Outcomes of the Workshop on the Geologic and Geothermal Development of the Western Branch of the Greater East African Rift System

Energy Ministerial Meeting

13 June 2016

AUC Headquarter

Addis Ababa, Ethiopia

About the Workshop

- The workshop was organized as part of the activities of the African Rift Geothermal Development facility (ARGeo) under UNEP on request by countries of western branch of EARS.
- The need for the workshop arose from the fact that despite enhanced exploration activities in the countries transected by the western branch of EARS, no successful geothermal projects have been developed.
- This therefore implied that a different exploration strategy may need to be employed for the exploration of resources in western EARS

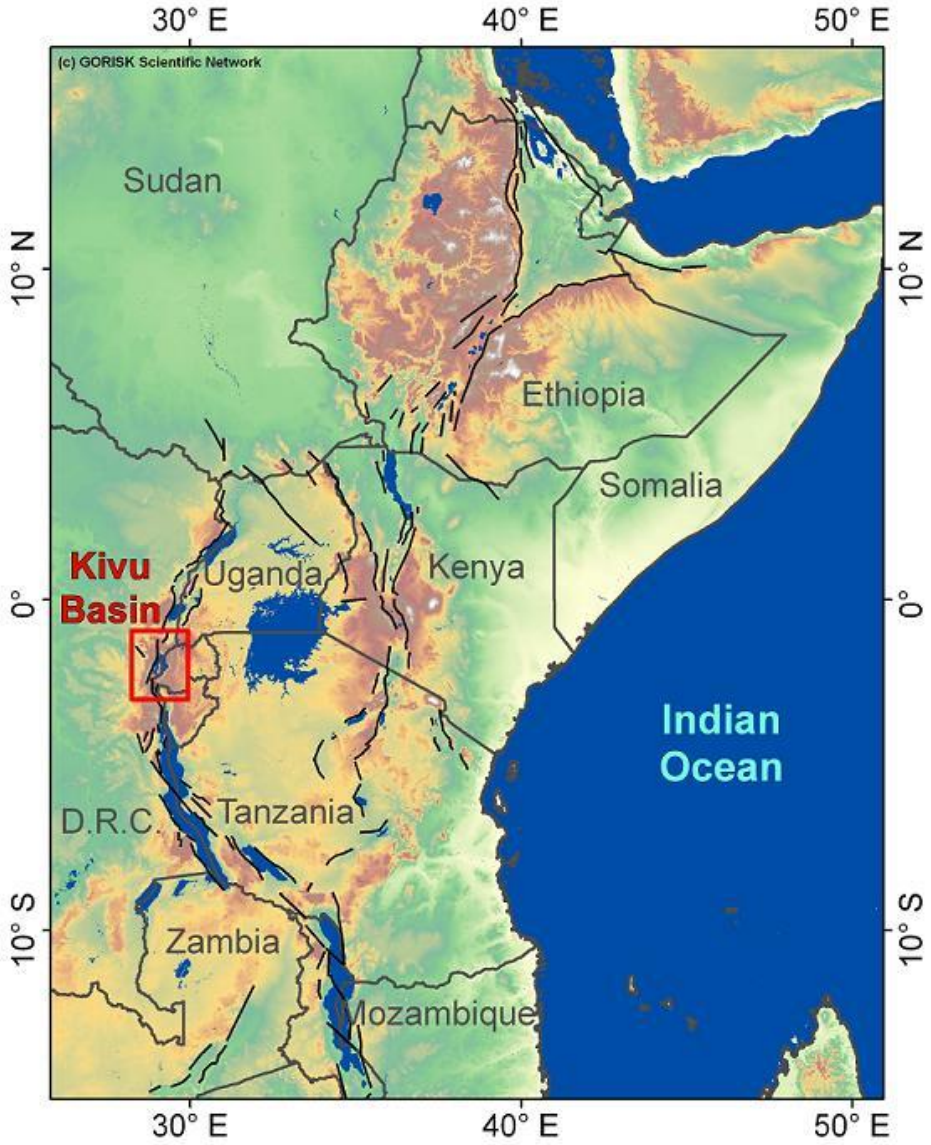
Workshop Organization

- The workshop was held in Kigali, Rwanda on 9-11 March 2016
- A total of 75 invite-only participants attended from countries of EARS (Burundi, DRC, Rwanda, Tanzania, Zambia, Malawi, Mozambique, Djibouti, Eritrea, Kenya, Ethiopia, Uganda)
- Resource persons came from Belgium, Italy, France, Germany, USA, New Zealand, Iceland, Kenya and Ethiopia.
- The workshop was sponsored by UNEP, MFA-Iceland and NDF, Energy Development Corporation Limited of Rwanda (EDCL) and Rwanda Energy Group (REG).

