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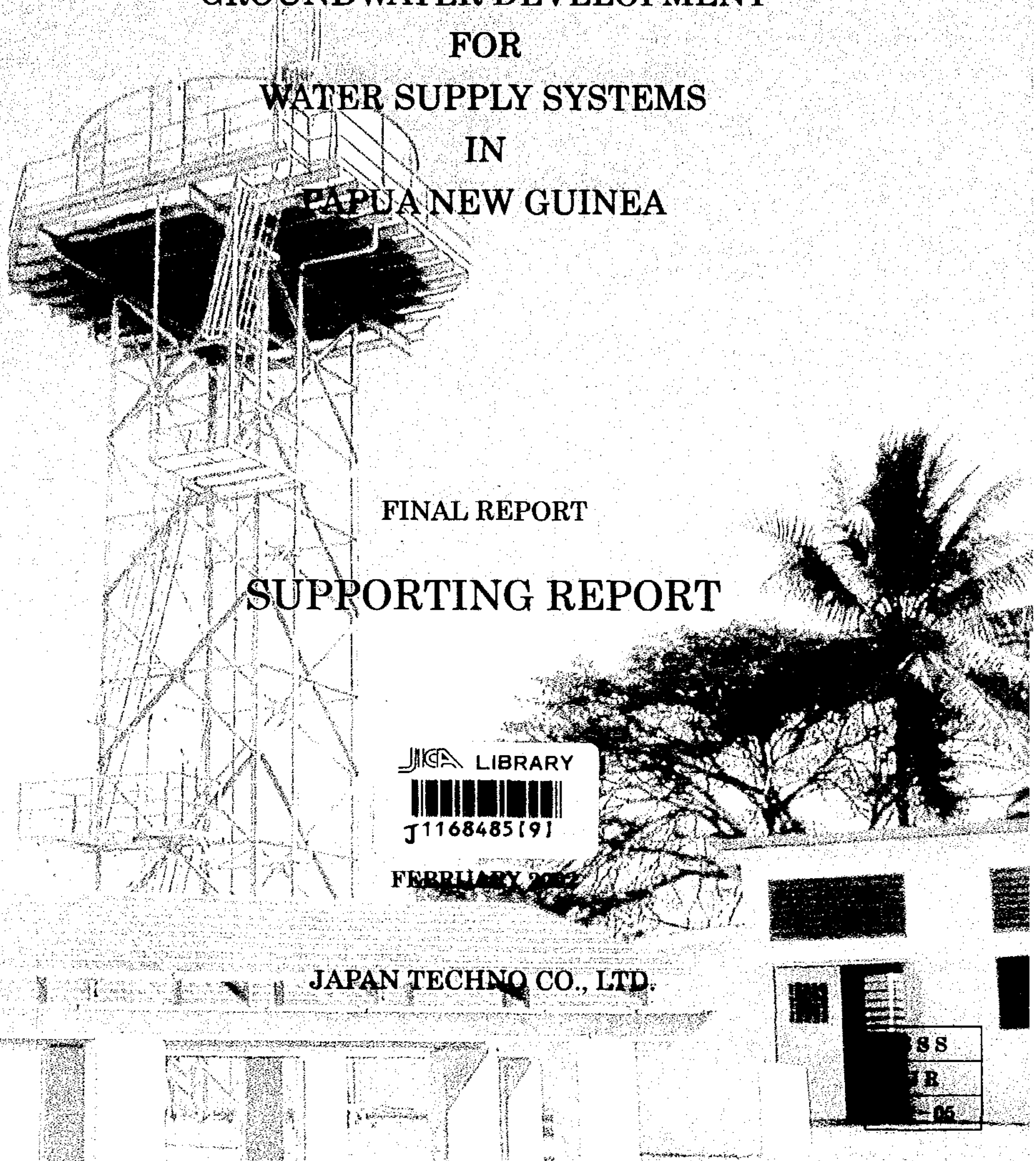
JAPAN INTERNATIONAL COOPERATION AGENCY
THE PAPUA NEW GUINEA WATERBOARD

THE STUDY ON GROUNDWATER DEVELOPMENT FOR WATER SUPPLY SYSTEMS IN PAPUA NEW GUINEA



FINAL REPORT

SUPPORTING REPORT

FEBRUARY 2002

JAPAN TECHNO CO., LTD.

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GEOPHYSICAL INVESTIGATIONS FOR GROUNDWATER IN EIGHT PROVINCIAL CENTRES IN PAPUA NEW GUINEA

1. INTRODUCTION

Papua New Guinea (PNG) has a moderate tropical climate with seasonal rainfall totaling more than 2,000 mm/year over much of the country (McAlpine, Keig and Falls, 1981). Although this is potentially good for water supplies, water resources are not so well developed. The low rainfall due to the El Niòo of 1997 – 1998 led to drought over large areas of PNG, while parts of the Highlands region were also affected by serious frosts. This caused widespread destruction of food gardens, on which much of PNG's rural population rely, and at the same time traditional water sources dried up.

In 1999 the PNG government requested the government of Japan to investigate the potential for developing water supply systems based on groundwater. In response to that request, the Japanese International Cooperation Agency (JICA) dispatched a preparatory study team in December 1999 to formulate the Scope of the Work for the study. The proposed study area covers 2 provincial towns and 6 district towns, all located on mainland of PNG.

Although the main partners in the project were JICA and the PNG Waterboard, the Geological Survey of Papua New Guinea (GSPNG) was requested to assist in providing personnel and equipment for the exploration component. In response to the request, GSPNG provided two geophysicists and the geophysical equipment. GSPNG also provided a hydrogeologist to assist in supervising the borehole drilling and testing part later in the project.

The geophysical survey was only one component of the study, the ultimate aim of which was towards improved water supplies to the selected towns. The other components included social and economic aspects, water quality, and the design and construction of the completed systems.

The eight provincial centres included in the project were Bereina, Gagidu (Finschhafen), Mutzing, Popondetta, Oro Bay, Daru, Kwikila and Kupiano, covering four provinces of PNG (Figure 1).

1.1 PROJECT INFORMATION

Exploration for groundwater in the eight provincial centres was organised and funded by the JICA. The project was contracted to Japan Techno, which in turn sub-contracted the geophysical exploration component to the Geological Survey of Papua New Guinea.

1.1.1 Aim of project

The aim of the geophysical investigations was to locate groundwater at depths possibly exceeding 50 m. Information on the depth and thickness of the aquifers would then be used to delineate suitable sites for drilling. Also, boreholes that were constructed as a result of the drilling programme should be able to meet the water supply demands of the towns concerned.

1.1.2 Team members

The exploration team comprised two geophysicists from the Geological Survey of Papua New Guinea and a counterpart geophysicist from the contractor, Japan Techno. The team was assisted, on a rotation basis, by civil engineers from the PNG Waterboard.

The team included the following members:

Nathan Mosusu	:	Geophysicist, GSPNG
Gabriel Tupi	:	Geophysicist, GSPNG
Masaru Fujita	:	Geophysicist, Japan Techno

1.1.3 Itinerary

Geophysical investigations were conducted according to the following schedule:

Bereina Station, 22 – 26th May, 2000

Finschhafen Station, 29th May – 1st June

Mutzing Station, 3rd – 5th June

Popondetta & Oro Bay, 9th –17th June

Daru, 29th June – 3rd July

Kwikila Station, 26th – 28th July

Kupiano Station, 8th – 12th August.

2. GEOPHYSICAL METHODS

Two geophysical methods were applied during the investigations; these are the resistivity and conductivity methods. The conductivity method was used only on Daru Island and with limited success, while the resistivity was applied in all the other towns and was the main method of investigation.

The conductivity method is based on electromagnetic fields (EM) generated by very low frequency (VLF) audio signals. The main physical properties involved here are the ratio between the primary magnetic field, generated by the transmitter, and the secondary magnetic field, generated by induced alternating currents in the earth. This ratio is proportional to the terrain conductivity, within certain limitations.

The equipment used for the conductivity survey was the Geonics EM34-3XL which has three intercoil spacing; 10 m, 20 m, and 40 m. The maximum depth achievable is 60 m, using a 40 m intercoil spacing applied in a vertical mode.

In the resistivity method direct current passed into the ground via steel electrodes. The potential drop across the current electrodes can be measured using potential electrodes, and thus the resistance to current flow can be calculated. By using appropriate geometrical constants applicable to the particular array type, apparent resistivity values are calculated. These are approximately representative of the formation resistivity being explored, at a given depth.

The equipment used for the resistivity survey was the Terrameter SAS 300 and its accompanying booster, the Terrameter SAS 2000.

Both the resistivity and the conductivity equipment had a few operating problems during the course of exploration.

The conductivity meter had communication problems between the transmitter and the receiver. This was diagnosed as a broken reference cable. It was discovered that all connecting leads had to be repaired in order to obtain reliable results. Resolving the problem and repairing the cable, took a lot of time and effort (Plate 1). In the end, conductivity measurements were carried out only on Daru Island and not Popondetta, as was original planned.

The Terrameter also had quite a few problems. The major one was with the power supply. The batteries used in the Terrameter are now quite old and should have been replaced. Due to high formation conductivity in certain areas, it was often difficult to reach the required depth of penetration. That meant a lot of power had to be used, resulting in quick draining of battery power. In areas where electricity supply was not a problem, it was easy to recharge the batteries to full capacity overnight before the next working day. However, in areas where electrical power supply was a problem, like Bereina and Kupiano, a car battery had to be used when the Terrameter battery was too low to operate (Plate 2).

Communication between the operator and the linemen was also a problem at times when long AB/2 spacing was required. That is due to the operational capabilities of the current walkie-talkies used, which are often hampered by tall trees. Again, like Terrameter batteries, the walkie-talkie batteries have to be recharged at the end of every field day. Where there was a problem with power supply, there was very little hope of using walkie-talkies the next day.

2.1 ANALYSIS AND INTERPRETATION METHODS

Resistivity data were interpreted using Resix-Ip software (Interpex, 1993). The linear filters used by the software to calculate resistivity curves are described by Davies et al., 1980. In this method of anaysis, an appropriate model is obtained by a process of inverse modeling to best fit the acquired data and is based on the least squares method. The method uses ridge regression as described by Inman, 1975, to iteratively adjust the starting model supplied by the user.

Interpretation procedures for conductivity are described by McNeil, 1980. Images obtained from the acquired data were created using Surfer (Golden Software, Inc., 1996).

The regional geology used in the figures described in the following report was taken from the Department of Mining's digitised geology map of Papua New Guinea. It is a preliminary version, and only contains the major rock units. In some areas the rock units may appear to be slightly translated in their respective positions. For a more detailed description of the geology of specific sites, it is recommended that reference is made to the 1:250 000 geological map sheets.

3. DETAILED ASSESSMENT OF PROVINCIAL CENTRES

3.1 BEREINA, CENTRAL PROVINCE

Eleven vertical electrical soundings (VES) were performed in and around the vicinity of the Bereina Station (Figure 2a). Ten of the soundings used the Schlumberger configuration, and one used the Wenner array. For the Schlumberger soundings, a maximum AB/2 spacing of 420 m was used, while for the Wenner array, soundings were performed up to a maximum electrode separation (a) of 200 m.

3.1.1 Geology

The geology of Bereina is detailed in the Yule 1:250 000 geology map sheet (Brown, 1977). In Figure 2b the locations of the resistivity soundings are superimposed on the digitised geology map of Papua New Guinea to show the area covered.

The area is mostly underlain by Quaternary alluvium (Figure 2b). The alluvium consists mainly of gravel, sand, silt and mud and littoral deposits. To the east are the Mount Davidson Volcanics comprising basaltic and minor andesitic agglomerate, tuff, lava, lava breccia with intercalated volcanically derived conglomerate. To the west of the Quaternary alluvium is the Apinaipi Formation. This formation contains calcareous and non-calcareous tuffaceous sandstone, pebble and cobble conglomerate, siltstone and mudstone.

3.1.2 Resistivity sounding results

Sounding BR-01S

Sounding BR-01S was located along the Bereina- Aipeana road. Coordinates for the GPS position of the sounding are 446950 mE and 9052644 mN and oriented in a NE direction (020 degrees).

The sounding was interpreted with 4 layers. The top layer is approximately 1 metre thick (0.84 m) and modeled with resistivity, 42 Ωm. Below the top layer is a layer with resistivity 418 Ωm, and 15 m thick. The third layer, at a depth of approximately 16 m, was modeled with a low resistivity, 8.6 Ωm, and is approximately 28 m thick. The bottom layer has a resistivity of 97 Ωm.

Sounding BR-02S

The second sounding, BR-02S was located along the same Bereina - Apeana road, approximately 4.5 km south of BR-01S. The coordinates for the GPS position of the sounding are approximately 446456 mE and 9049155 mN and on a bearing of 178 degrees magnetic north.

The sounding was modeled with 3 layers. The top layer with a resistivity of 72 Ωm and thickness 8 m. Below the top layer is a 15 m thick layer of resistivity 9 Ωm. This layer is very conductive, most probably indicative of a water-saturated clay. The third layer was modeled with a very high resistivity of 11,6516 Ωm and is most probably the bedrock layer.

Sounding BR-03S

Sounding BR-03S was conducted along the Bereina - Inawi road and was modeled with 4 layers. The top layer has a thickness of 0.6 m and resistivity 111 Ωm. The second layer, modeled with a thickness of approximately 5 m and has a resistivity of 3,611 Ωm. The third layer is a conductive layer with a modeled thickness of 18 m, and a resistivity of 19 Ωm. The underlying layer has a higher modeled resistivity, 98 Ωm.

Sounding, BR-04S

The fourth sounding was conducted along the main highway, approximately 6 km east of Bereina station. GPS coordinates of the sounding position are 452362 mE and 9046080 mN.

The sounding was modeled with 4 layers. The first layer is approximately 1 metre thick (0.85 m) and has a resistivity of 189 Ωm. This second layer was modeled with a thickness of 10 m and resistivity 252 Ωm. Below the second layer is a low resistivity layer, approximately 48 m thick with a modeled resistivity of 64 Ωm. The bottom layer has a higher resistivity than the third layer with a resistivity of 395 Ωm.

Sounding BR-05S

Sounding BR-05S was located between Bereina Station and Mainohana High School. The GPS location of the sounding is 448098 mE and 9046966 mN. and oriention is on a bearing of 022 degrees.

BR-05S was modeled with 4 layers. The top layer is approximately 0.6 m thick and has a resistivity of 120 Ωm. The second layer has a modeled thickness of approximately 5 m and a resistivity of 152 Ωm. The third layer, which is most probably the aquifer layer, has a resistivity of 50 Ωm and is approximately 84 m thick. The bottom layer has a resistivity, 9,219 Ωm, most probably representing the bedrock layer.

Sounding BR-06S

Sounding BR-06S was located along the road between Bereina Station and Waima. The GPS coordinates of the sounding position are 9046908 mN and 445505 mE and orientated on a bearing of 162 degrees.

The sounding was modeled with 4 layers. The top layer was modeled with a thickness of 0.4 m and has a resistivity of 11 Ωm. The second layer is very conductive with a resistivity of 3 Ωm and a thickness of 2 m. The third layer, at a depth of approximately 2.4 m, has a resistivity of 111 Ωm and thickness 15 m. This layer is most probably the water bearing layer. The resistivity of the fourth layer is higher at 442 Ωm.

Sounding BR-07S

Sounding BR-07S was located near the entrance to the Inawi road. The GPS location of the sounding is 448098 mE and 9046966 on a bearing of 135 degrees.

The sounding was modeled with 4 layers. At the top is a very thin layer (0.2 m) of resistivity 479 Ωm. The second layer is slightly lower in resistivity with a modeled value of 430 Ωm and is approximately 36 m thick. The third layer is very conductive with a resistivity of 5 Ωm and is approximately 8 m thick. The bottom layer is highly resistive, more than 54,000 Ωm and is probably the bedrock layer.

Sounding BR-08S

Sounding BR-08S was conducted within the Station area at GPS position 9045364 mN and 445778 mE and oriented on a bearing of 035 degrees.

The sounding was modeled with 4 layers. The top layer is 2 m thick with a resistivity of 442 Ωm. The second layer was modeled with a thickness of 4.6

m and resistivity 733 Ωm. The third layer, at a depth of approximately 6.3 m, is 15 m thick and has a resistivity of 32 Ωm, and probably represents the water bearing layer. The bottom layer was modeled with a high resistivity of 7,302 Ωm and is presumably the bedrock layer.

Sounding BR-09S

Sounding BR-09S was conducted within Bereina Station at an approximate GPS position of 446054 mE and 9045616 mN with an orientation of 101 degrees.

BR-09S was modeled with 4 layers. The top layer with a resistivity of 12 Ωm, is approximately 0.8 m thick. Below the top layer is a 5 m thick layer of resistivity 225 Ωm. The conductive second layer is approximately 22 m thick, with a resistivity of 9 Ωm and presumably is the aquifer layer. Underlying this water bearing layer is a bedrock layer with a high resistivity at 4,203 Ωm.

