Geological Survey of Tanzania

Federal Institute for
Geosciences and Natural Resources

High-enthalpy reservoir indications in Mbeya area (SW Tanzania) revealed by magnetotelluric measurements

by

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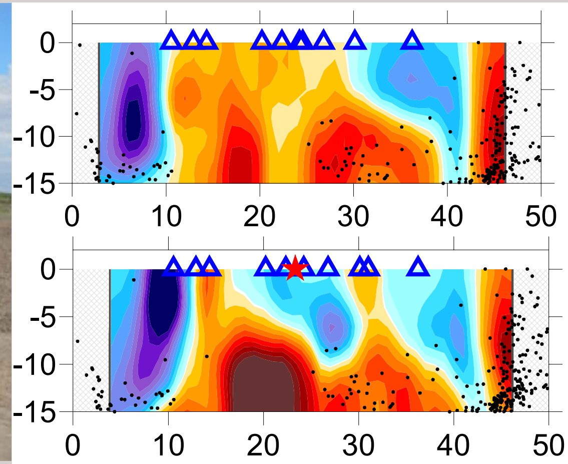
Outline

A Introduction

B The MT method

C MT results from Mbeya

A Introduction



Pilot projects reducing investment risks (feasibility studies, application of geoscientific methods for site evaluation)

Training

Policy advice and awareness raising

Goal:
Partner countries use their geothermal potential

GEF

UNEP

Networking and international cooperation

GEOTHERM Projects

Uganda: Investigation of Buranga geothermal site

Eritrea: Training of geo -thermal experts in cooperation with the United Nations University

Yemen: Feasibility Study at Al Lisi as part of a GEF Project

Vietnam: Socio-economic analysis of framework conditions for direct use and electricity production

Rwanda: geothermal studies, training

Ethiopia: geophysical exploration at Tendaho, Support to the African Geothermal Conference 2006

Chile: Geothermal explora-tion at Térmas de Río Blanco, Training, EIA guidelines

Tanzania: Geothermal exploration, training, and awareness raising of decision makers

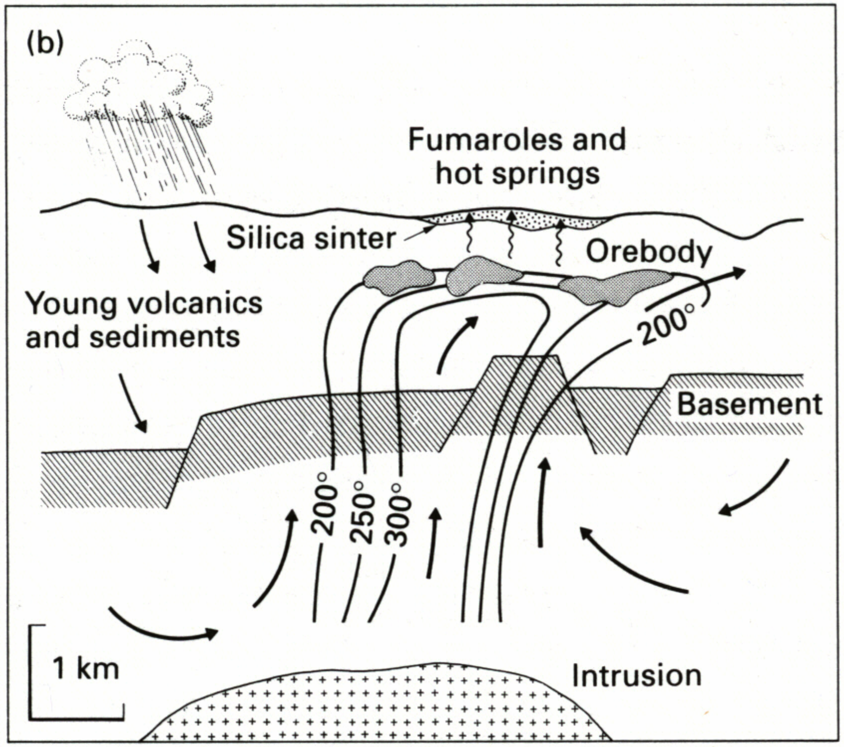
Kenya: Training in GIS, airborne thermal camera survey

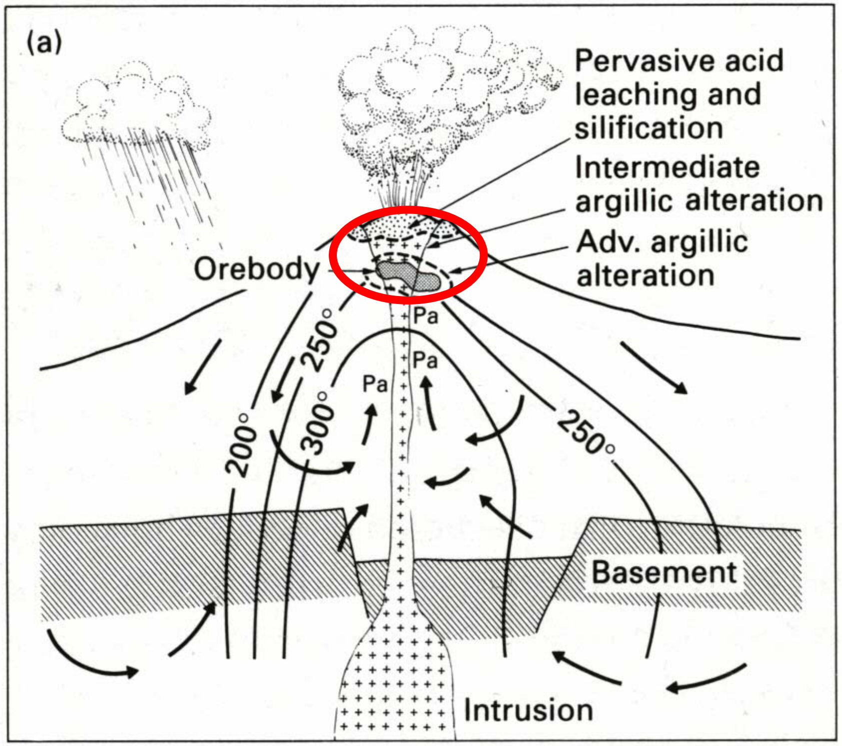
A Introduction

Main phases of surface exploration

- Literature survey (desk top study)
- Regional review (with prioritizing sites)
- Site selection (apply for concession of most promising site)
- Remote sensing (satellite images, aerial photographs, IR, InSAR)
- Geologic survey (rock units, tectonic setting, active faulting, age of youngest volcanic activity, surface manifestations, alteration zones)
- Hydrologic survey (meteorological data, discharge rates of springs, water table, hydraulic gradient, mean residence time)
- Geochemical survey (chemical and isotopic composition of fluids and gases, geo-thermometry, soil gas survey)
- Interim conceptual model (for geophysical survey planning)
- Geophysical survey (temperature gradient, resistivity methods, gravity, magnetics, micro-seismicity)
- Synthesis (final conceptual model with suggestion of sites for exploratory drilling)

