Tectonic Control on Hydrocarbon Accumulation in the Intra-Continental Albertine Graben of the East African Rift System*

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Search and Discovery Article #10183(2009)
Posted April 10, 2009

*Adapted from oral presentation at AAPG International Conference and Exhibition, Cape Town, South Africa, October 26-29, 2008

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Abstract

The Albertine Graben is a Tertiary intra-continental rift that developed on the Precambrian orogenic belt of the African Craton. It forms the northern termination of the Western arm of the East African Rift System (EARS) (Figure 1). It stretches from the border between Uganda and Sudan in the north, to Lake Edward in the south. The available geological and geophysical data indicate that rifting could have been initiated during the late Oligocene or Early Miocene.

The tectonic evolution of the Albertine Graben is little understood. It does not fit well with traditional models of rifted continental basins defined by discrete basin bounding faults opposed by a low gradient flexural margin especially over Lake Albert. Similar amounts of displacement on the eastern border faults and western border faults produce nearly a full graben structure that gently dips towards the west, in contrast to half graben structures of the Tanganyika and Malawi rifts.

The available geological and geophysical data indicate that the Albertine Graben has gone through extensional and compressional episodes resulting in a variety of structures. Deformation and prevalence of flower structures in the shallow sedimentary sections in some basins in the graben indicate that the neo-tectonic processes are compressional.

The Albertine Graben has undergone substantial tectonic movement and thick sediments (approximately 6 km) have been deposited in lacustrine and fluvial-deltaic environments (Figure 2). The sedimentary layers dip gently towards the depo-centre on the western margin of the rift. Rapid tectonic subsidence coupled with limited sediment input led to deep stratified lakes with the accompanying

deposition of source rocks. The hydrocarbon exploration wells drilled in the Albertine Graben have proven the deposition of source, reservoir and cap rocks.

Both structural and stratigraphic traps have been interpreted from geophysical data acquired in the graben. However, only structural traps have been tested for hydrocarbons by drilling. All the wells that have been drilled in the Albertine Graben have been on either positive flower (Palm Tree) structures or on fault blocks. Fault closures against basin bounding faults, or even intrabasinal faults, have proved prolific for hydrocarbon trapping.

Not only has tectonics played a crucial role in deposition of source, reservoir and cap rocks and formation of structural traps, but also provided migration pathways for the hydrocarbons. Complex fault patterns, as interpreted from geophysical data, have provided conduits for hydrocarbon migration, sometimes long distance migration.