Sounding BR -10S

Sounding BR-10S was conducted opposite the Police Station, at GPS position 446058 mE and 9045214 mN. At this location both Schlumberger (BR-10S) and Wenner (BR-10W) configurations were used. Both soundings were orientated on the same bearing of approximately 225 degrees.

Sounding BR-10S was modeled with 3 layers. The top layer is relatively dry with a resistivity of 161 Ωm, and is approximately 4 m thick. The second layer, approximately 11 m thick, is less resistive than the top layer with a modeled resistivity of 31 Ωm. This is most probably the aquifer layer. The third layer is very resistive, with a model resistivity value of 48,627 Ωm and represents bedrock.

Sounding BR-10W

Sounding BR-10W was modeled with 5 layers. The 3-layer model on BR-10S was used as the starting model for the top layers. Hence the top layer for this sounding has a model resistivity of 469 Ωm and a thickness of approximately 5 m. The second layer has a relatively low resistivity of 74 Ωm and thickness 10 m. The third layer has a very high resistivity at 1,186 Ωm and thickness 28 m. The fourth layer was modeled with a resistivity of 114 Ωm and is approximately 27 m thick. The bottom layer is highly resistive, at 1,873 Ωm, and is presumably the bedrock layer.

3.1.3 Discussions

Most soundings conducted around the vicinity of Bereina town were interpreted using 4 layer models. The only exceptions were soundings BR-02S and BR-10S (3 layers), and BR-10W (5 layers).

The location map, when overlain on the regional geology map (Figure 2b), shows all soundings are in Quaternary alluvium deposits. The only exceptions are BR-02S and BR-06S, which may have been located very close to the boundary between Quaternary deposits and the Apinaipi Formation.

The soundings performed in the northern part of the area include BR-01S, BR-02S, and BR-03S. Except for sounding BR-02S, which can be regarded as having had a lot of measurement errors, BR-01S and BR-03S can be used to discuss the general lithology of the area.

The soundings show a very thin top layer between 0.2 – 1 m thick. This layer most probably comprises damp silty clay. There is a general increase in the resistivity of the second layer, suggesting most probably a decline in water and clay content, and a general increase in the sand content. The thickness of this layer is between 5 and 15 m. There is a conductive layer at a maximum depth of approximately 16 m. This presumably is the water bearing layer and has a thickness of between 18 and 28 m. The geology may change yet again as the sounding reaches the weathered zone at a maximum depth of 43 m. This rise in the resistivity curve is not very well manifested in the sounding curves, and is therefore only an assumption.

Soundings BR-06S, BR-07S, and BR-04S can be grouped together due to their close proximity. The larger electrode spacing for sounding BR-07S was conducted using a car battery, after it was realised that the Terrameter battery was not giving enough power. Hence it is possible that the data obtained for the shallow penetration may not be very accurate.

Only sounding data for BR-06S and BR-04S were used to describe the general subsurface features of the area. Sounding BR-04S show similar features to the sounding curves for BR-01S – BR-03S. The conductive layer is the third layer, at depth between 11 and 15 m. Here the resistivity value for this layer is high, between 64 and 111 Ωm, indicating most probably a more potable freshwater layer.

Within the Station (BR-08S – BR-10S & BR-10W) show that the freshwater aquifer most probably would be at depths between 4 and 6 m. The resistivity of the possible freshwater bearing layer is between 9 Ωm at BR-09S and 30 Ωm for BR-08S and BR-10S. It is most likely the layer is 10 to 15 m thick. BR-10W was able to reach what may seem like another freshwater aquifer at a depth of 43 m. This layer has a resistivity of 114 Ωm, and appears to have an appropriate resistivity for potable freshwater. Based on the interpretation of sounding BR-10W, bedrock may be reached at depth approximately 70 m.

Sounding BR-05S has the freshwater aquifer at a depth of approximately 5.6 m and approximately 84 m thick. However, no other soundings were conducted within its proximity to confirm the true thickness.

Two profiles (Figure 2c) were created from the interpreted sounding results. The profiles are used to show the approximate horizontal variation in the interpreted depth to the freshwater aquifer and its thickness.

At the very northern end of the profile, the freshwater aquifer appears to be deeper within the town area (44 m), and very shallow further south, 3 to 6 m. The thickness of the freshwater aquifer at the northern end is not defined. Within the town area, however, the aquifer is bounded at depth by a conductive layer, most probably clay.

The position of the highly resistive bedrock layer is very well shown here. At the location of BR-06S, the bedrock layer is at a slightly shallower depth than the other areas. This is not unusual as the sounding location is very close to the Apinaipi Formation. The Apinaipi Formation most probably forms the bedrock around the survey area. Around the town area the depth to the bedrock layer appears to become shallow towards the south. Further south, however, the trend is different. The depth to the calcareous sandstone bedrock suddenly becomes very deep, which can also be explained by the sounding position with respect to the location of the Apinaipi Formation.

The location of the calcareous sandstone bedrock is important in order to establish the aquifer properties.

3.1.4 Conclusions and Recommendations

Interpretation of the sounding curves can be summarised as follows:

- Within the proximity of Bereina Station, shallow aquifers are present at approximate depths of 5 m. The thickness of the aquifer is between 30 and 40 m.
- Generally the aquifer thickens towards the south. This also implies that depth to bedrock is deeper to the south, near Mainohana High School.
- Based on the Wenner sounding, there is a possibility of finding a deeper freshwater aquifer at a depth greater than 40 m.
- It is recommended that more Wenner soundings should be conducted to ascertain this possibility.
- For a deeper borehole, the siting of a borehole near to sounding position BR-10W is recommended.

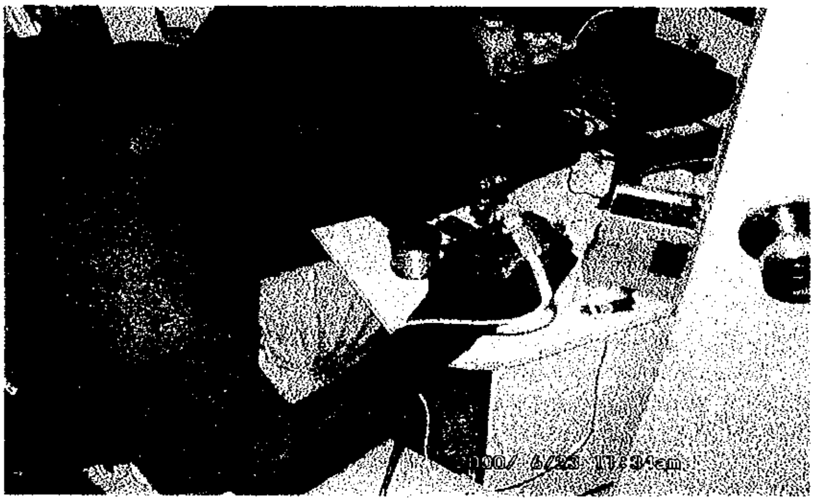
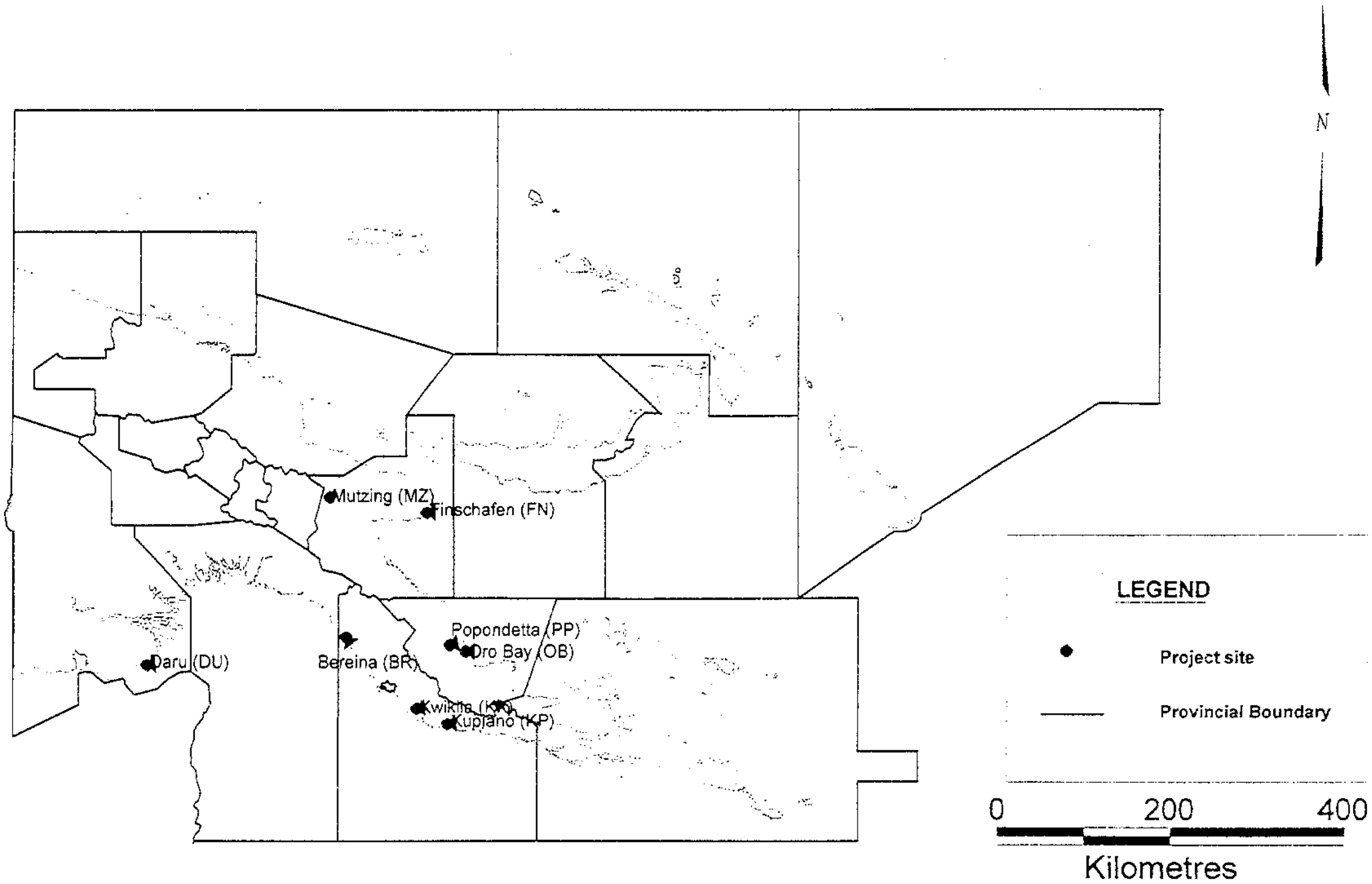


Plate 1. Repairing EM34-3XL reference cables.
Broken cables resulted in lack of communication between transmitter and receiver.

Plate 2. Prepairing car battery connectors for use with the Terrameter. Low terrameter battery voltage, due to insufficient charging, often led to the need to use car batteries.