Schematical geothermal reservoir types

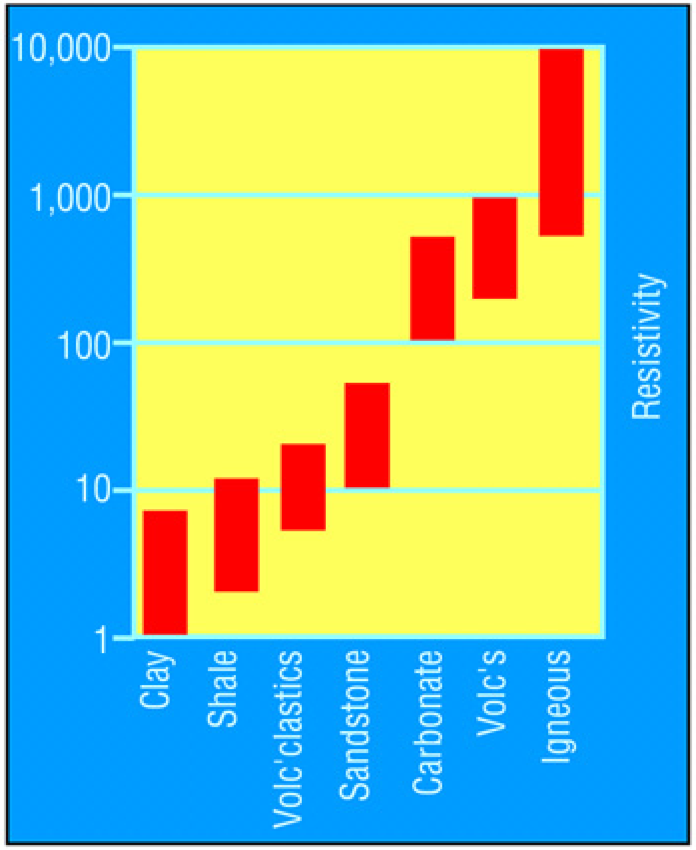


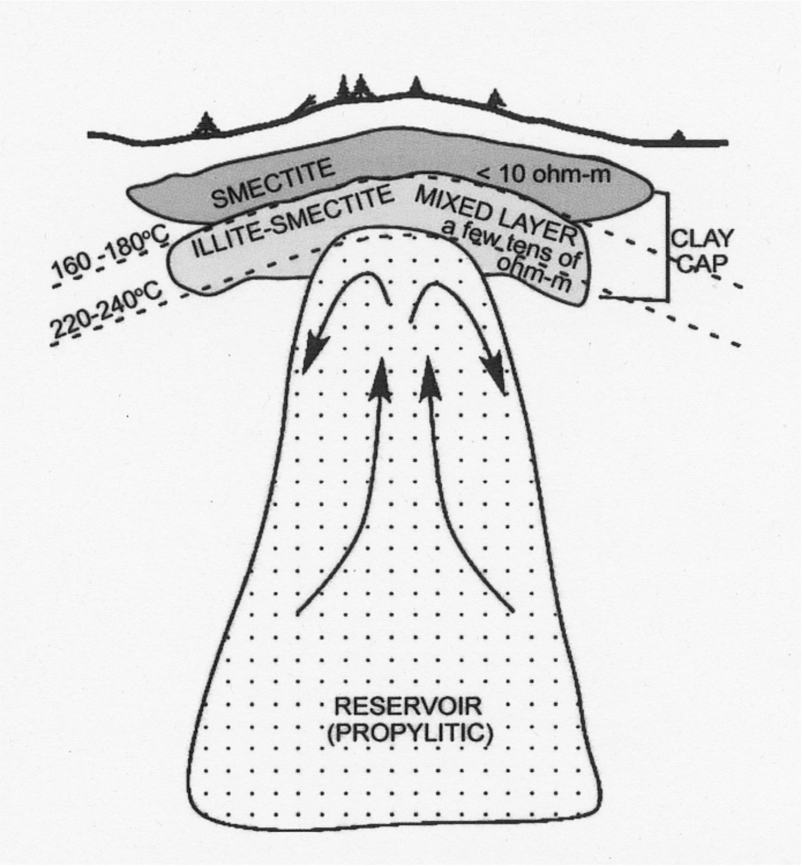


from: Evans 1997

A Introduction

Working model of a geothermal reservoir, produced by hydrothermal alteration

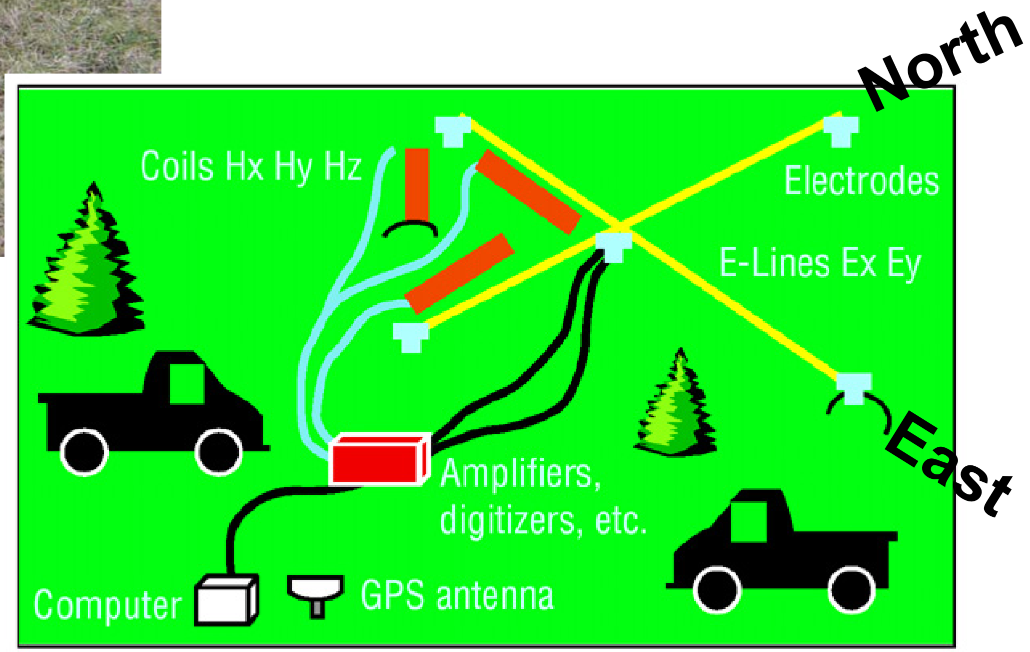




Modified after: Johnston et al. 1992

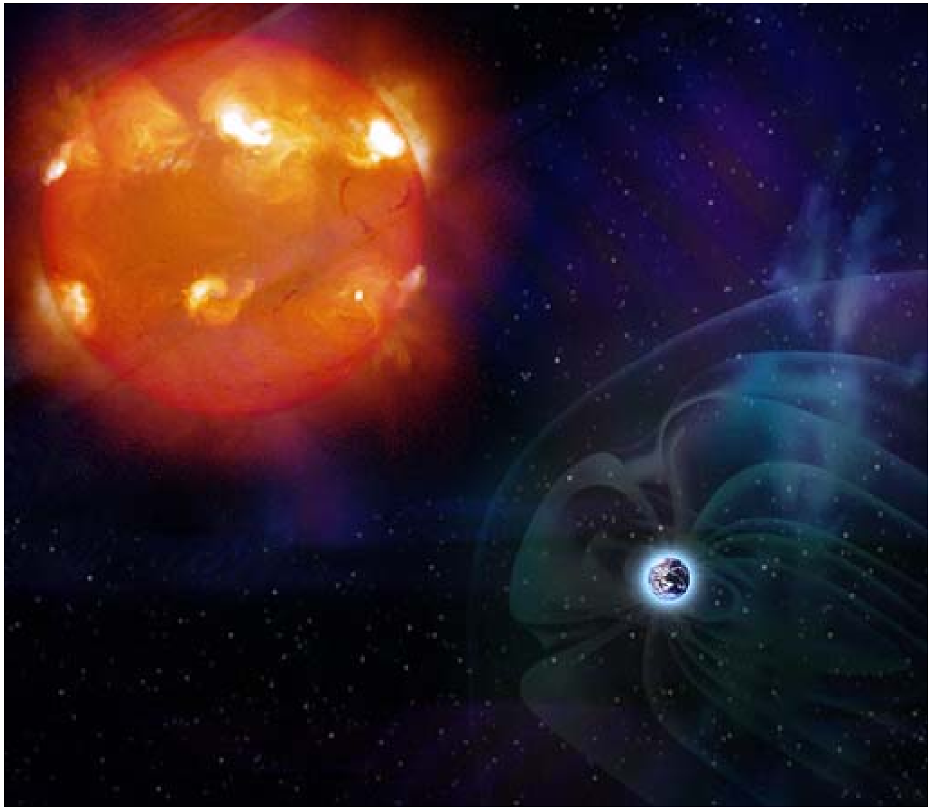
B The MT method

Two 5-channel stations (Ex, Ey, Bx, By, Bz)
Time synchronised recording
Frequency range: 10 kHz to 0.01 Hz (100 s)
Sensors: **Induction coil magnetometers**
Pb-PbCl electrodes, dipole length 100 m



B The MT method

No transmitter: passive method. What are the sources?



- Variations of the Earth‘s magnetic field cover a broad frequency range
- Lower frequencies penetrate deeper into the subsurface and thus allow conclusions on electrical conductivity structures at depth

B The MT method

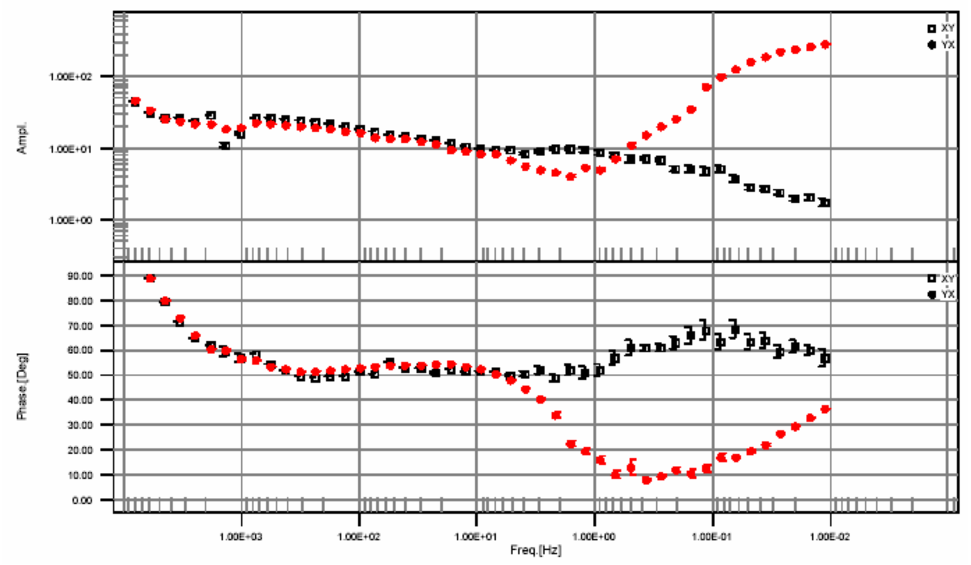
Exploration depth depends on frequency and conductivity of subsurface:

e.g.: 10 Ohm*m / 0.1 Hz
5 km depth of exploration

$$\delta \cong 0.5 \sqrt{\frac{\rho}{f}}$$

The ratio of E- to H- field variations is used to calculate **apparent resistivities** for selected frequencies.