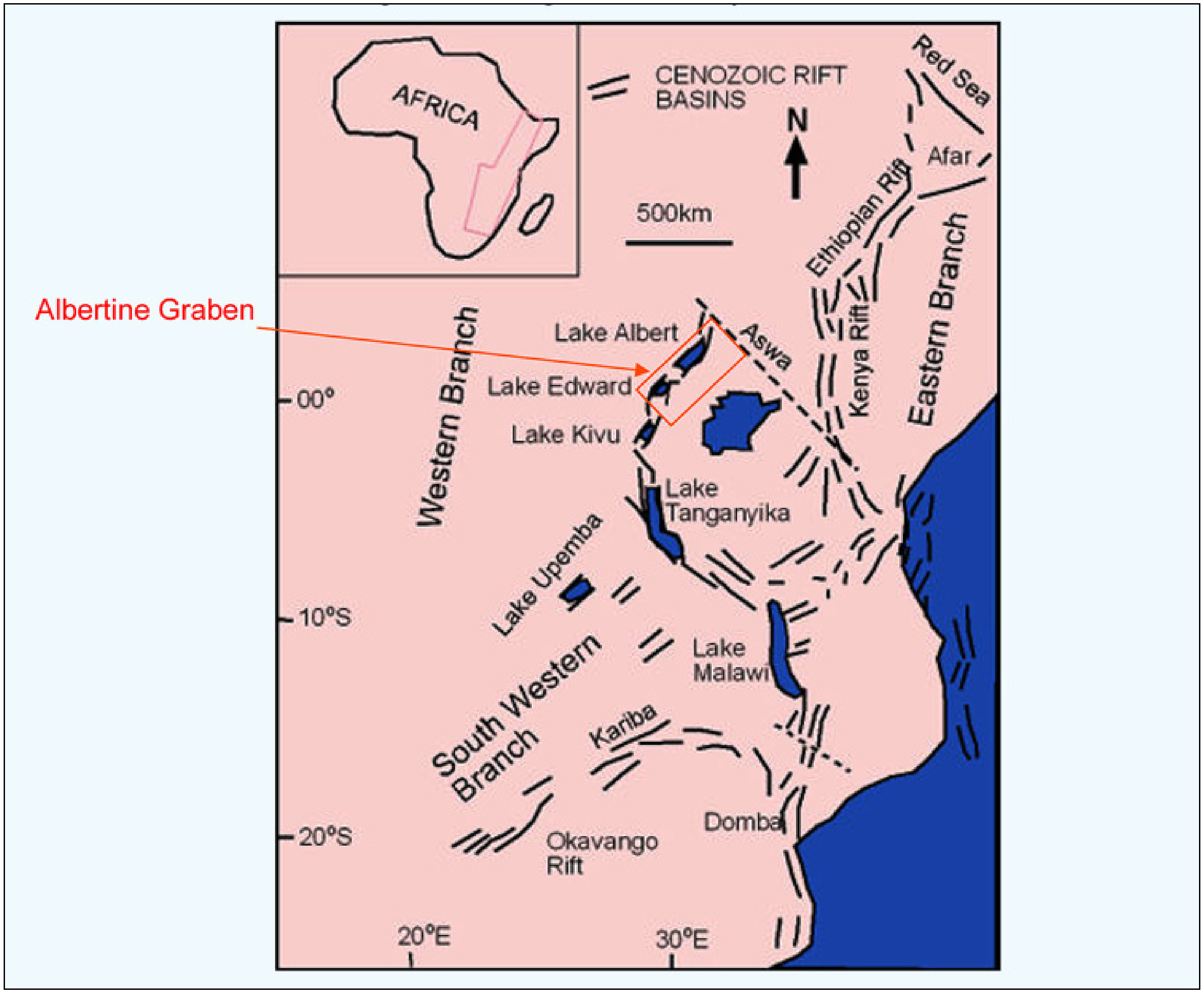

Figure 1. Map showing the East African Rift System and the Albertine Graben.