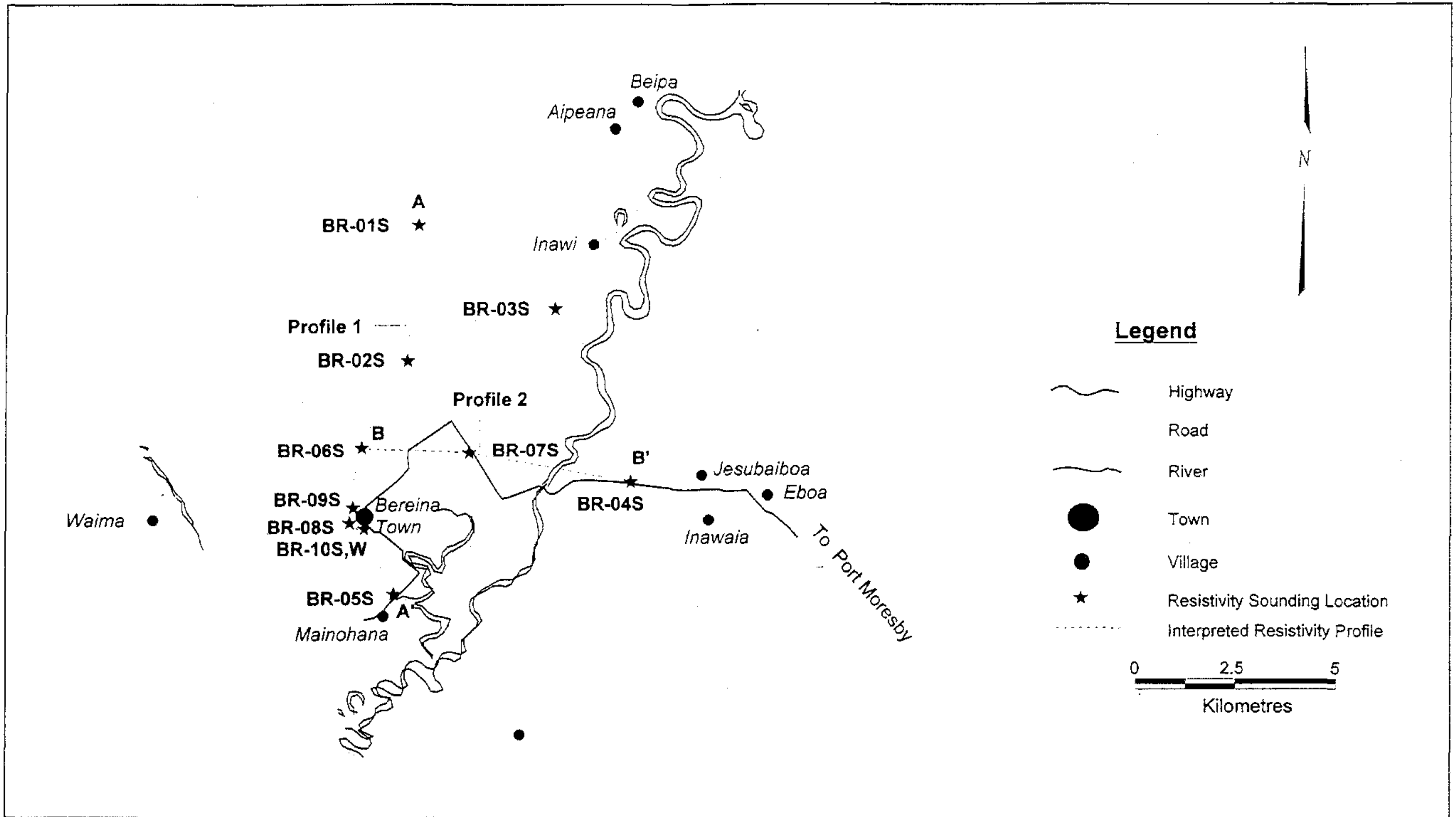


Location map of project sites

Investigations of groundwater resources in Papua New Guinea, 2000

Geophysical Surveys Branch
Geological Survey Division
Department of Mining

Figure 1

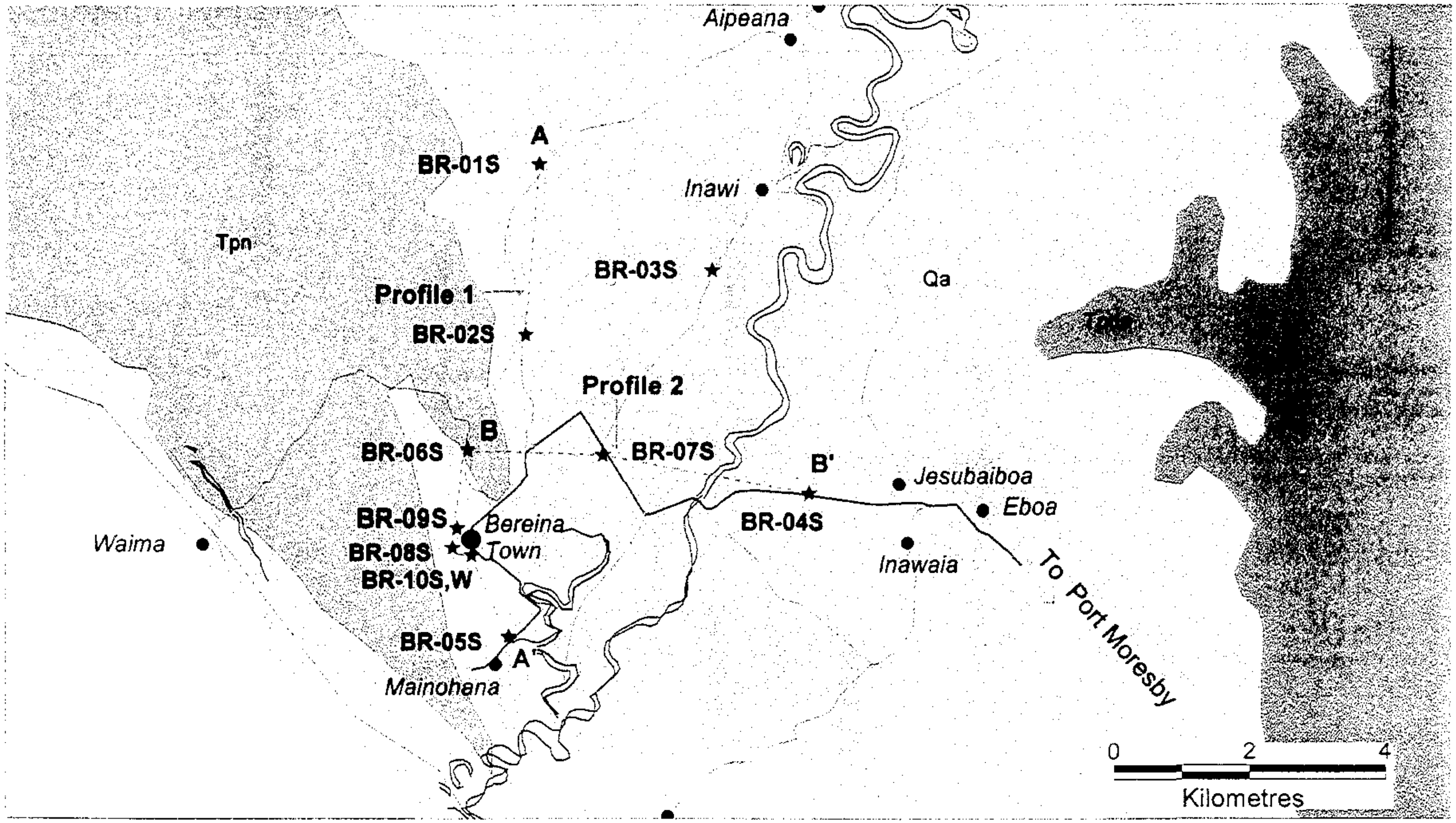


Location map of resistivity sounding, Bereina

Investigations of groundwater resources in Papua New Guinea, 2000

Geophysical Surveys Section
Geological Survey of PNG
Department of Mining

Figure 2a



Map of resistivity sounding over regional geology of Bereina

Investigations of groundwater resources in Papua New Guinea, 2000

Geophysical Surveys Branch
Geological Survey Division
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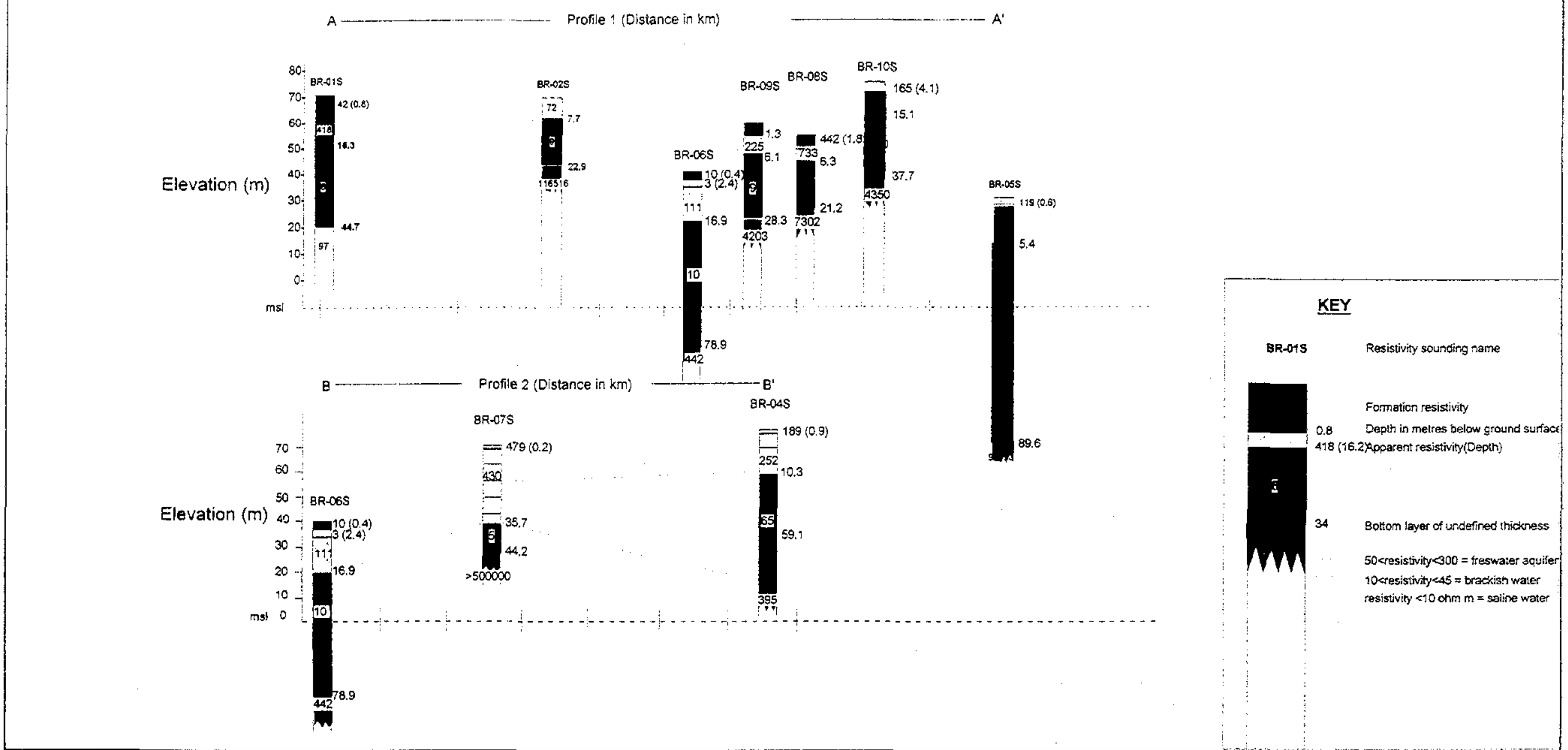
Figure 2b



Interpreted resistivity sounding profiles, Bereina

Investigations of groundwater resources in Papua New Guinea, 2000

Geophysical Surveys Section
Geological Survey of PNG
Department of Mining

Figure 2c

3.2 FINSCHHAFEN, MOROBE PROVINCE

Eleven geo-electrical soundings were conducted around the Finschhafen area (Figure 3a). Nine soundings were conducted using the Schlumberger configuration and two were conducted using the Wenner array. The Schlumberger soundings had a maximum AB/2 of 420 m while the Wenner array had a maximum electrode separation (a) of 200 m.

3.2.1 Geology

Finschhafen is located on the eastern tip of the Huon Peninsula, a tectonically active belt bounded to the south by the Markham Fault Zone, and to the north by the zone of active volcanic islands (Manam, Karkar, Long etc.) which extend from the Schouten Islands to northern New Britain Island.

The stratigraphy of the Huon Peninsula is described in the 1:250 000 *Geological Series-Explanatory Notes of the Huon-Sag Sag map sheet* (Robinson, 1974). Sixteen mappable units, ranging in age from Oligocene to Holocene, have been recognised within the Peninsula. To the southwest, the Lower Oligocene-Lower Miocene Finisterre Volcanics pass laterally into paraconglomerates associated with turbidite deposits of the Pindiu Sandstones. Probably throughout the Lower Miocene to Pliocene reefal complexes of the Gowop Limestone formed on the edges of the step-faulted blocks of the Finisterre Volcanics. The fine grained fore-reef Song River Calcarenite, equivalent to the limestone, occurs to the east of the volcanics. Raised coral reefs, Wandokai Limestone, formed by intermittent uplift and terraced by marine erosion, occur further to the east and northeast of the Huon Peninsula in the Madang area.

3.2.2 Resistivity sounding results

Sounding FN-01S

Sounding FN-01S was conducted at the southern end of the Finschhafen airstrip on a bearing of 166 degrees. Both the Schlumberger and Wenner configurations were employed at this location.
The soundings obtained were modeled using 4 layers. Layer one is approximately 5 m thick, with a resistivity of 1,041 Ωm. The layer is assumed to be composed of dry coral limestone hence the very high resistivity. The second layer was modeled with a resistivity of 309 Ωm, and a thickness of 43 m. The third layer is more conductive than the second layer and modeled with a resistivity of about 29 Ωm, and a thickness of 54 m. The bottom layer is a high resistivity layer, presumed to be the bedrock, with a resistivity of 2,342 Ωm.

Sounding FN-01W

Sounding FN-01W was conducted at the same location as FN-01S also using a 4-layer model. The top layer was modeled with a resistivity of 982 Ωm and has a thickness of about 10 m. The second layer has a modeled resistivity of

418 Ωm and a thickness of about 30 m. The conductive third layer was modeled with a resistivity of 33 Ωm and is about 62 m thick. At the bottom is a layer with high resistivity, approximately 2,110 Ωm and is most probably bedrock.

Both sounding curves are similar. However, there are minor variations due to the resolution of each sounding method, but this is not unusual.

Sounding FN-02S

Sounding FN-02S was conducted at the eastern end of the airstrip and was oriented parallel to the runway, on a bearing of 166 degrees.

The resulting sounding curve is strikingly different from that obtained on the western end. The curve has two very conductive layers between three very resistive layers. The curve was modeled with 5 layers. At the top is a very resistive layer approximately 1 metre thick (0.8 m) with a resistivity of 4,882 Ω m. The second layer was modeled with a thickness of 1.6 m and a resistivity of 154 Ωm. A very resistive third layer, 5,827 Ωm, and thickness approximately 5 m, separates the two conductive layers. The fourth layer has a resistivity of 14 Ωm and is approximately 5 m thick. The fifth layer is very resistive, with a model resistivity of 9,4625 Ωm and is presumed to be bedrock.

Sounding FN-03S

Sounding FN-03S was conducted east of the Logaweng Seminary and was aligned on a bearing of 166 degrees.

The sounding was modeled with 5 layers. The top layer has a resistivity of 192 Ωm, and is approximately 1.4 m thick. Below that is a 3 m thick layer with a model resistivity of 427 Ωm. The third layer was modeled with a thickness of 2 m and a resistivity of 1,100 Ωm. A conductive fourth layer follows with a resistivity of 27 Ωm and is approximately 29 m thick. The underlying bedrock layer was modeled with a resistivity of 391 Ωm.

Sounding FN-04S

Sounding FN-04S was conducted along the Finschhafen-Pindiu road, west of the Finschhafen-Logaweng road junction. The orientation of the resistivity spread was on a bearing of 230 degrees.

The sounding curve was modeled with 5 layers. The top layer has a modeled resistivity of 443 Ωm and a thickness of approximately 0.3 m. The second layer has a modeled thickness of about 2 m and a resistivity of 1,185 Ωm. The third layer has a lower resistivity than the second layer with a resisitvity of 439 Ωm and is approximately 32 m thick. A more conductive fourth layer follows with a resistivity of 39 Ωm and an approximate thickness of 25 m. At the bottom is the bedrock layer with a resistivity of 7,797 Ωm.

Sounding FN-05S

Sounding FN-05S is located approximately west of sounding FN-04S on a bearing of 279 degrees.

The sounding was modeled with 5 layers. The first layer is very thin, approximately 0.3 m thick and has a model resistivity of 1,066 Ωm. The second layer is more resistive than the top layer and was modeled with a resistivity of 2,253 Ω m and is approximately 3.5 m thick. Beneath the resistive second layer is a low resistivity third layer. The resistivity is about 246 Ωm, and is approximately 28 m thick. The fourth layer is even less resistive than the third, with a model resistivity of 139 Ωm and is approximately 10 m thick. Bedrock was intercepted at a depth approximately 73 m below ground level.

Sounding FN-06S

Sounding FN-06S was conducted along the Sokaneng - Bugaim road with the resistivity spread aligned on a bearing of 114 degrees.

The sounding was modeled with 3 layers. At the top is a 6 m thick layer with a resistivity of 50 Ωm. Below is a very conductive second layer with a model resistivity value of 8 Ωm and thickness 9 m. It is presumed that the bedrock layer is shallow, and may be intercepted at a depth of about 15 m.

Sounding FN-07S

Sounding FN-07S was conducted towards the southern end of the Logaweng Seminary. The GPS coordinates of the sounding location are 590314 mE and 9267561 mN and aligned on a bearing of 340 degrees.

The sounding curve was modeled with 4 layers. The top layer is very thin, approximately 0.3 m thick and was modeled with a resistivity of 16 Ωm. The second layer was modeled with a resistivity of 67 Ωm and a thickness of approximately 24 m. The third layer is more resistive than the second with a resistivity of 1,932 Ω m and is approximately 13 m thick. The fourth layer has a low resistivity at 269 Ωm.

Sounding FN-08S

Sounding FN-08S was conducted at the northern end of the Seminary. The GPS coordinates of the sounding are approximately 592112 mE and 9269016 mN and oriented on a bearing of 267 degrees.
The sounding curve was modeled with 3 layers. The top layer is approximately 0.1 m thick and has a resistivity of 16 Ωm. The second layer is the high resistivity layer with a resistivity of 77,276 Ωm and is 7 m thick. The third layer has a low resistivity of 8 Ωm.

Sounding FN-09

Sounding FN-09 was conducted along the Butaweng – Gagidu roads. The GPS coordinates of the sounding are 592216 mE and 9270359 mN. However due to the sounding's orientation with respect to the river, it was preferable to use the Wenner array.

The sounding was modeled with 6 layers. The first layer was modeled with a resistivity of 145 Ωm and a thickness of about 1 m. The second layer was modeled with a resistivity of 275 Ωm and thickness 3.5 m. Beneath the second layer is a 55 m thick layer of a slightly lower resistivity at 231 Ωm. The fourth layer is a high resistivity layer, 609 Ωm, and thickness 54 m. Before reaching bedrock, there is a conductive fifth layer with a resistivity of 57 Ωm and about 65 m thick. The bedrock layer with a resistivity of 2,552 Ωm follows.

Sounding FN-10S

Sounding FN-10S was located within the Station. The GPS coordinates of the sounding position are 594137 mE and 9270032 Mn and oriented on a bearing of 155 degrees.

The sounding curve for FN-10S used a 5-layers model. At the top is a 1.5 m thick layer of resistivity 108 Ωm. This is followed by a 7 m thick layer with resistivity 593 Ωm. The third layer was modeled with a resistivity 150 Ωm and thickness 28 m. An even less resistive layer was modeled for the fourth layer with a resistivity of 28 Ωm and is approximately 48 m thick. The bottom layer is most probably bedrock with a resistivity of 950 Ωm.

Sounding FN-11W

Sounding FN-11W is a Wenner sounding conducted near the Butaweng River and was oriented parallel to the river.

The sounding curve was modeled with 4 layers. The top layer is approximately 2 m thick and modeled with a resistivity of 333 Ωm. The second layer is lower in resistivity with a model value of 144 Ωm and thickness 7 m. A high resistivity layer was modeled as the third layer with a resistivity of 1,910 Ωm and a thickness of 12 m. At the bottom is a very conductive layer with a resistivity of 24 Ωm.

3.2.3 Discussions

The soundings performed around Finschhafen can be grouped into four main types of curves, and include double descending, double ascending, minimum and maximum.

Group One: Sounding FN-08S is a maximum-type curve, the bedrock layer is shallow, about 1 m below ground level, and may be at least 8 m thick, before conductive material is reached. This conductive zone is possibly the freshwater bearing layer.

Group Two: Minimum-type curves were observed at FN-06S and FN-11W. At FN-11W near the Butaweng creek, it is possible that the conductive layer, approximately 2 m below ground level, is the freshwater table. The Butaweng River also contributes to this very conductive layer. A resistive limestone borders this layer and forms another aquifer, at approximately 20 m below ground level. The thickness of this aquifer was not established from the sounding.

Sounding FN-06S shows similar conditions. The freshwater aquifer can probably be intercepted at depth approximately 44 m below ground level. The shallow conductive layer at 6 m may be influenced by nearby creeks. However as this layer is 15 m thick, it may be an option for drilling.

Group Three: Double ascending type-curves were obtained for soundings FN-02S, FN-03S, FN-07S, and FN-09S. The resistivity of the soundings at these locations suggests that resistivity progressively increases with depth. This may indicate the chances of intercepting freshwater aquifers at these locations are very low.

Group Four: Soundings FN-01S, FN-01W, FN-04S, FN-05S, and FN-0S yielded double descending-type curves. Freshwater aquifers are most likely to be found in the first descent. The resistivities of the layers range between 100 and 400 Ωm and thickness 30 and 40 m. These locations represent the best possibility to access freshwater aquifers. Depth to bedrock is between 40 m at FN-05S to almost 100 m near the coast.

Sounding locations do not appear to correspond with the known geology of the area. When compared to the geology map given in the explanatory notes, it would appear that all the soundings were located in the area covered by the Song River Calcarenite. Here bedrock is expected to be reefal limestone.