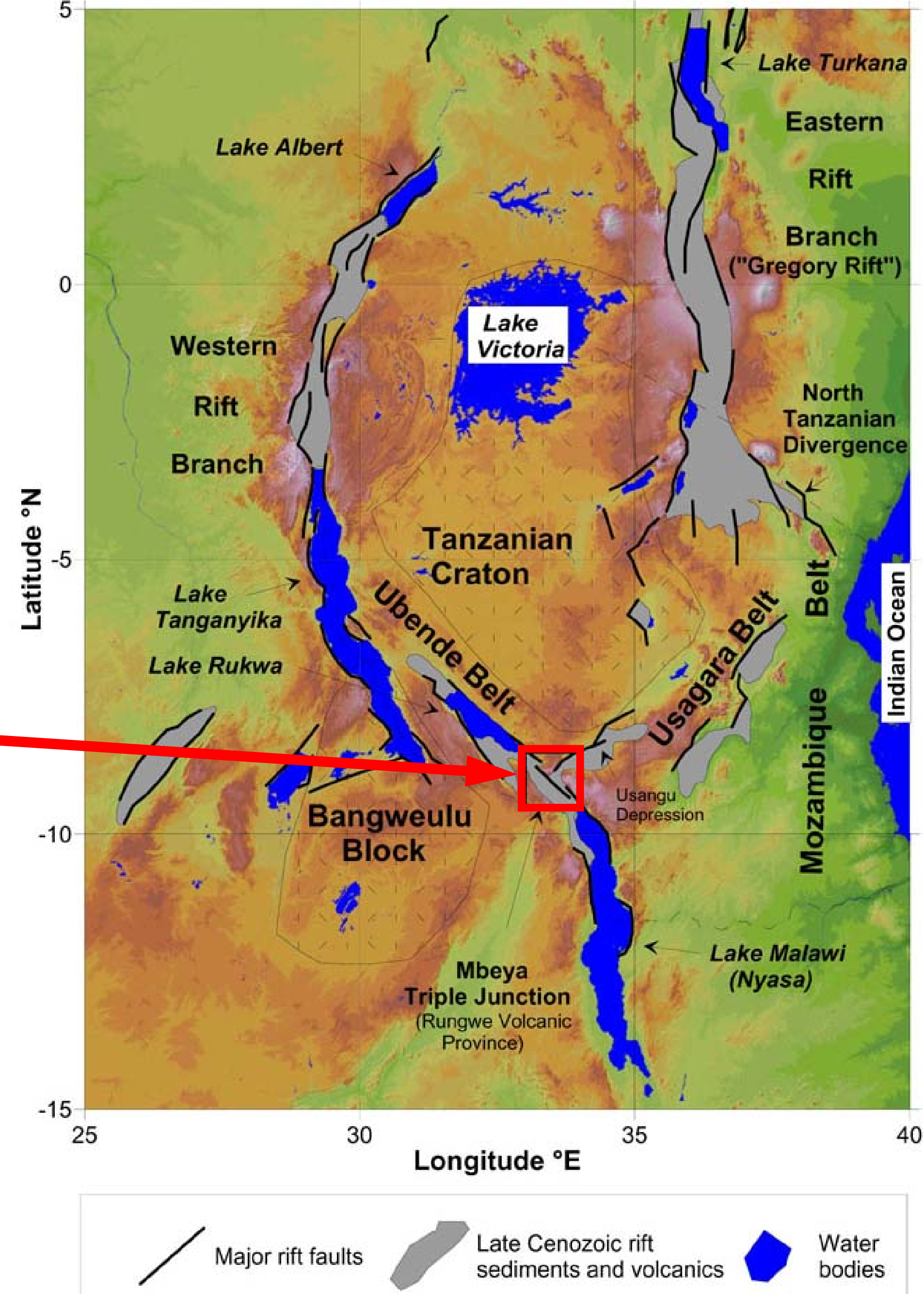
The **phase** shift between E- and H- fields is also indicative for changes in subsurface resistivity



C MT results from Mbeya

Major structural elements, Tanzania and surroundings

Rungwe Volcanic Province
Mbeya Triple Junction



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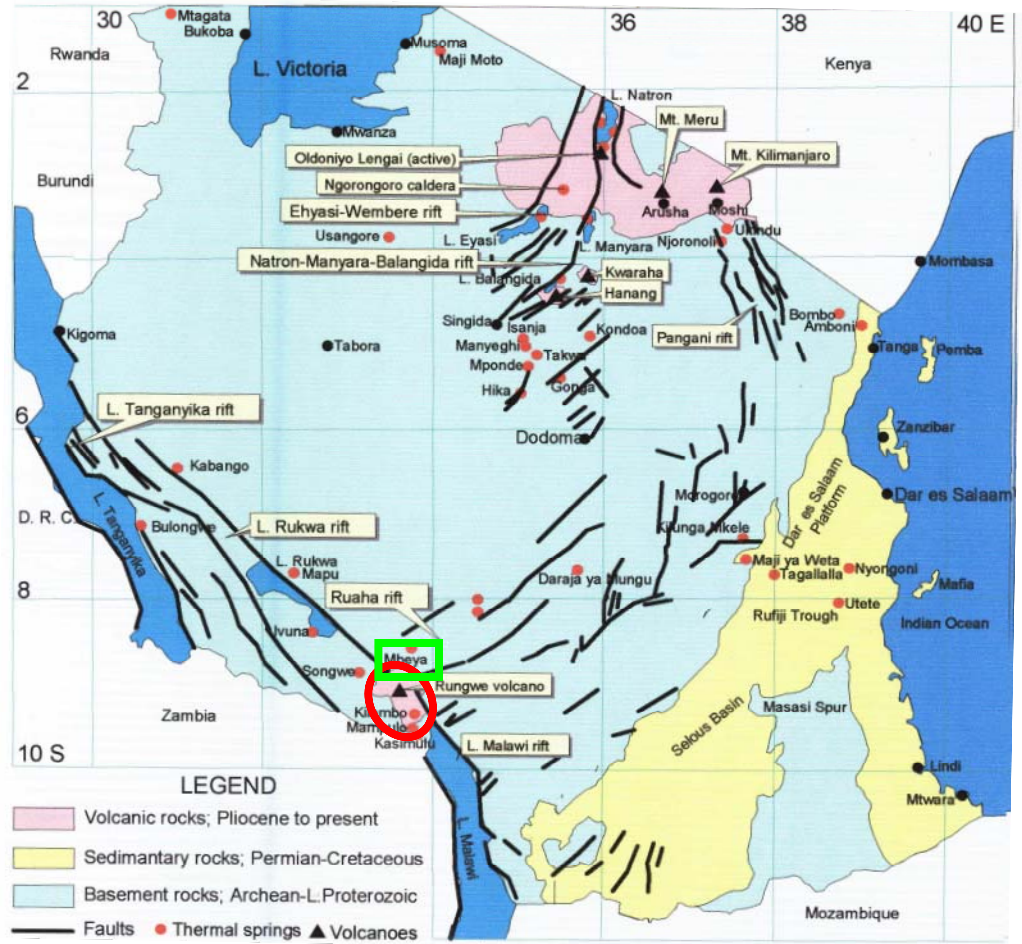
C MT results from Mbeya

