



OSA-040-Hydrocarbons-E. Africa

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The hydrocarbon potential of the East African Rift System

Country Profile

The hydrocarbon potential of the East African Rift System (EARS) has been known for years, with discoveries dating back to the early 1920s. Countries like Sudan, Uganda, Tanzania and Kenya have been proved to contain considerable quantities of oil and gas, but further south, where the rift passes through Malawi, exploration has barely started. Much of the country, and the Lake Malawi Basin in particular, is believed to possess promising geology and has indications of petroleum systems.

Rifting Dominates As with much of East Africa, the geology of Malawi is dominated by the ongoing splitting of the African plate, which has resulted in the East African Rift System (EARS). This stretches more than 4,000 km from Eritrea and Ethiopia in the north, where rifting initiated about 40–50 million years ago (Ma), southwards to Malawi where rifting may have commenced as recently as 8 Ma, and on into Mozambique.

The system comprises two arms; the older eastern branch through Kenya is more volcanically active than the younger western branch, which contains some of the world's oldest and deepest lakes, including Lakes Tanganyika and Malawi.

The majority of the country is dominated by crystalline metamorphic and igneous basement rocks which have been subjected to several periods of deformation, primarily during the Precambrian. In the Permo-Triassic, the continental extension splitting the supercontinent Gondwana apart led to extensive faulting, resulting in the formation of long narrow north-east to south-west trending troughs in which sandstones, limestones and mudstones of the Karoo Supergroup were deposited.

These sediments were subjected to repeated periods of uplift, erosion and faulting from the Jurassic to the present, producing graben structures in which Tertiary and younger sediments were deposited. Quaternary lacustrine sands and gravels are common in the Lake Malawi area, indicating the retreat of the lake to its present position. There are some Jurassic-aged basalts in the far north and south of the country and several carbonatite intrusions in southern and south-central Malawi. Unlike the older rift system, however, there is little evidence of magmatic activity and volcanism associated with rift formation, with the exception of some Pleistocene volcanics found near the northern end of Lake Malawi.

There are also hot springs in the western and southern lake area. Unexplored Malawi Plenty of hydrocarbons have been found in the East African Rift system, but Malawi, lying at its southern end, is virtually unexplored. JANE WHALEY Lake Malawi has a surface area of nearly 30,000 km², making it the ninth-largest freshwater body of water in the world.

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The lake has long been considered the most likely place to find hydrocarbons in Malawi. Although a very broad-brush approach, this survey did indicate that there were thick sedimentary units, in places exceeding 4,000m, and also identified large structural features, suggesting the potential for Tertiary hydrocarbon systems similar to those found in the Albertine Graben, where ten discoveries have been made since 2006.

The water depths where the greatest thicknesses of sediments were located made exploration uneconomical at the time. Further UN-funded airborne geophysical surveys noted the presence of thick sedimentary rock formations under Lake Malawi, in the Lower Shire Valley in the south and the northern Vwaza Marshes area. Oil seeps have been observed in Lake Malawi and its vicinity for years, indicating the possibility of mature source rock deposition at depth.

The seeps may be the result of the anoxic conditions which have been part of the development of the lake since the Tertiary, but could also be linked to the older Karoo sediments common in the southern part of the EARS, which are coal-bearing elsewhere in southern Africa. Studies by Kagya et al. (1991) suggest that kerogens found in Early Permian Karoo coals and carbonaceous shales in the Lake Malawi area could be good sources for gas/condensate or light oils.

The source rock kitchen is expected to be in the deeper part of the half graben. Through sequence stratigraphy (Saunders), it has been shown that there have been many oscillations in the lake level linked to climate variations, and that peak source rock deposition may be linked to lake highstands and reservoir formation to lake lowstands.

The evolution of the rift basin itself provides a trapping mechanism for migrating hydrocarbons, not just in the Lake Malawi area but also further south in the valley of the Shire River, the only outlet of the lake. State of Exploration In 2011 the government offered six blocks for hydrocarbon exploration. Block 1, covering the Vwaza Marshes/Chitipa area in the north-west, is considered to have potential, as it contains a number of fault-bounded basins filled with Karoo sediments, overlain by Tertiary sediments.

