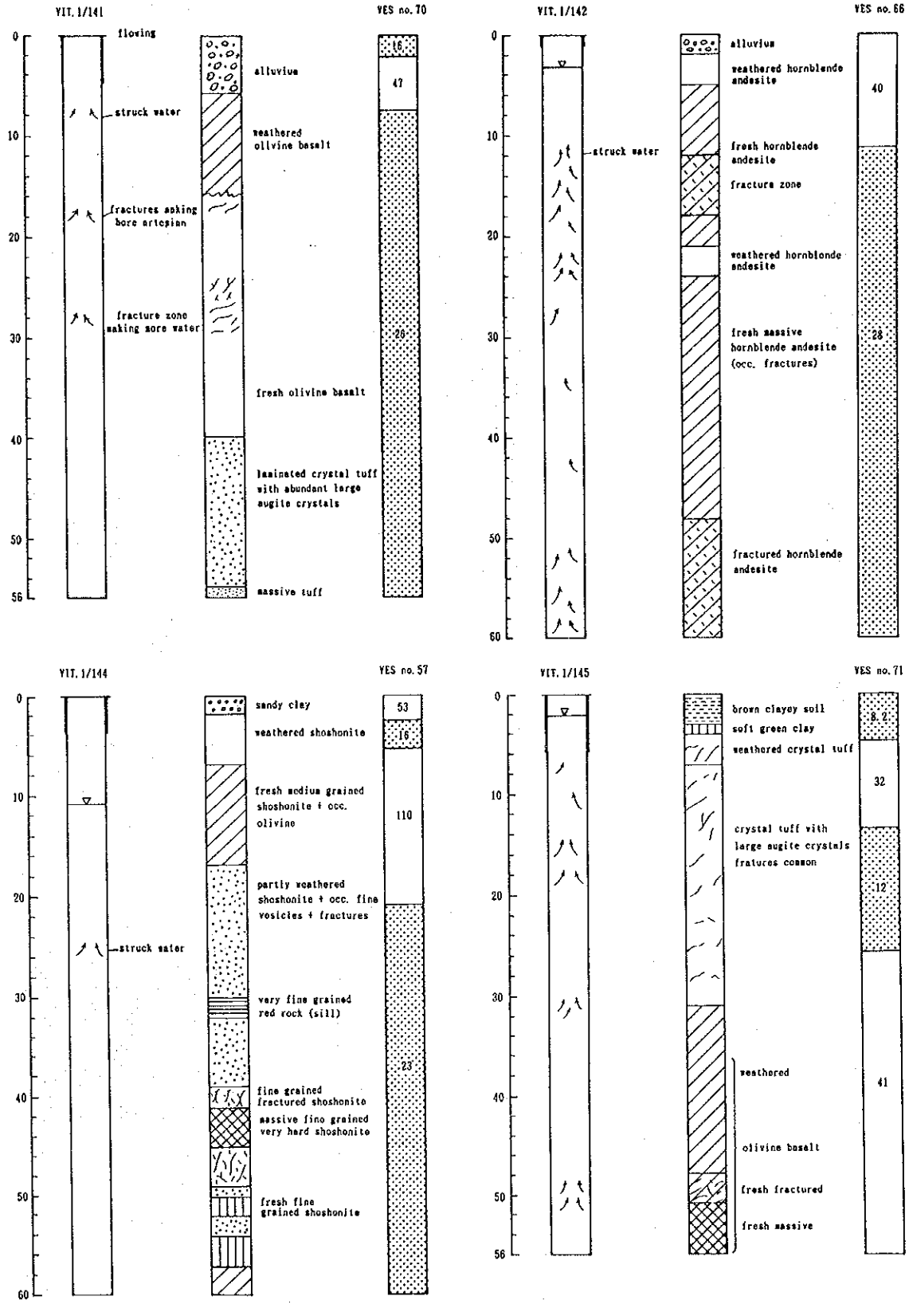


Type D



Type E

JAPAN INTERNATIONAL COOPERATION AGENCY (JICA)	
THE STUDY ON GROUNDWATER DEVELOPMENT IN NORTH VITI LEVU IN THE REPUBLIC OF FIJI	
Fig. B-2.6	TYPICAL VES CURVES
NIPPON KOEI CO., LTD NIKKO EXPLORATION & DEVELOPMENT CO., LTD	



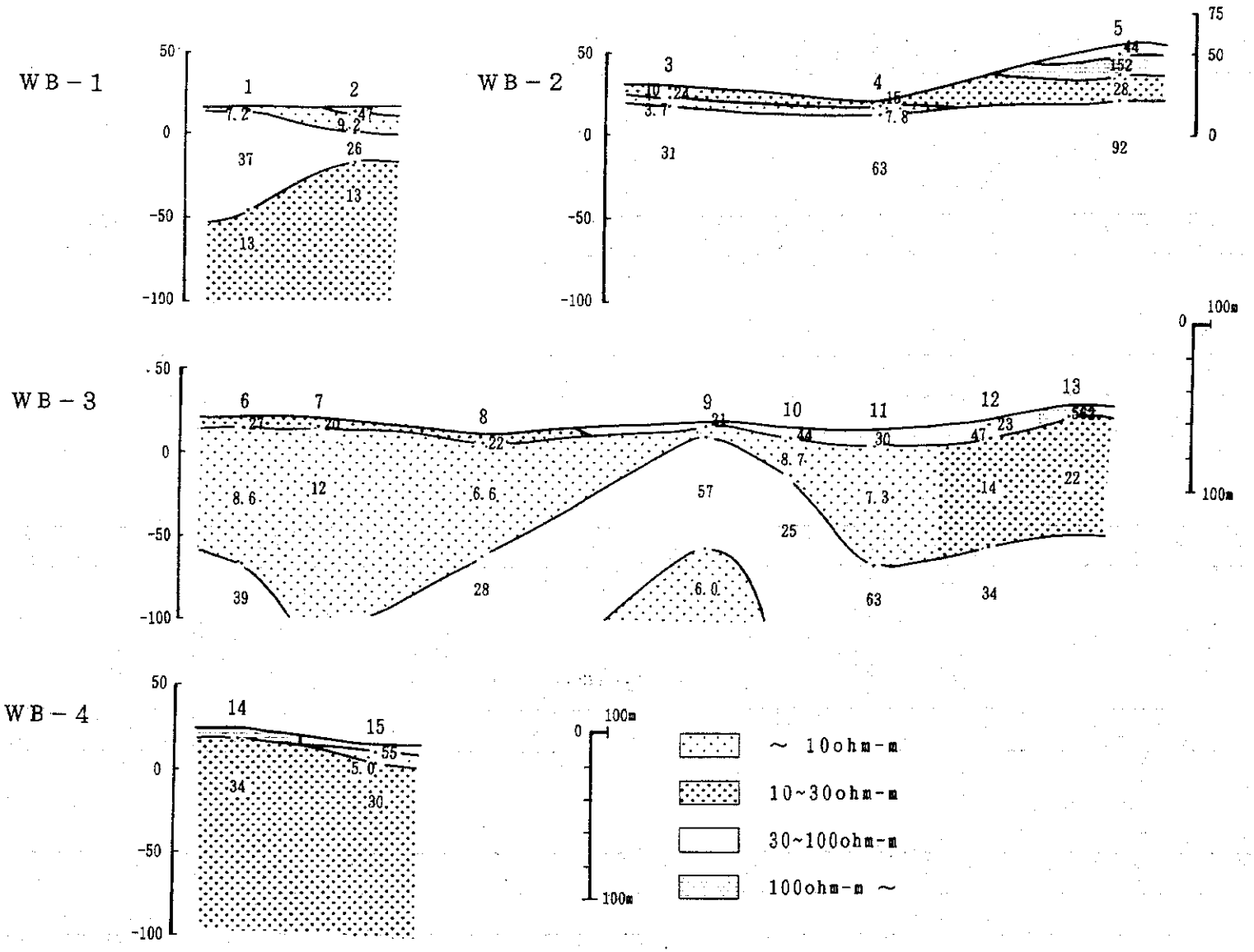
JAPAN INTERNATIONAL COOPERATION AGENCY (JICA)

THE STUDY ON GROUNDWATER DEVELOPMENT IN NORTH VITI LEVU IN THE REPUBLIC OF FIJI

Fig. B-2.7

COMPARISON OF WELL DATA AND RESISTIVITY STRUCTURE DERIVED FROM VES

NIPPON KOEI CO., LTD
NIKKO EXPLORATION & DEVELOPMENT CO., LTD



JAPAN INTERNATIONAL COOPERATION AGENCY (JICA)

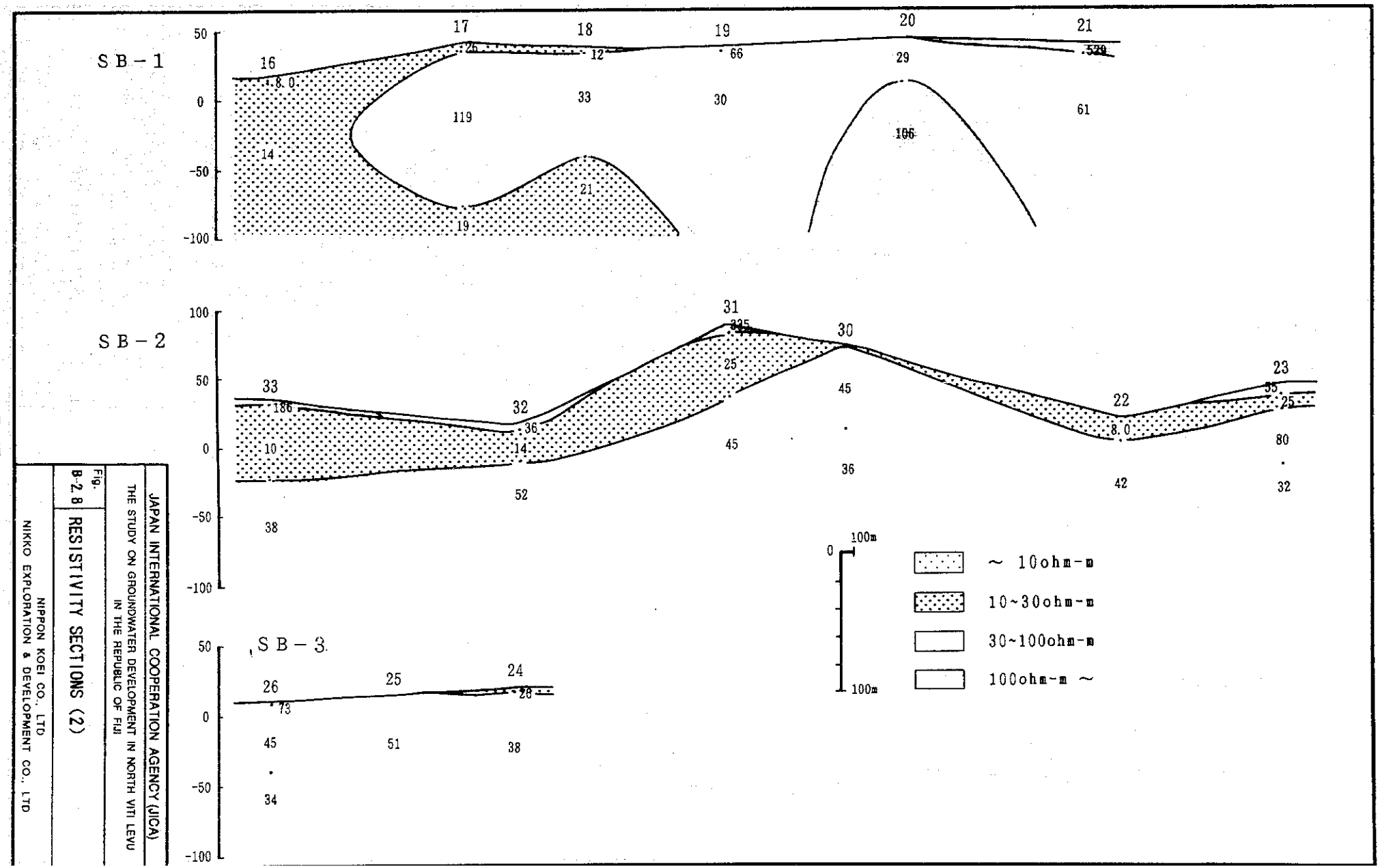
THE STUDY ON GROUNDWATER DEVELOPMENT IN NORTH VITI LEVU IN THE REPUBLIC OF FIJI

Fig. B-2.8

RESISTIVITY SECTIONS (1)

NIPPON KOEI CO., LTD

NIKKO EXPLORATION & DEVELOPMENT CO., LTD



JAPAN INTERNATIONAL COOPERATION AGENCY (JICA)

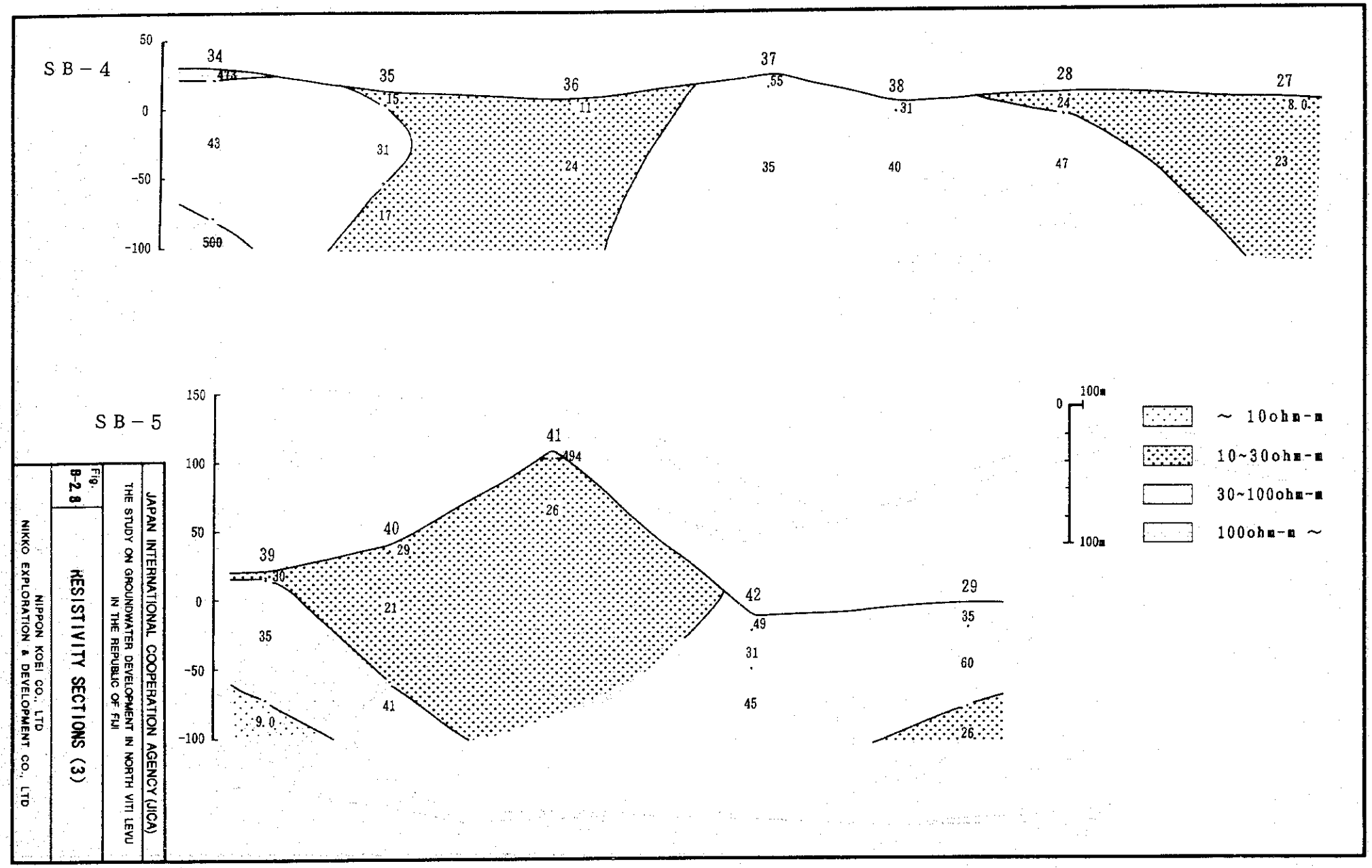
THE STUDY ON GROUNDWATER DEVELOPMENT IN NORTH VITI LEVU IN THE REPUBLIC OF FIJI

Fig. B-2.8

RESISTIVITY SECTIONS (2)

NIPPON KOEI CO., LTD

NIKKO EXPLORATION & DEVELOPMENT CO., LTD



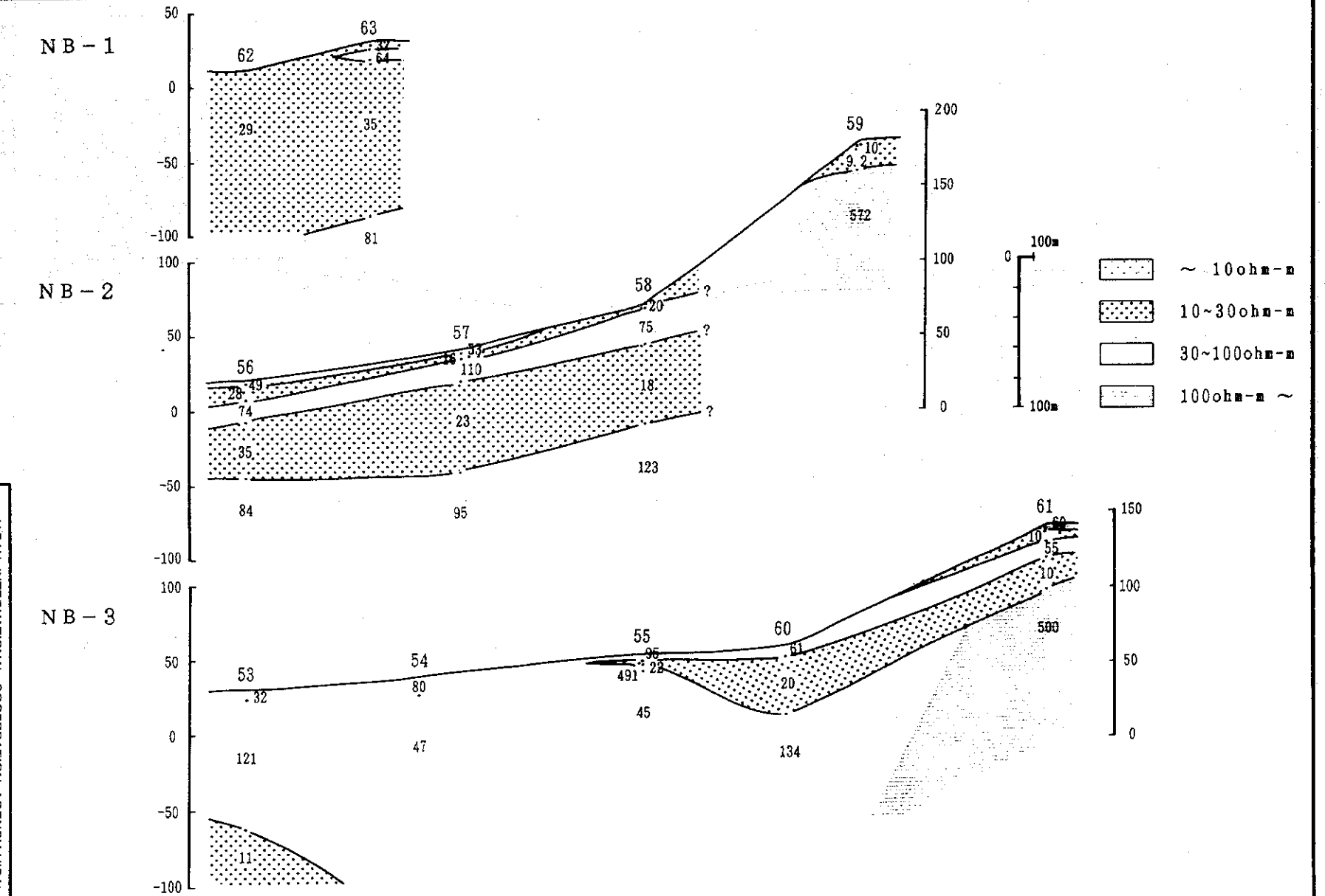
JAPAN INTERNATIONAL COOPERATION AGENCY (JICA)

THE STUDY ON GROUNDWATER DEVELOPMENT IN NORTH VITI LEVU IN THE REPUBLIC OF FIJI

Fig. 8-2.8

RESISTIVITY SECTIONS (3)

NIPPON KOEI CO., LTD
NIKKO EXPLORATION & DEVELOPMENT CO., LTD



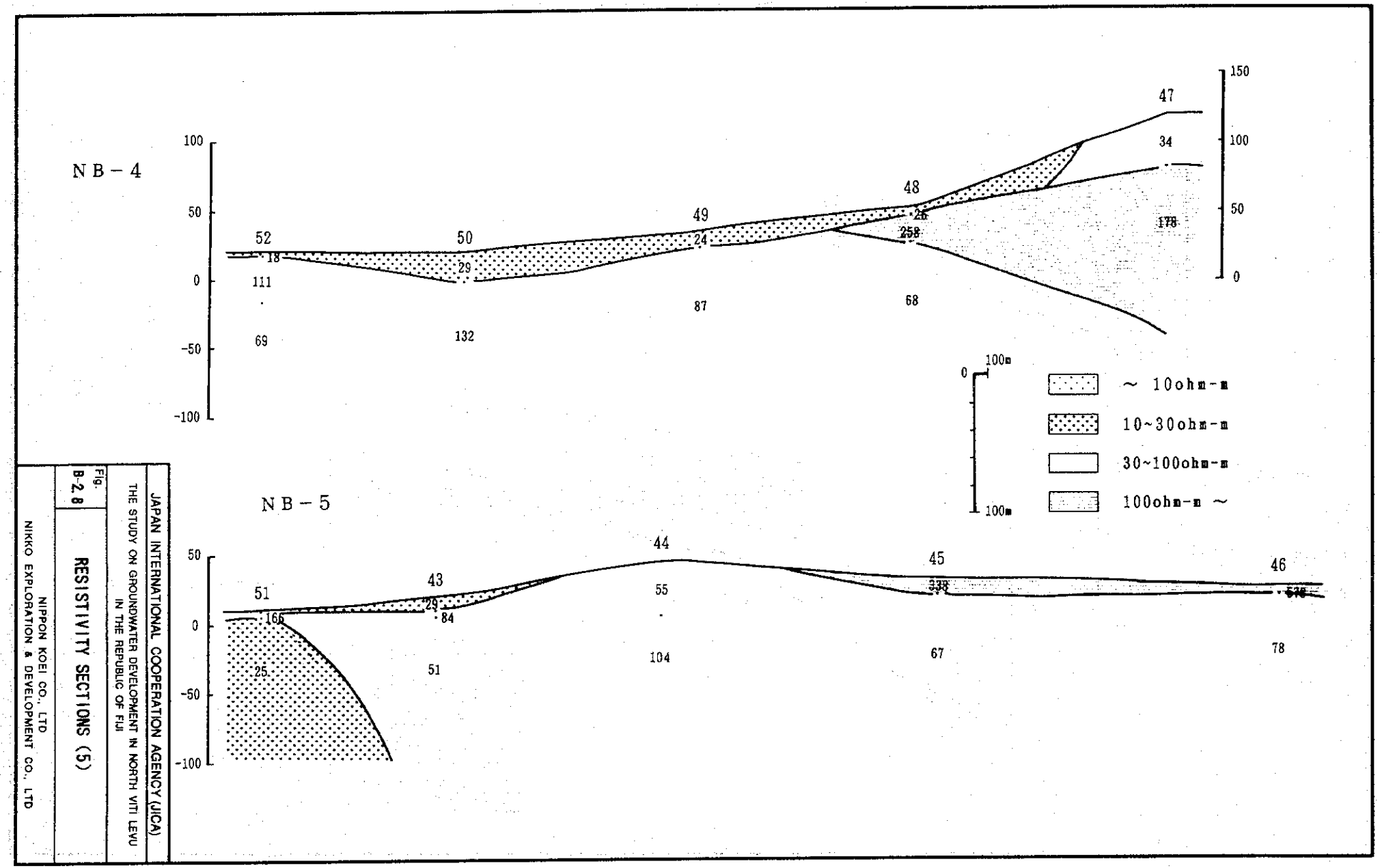
JAPAN INTERNATIONAL COOPERATION AGENCY (JICA)

THE STUDY ON GROUNDWATER DEVELOPMENT IN NORTH VITI LEVU IN THE REPUBLIC OF FIJI

Fig. B-2.8

RESISTIVITY SECTIONS (4)