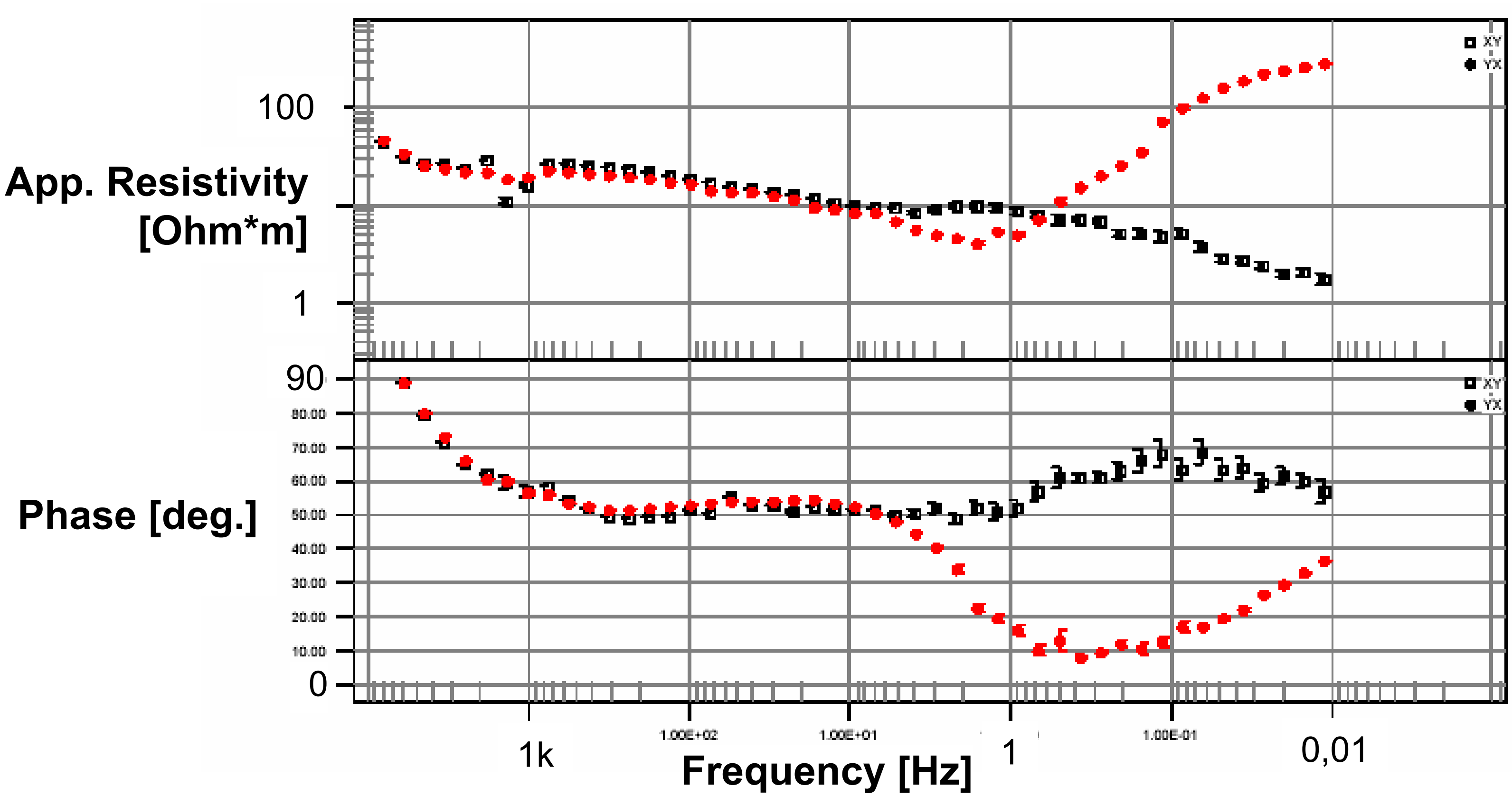
Survey area

Rungwe Volcanic Province

Ngozi volcano in the North



C MT results from Mbeya



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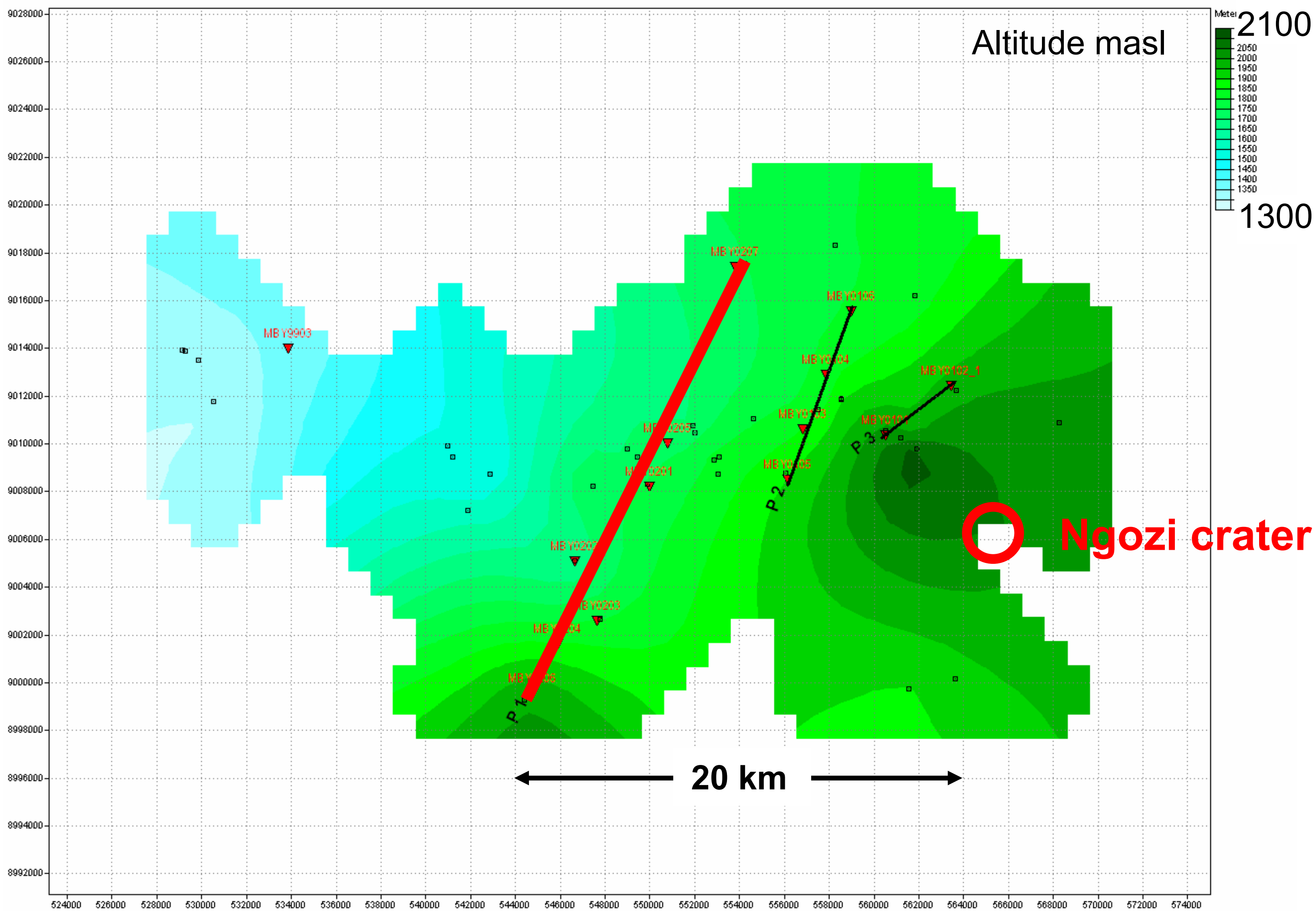
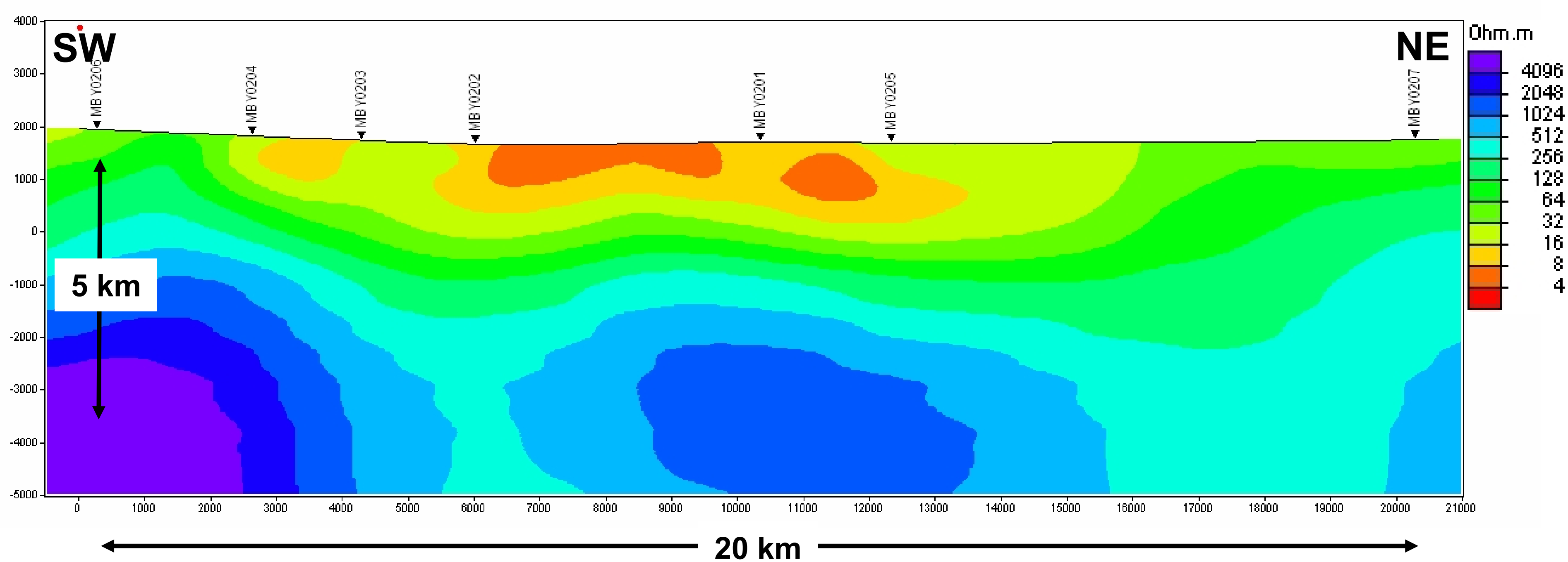