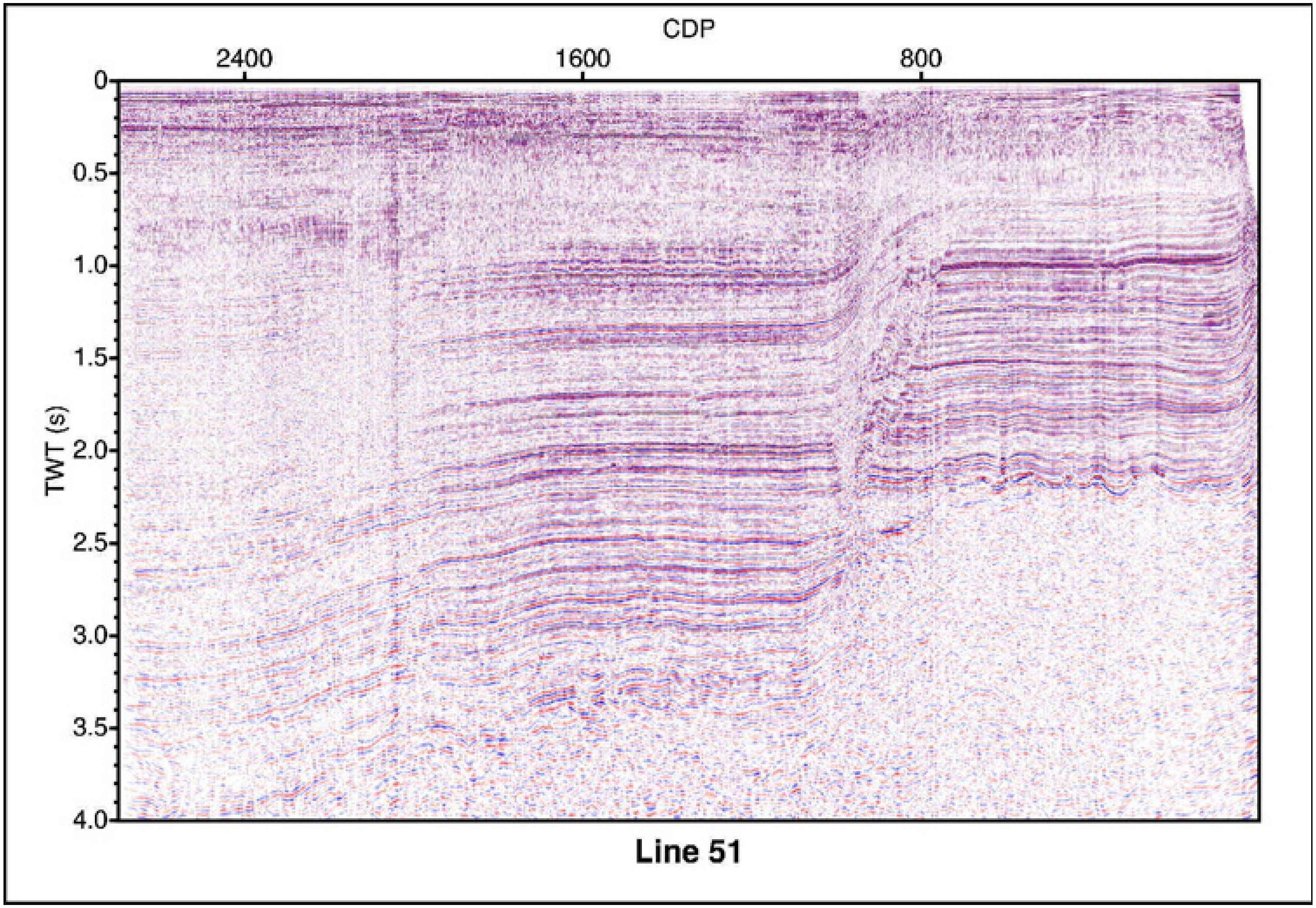

Figure 2. An East-West seismic cross-section across Lake Albert showing an almost full graben structure.

Figure 3. Photo showing deformed young volcanic rocks in the Albertine Graben indicating a young compressional episode.

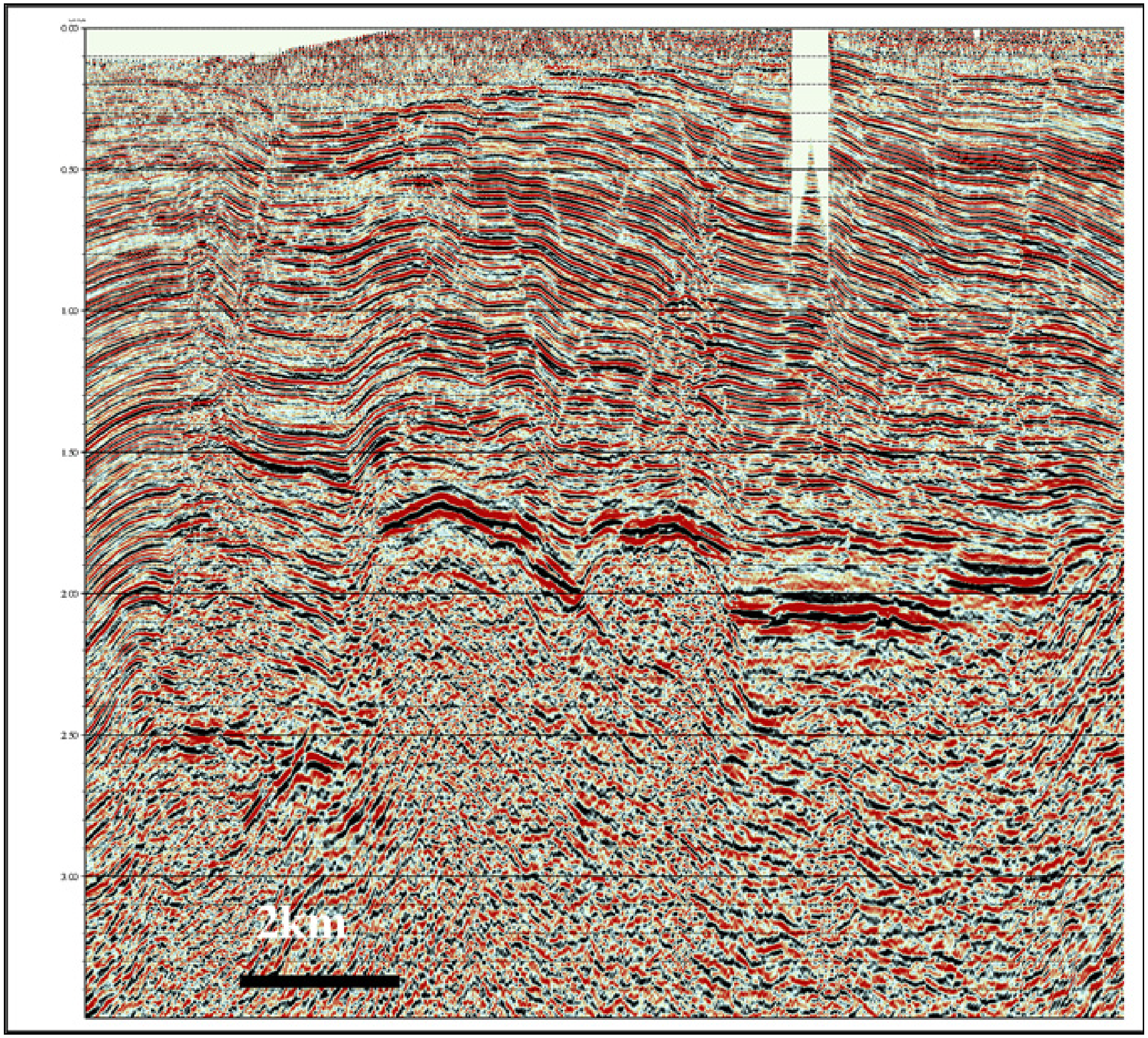

Figure 4. Seismic section showing positive flower structures persisting up to the top of the section, indicating a recent compressional episode.