The interpreted soundings were used to create three profiles of the resistivity properties of the subsurface lithology (Figure 3c):

Profile 1 comprises the western-most soundings. The maximum depth of penetration for this profile appears to be 45 m below ground level (bgl), near the coast. The character shown by this profile appears to be controlled by the topography. At higher elevations the conductive layer is most probably the freshwater layer. At the coast, however, this conductive layer appears to be too low in resistivity, implying most probably that it is saline water. In all soundings there is a high resistivity layer that appears just above the conductive layer. This resistive layer is most likely to be the Song River calcarenite/ reefal limestone. The thickness of this highly resistive layer is between 10 and 20 m, increasing towards the south.

Profile 2 attempts to show the behaviour of subsurface resistivity from the mountain to the coast. Again the behaviour is similar to that observed in

Profile 1. The only exception is in the middle, with sounding FN-08S. There appears to be a steep ascent and descent in resistivity levels, at a very shallow depth. Here it is assumed the coral limestone bedrock is at a very shallow depth. The thickness of the limestone layer is also quite consistent at about 10 to 15 m. Depth to the possible freshwater layer decreases from 12 m, at the highest elevation, to 2 m at the coast.

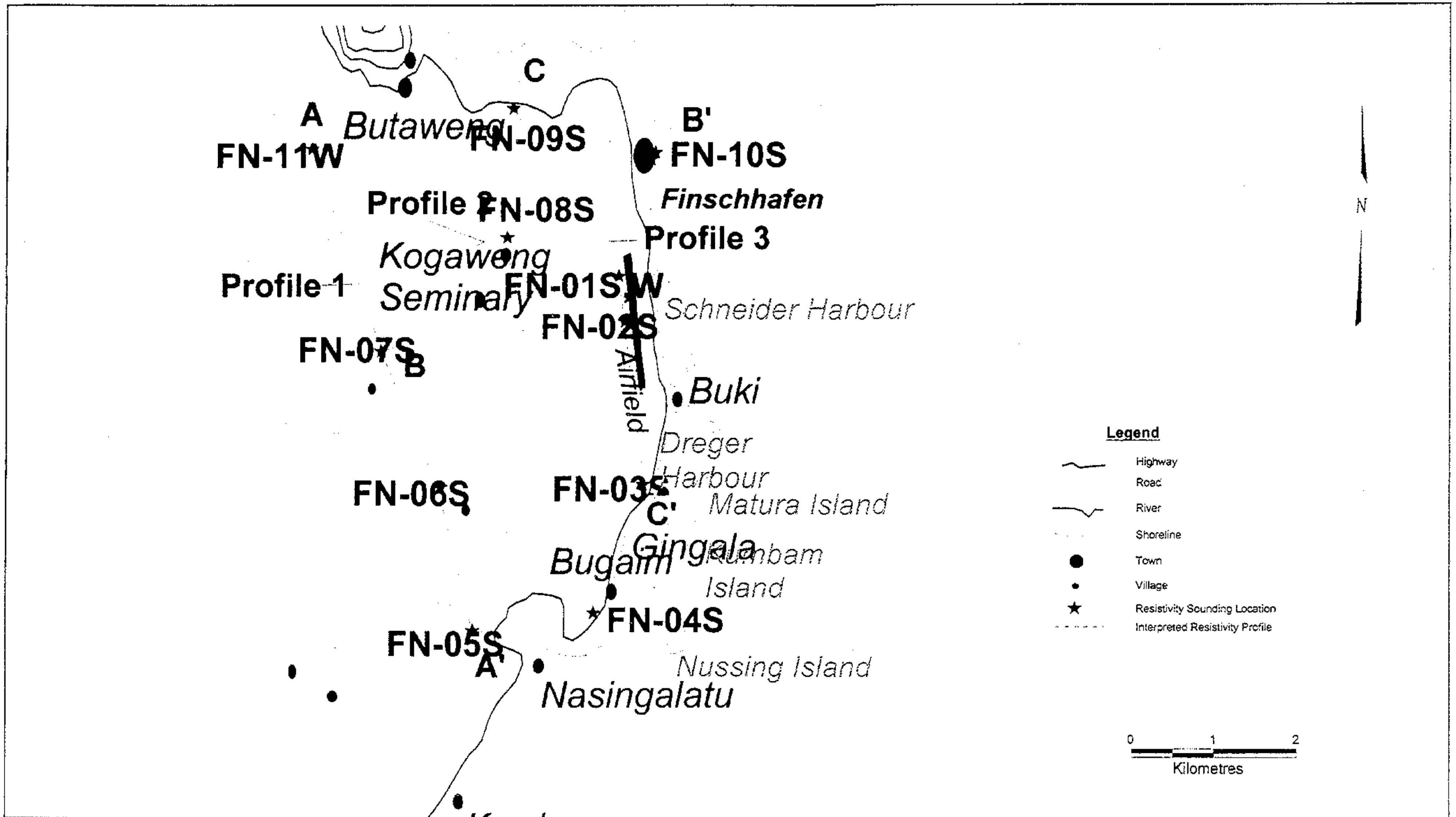
Profile 3 depicts very thin freshwater aquifer systems at a very shallow depth (1 m), up to about 5 m thick along the coastline. But below that, the high resistivity limestone layer separates the aquifers from the saline water layer. The saline water layer is at depth of about 40 m and is bounded at depth by another high resistivity layer. This occurs at depth of between 100 and 200 m.

From the profile it appears that the depth to the freshwater layer remains almost horizontal along the coast. The aquifers appear thicker in the northern part of the surveyed area while near Bugaim village the aquifer is thinnest.

3.2.4 Conclusions and recommendations

Interpretation of the sounding curves can be summarized as follows:

- The possibility of intercepting potable freshwater aquifers is higher between soundings near the coast.
- Freshwater aquifers may be detected at depth of around 5 m. Although the aquifers are shallow, their thickness indicate they may be suitable for exploitation.
- The aquifers are immediately underlain by a saline water layer. Hence aquifer exploitation must take into account the possibility of saline water intrusion.
- It is not recommended to drill at sites represented by ascending sounding curves, as the possibility of intercepting aquifers is very low.
- Aquifers detected in higher elevation soundings may also be suitable. However, as the bounding bedrock layer is not properly delineated, the thickness of potential aquifers is not well defined.



Location map of resistivity sounding, Finschhafen

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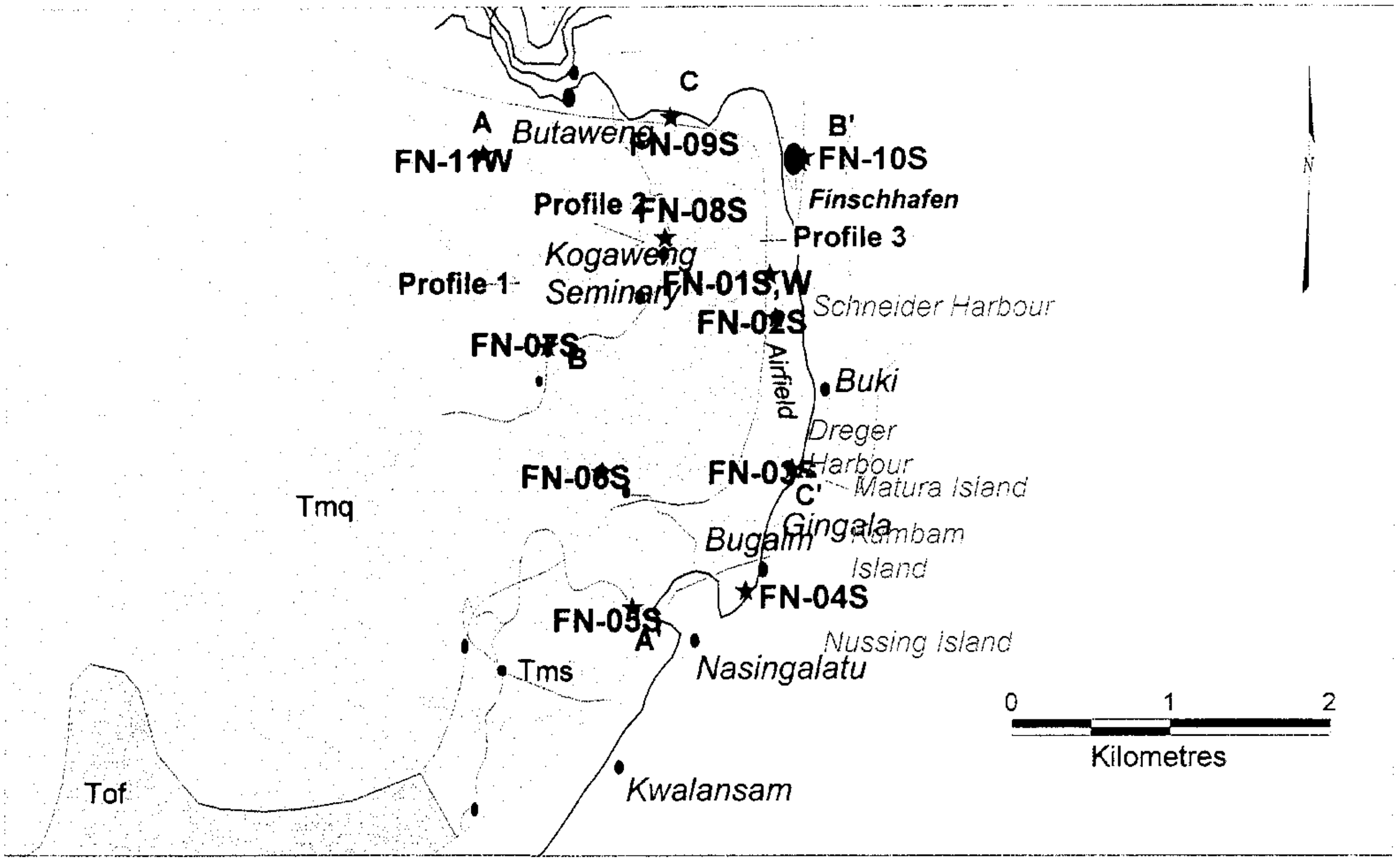
Figure 3a



Map of resistivity sounding over regional geology, Finschhafen

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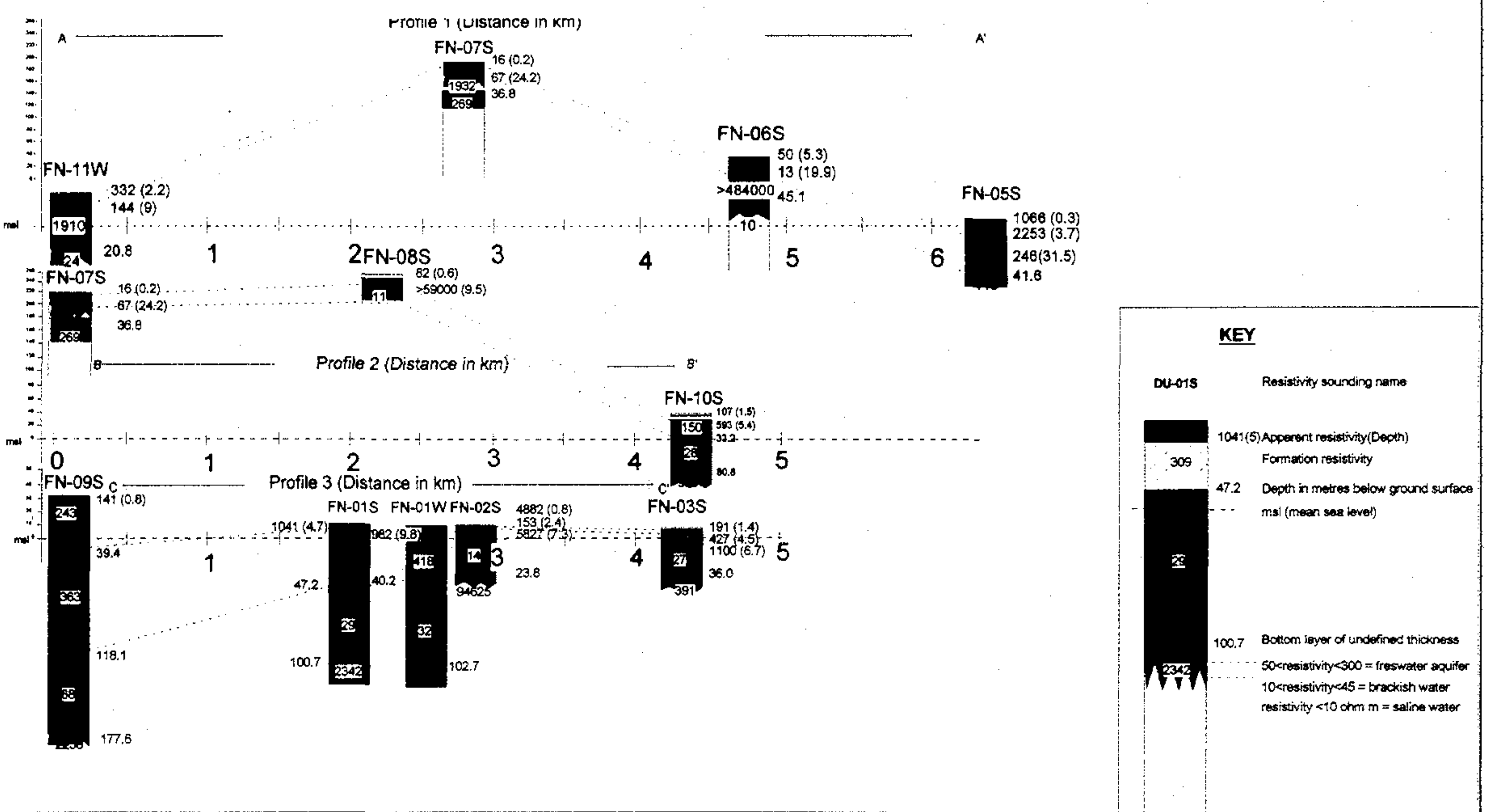
Figure 3b



Interpreted resistivity sounding profiles, Finschhafen

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Figure 3c

3.3 MUTZING, MOROBE PROVINCE

Eleven geo-electrical soundings were conducted around Mutzing Station (Figure 4a). Ten of the soundings used the Schlumberger configuration and one used the Wenner configuration. The Schlumberger soundings used a maximum AB/2 spacing of 420 m while the Wenner had a maximum electrode spacing (a) of 230 m.

3.3.1 Geology

Mutzing is located within the Ramu-Markham valley, a major land form, with a northwest-southeasterly alignment, bounded to the north by the Saruwaged Ranges and to the south by the Bismarck Ranges.

The Ramu-Markham valley is 150 km long and approximately 30 km wide, and is drained by the Ramu River, flowing northwest, and the Markham River, flowing southeast. A large proportion of the valley is made up of flood-plain deposits in the form alluvial fans deposited by tributary rivers.

Figure 4b shows the digitised portion of the regional geology of the Markham-Ramu valley. A detailed description of the geology is described in the 1:250 000 geological map sheet of Markham (Tingey and Grainger, 1976). Most resistivity soundings were conducted within the Quaternary deposits consisting of conglomerate, gravel, sand and silt. In the northern part of the valley is the Lower to Middle Miocene Mena Beds. This formation comprises micaceous sandstone, greywacke, lithic siltstone, conglomerate, and minor limestones lenses. The Pliocene Leron Formation comprising bedded sandstone, pebbly sandstone and conglomerate, siltstone, and minor lignite is present between the Mena Beds and the Quaternary deposits. Two major rock deposits mark the southern flank of the Ramu-Markham valley. These include Lower Miocene Intrusive Akuna Intrusives and the Middle to Upper Oligocene Omaura Greywacke.

3.3.2 Resistivity sounding results

Sounding MZ-01S

Sounding MZ-01S was conducted inside a cattle ranch northwest of the Mutzing station. The GPS location of the sounding is 414851 mE and 9300386 mN on a bearing of 155 degrees.

Sounding MZ-01S was modeled with 6 layers. The first layer is approximately 1 metre thick and modeled with a resistivity of 55 Ωm. This is followed by a higher resistivity second layer with a resistivity of 248 Ωm and thickness 31 m. The resistivity of the third layer is lower, at 61 Ωm, and is about 45 m thick. The fourth layer also has a high resistivity, modeled with a resistivity of 144 Ω m, and is approximately 53 m thick. Another conductive layer then follows before the sounding reached bedrock with a modeled resistivity of 823 Ωm, approximately 280 m below ground level.

Sounding MZ-02S

Sounding MZ-02S was conducted near Gandisap village, approximately 10 km north of Mutzing Station. The GPS location of MZ-02S is 417330 mE and 9308705 mN and oriented on a bearing of 137 degrees.

Sounding MZ-02S was modeled with 5 layers. The first layer with a resistivity of 667 Ωm and thickness 8 m. The second layer has a lower resistivity of 125 Ωm and is approximately 12 m thick. The third layer has a higher resistivity, approximately 656 Ωm and a thickness of 24 m. There is a lower resistivity fourth layer, at 51 Ωm and thickness 62 m. The final layer which appears to be the bedrock layer has resistivity of 2,167 Ωm.

Sounding MZ-03S

Sounding MZ-03S was conducted along the road between the villages of Bampiafan and Marangits. The GPS coordinates of the sounding are 419714 mE and 9303720 mN and is oriented on a bearing of 325 degrees.

