A Preliminary Geophysical Reconnaissance Mapping of Emirau Ground Water Resource, Emirau Island, New Ireland Province, PNG”

Presentation at the STAR 2017 Conference by:

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CONTENTS

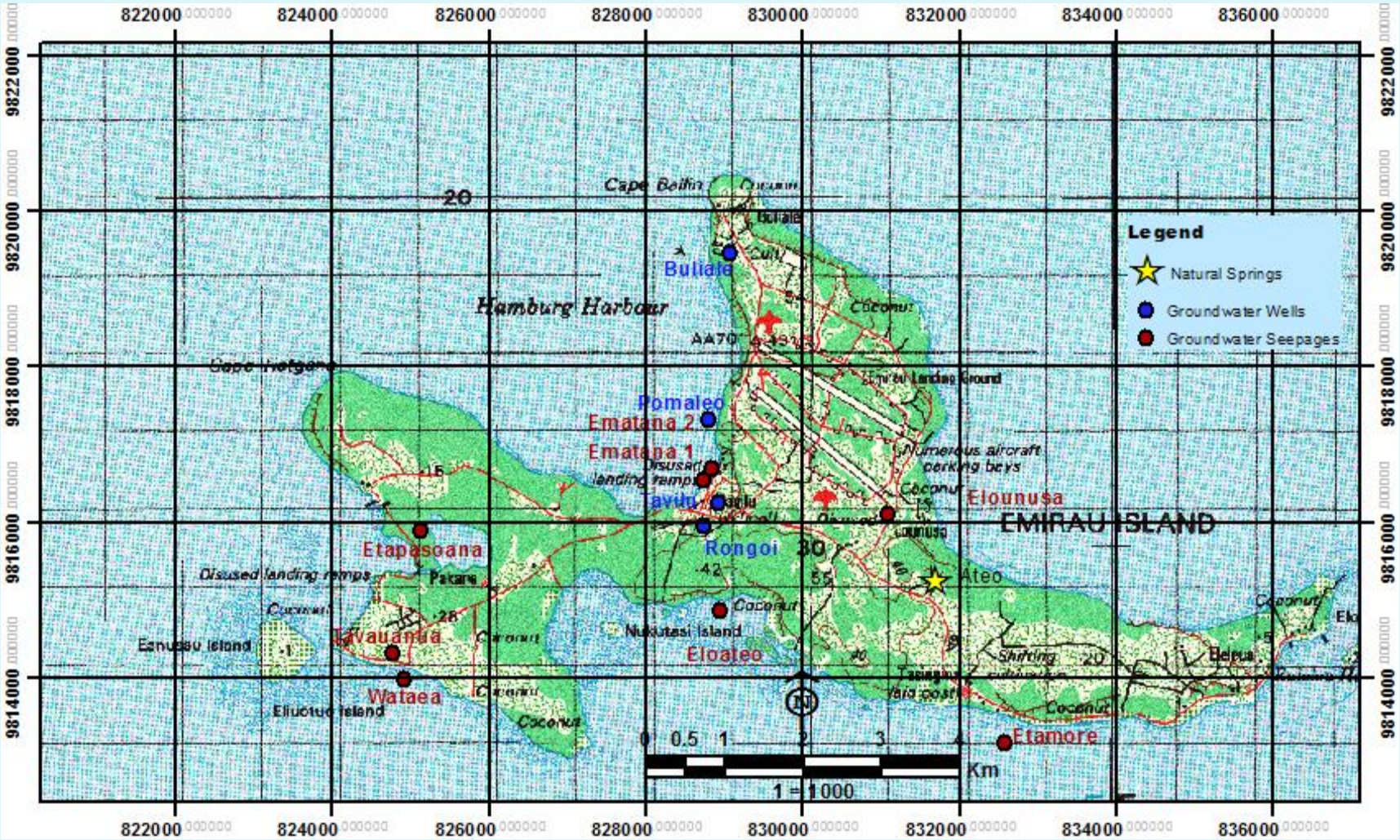
1. INTRODUCTION

- **Location**
  - One of the coral atolls in the Bismarck Archipelago
  - Located NE of Port Moresby and NW of Kavieng town
  - Approximately 7 hours boat ride from Kavieng

- **Land area**: approx 36 ha, 13 km long and 3 km wide
- **Elevation**: 75 m (highest elevation)
- **Population**: > 500 - 700 people
- **Ave annual rainfall**: 4417 mm (recorded at Lihir > 10 yrs)
- **Ave Temp**: 28 – 32 °C during the day and 20 – 24 °C at nights:

Infrastructure

- Old run-down airstrips, road links, relics of groundwater wells, and other infrastructure built by the US Army in the 1940s during WW2,
- > 4000 US Marines were believed to be based here.



