The GEOTHERM Programme of BGR, Hannover, Germany

Focus on support of the East African Region

Kraml, M., Kessels, K., Kalberkamp, U., Ochmann, N. & Stadtler, C.

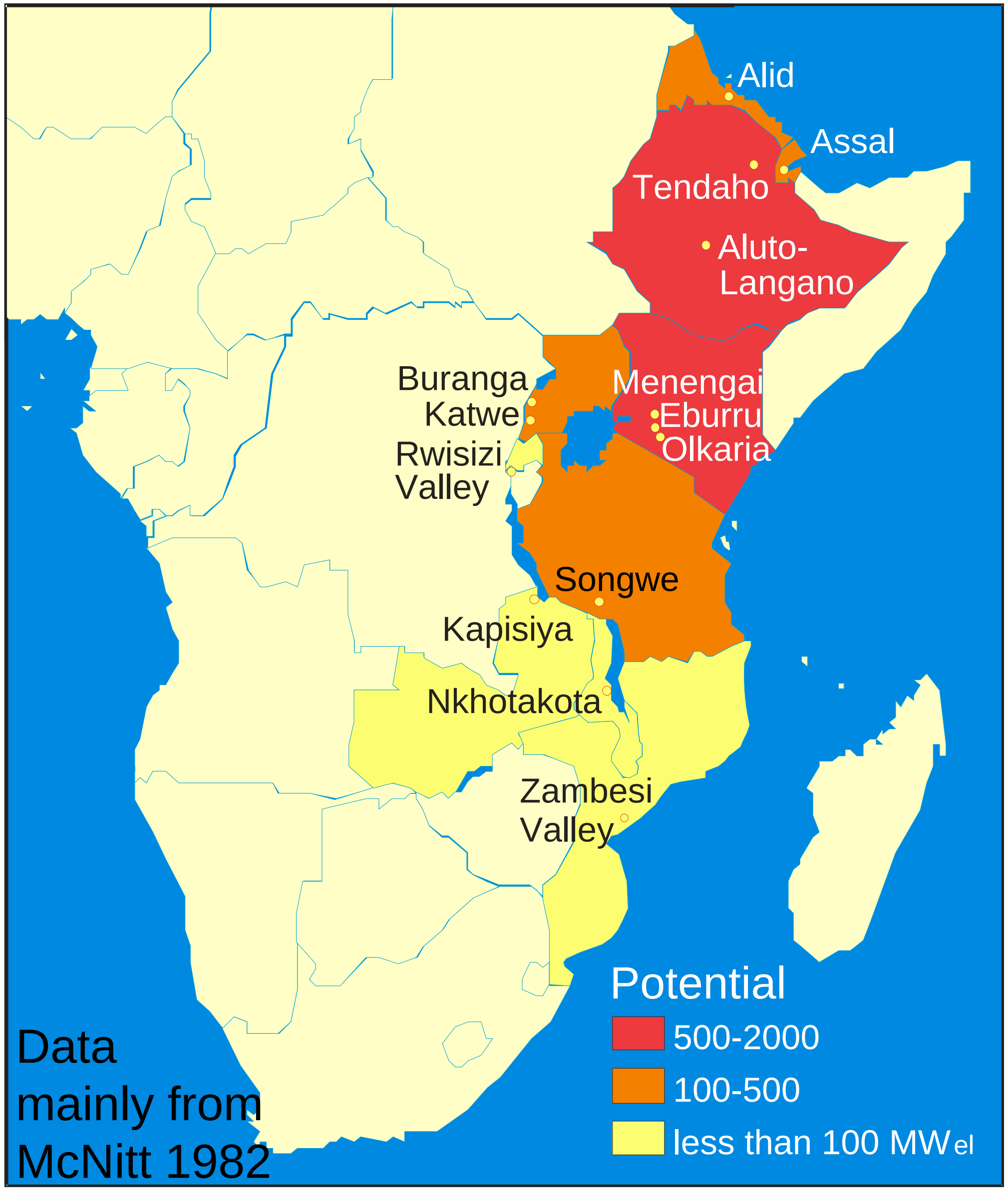
One World

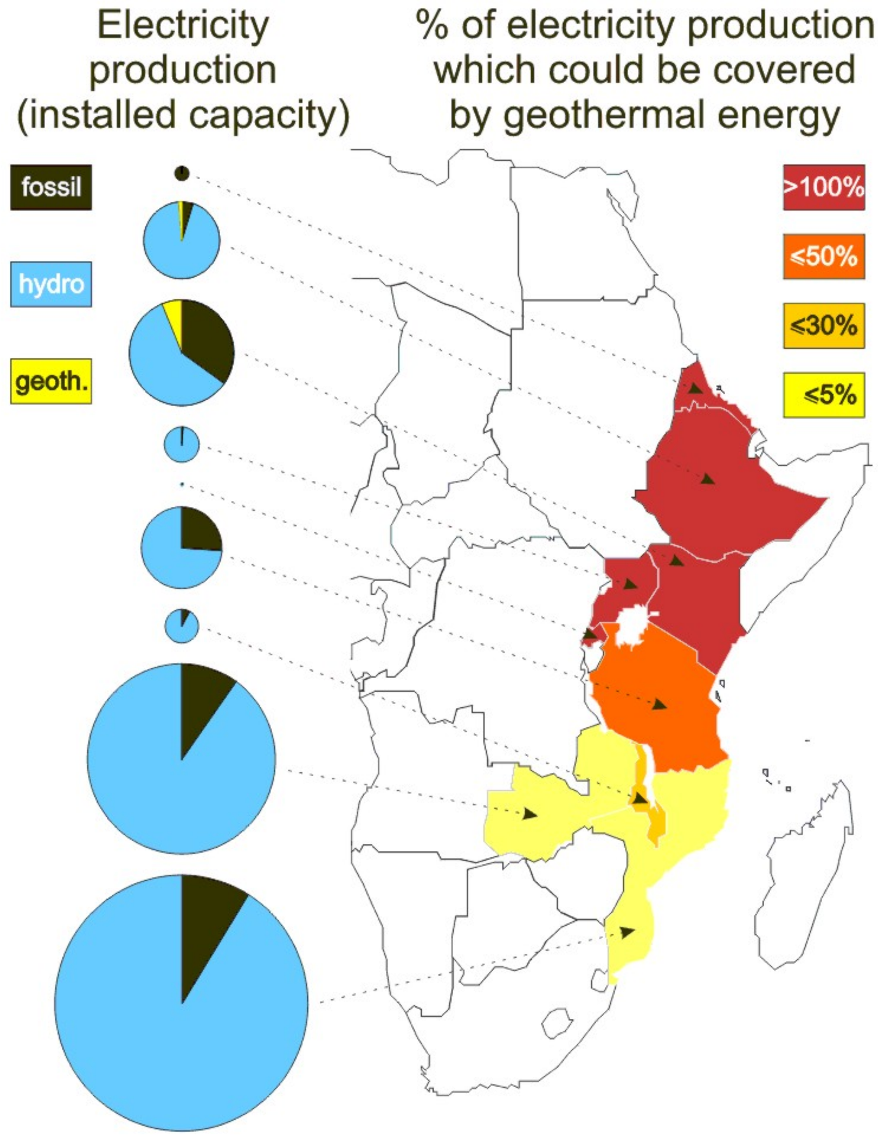
Bundesministerium für wirtschaftliche Zusammenarbeit und Entwicklung

www.bgr.de/geotherm

BGR Bundesanstalt für Geowissenschaften und Rohstoffe

Geothermal potential & selected prospects





Bundesanstalt für
Geowissenschaften
und Rohstoffe

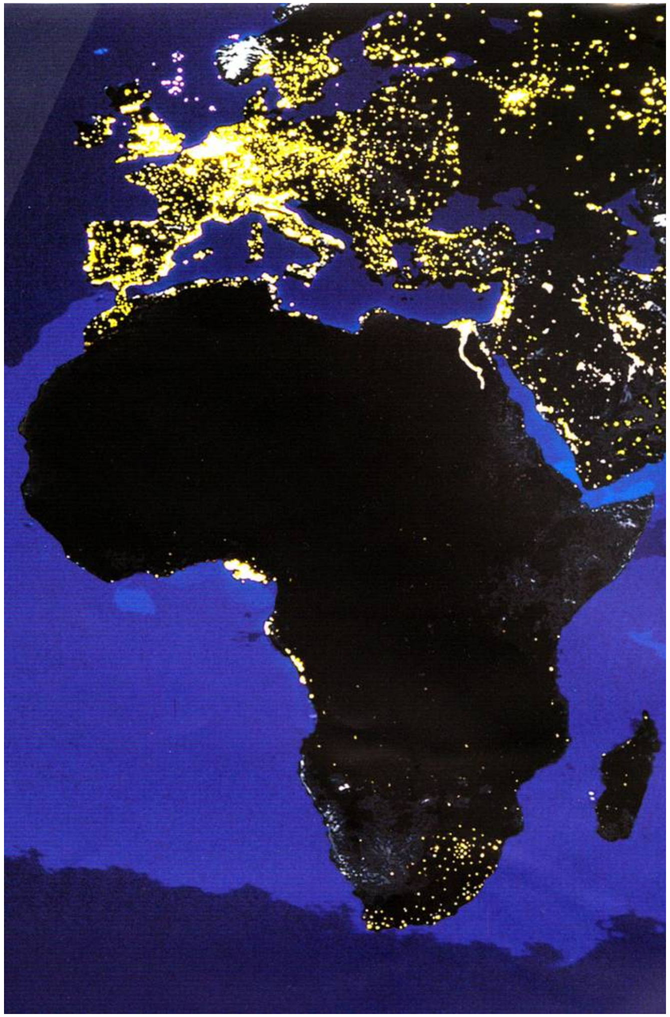
Why do not all countries use geothermal?