Sounding MZ-03S is similar to sounding to MZ-02S, the only noted difference is in the apparent resistivity levels. While MZ-02S begins with high values of more than 70 Ωm, MZ-03S begins with low values of less than 30 Ωm. Nevertheless sounding MZ-03S was modeled with 6 layers. The first layer has a resistivity of 134 Ωm and a thickness of approximately 2 m. The second layer is higher in resistivity at approximately 195 Ωm, and thickness 5 m. The resistivity of the third layer is lower than the second layer with a modeled resistivity of 58 Ωm and a thickness of 8 m. The fourth layer is another resistive layer, with a resistivity of 174 Ωm and an approximate thickness of 15 m. The fifth layer is another very conductive layer, with a model resistivity of 32 Ωm and thickness 39 m. The bottom layer with a modeled resistivity of 6,103 Ωm is most probably the bedrock layer.

Sounding MZ-04S

Sounding MZ-04S was conducted along the road near Urori village. The GPS coordinates for the sounding are 417717 mE and 9299992 mN and oriented on a bearing of 175 degrees. Again the nature of the curve suggests similar geological formations to the preceding soundings, with apparent resistivity values more or less within the range of sounding MZ-03S.

The sounding curve for MZ-04S was modeled with 4 layers. The first layer was modeled with a resistivity of 167 Ωm and a thickness of about 1.4 m. The second layer is lower in resistivity, at approximately 71 Ωm, and thickness 26 m. The third layer is slightly higher in resistivity than the second layer with a modeled resistivity of 310 Ωm and thickness of about 14 m. The bottom layer is lower in resistivity at 89 Ωm and the sounding failed to reach bedrock.

Sounding MZ-05S

Sounding MZ-05S was conducted near Wompua at GPS coordinates 414187 mE and 9303958 mN and oriented on a bearing of 065 degrees.

The sounding curve obtained was modeled with four layers. The first layer is a low resistivity layer, modeled with a resistivity of 49 Ωm and thickness 1.4 m. This layer is followed by a 8 m thick high resistivity layer with a resistivity of 156 Ωm. Below the second layer is another resistive layer, modeled with a resistivity of 218 Ωm and thickness 118 m. The fourth layer is also low in resistivity, at approximately 108 Ωm. The sounding again failed to reach bedrock.

Sounding MZ-06S

Soundings MZ-06S and MZ-06W were conducted inside the Markham High School boundary. The GPS location of the sounding is 415853 mE and 9298628 mN and oriented on a bearing of 126 degrees.

The curve obtained for sounding MZ-06S was modeled with only 3 layers. The first layer was modeled with a resistivity of 47 Ωm and thickness 2 m. The second layer has a thickness of approximately 90 m and resistivity 163 Ωm. The third layer was modeled with a resistivity 40 Ωm. There were no indications of reaching bedrock at the maximum current electrode spacing that was used, 420 m.

Sounding MZ-06W

Wenner sounding MZ-06W was conducted at the same location as MZ-06S using a maximum electrode separation of 300 m. It is possible that using this method, bedrock was reached at the electrode spacing used. The sounding curve was modeled with 4 layers. The top layer was modeled with a resistivity of 75 Ωm and thickness approximately 2 m. The second layer has a modeled resistivity of 465 Ωm and thickness 80 m. The third layer was modeled with a resistivity of 31 Ωm, and has a thickness of 58 m. A high resistivity layer was reached at depth of approximately 138 m and appeared to be bedrock.

Sounding MZ-07S

Sounding MZ-07S was conducted behind the Markham Station. It was orientated at a bearing of 227 degrees.

The sounding curve was modeled with 5 layers. The first layer has a comparatively high resistivity, 209 Ωm, compared with the second layer, modeled at 69 Ωm. The approximate thickness of the layers are 7m and 13 m respectively. The third layer is quite resistive, with a resistivity of 604 Ωm and thickness of approximately 25 m. The fourth layer is more conductive than the preceding layer and has a resistivity of 28 Ωm and is approximately 82 m thick. The sounding reaches the high resistivity bedrock layer at depth of 128 m with an approximate resistivity of 1,233 Ωm.

Sounding MZ-08S

Sounding MZ-08S was conducted along the main highway at GPS position 440537 mE and 9267330 mN and oriented parallel to the highway, on a bearing of 285 degrees.

The curve obtained for sounding MZ-08S was modeled with 4 layers. The first layer with a resistivity of 213 Ωm and thickness of about 1.5 m. The second layer is lower in resistivity, with a model value of 40 Ωm and thickness of just over 6 m. The resistivity of the third layer is higher again, at 121 Ωm and a thickness of approximately 25 m. The resistivity continues to increase at the fourth layer to 220 Ωm.

Sounding MZ-09S

Sounding MZ-09S was conducted at Nasawasiang village. The GPS coordinates for the sounding location are 424139 mE and 9295247 mN on a bearing of 177 degrees.

The curve obtained for sounding MZ-09S was modeled with 5 layers. The first layer with a resistivity of 238 Ωm and a thickness of approximately 1 m. A low resistivity second layer was modeled with a resistivity of about 136 Ωm and a thickness of about 12 m. The third layer is more resistive than the second layer, with a resistivity of 391 Ωm and thickness of 31 m. The resistivity of the fourth layer is again low with a value of 27 Ωm and thickness 64 m. The fifth layer appears to be the bedrock layer with a high resistivity of 578 Ωm.

Sounding MZ-10S

Sounding MZ-10S was conducted near the Zenag poultry farm at Atzera. The *GPS coordinates for the sounding are 423735 mE and 929936 mE and* oriented on a bearing of 120 degrees.

The sounding curve obtained for MZ-10 was modeled with 4 layers. The first layer was modeled with a resistivity of 14 Ωm and a thickness of approximately 6 m. The second layer is more resistive, with a model resistivity of 104 Ωm and thickness 14 m. The third layer has a low resistivity of about 6 Ωm and a thickness of around 16 m. The fourth layer appears to be the bedrock layer with a high resistivity of 561 Ωm.

3.3.3 Discussions

Soundings conducted around Mutzing have been divided into two main groups although there are no significant differences between the two groups.

The curves can be used to describe the subsurface lithology where they were conducted.

Group One: This group comprises soundings MZ-04S, MZ-05S and MZ-08S. The soundings do not have the depth of penetration where it can be assumed to have reached bedrock. The soundings reach a minimum at depths of around 1.5 m, before rising to a maximum and then leveling out at a resistivity of around 100 Ωm. The depth at this level is between 33 m at sounding MZ-08S, and 128 m at sounding MZ-05S.

Freshwater aquifers within the Markham valley may be located at very shallow depths. From the soundings, the aquifers may be within the first layer. The existence of deeper aquifers, however, cannot be ruled out. And from this group of soundings it is probable that the bottom layer is the aquifer layer. The thickness of these aquifers could not be determined from the soundings.

From the positions of these soundings, it can be seen that soundings MZ-04S, MZ-05S and MZ-08S are almost within the central part of the valley. Hence the layer of sedimentation would be quite thick around these locations. It is therefore possible that the aquifer would be quite thick.

Group Two: The second group comprises the rest of the soundings and show indications of reaching bedrock levels, but at various depths. The depth to bedrock ranges from a shallow 32 m at sounding MZ-10S, to a deep 280 m, at sounding MZ-01S. However depth to bedrock determined at sounding MZ-01S is doubtful.

The soundings from this group were modeled as 4, 5 and 6 layers. The deep freshwater aquifer for these soundings most likely would be found between the third and fourth layers. The average depth to the freshwater aquifer layers is 45 m and the minimum depth would be between 15 m and 19 m at soundings MZ-03S and MZ-10S respectively. To the south, the depth increases to at least 70 m near MZ-01S, MZ-06W and MZ-07S.

Three profiles (Figure 4c) were created from interpretation of the soundings:-

Profile 1 comprises soundings conducted along the southern flank of the Ramu-Markham valley. It shows that the depth, to the possible freshwater aquifer is deeper, about 130 m, and thicker at the northwestern end and gradually decreases to 33 m at the southeastern end of the profile. Depth to bedrock (Omaura greywacke) follows the same trend as the depth to freshwater aquifer. At the beginning of the profile, depth to bedrock is about 280 m while towards the end of the profile, the depth is about 127 m.

Profile 2 comprises resistivity sounding conducted along the northern flank of the valley. Here depth to the possible freshwater aquifer and bedrock follow a pattern similar to that observed on the southern flank. The aquifer is deeper and thicker at the northwestern end than at the southeastern of the profile. Potential aquifer depth at the start of the profile is about 45 m, while at the southeastern end it is only about 20 m. The bedrock is represented by the Leron Formation sandstone, along this flank of the valley.

Profile 3 attempts to show the variation across the valley. Unfortunately the profile only confirms the results derived from the northern and southern profiles, that depth to aquifer and bedrock is deeper in the south. No bedrock layer is evident in the mid-valley sounding.

3.3.4 Conclusions and Recommendations

Results of the geo-electrical soundings can be summarised as follows:

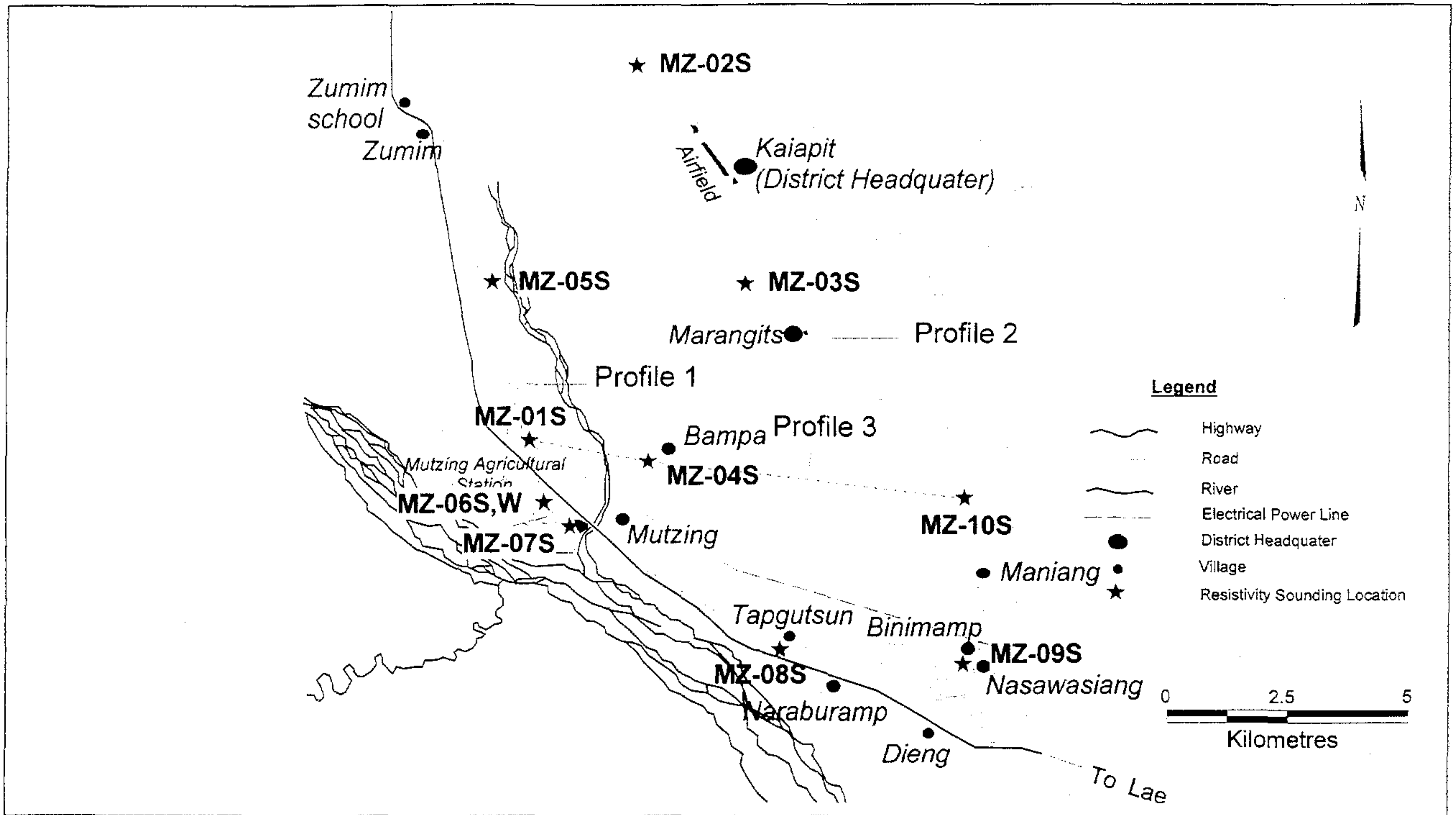
- At Mutzing freshwater aquifers are quite shallow.

- Deeper aquifers may be located at depths ranging between 19 m in the northern areas, to at least 100 m in the south. In the central part of the valley, depth to possible aquifers is around 45 m.

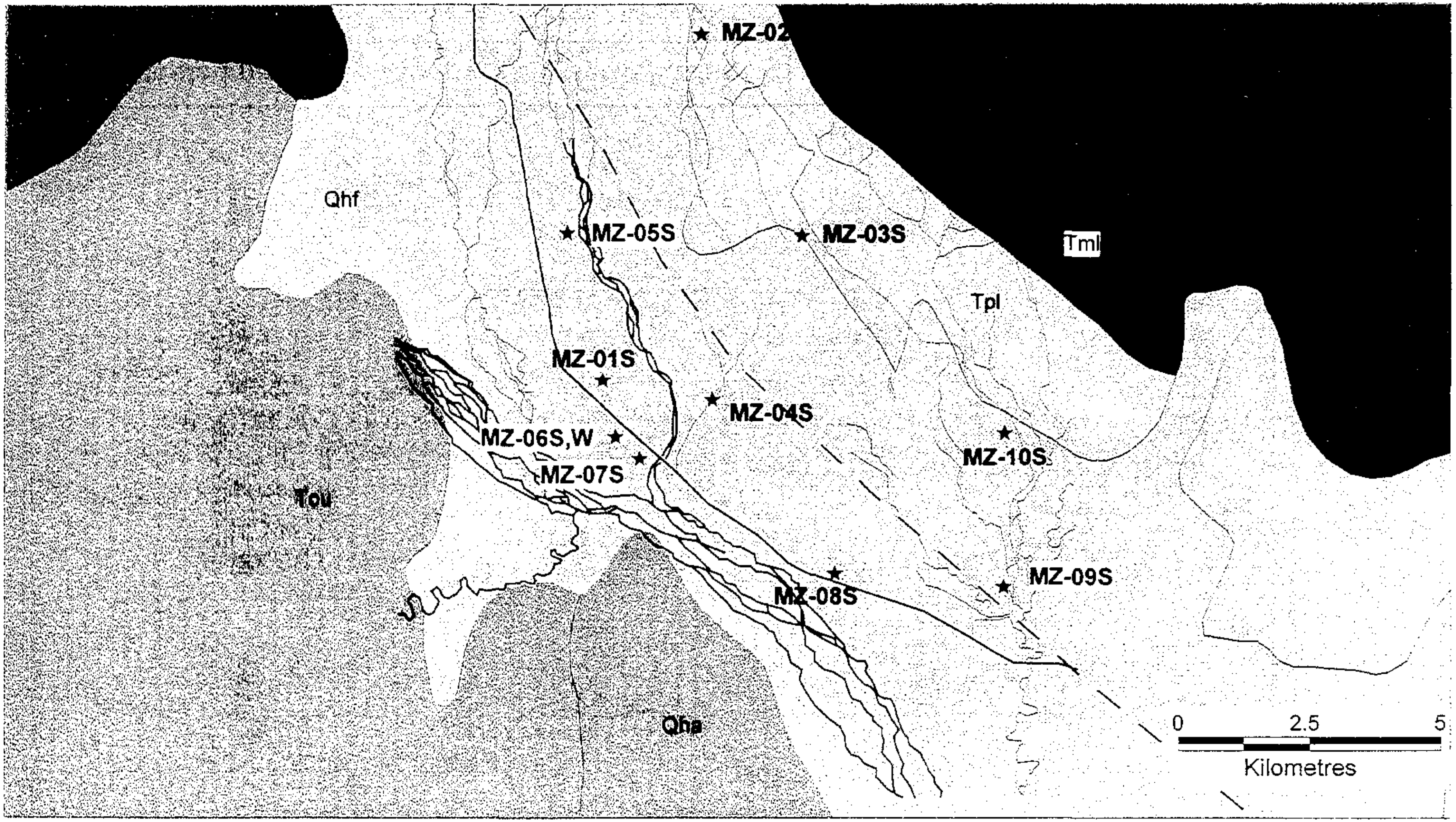
- Depth to the bedrock is usually parallel with depth to the freshwater aquifers that is quite shallow towards the north compared with the areas to the south.