➢Water Resources

- no major drainage systems (no rivers and streams).
- no proper water supply and sanitation systems in place except for a few Tuffa tanks and discarded galvanized iron tanks.
- Only water resources available on the island are rainwater and groundwater






- Locals have constructed hand-dug wells beside old wells drilled by the US Army to fetch water for their daily use
- Groundwater from hand-dug wells and sub-marine seepage has proven to be the main source of clean water all-year round

2. Previous Investigations

- **Two hydro-geological studies were carried by Mineral Resources Authority (MRA) at the request by Emirau Water Project Committee:**

1. 2015 – Egara and Kuman *(2015)*

2. 2016 – Otmar and Ken (2016)

- **Findings and suggestions:**

- No major drainage systems (no rivers and streams).

- Most of the water on the island peculates through the subterranean karst terrain, or occur as sub-marine seepage and springs.

- Groundwater from hand-dug wells and sub-marine seepage have been the main source of clean water all-year round

- Suspected fault / fault zone along the N-S trending valley could be controlling ground water flow and storage

- The potential aquifers that may be present within such raised coral island setting are:

1. ***the permeable limestone/raised coral aquifer of the Quaternary deposit, and***
2. ***fracture-controlled rock aquifer at depth within the same limestone unit or the early Miocene-Pliocene limestone unit.***

3. Brief Geology

- **Extensive reefal limestone spread across most of the region after the volcanism in Eocene-Oligocene age representing large fringing reefs deposited over a gradually subsiding volcanic basement** (Katz, 1986).

- **The early Miocene-Pliocene volcanics are shown on the interior portions of Mussau Island while Emirau Island is comprised predominantly of limestone, marl, and raised coral reef of the Quaternary age** (Davies, 2012).

4. Objectives of conducting Geophysical Reconnaissance Mapping - Electrical Resistivity Surveying

Main objectives:

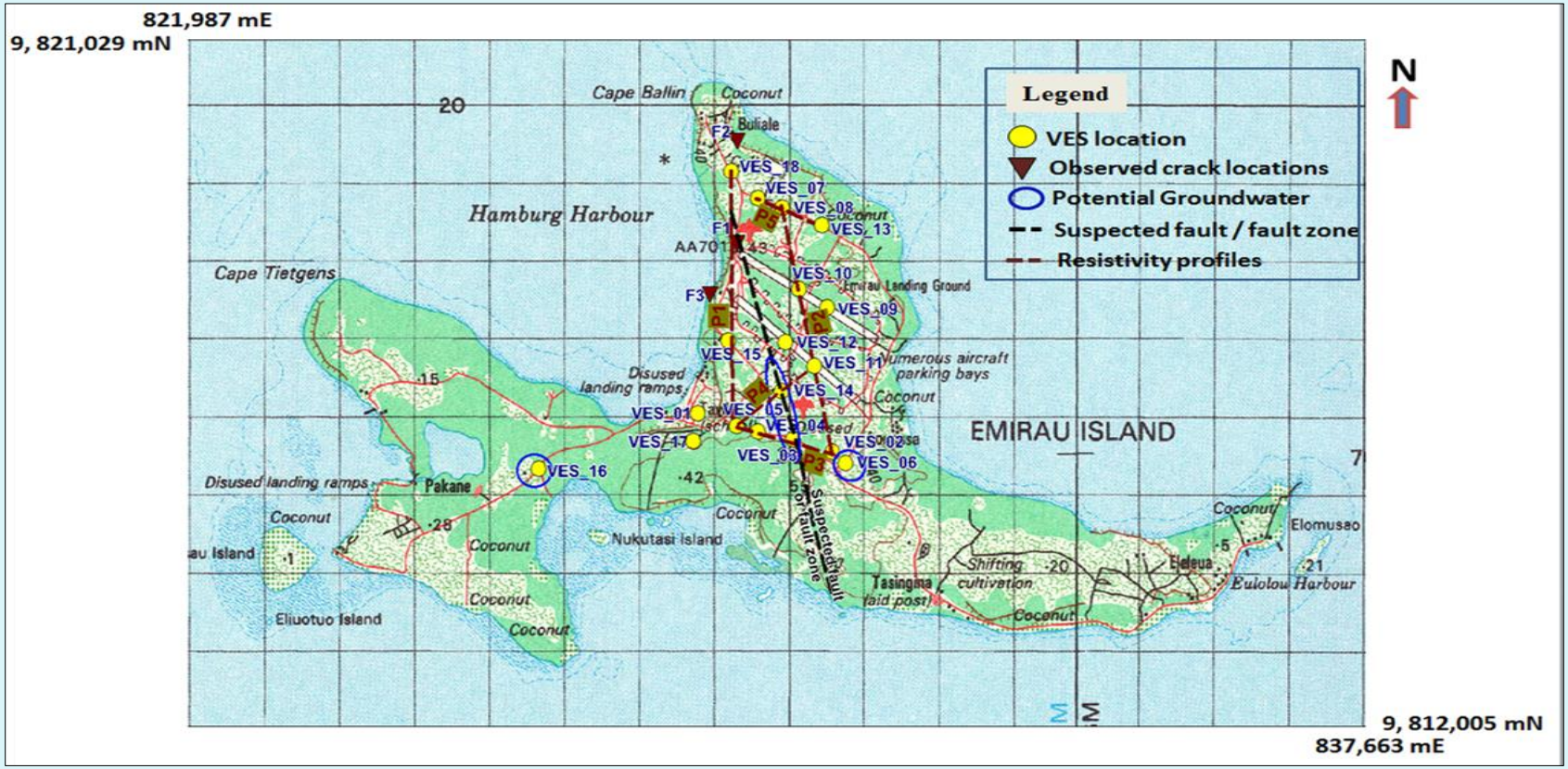
- to understand aquifer (or ground water bearing layer) depth, thickness and distribution with respect to topography (or elevation distribution).