NIPPON KOEI CO., LTD
NIKKO EXPLORATION & DEVELOPMENT CO., LTD



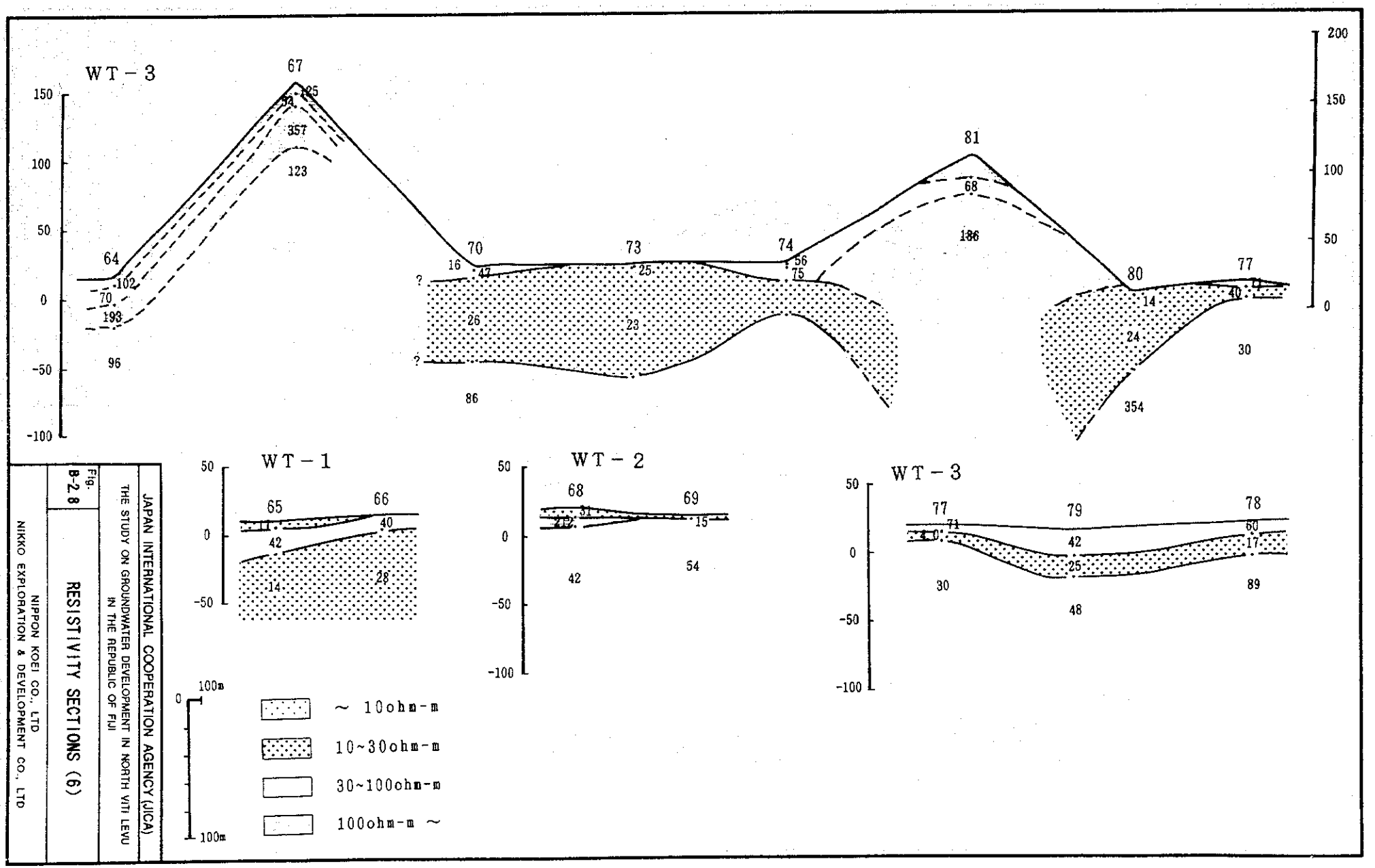
JAPAN INTERNATIONAL COOPERATION AGENCY (JICA)

THE STUDY ON GROUNDWATER DEVELOPMENT IN NORTH VITI LEVU IN THE REPUBLIC OF FIJI

Fig. B-2.8

RESISTIVITY SECTIONS (5)

NIPPON KOEI CO., LTD
NIKKO EXPLORATION & DEVELOPMENT CO., LTD



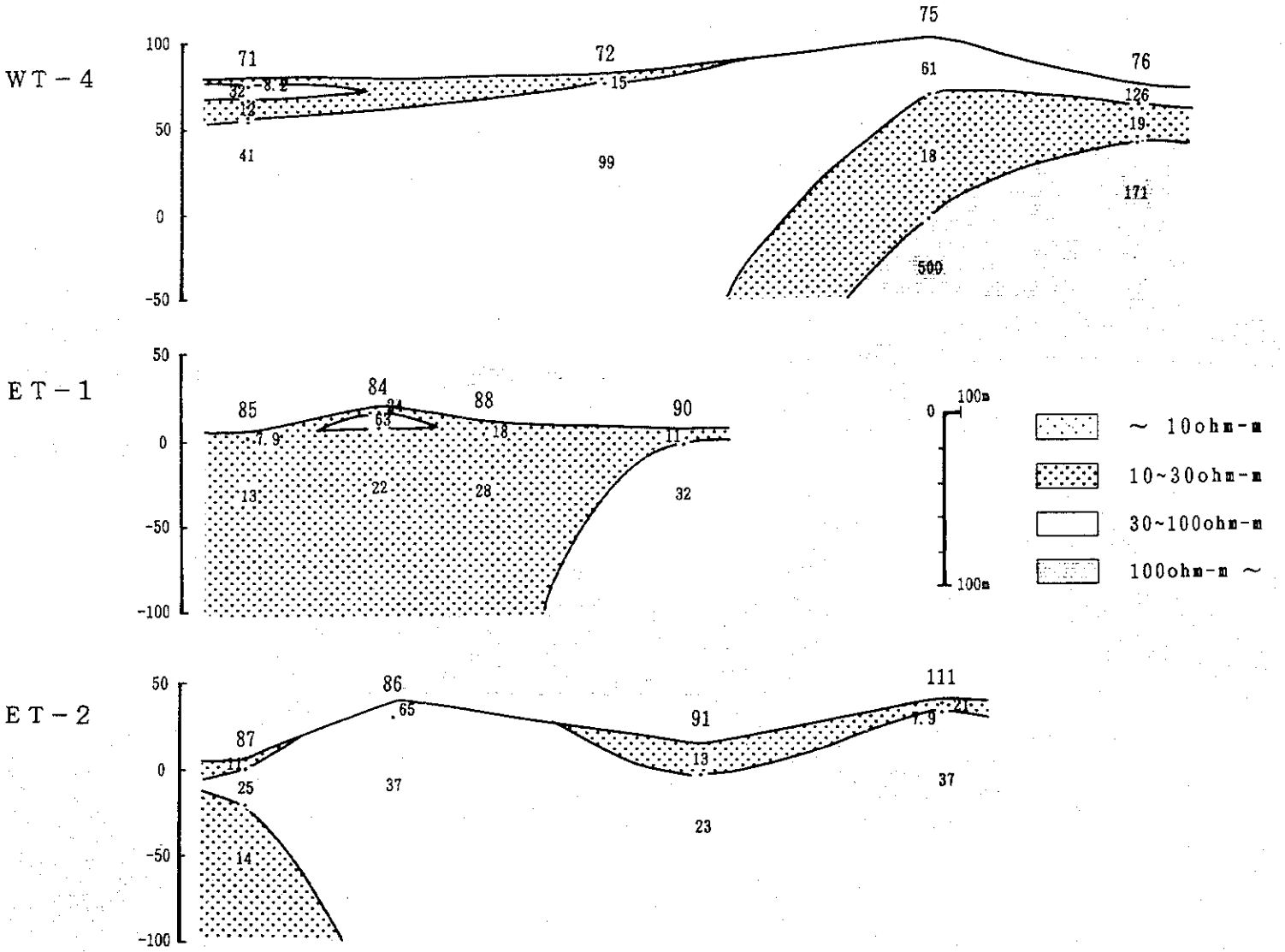
JAPAN INTERNATIONAL COOPERATION AGENCY (JICA)

THE STUDY ON GROUNDWATER DEVELOPMENT IN NORTH VITI LEVU IN THE REPUBLIC OF FIJI

Fig. B-2.8

RESISTIVITY SECTIONS (6)

NIPPON KOEI CO., LTD
NIKKO EXPLORATION & DEVELOPMENT CO., LTD



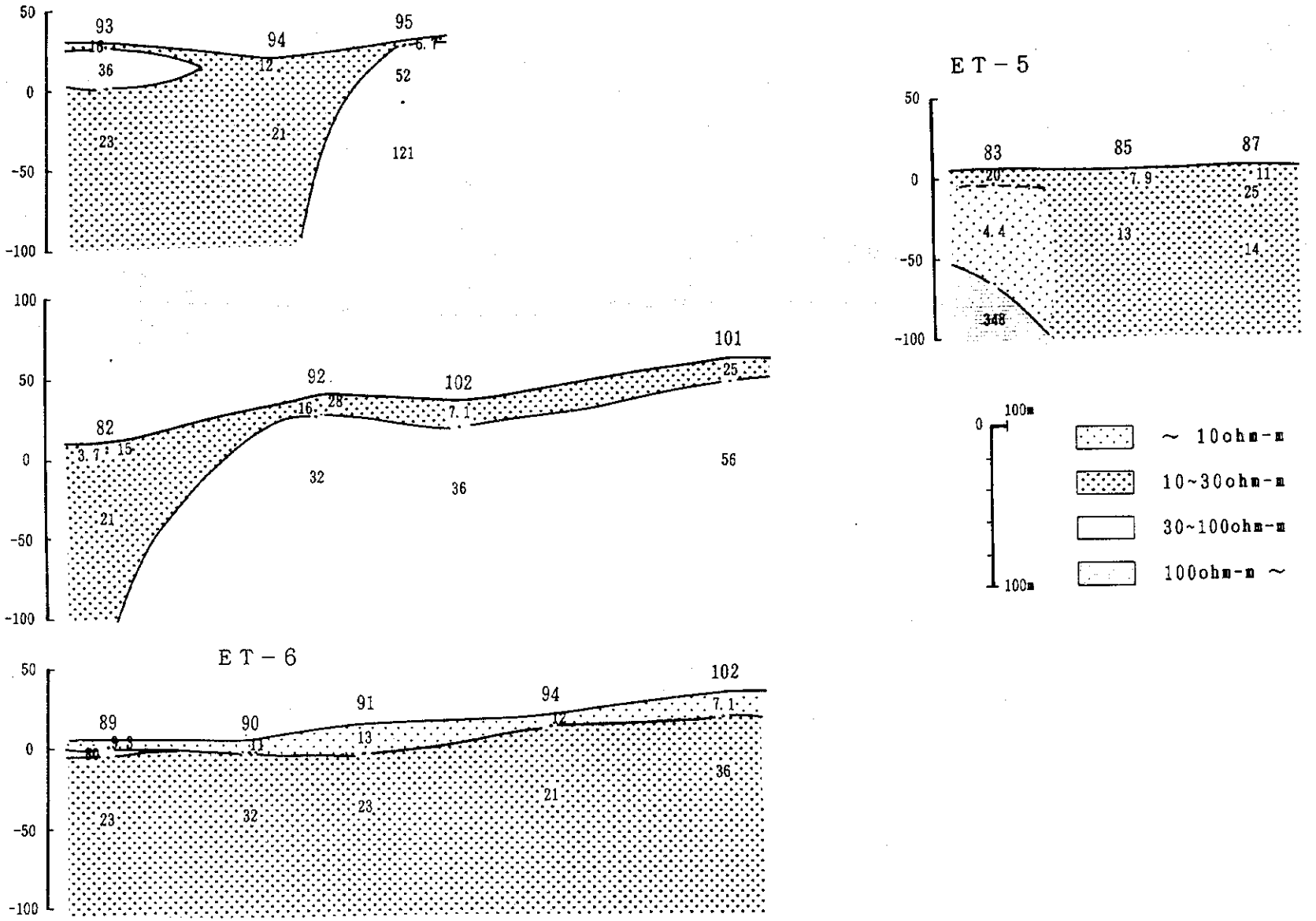
JAPAN INTERNATIONAL COOPERATION AGENCY (JICA)

THE STUDY ON GROUNDWATER DEVELOPMENT IN NORTH VITI LEVU IN THE REPUBLIC OF FIJI

Fig. 8-2.8

RESISTIVITY SECTIONS (7)

NIPPON KOEI CO., LTD
NIKKO EXPLORATION & DEVELOPMENT CO., LTD



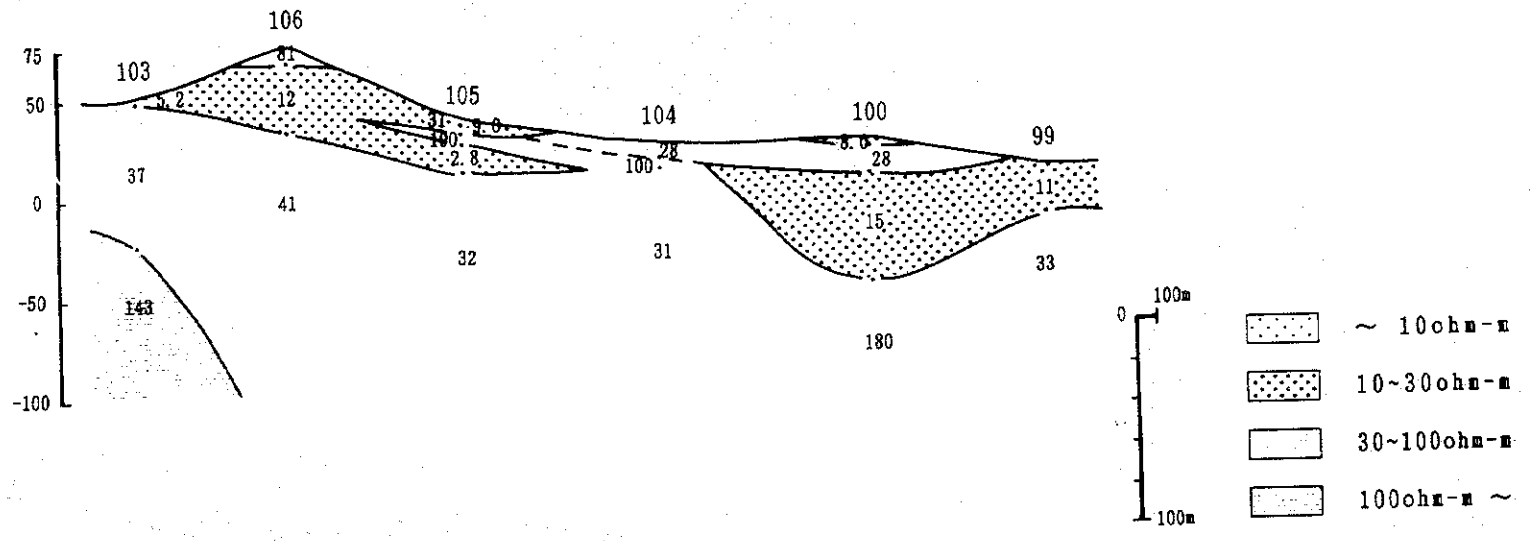
JAPAN INTERNATIONAL COOPERATION AGENCY (JICA)

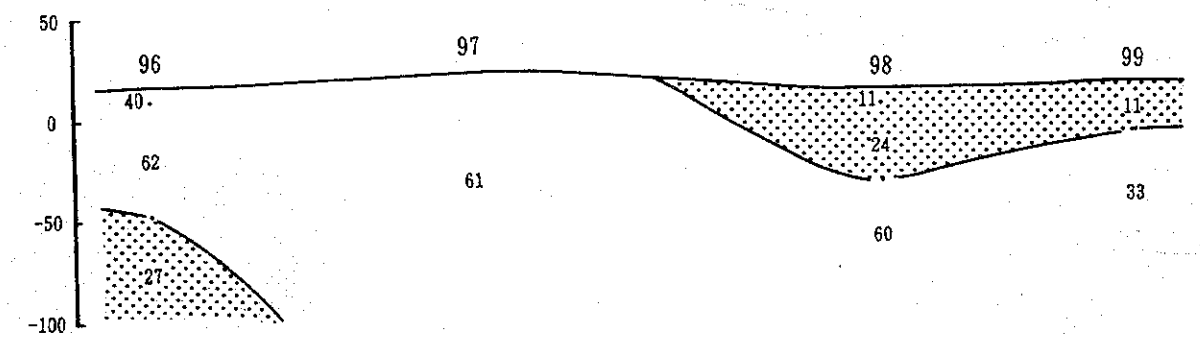
THE STUDY ON GROUNDWATER DEVELOPMENT IN NORTH VITI LEVU IN THE REPUBLIC OF FIJI

Fig. B-2 8

RESISTIVITY SECTIONS (8)

NIPPON KOEI CO., LTD
NIKKO EXPLORATION & DEVELOPMENT CO., LTD





JAPAN INTERNATIONAL COOPERATION AGENCY (JICA)

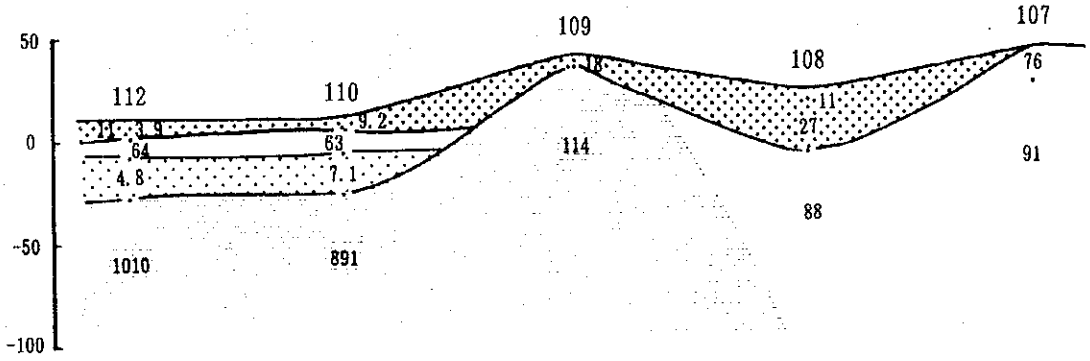
THE STUDY ON GROUNDWATER DEVELOPMENT IN NORTH VITI LEVU IN THE REPUBLIC OF FIJI

Fig. B-2.8

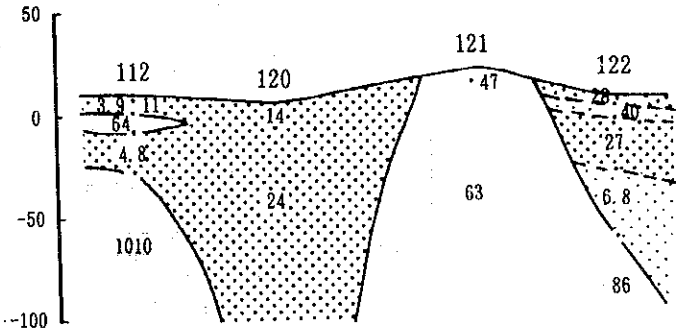
RESISTIVITY SECTIONS (9)

