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Geological Society of South Africa

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Geothermal Energy in Africa

A Solution to the Electricity Crisis

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TÜV NORD GROUP

DMT Business Unit

Plant Engineering & Process Engineering

Civil Engineering & Infrastructure

Mining

Energy

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3. What is geothermal energy?
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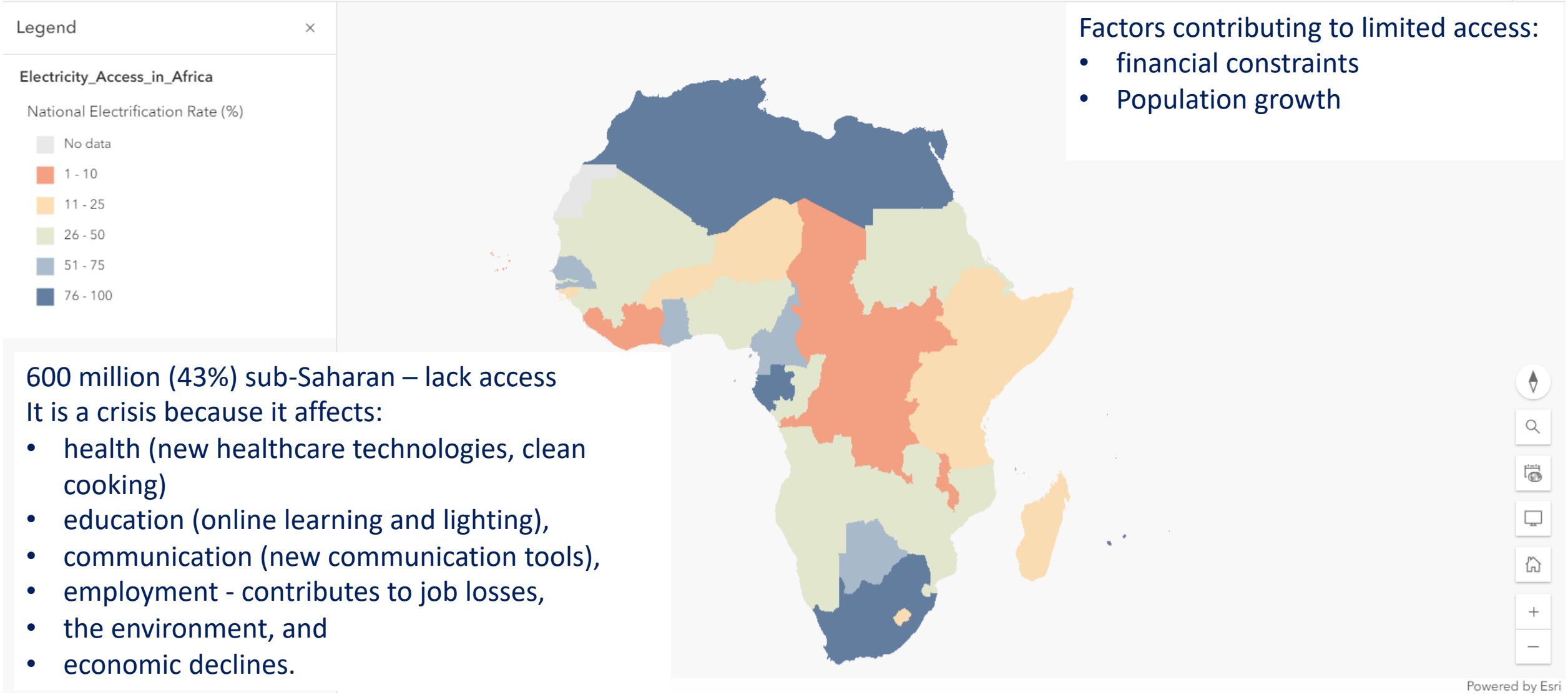
Access to Electricity in Africa



Factors contributing to limited access:

- financial constraints
- Population growth

600 million (43%) sub-Saharan – lack access
It is a crisis because it affects:

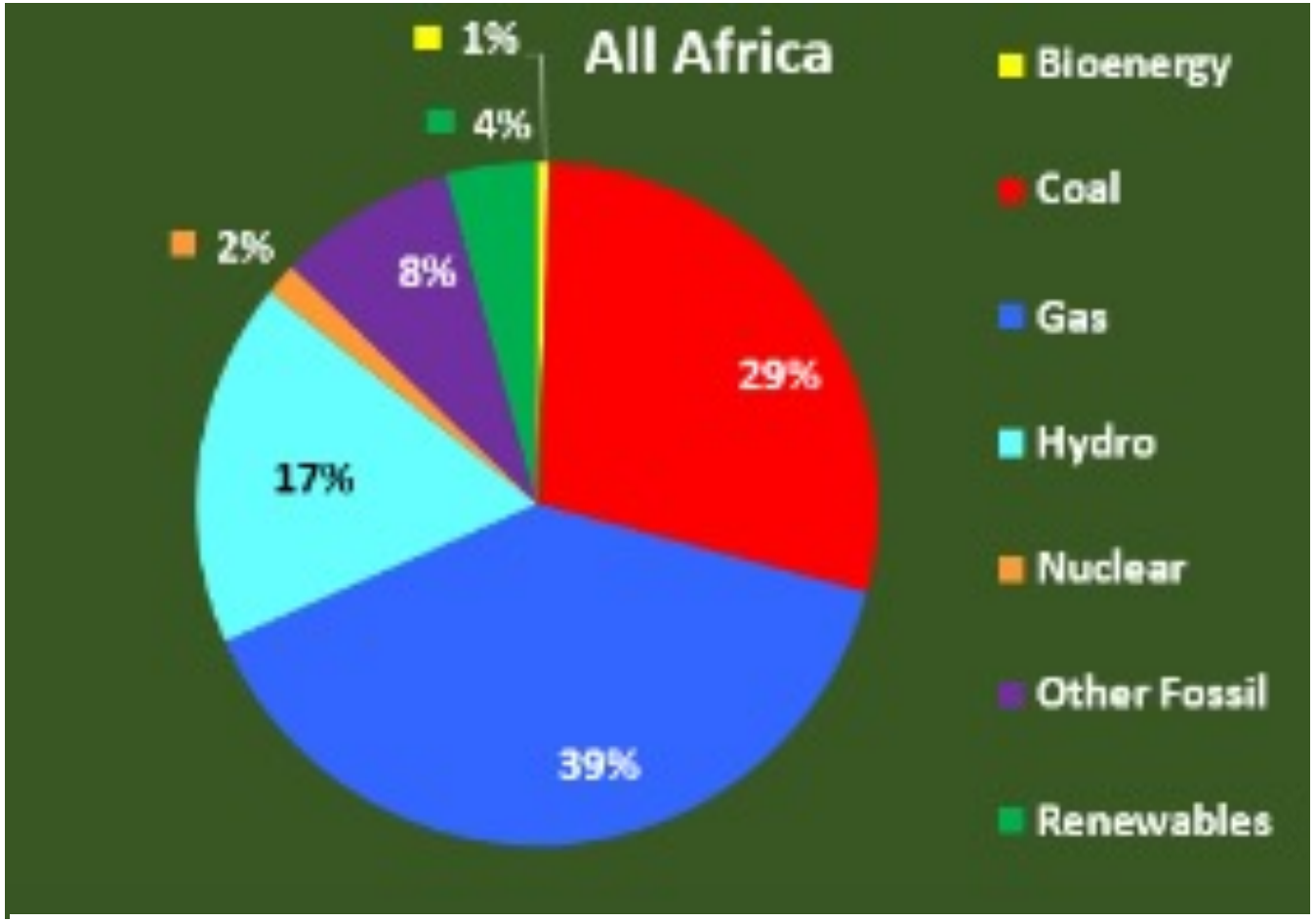
- health (new healthcare technologies, clean cooking)
- education (online learning and lighting),
- communication (new communication tools),
- employment - contributes to job losses,
- the environment, and
- economic declines.