- to understand and establish whether the aquifer (or ground water flow and storage) on the Island is structural controlled or lithological or both

- to locate potential aquifer and recommend suitable sites for test drilling based on the resistivity survey results.

5. Emirau Resistivity Survey

- 18 vertical electrical soundings (VES01 – VES18) employing the Schlumberger array method were conducted.
- Sounding locations selected so that some soundings were conducted along the north - south trending valley (or along suspected fault / fault zone) while others conducted on either sides of the valley and on other selected sites.



- The resistivity surveys were conducted from 12 – 21 February, 2017 by the officers from MRA

6. Discussion of Resistivity Survey Results

- **The sounding data acquired were processed and modeled using Occam's inversion method in the Interpex 2007 program on the computer.**

- **Five interpretative profiles were constructed from the resistivity models (P1, P2, P3, and P4)**

- **The profiles describe variations in the depth and thickness of possible aquifer and other lithologic layers from one sounding site to another with respect to elevation.**

- **Four layers were identified:**

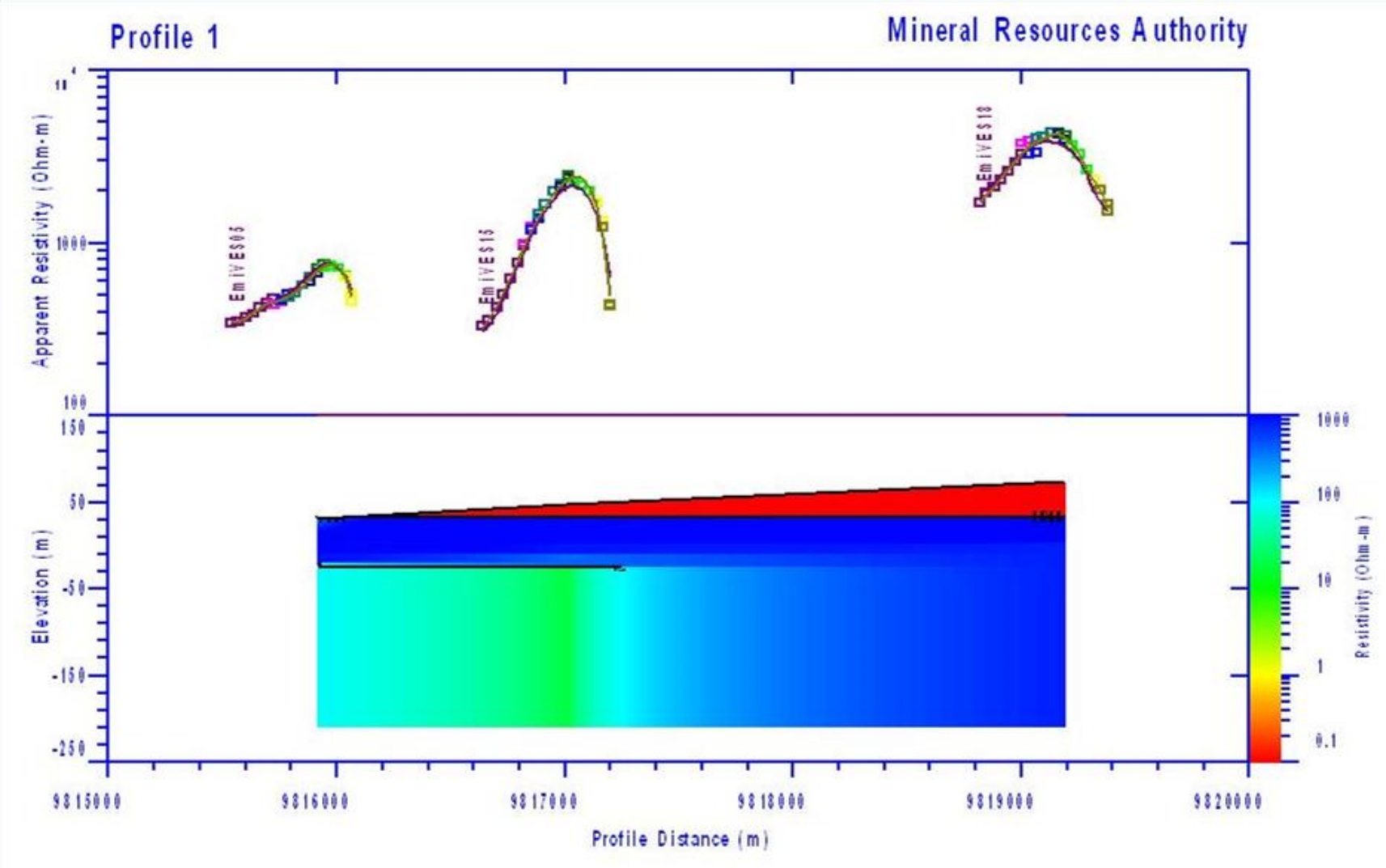
1. **Conductive (low resistivity) surface layer** – with thickness (1.7 – 5.5 m) and layer resistivity (216 – 981.7 Ωm)

