Project development in Africa: The East African Rift and the Example Tanzania

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Introduction

In terms of geothermal power in the region of the East African Rift System (EARS), Tanzania's northern neighbor Kenya has always been in the focus as the largest geothermal player in Africa. Yet Tanzania reveals a significant geothermal potential for high- and low-temperature geothermal systems. A first assessment in the early 1980th based on analogy method gave a potential of 650 MW for electricity generation in the country (McNitt 1982).

Potential geothermal prospects

Taking a closer look at the geological and structural conditions in Tanzania, three major areas have been identified for geothermal project development.

1. **Northern Tanzania** with a section of the eastern branch of the East African Rift System (splay) and its prominent volcanoes Ngorongoro, Mount Meru and Kilimanjaro being characterized by evolved rock compositions and caldera formation. Gas geothermometric results of fumarole samples from the top of Kilimanjaro gave clear indications of a high-temperature geothermal system (Giggenbach 1997). Unique Ol Doinyo Lengai with its current natro-carbonatitic activity and also neighboring carbonatitic Kerimasi volcanoes are special cases. The role of their "magma chamber" acting as heat source that sustainably drives a geothermal system has still to be proven. Fumaroles at Mount Meru caldera are so far not investigated. Lacking fumaroles at Ngorongoro caldera caused doubt that a geothermal system currently exists, since lukewarm springs are not enough evidence (Hochstein et al. 2000). This view is supported by an old age of 2.3 to 2.0 Ma for the entire volcanic activity period of the Ngorongoro volcano (Mollel 2007).

2. **Eastern Tanzania** in the coastal area of Rufiji basin and Dar es Salaam platform. For both regions hot springs occur as surface expression of low-temperature geothermal activity in the subsurface. A potential of >100 MW has been estimated for a modeled block with an extent of of 90 × 45 km (MEM 2004).

3. **South-western Tanzania** with the Mbeya area between Lake Nyasa and Mbeya town. Mbeya area is part of a triple-junction of the East African Rift System with its Quaternary Rungwe volcanic province. There, high- and low-temperature resources exist e.g. at Ngozi volcano (Fig. 1) and at Mbaka fault, respectively (Kraml et al. 2010).

Besides those major areas, minor geothermal resources exist in the NW of Tanzania (e.g. Maji Moto) and in the center of the country N of Dodoma, where mainly fault related hot springs occur as surface expression of low-temperature systems. In summary, only one high-temperature hydrothermal system is known in Northern Tanzania (Kilimanjaro in extremely

high elevation causing logistical difficulties in development of the resource) and two additional high-temperature systems (Mount Meru and Ol Doinyo Lengai) are assumed to reflect an immature status (Hochstein et al. 2000). Additionally, all possible high-temperature prospects in Northern Tanzania are situated in ecological sensitive areas (National Parks, Conservation Areas, UNESCO Heritage sites) and are of utmost importance for the tourism industry. Since no geothermal law is in place for utilization of geothermal resources in such sensitive areas, project development is not expected to take place in Northern Tanzania in the near future.

Fig. 1: Ngozi volcano caldera (picture: Michael Kraml).

Surface exploration and conceptual models

Two areas are so far intensively investigated in Eastern and South-Western Tanzania:

1. Rufiji basin / Dar es Salaam platform: During hydrocarbon exploration hot water of 140°C was found in 1179 m depth indicating a Mesozoic aquifer with lateral fluid flow within the sedimentary basin (MEM 2004). Supplementary surface exploration was done by private company Geothermal Power Tanzania Ltd. (GPT).

2. Mbeya area: Intense surface exploration during the GEOTHERM technical cooperation programme of BGR, Hannover, Germany and subsequent surface exploration by private company GPT indicates a high-temperature system (≥220°C) at Ngozi volcano and a low-temperature system (≥160°C) at Mbaka fault both with fracture-controlled fluid-flow within the East African Rift (Kraml et al. 2010).

In late 2011 six prospecting licenses were granted to GPT in those two areas (one at Dar es Salaam platform low-temperature resource; two at Ngozi high-temperature resource; three at Mbaka / Livingstone fault low-temperature resources; Fig. 2). Due to sufficient surface exploration data already acquired at Ngozi volcano and Dar es Salaam platform, the major focus of GPT in 2012 was surface exploration for developing a conceptual model for Mbaka fault.

GPT started the drilling of two exploration wells at Mbaka fault in the first quarter of 2013 together with its German joint-venture partner Geothermal Engineering GmbH (GeoT) and the drilling company AAA Drilling based in Tanzania (Fig. 3). While the first well exposed the stratigraphy of the Tertiary cover, the second well already discovered thermal water in

shallow depth and provided valuable hydrological framework conditions (artesian pressure) to be expected in the future production well.