Possible reasons are for renewable energies in general:

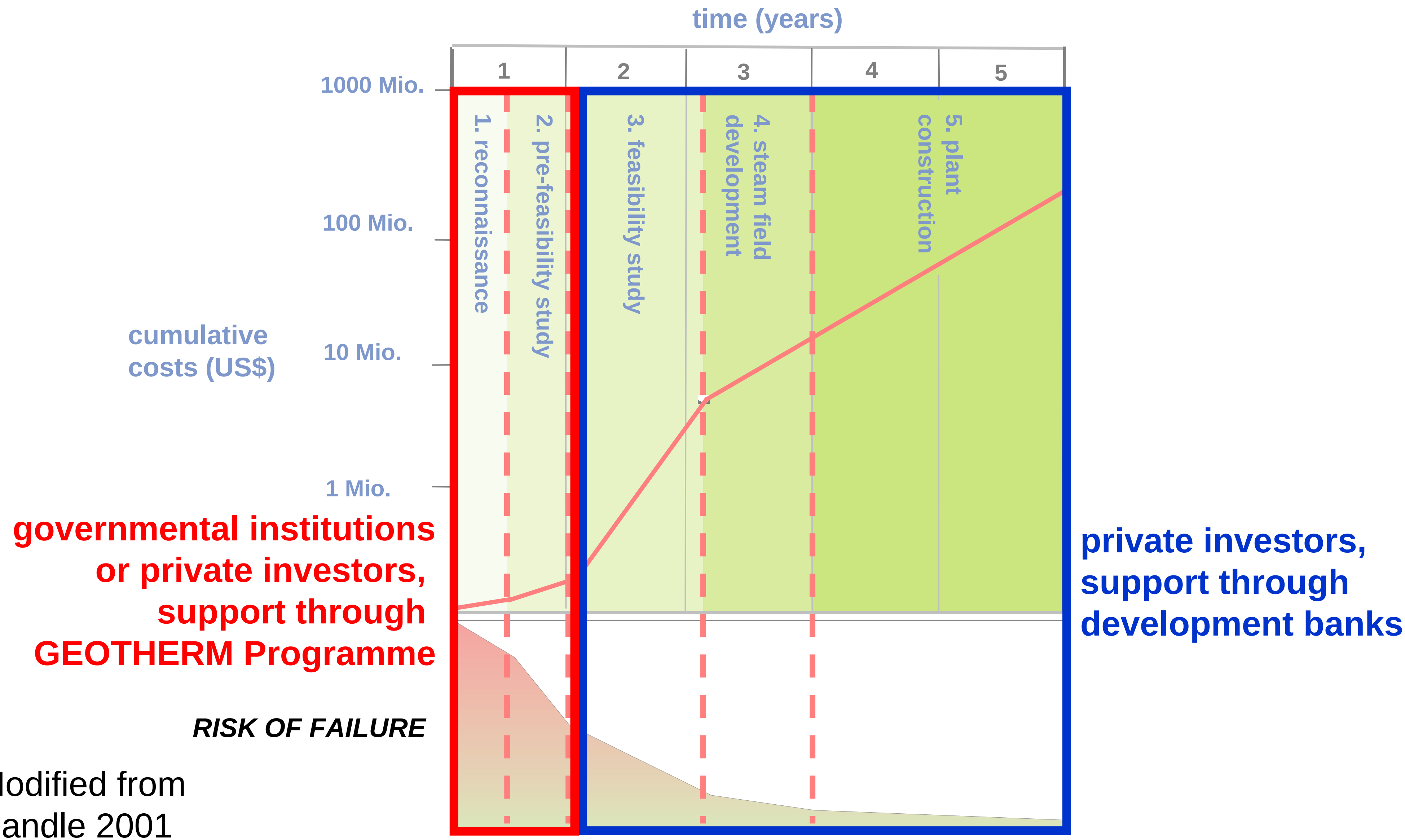
- inadequate political, institutional and economic framework conditions

and for geothermal energy:

- different geological situation at every site
- lack of know-how in some countries
- high initial costs with associated
- high initial risks (exploration wells)



Investment and associated risk (for a 100 MW plant)



Modified from Randle 2001

Renewable Energy Conference in Bonn

Memorandum of Understanding

between

the United Nations Environment Programme

and

the German Federal Ministry for

Economic Cooperation and Development

Characteristics of GEOTHERM

Principle:	BMZ (Federal Ministry for Economic Cooperation and Development)
Executed by:	BGR (Federal Institute for Geosciences and Natural Resources)
Partners:	Ministries of Energy, Geological Surveys, private or governmental energy suppliers …
Cooperation with:	UNEP (United Nations Environment Programme); KfW (German Development Bank); GEF (Global Environment Facility); UNU-GPT (United Nations University Geothermal Training Programme, Iceland); GTZ (German Technical Cooperation); Companies; GtV (German Geothermal Union)
Duration:	2003 – 2008 (1. Phase)

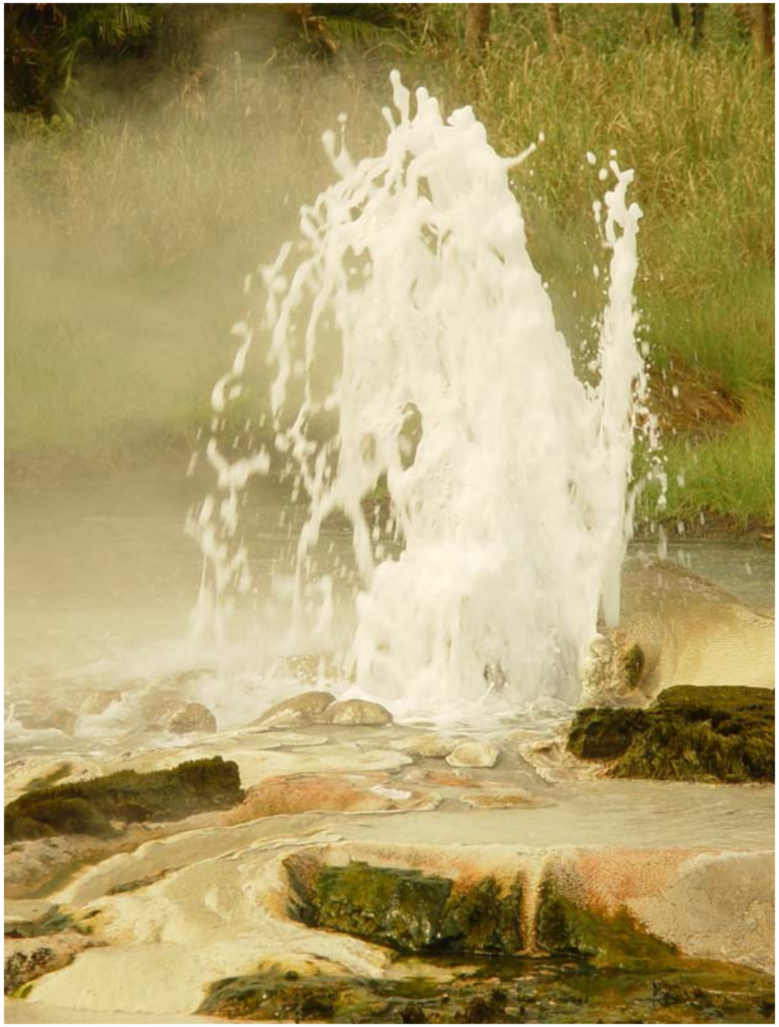
Objective of the GEOTHERM Programme

Partner countries promote the development of their geothermal potentials.