2. **Possible aquifer (low resistivity)** – with thickness (2.0 – 12.5 m) and layer resistivity (283.7 – 841.8 Ωm)

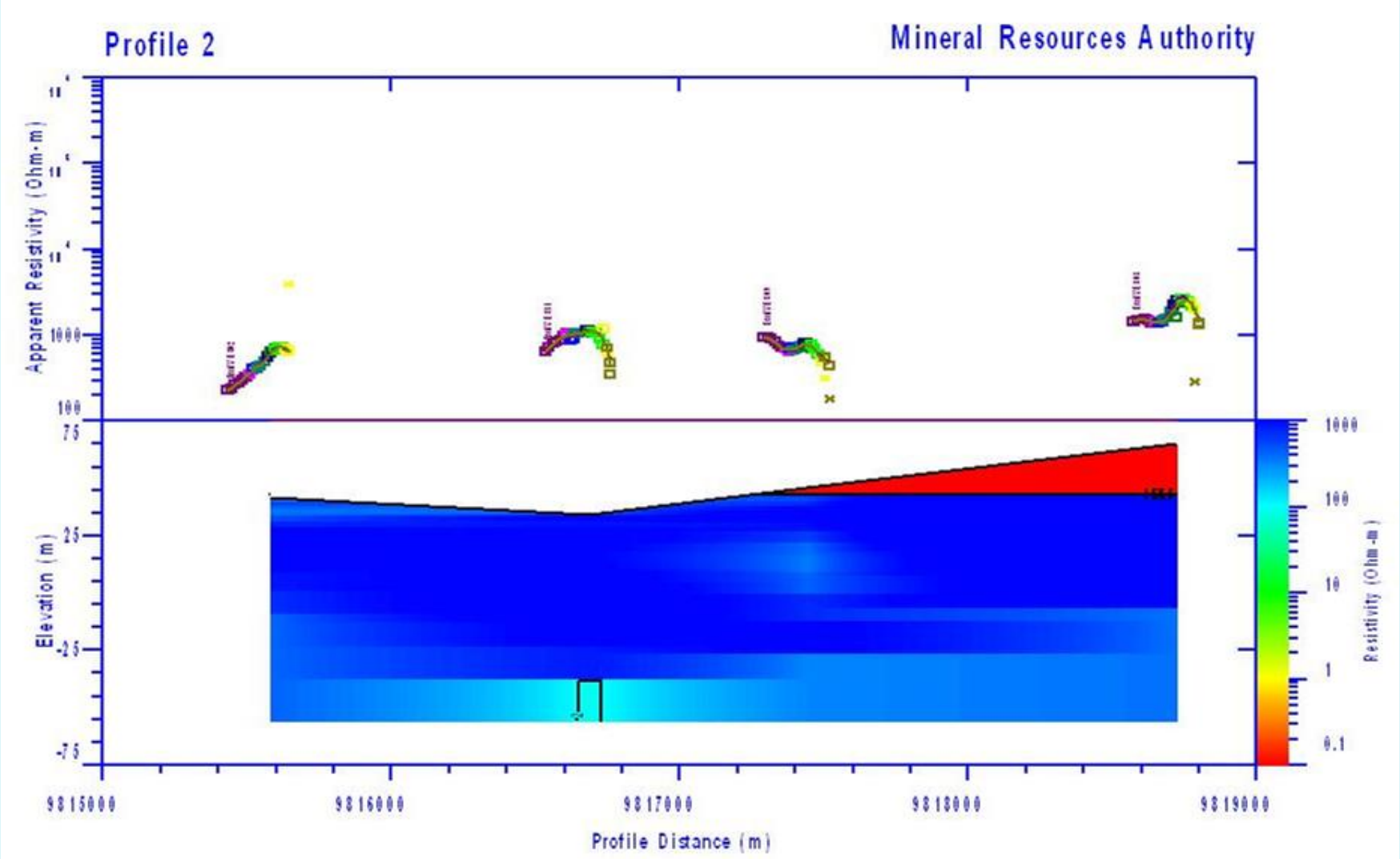
3. **Thick high resistivity (dry) layer** – at 1.3 – 12.4 m depth below surface and approximately 28.1 – 56.8 m thick. Has layer resistivity of 660.7 – 9289.7 Ωm).