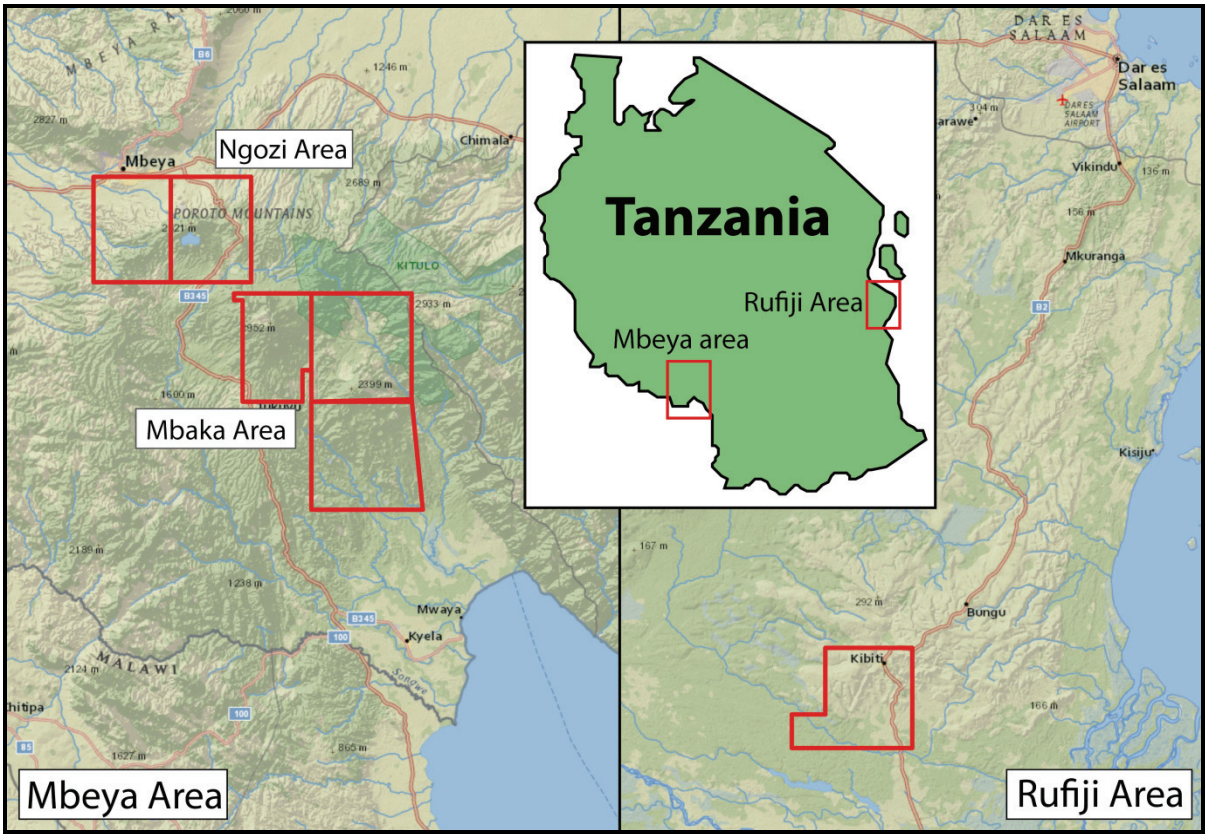

Fig. 2: Location of GPT's Prospecting Licenses in Tanzania.

Within the next months a deep exploration well shall proof productivity of the reservoir at Mbaka fault. Additionally, further surface studies are planned to clarify the conceptual model of Mbaka fault and to identify a suitable area for re-injection. Therefore, further field work and sampling campaigns as well as a detailed investigation of the drill cores will enhance the data base and the related reliability of the Mbaka model.

The first exploration well at Ngozi will be drilled after completion of the deep exploration well at Mbaka fault.

Conclusions

The geothermal potential of Tanzania as estimated by McNitt (1982) will soon be updated once the two low-temperature resources at Mbaka fault and Rufiji area as well as the high-temperature resource at Ngozi are proven by exploration wells. With the first geothermal development in Tanzania implemented in Mbaka area, GPT has already set relevant aspects in the discussion of a turnaround in the energy policy of Tanzania, as the country still lacks legal regulations for geothermal development.

Fig. 3: Drilling of exploration well at Mbaka fault using the Atlas Copco CS-14 rig (picture: GPT).

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