- well founded decisions on further development of geothermal sites are made
- partner countries are informed on their possibilities to use geothermal energy
- partner countries are qualified for geothermal resource assessment
- a regional platform for exchange of know-how is established in cooperation with ARGeo

Services of the GEOTHERM Programme

- support of pre-feasibility studies (surface exploration of geothermal resources with geoscientific methods)
- assistance in ranking of prospects
- geo-hazard assessment (e.g. volcanic hazards)
- training in geothermal issues („on the job“ e.g. advice on technical realisation of geophysical measurements; short courses)
- ecological evaluation (environmental impact assessment)
- economic and socio-economic analyses
- support in geo-data management
- advice on financing options



Criteria for selection of partner countries

prerequisites:

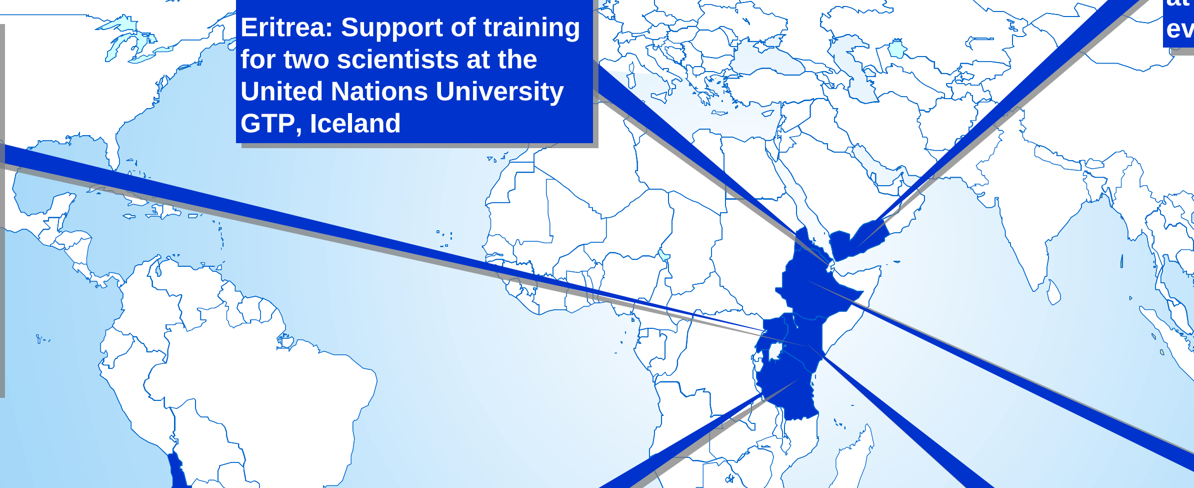
- demand for support (official proposal)
- partner country of German Development Cooperation

additional criteria:

- high geothermal potential
- high power demand
- need to diversify energy mix
- high electricity prices
- favorable political conditions
- interest of investors
- possibility to cooperate with development banks and/or financing institutions

→ high probability of subsequent investment

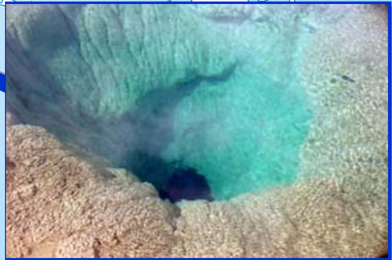
GEOTHERM Projects



Eritrea: Support of training for two scientists at the United Nations University GTP, Iceland

Yemen: Pre-feasibility study at Al Lisi as part of an evisaged GEF project

Uganda: Geothermal exploration at Buranga



Ethiopia: Geophysical (MT) exploration at Tendaho, Support to the First African Geothermal Conference 2006

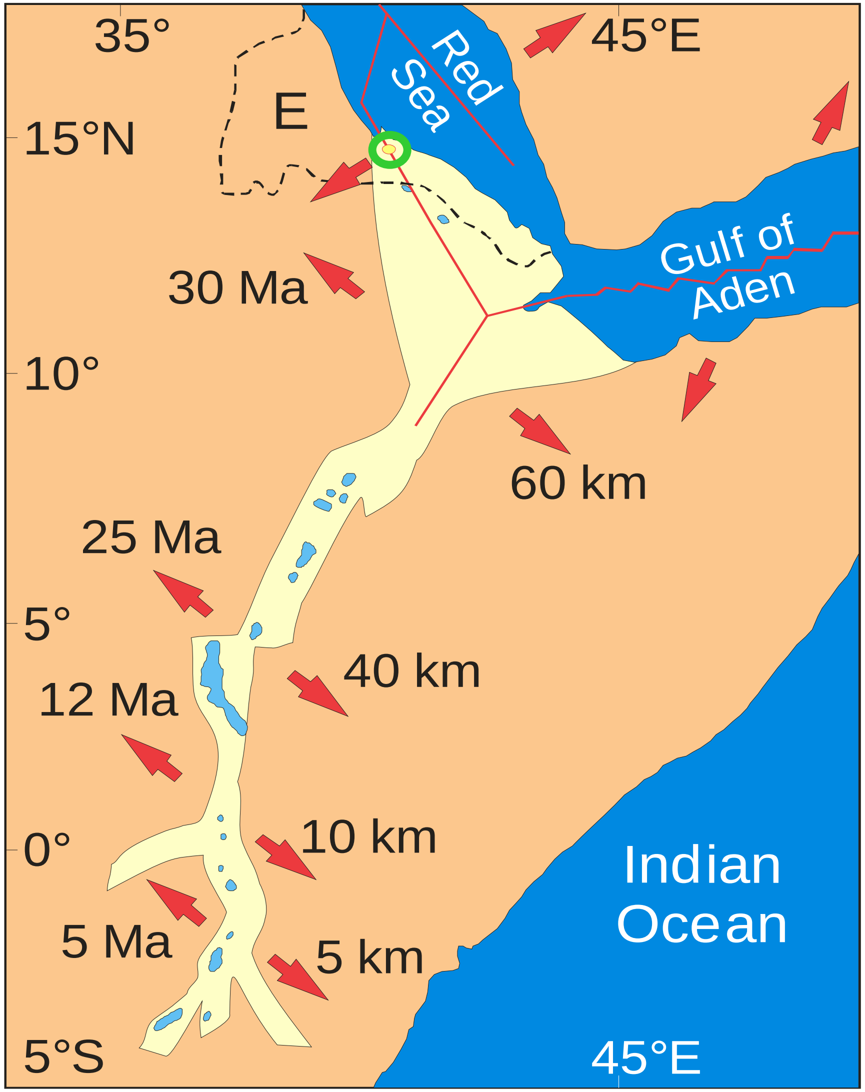
Chile: Geothermal exploration at Térmas de Río Blanco, training, EIA guidelines

Tanzania: Geothermal exploration at Songwe, training, awareness raising of decision makers

Kenya: Training in GIS, thermal camera survey, dating & geochemistry of Menengai volcanic rocks

BGR Bundesanstalt für Geowissenschaften und Rohstoffe

GEOTHERM project in Eritrea



Modified from Strecker & Bosworth 1991

Project partner:

Geological Survey of Eritrea

Project site:

