

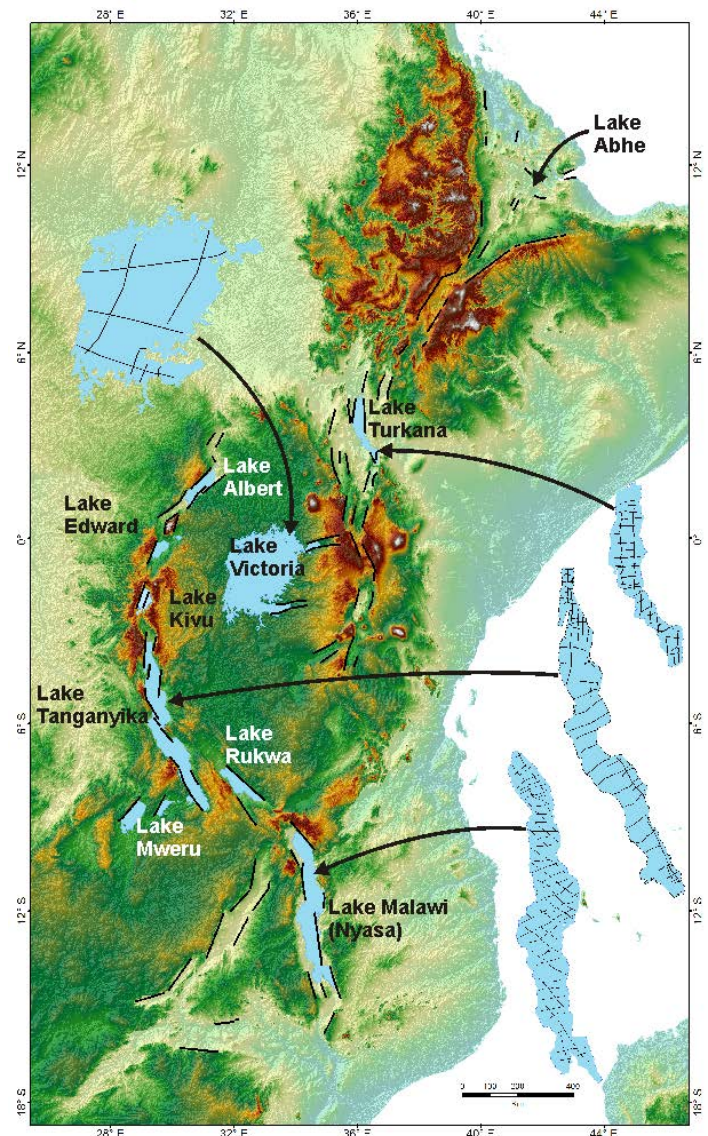
## PROJECT PROSPECTUS

### Stratigraphic Evolution of the East African Rift

**SYNOPSIS** This new research project is evaluating the stratigraphic and structural evolution of the East African Rift System, in light of *newly acquired, and newly reprocessed legacy multichannel seismic reflection data* from lakes in the rift. Data sets under evaluation include new academic and commercial seismic data sets, recent exploration wells, scientific drill cores, and high-resolution seismic and sediment core data recovered from the full length of EAR. Project deliverables are designed to 1) help exploration teams understand processes and stratigraphic architecture of rift systems globally, and 2) provide a unified geologic framework for groups directly exploring the East African Rift. Project duration is 3 years, cost = \$50,000 per company, and start date is July 1, 2015.

#### Introduction

The East African Rift is the largest and best-expressed modern example of a continent in the early stages of break-up (e.g. Rosendahl, 1987; Ebinger 1987). This continental system is directly linked to juvenile ocean basins (e.g. Gulf of Aqaba and the Red Sea) and there exists a continuum of rifting processes from the northern rift terminus in the Afar, to zones of incipient rifting in south-central Africa. New oil and gas discoveries in the Albertine and Turkana rifts demonstrate the potential for substantial commercial quantities of hydrocarbons in the Cenozoic parts of the rift section (Smith and Rose, 2002a, 2002b; Cassie et al., 2006), and within the tectonic lakes that occupy large parts of the system. Moreover, it is clear from the Uganda discoveries that working hydrocarbon systems are



**Figure 1. Digital Elevation Model of the East African Rift System with main lakes identified. Trackline maps show MCS data acquired by Project PROBE, now undergoing reprocessing by ION's GX Technology group.**

viable within very young rift-lake basins - just a few million years in age. These breakthrough finds are stimulating extensive exploration interest along the full ~4000 km length of the Great Rift Valley. The aim of this project is to evaluate the stratigraphic and structural evolution of the East African Rift System, in light of recently acquired and newly reprocessed legacy multichannel seismic reflection data from extant lakes in the rift, from new scientific drill cores recovered from parts of the system, and from new commercial data sets as available. The project objectives in the forthcoming three-year program are to:



