Location Map of Uganda

TURACO - Rig in the Semliki Basin, Uganda
A product pipeline which runs from the Mombasa refinery to Eldoret and Kisumu in Western Kenya exists in the region. A study for the extension of this pipeline from Eldoret to Kampala has been completed. Feasibility studies for the extension of this pipeline from Kampala to Kigali, Rwanda and on to Bujumbura in Burundi are also planned. Uganda pipeline if this is considered economic.

The existing railway and road network (Figure 22) provides alternative means for the transportation of any refined petroleum products, although some of the existing railway lines require significant improvement.

**Figure 22: Road and Rail Network in East and Central Africa**

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**KEY FACTS ABOUT THE REPUBLIC OF UGANDA**

**Location:** Uganda is a land locked country in East Africa with Kenya to the East, Sudan to the North, Democratic Republic of Congo (former Zaire) to the west, Tanzania and Rwanda to the South.

**Geographical Indicators:** The country experiences a typically tropical climate, which is warm and humid. In most parts of the country, there are two dry seasons (June to August and December to February) and two wet seasons (March to May and September to November). The average rainfall and temperature is in the range of 700-2000 mm/year and 12-30°C respectively.

- **Latitude:** 04°12' N & 1°29' S
- **Longitude:** 29°34' E & 35°0' E
- **Altitude:** (Min ASL): 620 m
- (Max ASL): 5,109m
- **Total surface area:** 241,038 km²
- **Area under land:** 197,097 km²
- **Under water & swamps:** 43,941 km²

**Accessibility:** Uganda’s air gateway is the Entebbe International Airport, which handles local and international passengers together with cargo services. Several airstrips exist within and near the Albertine Graben, the principal area with the potential for petroleum production in the country.

**Accommodation:** High quality hotels are available in the Kampala/Entebbe area, while other suitable hotels are located near the Graben in the towns of Arua, Masindi, Homa, Fort-Portal and Kasese. First class lodges in the Murchison Falls and Queen Elizabeth National Parks also provide good accommodation within the Albertine Graben.

**Language and Religion:** English is the official language. Other languages include Swahili, Bantu as well as Hamitic and Nilotic dialects. The major religions are Christianity and Islam.

**Demographic & Socio-Economic indicators**

- **Total population (2007):** ≈31.3 million
- **Population density (2007):** ≈130 persons/km²
- **Per capita GDP:** 221 US$
- **Per capita GDP rate:** 1.8%
- **GDP at factor cost:** 5,424 US$
- **GDP growth rate:** 6.5%

**Type of Government:** Republic and Constitutional Democracy. Constitution provides for a house of parliament with 304 members.

**Currency Code =** Uganda Shilling (UGX)

**Exchange Rate:** 1US$ = 1680 Uganda Shillings (April 2008).

**Main Imports:** Petroleum related products, machinery and transportation equipment, manufactured goods, chemicals and cereals.

**Main Exports:** Coffee, tea, maize, cotton, flowers, fish, gold, tobacco and hides.

**Figure 1: A tea estate in Kabarole District, Western Uganda**
INTRODUCTION

It has now been established that Uganda’s rift basins contain commercially exploitable reserves of oil and gas and the country is planning to commence oil production in the short term.

The earliest reference to oil in Uganda was in reference to an oil seepage near Kibiro on the shores of Lake Albert which was known to the indigenous people who lived in the area. The first contribution to the evaluation of the country’s hydrocarbon potential was by E. J Wayland, a Government geologist, who documented numerous hydrocarbon occurrences in the Albertine Graben in the 1920’s. Oil exploration continued intermittently through the 1930’s but came to a halt during the second world war. Serious exploration work commenced again in early 1980’s with the acquisition of aeromagnetic data across the entire graben and the subsequent follow up ground geophysical and geological work in the late 1980’s and 1990’s. Seismic data was first acquired in the Graben during 1998 and several surveys have been undertaken to date. Fourteen exploration wells have been drilled from 2002 to date and more are planned. Development wells are also planned for the Mputa oil field in preparation for implementing the Early Production Scheme.