4. **Low resistivity layer (possible aquifer with possibility of sea water intrusion)** – with unknown thickness at 38.5 – 59.8 m depth below surface. Layer resistivity varies 51.3 – 723.1 Ωm

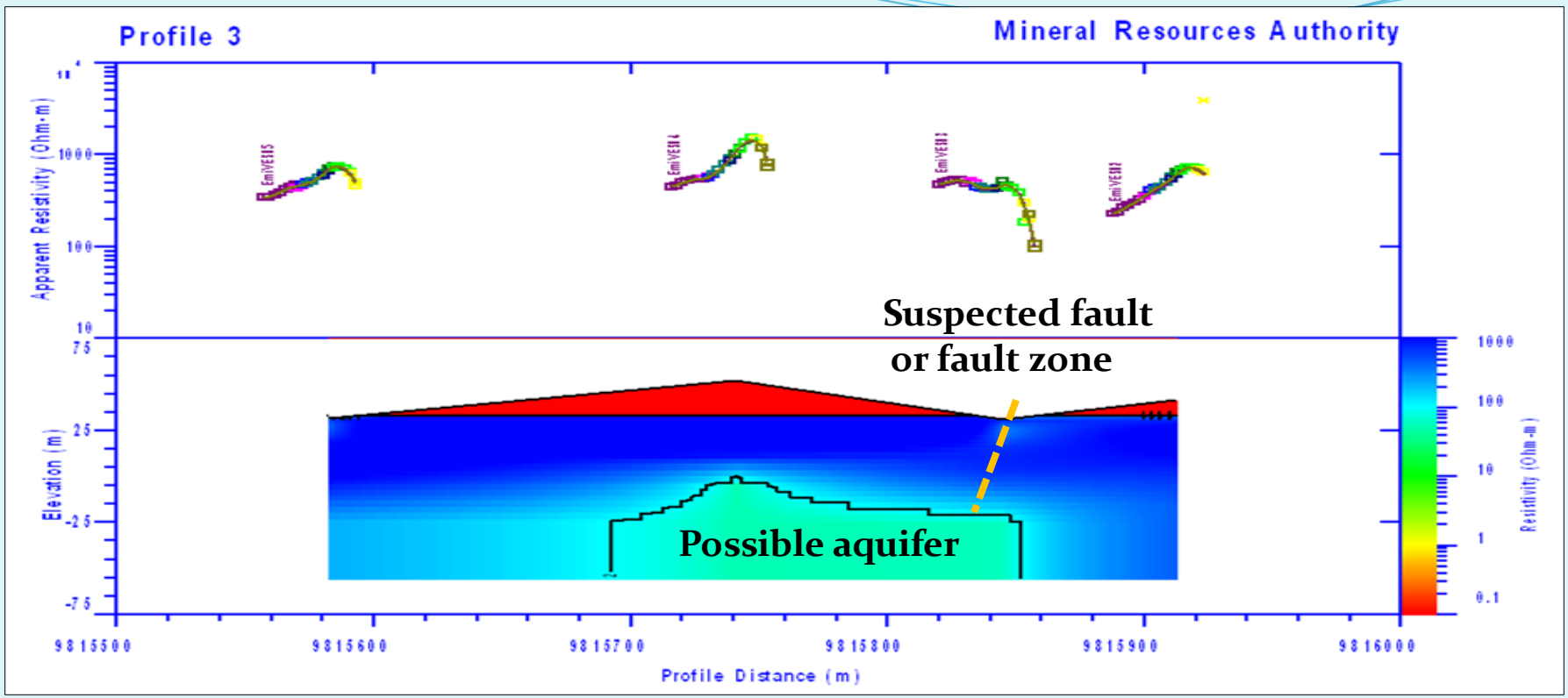
- **Profile 1 shows variation in the resistivity models with change in elevation in a N-S direction for soundings EmiVES05, EmiVES15 and EmiVES18 conducted on the higher land and west of the north – south trending valley.**



- Profile 2 shows variation in the resistivity models with change in elevation in a N-S direction for soundings EmiVES02, EmiVES11, EmiVES12 and EmiVES07 conducted on the higher land and east of the north – south trending valley.