**Figure 2. Nyaragongo stratovolcano above Lake Kivu.**

- Identify and characterize the main structural and tectonic elements of the rift
- Evaluate the importance of structural inheritance and regional basement architecture
- Establish the spatial-temporal basin histories in key basins
- Determine the climate history of the system on various time scales, and assess the impacts on drainage development and lake fills
- Conduct a source-to-sink evaluation of catchments and depocenters along the rift axis
- Evaluate the source rock kitchens within respective basins
- Calibrate new stratigraphic interpretations through basin modelling of individual rift zones using modern numerical toolkits (e.g. subsidence/geohistory analysis; structural reconstruction; stratigraphic prediction)
- Integrate basin models with landscape evolution and regional climate models, and generate a paleogeographic atlas of sediment delivery systems through time
- Catalogue play types in the context of the basin histories
- Summarize the integrated history of lakes and lake types, for predicting intervals of source rock generation
- Compare and contrast the magmatic and amagmatic parts of the system, and evaluate relative influences on carbonate and siliciclastic reservoir properties

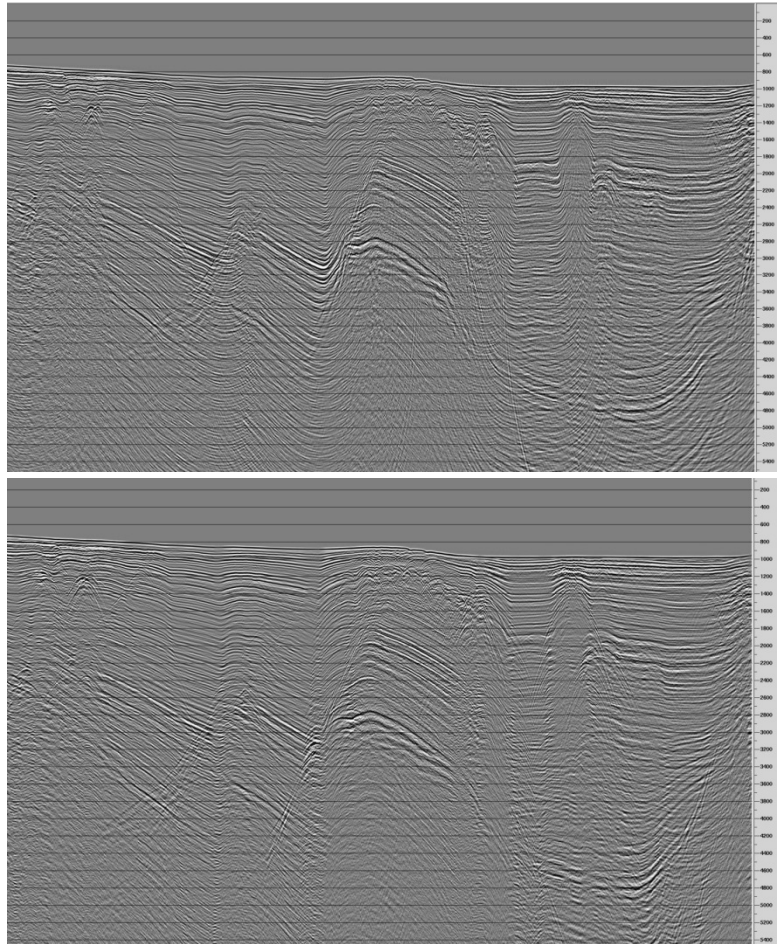
## New Data Acquisition

New academic and commercial seismic data sets have been acquired in the rift valley in recent years and these will be utilized during the course of this project. For example, new commercial multifold data have been acquired on Lake Tanganyika over the past two years, and in March and April 2015, our group collected an academic research data set on Lake Malawi, using a large (2500 cubic inch) seismic source. These data were acquired with funds from the National Science Foundation, and will soon migrate to the public domain. This new data set, totaling more than 2500 line-km, is revealing conclusive new results regarding the thickness of the sedimentary section in the Malawi (Nyasa) Rift, and clearly demonstrates the prospectivity of that rift zone. Other new data sets acquired by our research team in recent years include data acquired on Lakes Kivu, Turkana, and Albert.