The principal prospective area for petroleum in Uganda is the Albertine Graben. It forms the northern most part of the western arm of the East African Rift System, stretching from the border with Sudan in the north to Lake Edward in the south, a distance of over 500km. Although of variable width, the Graben is commonly 45 km wide and extends into the Democratic Republic of Congo in some parts. An agreement of co-operation for exploration and exploitation of any common fields between the two countries was entered into in 1993 and updated at the beginning of 2008.

Geophysical work carried out in the Graben has confirmed sediment thicknesses in excess of 5 kilometres. Surface geological mapping shows that the Albertine Graben is an interior rift basin where both good source rocks and excellent reservoir quality sandstones are exposed. The wells drilled in the area have also confirmed the existence of rocks with similar qualities at depth.

Fifteen oil seepages around Lake Albert confirm generation, expulsion and migration of oil in the Graben. Seismic data shows the existence of rollover anticlines and flower structures of significant size in the subsurface of the Albertine graben. Exploration wells, drilled on the TURACO, MPUTA, WARAGA, KINGFISHER, NGASSA and NZIZI prospects during 2002 – 2007 respectively have not only confirmed the existence of a petroleum system in the area, they have also confirmed the presence of multiple exploitable accumulations of hydrocarbons in the Graben. Except for the TURACO and NGASSA prospects, the flow of hydrocarbons has been established in all the other prospects.

Flow testing of the Waraga, Mputa and Kingfisher prospects has yielded combined flow rates of 12,000, 1,100 and 4,200 BOPD respectively. These findings prove the substantial potential for the hydrocarbon plays in the Graben.

The Great Lakes Region with a population of over 150 million people consumes up to 150,000 bopd and this consumption has been increasing at a rate of 5% per annum. This provides the incentive to refine any discovered crude oil for local and regional consumption. The increasing demand for and the resultant acute shortage of TRANSPORT ROUTES

MARKETS AND POSSIBLE TRANSPORT ROUTES

The potential market for any petroleum produced in Uganda is mainly constituted by: Western Kenya, Southern Sudan, Uganda, Northern and Western Tanzania, Burundi, Rwanda and Eastern Democratic Republic of Congo. This region has an estimated population of 150 million people. The total oil products consumption for this region is estimated at over 5 million tonnes per annum (Figure 21). Considering that Uganda is a member of the Common Market for Eastern and Southern Africa (COMESA) and the Preferential Trade Area (PTA), most of whose members do not produce oil, the market for petroleum products could be even bigger.

Figure 21: Population and Energy consumption in East and Central Africa
EXPLORATION ACREAGE, LICENSING REGIME AND FISCAL TERMS

The Government of Uganda has defined nine Exploration Areas (EA’s) in the Albertine Graben as shown in Figure 20. These EA’s comprise of the following sizes:

- **Exploration Area 1**: 4,285 Sq. km.
- **Exploration Area 2**: 4,675 Sq. km.
- **Exploration Area 3A**: 1,991 Sq. km.
- **Exploration Area 3B**: 266.6 Sq. km.
- **Exploration Area 3C**: 395.5 Sq. km.
- **Exploration Area 3D**: 1,112 Sq. km.
- **Exploration Area 4A**: 3,812 Sq. km.
- **Exploration Area 4B**: 2,021 Sq. km.

Over Exploration Area 5. Exploration Areas 3B, 3C, 3D and 4A are available for licensing.

### Licensing Regime

Petroleum Exploration and Production activities in Uganda are carried out under the Laws of Uganda, 2000 Chap. 150, Petroleum (Exploration and Production) Act. Under this law, Government grants exclusive rights for exploring and producing petroleum in any licensed area. The size and location of the acreage to be included in a Petroleum Sharing Agreement (PSA) will be settled by negotiation. An exploration license is awarded for a period not exceeding 8 years, divided as follows: Initial exploration period not exceeding 4 years, a first extension period not exceeding 2 years and a second extension period not exceeding 2 years.

Mandatory relinquishments will be expected at the end of each exploration period. This should not exceed 50% after the first period and less or equal to 25% of the original area after the second period. At the end of exploration, a development plan is presented and a production license can be awarded for 25 years.

### Work Programme

Government recognises that an applicant may wish to apply for one or more EA’s. The acreage awarded will depend on the work program proposed. In granting licenses, Government will be seeking commitments for seismic data acquisition and an early well. The framework for the work programme is formulated in the model PSA. The actual work obligations are finalised by negotiation. Government attaches much importance to early drilling in the exploration phase and priority is accorded to work programmes which emphasise the early drilling of wells to a depth adequate to evaluate a significant portion of the prospective section, both syn-rift and pre-rift. Work commitments also have to be tied to a minimum expenditure commitment.