How to Overcome

- Africa must prioritise ensuring affordable energy for all.
- African countries must develop clear policies and strategies.
- International institutions should increase their support to accelerate progress.
- solar home systems and mini-grids are making a difference, but more needs to be done.

In summary, addressing electricity access in Africa requires concerted efforts, innovative solutions, and global collaboration. By prioritizing this issue, we can empower communities, drive economic growth, and improve lives

Fossil Fuel



fossil fuels have historically been a significant source of electricity in Africa, especially in countries with abundant coal and natural gas reserves. Coal-fired power plants, oil-based generators, and natural gas facilities have provided a substantial portion of the continent's electricity.

UN SDG #7

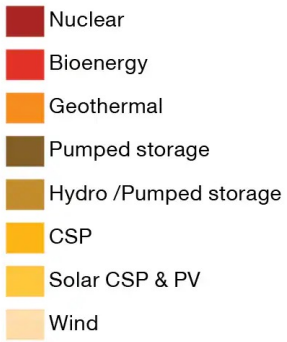
- ensure access to affordable, reliable, sustainable and modern energy
- ensuring access to clean and affordable energy
- key to the development of agriculture, business, communications, education, healthcare and transportation

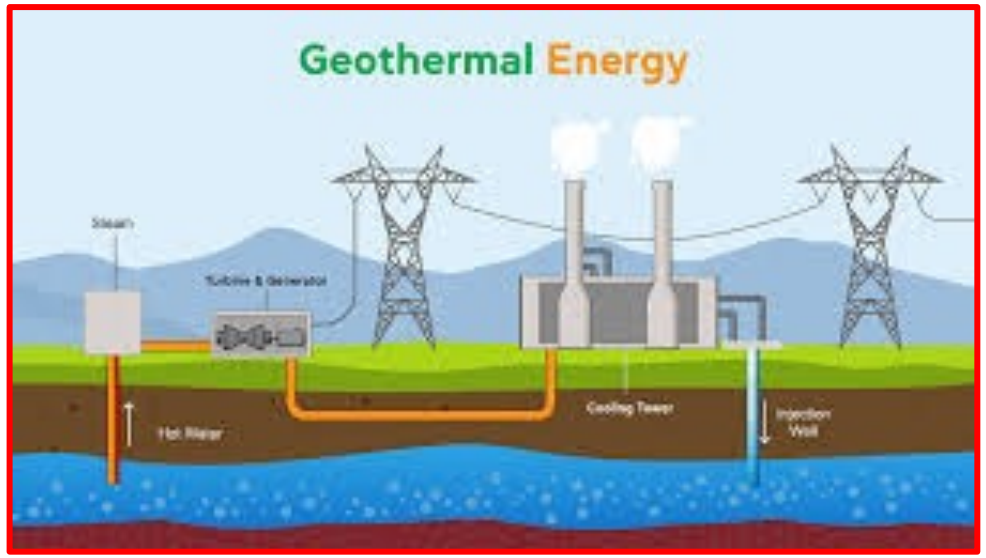
Renewable Energy Sources

- Africa is home to 60% of the best solar resources globally
- only 1% of installed solar PV capacity

- According to PwC, Africa's technical wind resource potential is as high as 59 000GW
- only 0.01% (6.5GW) of total capacity is utilised
- Potential areas having wind speed of 6m/s