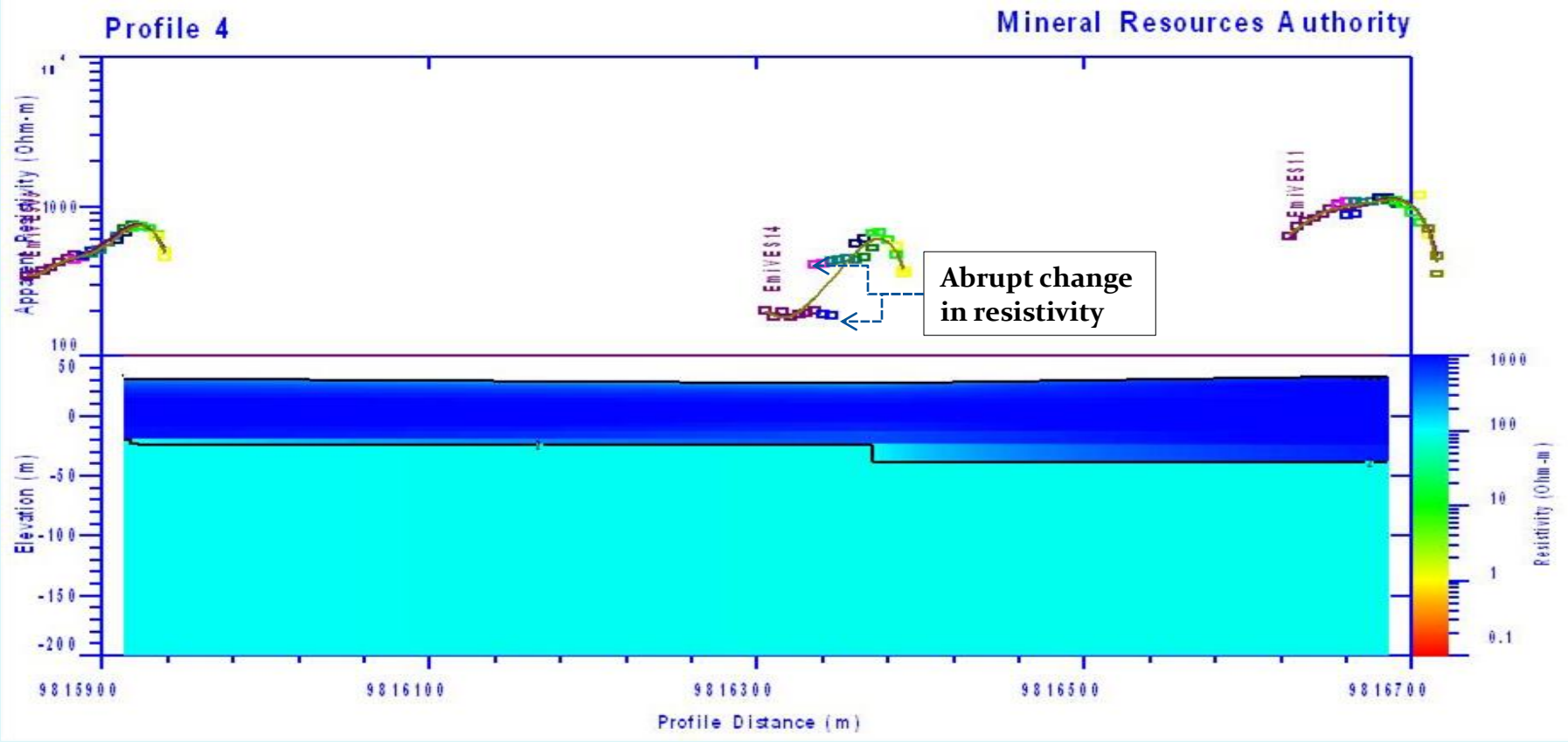


- *Profile 3 shows variation in the resistivity models with change in elevation in a E-W (or NW – SE) direction for soundings EmiVES05, EmiVES04, EmiVES03 and EmiVES02.*



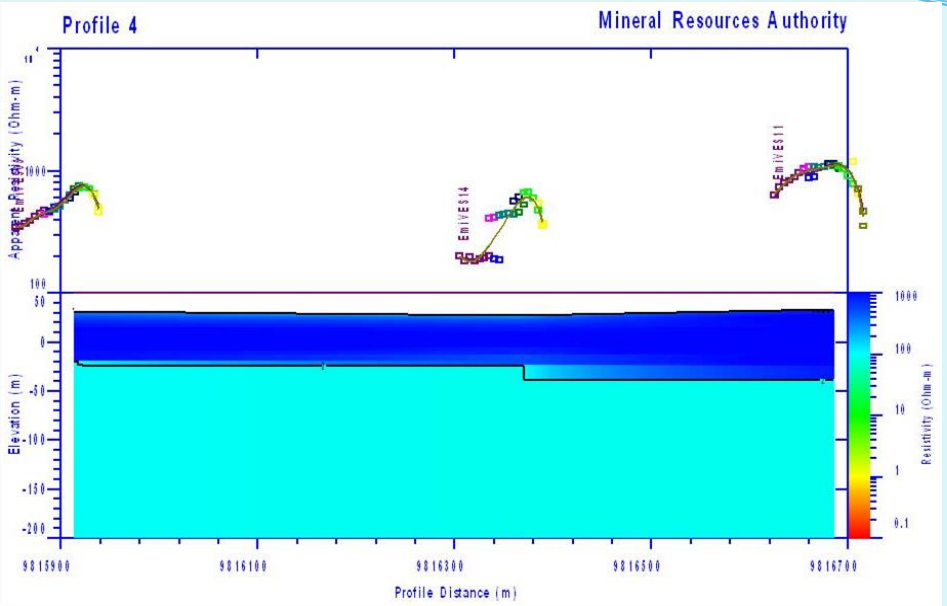
- *EmiVES05 and EmiVES04 were conducted on higher land west of the north-south trending valley while EmiVES02 was conducted toward the eastern side.*
- *EmiVES03 was conducted within the north-south trending valley and probably intersected the suspected fault or fault zone.*