### Fiscal / Economic Terms

Government seeks a fiscal program, which will achieve the following two objectives:

1. Encourage investment from petroleum to upstream petroleum activities in the country.
2. With the latest developments in exploration, a National Oil and Gas Policy for the country has been approved. The Policy put in place a framework that will create a conducive environment for efficient management of, continuing promotion and exploration of the country’s oil and gas potential, evaluation of the discovered oil and gas reserves, exploitation and utilization of these reserves and; revenues accruing from oil and gas resources.

### HISTORY OF EXPLORATION

Although the Albertine Graben in Uganda covers an area in excess of 20,000 sq. km and sediment thicknesses are in excess of 5,000m, only a total of 1810 line kilometres of onshore 2D seismic data, 2105.5 line kilometres of 2D lake seismic data, 841.3 sq.km transition 3D, 404.14 line kilometres of transition 2D and 390 sq. km transition 2D, 404.14 line kilometres of transition 2D and 390 sq. km transition 2D and 390 sq. km transition 2D were acquired in an effort to establish the presence of sedimentary basins as an initial step towards a systematic evaluation of its petroleum potential. This effort was driven by the worldwide interest in exploration arising mainly from the very high oil prices of the late 1970’s. This survey was very successful because it identified three depocentres along the entire length of the Graben, as shown in Figure 3.

As a follow-up to this survey, the Petroleum Unit in the Department of Geological Survey and Mines carried out a significant amount of geological and geophysical work from the late 1980’s through the early 1990’s. This unit was transformed into Petroleum Exploration and Production Department (PEPD) in 1991.

#### Figure 2: Locations of Some of the shallow Stratigraphic wells drilled between 1936 and 1956

- Shallow stratigraphic wells (Figure 2), drilled by the African-European Investment Company between 1936 and 1956 (Harris 1956), revealed numerous shows and recovered free oil on test. Geological surveys carried out during the 1940’s and 50’s established the presence of sedimentary sequences of clays and silts in the Kaiso area on the eastern shores of Lake Albert and along the Kisegi river valley in the Semiliki Basin. These beds were subsequently called the Kaiso and Kisegi beds respectively, (Memoirs of the Geological Survey, 1959).

Oil exploration activity was spurred again at the beginning of the 1980’s when a 15,000 line kilometre aeromagnetic survey was carried out over the entire Albertine Graben in an effort to establish the presence of sedimentary basins as an initial step towards a systematic evaluation of its petroleum potential. This effort was driven by the worldwide interest in exploration arising mainly from the very high oil prices of the late 1970’s. This survey was very successful because it identified three depocentres along the entire length of the Graben, as shown in Figure 3.

#### Figure 3: Aeromagnetic data showing the Five depocenters (green contours) in the Albertine Graben.
Recent surveys have included ground gravity, magnetic and seismic surveys together with surface geological mapping in the areas south, east and north of Lake Albert and in the Lakes Edward and George Basin. In addition an 800 line kilometre gravity survey was carried out over Lake Albert in 1992 as a collaborative effort between Lamont-Doherty Geological Observatory of the University of Columbia, the Universities of Leeds, and Lubumbashi respectively, Fina Exploration (Uganda) bv and PEPD. Interpretation of the data acquired during gravity/magnetic surveys not only confirmed the broad basins identified on the aeromagnetic data, but it also led to better definition of these basins and the identification of some new ones (Figure 4). Basin depth estimates from the data acquired during these surveys pointed to over 5,000 metres of sediments in several parts of the Graben (Figure 5).

An aeromagnetic survey of North Eastern and Central Uganda was carried out in 1992 with a view of identifying additional areas with the potential for petroleum generation and accumulation in the country. The results of these surveys identified two relatively shallow sedimentary basins that await ground follow up. These are the Kyoga and Kadam—Moroto basins respectively.