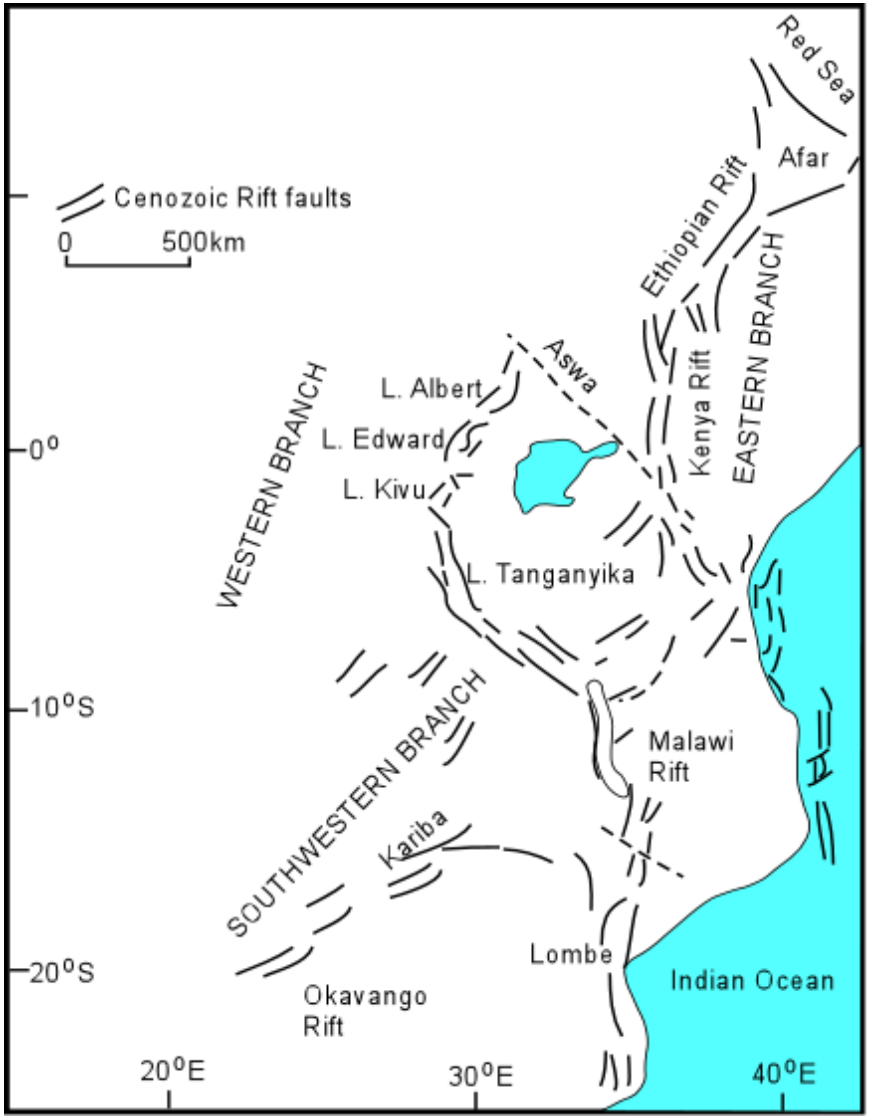
Specific Objectives

- To understand the occurrence, nature and characteristics of the geothermal systems in the western branch of EARS
- Compare and contrast experiences and research methods for geothermal exploration used in the eastern vs western branch of EARS.
- Review case studies of developed medium temperature geothermal systems in western USA as possible approach for development for western EARS
- Identify gaps that need to be bridged through improved exploration strategies or collaborative research projects.

Countries of EARS



The East African Rift Segments



The EARS consists of:

Eastern Branch

- Afar Rift
- Ethiopian Rift
- Kenya Rift

Western Branch

- Albertine rift
- L. Tanganyika – Rukwa - L. Malawi
- SW rift

Geothermal Systems in EA

- **Volcano hosted geothermal systems**
  - Characterized by young volcanoes, shallow magmatic heat sources, convective, high temperature. E.g. Olkaria, Aluto Langano. Good for flash generation, direct use
- **Fault controlled geothermal system**
  - Medium to high temperature, Reservoir controlled by fault systems, conduction dominated, volcanoes usually absent. Good for binary power generation and direct use

Classification by Resource Temperature

	Muffler [1979]	Hochstein [1988]	Benderitter and Cormy [1990]	Haenel et al. [1988]
Low enthalpy	< 90°C	<125°C	<100°C	<150°C
Moderate enthalpy	90-150°C	125-225°C	100-200°C	-
High enthalpy	>150°C	>225°C	>200°C	>150°C

Workshop Outcomes

- **The geothermal system in western EARS:**
  - Dominantly Fracture/fault controlled. A few may be magmatic
  - Medium to high temperature. Med T more abundant
  - Shallow resource potential
- **Exploration methods**
  - Detailed geologic and structural analysis,
  - Geochemical analyses using accurate interpretation techniques
  - shallow resistivity and seismic surveys, and
  - Temperature gradient (TG) wells

Outcomes-2

- It is recommended that drilling of slim holes should be considered after successful drilling of TG wells to further de-risk the projects
- Geothermal Reservoirs commonly occur within 1km depth.

Case Study – B&R, USA

- Western USA (Basin and Range Province)
  - Dominantly medium temperature systems
  - Fault controlled with reservoirs within 1km depth
  - Volcanoes are absent
  - Most of the systems are “blind”
  - Power plants are dominantly Binary

Basin and Range, USA

- Hosts ~425 known geothermal systems ≥37° C
- More than 150 resources have temperatures ≥100° C and 72 systems have temperatures ≥150° C
- Currently, 31 resources in the Great Basin region are in production or have had successful flow tests
- Total installed capacity is nearly 1,000 MWe.
- Individual systems range from 0.5 to 275 MWe capacity.
- Twenty-seven systems of the 31 total productive systems are < 50 MWe in size and the median
- Installed capacity of all 31 systems is 18 MWe.

Conclusions

- Geothermal systems in western EARS are dominantly fault controlled and probably medium temperature
- Viable geothermal systems exist within the western EARS which can be used for both electric power generation and direct use
- Direct use should be given high priority as it presents great economic benefits to the countries that may even surpass electricity production, e.g. Blue Lagoon in Iceland and Beppu in Japan

Recommendations

- A new approach must be employed to explore the geothermal systems in western EARS using geology, geochemistry, geophysics and temperature gradient wells
- It was strongly recommended that temperature gradient wells be drilled as part of surface exploration
- Drilling of slimholes should be adopted as an early exploration well prior to deep exploration well
- Temperature Gradient wells should be considered for financing during surface exploration stage

Group Photo of Participants