- 38GW installed capacity
- potential hydropower of 300 GW in Sub-Saharan



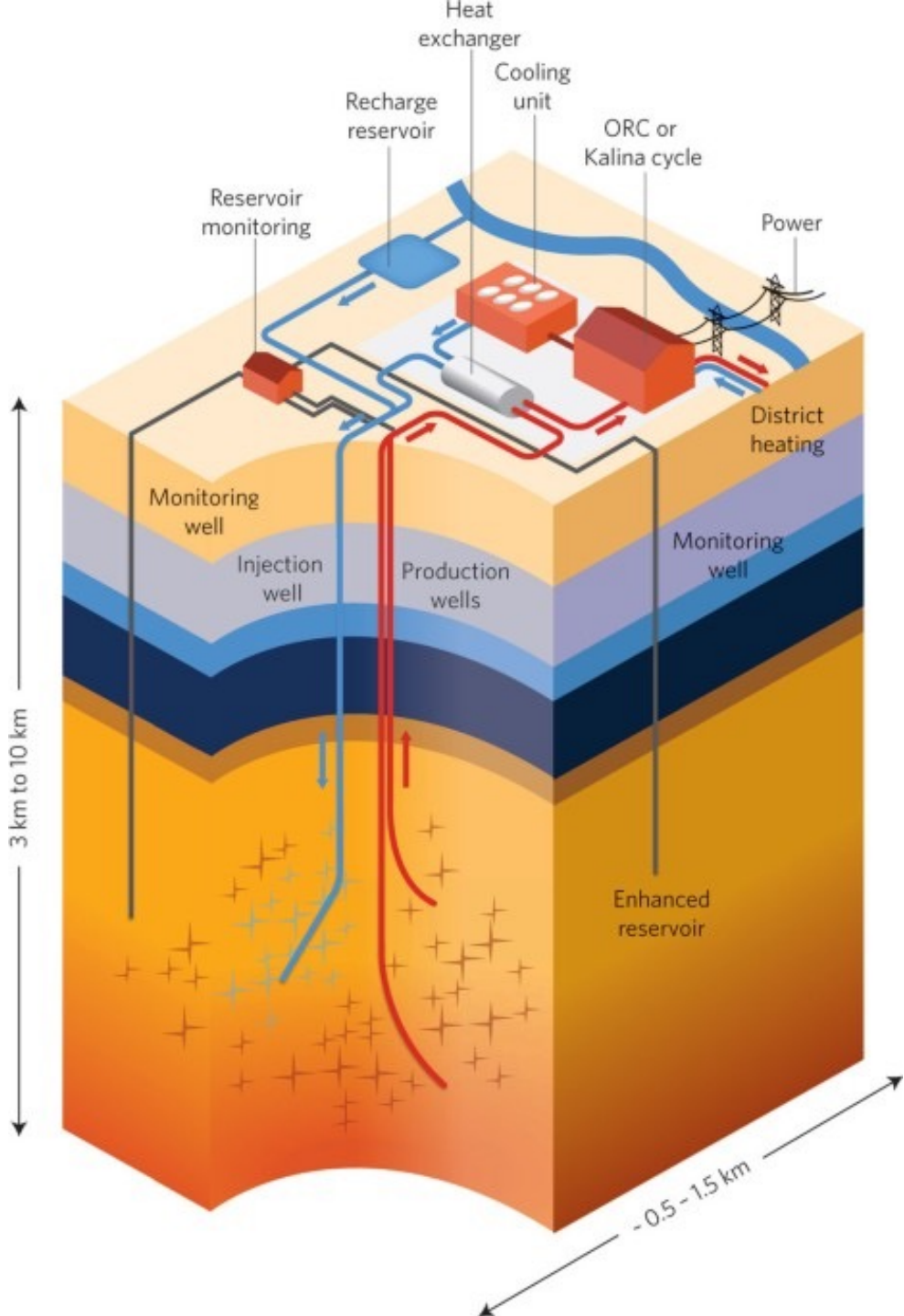


Geothermal Energy

- heat that is generated within the Earth.
- renewable resource from decay of radioactive elements underground and can be harvested for human use.
- resources can be harnessed for power production, heating and cooling without worrying about supply shortages
- environmentally friendly: power plant uses less land

Utilization:

- can be harnessed directly for heat (e.g., heating buildings, parking lots, sidewalks)
- Hot water or steam from geothermal sources can drive turbines to produce electricity.



Heat Distribution

Earth's Core Heat:

- ~2,9km below the Earth's crust lies the hottest part of our planet: the **core**.
- the core's heat primarily results from the decay of radioactive isotopes, such as K-40 and Th-232.
- as these isotopes decay, they emit enormous amounts of energy.
- temperatures in the core soar to over 5,000°C.

Heat Transfer and Geothermal Gradient:

- heat from the core constantly radiates outward, warming rocks, water, gas, and other geological materials.
- earth's temperature gradually rises from the surface to the core. This change is known as the **geothermal gradient**.
- in most parts of the world, the geothermal gradient is about 25°C/km of depth.

Magma and Geothermal Sources:

- if underground rock formations are heated to about 700 - 1 300°C, they can become **magma** (molten rock permeated by gas bubbles).
- magma exists in the mantle and lower crust and sometimes reaches the surface as **lava**.

Sources

Geothermal energy sources include:

Geysers

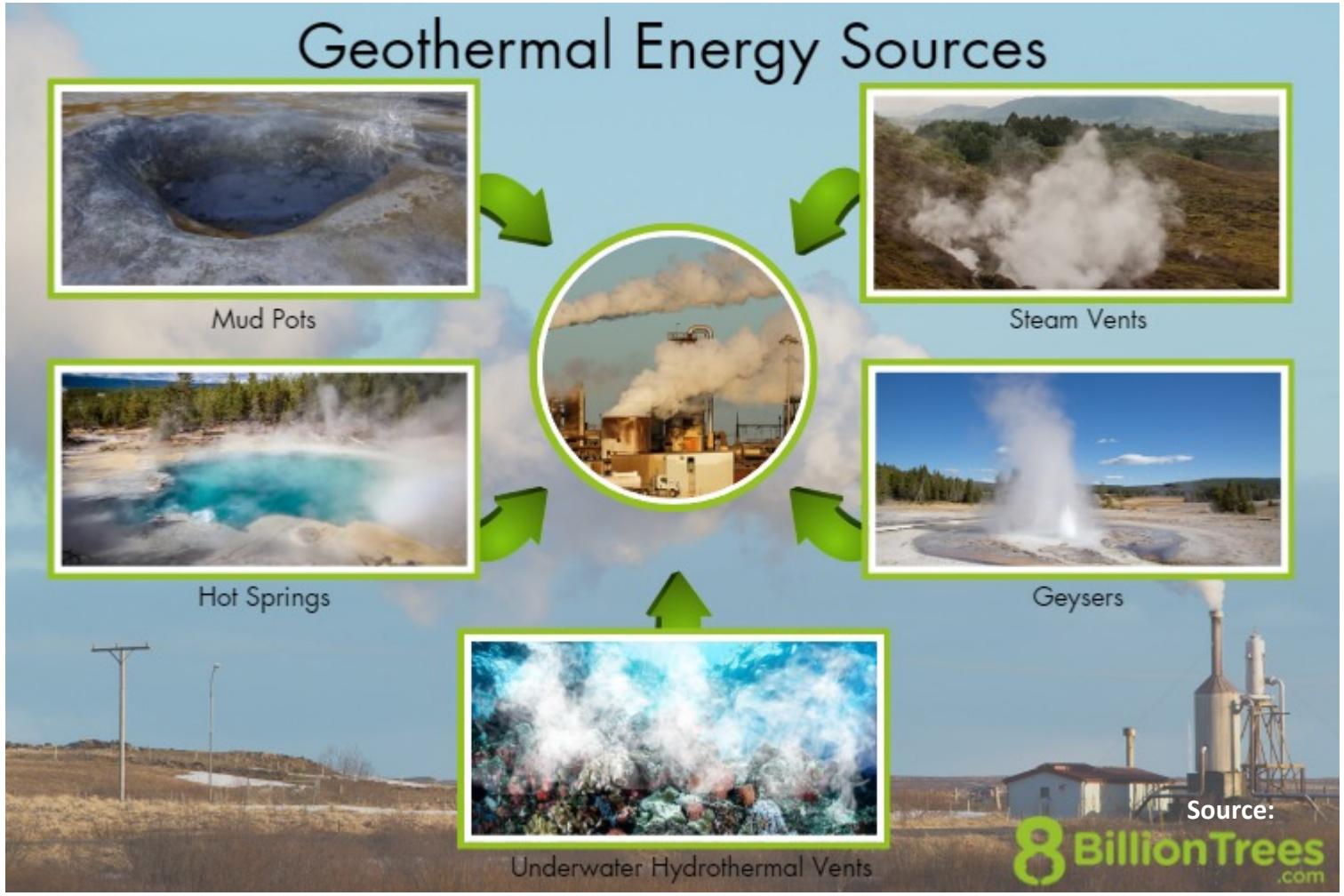
Hot springs

Steam vents

Underwater hydrothermal vents

Mud pots

Enhanced GE via drilling



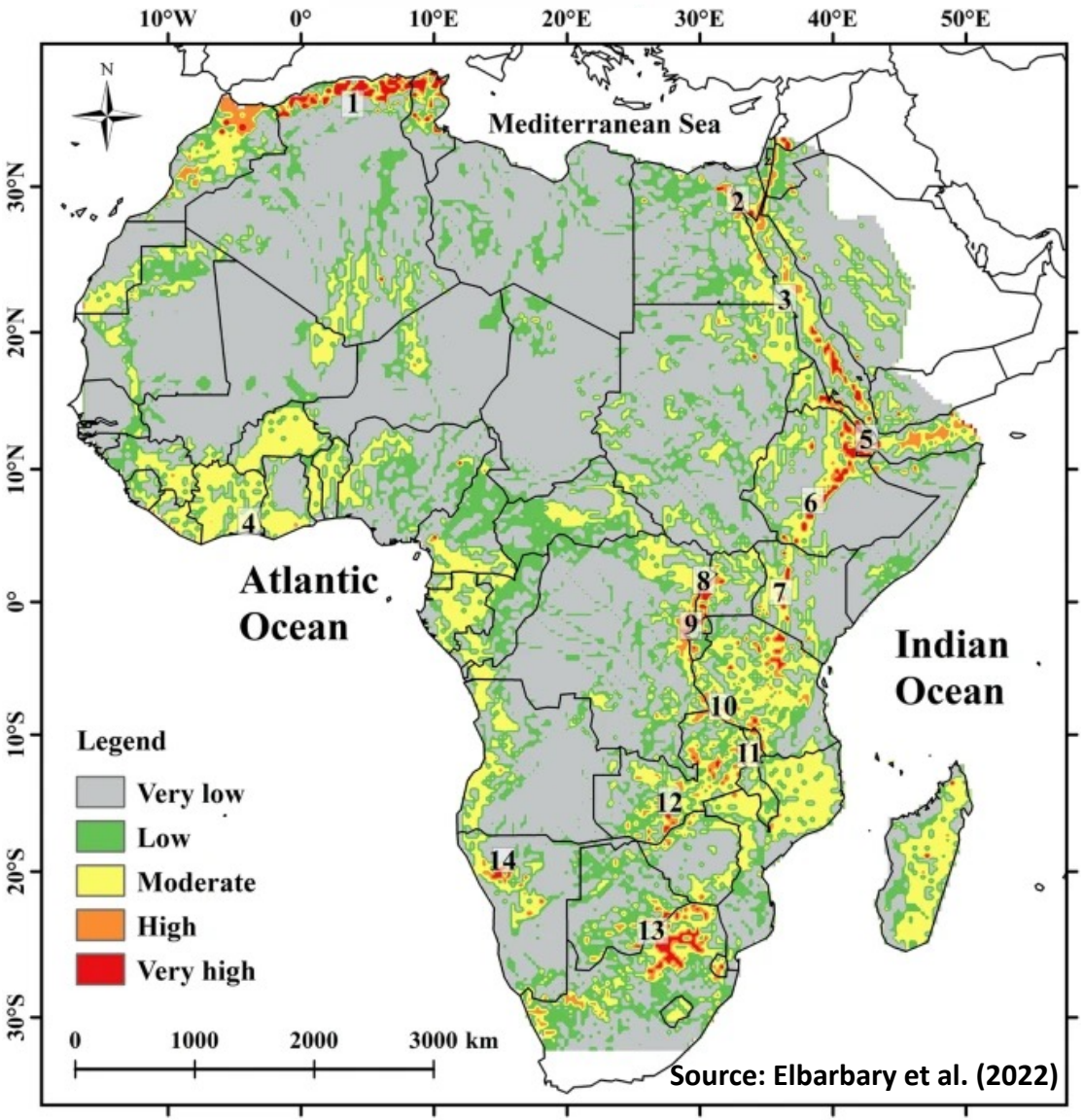
Prospects for Geothermal Energy in Africa

- the first geothermal potential map of Africa was constructed using GIS to estimate the geothermally promising areas within Africa.

- a weighted overlay method was used to integrate various geo-datasets:
  - geological thematic layers (rock units and faults),
  - geophysical layers (heat flow derived from aeromagnetic data and seismicity), and
  - geothermal layers (hot springs and volcanoes)

- the geothermal favourability map of Africa detected 14 high-potential zones.

- the map of Africa is useful for targeting and exploring new geothermal renewable energy sites and can reduce exploration costs and pinpoint investigation areas during preliminary geothermal studies.



Source: Elbarbary et al. (2022)

[1] Northernmost Africa
[2] Gulf of Suez, Gulf of Aqaba (Egypt)
[3] Red Sea access
[4] Liberia – Ivory Coast
[5] Djibouti
[6] Main Ethiopian Rift (MER)
[7] Kenyan Rift
[8] Lake Albert Rift (DRC – Uganda)
[9] Lake Kivu Rift
[10] Tanzanian Rift
[11] Northern Malawi
[12] Central Zambia
[13] Botswana – South Africa border
[14] Namibia