Surface geological mapping led to the identification of organic rich source rocks exposed in the Kaiso-Tonya area on the shores of Lake Albert (Figure 6). Sedimentary sequences comprising of stacked channel sandstones of excellent reservoir quality, together with clays with a potential to act as seals were also mapped in the Semliki Basin, south of Lake Albert. Geochemical analyses carried out by different laboratories on the oil samples from four oil seeps in the Graben pointed to the occurrence of lacustrine sources of hydrocarbons. This has

**Figure 4: Aeromagnetic map of the Albertine Graben**

**Figure 5: Bouguer gravity anomaly map of EA3 and Model of the basin geometry along B-B’**

**Figure 6 - Shale exposed on the shores of Lake Albert in the Kaiso-Tonya area of Exploration Area 2**

**DATA AVAILABLE**

The data listed below is archived at the Petroleum Exploration and Production Department Headquarters in Entebbe-Uganda. Except for some of the Seismic and well data, which is not yet available for sale, the rest of the data can be purchased at the costs indicated. This data is neither for resale nor distribution.

**DATA TYPE** | **DATE ACQUIRED** | **CONTRACTOR** | **COST**
--- | --- | --- | ---
**GEOPHYSICAL** | | | |
Seismic data | On-shore 2-D Seismic data (170 Line Km) | July 1998 | IMC Geophysics on behalf of Heritage Oil & Gas Ltd | US$ 15,000.00
Seismic data | On-shore 2-D Seismic data (228 Line Km) | December 2001 | IMC Geophysics on behalf of Heritage Oil & Gas Ltd | US$ 15,000.00
Oil-Shore (L. Albert) 2D Seismic data (1569 Line Km) | October 2003 | Syracuse University on behalf of Hardman Resources Pty (Australia) and Heritage Oil & Gas Ltd | Not for Sale
On-shore Seismic data (1300 Sq. Km) | July - Dec. 2004 | IMC Geophysics on behalf of Heritage Oil & Gas Ltd | Not for Sale
Transition 2-D Seismic data (20.9 line Km) | Nov. – Dec. 2004 | IMC Geophysics on behalf of Heritage Oil & Gas Ltd | Not for sale
Onshore and Transition 2-D Seismic data (216.16 line km) | Jan. – Mar. 2005 | IMC Geophysics on behalf of Heritage Oil & Gas Ltd | Not for sale
Onshore and Transition 2-D Seismic data (97.84 line km) | June – Aug. 2005 | IMC Geophysics on behalf of Heritage Oil & Gas Ltd | Not for sale

**Magnetic Data**

(a) Aeromagnetic data Survey (134201Km) | 1983 | Kenting Earth Science, Ottawa, Canada | US$ 60.00
(b) Ground Magnetic data | 1991 – Present | PEPD | US$ 60.00

**Gravity Data**

(a) Land gravity data | 1934 – Present | Several including PEPD | US$ 45.00
(b) Lake Albert gravity data | 1992 | Regional Examination of the Gravity of Longonot and Edward Rifts (REGGAE) | US$ 40.00

**GEOLOGICAL**

Geological Maps and reports are available for review at P.E.P.D.

**GEOCHEMICAL**

Geochemical analysis of Kibiro Oil seep (report No. 6542/lc) | June 1989 | Robertson Group plc | US$ 50.00
Uganda Naphi oil study (Four seeps from Kibiro) | August 1992 | Fina Research | US$ 100.00
Geochemical analysis of shale samples from Kaiso on the shores of Lake Albert | April 1995 | National Oil Corporation of Kenya | US$ 50.00
Geochemical characterization of surface seeps and shale samples from Uganda | September 1995 | GeMark Research Inc. Houston, Texas USA | US$ 100.00
Organic Geochemical analysis of samples from Uganda | October 1996 | Research Institute of Petroleum Industry National Oil Corporation of Kenya (NOCIK) | US$ 50.00

**WELL DATA**

TURACO 1: Includes: Geology and operational reports, Mud and Wireline log data, Geochemistry, Drilling parameters, Gas readings and lithology (0—2467m) and VSP data. | September 2002—February 2003 | Heritage Oil and Gas (U) Ltd | US$ 20,000.00
TURACO 2: Includes: Drilling and geological reports, Deviation data, Elevation data, Final well report, Mudlog data, Petrophysical reports, Wireline log and Formation evaluation (Petrophysics and MFT) data. | October 2003—June 2004 | Heritage Oil and Gas (U) Ltd | US$ 20,000.00
TURACO 3: Includes: Drilling and Geology reports, Deviation data, Final well reports, Mudlog and Petrophysical data, Well test report, Wireline Log data, Petrophysical analysis plus addendum on implications of MFT pressure gradients for CO2 in zone 2 of the prospect. | September 2004—November 2004 | Heritage Oil and Gas (U) Ltd | US$ 20,000.00
now been confirmed by the analysis carried out on the oil recovered from the recently drilled wells.