NIPPON KOEI CO., LTD
NIKKO EXPLORATION & DEVELOPMENT CO., LTD

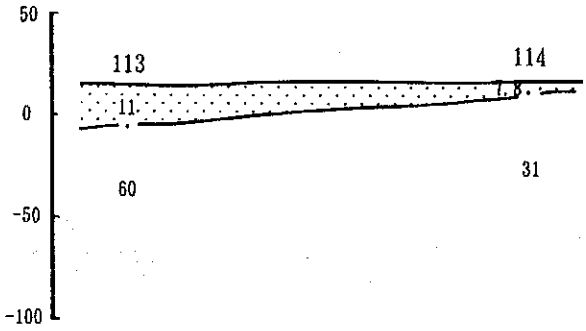
YA－1

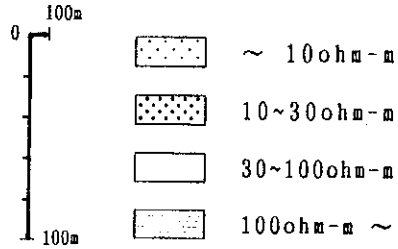


YA－2

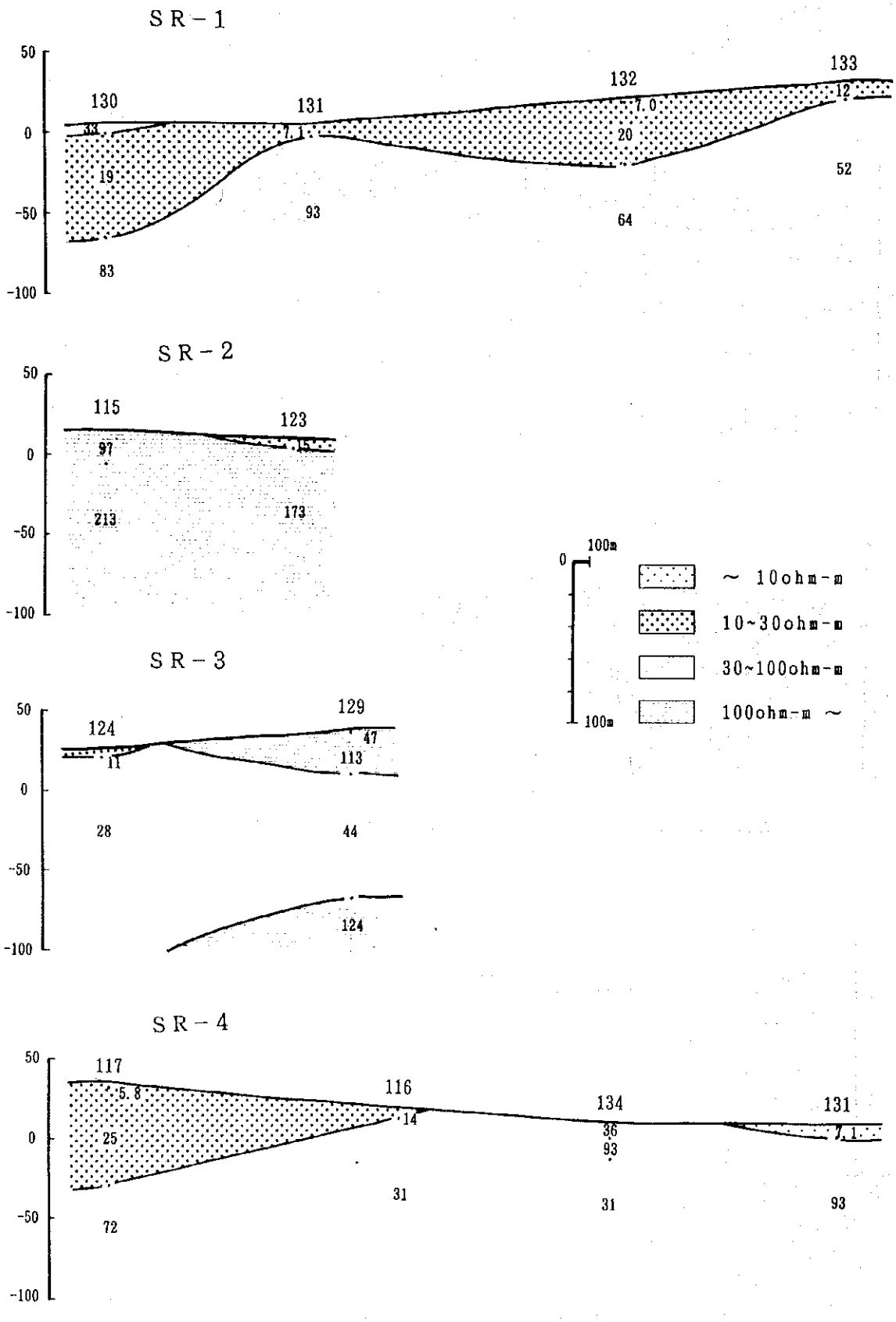


WR－1

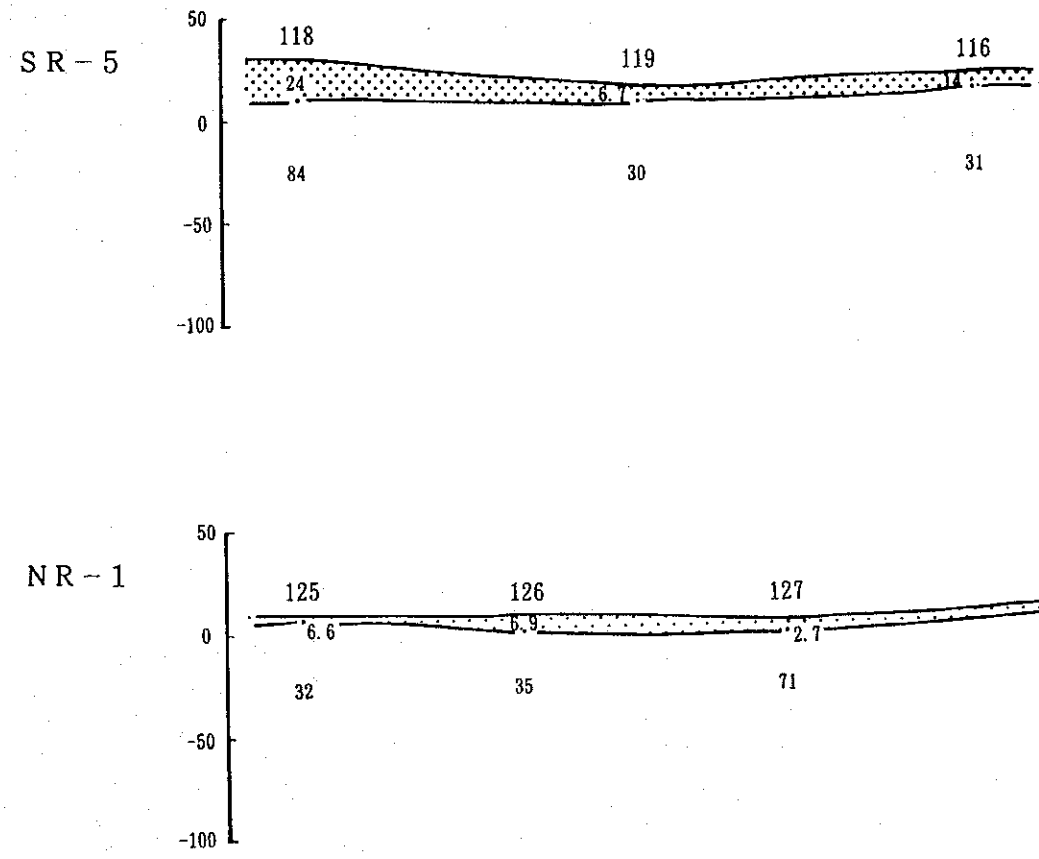




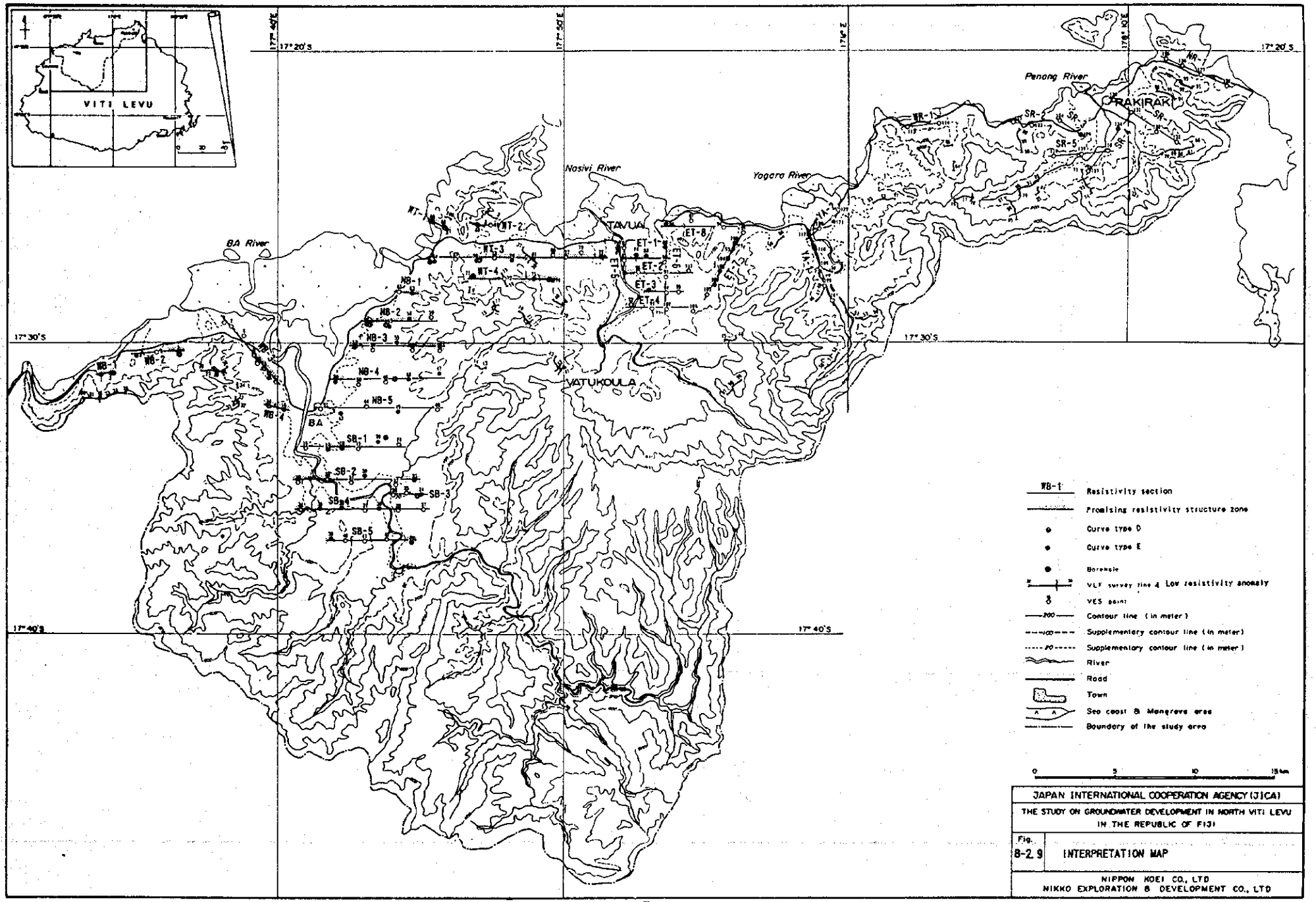
JAPAN INTERNATIONAL COOPERATION AGENCY (JICA)	
THE STUDY ON GROUNDWATER DEVELOPMENT IN NORTH VITI LEVU IN THE REPUBLIC OF FIJI	
Fig. B-2.8	RESISTIVITY SECTIONS (10)
NIPPON KOEI CO., LTD NIKKO EXPLORATION & DEVELOPMENT CO., LTD	

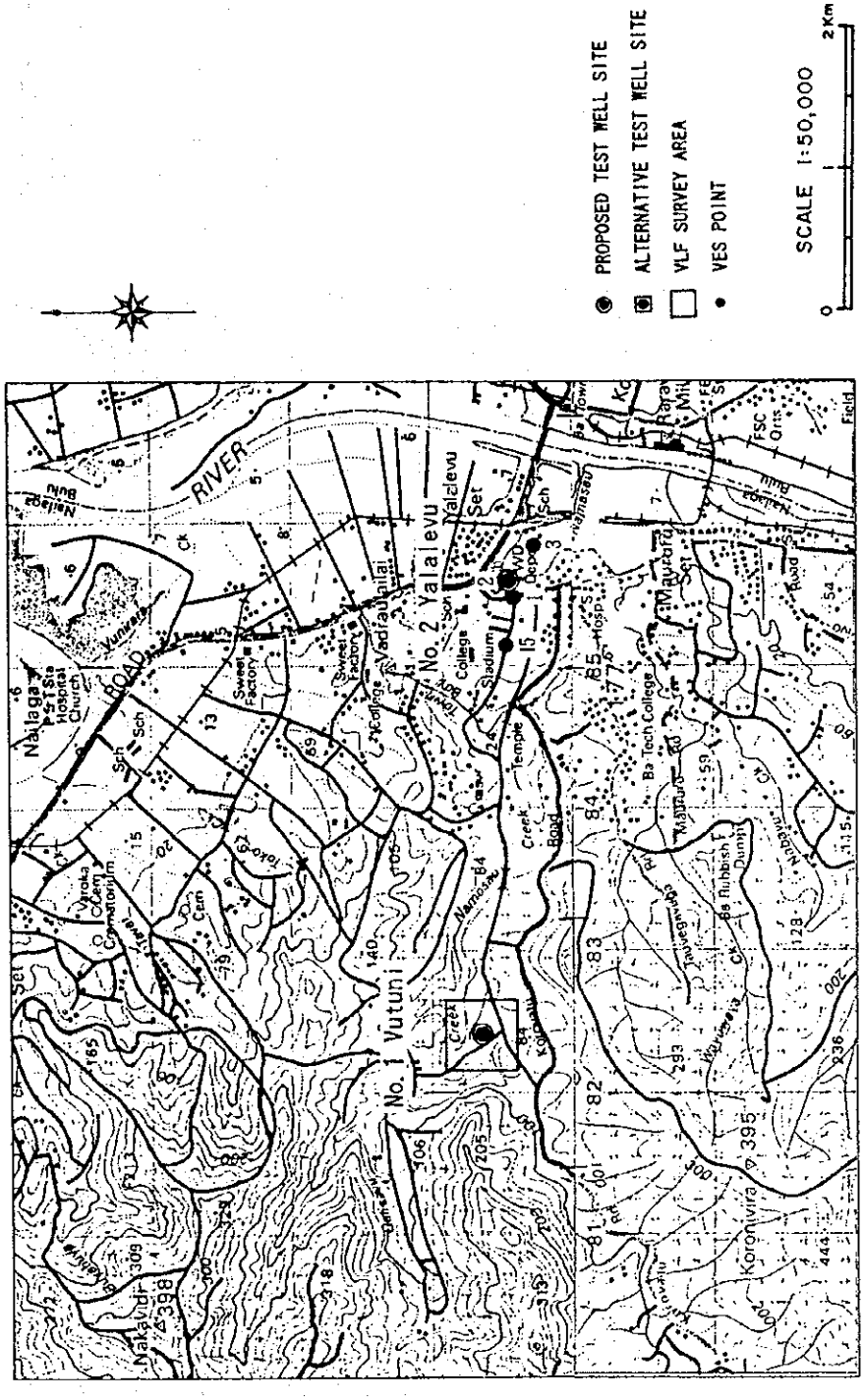


JAPAN INTERNATIONAL COOPERATION AGENCY (JICA)	
THE STUDY ON GROUNDWATER DEVELOPMENT IN NORTH VITI LEVU IN THE REPUBLIC OF FIJI	
Fig. B-2.8	RESISTIVITY SECTIONS (11)
NIPPON KOEI CO., LTD NIKKO EXPLORATION & DEVELOPMENT CO., LTD	



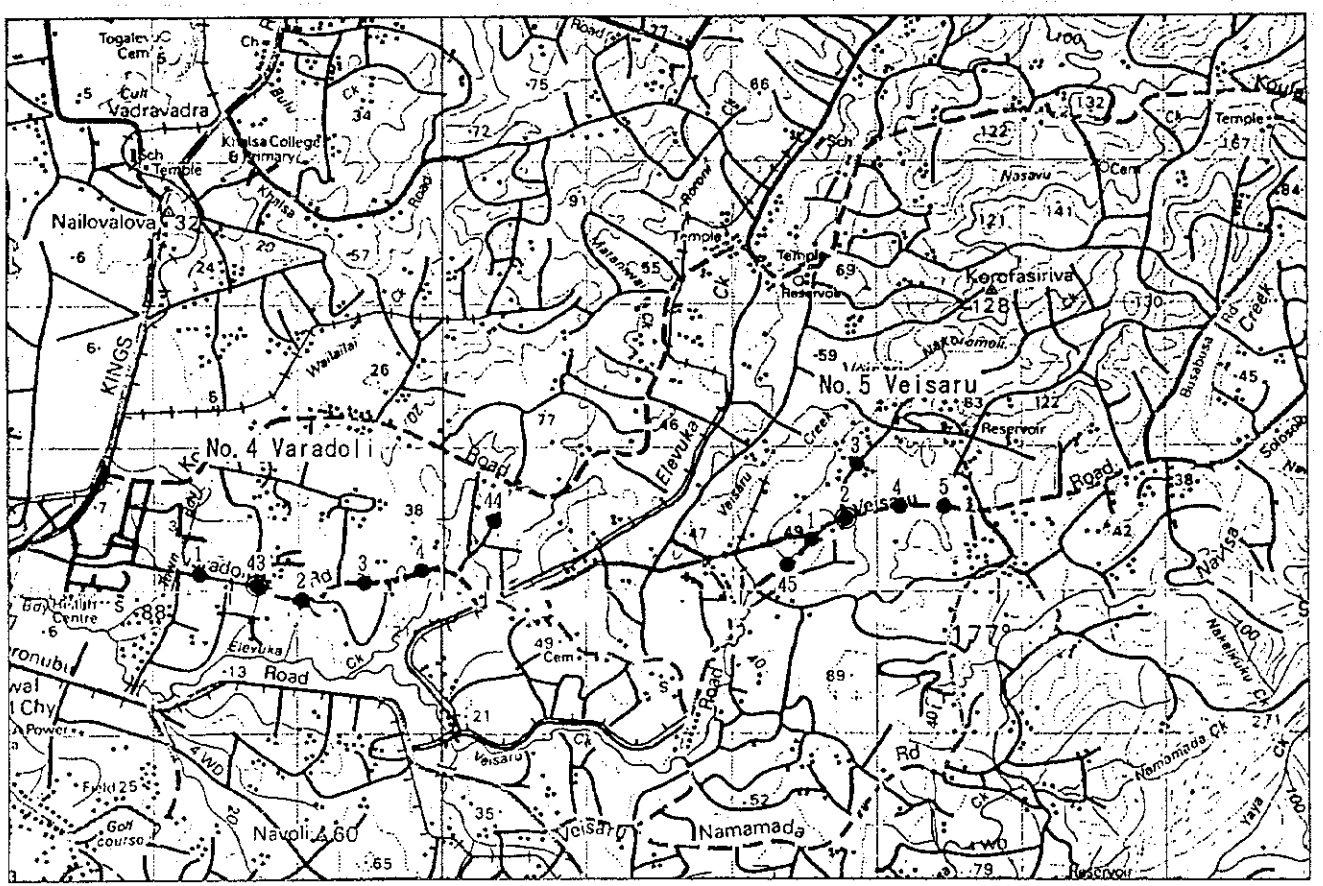
JAPAN INTERNATIONAL COOPERATION AGENCY (JICA)	
THE STUDY ON GROUNDWATER DEVELOPMENT IN NORTH VITI LEVU IN THE REPUBLIC OF FIJI	
Fig. B-2.8	RESISTIVITY SECTIONS (12)
NIPPON KOEI CO., LTD NIKKO EXPLORATION & DEVELOPMENT CO., LTD	


VITI LEVU
17°20'S
17°30'S
17°40'S
177° 45'E
177° 50'E
178° E
178° 10'E
Nosivi River
Yogara River
Penang River
BA River
TAVUA
VATUKOULA
BA
NAKIRAKI
WT-1
WT-2
WT-3
WT-4
ET-1
ET-2
ET-3
ET-4
ET-5
ET-6
ET-7
ET-8
NB-1
NB-2
NB-3
NB-4
NB-5
SB-1
SB-2
SB-3
SB-4
SB-5
WB-1
WB-2
WB-3
WB-4
NR-1
SR-1
SR-2
SR-3
SR-4
SR-5
WB-1 Resistivity section
Promising resistivity structure zone
Curve type D
Curve type E
Borehole
VLF survey line & Low resistivity anomaly
VES point
200 Contour line (in meter)
100 Supplementary contour line (in meter)
20 Supplementary contour line (in meter)
River
Road
Town
Sea coast & Mangrove area
Boundary of the study area
0 5 10 15km
JAPAN INTERNATIONAL COOPERATION AGENCY (JICA)
THE STUDY ON GROUNDWATER DEVELOPMENT IN NORTH VITI LEVU IN THE REPUBLIC OF FIJI
Fig. 8-2.9
INTERPRETATION MAP
NIPPON KOEI CO., LTD
NIKKO EXPLORATION & DEVELOPMENT CO., LTD



JAPAN INTERNATIONAL COOPERATION AGENCY (JICA)	
THE STUDY ON GROUNDWATER DEVELOPMENT IN NORTH VITI LEVU IN THE REPUBLIC OF FIJI	
Fig. B-3.1	LOCATION MAP OF PROPOSED SITES FOR TEST WELLS (1)
NIPPON KOEI CO., LTD NIKKO EXPLORATION & DEVELOPMENT CO., LTD	

JAPAN INTERNATIONAL COOPERATION AGENCY (JICA)	
THE STUDY ON GROUNDWATER DEVELOPMENT IN NORTH VITI LEVU IN THE REPUBLIC OF FIJI	
Fig. B-3.1	LOCATION MAP OF PROPOSED SITES FOR TEST WELLS (2)
NIPPON KOEI CO., LTD NIKKO EXPLORATION & DEVELOPMENT CO., LTD	



JAPAN INTERNATIONAL COOPERATION AGENCY (JICA)

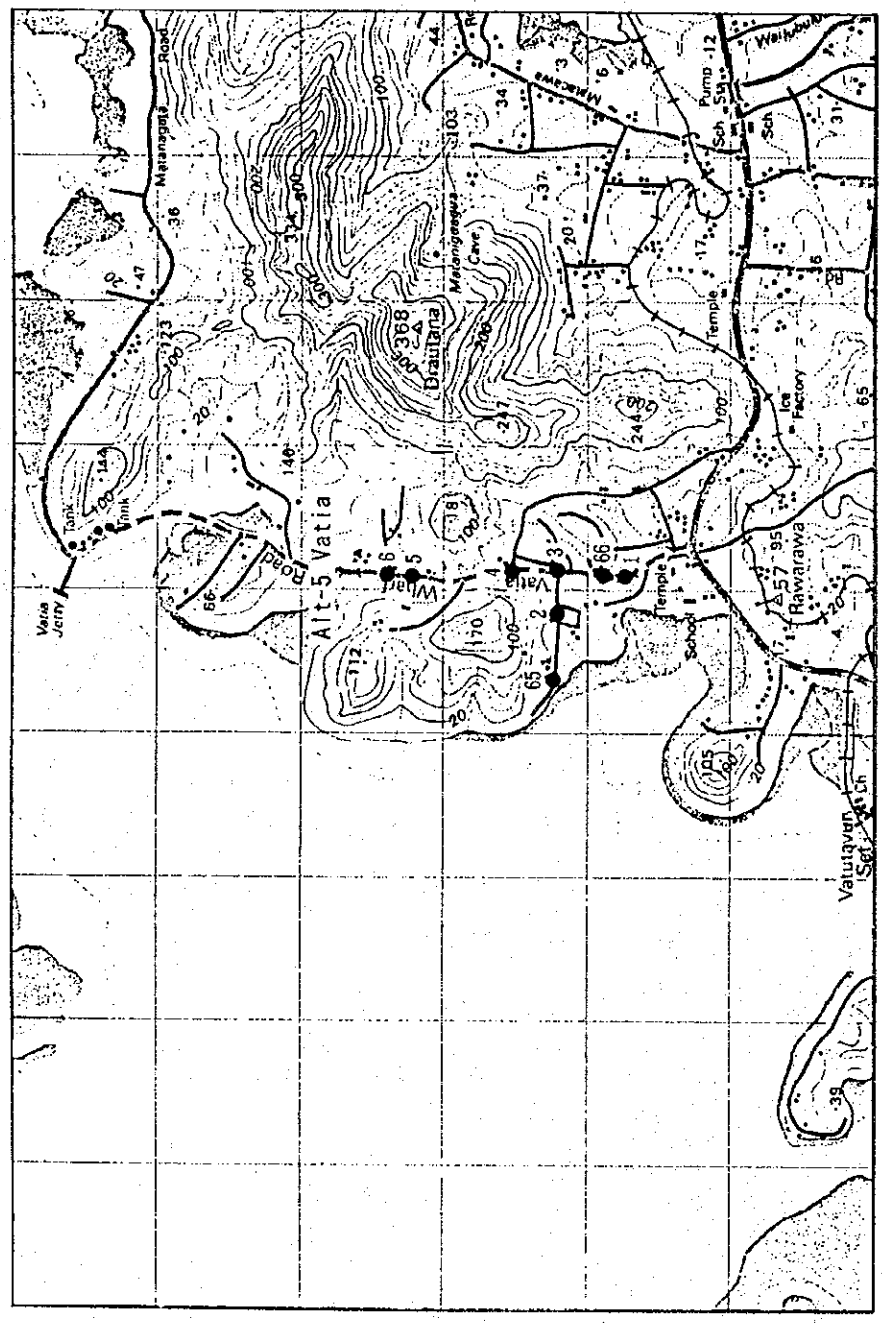
THE STUDY ON GROUNDWATER DEVELOPMENT IN NORTH VITI LEVU IN THE REPUBLIC OF FIJI

Fig. B-3.1

LOCATION MAP OF PROPOSED SITES FOR TEST WELLS (3)

NIPPON KOEI CO., LTD

NIKKO EXPLORATION & DEVELOPMENT CO., LTD



JAPAN INTERNATIONAL COOPERATION AGENCY (JICA)	
THE STUDY ON GROUNDWATER DEVELOPMENT IN NORTH VITI LEVU IN THE REPUBLIC OF FIJI	
Fig. B-3.1	LOCATION MAP OF PROPOSED SITES FOR TEST WELLS (4)
NIPPON KOEI CO., LTD NIKKO EXPLORATION & DEVELOPMENT CO., LTD	

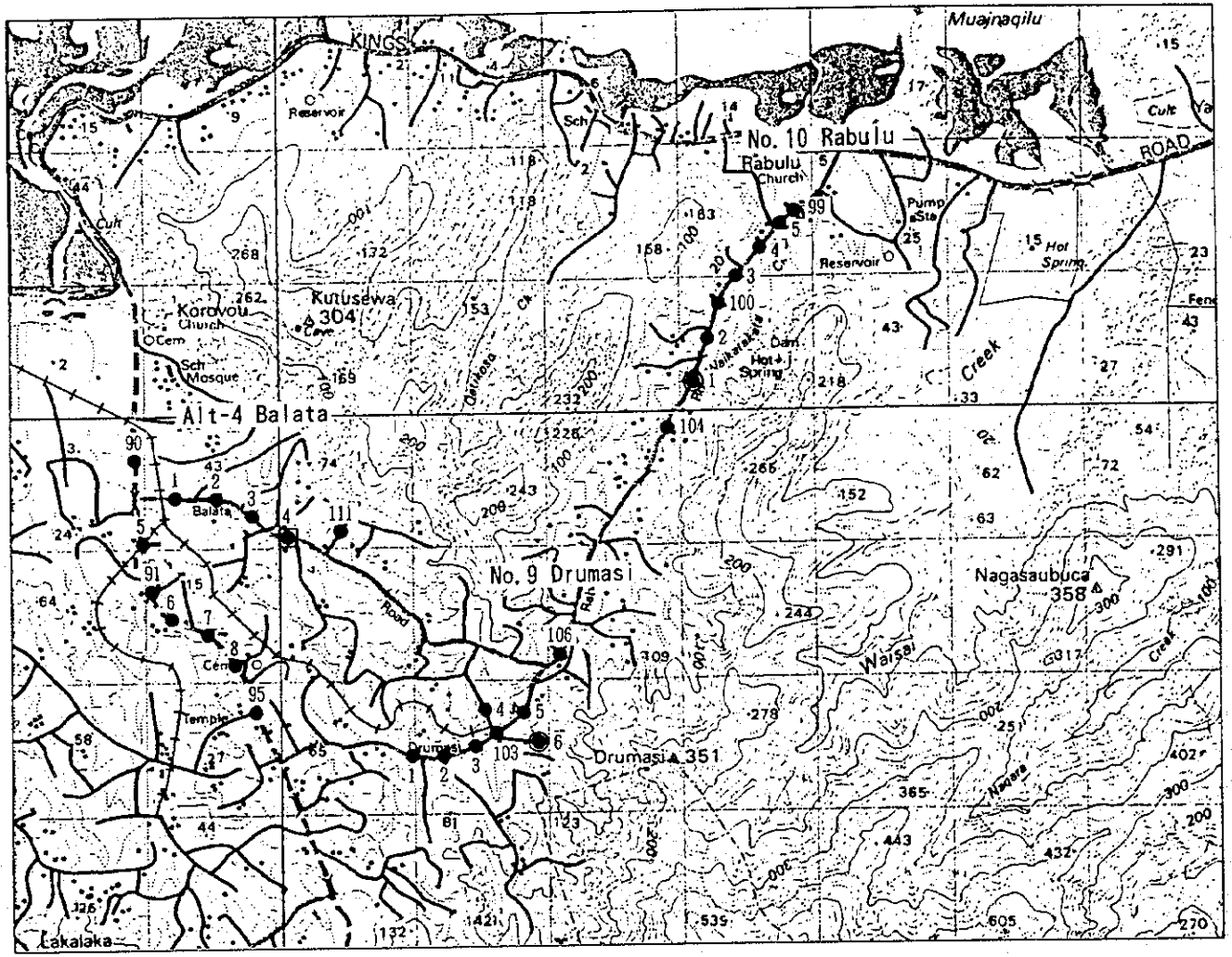
JAPAN INTERNATIONAL COOPERATION AGENCY (JICA)

THE STUDY ON GROUNDWATER DEVELOPMENT IN NORTH VITI LEVU IN THE REPUBLIC OF FIJI

Fig. B-3.1

LOCATION MAP OF PROPOSED SITES FOR TEST WELLS (5)

NIPPON KOEI CO., LTD
NIKKO EXPLORATION & DEVELOPMENT CO., LTD



PROPOSED TEST WELL SITE

ALTERNATIVE TEST WELL SITE

VLF SURVEY AREA

VES POINT

SCALE 1:50,000

0 1 2Km

JAPAN INTERNATIONAL COOPERATION AGENCY (JICA)