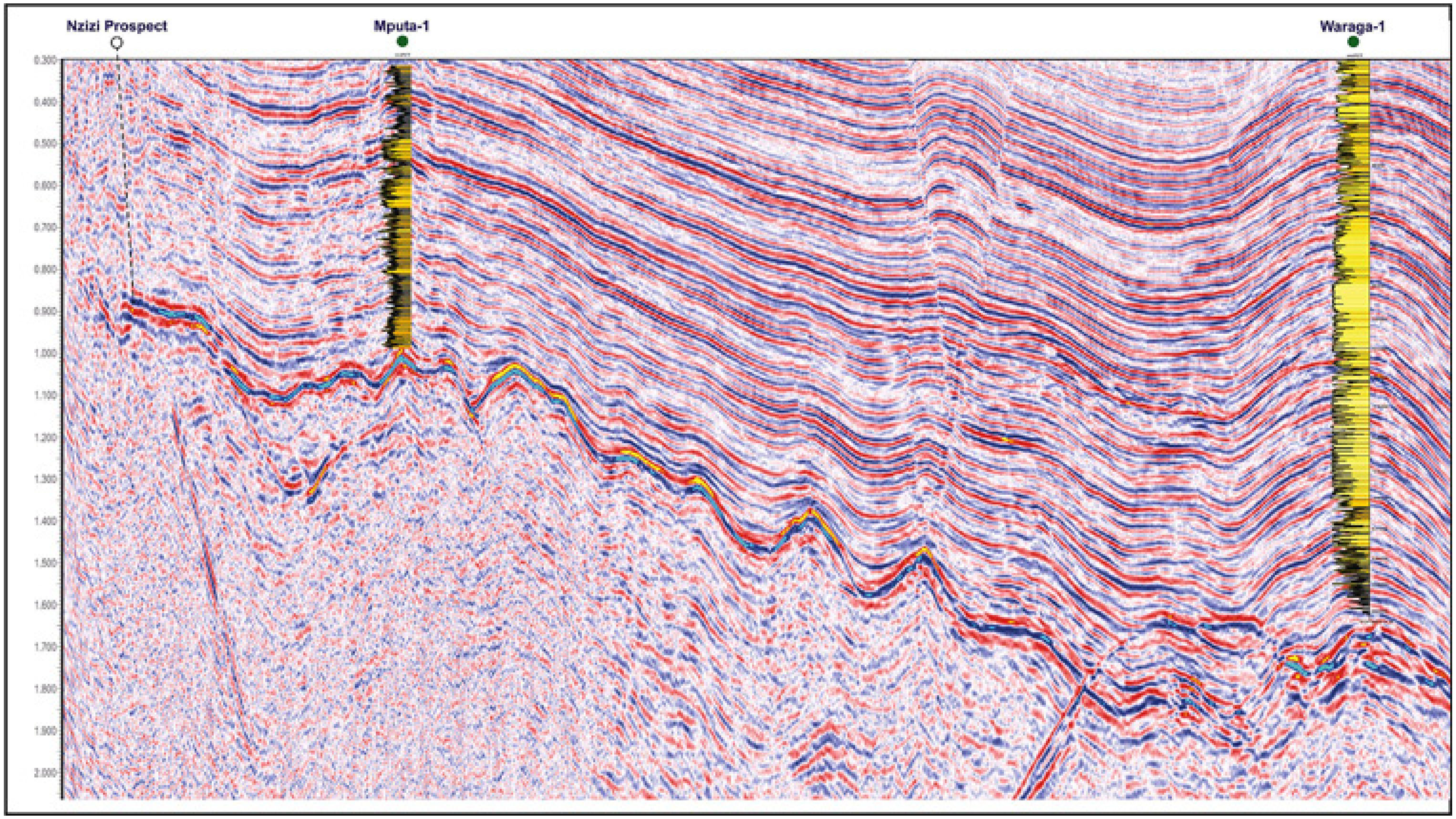

Figure 5. Seismic section showing anticline-syncline pairs in the Kaiso-Tonya area. The anticlines have been drilled and found to contain hydrocarbons.

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