The seismic data acquired in the graben to date confirms earlier modelled sediment thickness in the basin and also identified several drillable prospects, both onshore and offshore in the area. Details of the seismic data acquired in the Graben are shown in Table 1 below.

Table 1: Status of Seismic data acquisition in the Albertine Graben.

The Turaco-1 exploration well which was drilled on the TURACO prospect during 2002, reached a total depth of 2487m and encountered significant oil and gas shows along its depth. Turaco 2 and 3 were subsequently drilled during 2003 and 2004 respectively to access the deeper targets of the prospect. Turaco-3 was flow tested but flowed natural gas which was heavily contaminated with Carbon dioxide.

The Mputa 1 and Waraga 1 wells drilled in the Kaiso–Tonya area, Exploration Area 2 during 2005 and 2006 respectively encountered oil shows along their depths. Other prospects drilled include Nziizi which contains both oil and gas, Kingfisher which was an oil discovery and Ngassa on which the drilling did not reach the primary target due to technical reasons. A summary of the wells drilled so far in the Graben is shown in Table 2 below.

Mputa, Waraga and Kingfisher have now been declared discoveries after well testing. Currently the Kingfisher-2 well is being drilled to appraise the Kingfisher discovery. The Taitai-1 and Ngege-1 wells have been drilled to evaluate the petroleum system in the Northern part of Exploration Area 2. Oil was encountered at Taitai-1 whereas oil and gas were found at Ngege-1. Plans are underway to drill several other prospects in EA2, EA3A, and EA1. These prospects include; Karuka, Leopard, Kasamene, Pelican, and others. Planning for an Early Production Scheme to produce oil from the Mputa Field by Tullow Oil is underway, with the first production expected at the end of 2009.

**REGIONAL GEOLOGY**

**Geological History**

Uganda is underlain by some of the world’s oldest rocks, some of which were formed as long ago as 3 billion years (Figure 7). A large part of these rocks were modified by deep-seated mountain-building movements, which extended throughout the Precambrian to the beginning of Cambrian time approximately 500 million years ago. At this time, the mountain building movements apparently ceased and the
area became a continental environment escaping very largely the marine incursions, which led to the deposition of the fossiliferous series extending from the Cambrian to recent times, in other parts of the World. Tiny pockets of Karoo shale exist in south-eastern Uganda indicating that the Permo-Triassic Karoo deposition of southern Africa extended as far as Uganda.

Rifting started affecting the area during the Tertiary resulting in the commencement of active geological deposition. Since this time, rift movements became very important in the western rift valley as it formed and filled with sediments. The latest stages in the formation of the rift gave rise to renewed volcanic activity in the south-western parts of the country and a general sag in the centre of the country. The latter led to the formation of the Lakes Kyoga and Victoria drowned sag basins.

Tectonic Setting

The pattern of orogenic fold belts and shear zones in the Precambrian, the formation of the rift valley, the distribution of later volcanic centres and Pleistocene warping constitute the major tectonic elements of Uganda. Out of these, the rift valley is most pertinent to petroleum exploration. The rift valley, also known as the Albertine Graben (Figure 8), forms the northern most part of the western arm of the East African Rift System and runs along the entire length of Uganda’s western boundary. Compared to the eastern arm of the East African Rift System, the Albertine Graben contains much less extrusive rocks like volcanics and intrusive rocks. It comprises thick sequences of sandstones and shales derived from basement gneisses and schists. The Graben is highly asymmetrical in some places (Figure 9) but trends NE-SW through most of its length. It trends N-S in the Pakwach and Rhino Camp Basins, to the north of Lake Albert, probably following Pre-Cambrian lineaments. Although the major tectonic forces in the Graben are extensional, there is evidence of compression episodes occurring within the extension regime. Inversion structures and compression anticlines interpreted from seismic data confirm these episodes.