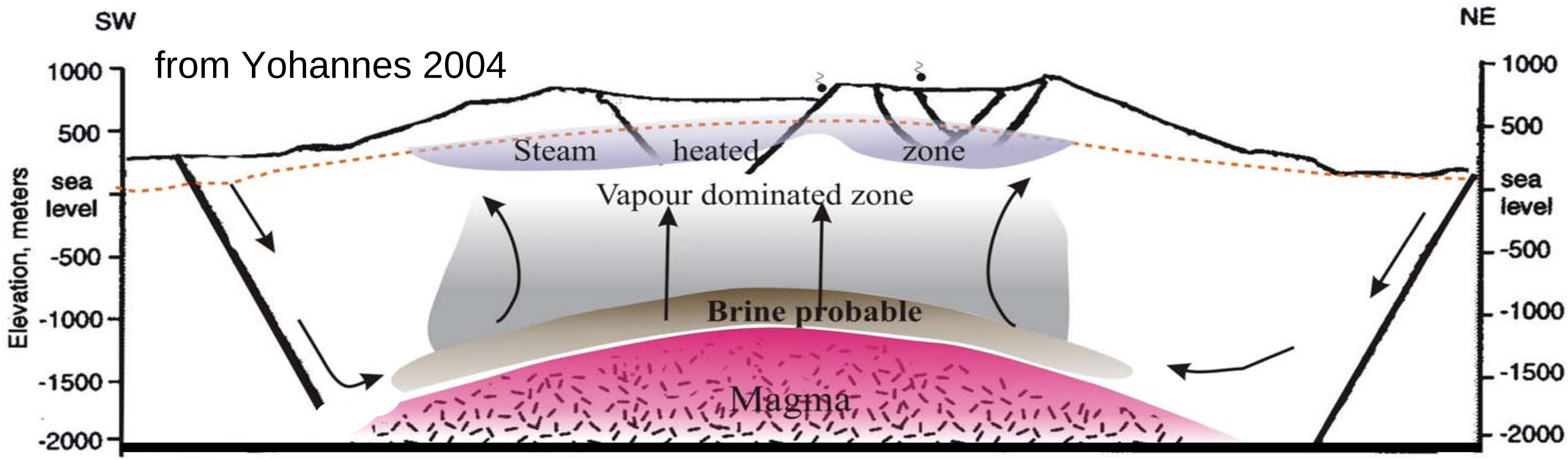
Alid

Support of training at UNU-GTP in Iceland in 2004

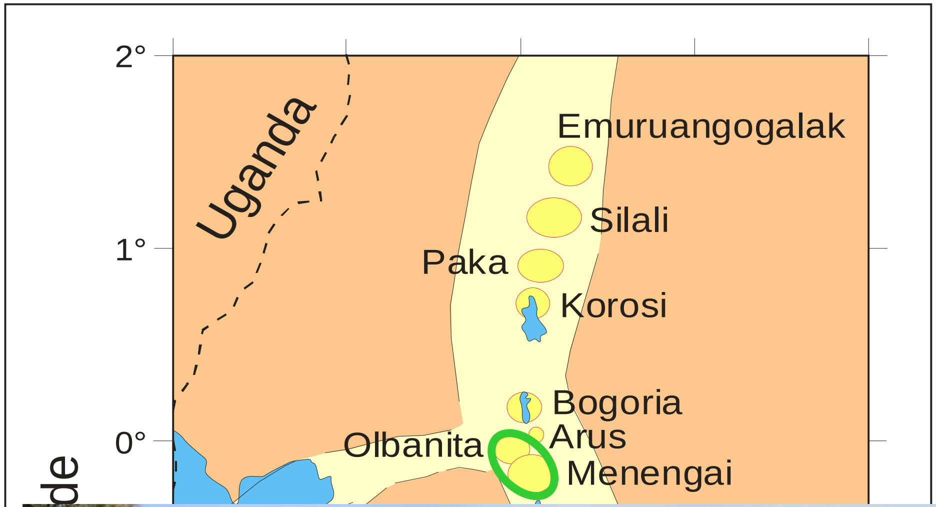
Activity
Re-interpretation of Alid geochemical data by Ermias Yohannes and subsequent structural analysis (=> conceptual model)


Source: UNU-GTP

Impact
A global leader in power generation plans to develop the Alid geothermal resource



GEOTHERM project in Kenya



Project partner:

Ministry of Energy
KenGen (= Kenya Electricity Generating Company Ltd)

Project site:

Menengai / Olbanita

Project activities

- **New data acquisition:**

  a) Additional geochemical analyses of youngest volcanic rocks in Menengai caldera

  b) 14C dating of paleosoil found in Menengai caldera which is related to youngest volcanic activity

  c) Thermal camera survey for surface manifestations in rough areas of Menengai and northern prolongation to allow detection of thermal activity in hardly accessible areas

- **New data interpretation:**

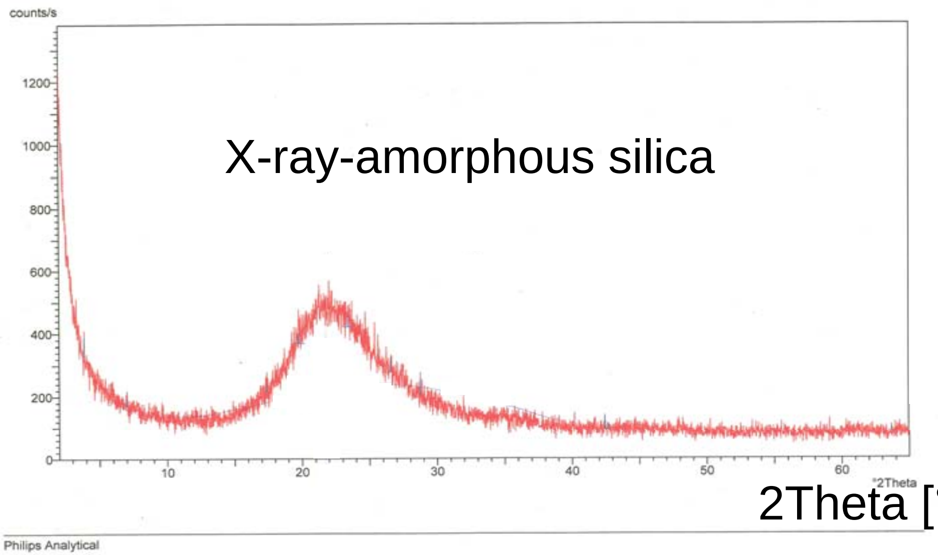
  Was the last volcanic activity at Menengai in historic times or was it about 10000 years ago (=> e.g. implications for activity of geothermal system)? The age of the last activity has also implications for volcanic hazard assessment (=> planning of site for construction of geothermal power plant)

- **New data management and common visualisation:**

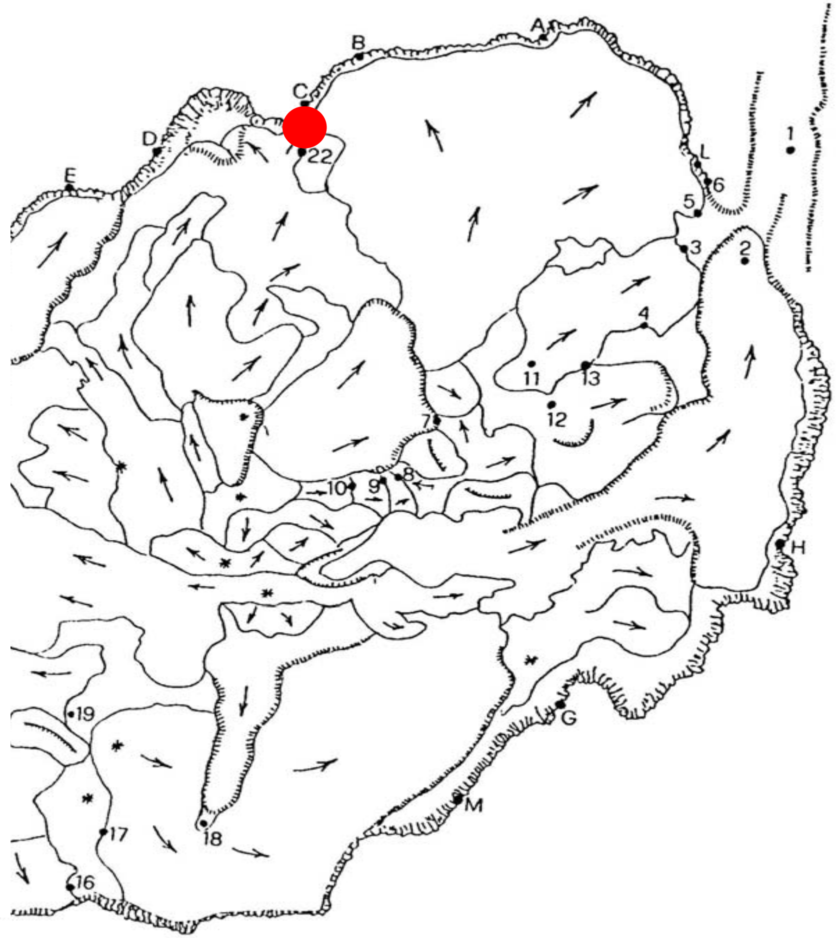
  GIS training course to make comparison with other project areas easier, to facilitate communication with decision makers, to enhance accessibility of project data etc.