- *Profile 4 shows variation in the resistivity models with change in elevation in a SW-NE direction for soundings EmiVES05, EmiVES14, and EmiVES11 conducted across the N-S trending valley.*

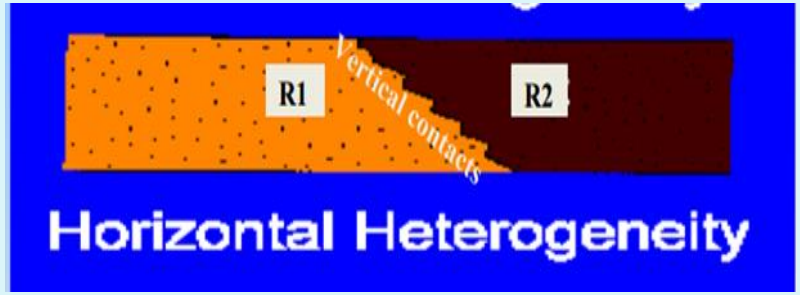


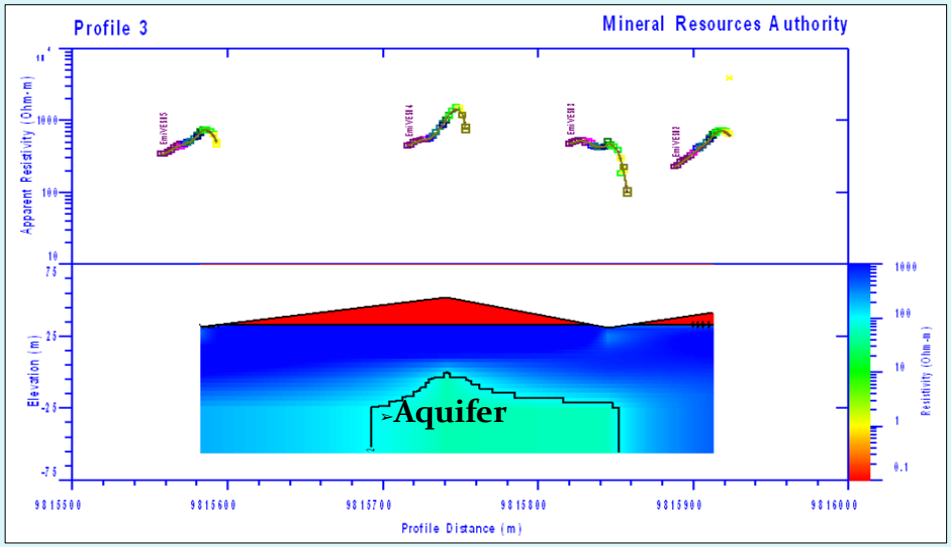
- *Profile 4 shows variation in the resistivity models with change in elevation in a SW-NE direction for soundings EmiVES05, EmiVES14, and EmiVES11 conducted across the N-S trending valley.*
- *EmiVES14 was conducted within the N-S trending valley*

➢Comparison of profile 3 and 4 for soundings VES14 and VES03 conducted along the N-S trending structure



➢Abrupt change (shift or non-continuity)in the resistivity curve reflects lateral change in resistivity due to vertical contacts