- In the central region, soundings did not reach bedrock levels.

- The recommended location for a test drill site is near soundings MZ-06S and MZ-07S.



Location map of resistivity sounding, Mutzing	Geophysical Surveys Section Geological Survey of PNG Department of Mining	**Figure 4a**
Investigations of groundwater resources in Papua New Guinea,2000		

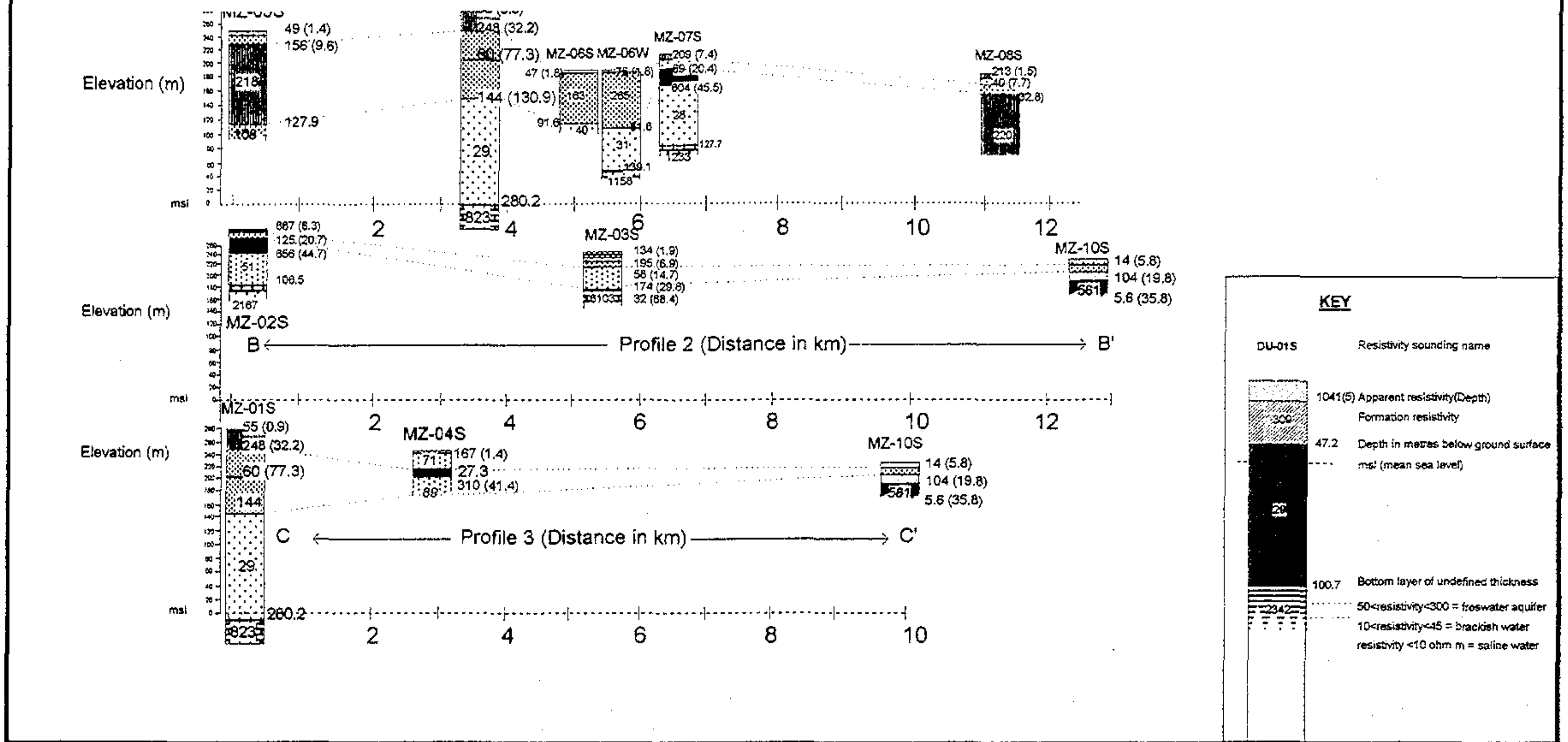


Map of resistivity sounding over regional geology, Mutzing

Investigations of groundwater resources in Papua New Guinea, 2000

Geophysical Surveys Branch
Geological Survey Division
Department of Mining

Figure 4b



Interpreted resistivity sounding profiles, Mutzing

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Department of Mining

Figure 4c

3.4 POPONDETTA, ORO PROVINCE

Fifteen resistivity soundings were conducted at selected sites around Popondetta (Figure 5a) and within the town area (Figure 5b). Fourteen of these used the Schlumberger configuration and one was performed using the Wenner array. Wenner profiles were also performed at two sites.

3.4.1 Geology

Figure 5c attempts to show the location of the resistivity soundings with respect to the underlying geology.

The geology and hydrogeology of Popondetta and the surrounding villages is described by Aruai et al,. 1993. A series of volcaniclastic deposits made up of poorly sorted alluvials, mostly of volcanic origin, and tephra deposits, form the volcanic outwash fans. South of Popondetta town are the Quaternary volcanics of the Lamington Group (Williamson and Francis, 1985).

The striking geological feature of the area is the Mesozoic and older peridotite, gabbro, and basalts of the Papuan Ultramafic Belt (PUB), that give rise to the mountain blocks north and south of the area. Williamson and Francis, 1985, indicate that the PUB is marked by the Owen Stanley Fault Zone that runs approximately 60 km west of the township of Popondetta.

3.4.2 Resistivity sounding results

Sounding PP-01S

Sounding PP-01S was conducted along the main road, at GPS position 64189 mE and 9039954 mN and aligned on a bearing of 196 degrees.

The sounding curve obtained was modeled using 4 layers. Layer one is approximately 1 metre (0.8 m) thick, with a resistivity of 530 Ωm. The second layer was modeled with a resistivity of 28 Ωm, and a thickness of 22 m. The third layer was modeled with a resistivity of 159 Ωm and thickness 12 m. The underlying layer has a higher resistivity , 3,950 Ωm and this is assumed to be the bedrock layer.

Sounding PP-02S

Sounding PP-02S was conducted along the main road at GPS position 639014 mE and 9035705 mN and aligned on a bearing of 205 degrees.

The sounding curve is similar to that obtained for sounding PP-01S, but this curve was modeled with 5 layers. At the top is a 1.3 m thick layer with a resistivity of 2,306 Ωm. The second layer was modeled with a thickness of approximately 13 m and resistivity 213 Ωm. Below the second layer is a high resistivity layer, approximately 9 m thick with a resistivity of 374 Ωm. The fourth layer is approximately 14 m thick, reaching the underlying high resistivity layer at a depth of approximately 38 m. The fifth layer has a high resistivity, 28,959 Ωm and is presumably bedrock.

Sounding PP-03S

Sounding PP-03S was conducted along the Sangria road, at GPS position 631232 mE and 9094081 mN and aligned on a bearing of 225 degrees.

The sounding was modeled with 5 layers. The top layer with a thickness of 1.2 m and a resistivity of 566 Ωm. Below is a 7 m thick layer with a resistivity of 1,290 Ωm. The third layer has a modeled thickness of 56 m and resistivity 1,049 Ωm. Below this high resistivity layer is a conductive layer of resistivity 43 Ωm and thickness 56 m. The underlying bedrock layer was modeled with a resistivity 4,721 Ωm.

Sounding PP-04S

Sounding PP-04S was conducted along the Dobuturu road at GPS position 633168 mE and 9030939 mN and aligned approximately due north, on a bearing of 003 degrees.

The sounding curve was modeled with 3 layers. The top layer is approximately 7 m thick and has a resistivity of 2,195 Ωm. The second layer has a modeled thickness of 22 m and has a resistivity of 506 Ω m. The bottom layer has a very high resistivity and presumably is the bedrock layer with a resistivity of over 143,000 Ωm.

Sounding PP-05S

Sounding PP-05S is located along the Popondetta-Isuga road with GPS coordinates 638394 mE and 9029191 mN and on a bearing of 089 degrees.

The sounding was modeled with 4 layers. The first layer has a thickness of approximately 1m and a resistivity of 5,148 Ωm. The second layer was modeled with a thickness of 20 m and resistivity 1,181 Ωm. The third layer has a low resistivity, 494 Ωm, and is 472 m thick. The bottom layer has a high resistivity at 1,211 Ωm.

Sounding PP-06S

Sounding PP-06S was conducted near Jonita village. The location of the sounding is approximately 635864 mE and 9025453 mN and aligned on a bearing of 318 degrees.

The curve obtained for the sounding was modeled with 4 layers. At the top is a 1.2 m thick layer with a resistivity of 713 Ωm. Below is the second layer, 4 m thick, with a resistivity of 1,400 Ωm. A third layer, at a depth of approximately 5.6 m, is slightly more conductive with a resistivity of 364 Ωm and is approximately 254 m thick. The fourth layer is the bedrock layer with a high resistivity, 20,233 Ωm.

Sounding PP-07S

Sounding PP-07S was conducted along the Ijica road. The GPS coordinates of the sounding location are 640086 mE and 9026996 mN and aligned on a bearing of 054 degrees.

The sounding curve was modeled with 6 layers. The top layer with a thickness of approximately 0.4 m has a resistivity of 204 Ωm. The second layer was modeled with resistivity 82 Ωm and has a thickness of 0.8 m. Below the second layer is a high resistivity layer with a model value of 1,674 Ωm and a thickness of approximately 9 m. The fourth layer is quite conductive with a resistivity of 166 Ωm and thickness 27 m. Another very resistive layer lies beneath the fourth layer with a resistivity of 516 Ωm and is approximately 37 m thick. The sixth layer, representing bedrock, has a resistivity at 1,710 Ωm.

Sounding PP-08S

Sounding PP-08S was conducted at GPS location with coordinates 638999 mE and 9023609 mN and aligned on a bearing of 140 degrees.

The sounding curve for PP-08S was modeled with 6 layers. The top layer is approximately 0.6 m thick and has a resistivity of 1,667 Ωm. Another thin layer, approximately 0.7 m in thickness lies below the top layer and has a resistivity of 204 Ωm. Below the two thin layers is a highly resistive layer of resistivity of 4,008 Ωm, and thickness approximately 4 m. After the third layer is a conductive layer of resistivity 290 Ωm and thickness 9 m. The fourth layer has a slightly higher resistivity, 836 Ωm, and thickness 17 m. The resistivity of the bottom layer is lower at 365 Ωm and it is assumed that bedrock was not reached by this sounding.

Sounding PP-09S

Sounding PP-09S was conducted along the main road. The GPS co-ordinates of the sounding are 642395 mE and 9024472 mN and aligned on a bearing of 047 degrees.

The sounding was modeled with 4 layers. The first layer is 3 m thick and has a resistivity of 2,250 Ωm. Below is a less resistive layer, approximately 24 m thick with a resistivity of 1,022 Ωm. The third layer, at a depth of approximately 28 m, has a low resistivity, approximately 89 Ωm and is approximately 29 m thick. The fourth layer is a high resistivity layer, modeled with a resistivity of 3,350 Ωm and is presumably the bedrock layer.

Sounding PP-10S

Sounding PP-10S was conducted along the main road. The GPS co-ordinates of the sounding location are 646154 mE and 9026345 mN and oriented on a bearing of 095 degrees.

The sounding was modeled with 4 layers. At the top is a 3 m thick layer of resistivity 6,848 Ωm, followed by a 10 m thick high resistivity layer with a resistivity of 2,538 Ωm. The third layer was modeled with a resistivity of 339 Ωm and is approximately 230 m thick. At a depth of approximately 240 m is the very resistive bedrock layer, modeled with a resistivity of 36,886 Ωm.

Sounding PP-11S

Sounding PP-11S was conducted along the road leading to Popondetta Agricultural College. The GPS location of the sounding is 637127 mE and 9032753 mN and aligned on a bearing 180 degrees magnetic north.

The sounding was modeled with 5 layers. The first layer with a thickness of 2 m and resistivity 914 Ωm. Beneath is a low resistivity layer with a resistivity of 208 Ωm and a thickness of about 10 m. The third layer, at a depth of approximately 11 m, has a high resistivity, 1,261 Ωm, and is approximately 12 m thick. Another conductive layer follows the third layer before the sounding intercepts bedrock. The conductive layer was modeled with a resistivity of 4 Ωm and is approximately 18 m thick. The bedrock layer was modeled with a resistivity of 1,297 Ωm.

Sounding PP-12S

Sounding PP-12S was conducted along the Popondetta-Sohe road. The GPS coordinates of the sounding position are 636295 mE and 9032056 mN. The sounding was aligned on a bearing of 120 degrees magnetic north.

The sounding curve was modeled with 5 layers. The first layer was modeled with a thickness of about 2 m and a resistivity of 384 Ωm. The second layer was modeled with a resistivity of 405 Ωm and has a thickness of 3 m. The third layer, at a depth of approximately 5 m, is quite low in resistivity , 97 Ωm, and is approximately 9 m thick. Below the third layer is a 19 m thick layer of resistivity 324 Ωm, the fourth layer. This is followed by the bottom layer with a low resistivity, at 272 Ωm.

Sounding PP-13S

Sounding PP-13S was conducted along the main road. The sounding location has GPS coordinates 635416 mE and 9030143 mN and was aligned on a bearing of 032 degrees magnetic north.

The curve obtained for sounding PP-13S was modeled with 4 layers. The top layer has a modeled thickness of about 3 m and a resistivity of 2,356 Ω m.

Following the top layer is a less resistive layer 442 m thick with a resistivity of 31 Ωm. The third layer is even less resistive, with a model resistivity of 230 Ωm. The bottom layer has a higher resistivity, 409 Ωm, and may be the bedrock layer.

Sounding PP-14S

Sounding PP-14S was conducted along the main road. The GPS coordinates of the sounding are 635310 mE and 9029210 mN and aligned on a bearing of 004 degrees magnetic north.

The curve obtained for the sounding was modeled with 5 layers. The top layer was modeled with a thickness of 0.6 m and resistivity 1,003 Ωm. Beneath the top layer is a low resistivity layer approximately 1.5 m thick with a modeled resistivity of 131 Ωm. The third layer is higher in resistivity, 607 Ωm, and also quite thick, at 64 m. The fourth layer, at a depth of approximately 66 m, is another low resistivity layer, about 99 Ωm, and is approximately 72 m thick. The lowest layer is the high resistivity bedrock layer, modeled with a resistivity of 2,457 Ωm.

Sounding PP-15S

Sounding PP-15S was conducted along the Popondetta–Isuga road, approximately 2.5 km west of sounding PP-05S. A Wenner sounding, WS20005, was also performed at this location. The GPS position of the sounding is 653614 mE and 9029486 mN.

The curves obtained for the soundings were modeled with 4 layers. Although there are variations in the resistivity of the layers, there is very good correlation in their thicknesses. For that particular site, the first layer has a modeled thickness of around 2 m and resistivity in the range 1,300 to 5,200 Ωm. The second layer is modeled with a thickness between 6 and 7 m, and resistivity ranging from 80 to 290 Ωm. The third layer was modeled with a thickness ranging between 13 and 16 m, and resistivity in the range 245 to 344 Ωm. The high resistivity bedrock layer was not reached by the soundings.

3.4.3 Wenner resistivity profiling results

Four Wenner profiles were also conducted along this stretch of road. The profiles were carried out using electrode spacings of 10 m, 20 m, 30 m and 40 m and with a maximum profile length of 400 m.

It can be noted that all profiles followed a similar pattern, beginning and ending with high resistivity values in the range 500 to 700 Ωm. In the central part of the profiles there is an anomalous low resistivity zone with resistivities in the range 370 to 400 Ωm. A good proportion of the survey profile is covered by intermediate resistivities, ranging from 400 to 500 Ωm.

Another four Wenner profiles were conducted between PP-13S and PP-14S. There is no obvious trend in horizontal resistivity at different depth levels in these profiles.

3.4.4 Discussion

Soundings in and around the town of Popondetta can be grouped into at least three different type-curves, these are the minimum-type, double descending, and double ascending-type curves. The majority of the curves are of the latter two types.

Group One: Minimum-type curves were observed at PP-04S and PP-06S and this was interpreted as representing very shallow aquifers. These aquifers are within the first 10 m at depths ranging between 5 and 7 m. Only sounding PP-06S gives a reasonable aquifer thickness of 22 m, and is within the range interpreted for the other soundings.

Group Two: Double ascending type-curves were observed for soundings PP-01S, PP-02S and PP-07S. Aquifer depths for these soundings were interpreted to be around 22 m. Only sounding PP-07S indicated a shallow aquifer at 10 m, and it also showed a different aquifer thickness of 27 m. The thickness of the other two aquifers is between 11 and 14 m with depth to bedrock between 30 and 38 m at these sites.

Group Three: Double descending type-curves were observed in the remaining soundings, which account for the majority of the soundings. These curves show an interpreted depth to possible aquifers in the range 20 to 30 m. These aquifers are about 20 m thick, and depth to bedrock is about 50 m.