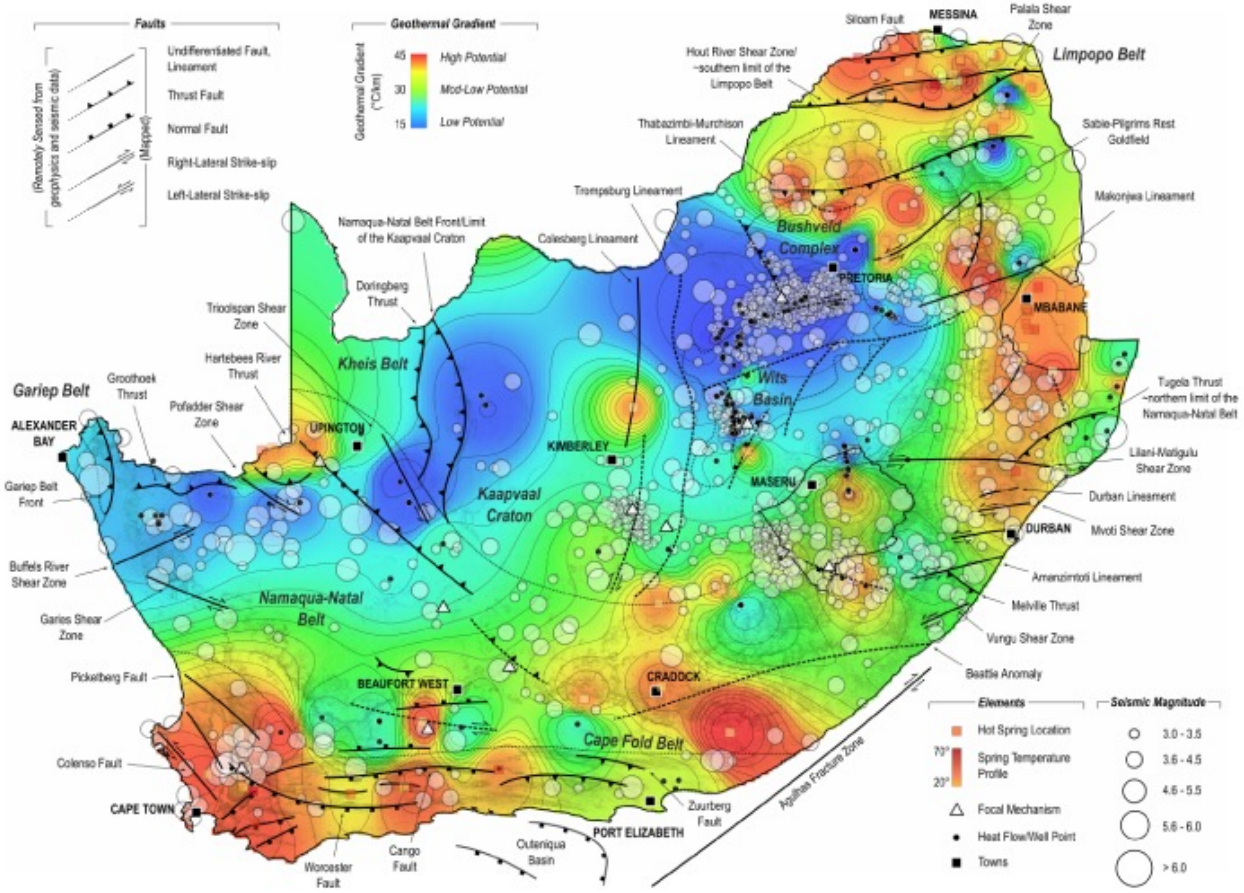
Council for Geoscience and UNISA

South Africa: Researchers

- Council of Geosciences (CGS) is investigating the potential of geothermal energy as an affordable, reliable, and renewable energy for direct heating of commercial and residential buildings

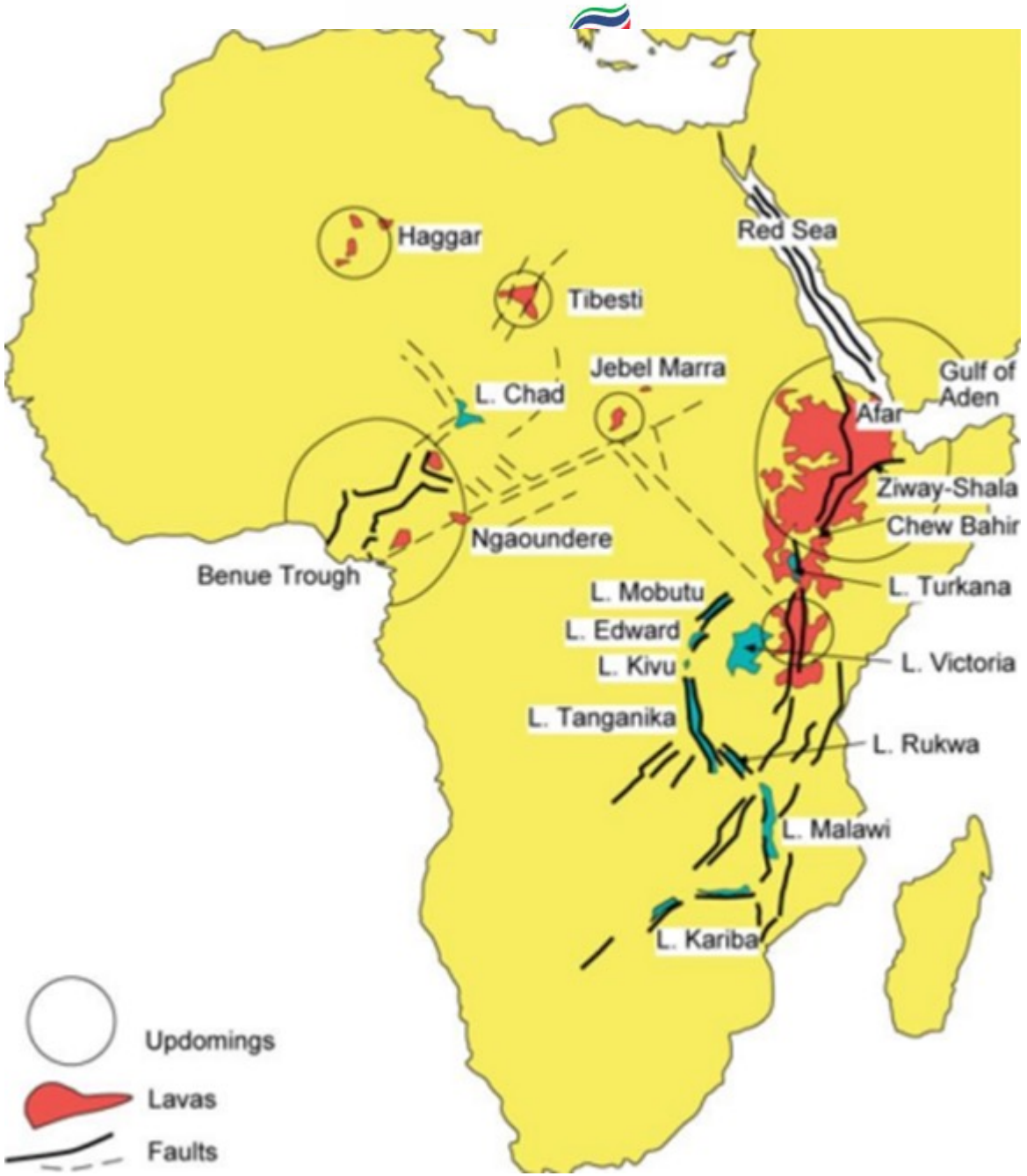
- the International Geothermal Association (IGA) has appointed UNISA's Dr Azwindini Enerst Tshibalo as its ambassador in South Africa to conduct research on geothermal energy and contribute research data to the IGA

- drilling activities – Tshipise in Limpopo and Karoo Basin in Eastern Cape



East African Rift System (EARS)

- total length of the rift is around 6 400km and up to 64km in width
- Djibouti, Ethiopia, and Eritrea, Kenya, Tanzania, Uganda, Rwanda, DRC, Burundi, Malawi, Zambia, and Mozambique
- total installed electricity capacity from all energy sources in the East African Rift countries is about 20GW
- currently, 900MW geothermal energy is utilised in the region
- Kenya and Ethiopia are considered as notable producers in East Africa currently



DRC 1952:

- first geothermal electricity generation plant developed.
- first binary power plant in the world
- installed capacity of 0.2MW.
- 1970 was decommissioned due to declining mining operations.

Kenya 1981-1985:

- second country to install a geothermal power plant.
- 45MW capacity Olkaria I power plant.
- capacity has since grown to 880MW from several sites.
- Kenya has continued to lead in geothermal development representing ~46% of electricity produced in the country against its installed capacity of about 28% in 2017.