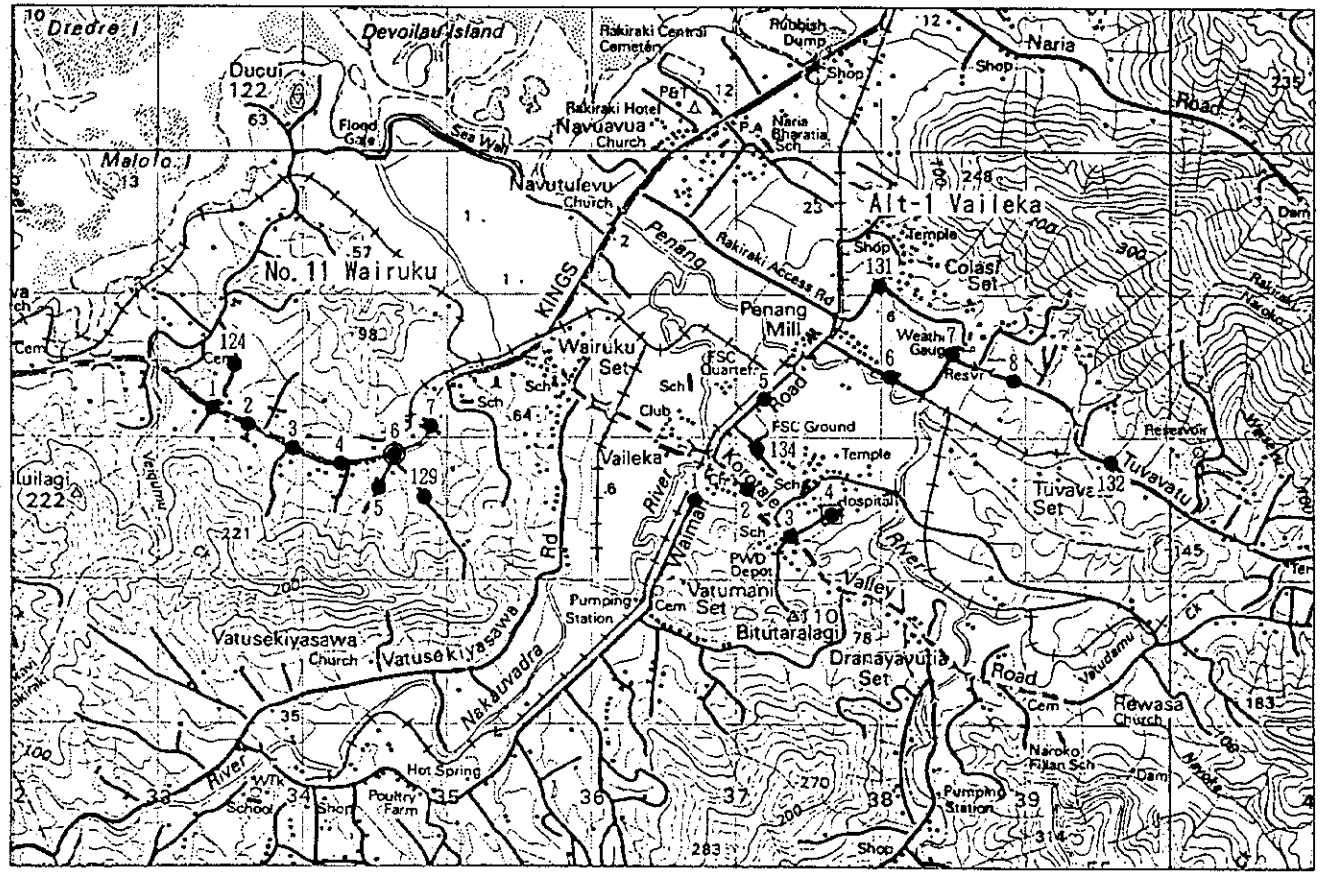
THE STUDY ON GROUNDWATER DEVELOPMENT IN NORTH VITI LEVU IN THE REPUBLIC OF FIJI

Fig. B-3.1

LOCATION MAP OF PROPOSED SITES FOR TEST WELLS (6)

NIPPON KOEI CO., LTD

NIKKO EXPLORATION & DEVELOPMENT CO., LTD



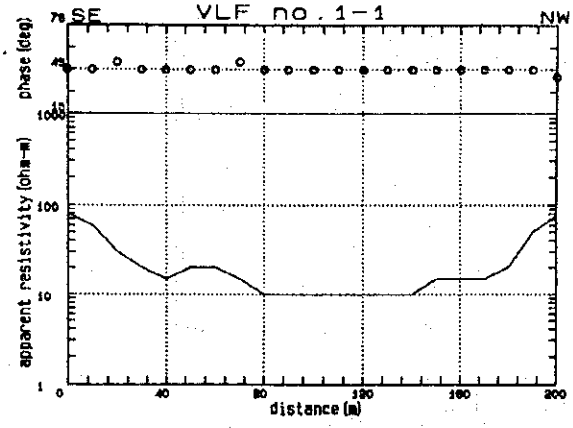
JAPAN INTERNATIONAL COOPERATION AGENCY (JICA)

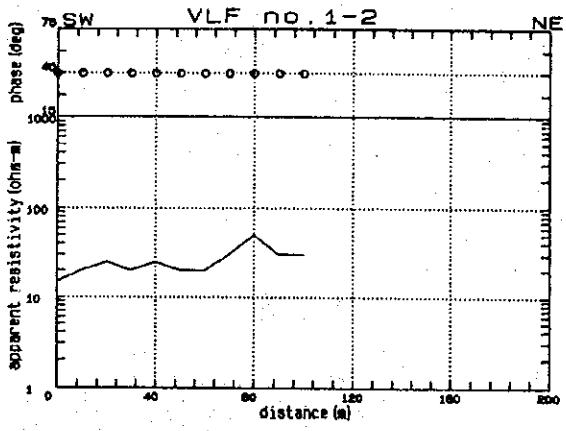
THE STUDY ON GROUNDWATER DEVELOPMENT IN NORTH VITI LEVU IN THE REPUBLIC OF FIJI

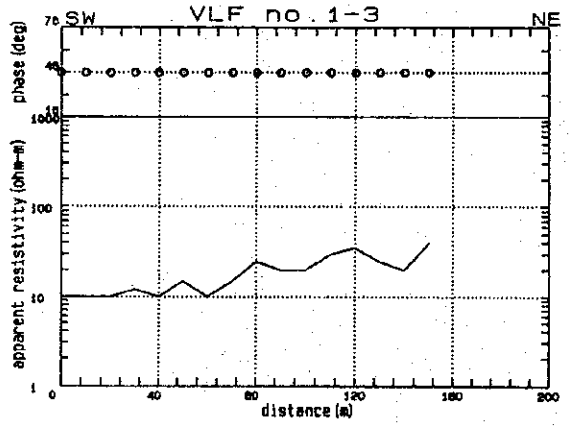
Fig. B-3.1

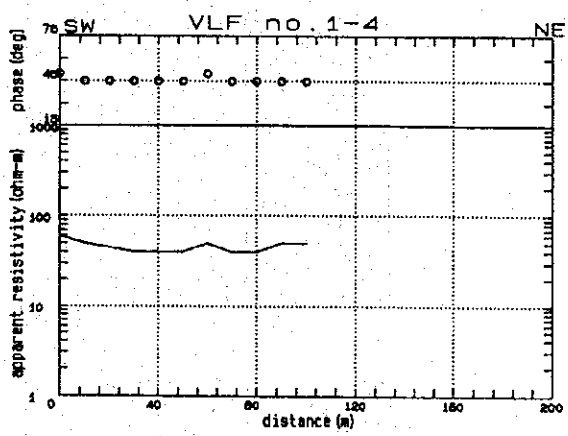
LOCATION MAP OF PROPOSED SITES FOR TEST WELLS (7)

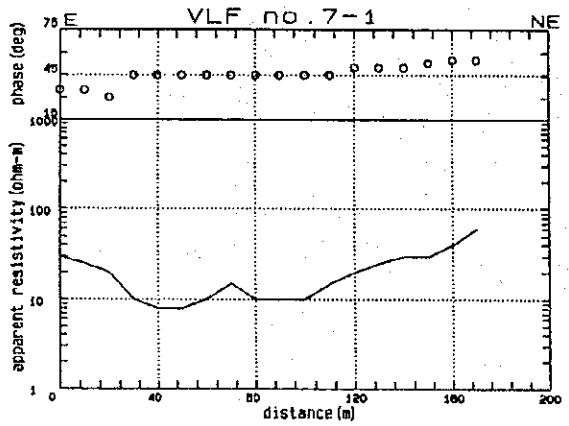
NIPPON KOEI CO., LTD
NIKKO EXPLORATION & DEVELOPMENT CO., LTD

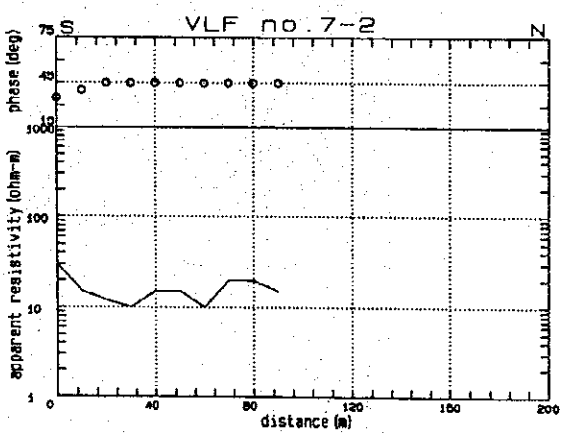


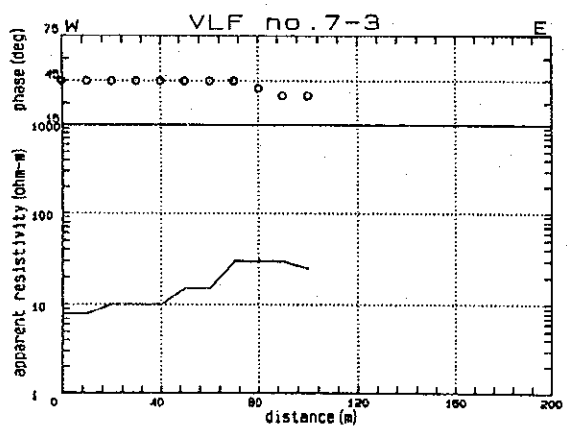


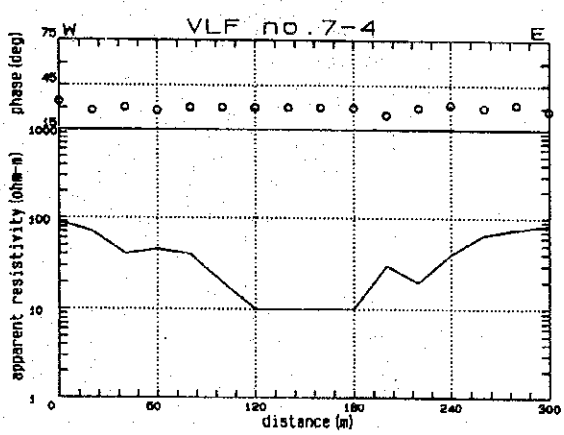












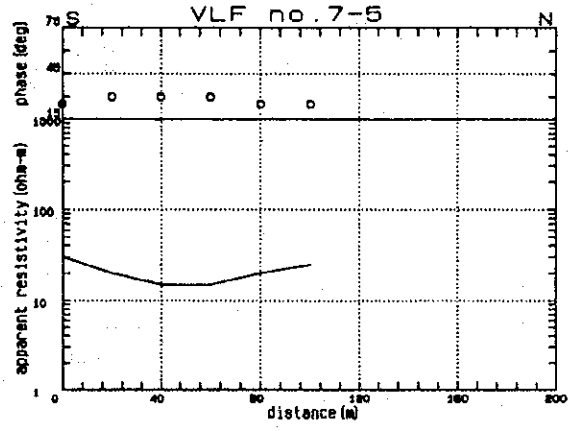
JAPAN INTERNATIONAL COOPERATION AGENCY (JICA)

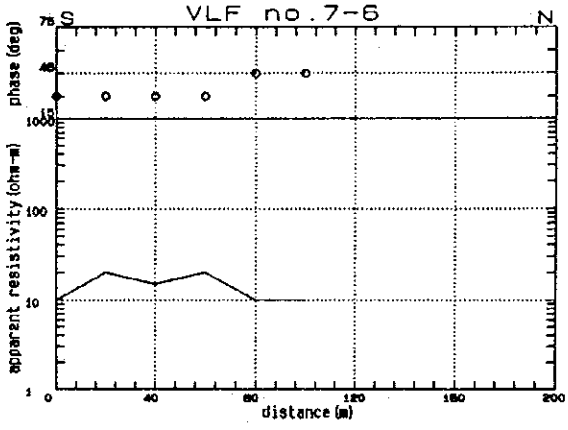
THE STUDY ON GROUNDWATER DEVELOPMENT IN NORTH VITI LEVU IN THE REPUBLIC OF FIJI

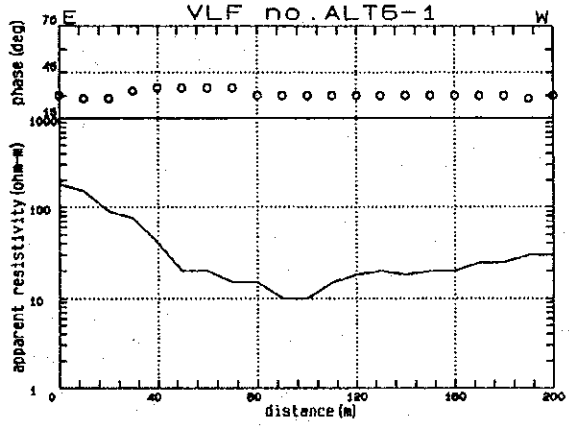
Fig. B-3.2

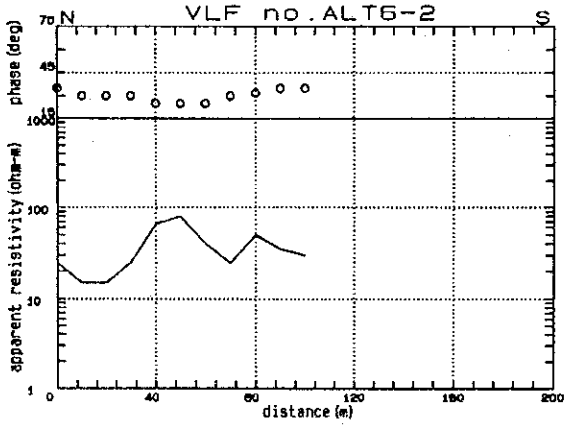
VLF RESISTIVITY AND PHASE ANGLE PROFILES (1)

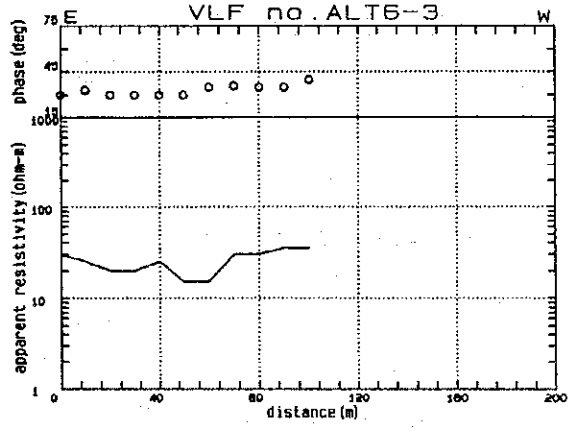
NIPPON KOEI CO., LTD
NIKKO EXPLORATION & DEVELOPMENT CO., LTD

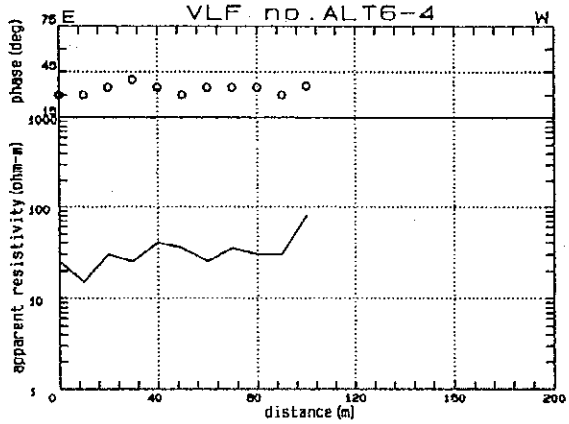












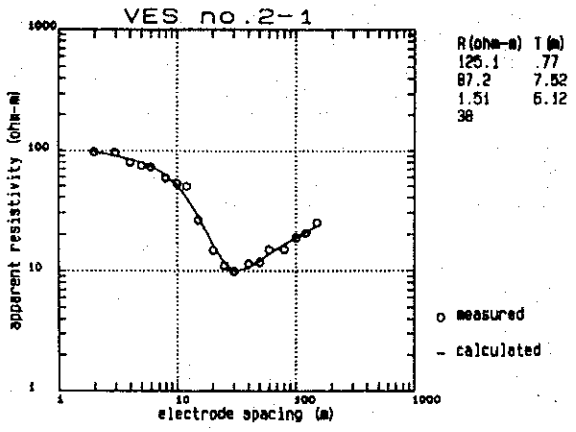
JAPAN INTERNATIONAL COOPERATION AGENCY (JICA)

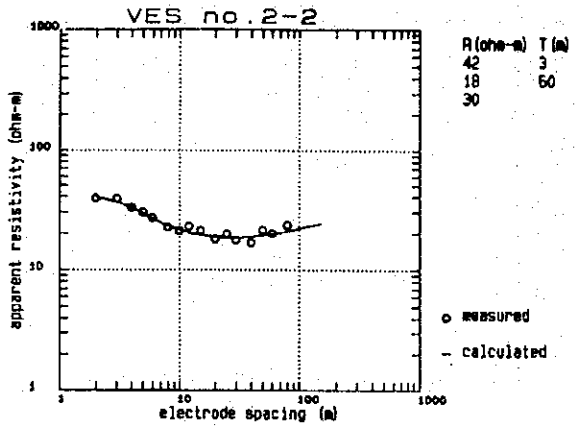
THE STUDY ON GROUNDWATER DEVELOPMENT IN NORTH VITI LEVU IN THE REPUBLIC OF FIJI

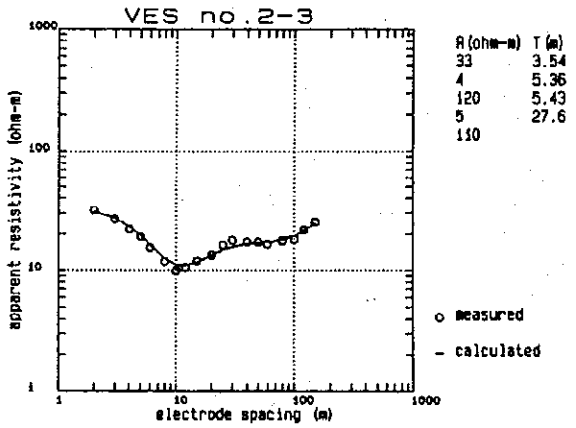
Fig. B-3.2

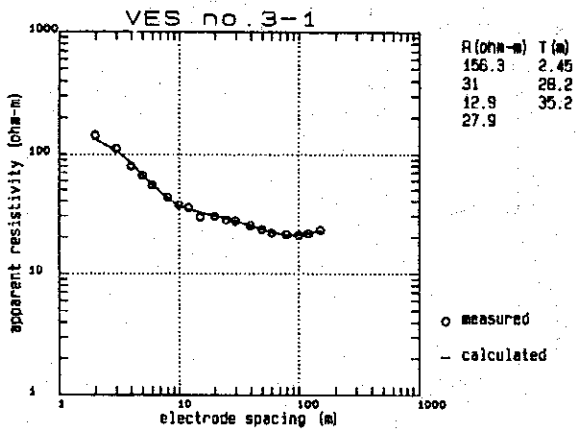
VLF RESISTIVITY AND PHASE ANGLE PROFILES (2)

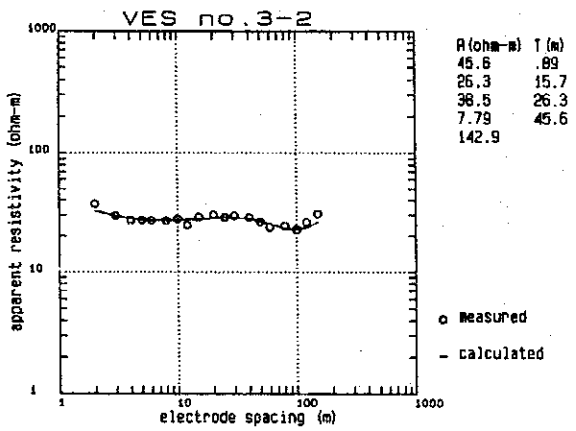
NIPPON KOEI CO., LTD
NIKKO EXPLORATION & DEVELOPMENT CO., LTD

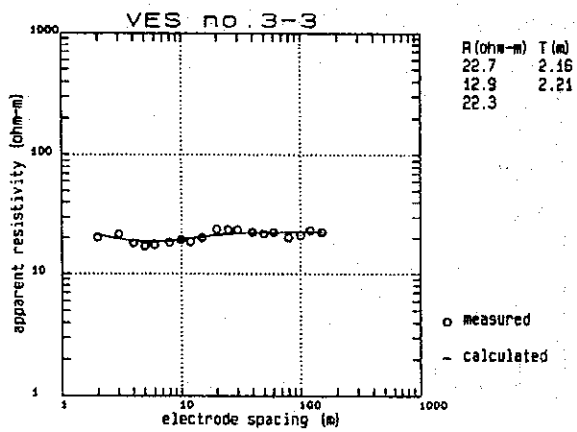


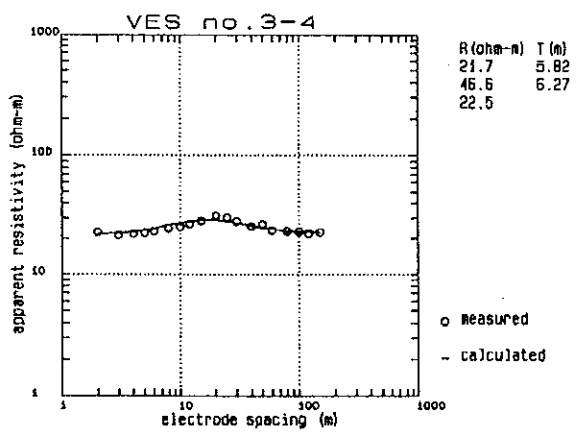


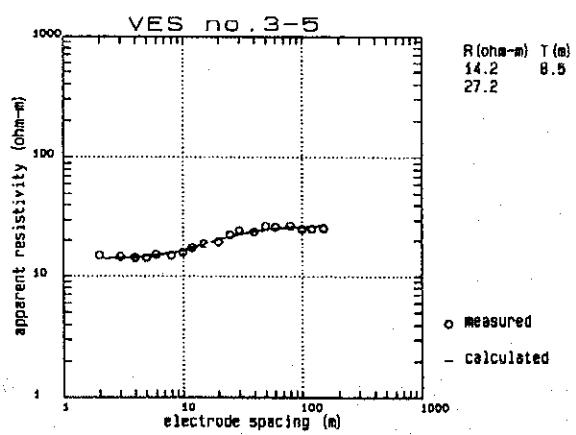










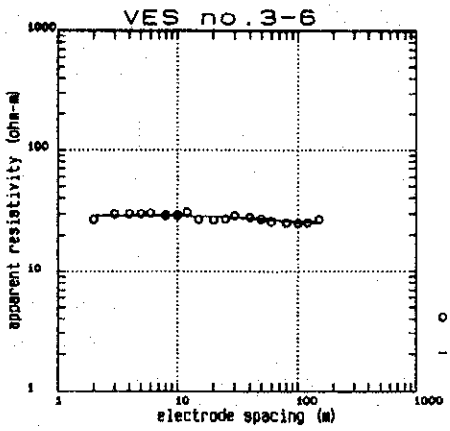


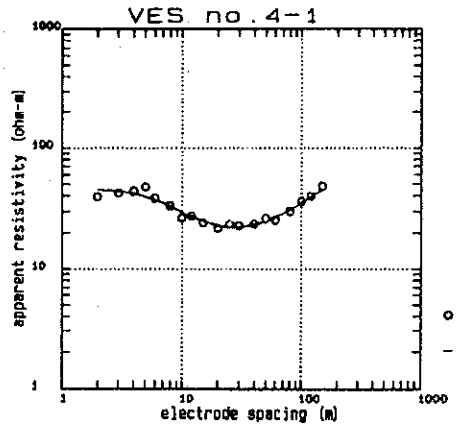
JAPAN INTERNATIONAL COOPERATION AGENCY (JICA)

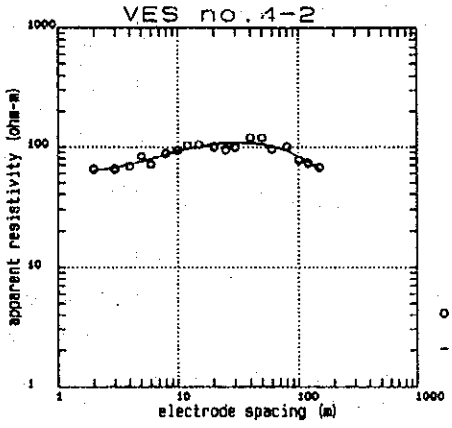
THE STUDY ON GROUNDWATER DEVELOPMENT IN NORTH VITI LEVU IN THE REPUBLIC OF FIJI

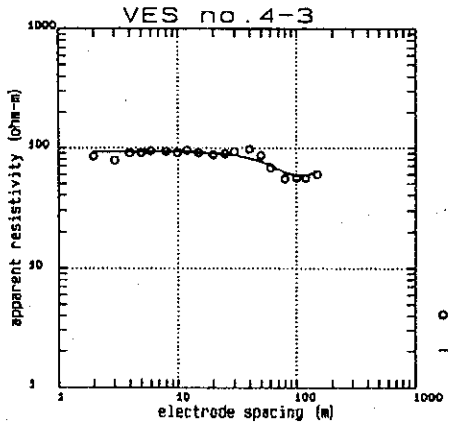
Fig. B-3.3 VERTICAL ELECTRIC SOUNDING CURVES (1)