South African independent Sac Holdings have held the area since 2012 and have undertaken regional geological, geophysical and satellite screening studies, as well as environmental and social risk screening. After positive results from these, they are now planning a geochemical study and passive seismic tomography. The block encompasses environmentally sensitive areas both inside and outside national parks. Lake Malawi is divided into three blocks roughly coincident with the basin structure. Block 2, Lake Malawi North, encompasses the North Basin, which is a single half-graben with the primary border-fault margin running along the eastern side of the lake. A zone of north-south trending faults downthrown to the west lies in the centre of the lake here. The Central Basin, covered by Block 3, extends about 150 km and is bound on the west by a border fault system downthrown to the east. In the middle of the block a north-west dipping fault zone striking south-west to north-east cuts through the southern edge of the basin, displacing the water bottom by about 75m. Blocks 2 and 3 were awarded to Surestream Petroleum in 2011, who undertook environmental and social Tanzania Mozambique Mozambique Zambia Block 1 Block 2 Block 3 Block 4 Block 5 Block 6 L a k e M a l a w i Lake Chilwa Lake Malombe S h i r e R i v e r L a k e M a l a w i Lake Chilwa Lake Malombe S h i r e R i v e r Vwaza Marshes Lilongwe Blantyre Molanje Massif Vwaza Marshes Lilongwe Blantyre

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Country Profile impact studies before selling the acreage to UAE-based Hamra Oil in 2013. It undertook airborne gravity, magnetic and full tensor gravity surveys and claims that the results indicate potential hydrocarbon accumulations, particularly in the deepest areas of the lake. The company is reportedly planning further

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investigations, possibly including 2D seismic and onshore drilling using environmentally friendly techniques. Block 4, Lake Malawi South, encompasses the largest and shallowest part of Lake Malawi, the South Basin, where water depths of about 400m are found near the primary borderfault on the eastern edge of the lake. Another UAE company, RAK Gas, holds this acreage and the adjacent onshore Block 5 in the Lake Chilwa/Lake Malombe area to the south and has completed full tensor gravity surveys as well as environmental impact assessments over the two blocks.

There are plans for more detailed geological mapping in parts of the acreage. Block 5 is believed to hold good thicknesses of sedimentary rocks. Ghana-based Pacific Oil and Gas has also conducted airborne geophysical surveys across its Block 6 Lower Shire rift acreage in the very south of the country.

The Malawi government recently launched a project to geologically map the whole country, last done in the 1960s. Funded by France, Finland and South Africa, the project will commence with a countrywide aeromagnetic survey and will have a particular emphasis on mineral potential. Issues to solve although still in its infancy, hydrocarbon exploration in Malawi is already controversial. License allocation and alleged secrecy surrounding the process raised concerns that the original contracts had serious shortcomings. Exploration by RAK Gas and Hamra was briefly suspended in 2014 while legal investigations were ongoing and there have been some renegotiations, with moves to increase government take. The government is also undertaking a review of the Petroleum Act to tighten licenses and regulations.

The greatest chance of hydrocarbon discoveries is in and around Lake Malawi, which is bordered to the north and north-east by Tanzania. There is a decades-long dispute over this area, as Tanzania claims half the lake – which it calls Lake Nyasa – while Malawi draws the boundary at the east coast. In May, Malawi threatened to take Tanzania to the International Court of Justice over the issue and negotiations are ongoing. Neither Mozambique, which owns the east central part of the lake, nor Tanzania are encouraging exploration in the area at the moment, because exploration and discoveries elsewhere in their countries are taking priority. Heritage Oil has undertaken gravity and geochemical surveys on its Tanzanian Kyela block at the northern end of the lake and reported the presence of tilted fault blocks and structural features, reinforcing the prospectivity of the area. Environmental Concerns The prospect of drilling in Lake Malawi raises a number of environmental and ecological concerns which must also be taken into consideration. The third largest lake on the African continent, it is hugely important in the local economy; over a million Malawians rely on it for water, electricity, irrigation, and most importantly, fish. The lake is thought to be home to more tropical fish species than found in any other freshwater body on Earth, including over 1,000 species Elephants in the Vwaza Marsh National Park. ©

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