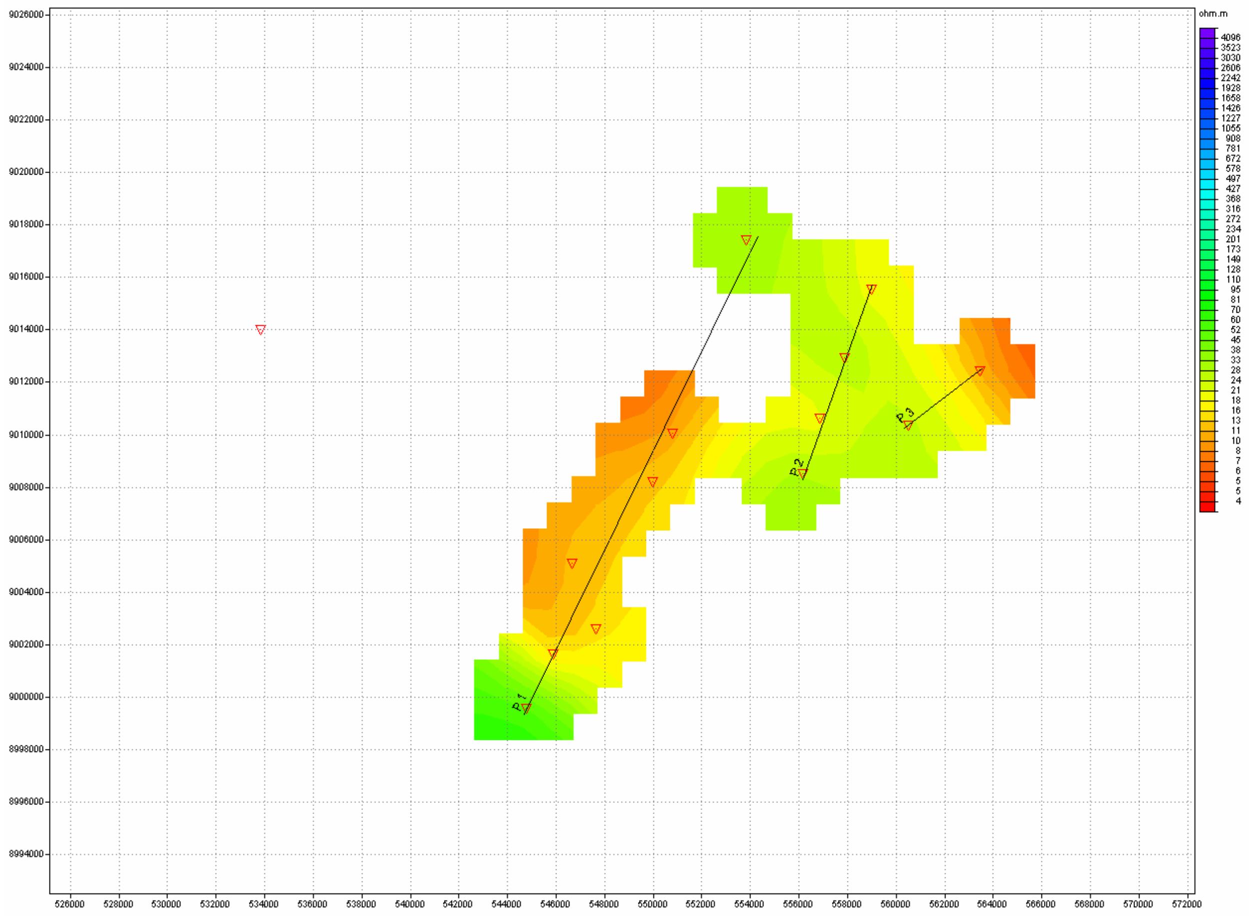
C MT results from Mbeya



Line 1: Resistivity section

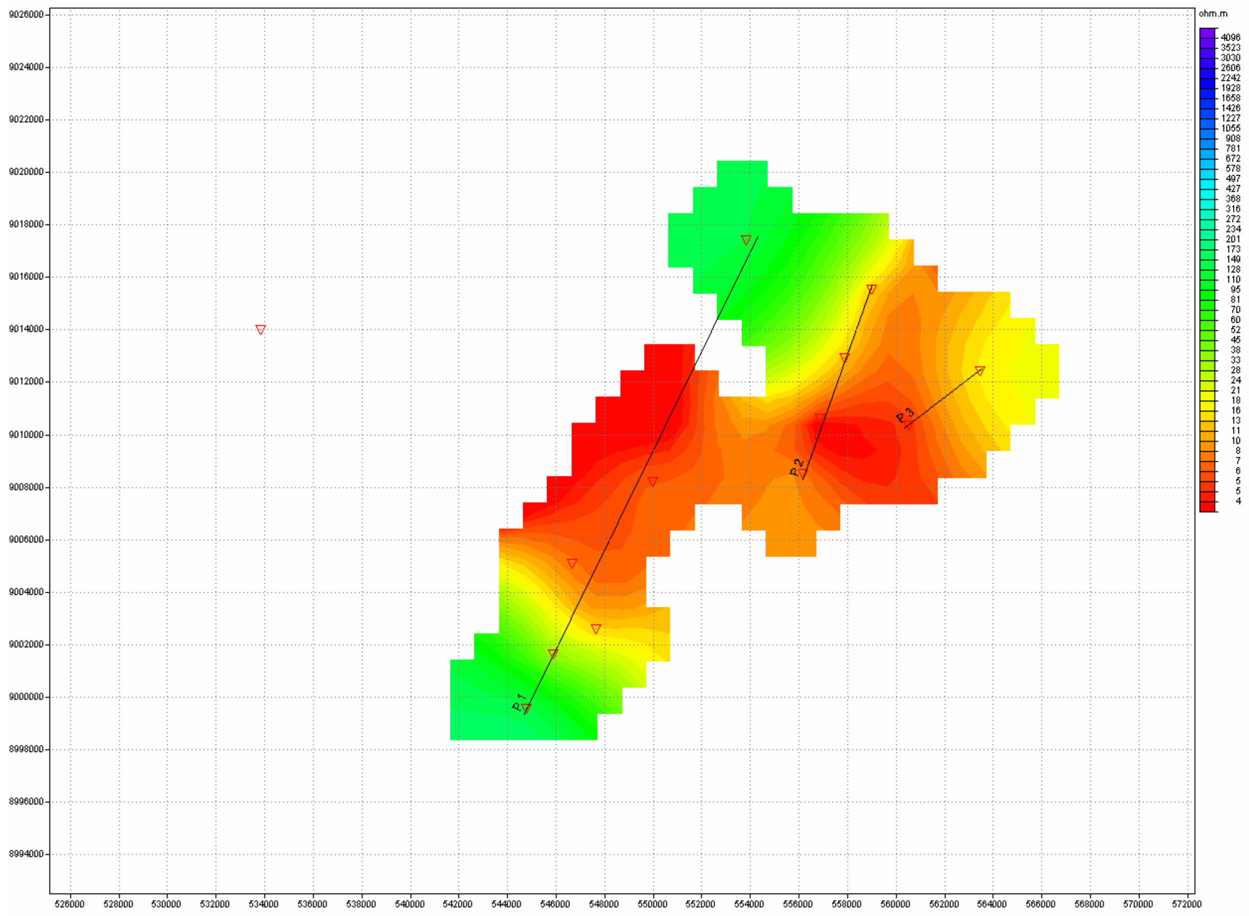
C MT results from Mbeya

Resistivity map
at 1500 masl



C MT results from Mbeya

Resistivity map at 1000 masl



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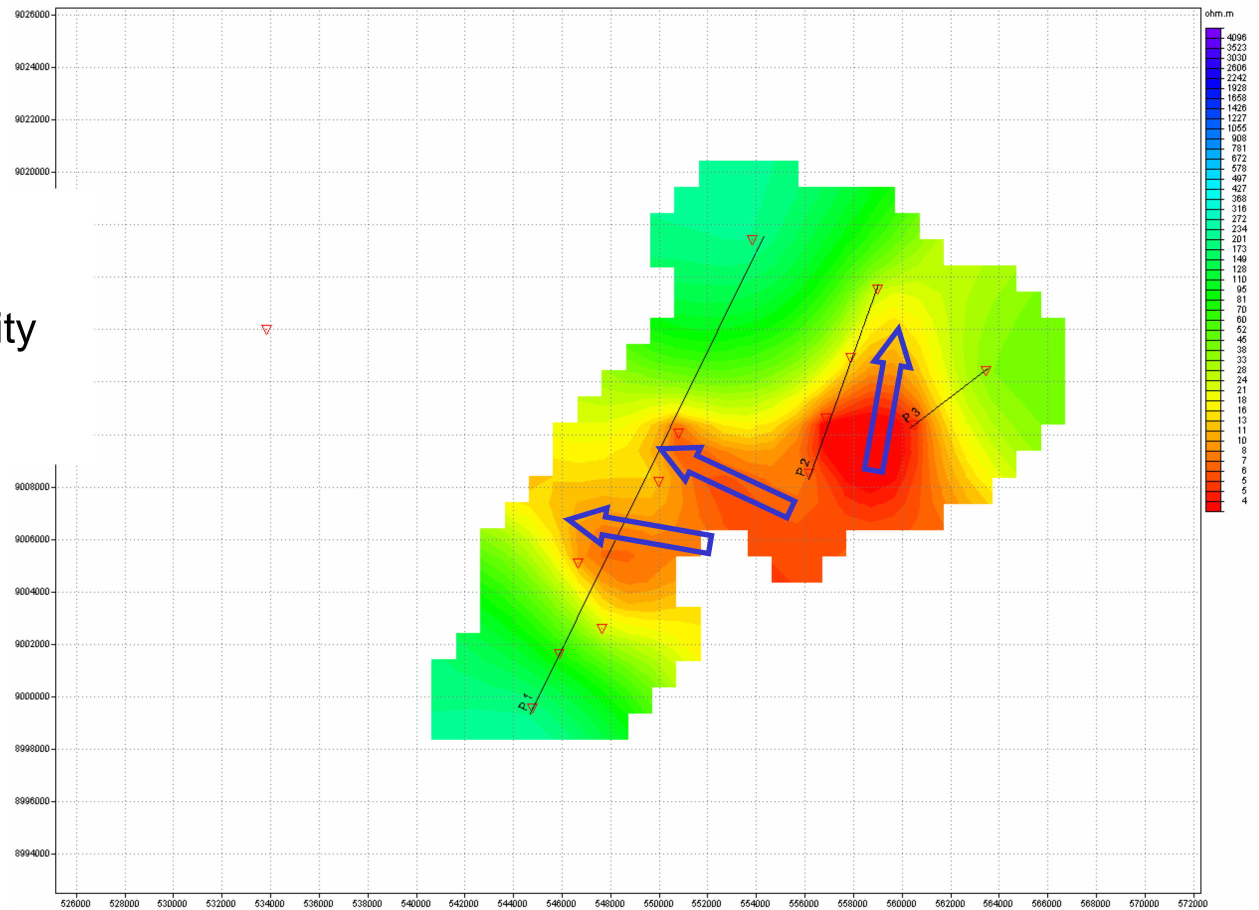
C MT results from Mbeya