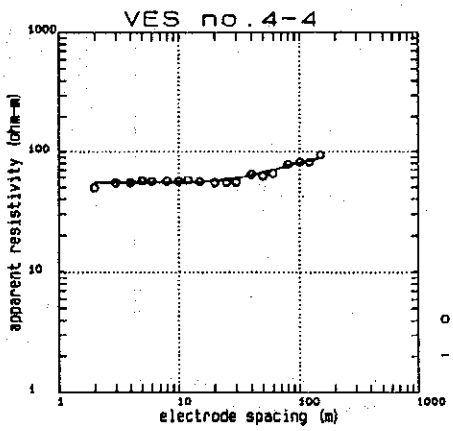
NIPPON KOEI CO., LTD
NIKKO EXPLORATION & DEVELOPMENT CO., LTD

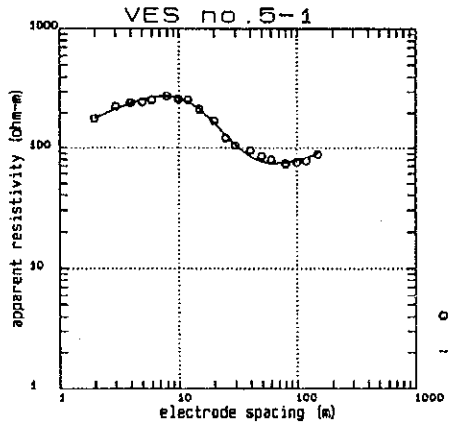


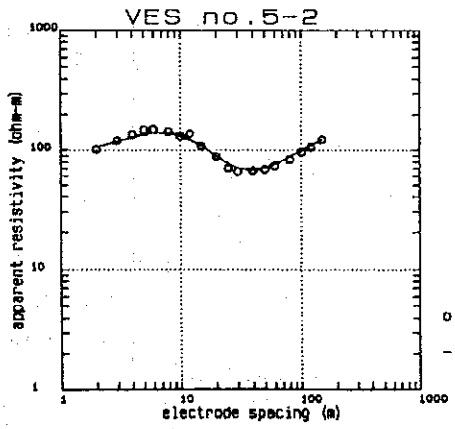


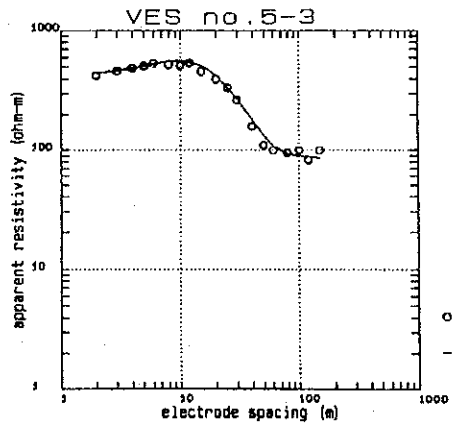










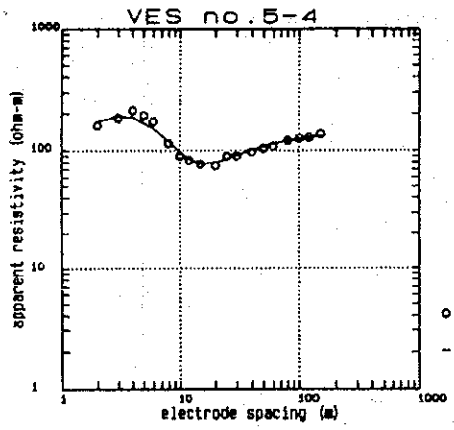


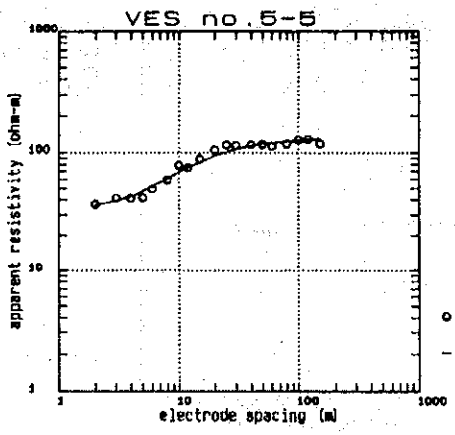
JAPAN INTERNATIONAL COOPERATION AGENCY (JICA)

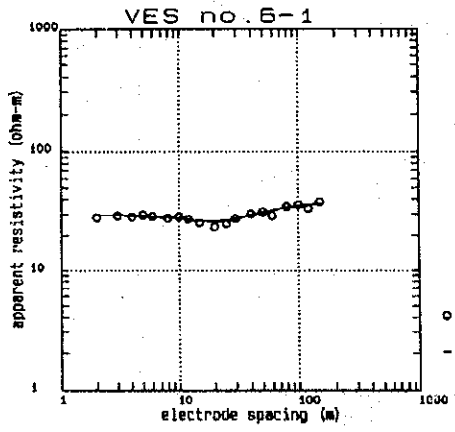
THE STUDY ON GROUNDWATER DEVELOPMENT IN NORTH VITI LEVU IN THE REPUBLIC OF FIJI

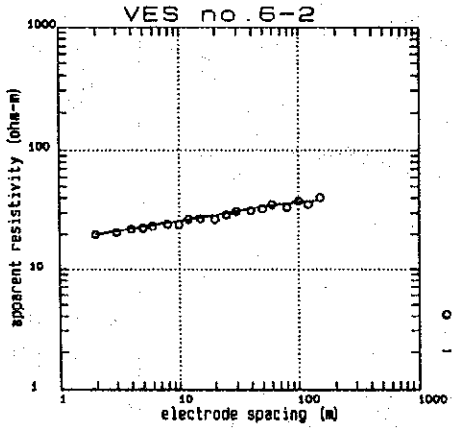
Fig. B-3.3 VERTICAL ELECTRIC SOUNDING CURVES (2)

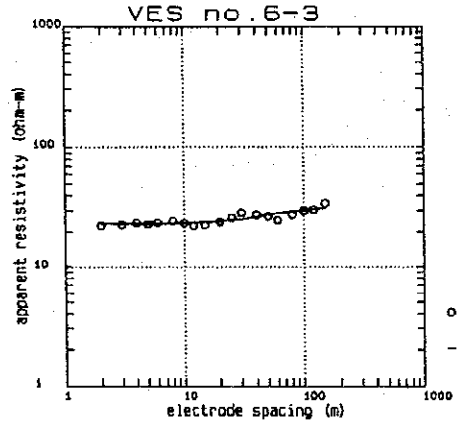
NIPPON KOEI CO., LTD
NIKKO EXPLORATION & DEVELOPMENT CO., LTD

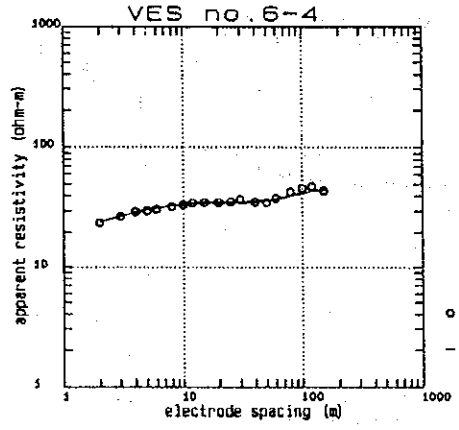


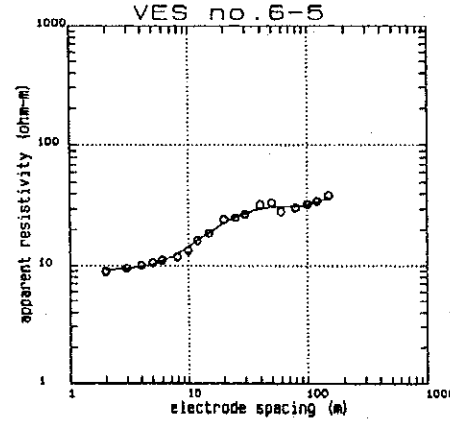


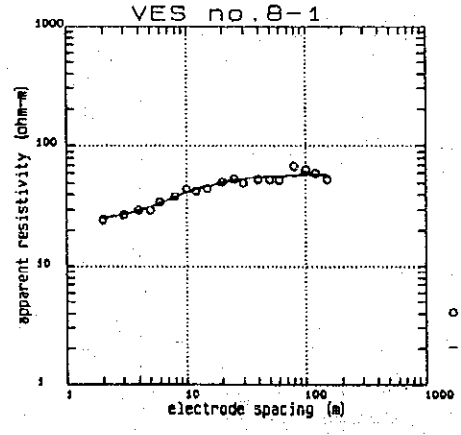










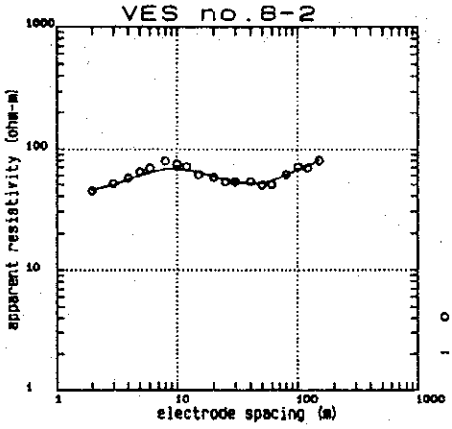


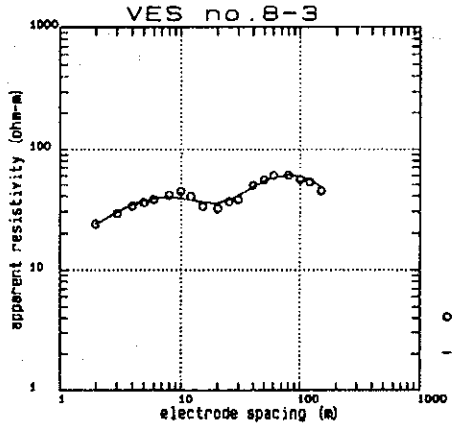
JAPAN INTERNATIONAL COOPERATION AGENCY (JICA)

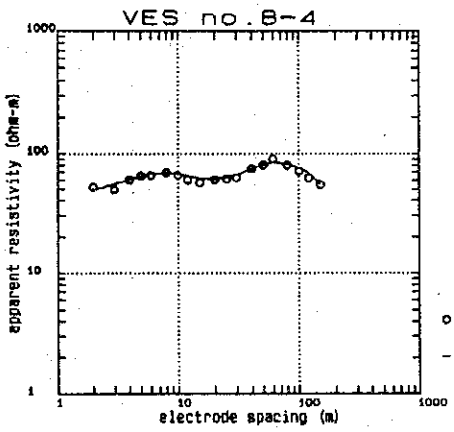
THE STUDY ON GROUNDWATER DEVELOPMENT IN NORTH VITI LEVU IN THE REPUBLIC OF FIJI

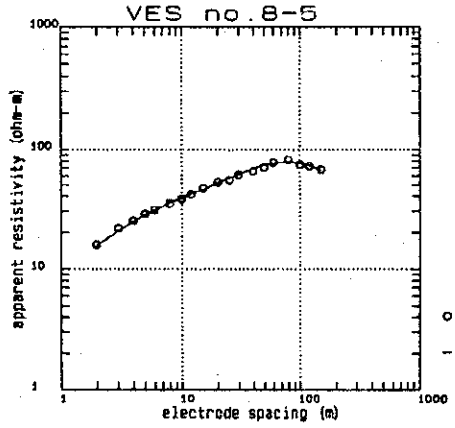
Fig. B-3.3 VERTICAL ELECTRIC SOUNDING CURVES (3)

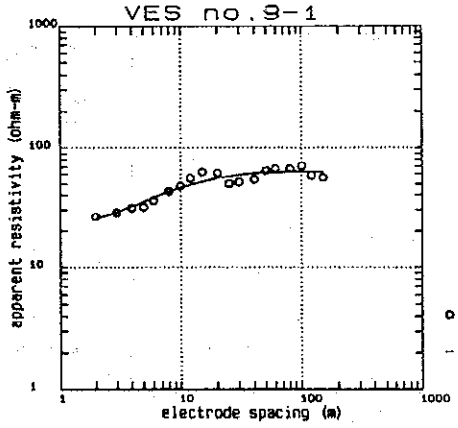
NIPPON KOEI CO., LTD
NIKKO EXPLORATION & DEVELOPMENT CO., LTD

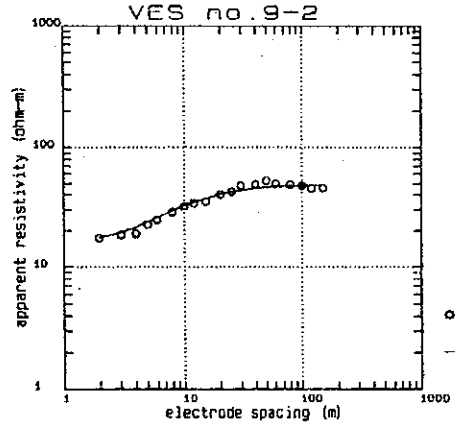


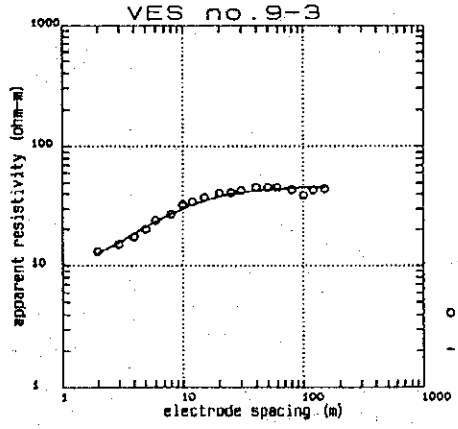


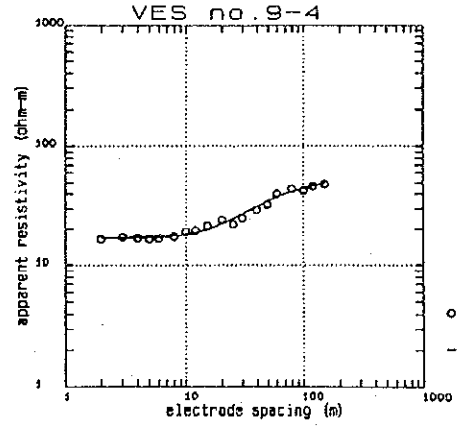










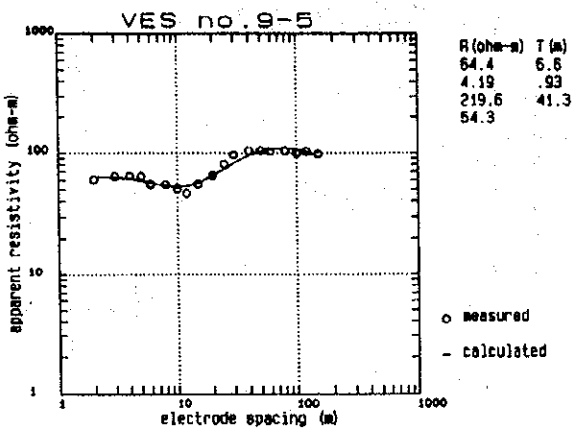


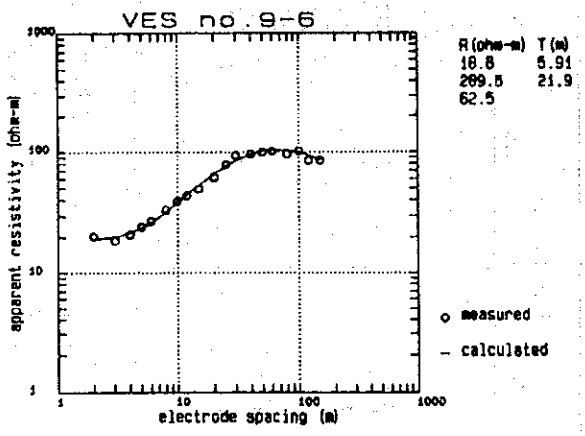
JAPAN INTERNATIONAL COOPERATION AGENCY (JICA)

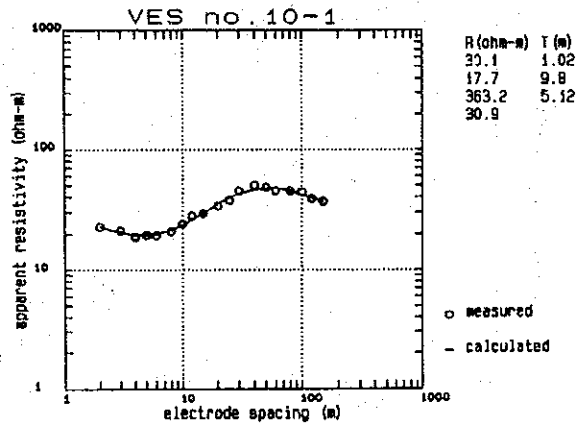
THE STUDY ON GROUNDWATER DEVELOPMENT IN NORTH VITI LEVU IN THE REPUBLIC OF FIJI

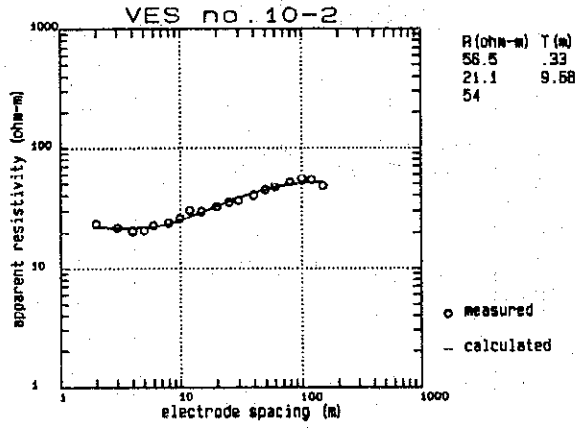
Fig. B-3.3 VERTICAL ELECTRIC SOUNDING CURVES (4)

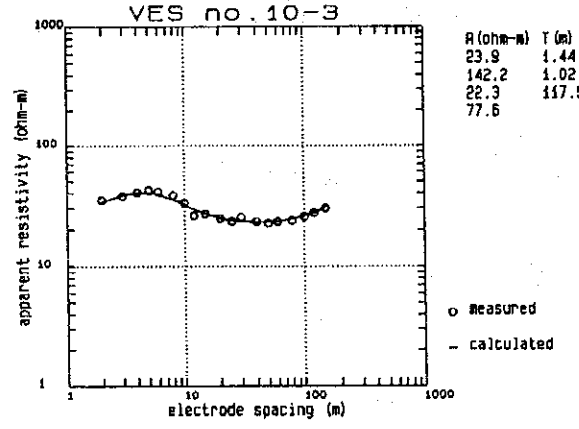
NIPPON KOEI CO., LTD
NIKKO EXPLORATION & DEVELOPMENT CO., LTD

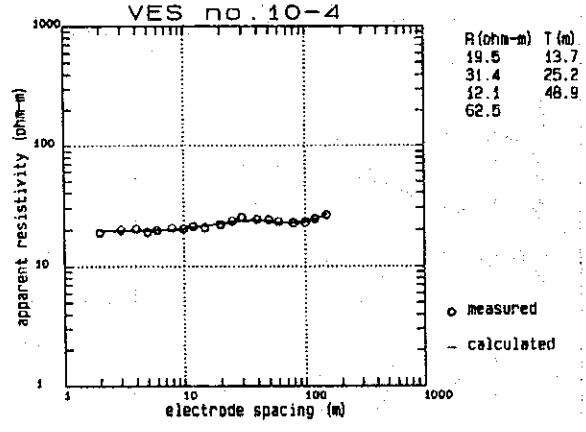


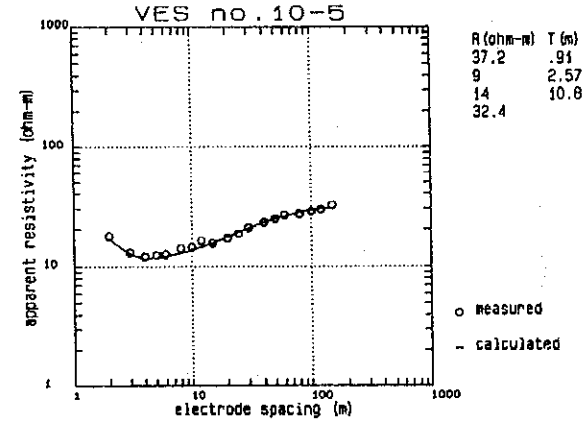


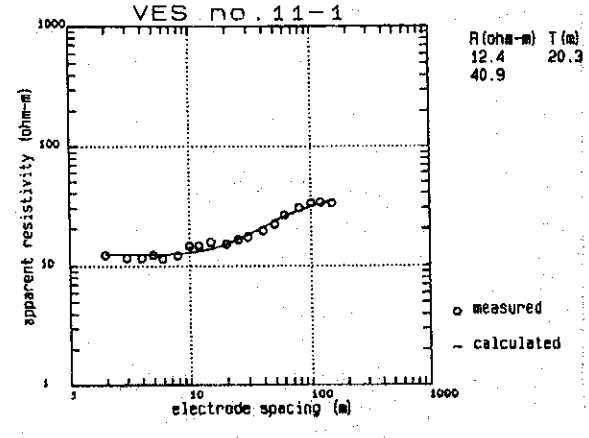










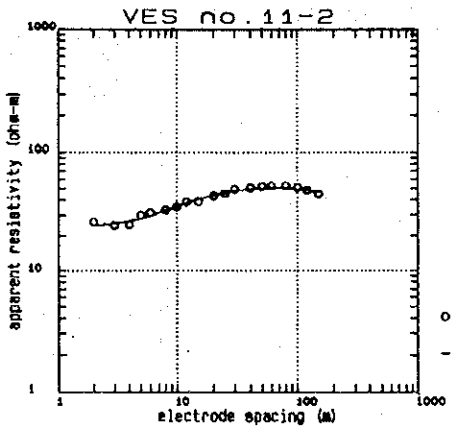


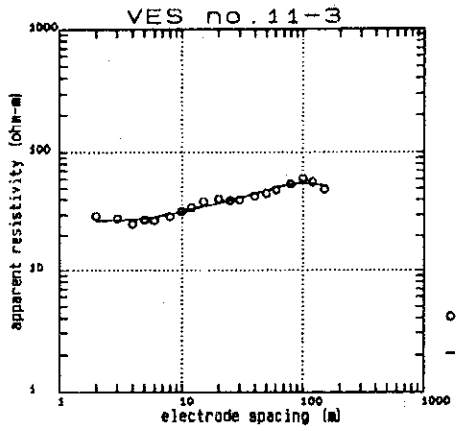
JAPAN INTERNATIONAL COOPERATION AGENCY (JICA)

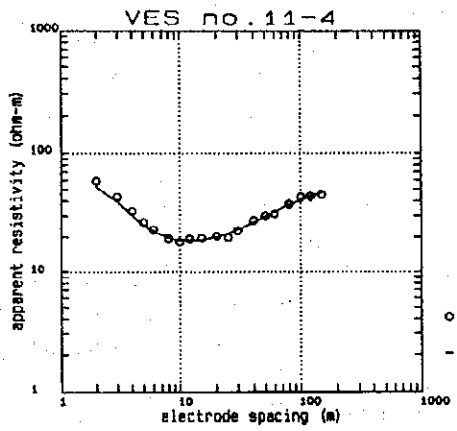
THE STUDY ON GROUNDWATER DEVELOPMENT IN NORTH VITI LEVU IN THE REPUBLIC OF FIJI

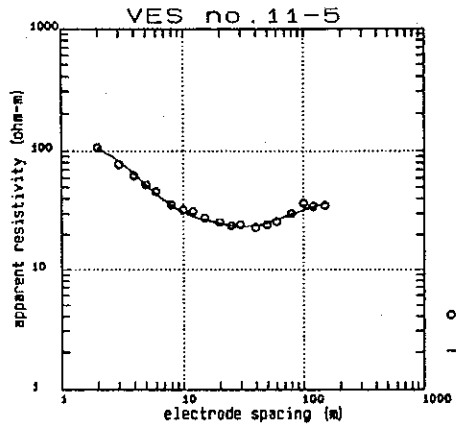
Fig. B-3.3 VERTICAL ELECTRIC SOUNDING CURVES (5)