Most soundings have been interpreted as having an aquifer depth of around 20 m and approximately 30 m thick. There are also instances where aquifers have been interpreted to be at shallower depths, 10 to 15 m. The modeled thickness of these aquifers is also about 30 m, the same as obtained for the deeper aquifers. Deeper aquifers derived from soundings PP-03S and PP-14S have been modeled as thicker than the shallower aquifers derived for most of the soundings.

The interpreted soundings were used to create three profiles (Figure 5d) showing approximate horizontal variations in the modeled aquifers :-

Profile 1 soundings are located in an area mostly underlain by Quaternary Mt. Lamington Volcanics. The interpreted soundings do not suggest any promising aquifers. The only soundings that indicate possible aquifers are PP-03S, located on Quaternary alluvium, and PP-014S, located approximately on the boundary of the alluvium and the volcanics. Aquifer profiled by these two soundings lie very much within the same depth range. The other soundings show very shallow depth to bedrock, and very thin aquifers.

Profile 2 soundings are conducted within alluvium. The profile shows an *almost homogeneous aquifer thickness of about 20 m and is much shallower* than that interpreted for the volcanics.

Profile 3 shows soundings in the volcanics, the boundary between volcanics and alluvium, and alluvium. The profile shows the aquifer is deeper within the volcanics than at the alluvium/volcanics boundary and even within the alluvium itself

Wenner profiles

The area of the Wenner profiles conducted at site PP-15W was gridded using Surfer. The profiles were interpreted as having a very homogeneous subsurface (Figure 5e). It appears that background sediments that make up most subsurface formations have resistivities of around 400 Ωm.

Anomalous highs that are recorded towards the ends of the profiles may be attributed to topographical effects, as they appear to coincide with areas that have slightly higher elevations than the rest of the site.

The anomalous low in the central part of the profile is a conductive body confined to that area. The body lies at a very shallow depth and is almost radial, indicative of a dyke-like structure which is horizontal with a radius of approximately 10 m.

Another four Wenner profiles were taken between sites PP-13S and PP-14S. These profiles (Figure 5f) are generally very homogeneous for the first 20 m. However near site PP-13, there is an anomalous high at a depth of around 35 m. This has been attributed to bedrock and correlates well with the resistivity sounding for PP-13S, which indicates a depth to bedrock of about 59 m.

Towards site PP-14S, the anomalous high is not significant but is present approximately 100 m away. The fact that this anomalous resistivity high is not visible here also confirms the model depth to bedrock of sounding PP-14S, at about 140 m. Depth to bedrock is clearly out of the range of the profile soundings.

3.4.5 Conclusions and recommendations

Interpretation of the sounding curves is summarised below:

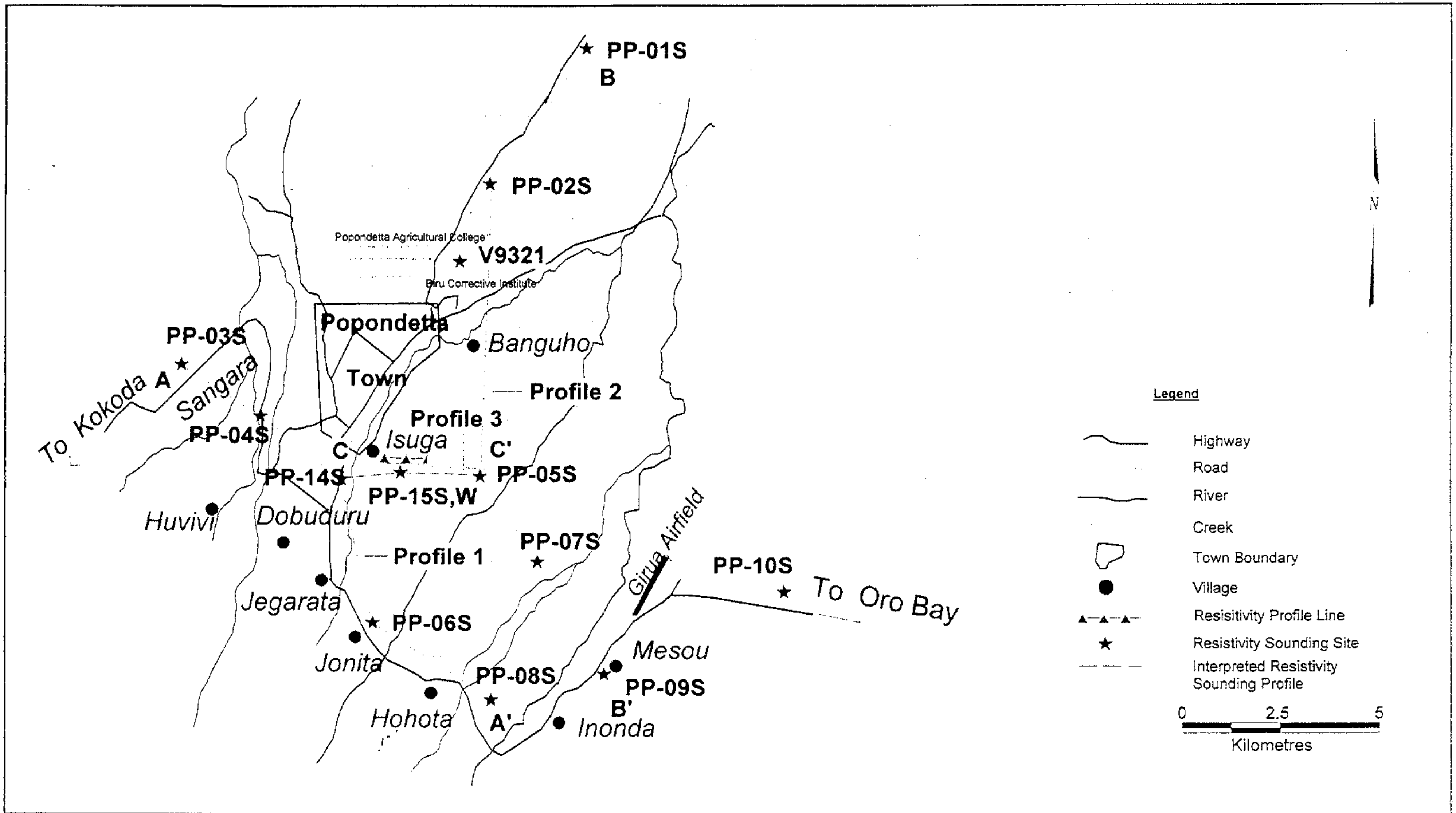
- Depth to possible aquifers is around 20 m.

- The aquifers are approximately 30 m thick.

- *Where deeper aquifers have been delineated, they appear to be* much thicker than the shallow aquifers and are located at soundings PP-03S and PP-14S. Depth to bedrock varies from site to site, ranging from about 30 m to 140 m.

- Any site around Popondetta appears suitable for the location of test drill holes, as the depth and thickness of the aquifers appear consistent. However, it is advisable to avoid sites where shallow aquifers are predicted which includes soundings PP-04s, PP-06s, PP-07S and PP-10S.

- The possibility of locating deeper and thicker aquifers is higher near soundings PP-14S and PP-03S.

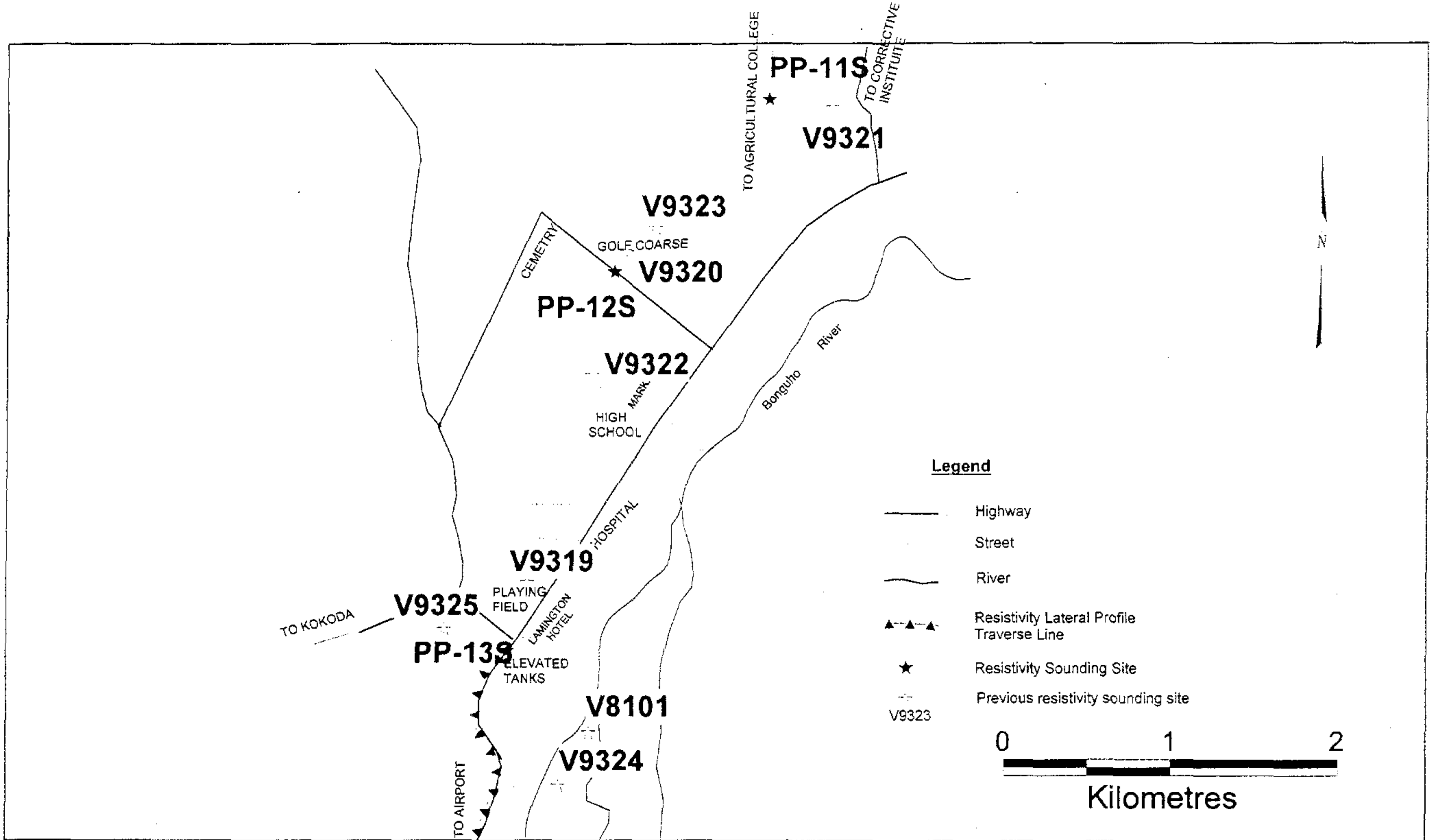


Location map of resistivity sounding, Popondetta

Investigations of groundwater resources in Papua New Guinea, 2000

Geophysical Surveys Section
Geological Survey of PNG
Department of Mining

Figure 5a



Location Map of Resistivity Sounding, Popondetta Town
Previous surveys: V93* from Aruai et al.,1993; V81* from Hill, 1981.

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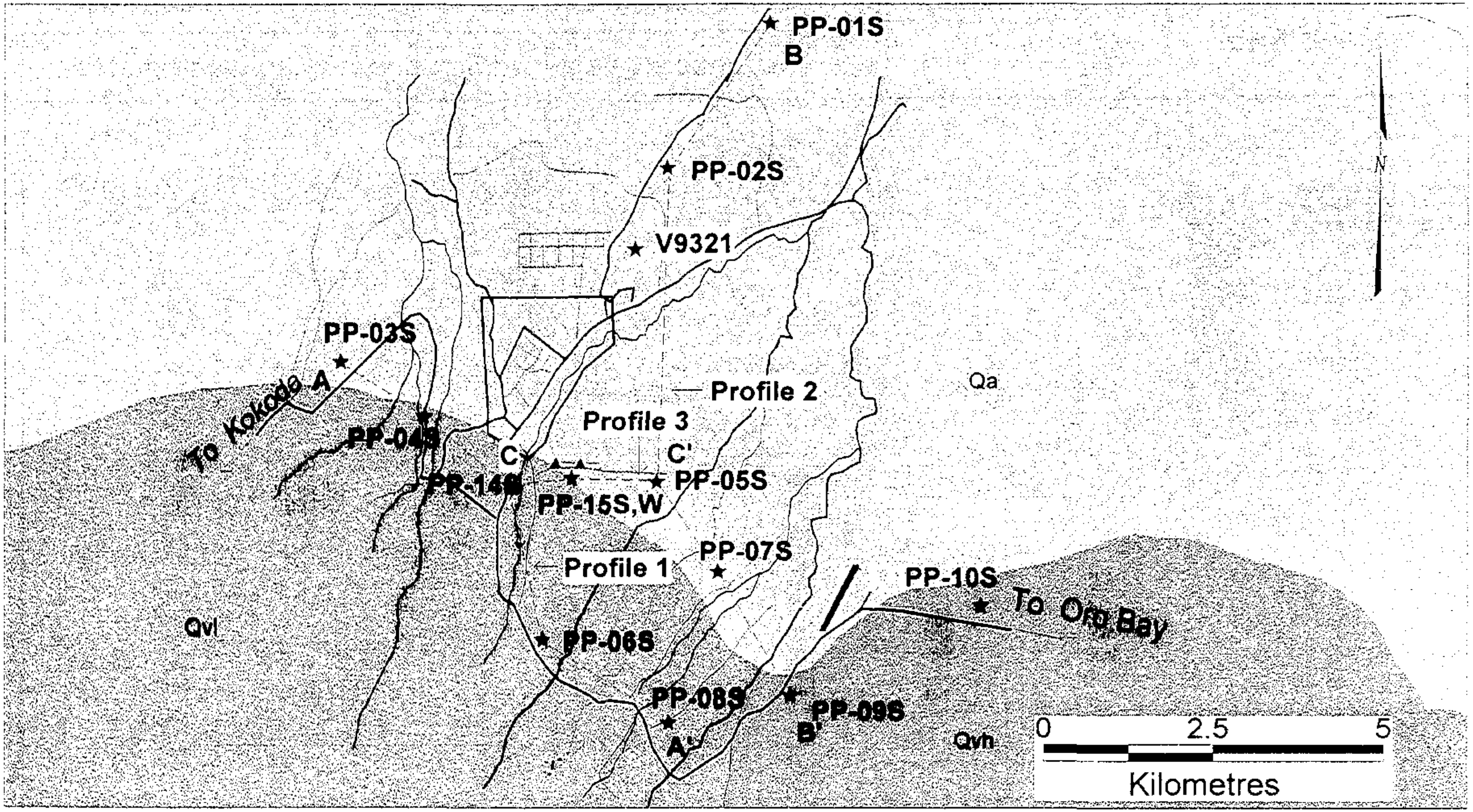
Figure 5b