Resistivity map
at 500 masl

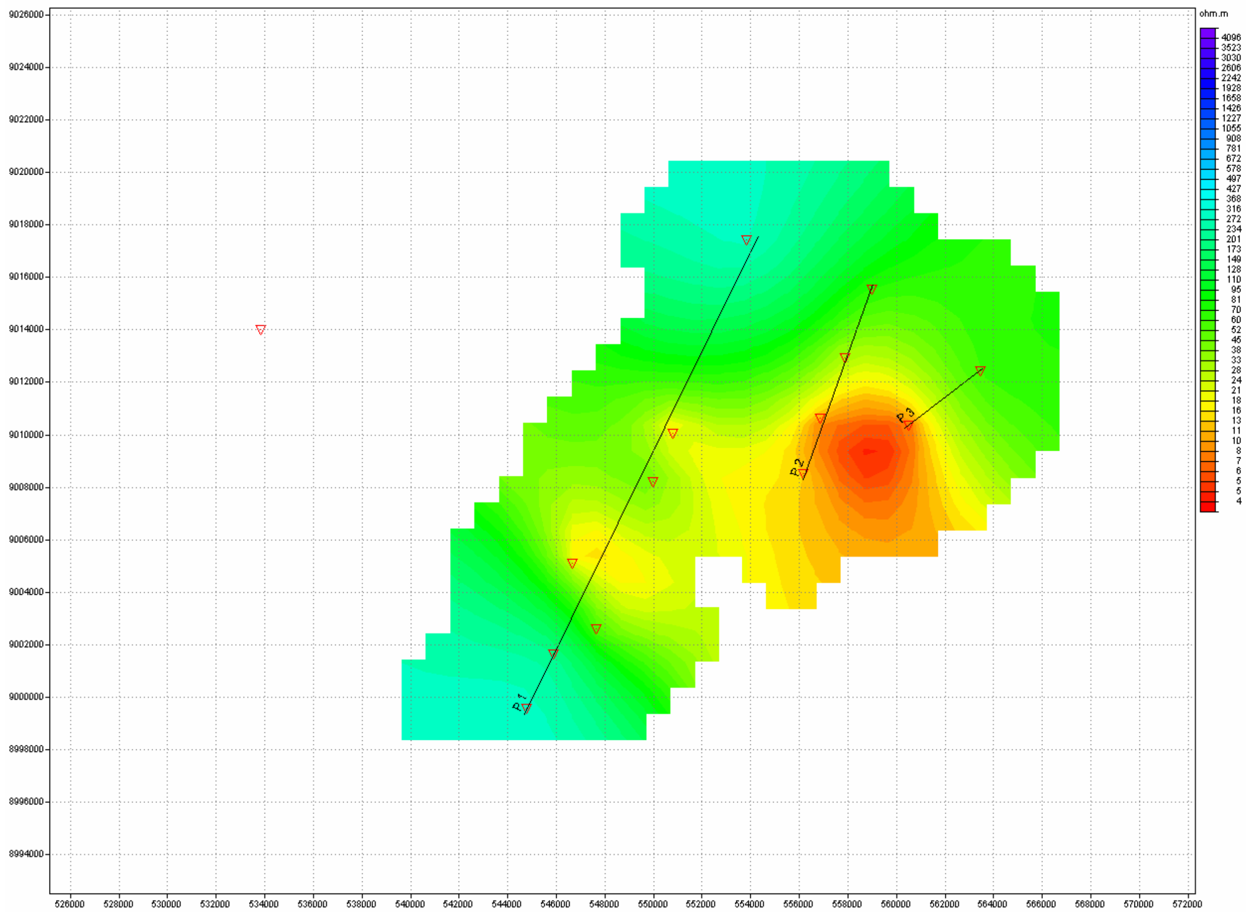
1400 m depth

Increased conductivity
in flowdirection of
hydrothermal waters



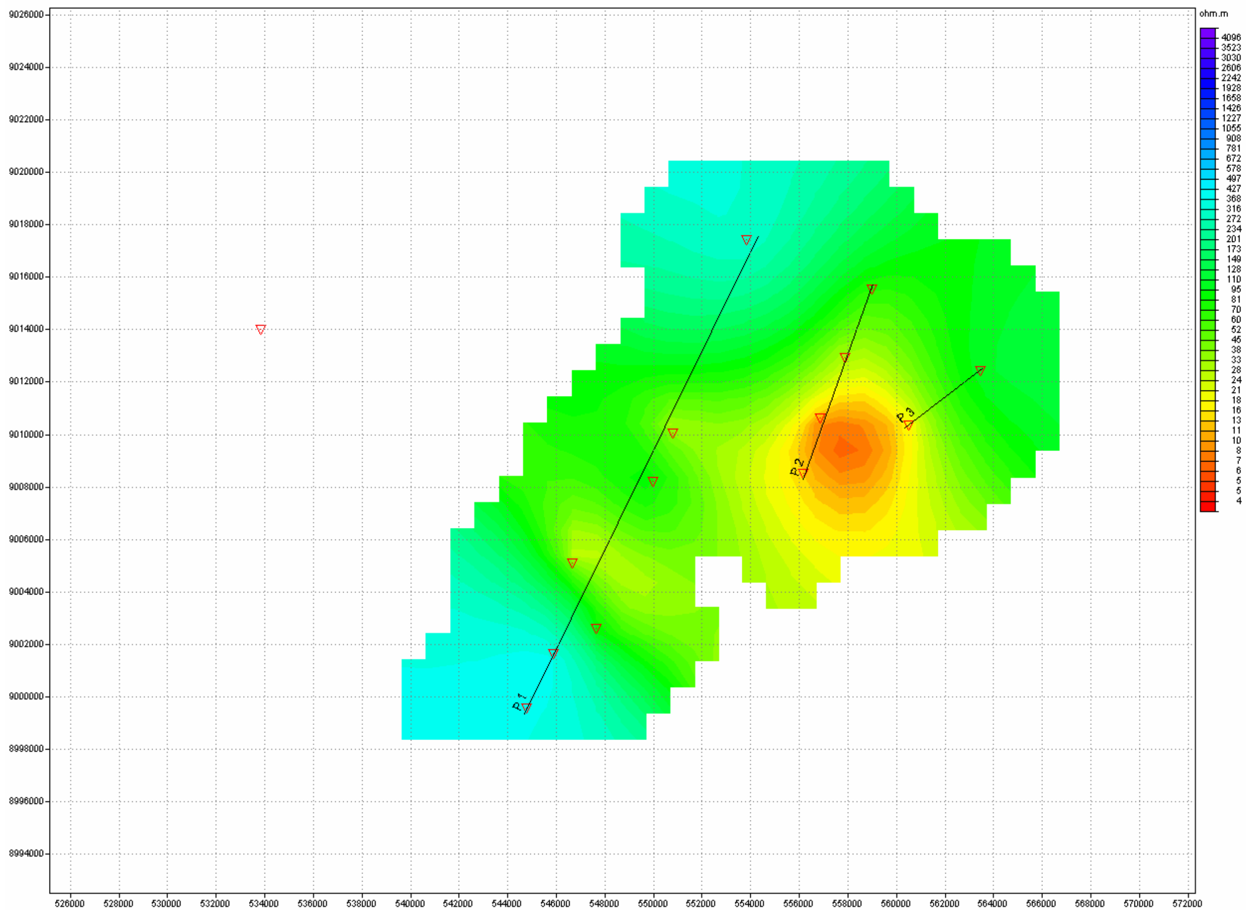
C MT results from Mbeya

Resistivity map
at sea level



C MT results from Mbeya

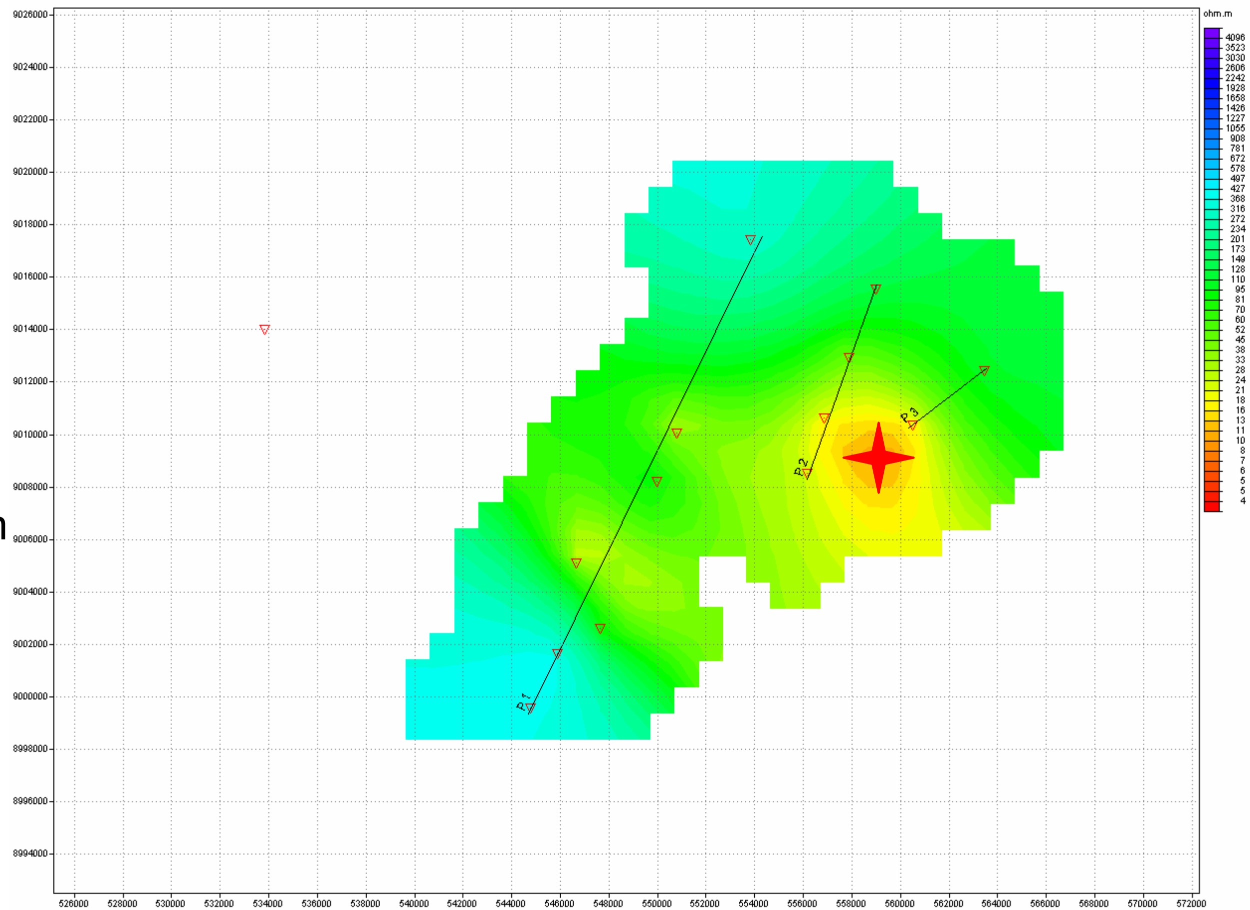
Resistivity map at 125 mbsl