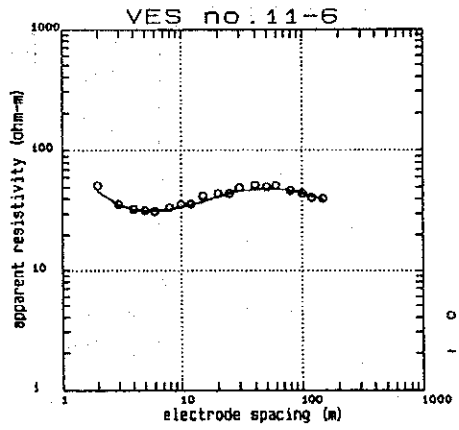
NIPPON KOEI CO., LTD
NIKKO EXPLORATION & DEVELOPMENT CO., LTD

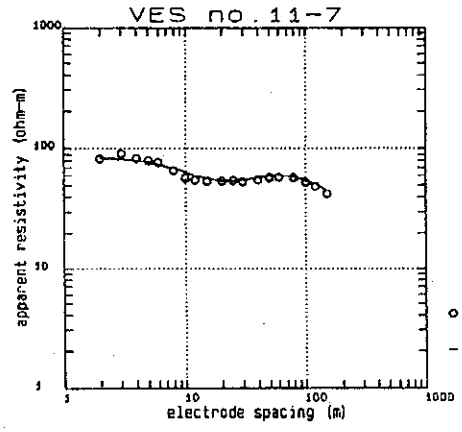


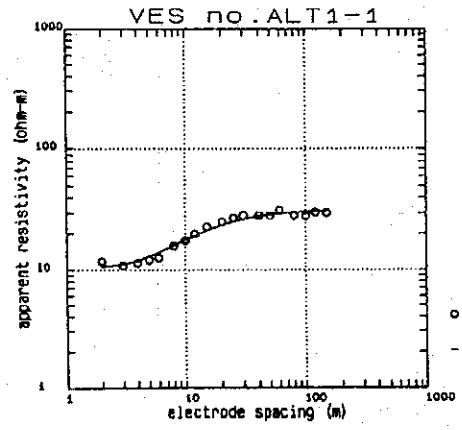


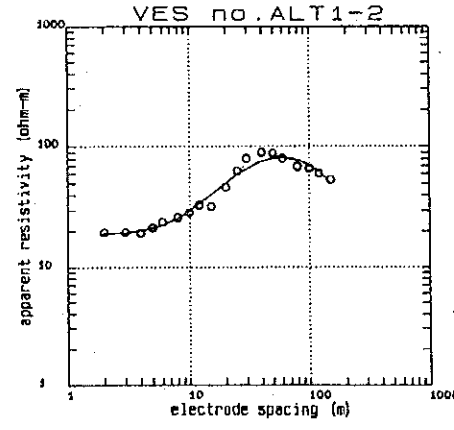










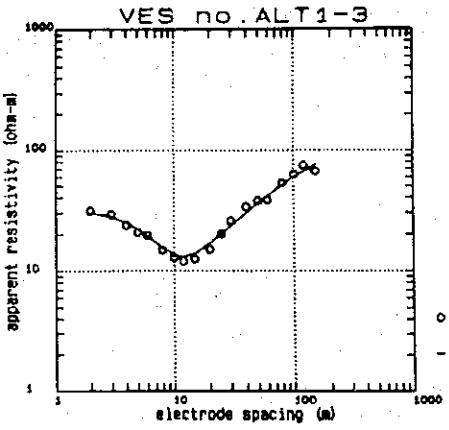


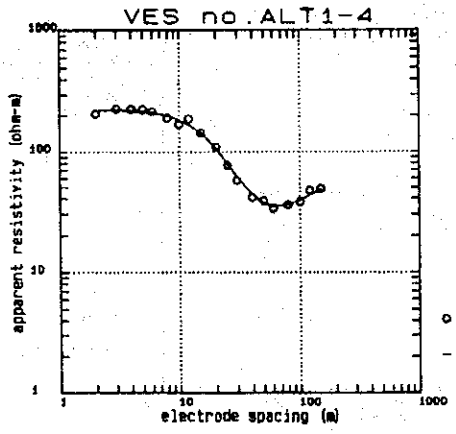
JAPAN INTERNATIONAL COOPERATION AGENCY (JICA)

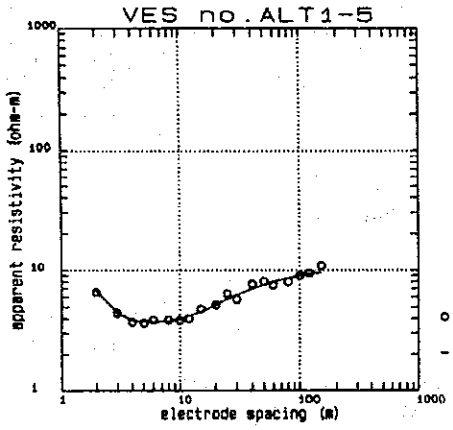
THE STUDY ON GROUNDWATER DEVELOPMENT IN NORTH VITI LEVU IN THE REPUBLIC OF FIJI

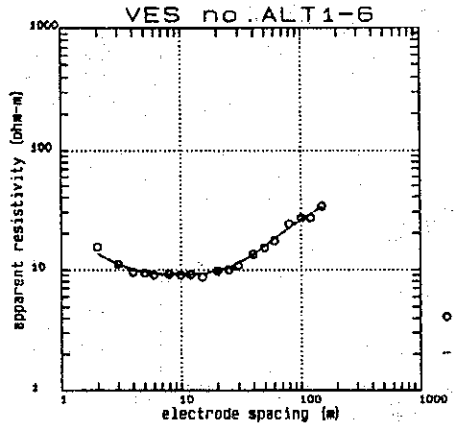
Fig. B-3.3 VERTICAL ELECTRIC SOUNDING CURVES (6)

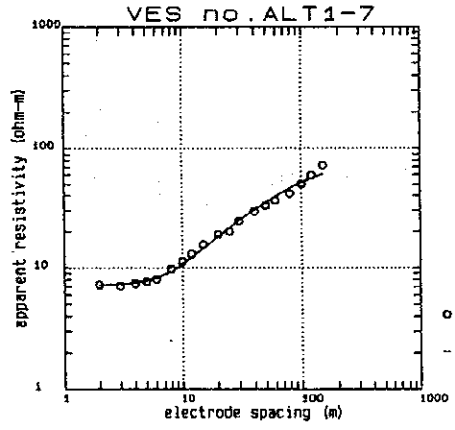
NIPPON KOEI CO., LTD
NIKKO EXPLORATION & DEVELOPMENT CO., LTD

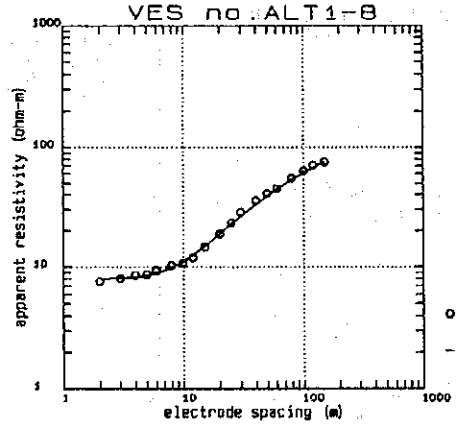


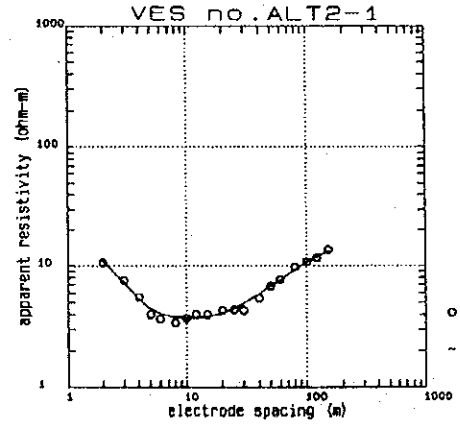


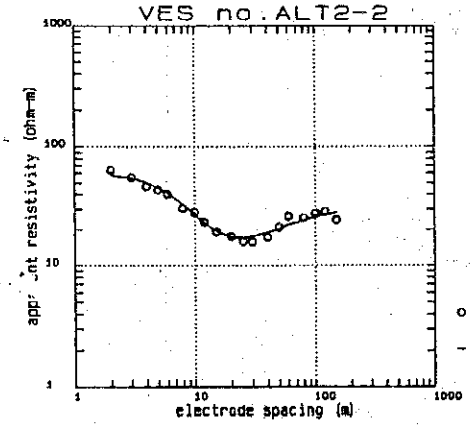










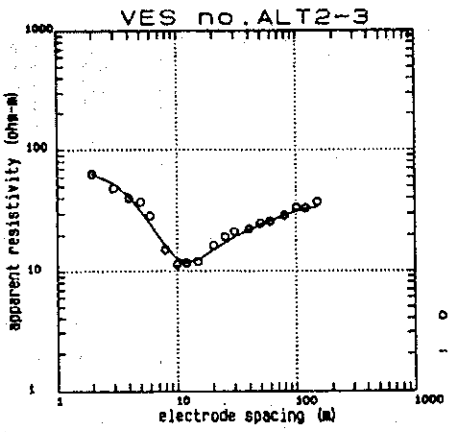


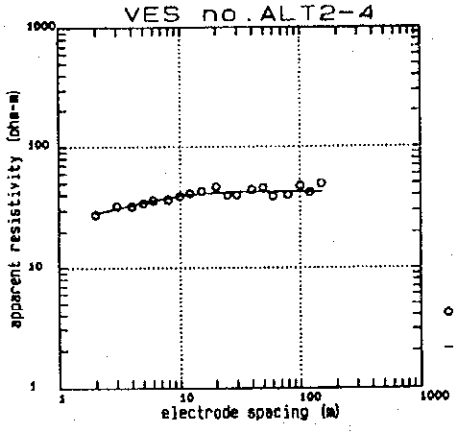
JAPAN INTERNATIONAL COOPERATION AGENCY (JICA)

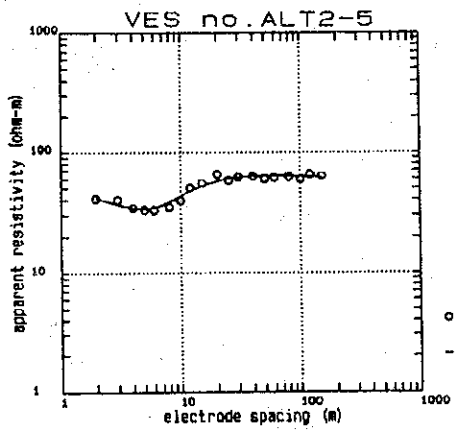
THE STUDY ON GROUNDWATER DEVELOPMENT IN NORTH VITI LEVU IN THE REPUBLIC OF FIJI

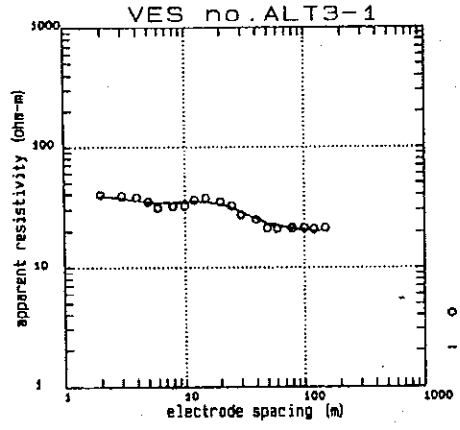
Fig. 8-3-3 VERTICAL ELECTRIC SOUNDING CURVES (7)

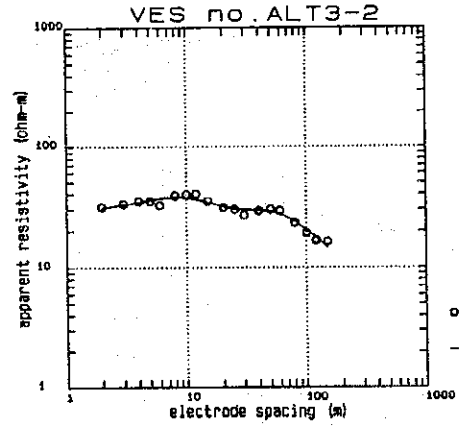
NIPPON KOEI CO., LTD
NIKKO EXPLORATION & DEVELOPMENT CO., LTD

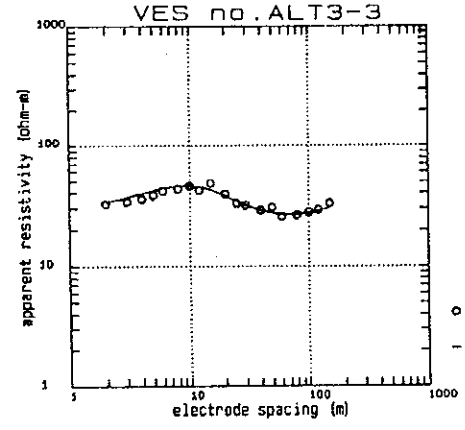


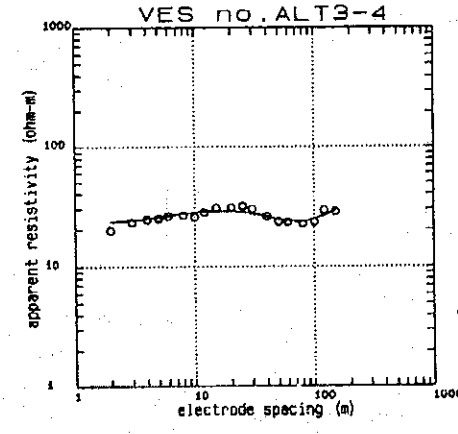


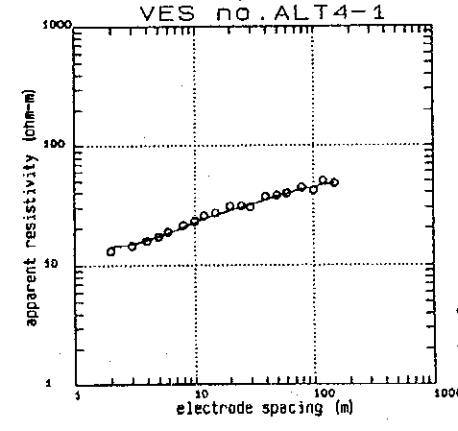










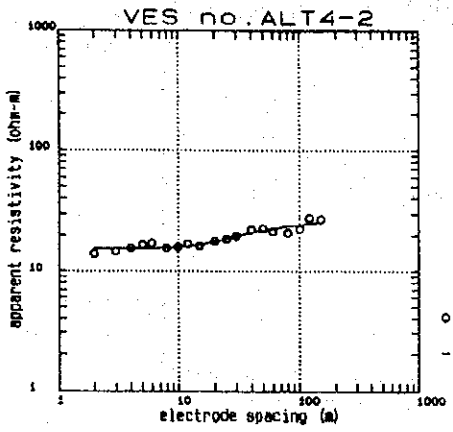


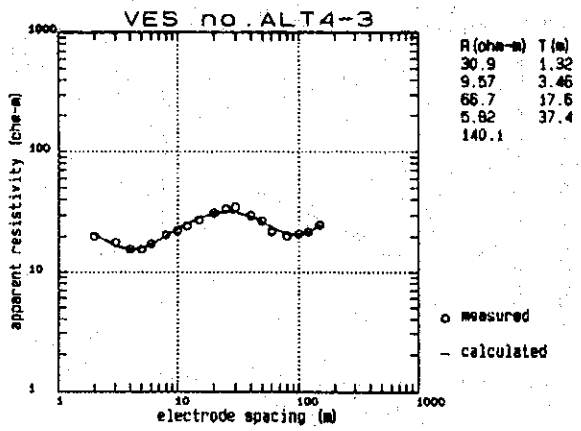
JAPAN INTERNATIONAL COOPERATION AGENCY (JICA)

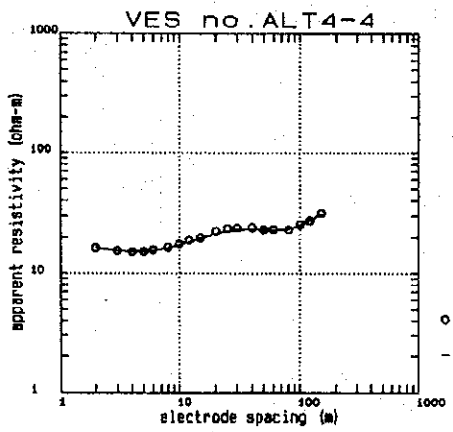
THE STUDY ON GROUNDWATER DEVELOPMENT IN NORTH VITI LEVU IN THE REPUBLIC OF FIJI

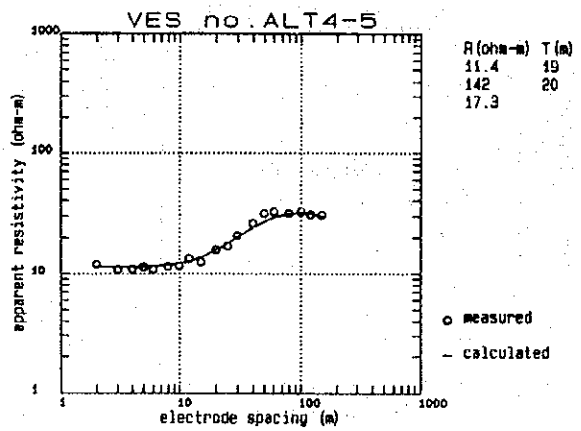
Fig. B-3.3 VERTICAL ELECTRIC SOUNDING CURVES (8)

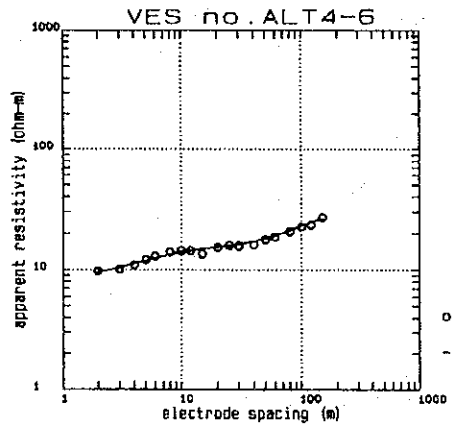
NIPPON KOEI CO., LTD
NIKKO EXPLORATION & DEVELOPMENT CO., LTD

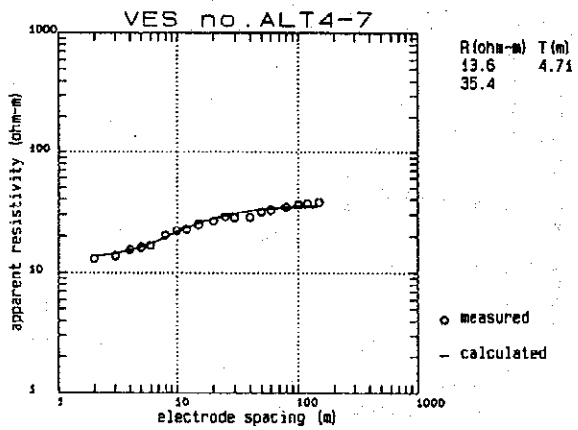


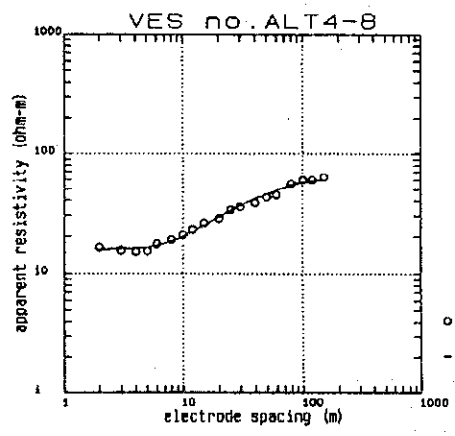


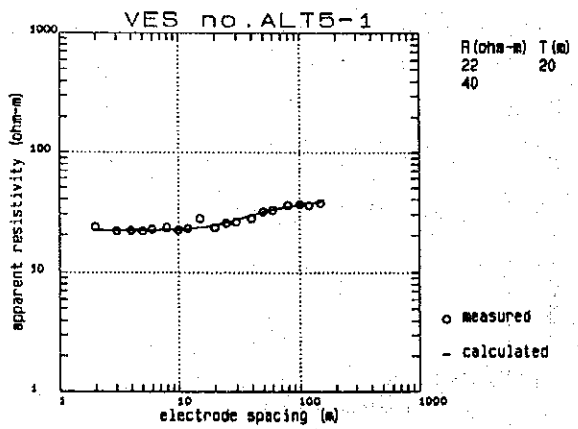










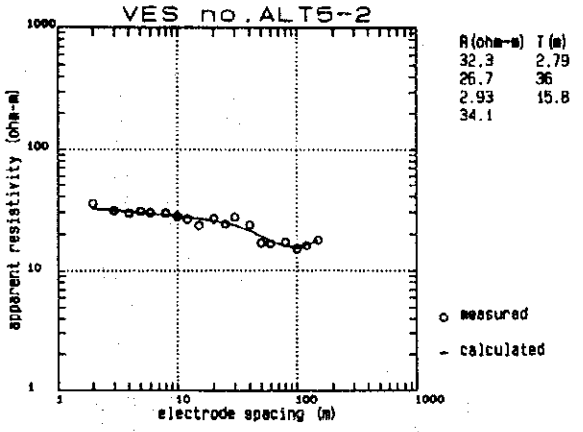


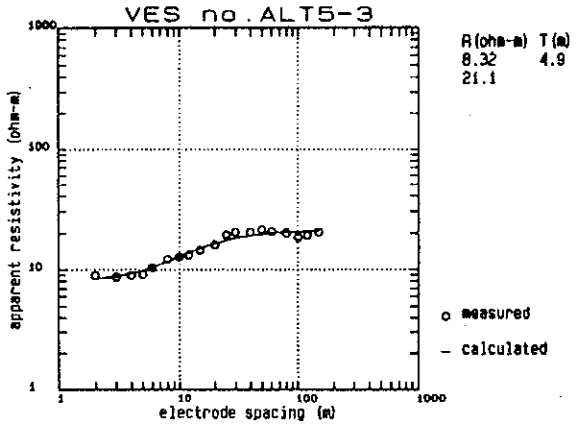
JAPAN INTERNATIONAL COOPERATION AGENCY (JICA)

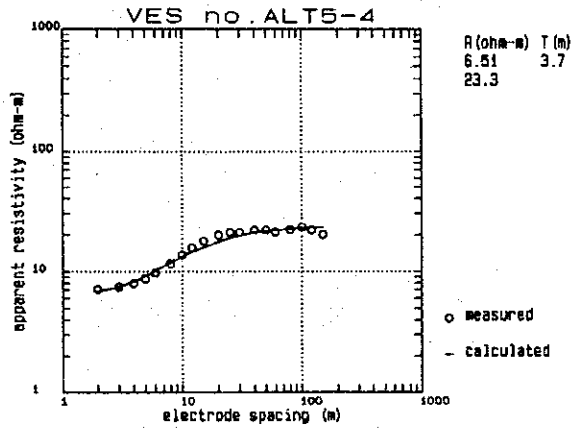
THE STUDY ON GROUNDWATER DEVELOPMENT IN NORTH VITI LEVU IN THE REPUBLIC OF FIJI

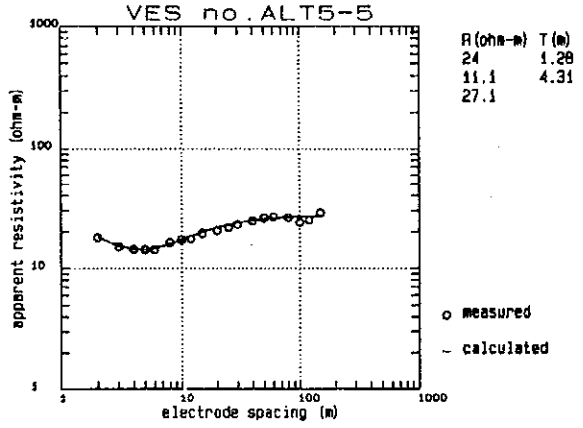
Fig. B-3.3 VERTICAL ELECTRIC SOUNDING CURVES (9)

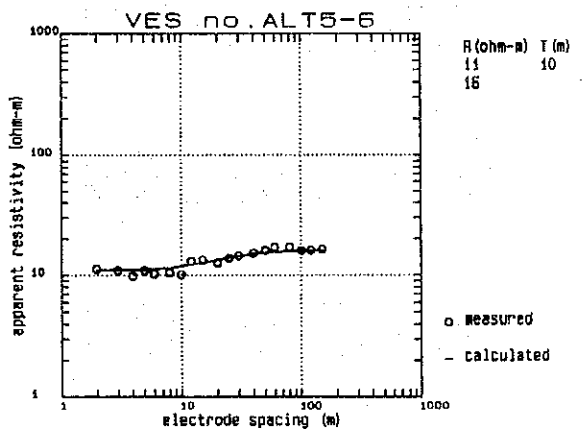
NIPPON KOEI CO., LTD
NIKKO EXPLORATION & DEVELOPMENT CO., LTD











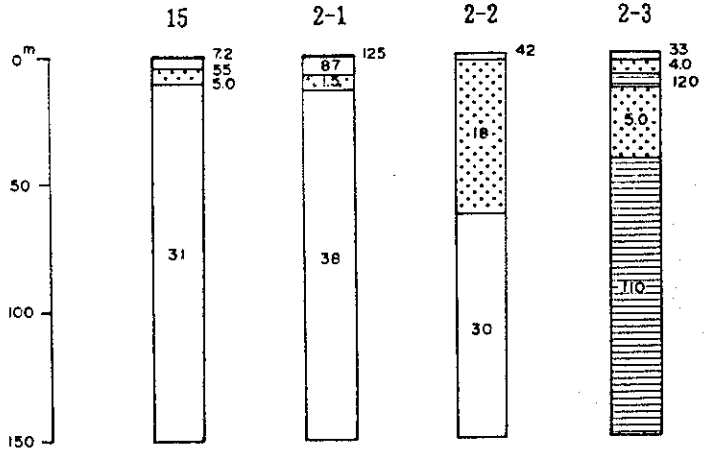
JAPAN INTERNATIONAL COOPERATION AGENCY (JICA)