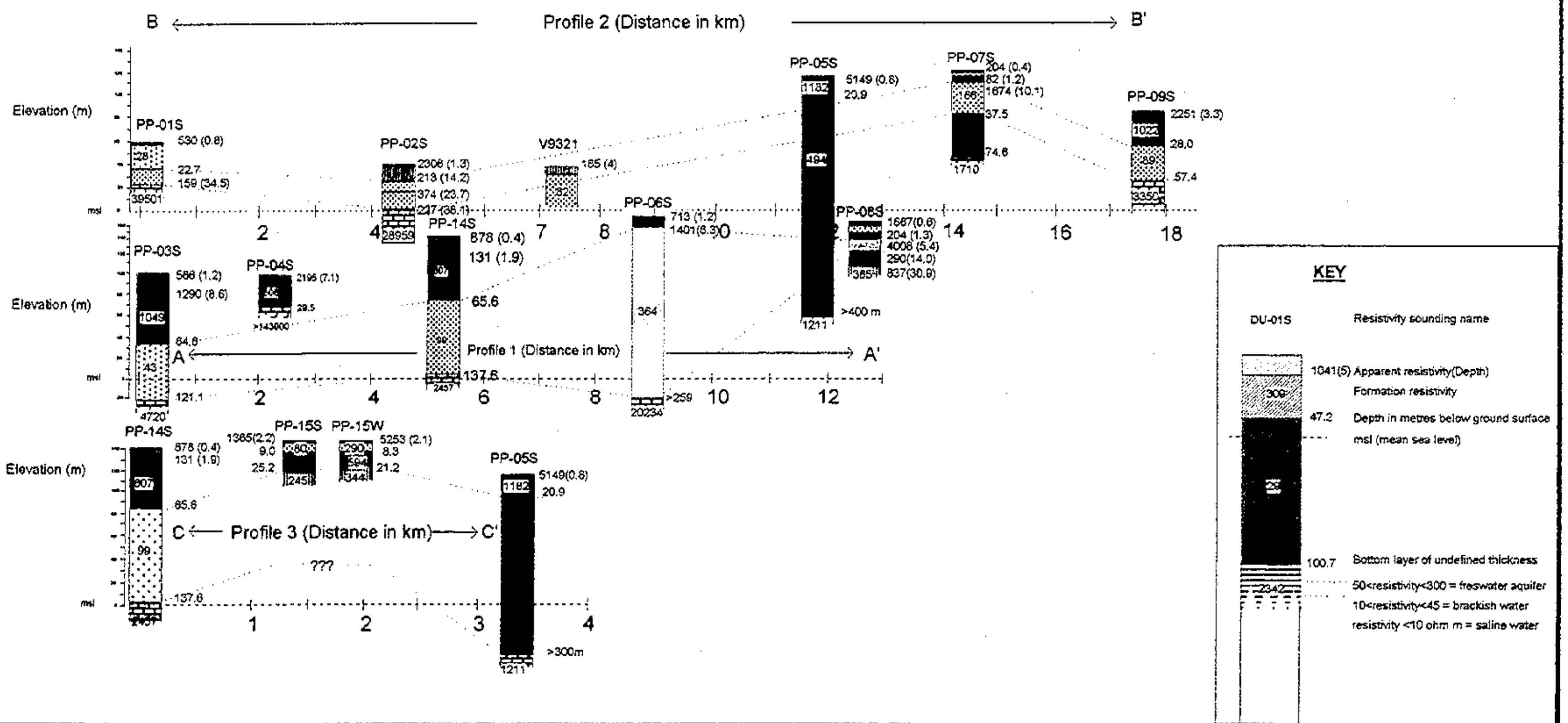


Map of resistivity sounding over regional geology, Popondetta

Investigations of groundwater resources in Papua New Guinea, 2000

Geophysical Surveys Branch
Geological Survey Division
Department of Mining

Figure 5c



Interpreted resistivity sounding profiles, Popondetta

Investigations of groundwater resources in Papua New Guinea, 2000

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Figure 5d

PP-15 Resistivity traverse

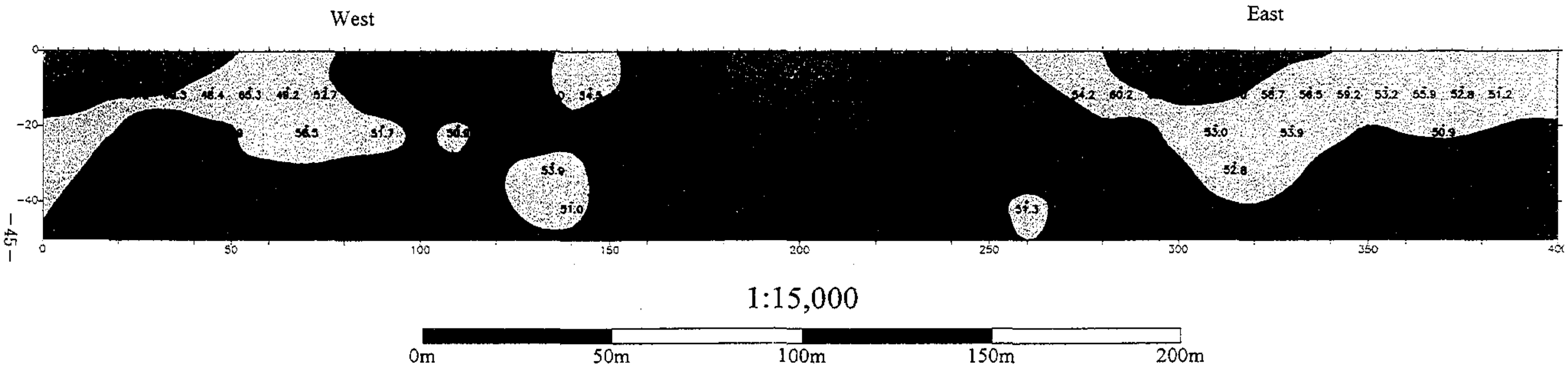

Figure5e Apparent Resistivity Profile in Wenner Array at Popondetta No.15. Measurements were taken at 10m, 20 m, 30, and 40m electrode spacings. Note the annomalous low resistivity area near the center, as opposed to the highs at the ends of the profiles.

PP-13 - PP-14 Resistivity traverse.

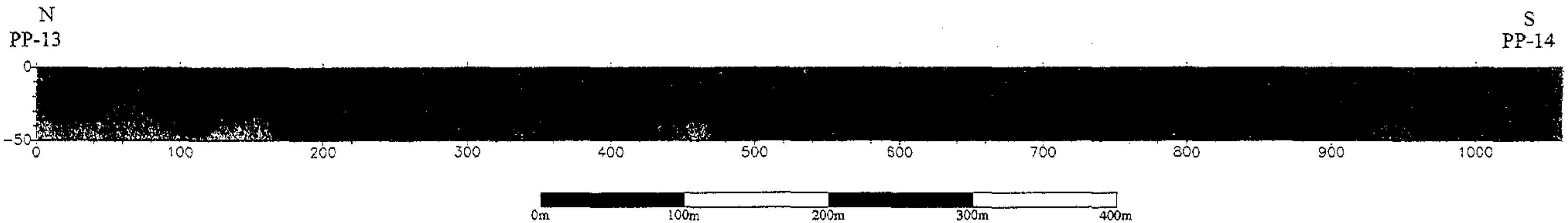

Figure 5f Resistivity Profile in Wenner Array on Popondetta between No.13 and No.14.
Measurements were taken at 10m, 20m, 30m and 40m electrode spacings.
Image depicts an almost homogenouse layer up to a dept of 40 m.

3.5 ORO BAY, ORO PROVINCE

Ten geo-electrical soundings were conducted around selected sites at Oro Bay (Figure 6a). All the soundings were done using the Schlumberger configuration and with a maximum AB/2 spacing of 420 m.

3.5.1 Geology

The geology of Oro Bay is not so much different from that of Popondetta. The Quaternary cover of alluvium, colluvium and beach deposits extend from Popondetta right down to Oro Bay on the coast (Williamson and Francis, 1985). The area to the west and south is mostly covered with volcanic deposits derived from the Mt Lamington Volcano (Figure 6b). Davies, 1971, describes the volcanic deposits of the Hydrographers Range as comprising andesite, dacite and some basalt.

3.5.2 Resistivity sounding results

Sounding OB-01S

Sounding OB-01S was conducted along the Oro Bay road, approximately 20 m from the shoreline. The GPS location of the sounding is 663978 mE and 9015722 mN. The sounding was oriented at bearing 243 degrees.

The sounding curve obtained for OB-01S was modeled with 5 layers. The first layer was modeled with a resistivity of 93 Ωm and a thickness of about 1.7 m. This second layer is followed by a lower resistivity layer, 19 Ωm, with a thickness of approximately 2 m. The third layer is a high resistivity layer modeled with a resistivity of 235 Ωm, and is about 5 m thick. The fourth layer is another low resistivity layer at 13 Ωm, slightly more conductive than the second layer and is approximately 15 m thick. The bottom layer is a very resistive, 17,535 Ωm, and is probably bedrock, at a depth of approximately 24 m.

Sounding OB-2S

Sounding OB-2S was conducted along an unsealed road. The GPS location for OB-02S is 662491 mE and 9014649 mN and oriented on a bearing of 040 degrees.

The curve obtained for sounding OB-02S was modeled with 4 layers. The first layer was modeled with a resistivity of 1,688 Ωm and thickness 0.5 m. The second layer has a higher resistivity of 2,796 Ωm and is about 10 m thick. The third layer is lower in resistivity, approximately 134 Ωm, and has a thickness of 16 m. The fourth layer is a high resistivity layer, with a modeled resistivity of 637 Ωm.

Sounding OB-03S

Sounding OB-03S was conducted along an unsealed road at GPS coordinates 661421 mE and 9092113 mN. The sounding was oriented on a bearing of 225 degrees.

Sounding OB-03S was modeled with 4 layers. The first layer with a high resistivity, 1,775 Ω m, and a thickness of about 3 m. The second layer is lower in resistivity, 411 Ωm, and is about 29 m thick. The third layer has a high resistivity, modeled at about 4,574 Ωm, and thickness of 36 m. The fourth layer is lower in resistivity, at about 242 Ωm. There is no indication of reaching a high resistivity layer below this, to indicate bedrock levels.

Sounding OB-04S

Sounding OB-04S was conducted along a ridge, with the centre of the spread positioned in the depression. The GPS coordinates for the sounding are 662243 mE and 9016140 mN. The sounding was oriented on a bearing of 235 degrees.

The sounding curve for OB-04S was modeled with 5 layers. The first layer was modeled with a resistivity of 2,149 Ωm and is about 1.3 m thick. Below the top layer is a 21 m thick lower resistivity layer, 456 Ωm. The third layer has a high resistivity (3,392 Ωm) and is 13 m thick. The fourth layer is 29 m thick and also has a low resisitivity, 77 Ωm. The fifth layer represents bedrock, and has a resistivity of 7,089 Ωm.

Sounding OB-05S

Sounding OB-05S was conducted near Kopure village with GPS coordinates 660355 mE and 9017861 mN and oriented on a bearing of 200 degrees. A Wenner sounding (OB-05W) was also conducted at the same location and used a maximum electrode separation of 200 m.

The sounding curves obtained were modeled with only three layers. The first layer is a high resistivity layer, 2,225 Ωm, with a thickness of approximately 7 m. This is followed by a layer with a resistivity of 651 Ωm and is almost 40 m thick. The bottom layer is a more conductive layer than the second layer with a modeled resistivity of 202 Ωm. There is no increase in resistivity below this depth to indicate bedrock.

Sounding OB-05W

Wenner sounding OB-05W was conducted at the same location as OB-05S, and modeled with 4 layers. The sounding indicates a highly resistive layer in-between the second and fourth layers. The second and fourth layers have progressively lower resistivities. The first layer was modeled with a resistivity of 1,631 Ωm, and has a thickness of about 5 m. These parameters are consistent with the model parameters for sounding OB-05S. The second layer was modeled with a resistivity of 425 Ωm and a thickness of about 5 m. Only the resistivity is within the value modeled for sounding OB-05S.

Sounding OB-06S

Sounding OB-06S was conducted along the road, approximately 50 m from the shoreline. The GPS location of the sounding is 663337 mE and 9016656 mN and orientated on a bearing of 106 degrees.

The curve obtained for sounding OB-06S was modeled with 4 layers. The first layer was modeled with a high resistivity of 2,310 Ωm. The layer is quite thin, approximately 0.5 m. A second layer, which is about 26 m thick, is slightly less resistive than the top layer at 240 Ωm. The third layer is again highly resistive (1,002 Ωm) but is thinner than the second layer and is approximately 15 m thick. At the bottom is the highly conductive saline water layer with a resistivity of 18 Ωm.

Sounding OB-07S

Sounding OB-07S was conducted along the main road. The location has GPS coordinates 663235 mE and 9019035 mN and oriented on a bearing of 325 degrees.

The curve obtained for sounding OB-07S was modeled with 4 layers. The top layer is very thin (0.3 m) but with a high resistivity, 2,248 Ωm. The second layer is less resistive than the first layer with a resistivity of 493 Ωm and model thickness of about 5 m. The third layer is even less resistive than the second, with a resistivity of 18 Ωm and a thickness of approximately 15 m The highly resistive bedrock layer is at a depth of about 21 m below ground level.

Sounding OB-08S

Sounding OB-08S was conducted at Koroto village. The GPS location of the sounding position was not taken but it was oriented parallel to the highway, on a bearing of 193 degrees.

The resulting curve for sounding OB-08S was modeled with 4 layers. The first layer was modeled with a resistivity of 116 Ωm and a thickness of nearly 1 m (0.8 m). The second layer is slightly lower in resistivity, 79 Ωm, and is 5 m thick. The two bottom layers are progressively higher in resistivity. The resistivity of the third layer is 187 Ωm and fourth layer is 405 Ωm. Modeled thickness of the third layer is quite high, about 134 m. However, this is questionable as no other sounding curve has a comparable thickness.

Sounding OB-09S

Sounding OB-09S was conducted along the Oro Bay - Popondetta road. The GPS coordinates for the sounding location are 662027 mE and 9020852 mN and oriented on a bearing of 325 degrees.

The curve obtained for sounding OB-09S was modeled with only 3 layers. The first layer was modeled with a resistivity of 1,317 Ωm and is about 5 m thick. The second layer is approximately 21 m thick, and modeled with a resistivity of 27 Ωm. The bottom layer has a higher resistivity at 231 Ωm.

Sounding OB-10S

Sounding OB-10S was conducted approximately 800 m east of sounding OB-9S. The GPS coordinates for the sounding are 662873 mE and 9016006 mN and oriented on a bearing of 004 degrees.

The sounding curve obtained for OB-10S was modeled with 6 layers. The top layer was modeled with a resistivity of 350 Ωm and thickness of 0.5 m. The second and third layers are progressively less resistive, the second with resistivity, 21 Ωm, and the third with a resistivity of 12 Ωm. The second layer is about 2 m thick while the third is about 1 metre thicker. Subsurface resistivity increases again at the fourth layer to 584 Ωm and drops to 98 Ωm at the fifth layer before the final rise to 889 Ωm at the bottom layer. The fourth layer is about 16 m thick while the fifth has a modeled thickness of 85 m.

3.5.3 Discussion

The first attempt to group the curves was based on their elevations or their proximity to each other. This plan was discarded, as there appeared to be no real correlation with the curves. It was then decide to base the groupings on the nature of the curves. Hence the curves were divided into three main groups based on their similarity.

Group One: comprises soundings OB-01S, OB-04S, OB-10S and to some extent OB-07S. The curves in this group show a distinct rise at the deeper part of the sounding, indicating the soundings most probably reached bedrock levels.
On closer examination it will be noticed that these soundings were located near the coastline, where sedimentation may be thin. However, interpretations do not show a consistent depth to bedrock for all soundings. Soundings OB-01S and OB-07S indicate shallow depths between 20 and 23 m, while soundings OB-04S and OB-10S show depths between 60 and 100 m to bedrock. The location of the soundings with respect to the geological boundary between the Quaternary alluvium and the volcanics may also play a role in the depth to the bedrock.
From Figure 6b it is probable that the top layers for soundings OB-01S and OB-07S comprises alluvium. The alluvium is followed immediately by the volcanics as the bedrock, at depths not exceeding 25 m. Soundings OB-04S and OB-10S will most probably lie on the Quaternary volcanics/alluvium boundary.
The possibility of locating freshwater aquifers for this group of curves may be highest where there is cover of alluvium, followed by the volcanics. The aquifer would then be located around the third layer. Depth here is between 3

and 5 m where the aquifer layer has a resistivity of 13 to 18 Ωm. However the aquifer may be too saline for human consumption.

Group Two: comprises soundings OB-2S, OB-05S/OB-05W, and OB-08S. These soundings do not appear to reach bedrock levels, instead appear to level out, gradually increasing in resistivity with depth.

These soundings are mostly located in areas underlain by Quaternary volcanics, and the resistivity, it appears, is largely influenced by the volcanic sedimentation. Apart from water content of the layers, the degree of sorting of the pyroclastic sediments appears to be one of the dominant factors affecting the resistivity.

For this group the freshwater aquifer appear to be located at very shallow depths between 5 and 10 m. Aquifer thickness ranges between 5 m at OB-05W to 20 m at OB-09S. There is also a possibility of reaching deeper aquifers at depths between 20 and 40 m. Thickness of these aquifers, however, could not be delineated from interpretation of the soundings. From the sounding curves there is a very gradual increase in resistivity with depth. This effect is probably due to the sorting matrix of the volcanic sedimentation. Therefore it is possible that any deep aquifers which exist here are quite thick.

Group Three: These curves comprises soundings OB-03S and OB-06S. show a decline in resistivity with depth. It is possible that the decline in resistivity, especially for sounding OB-03S, is due to the presence of a freshwater aquifer. Resistivity at that depth (68 m) is around 242 Ωm, which could be correlated with a freshwater aquifer. The same cannot be said of sounding OB-06S where the decline is almost certainly due to saline water with a resistivity of around 18 Ωm.

The interpreted soundings are presented as three profiles (Figure 6c) :-

Profile 1 is made up of the soundings furthest away from the coastline. Two of the three sites are within volcanics and one is located predominantly in alluvium. The profile shows the aquifer to be deeper in the alluvium than in the volcanics. In the area dominated by volcanics, a highly resistive layer covers the aquifer.

Profile 2 comprises the near-coastline soundings. The only prospective aquifer in this profile is that interpreted for sounding OB-04S, conducted at a slightly higher elevation than the other two soundings. The trend in this profile suggests that near the coast the possibility of a sustainable aquifer is very low.

Profile 3 shows the soundings conducted at increasing elevations. At low elevations, the prospects for the development of an aquifer are very poor. The aquifer is at a depth of 10 m, and is 16 m thick at slightly higher elevations (OB-02S). OB-03S, conducted at the highest elevation in the profile, shows an aquifer is present at much deeper levels and is also thicker (undefined).