Wanyororo sample

counts/s

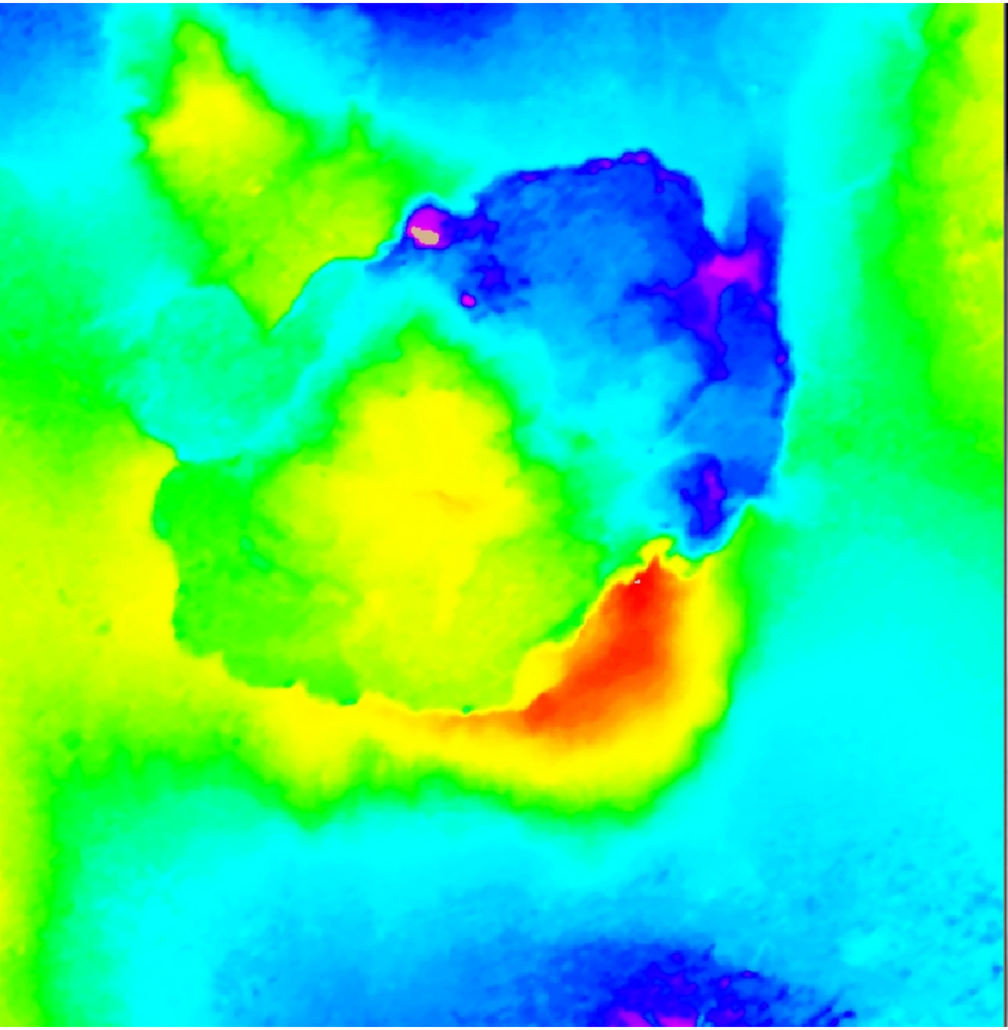


2Theta [°]



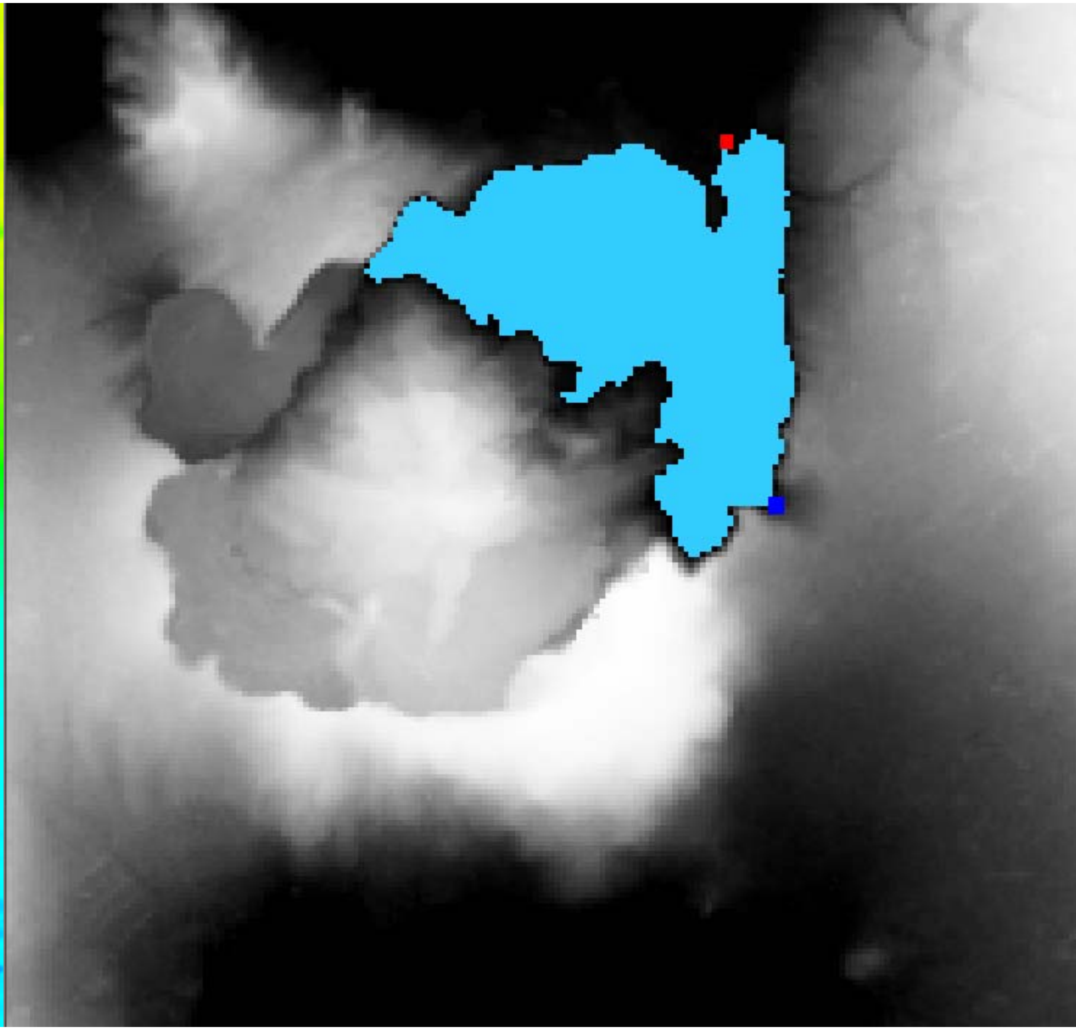
from ITALIANA 1987

Implications of diatomite deposit



30m resolution ASTER DEM

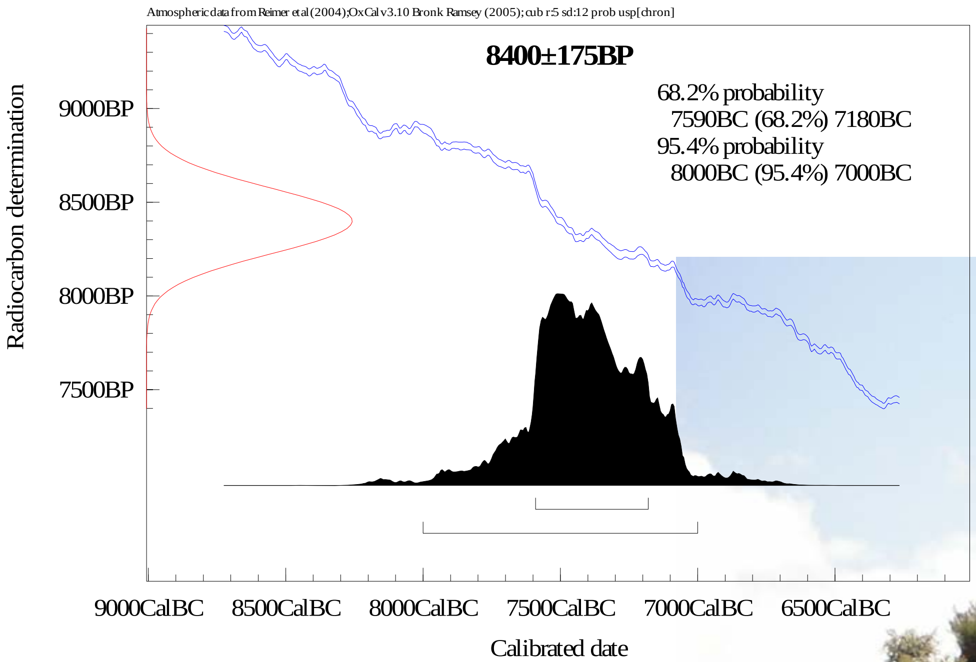
(source: http://edcdaac.usgs.gov/dataproducts.asp)

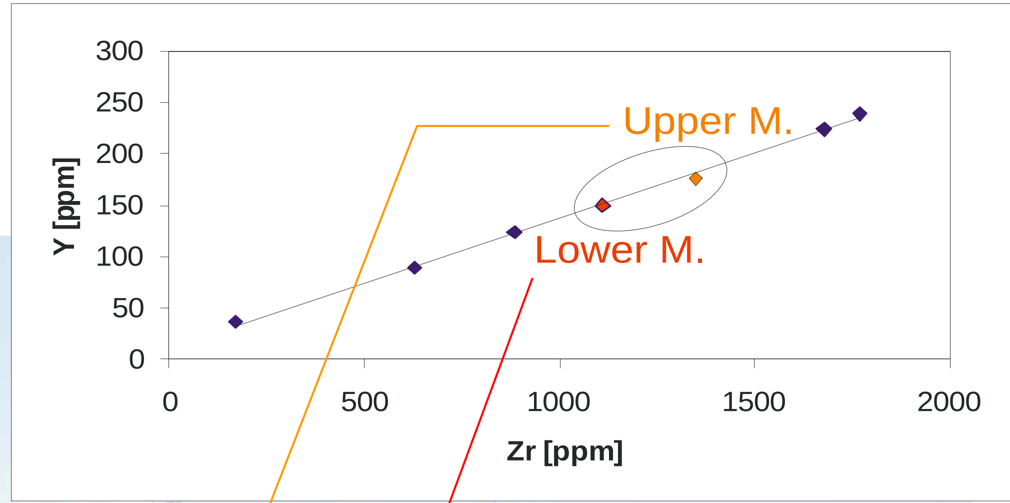


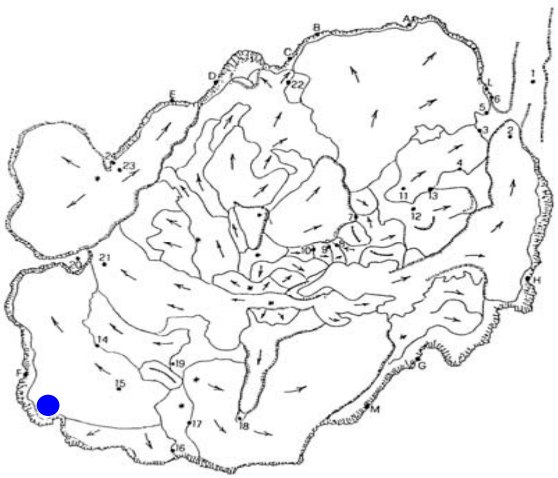
90m resolution SRTM DEM

(data source: http://seamless.usgs.gov/Website/Seamless)