## Legacy Data and the Reprocessing Effort

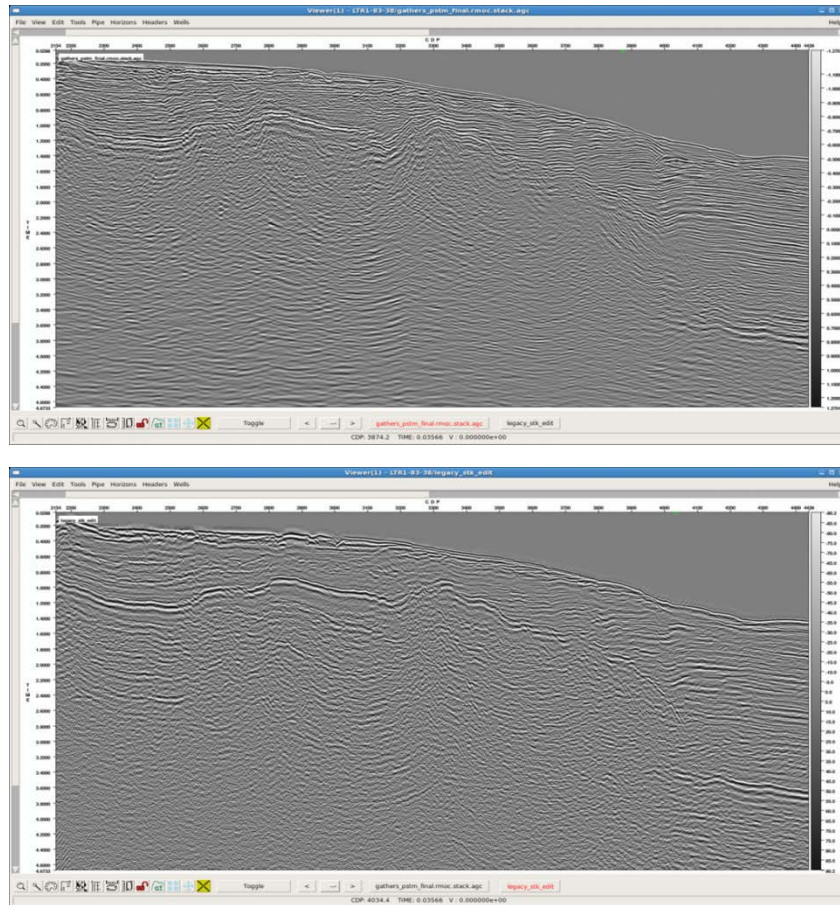
A pioneering investigation of the East African Rift System was carried out between 1983 and 1987 by Duke University under the direction of B.R. Rosendahl. The study involved the acquisition of “marine” multichannel seismic data sets on four of the Great Lakes of Africa (Tanganyika, Turkana, Malawi and Victoria) using a small, purpose-built vessel constructed in the USA and flown by cargo aircraft to Lake Tanganyika, and subsequently transported to other lakes in the rift. In total ~6000 km of 24-fold 6-second data was acquired by a dedicated team of technical specialists and graduate students in the 1980’s. These studies led to new models of rift evolution and propagation, and to several early exploration efforts around the rift valley.

The full data volume of marine MCS is now undergoing reprocessing by specialists from ION Geophysical, is providing spectacular new imaging in many areas, and is available through



**Figure 3. Example of new data acquired on Lake Malawi in March and April 2015. Example is a 30-fold record, acquired with a 1020 cubic inch G-gun array, and a new HTI digital seismic streamer. Top profile, processed immediately following data acquisition, is first-pass FK-time migrated section of brute stack. Bottom profile = raw brute stack. Record length of illustrated sections is 6 seconds TWTT.**

ION's GXT division. Trackline maps of the four lake systems studied in the 1980's are shown as insets in Figure 1.



**Figure 4. Examples of seismic lines before (above) and after (below) ION reprocessing (examples from Lake Tanganyika).**

## Products and Deliverables

The principal products of the project will be a series of digital atlases of four main lakes studied by Project PROBE: Lakes Tanganyika, Malawi, Turkana, Victoria. Each atlas will contain a regional analysis of key sites based upon reprocessed MCS data, and augmented by regional potential field data, high-resolution seismic data, scientific drill cores (Fig. 5, in the case of Lake Malawi) and surface sediment cores. Interpretations from the various observational data sets will be integrated and then calibrated using the modeling efforts described above. Metadata will be provided in ARCGIS framework. These data will be integrated with regional geological and geophysical data in a commonly used ARC format.

The consortium will also generate ancillary reports of other lake data sets available to our program, including Lakes Albert, Edward, Kivu, Rukwa, and Abhe. These ancillary data sets include >10,000 km of high-resolution single-channel digital data, acquired using airgun and

transducer source systems; several hundred shallow sediment cores and surface sediment samples; and scientific drill cores.

Other prospective areas and forthcoming data sets will be considered on a case-by-case basis, in concert with regional governments, commercial entities with new data volumes, and public domain data, as available.

Linking the main study areas will be a series of chronostratigraphic charts relating key basins. A comprehensive annotated bibliography of the East African Rift is included as a key deliverable.

### **Budget and Operational Plan**

The cost of the project per company is \$50,000 per year for three years. Our nominal budget for the program is based upon five companies supporting the project and we target a start date of July 1, 2015. The sequence of studies is as follows:

Year 1 Lake Tanganyika and Lake Turkana

Year 2 Lake Malawi and Lake Victoria

Year 3 Ancillary data sets and other study areas; Program synthesis.

Sponsorship meetings will be held in London and Houston in alternate years.

**Figure 5. Scientific drilling barge on Lake Malawi (Nyasa). This one-of-a-kind set of drill samples is being used to calibrate seismic data sets from that lake, including the new 2500 km large-source array data set acquired in 2015.**



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