C MT results from Mbeya

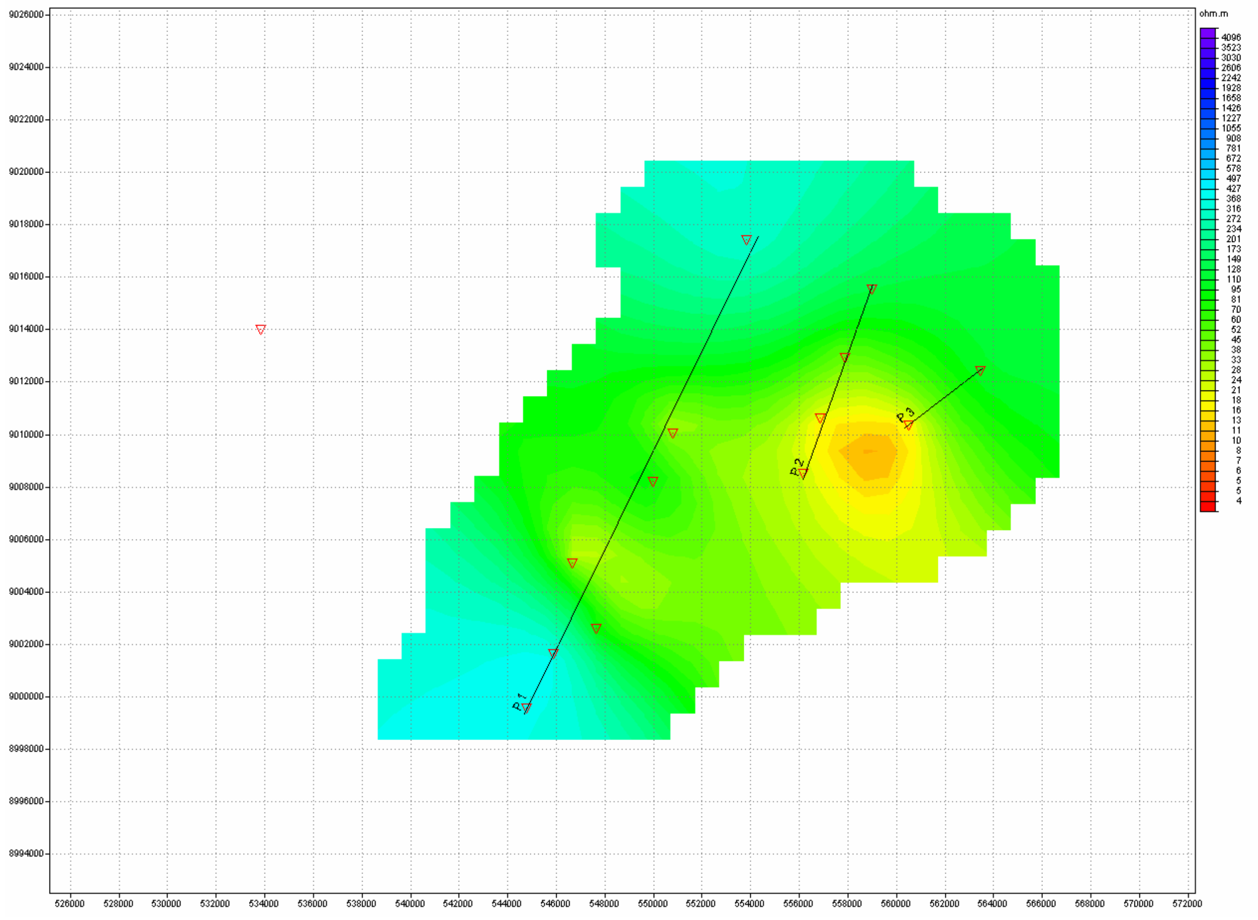
Resistivity map at 250 mbsl

Assumed reservoir location,
Depth approx. 2200m



C MT results from Mbeya

Resistivity map
at 375 mbsl



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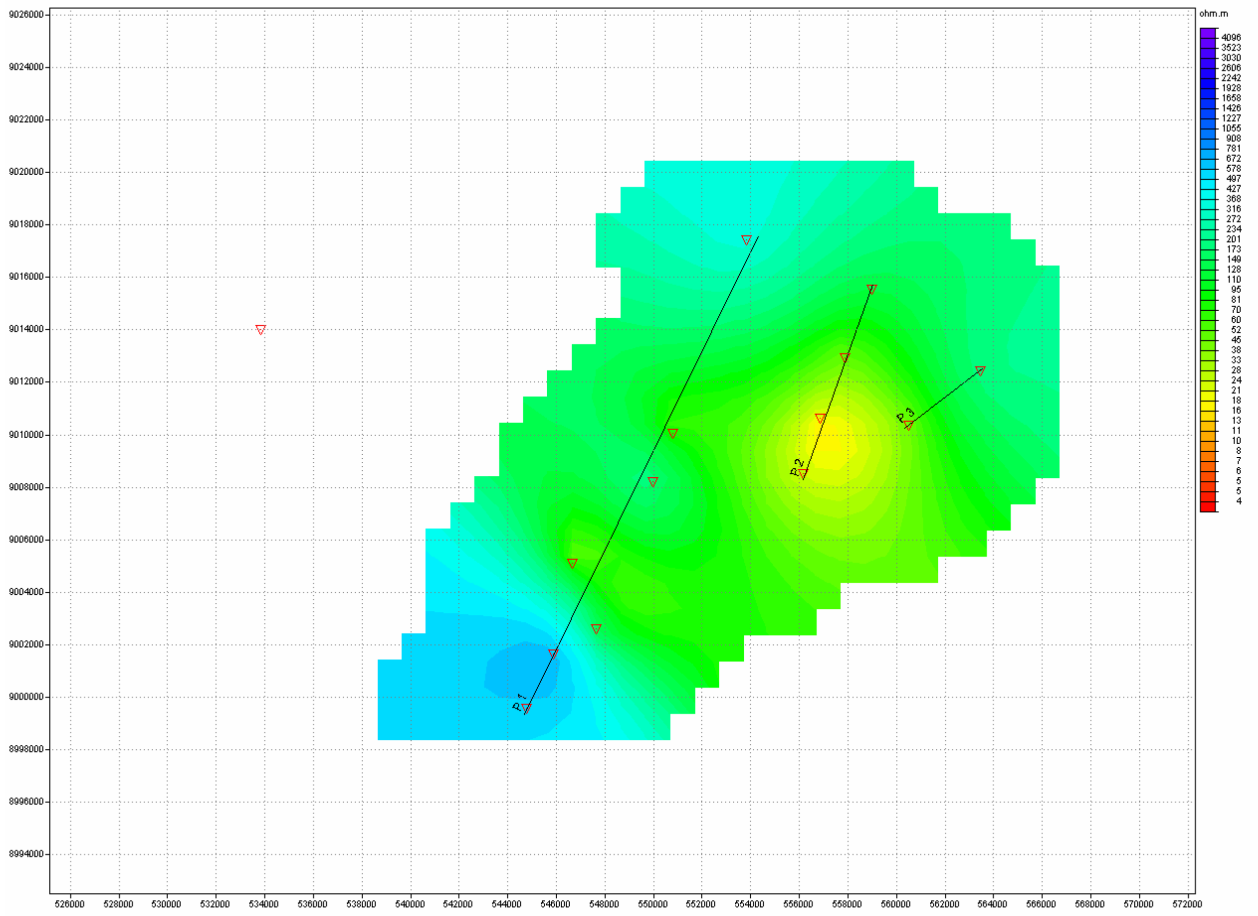
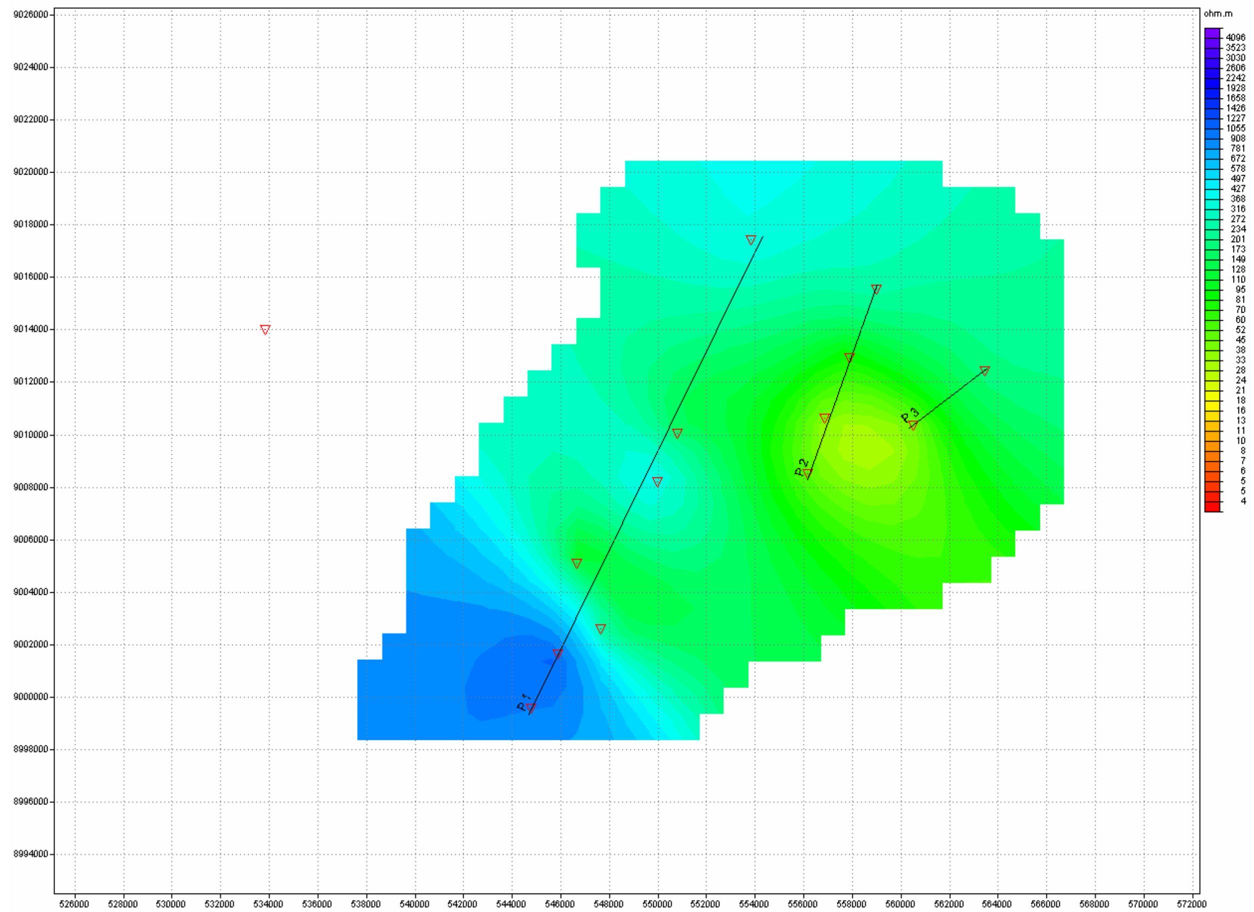
C MT results from Mbeya