14C dating & geochemistry (Mussonic samples)



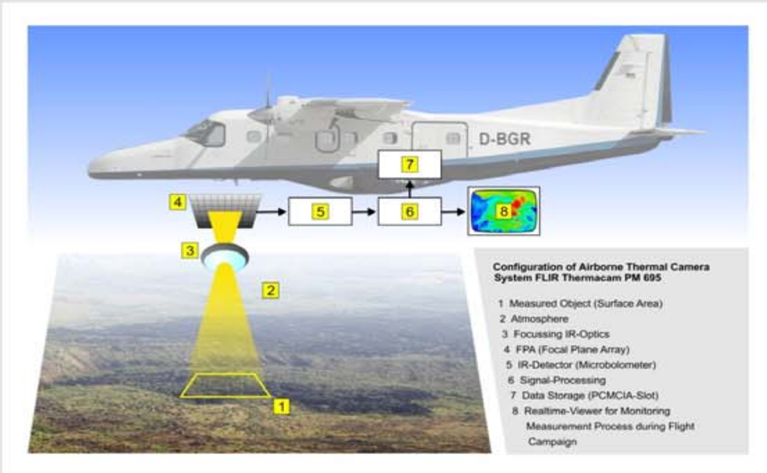




From ITALIANA 1987

Upper and Lower Mussonic trachytic fall out pumice deposits belong to the evolved post-caldera pyroclastic sequence of Menengai defined by Leat & Macdonald (1984) - evidence from major (MP) and trace element composition (XRF)

Thermal camera survey



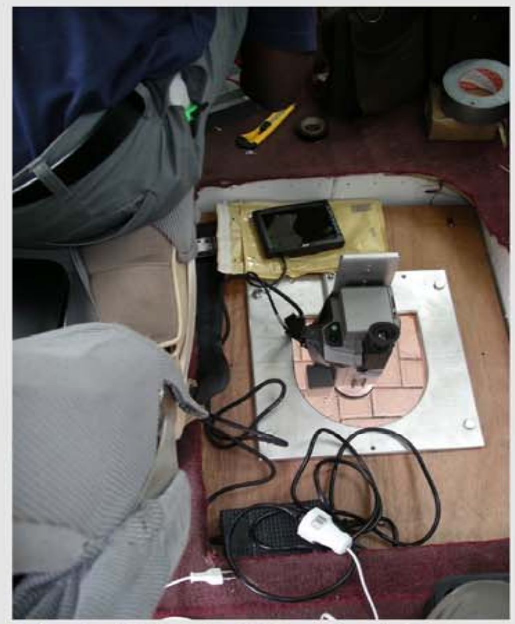
▲ *Figure 2 Configuration of Airborne Thermal Camera System FLIR ThermaCam PM 695*

Technical specifications FLIR ThermaCAM Pm695

Object temperature	-40—+120 °C (–40—+248 °F) measurement range
Measurement accuracy	± 2 %
Thermal sensitivity	< 0.08 °C at 30°C (0.14 °F at 86 °F))
Field of view (F × V)	24° x 18°
Detector type	Focal Plane Array (FPA), uncooled microbolometer, 320 × 240 pixels
Spectral range	7.5—13 µm, built-in atmospheric filter with cut-on at 7.5 µm
PC-Card™ drive	Slot for Type II or Type III PC-Cards, FLASH cards or hard disks (ATA-compatible), PCMCIA-Card
Image storing	Full dynamics, 14-bit digital storage
Battery system	One rechargeable nickel-metal-hydride (NiMH) battery
Operating time	Approx. 1.5—2 hours per battery (depending on how much the video camera is used)
Weight	1.96 kg, excluding battery 2.43 kg, including battery
Size	209 × 122 × 130 mm (8.23 × 4.80 × 5.12")

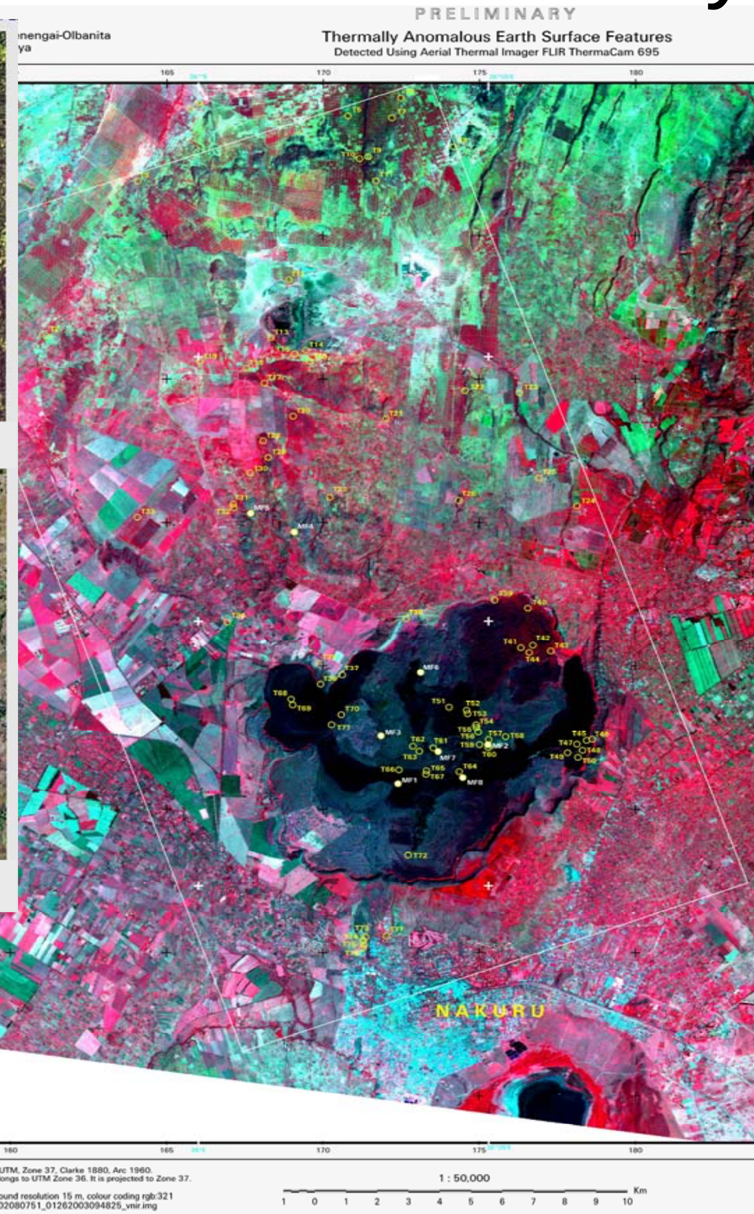
▲ *Figure 3 Aircraft PIPER NAVAJO used for Thermal Imaging Campaign at Menengai Caldera Prospect*

▲ *Figure 4 FLIR ThermaCam PM 695 mounted on aircraft PIPER NAVAJO, seen from outside the aircraft*



▲ *Figure 5 FLIR ThermaCam PM 695 mounted on aircraft PIPER NAVAJO, seen from inside the aircraft*

Thermal camera survey (results)