Zambia 1986:

- third country to install a geothermal power plant.
- the 0.2MW ORC pilot plant developed at Kapisya
- however, has not been commissioned to date
  - absence of a transmission line,
  - breakdown of the production well equipment

North and West Africa

Additional areas for potential Geothermal Energy presence:

- West African countries including Chad, Cameroon, Nigeria, Ghana, Ivory Coast, Liberia, Sierra Leone, Guinea, Senegal, Mauritania, and Algeria also possess geothermal energy potential.

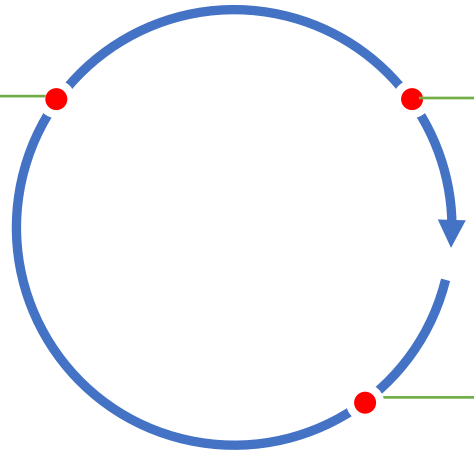
- farther south, the **West Congolian Belt** in Gabon, Congo, Cabinda, and Angola has granitoids with thermal anomalies indicative of geothermal potential.

Summary

- geothermal energy resources would support better electrification, improve living standards, and transform the region's countries from a socio-economic development perspective
- it is a renewable resource and therefore will contribute towards eliminating the carbon emission
- reliable - produces electricity consistently (24/7) regardless of weather conditions
- resources can be harnessed for power production and heating and cooling without worrying about supply shortages
- environmentally friendly – power plant uses less land

DMT's Deep Geothermal Services

Site Investigation



Construction

Project Planning

GSSA Geological Society of South Africa

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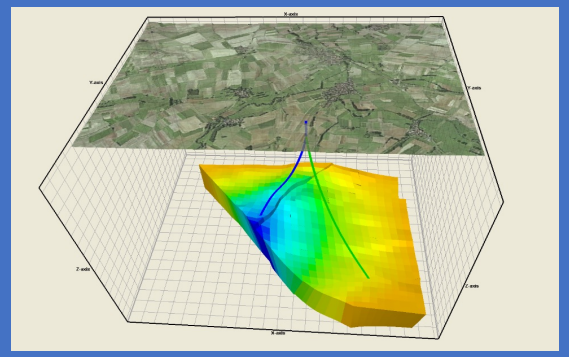
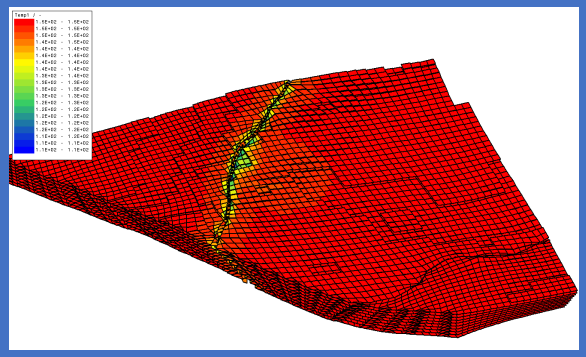
Transfer of Petrel to HeatFlow