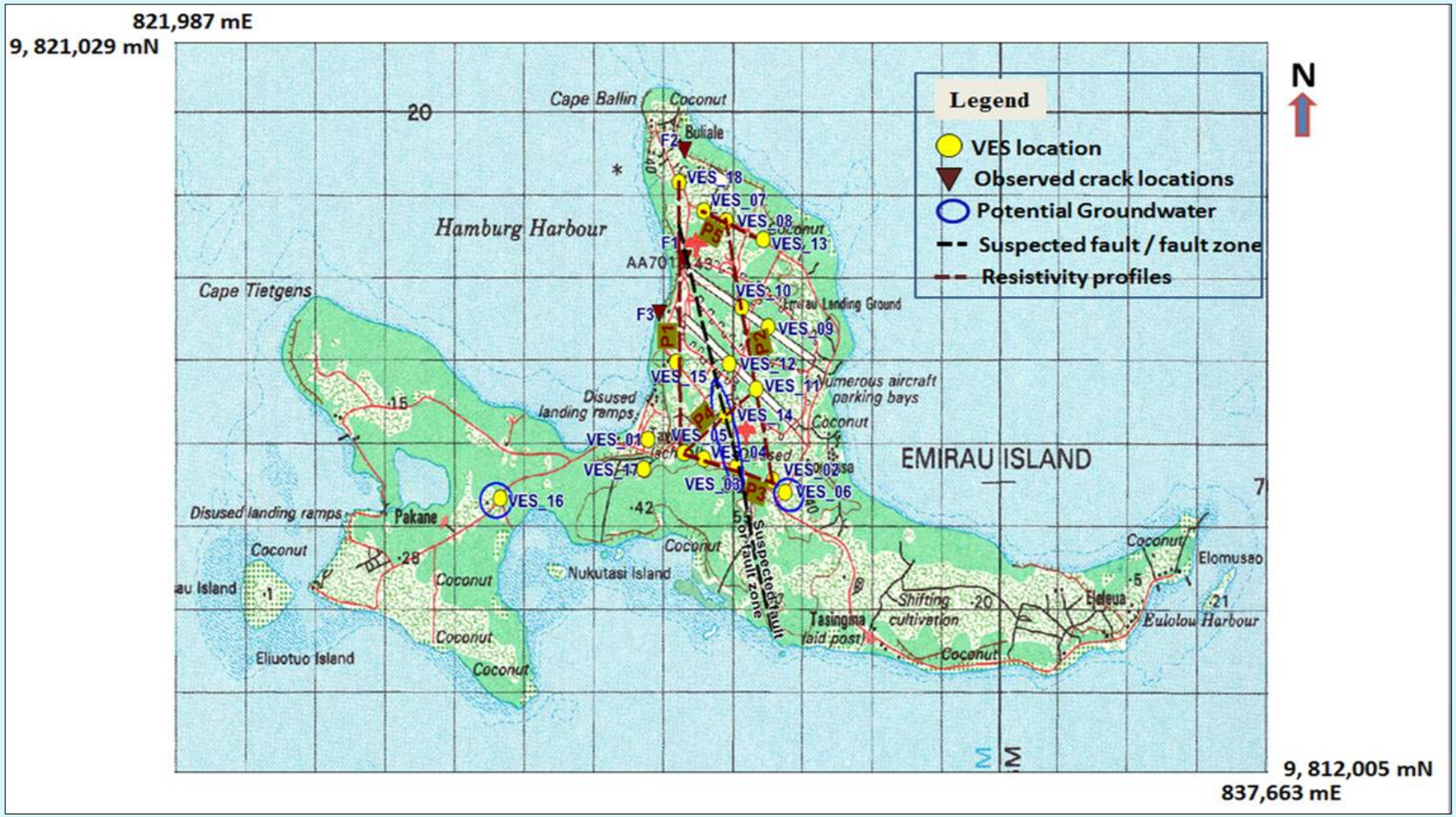




➢Differences in resistivity curves / models reflects differences in subsurface lithology.

➢Similarities in resistivity curves and models reflects similarities in subsurface lithology

- Other soundings (EmiVES06 and EmiVES16) conducted further south and away from the suspected geological structure also revealed a possible aquifer at relatively shallow depth (5.2 m below surface) and thick enough (12.5 – 17.4 m) for ground water development.



7. Conclusion

- A thick high resistivity layer exists at 1.3 – 12.4 m below surface

- Two possible aquifer layers encountered:
1. a shallower aquifer – of 2.0 – 12.5 m thickness lies above the thick high resistivity layer
2. a deeper aquifer – of unknown thickness lies below the thick high resistivity layer at 38.5 – 59.8 m below surface. Possibility of sea water intrusion here is likely.

- Soundings EmiVES06 and EmiVES16 conducted further south revealed possible aquifers at relatively shallow depth (5.2 m below surface) and thick enough (12.5 – 17.4 m) for ground water development.

- Possible presence of the suspected fault / fault zone is intersected / encountered by EmiVES03 and EmiVES14 conducted along the N-S trending valley. Possible aquifers have been delineated here.

- Ground water flow and storage on the island is probably both structural and lithologically controlled

6. RECOMMENDATION

- Further studies (resistivity surveys) are recommended for areas around EmiVES06 and EmiVES16

- Further resistivity surveys are recommended for areas around EmiVES03 and EmiVES14 and along the N-S trending valley

- Test drilling for ground water should focus on areas around EmiVES16, EmiVES06 and EmiVES03

- Finally, care must be taken during test drilling and ground water extraction to avoid depletion and destruction of available ground water resource

Thank you very much for your attention

Mineral Resources Authority