THE STUDY ON GROUNDWATER DEVELOPMENT IN NORTH VITI LEVU IN THE REPUBLIC OF FIJI

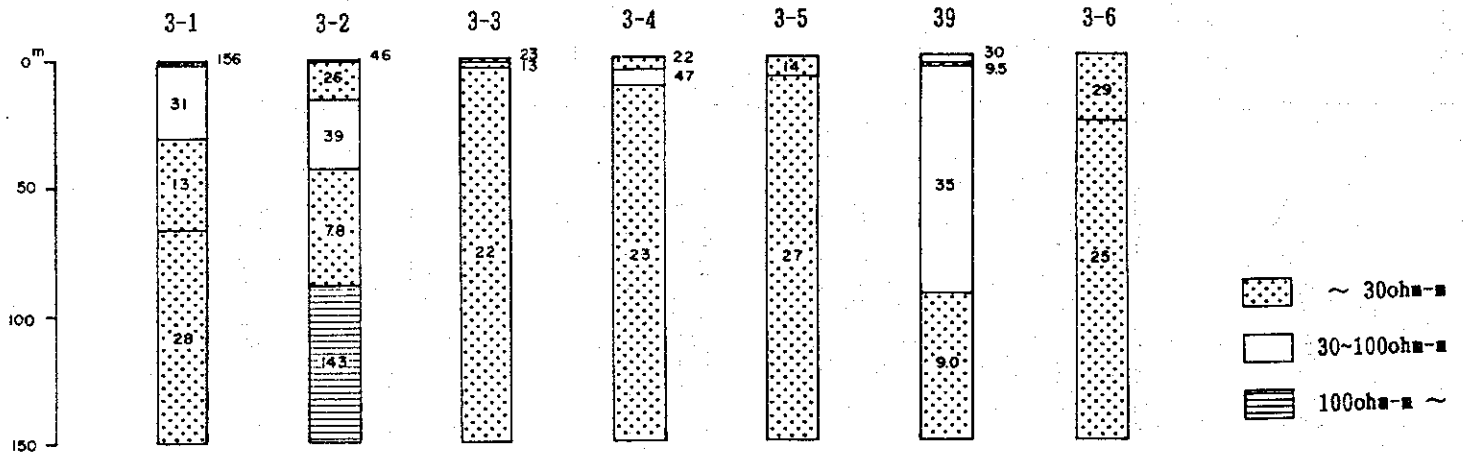
Fig. B-3.3 VERTICAL ELECTRIC SOUNDING CURVES (10)

NIPPON KOEI CO., LTD
NIKKO EXPLORATION & DEVELOPMENT CO., LTD

No. 2 Yalalevu



No. 3 Nukuloa



JAPAN INTERNATIONAL COOPERATION AGENCY (JICA)

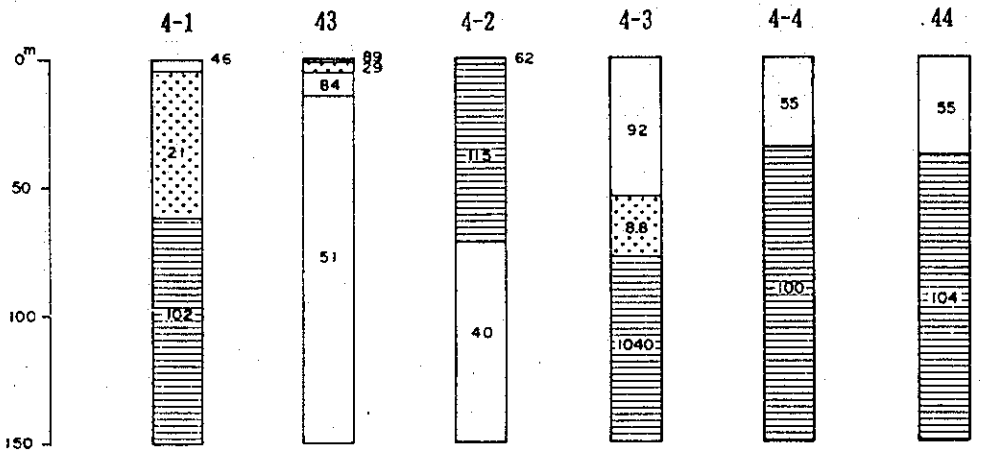
THE STUDY ON GROUNDWATER DEVELOPMENT IN NORTH VITI LEVU IN THE REPUBLIC OF FIJI

Fig. B-3.4

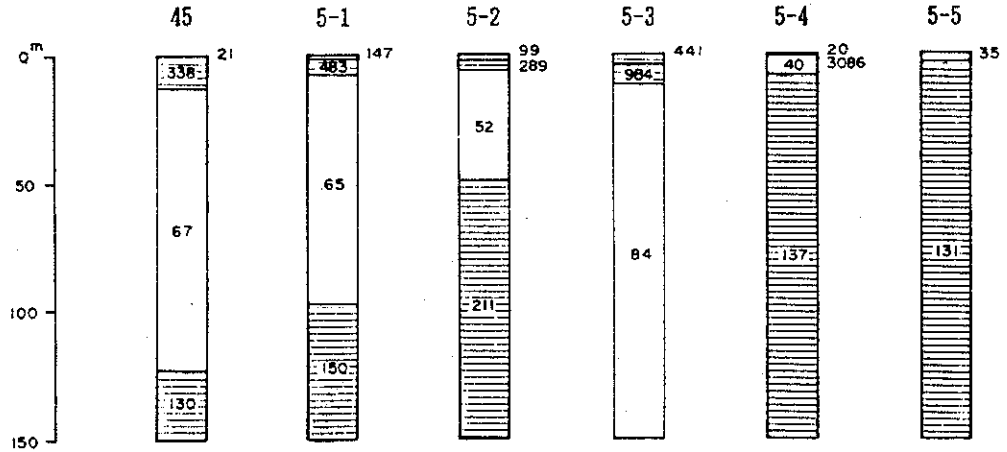
RESISTIVITY COLUMNS DERIVED FROM VES (1)

NIPPON KOEI CO., LTD.
NIKKO EXPLORATION & DEVELOPMENT CO., LTD.

No. 4 Varadoli



No. 5 Veisaru



JAPAN INTERNATIONAL COOPERATION AGENCY (JICA)

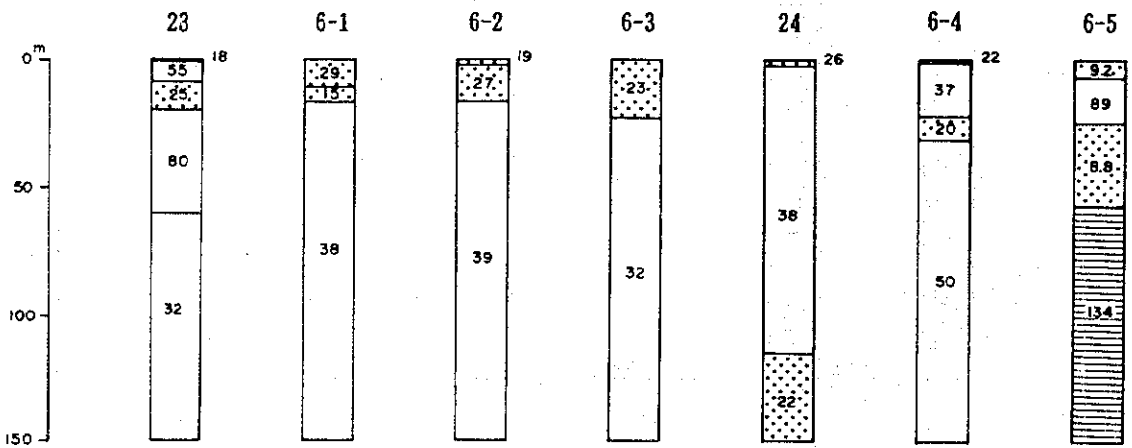
THE STUDY ON GROUNDWATER DEVELOPMENT IN NORTH VITI LEVU IN THE REPUBLIC OF FIJI

Fig. B-3.4

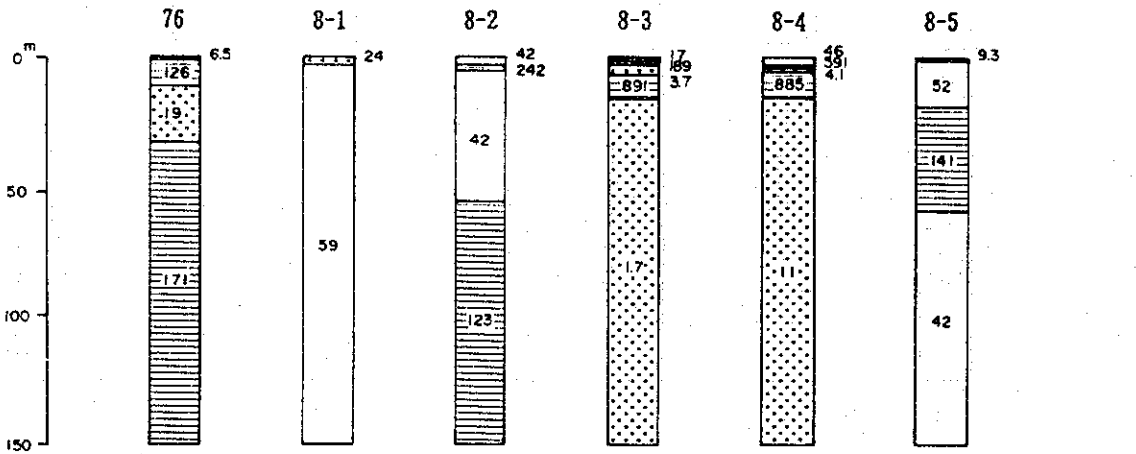
RESISTIVITY COLUMNS DERIVED FROM VES (2)

NIPPON KOEI CO., LTD
NIKKO EXPLORATION & DEVELOPMENT CO., LTD

No. 6 Koronubu



NO. 8 Kukunirewa



JAPAN INTERNATIONAL COOPERATION AGENCY (JICA)

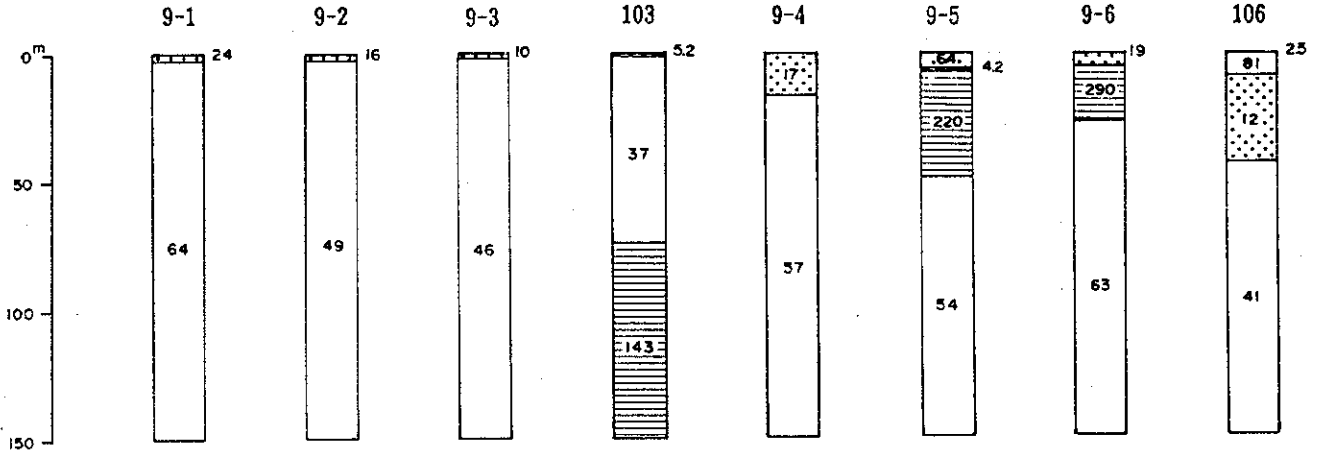
THE STUDY ON GROUNDWATER DEVELOPMENT IN NORTH VITI LEVU IN THE REPUBLIC OF FIJI

Fig. B-3.4

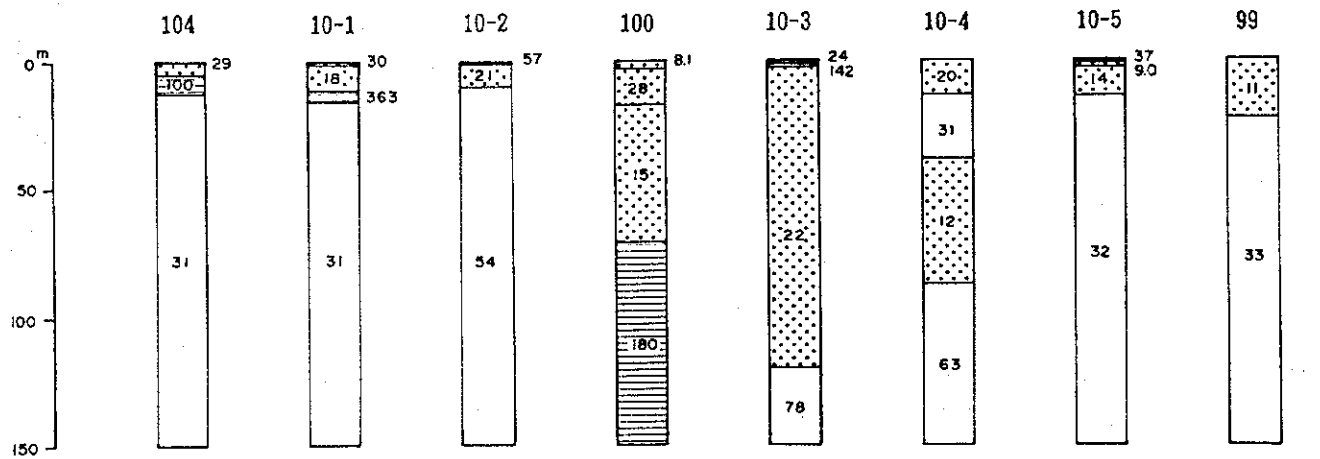
RESISTIVITY COLUMNS DERIVED FROM VES (3)

NIPPON KOEI CO., LTD
NIKKO EXPLORATION & DEVELOPMENT CO., LTD

No. 9 Drumasi



No. 10 Rabulu



JAPAN INTERNATIONAL COOPERATION AGENCY (JICA)

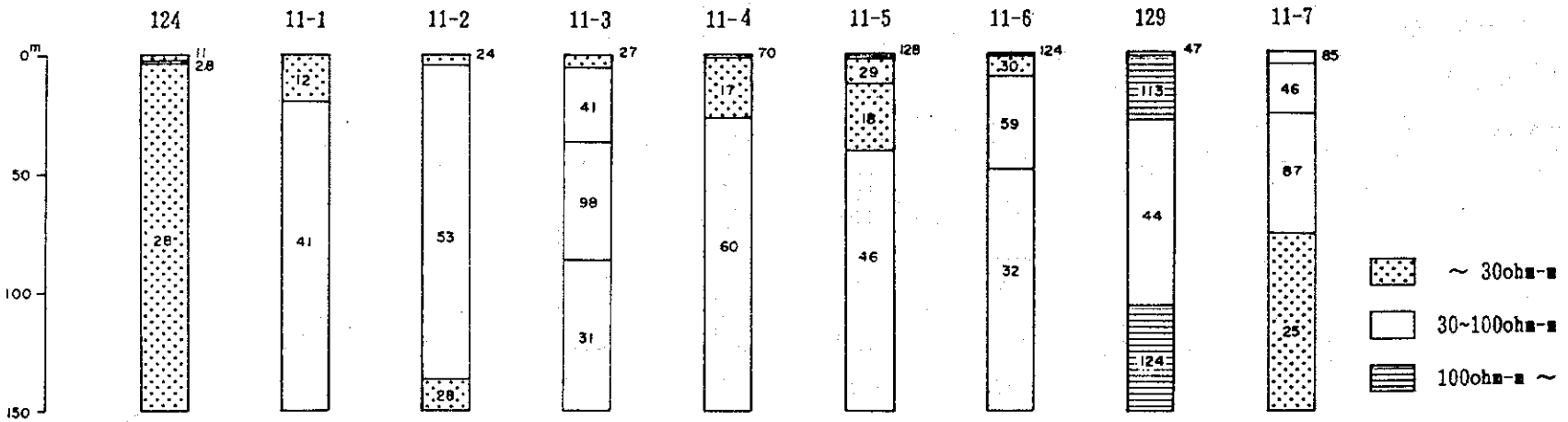
THE STUDY ON GROUNDWATER DEVELOPMENT IN NORTH VITI LEVU IN THE REPUBLIC OF FIJI

Fig. B-3.4

RESISTIVITY COLUMNS DERIVED FROM VES (4)

NIPPON KOEI CO., LTD
NIKKO EXPLORATION & DEVELOPMENT CO., LTD

No. 11 Wairuku



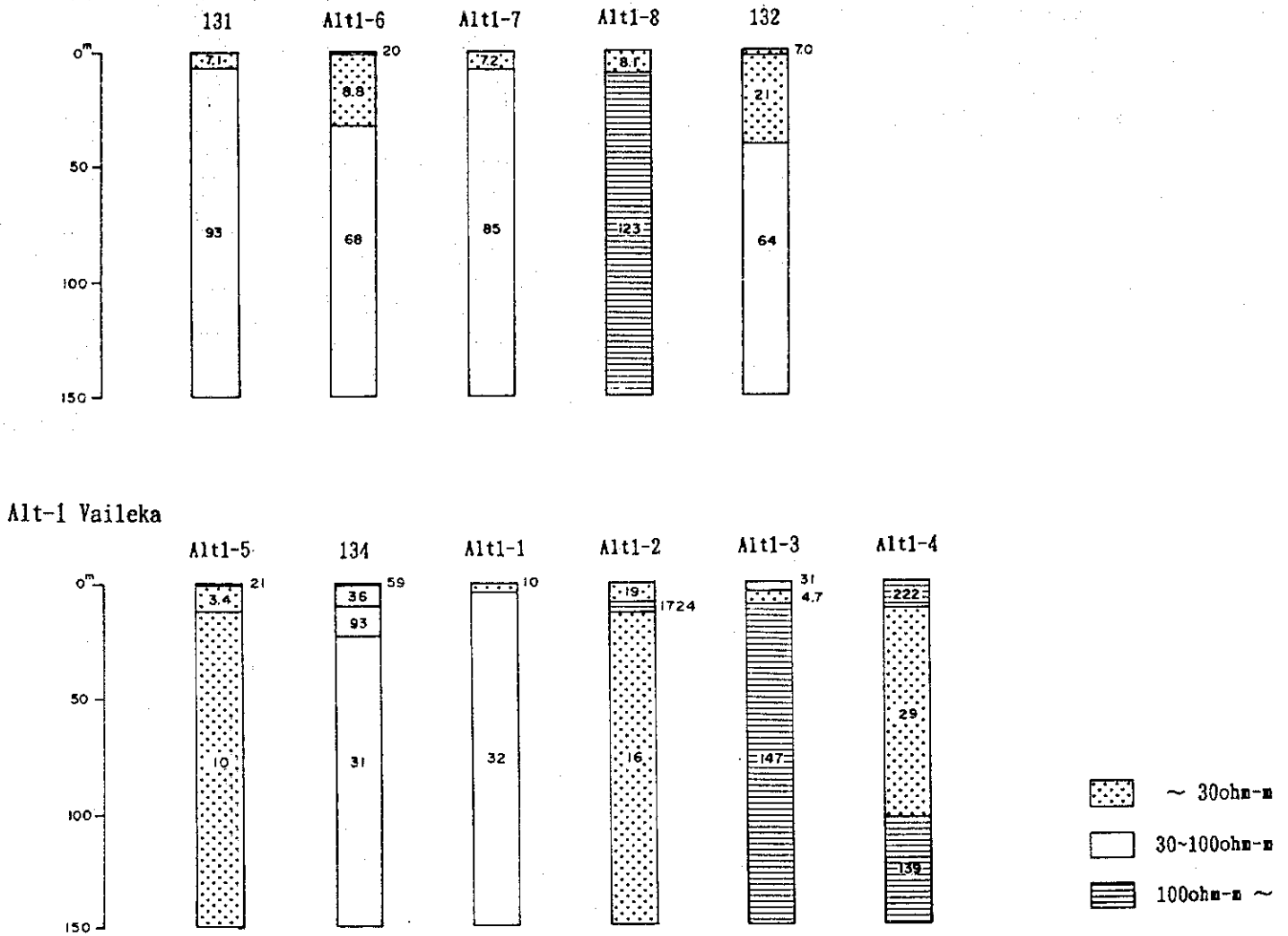
JAPAN INTERNATIONAL COOPERATION AGENCY (JICA)

THE STUDY ON GROUNDWATER DEVELOPMENT IN NORTH VITI LEVU IN THE REPUBLIC OF FIJI

Fig. B-3.4

RESISTIVITY COLUMNS DERIVED FROM VES (5)

NIPPON KOEI CO., LTD.
NIKKO EXPLORATION & DEVELOPMENT CO., LTD



JAPAN INTERNATIONAL COOPERATION AGENCY (JICA)

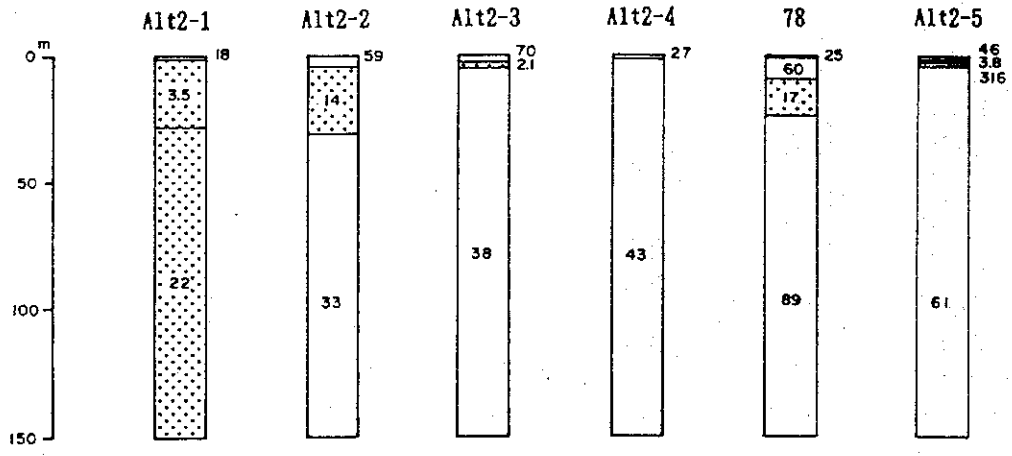
THE STUDY ON GROUNDWATER DEVELOPMENT IN NORTH VITI LEVU IN THE REPUBLIC OF FIJI

Fig. B-3.4

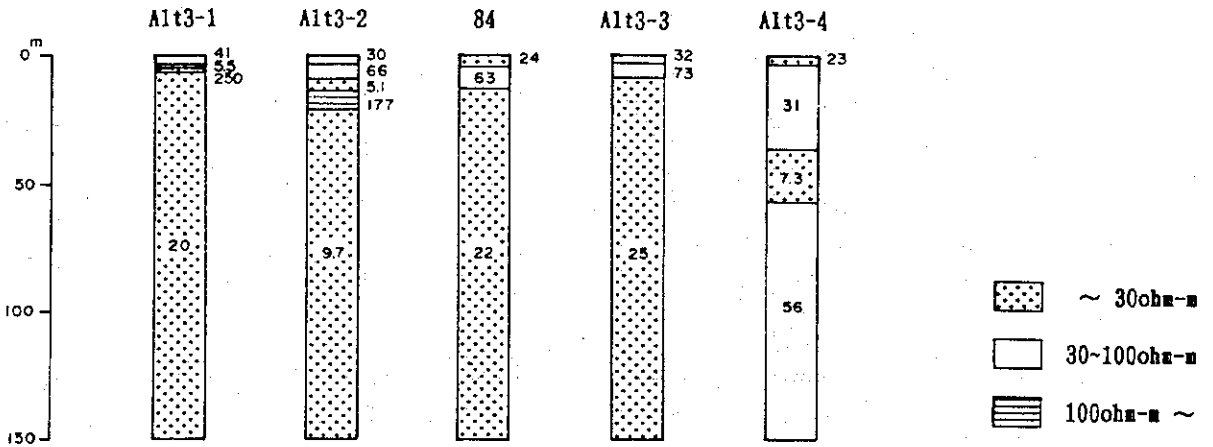
RESISTIVITY COLUMNS DERIVED FROM VES (6)

NIPPON KOEI CO., LTD.
NIKKO EXPLORATION & DEVELOPMENT CO., LTD.