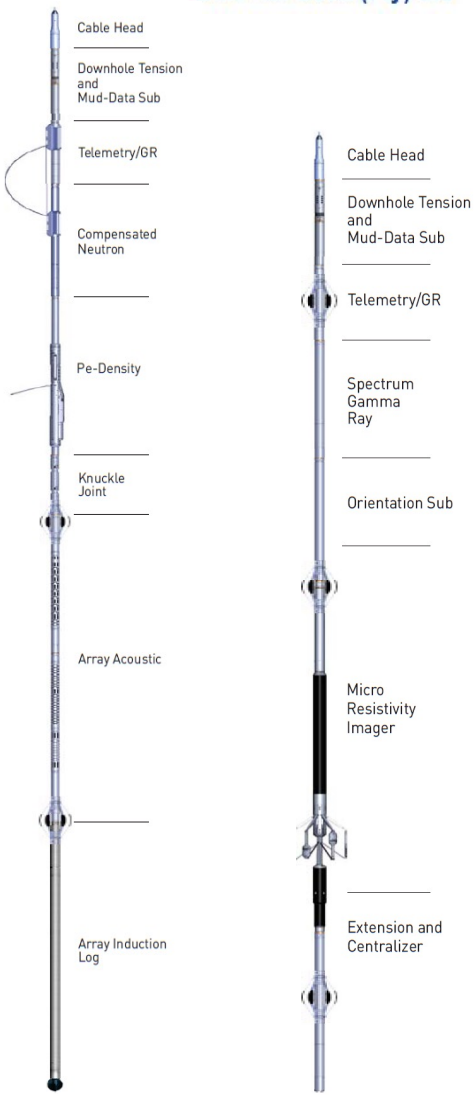
Petrel



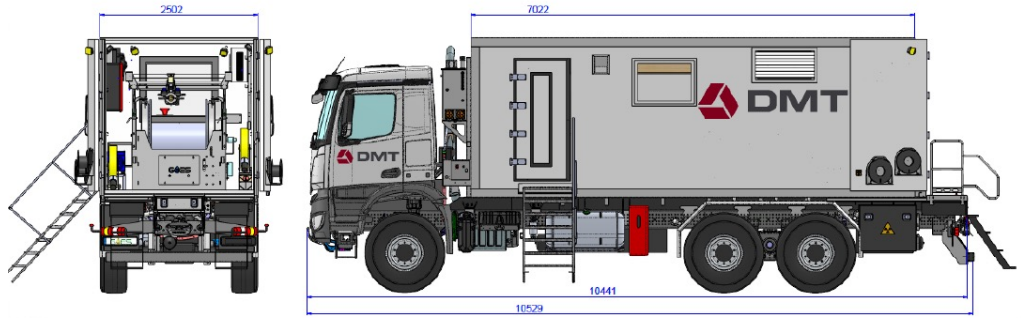
HeatFlow



Open Hole Services



Well logging in geothermal wells
DMT measurement truck



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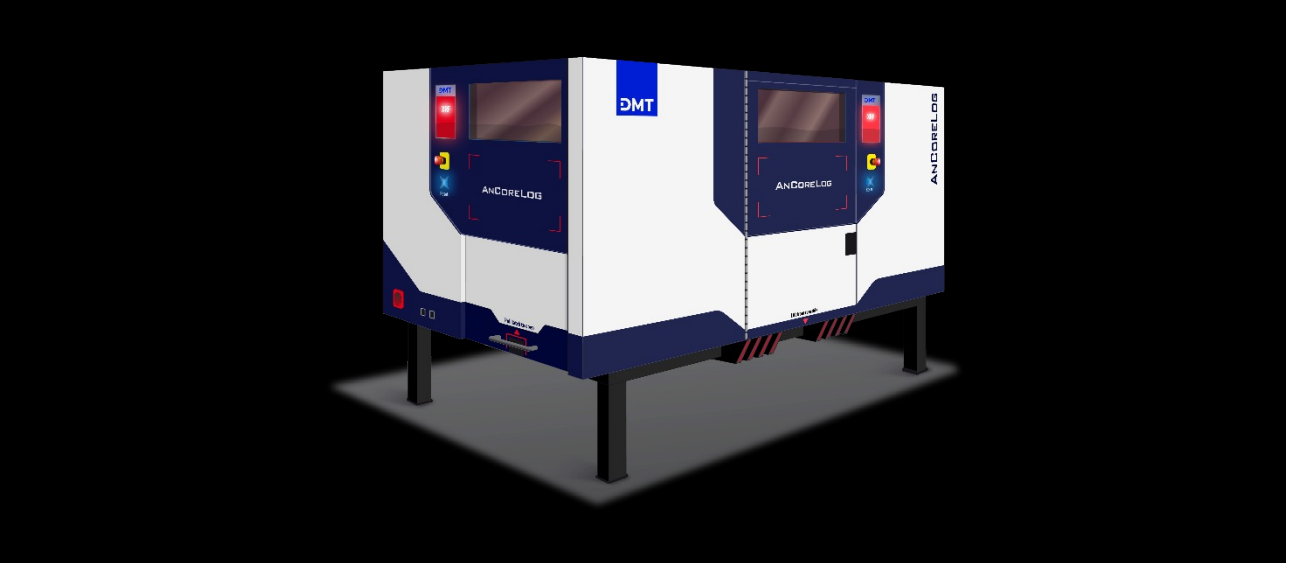
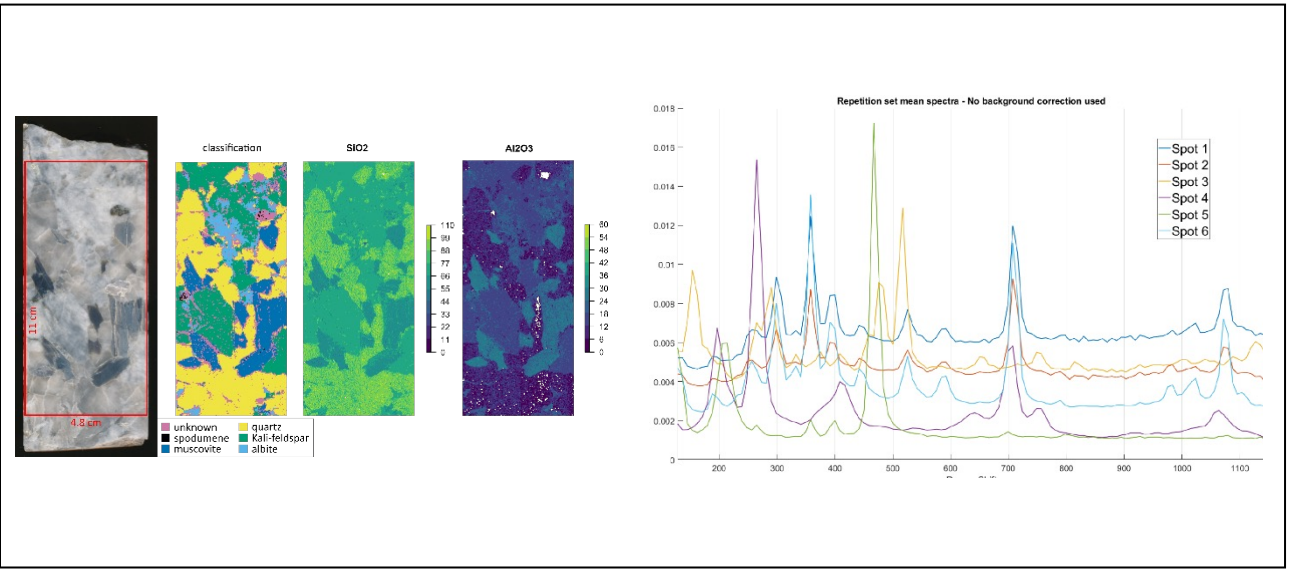
DMT borehole geophysics

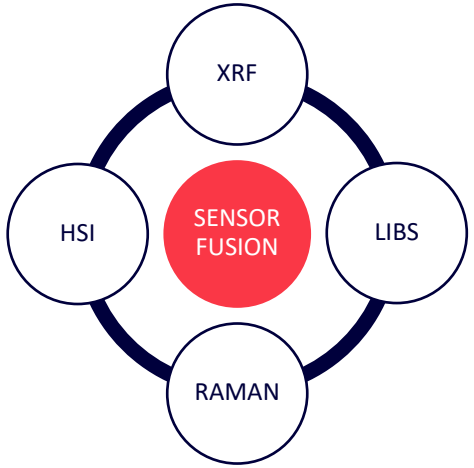


ANCORELOG drill core scanner

- Automated **multi-sensor digital scan**
- Creation of a **virtual 3D drill core**
- High resolution 3D photo
- continuous **geochemical and mineralogical data collection**
- AI based **automatic analysis**, evaluation and classification along the drilling profile



GEOCHEMISTRY → MINERALOGY → CLASSIFICATION



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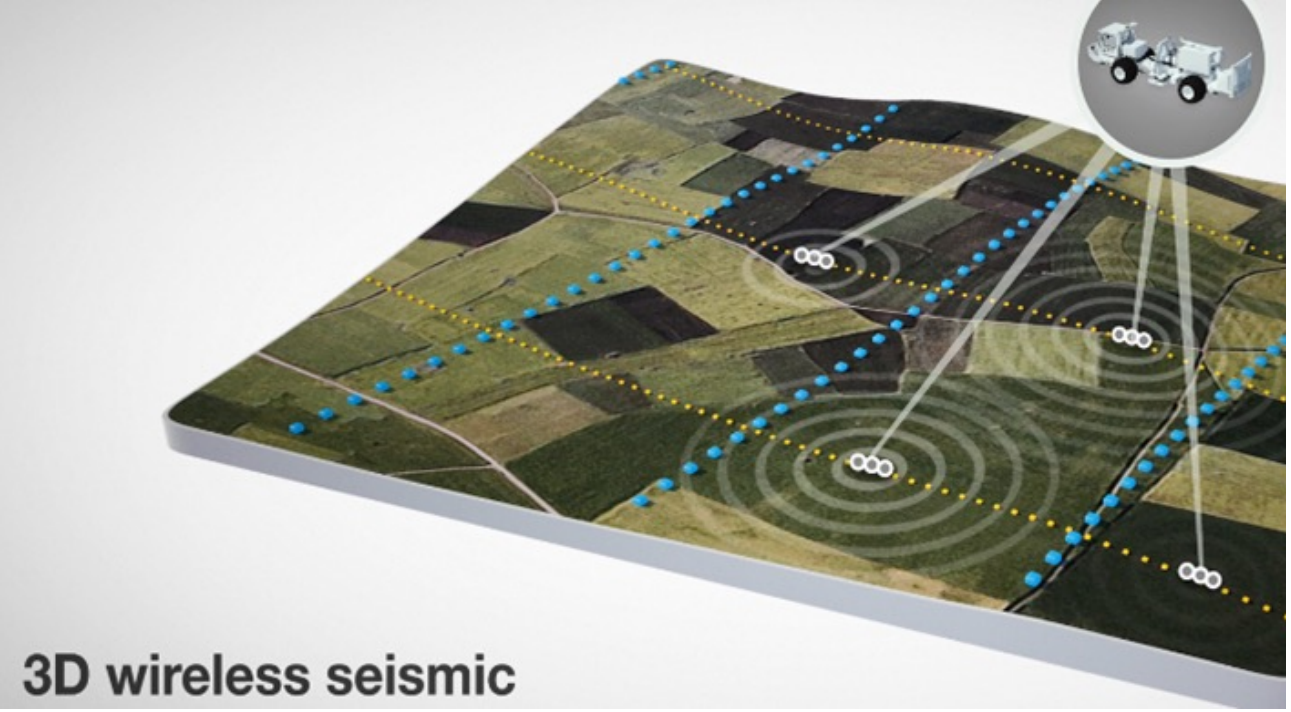
Project examples