GIS training course

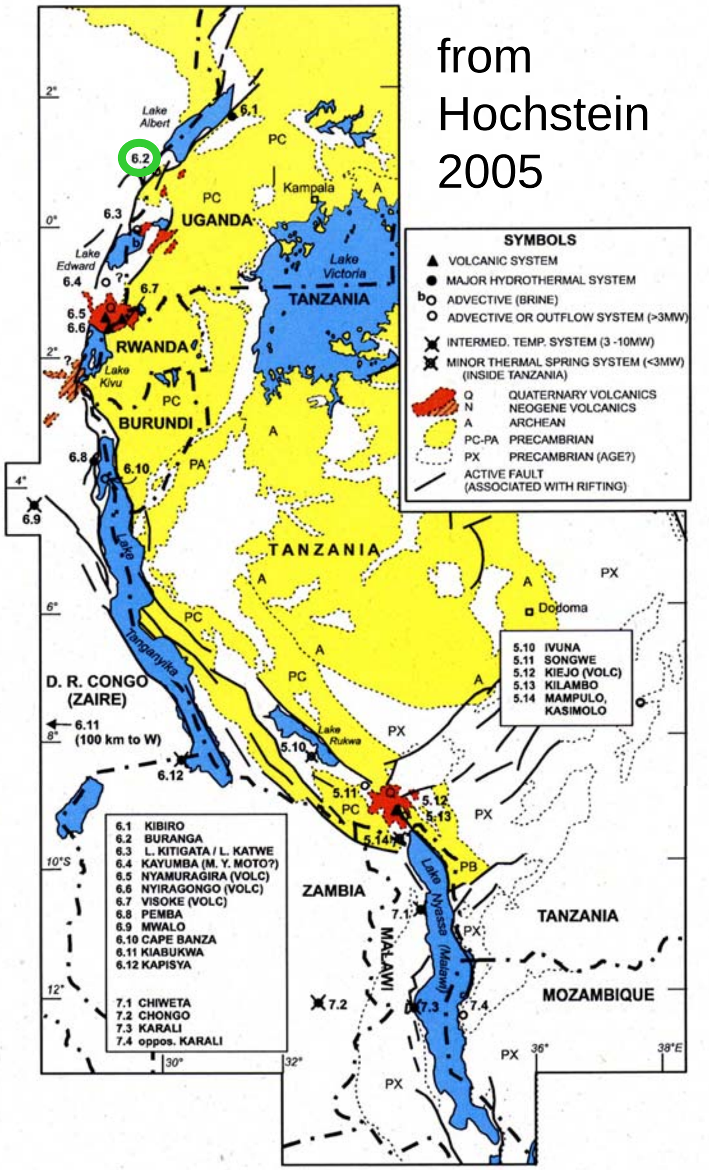
Conclusions

a) post-caldera lava flows in NE part are older than Termination I and post-caldera lava flow in SW part of Menengai caldera is older than 8400 a BP => **geothermal system is older and volcanic hazard potential is lower than expected => power plant can be constructed within the caldera**

b) It is expected that at least some of the **77 newly discovered thermal anomalies** are surface manifestations which can be sampled and therefore help to **enhance the statistical base for geochemical characterization of the reservoir**

c) **GIS is a suitable tool to assist in an integrated evaluation of all geoscientific information from geothermal systems** (exploration, environmental impact assessment, planning of steam field development, selection of suitable sites for power plant construction, …), **to convince decision maker** (politicians, investors, …) which are not familiar with geoscientific investigations, **to facilitate internal data access** etc.

GEOTHERM project in Uganda



from Hochstein 2005

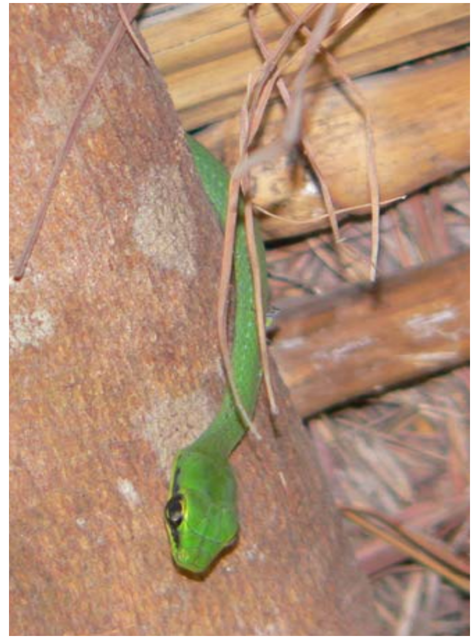
Project partner:

Ministry of Energy and Mineral Development through Geological Survey and Mines Department

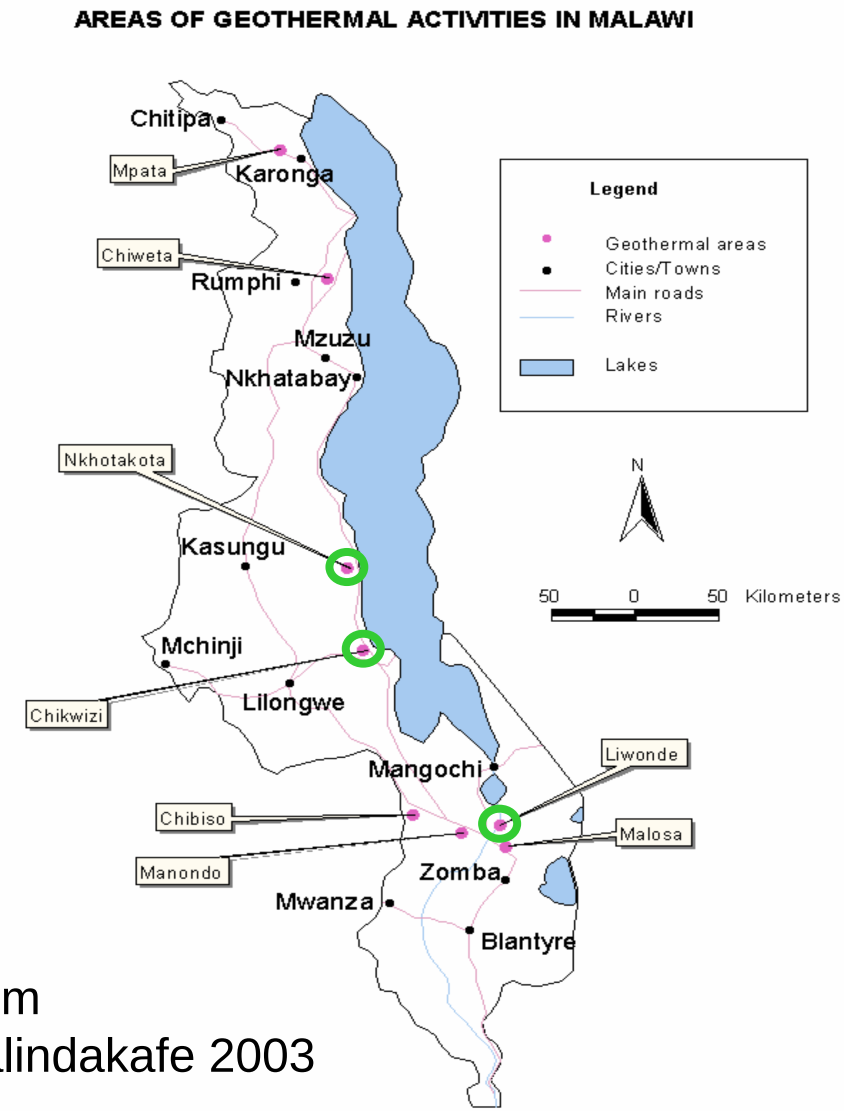
Project site:

Buranga

Impressions from field work in Uganda



GEOTHERM project in Malawi



from
Kalindakafe 2003

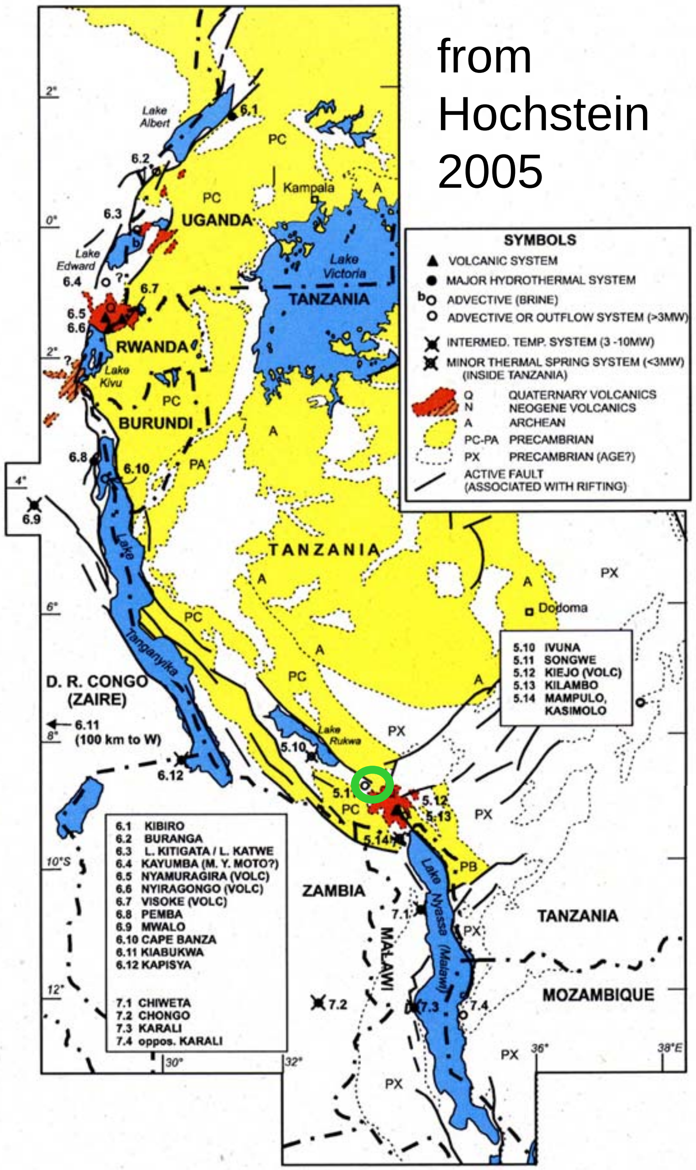
Project partner:

Geological Survey of Malawi

Sampled hot springs:

Nkhotakota, Chikwizi, Liwonde

GEOTHERM project in Tanzania



from Hochstein 2005

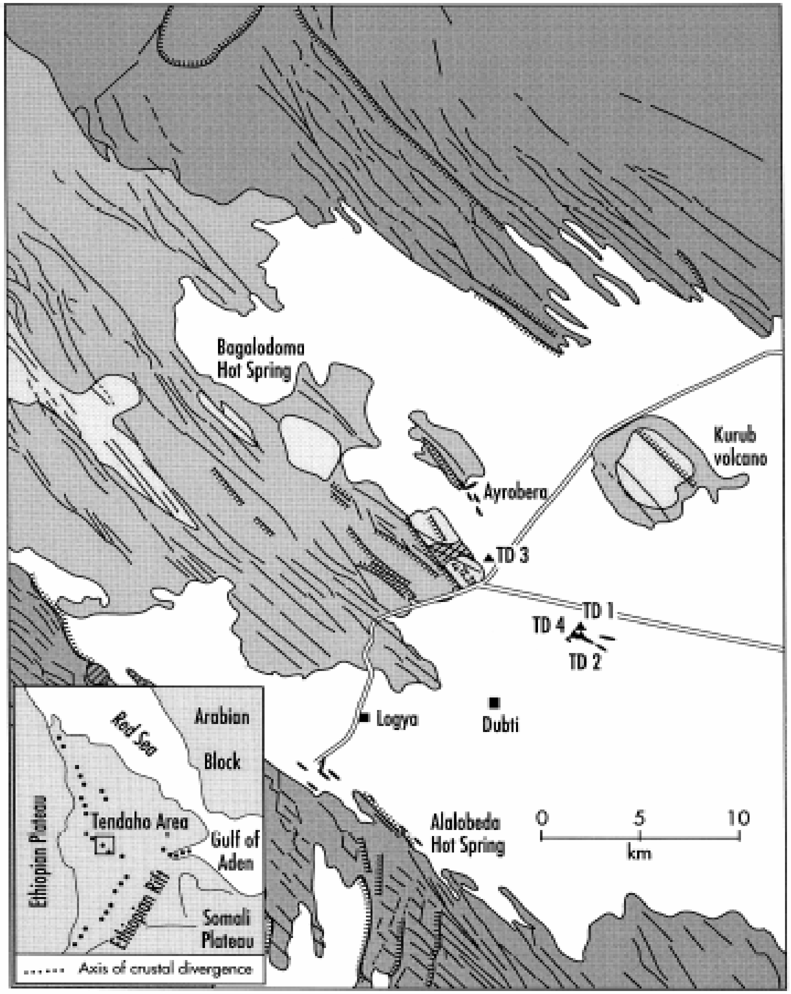
Project partner:

Ministry of Energy and Minerals
Geological Survey of Tanzania

Project site:

Songwe

GEOTHERM project in Ethiopia



from Gianelli et al. 1998

Project partner:

Geological Survey

Project site:

Tendaho

Related ARGeoC1 contributions

Tuesday 28 November **SESSION VI: ETHIOPIA**

Poster session Potential Environmental Impact Assessment for the development of Tendaho geothermal field, Ethiopia.- (*Kebede, S.;* GSE)

Wednesday 29 November **SESSION VIII: KENYA**

Poster session GIS in geothermal resources development.- (*Mungania, J.;* KenGen)

SESSION IX: DJIBOUTI, TANZANIA and UGANDA

10:45 – 11:00 AM Geothermal as an alternative source of energy for Tanzania.- (*Ndonde, P., Stadtler, C., Mwihava, N., Kessels, K., Kraml M. & Delvaux, D.;* GST, MEM, BGR)

11:00 – 11:15 AM Geothermal energy exploration in Uganda, country update 2006.- (*Bahati, G.;* DGSM)

11:15 – 11:30 AM Isotope hydrology in the exploration of three geothermal areas in Uganda.- (*Bahati, G.;* DGSM)

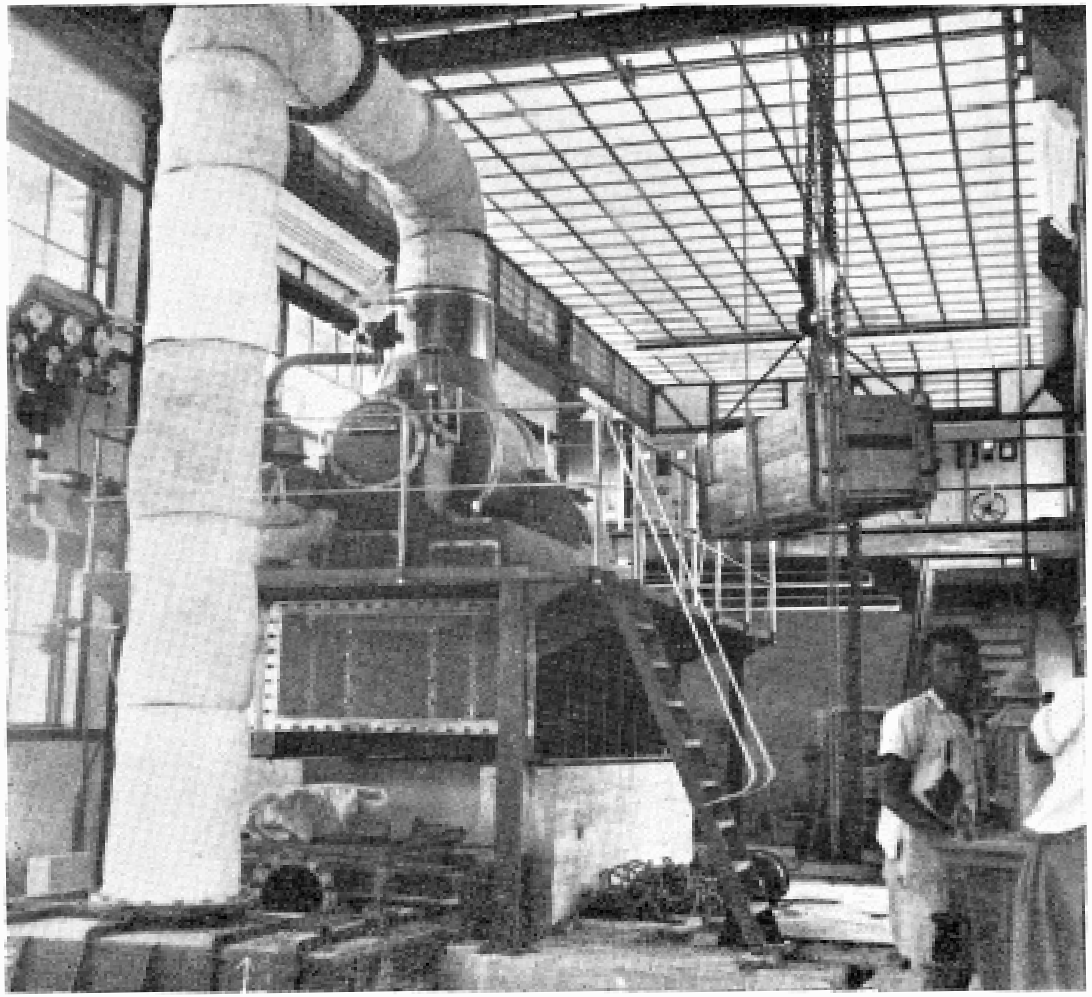
11:30 – 11:45 AM Geochemistry of Rwenzori Hot Springs, Western Uganda (*Kato, V. & Kraml, M.; DGSM & BGR*)

11:45 – 12:00 AM Microearthquake Survey at the Buranga Geothermal Prospect, Western Uganda (*Ochmann, N., Lindenfeld, M., Barbirye, P. & Stadtler, C.;* DGSM & BGR)

Olkaria geothermal field in Hells Gate National Park, Kenya

BGR Bundesanstalt für Geowissenschaften und Rohstoffe

First geothermal power plant in Africa



D.R. Congo: Kiabukwa
located in Upemba graben
(incipient non-volcanic rift)

Binary power plant commissioned 1952
(installed capacity of 0.2 MW; thermal
water with temperature of 91°C and
flow rate of 40 liters per second)

from: Robert 1956 (Photo July 1953)