Resistivity map at 500 mbsl



C MT results from Mbeya

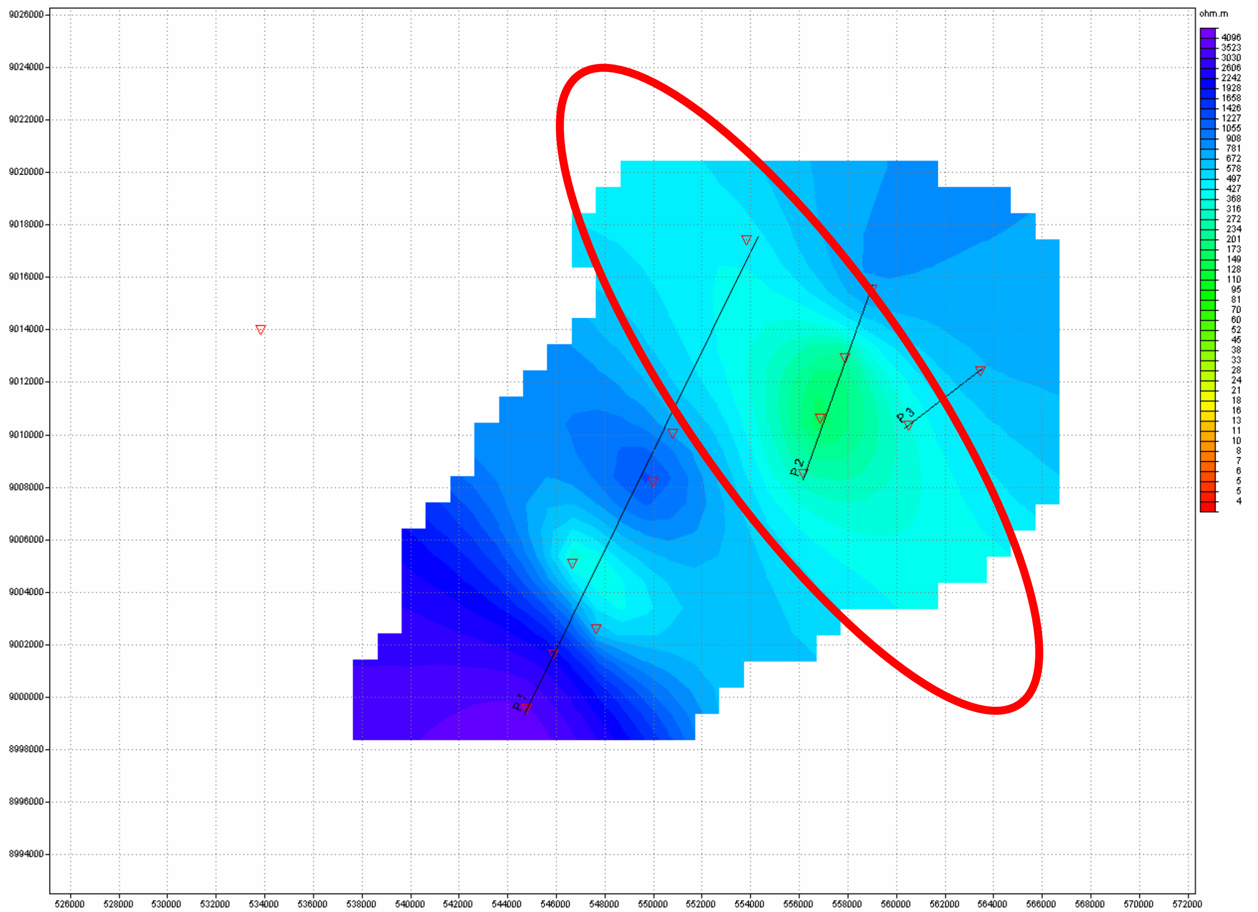
Resistivity map
at 1000 mbsl

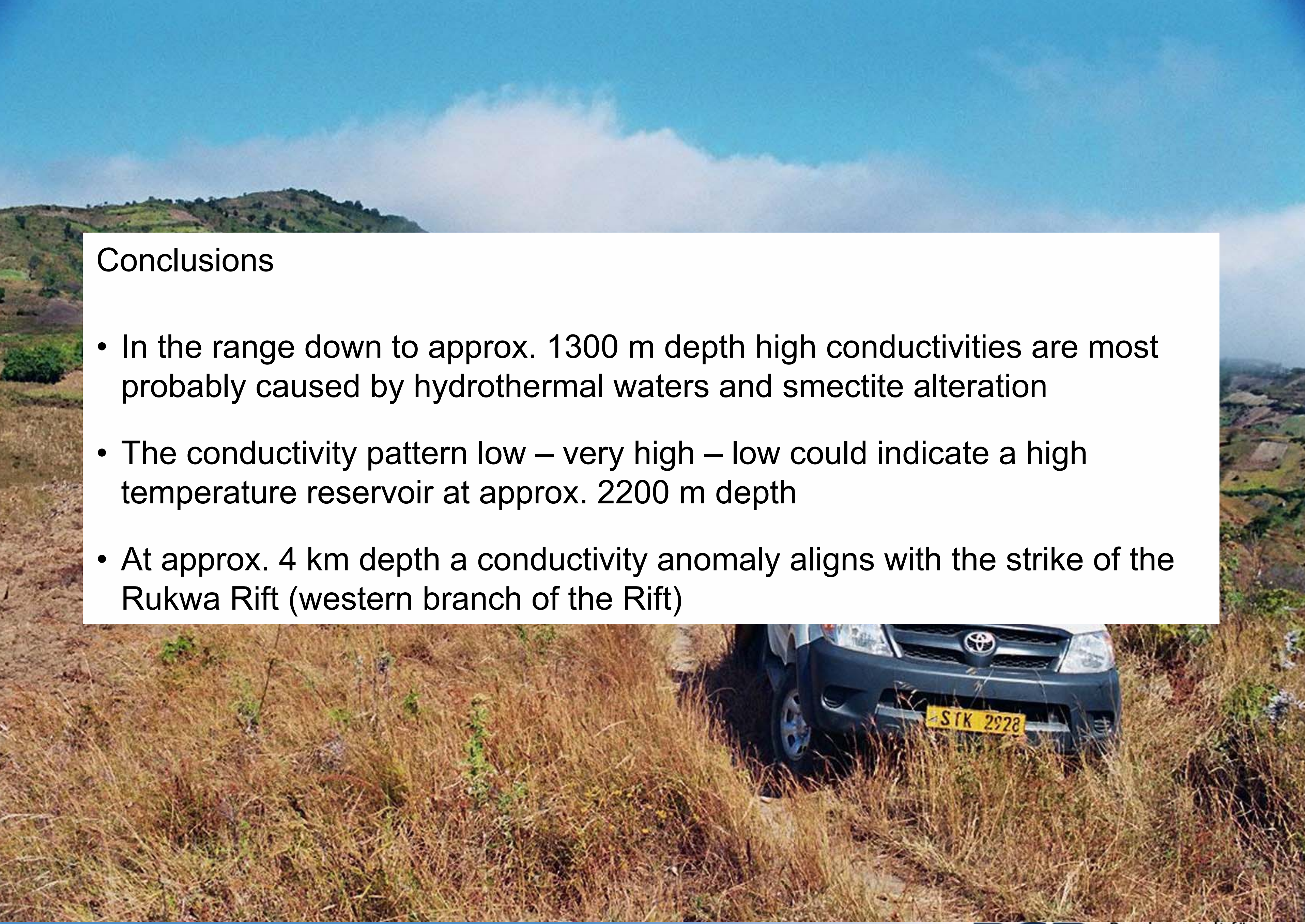


C MT results from Mbeya

Resistivity map at 2000 mbsl

Rukwa Rift?





Conclusions

- In the range down to approx. 1300 m depth high conductivities are most probably caused by hydrothermal waters and smectite alteration
- The conductivity pattern low – very high – low could indicate a high temperature reservoir at approx. 2200 m depth
- At approx. 4 km depth a conductivity anomaly aligns with the strike of the Rukwa Rift (western branch of the Rift)

Thank you for your attention!