- Deep geothermal energy

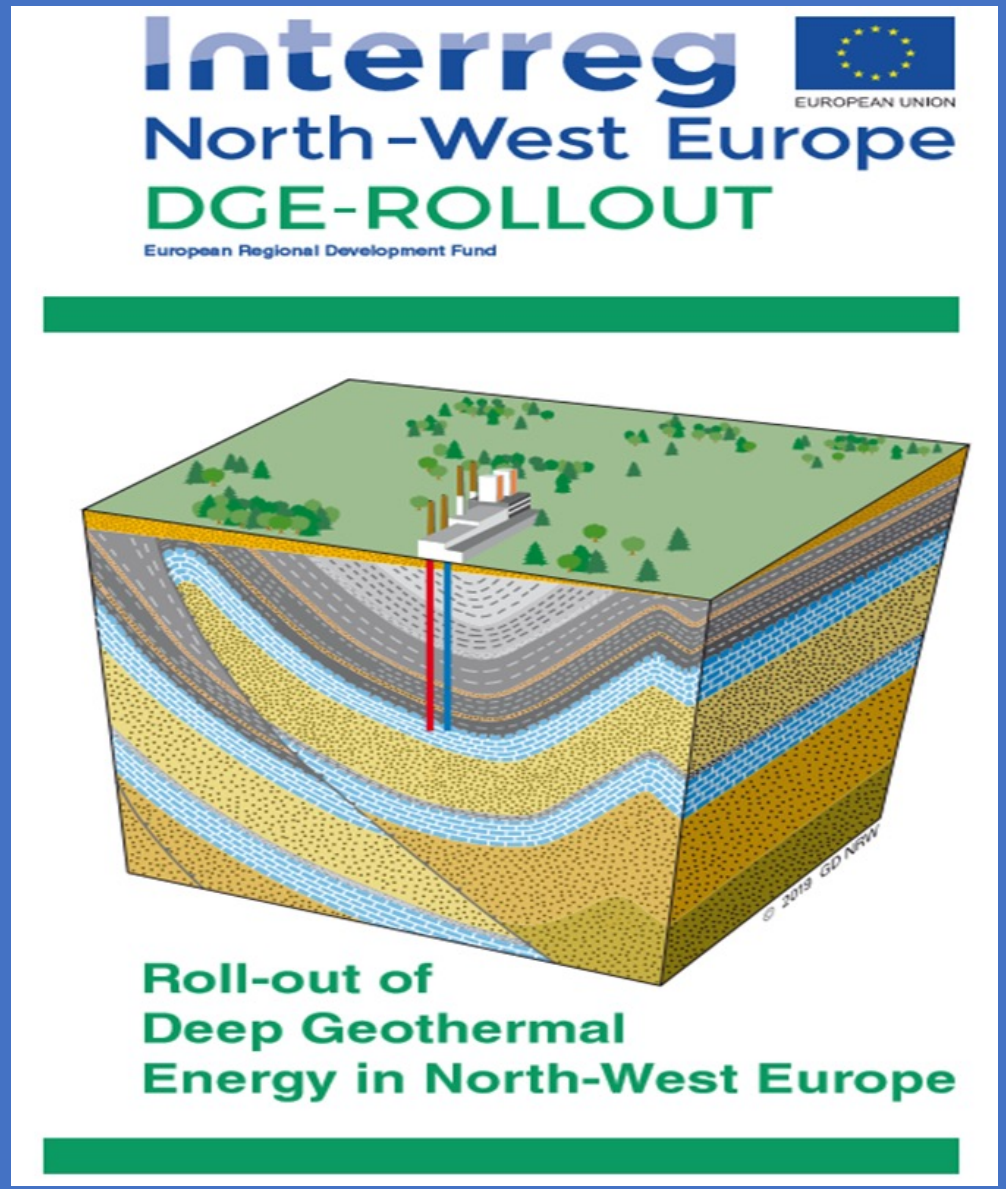


geothermal energy

3D seismics for exploration in the Vienna region

OMV – Austria

- Geological exploration with highly productive excitation technology for data acquisition
- Exploration of an area of approx. 1,500 square kilometres in the Vienna region, to a maximum depth of 6,000 metres
- 4 vehicle groups à 3 vibs in slip-sweep mode
- About 1,000 vibration points/day
- More safety through the use of wireless technology
- Digitisation of customer interface with DMT SurveyView App



geothermal energy

Interreg – Expansion of deep geothermal energy as a climate and environmentally friendly energy resource

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European Union - North West Europe

- Promotion of development of deep geothermal energy as a climate and environmentally friendly energy resource in Northwest Europe
- Thus supporting the economy of the region and well-being of the citizens
- The aim is to generate energy and reduce CO_2 emissions by replacing fossil fuels through increased use for large infrastructures which require high-temperature heat supply to meet their base energy load
- This will reach up to 160,000 t/a by 2022 through the realisation of further systems. It is estimated that at least 1,600,000 t/a reduction will have been achieved 10 years after the end of the project. A reduction of up to 7,000,000 t/a is expected in the long term

geothermal energy

Seismic borehole measurement within the of the GRAME research project

Stadtwerke München Services GmbH – Germany

- VSP measurements and checkshot measurements up to depths of of 3,220m NN.
- Three AHV IV seismic vibratory vehicles were used for data acquisition
- The VSPs are used in the GRAME research project to validate time-depth conversion of the 3D seismic data and to improve seismic interpretation through the inclusion of two boreholes in the large-scale model.

Thank you !

Questions ?

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