Alt-2 Yasiyasi



Alt-3 Yaladro



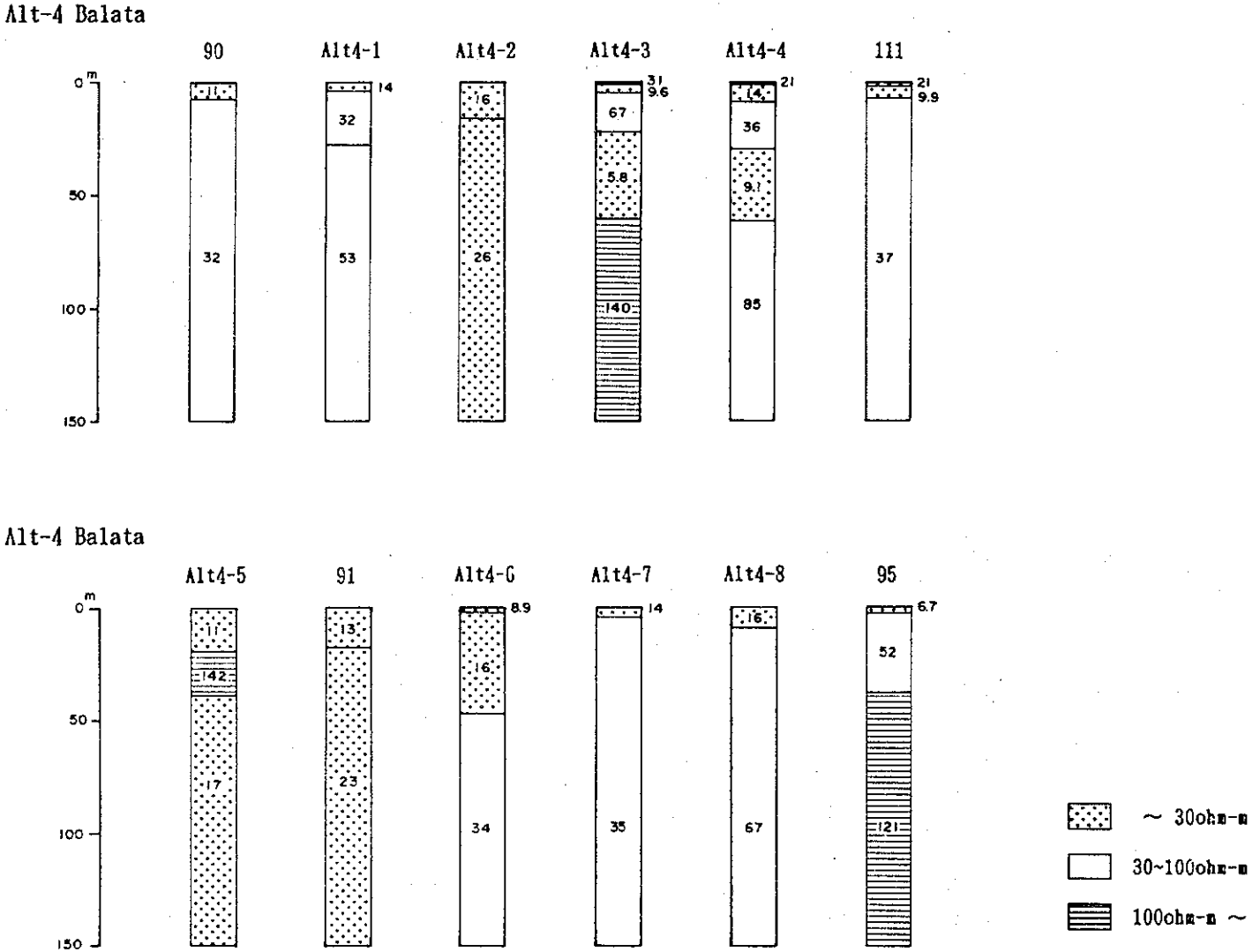
JAPAN INTERNATIONAL COOPERATION AGENCY (JICA)

THE STUDY ON GROUNDWATER DEVELOPMENT IN NORTH VITI LEVU IN THE REPUBLIC OF FIJI

Fig. B-3.4

RESISTIVITY COLUMNS DERIVED FROM VES (7)

NIPPON KOEI CO., LTD
NIKKO EXPLORATION & DEVELOPMENT CO., LTD



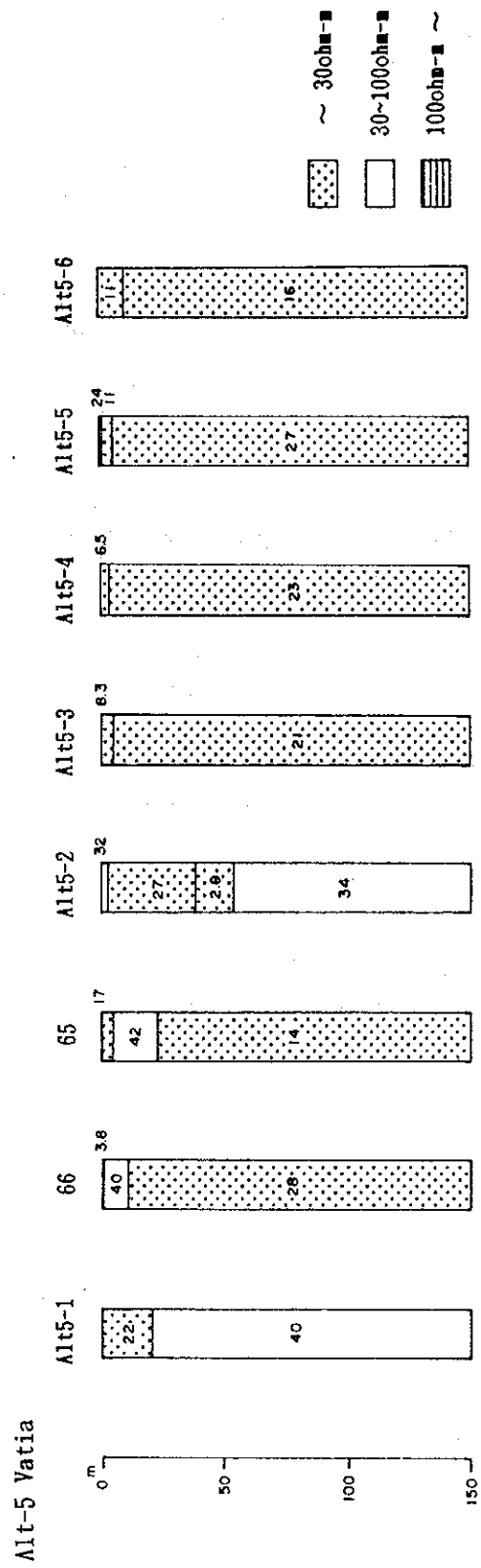
JAPAN INTERNATIONAL COOPERATION AGENCY (JICA)

THE STUDY ON GROUNDWATER DEVELOPMENT IN NORTH VITI LEVU IN THE REPUBLIC OF FIJI

Fig. B-3.4

RESISTIVITY COLUMNS DERIVED FROM VES (8)

NIPPON KOEI CO., LTD
NIKKO EXPLORATION & DEVELOPMENT CO., LTD



JAPAN INTERNATIONAL COOPERATION AGENCY (JICA)	
THE STUDY ON GROUNDWATER DEVELOPMENT IN NORTH VITI LEVU IN THE REPUBLIC OF FIJI	
Fig. B-3.4	RESISTIVITY COLUMNS DERIVED FROM VES (9)
NIPPON KOEI CO., LTD NIKKO EXPLORATION & DEVELOPMENT CO., LTD	

APPENDIX - C

TEST WELL DRILLING AND PUMPING TEST

APPENDIX - C

TEST WELL DRILLING AND PUMPING TEST

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1. INTRODUCTION

1.1 Drilling Works

The test well drilling work was programmed with an average depth of 70 m in order to understand the aquifer at 11 sites as shown in Fig. C-1.1 The target depth of test wells was determined according to the depth of existing wells, and the hydrogeological and geological conditions in the Study Area. The drilling work by direct rotary method was commenced by the JICA-MRD Study Team on 21 January 1994 during the 2nd field investigation using the existing MRD rotary drilling rig (Model Top-200), and 3 test wells, TW004, TW005 and TW010, were completed at the end of March 1994. The drilling tools and materials such as drilling bits, bentonites, casing pipes, and screens were prepared by JICA.

On 23 May 1994, drilling work during the 3rd field investigation was started at TW008 using a new rotary drilling rig (Model Top-300) which was provided by JICA. The drilling work by the direct rotary method using new and old drilling rigs progressed smoothly and 9 test wells, TW001, TW002, TW003, TW006, TW006A, TW008, TW009, TW011, and TW012, were completed at the end of August 1994, as shown in the drilling progress chart (Fig. C-1.2).

A geophysical logging was carried out by the JICA Study Team after drilling to the designated depth at each well. The following tests were carried out in the test wells during the 3rd field investigation because test pumps were not available in the 2nd field investigation.

- Step drawdown test
- Time drawdown test and recovery test
- Water quality analysis

The results of the drilling and tests are shown in Figs. C-1.3 (1) to C-1.3 (12).

1.1.1 Location and Quantity

The location of the test wells is shown on the location map (Fig. C-1.1) and the Composite Well Logs (Figs. C-1.3 (1)-(12)). The coordinates of the wells and the execution period are as follows:

Test Well No.	Coordinates	Execution Period	
		Commenced	Completed
TW001	1882400mE: 3940580mN	5-7-1994	21-7-1994
TW002	1885560mE: 3940330mN	18-7-1994	12-8-1994
TW003	1887600mE: 3932440mN	22-7-1994	6-8-1994
TW004	1888700mE: 3940050mN	28-1-1994	10-2-1994
TW005	1892800mE: 3940500mN	2-3-1994	15-3-1994
TW006	1894400mE: 3935380mN	14-6-1994	2-7-1994
TW006A	1894400mE: 3935380mN	27-6-1994	5-7-1994
TW008	1901780mE: 3947660mN	23-5-1994	16-6-1994
TW009	1911800mE: 3947560mN	30-6-1994	16-7-1994
TW010	1913050mE: 3950250mN	16-2-1994	28-2-1994
TW011	1934620mE: 3957840mN	25-5-1994	24-6-1994
TW012	1937740mE: 3957480mN	16-6-1994	30-6-1994

The drilling depth, diameter, screen position, and screen length are summarized in the List of Test Wells (Table C-1.1).

1.1.2 Method and Procedure

The drilling work was performed with Model Top-200 and Top-300 drilling rigs using a direct rotary drilling method.

The operation time of the well drilling is shown in Table C-1.2. According to this table, the drilling operation for 70 m accounted for 17 % of the total operation period of 4 days. The normal procedure for drilling work is summarized as follows:

Drilling commenced with 12.1/4" or 10.5/8" tricone bits to a depth of 10 to 20 meters using bentonite mud water. After the drilling reached these depths, the diameter was reduced to 8.1/2" and drilling continued to the designated depth. In some cases', 11" surface casings were installed into 12.1/4" holes and/ or 9" work casings were installed into 10.5/8" holes to protect the drilled holes from caving or collapse.

1.1.3 Geophysical Logging

The purpose of geophysical logging is to observe the lithological condition and determine the exact depth of each aquifer. The geophysical logging which consists of normal resistivity, SP, temperature and gamma ray logging, was performed with OYO

GEO-LOGGER 3030 MARK2. The results of the geophysical logging are shown in the composite logs in Fig. C-1.3.

1.1.4 Casings and Screens

Steel pipes with a diameter of 6 inches were used as casings for the test wells. The screens were stainless steel wedged wire wound types with continuous-slot screens and were installed at the water bearing formations, determined by lithology and geophysical logging. The slot size of the continuous-slot screen is 1 mm. The casing pipes and continuous slot screens for the test wells were joined by threaded and coupled joints. Steel pipes with a diameter of 11 inches were used for surface casing, and pipes with a diameter of 9 inches were used for work casing. The materials of the casing pipes and continuous-slot screens are shown in Table C-1.3.

1.1.5 Gravel Packing

Natural gravel was used to fill the annular space around the casing pipes and continuous slot screens of the test wells, except in the stable hard-compacted boreholes. The artificial packing gravel was composed of the rounded gravel of volcanic rocks and was sieved into 3 to 10 mm diameter gravels. The gravel was placed using a bucket into the annular space between the borehole and casing pipes from ground. After installation, the annular space above the top of the packing gravel was filled up to the ground surface with cement grout . The volume of gravel for each test well is shown in Fig. C-1.3.

1.1.6 Development

The development procedure is the most important work in the completion of a water well because the specific capacity of the well is improved by removing drilling fluid and fine clogging materials. Three stages of development were carried out in each rock aquifer test well. Initially, well development was executed with a high velocity water jetting method, that uses a jetting tool with nozzles and high pressure drilling pumps. The jetting action removed the drilling fluid and fine clogging materials from the fractures and crevices in the hard-rock formation. This method was continued until the water in the well contains only a very small quantity of sand.

The airlift method was then applied in the second stage of development, using an air pipe, which was lowered to the bottom of the drilled holes to clean the accumulated sand until the water became clean.

Final development was executed with the over pumping method by utilizing the test pump. Pumping was carried out at a higher rate than normal until the water become free of sand. Obviously, this method was not applied for the small capacity well, with big drawdowns.

In the case of unconsolidated formation aquifers, the same development methods were carried out until the water became clean. The overpumping operation at TW002 lasted for about 130 hours, due to difficulties encountered of drilling which resulted in the use of a large amount of bentonite.

1.2 Pumping Tests

1.2.1 General

The objectives of the pumping test are to determine the hydraulic characteristics of the water bearing formation, and ascertain the performance of the test well. There are three kinds of tests involved in the pumping test: the step drawdown test, the time drawdown test, and the recovery test. The step drawdown test is performed to evaluate the efficiency of the test well. The time drawdown test and time recovery test are performed to determine the hydraulic properties of the aquifer.

The pumping tests were carried out from June to August 1994, at eleven JICA test wells. The time drawdown and recovery tests were also accomplished by the JICA-MRD Study Team at two existing MRD observation wells to determine the coefficients of transmissivity. Two large yield wells were selected as pumping test wells from the MRD test wells. These wells were not evaluated using a long time continuous pumping test. The results of the pumping tests are shown in Table C-1.4.

1.2.2 Step Drawdown Test

The step drawdown test was performed to ascertain the aquifer behavior at different discharge rates and to evaluate the well loss at the each test well. Each step normally continued for 3 hours and there were 4 steps for each test. The tests were carried out on only 7 of the 11 test wells, because of the poor yield of 4 test wells. The relation between yield and drawdown of the test wells was calculated by the step drawdown test to ascertain the well loss and aquifer loss (see Table C-1.5).

1.2.3 Time Drawdown and Time Recovery Test

The drawdown test and recovery test were performed to determine the hydraulic characteristics of each aquifer at 11 JICA test wells and 2 PWD wells. The time drawdown and time recovery test data were interpreted by the Jacob's non-equilibrium equation. The pumping test analyses are shown in Table C-1.6. The recovery test, performed after the time drawdown test had finished, measures the water level after pumping has ceased.

2. TEST WELLS

2.1 TW001

Test well TW001 was drilled at the low resistivity anomaly zone, determined by electromagnetic sounding, in Vutuni Creek about 4 km from PWD's Ba depot. The purposes of TW001 were to confirm the lithology, permeability, and groundwater level of the low anomaly zone. The results of the test well drilling and pumping test are shown in Fig. C-1.3 (1).

The drilling operation was performed using mud water by a Model Top-300 drilling rig with a tricon rock bit to 76 m. The operation times of the well drilling are shown in Table C-1.2. The productive zone of this test well was expected 40 m below, because drilling cuttings have shown the existence of a thick clayey weathered layer beneath the thin topsoil 40 m below the surface.

The assembly of casing pipes and screens was installed to a depth of 76 m. Screens were installed at the productive zone from 43.1 m to 69.35 m which was determined by the lithology and geophysical logging. The results of the drilling cuttings indicate that the productive zone is composed of fractured andesite of Ba volcanics.

The step drawdown test was carried out in four steps from 2.59 l/sec to 3.73 l/sec. The depth to the water level in TW001 before the time drawdown test was 23.03 m. The time drawdown test was carried out for 48 hours at a 3.2 l/sec constant pumping rate. The final drawdown of the test was 11.2 m. According to the analysis of the pumping test data, the transmissivity of TW001 ranges from 46 to 49.1 m^2/day.

The water quality analysis of the pumped water obtained from TW001 indicated a good potable water supply.

2.2 TW002

Test well TW002 was spudded on the alluvial plain of the Ba river on July 18, 1994, by a Model Top-200 drilling rig with a tricon rock bit to determine the permeability of the alluvial deposits. The target depth was the bottom of the Quaternary deposits at about 30 m. Drilling began smoothly using mud water circulation. However, the driller encountered uncontrollable unconsolidated formations with hard boulders at a depth of 18 to 24.3 m. Despite the technical difficulties in drilling, the

driller reached the bottom of the Quaternary deposits at 24.6 m by using 2,400 kg of bentonite and 10 kg of Carboxy - Methyl - Cellulose (CMC). Finally the tricon bit reached the 36.40m level on July 26 1994. The well development procedure took a long time to remove the bentonite and CMC from the water bearing formation. The test well was completed on August 12, 1994 with the assembly of casing pipes and screens which had an inside diameter of 150 mm and a depth of 35 m. The operation times of the well drilling are shown in Table C-1.2.

Screens were installed at the lower portion of the unconsolidated deposits zone from 16 to 26.5 m which was determined by lithology of the drilling cuttings. The drilling cuttings indicate that the aquifer is composed of boulder, gravel, sand, and clay of alluvial deposits. The composite well log of TW002 is shown in Fig. C-1.3(2).

The step drawdown test was carried out in four steps from 2.43 l/sec to 4.27 l/sec. The depth to water level in TW002 before the time drawdown test was 3.27 m. The time drawdown test was carried out for 48 hours at a 2.75 l/sec constant pumping rate. The final drawdown of the test was 10.45 m. According to the analysis of the pumping test data, the transmissivity of TW002 is about 20 m^2/day.

According to the results of the water quality analysis of the pumped water the levels of, Iron (Fe) and Manganese (Mn) exceed the standards for drinking water.

2.3 TW003

Test well TW003 was drilled at Nukuloa in the Moto Uplands about 8 km south of Ba town to confirm of the permeability and water level of the tuffaceous sandstone in the left bank of the Ba river. The drilling operation was performed using mud water, by a Model Top-300 drilling rig using a tricon rock bit to 77 m. The results of the test well drilling and pumping test are shown in Fig. C-1.2. The operation time of the well drilling is shown in Table C-1.2.

According to the geological log, drilling cuttings of TW003 are mainly composed of impervious fine grained compacted tuffaceous sandstone. However, water leakages were observed in the shallow weathered sandstone of the test pit. The assembly of casing pipes and screens was installed to a depth of 76 m. Screens were installed from 37.6 to 53.35 m and from 58.75 to 69.25 m. During the development, a very small quantity of water with a large drawdown was confirmed using an air lift. After the development procedure, the static groundwater level was 41.19 m below the ground surface.

Consequently, the step drawdown test could not be carried out. The pumping test was carried out at 0.05 l/sec constant pumping discharge rate. The pumping time of the time drawdown test was only 45 minutes, due to its very small capacity. The final drawdown of the test was 3.76 m. According to the analysis of the pumping test data, the transmissivity of TW002 is 0.12 m^2/day. Therefore, groundwater development in tuffaceous sandstone is not expected in the Moto Uplands area.

2.4 TW004

Test well TW004 was drilled at Varadoli in the Ba Uplands which is located at the east end of Ba town. The purposes of this test well were to obtain data on the permeability and water level of basalt and basaltic breccia in the low hilly area on the right bank of the Ba river. The results of the test well drilling and pumping test are shown in Fig. C-1.3.

The drilling operation was performed using mud water by a Model Top-200 drilling rig with a tricon rock bit to 75.3 m. The operation times of the well drilling are shown in Table C-1.2. According to the geological log, the geological formation of TW004 can be divided into two parts. The first formation from the surface until 39 m is permeable and consist of basaltic volcanics of the Ba series . The second formation from 39 m to the bottom seems to be an impermeable formation of tuffaceous mudstone of the Ba series.

An assembly of casing pipes and screens was installed to a depth of 75.3 m. Screens were installed at the productive fractured zone from 10.3 m to 37.8 m which was determined by lithology and geophysical logging. The results of the drilling cuttings indicate that the productive zone is composed of a fractured andesite of Ba volcanics.

The step drawdown test was carried out in four steps from 1.95 l/sec to 2.40 l/sec. The depth to the water level in TW004 before the time drawdown test was 8.12 m. The time drawdown test was carried out for 48 hours at 2.89 l/sec constant pumping rate. The final drawdown of the test was 10.25 m. According to the analysis of the pumping test data, the transmissivity of TW004 ranges from 57.1 to 101.5 m^2/day.

The water quality analysis of the pumped water obtained from TW004 indicated a good potable water supply.

2.5 TW005

Test well TW005 was drilled at Veisaru in the Ba Uplands 5 km east of Ba town to obtain the data on the permeability of basalt and basaltic breccia, and to observe the water level. The results of the test well drilling and pumping test are shown in Fig. C-1.3.

The drilling operation was performed with mud water circulation by a Model Top-200 drilling rig using a tricon rock bit to 72 m . The operation times of the well drilling are shown in Table C-1.2. According to the geological log and geophysical logging, the geological formation of TW005 can be divided into three parts. The first group from surface until 37 m is composed of altered to weathered basaltic volcanics and lapilli tuff. The second group from 37 to 53 m consists of fresh olivine basalt of the Ba series . The third group from 53 to 72 m is composed of weathered basalt and volcanic ash.

The productive zones of this test well were expected at the weathered fractured volcanic area, and at the boundary of the fresh rock and weathered rock. Therefore, screens were installed independently at the three potential productive zones between 16.0 m and 54.3 m and a assembly of casing pipes and screens was installed to a depth of 72 m.

The step drawdown test was carried out with four steps from 2.01 l/sec to 3.43 l/sec. The depth to the water level in TW005 before time drawdown test was 9.81 m. The time drawdown test was carried out for 48 hours at a 2.35 l/sec constant pumping rate. The final drawdown of the test was 13.64 m. According to the analysis of the pumping test data, the transmissivity of TW005 ranges from 16.9 to 21.2 m^2/day.

According to the results of water quality analysis of the pumped water, the levels of Iron (Fe), Manganese (Mn), and Aluminum (Al) exceed the standards for drinking water.

2.6 TW006

Test well TW006 was drilled on the Koronubu Uplands by a Model Top-300 drilling rig with a tricon rock bit to determine the permeability of tuffaceous mudstone. Drilling began smoothly using mud water circulation. However, the driller encountered self flowing fissures at the depths of 12, 31.7, 49, and 67 m. Despite the technical difficulties in drilling, the driller reached the bottom of the target depth of 76 m.

Self flowing water indicates high electrical conductivities and has bad odor. The electrical conductivity below 31.7 m was 1,400 micro-simens, but at 12 m it was 670 micro-simens. It was then decided that the deeper portion fissures should be completely closed. Despite the technical difficulties, the self flowing fissures except shallower fissures were filled up from the bottom to 18.8 m from the surface by sand, gravel and cement. An assembly of casing pipes, with an inside diameter of 280 mm. was installed from the surface to 6.1 m to protect the drilled hole from caving. The operation times of the well drilling are shown in Table C-1.2. The drilling cuttings indicate that the aquifer is composed of a fractured zone of mudstone. The composite well log of TW006 is shown in Fig. C-1.3(6).

The step drawdown test was carried out in four steps from 1.53 l/sec to 2.63 l/sec. The depth to the water level in TW006 before the time drawdown test was 0.26 m above ground level. The time drawdown test was carried out for 48 hours at a 2.00 l/sec constant pumping rate. The final drawdown of the test was 4.80 m. According to the analysis of the pumping test data, the transmissivity of TW006 ranges from 45.8 to 57.5 m^2/day.

According to the results of the water quality analysis of the pumped water, the level of turbidity exceeds the standards for drinking water.

2.7 TW006A

Test well TW006A was drilled 1.5 m beside TW006 to measure the water quality and the permeability of a shallow fractured aquifer of mudstone, as the deep fractured mudstone in TW006 has very high electric conductivity. The target of the drilling depth was about 20 m. The drilling operation was performed smoothly using mud water, by a Model Top-300 drilling rig with a tricon rock bit to 21.35 m. The assembly of casing pipes and screens was installed to a depth of 21.35 m. Screens were installed from 6.3 to 15.85 m.

TW006A was used to observe the TW006 pumping test. The depth to the water level in TW006A before the time drawdown test was 0.22 m above ground level and the electrical conductivity of the self flowing water was 784 micro-simens. The results of the test well drilling and pumping test are shown in Fig. C-1.3(7). The operation time of the well drilling is shown in Table C-1.2.

2.8 TW008

Test well TW008 was drilled at Kukunirewa in the Matalevu Uplands, 5 km south-east of Tavua town. The purposes of this test well were to confirm the permeability, water level, and the water quality of basalt and basaltic breccia of the Matalevu Uplands. The results of the test well drilling and pumping test are shown in Fig. C-1.3 (8).

The drilling operation was performed using mud water, by a Model Top-300 drilling rig with a tricon rock bit to 75 m. The operation times of the well drilling are shown in Table C-1.2. The assembly of casing pipes and screens was installed to a depth of 75 m. Screens were installed at the four water bearing beds which were determined by lithology and geophysical logging from 16 m to 69.25 m . The results of the drilling cuttings indicate that the water bearing beds are composed of weathered fractured basalt of Ba volcanics.

The step drawdown test was carried out in four steps from 0.83 l/sec to 1.78 l/sec. The depth to the water level in TW008 before the time drawdown test was 0.92 m. The time drawdown test was carried out for 48 hours at a 1.3 l/sec constant pumping rate. The final drawdown of the test was 7.0 m. According to the analysis of the pumping test data, the transmissivity of TW008 is 51.38 m^2/day.

The results of an analysis of the water pumped from TW008 indicate that it is good for drinking.

2.9 TW009

Test well TW009 was drilled to confirm the water bearing bed of basalt and basaltic breccia along the geological lineaments at Drumasi in the Tavua Basin about 7.5 km southeast of Tavua town. The drilling operation was performed using mud water, by a Model Top-300 drilling rig with a tricon rock bit to 77 m. The results of the test well drilling and the pumping test are shown in Fig. C-1.3 (9). The operation time of the well drilling is shown in Table C-1.2.

According to the geological log, drilling cuttings of TW009 are mainly composed of very hard, fresh, consolidated, stiff, olivine basalt. Therefore, screens were not installed. An assembly of the casing pipes with an inside diameter of 280 mm, was installed 11 m from the surface to protect the residual soil of the shallow portion of the drilled hole from caving. During the development, a very small quantity of water with