Stratigraphic Sequence

The Pre-rift section

The Proterozoic is well exposed on the rift flanks and shoulders of the Albertine Graben. Like the rest of the country, it is composed predominantly of high-grade metamorphosed and igneous rocks of Pre-Cambrian age. Seismic
This well penetrated both the Lower and Upper Tertiary syn-rift section and went through the Mesozoic pre-rift section before reaching basement. Though the Lower Tertiary may overlie the crystalline basement in many parts of the Graben, there is a strong possibility that it overlies a Mesozoic section (Karoo) in parts of the Graben.

**HYDROCARBON PLAYS**

Rift basins constitute only 5% of the world’s basins, but contain 12% of the world’s proven oil thus demonstrating their high hydrocarbon productivity. Marine regimes of source and reservoir rocks are common in rift basins and a combination of marine and continental or even entirely continental regimes have been documented as very prolific. Although it has been established that substantial portions of the sediments in the Albertine Graben are of continental origin, a greater portion of the rest have not been drilled and therefore remain unknown. Seismic data interpretation for EA3 and EA2 to date has identified several prospects in the graben (Figure 11) some of which have seen hydrocarbon accumulations such as the Stanleyville formation.

The *Syn*-rift section.
The *Syn*-rift section of the Albertine Graben was first recorded in the Waki-1B well, which was drilled in the 1938. A section of this well is shown in Figure 10. This well penetrated both the Lower and Upper Tertiary syn-rift section and went through the Mesozoic pre-rift section before reaching basement.

**Figure 9. Map showing the Structural Elements in the Albertine Graben**

**Figure 10: A section of Waki-1B well**

Data points to a Pre-tertiary rift sedimentary section in some parts of the Graben.

**Table 3: Geochemical parameters of four oil seeps in the Albertine Graben**

<table>
<thead>
<tr>
<th>Name of Seep</th>
<th>Pistons</th>
<th>Kibiro</th>
<th>Kibiko</th>
<th>Robins Oil Sands</th>
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<tr>
<td></td>
<td>Description</td>
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<td></td>
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<tr>
<td>Organic Matter Type</td>
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<td>Non-marine/Siliceous</td>
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<td>Fluvio-lacustrine</td>
<td>Lacustrine</td>
</tr>
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<td>Extensive</td>
<td>Moderate</td>
<td>Moderate to Strong</td>
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<tr>
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<td>Early - mid mature</td>
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</table>


**Table 3: Geochemical parameters of four oil seeps in the Albertine Graben**

As is typical of rift basins, the Albertine Graben has relatively rapid facies changes common in terrestrial alluvial fan, deltaic and lacustrine sediments which provide the potential for stratigraphic traps with or without structural components. Unconformities in the sedimentary section also provide for stratigraphic, or both stratigraphic and structural traps. Down-to-the-basement block faulting is dominant in the graben and this can play a major role in the formation of hydrocarbon traps (Figure 17). Dip reversals against faults and fault-on-fault traps are present. A large number of small tilted fault blocks, apparent rollovers as well as anticlinal features associated with listric fault propagation can be identified from the seismic data (Figure 18 and Figure 19).

**Seals**
The more than 30m thick clay bed mapped on top of the good reservoir quality sandstone in the Kisegi area of Semliki Basin is a potential regional seal. The wells drilled in the basin have also penetrated thick sequences of clays that have the potential of acting as sealing rocks to the underlying reservoirs. Correlation of wells in the Kiso-Tonya area points to a laterally extensive source/seal rock of lacustrine origin.
Uganda part of the Albertine Graben and these include: two live oil seeps on the Victoria Nile near Paraa, two seeps at Kibuku in the Semliki basin, three seeps at Kibiro, on the shores of Lake Albert, five oil and one gas seepages in the Kaiso-Tonya Area and three oil seeps in the Butiaba area. The presence of these oil seeps indicates that mature organic rich source rocks are present in the Graben and that some of them have generated and expelled oil.

Similar tertiary shales in the Muglad rift basin of Sudan, which is 200km from the extreme north of the Albertine Graben, have been established to be a major source of oil in the Unity and Heglig fields.

At Paraa, oil freely bubbles onto the surface of the Victoria Nile River at several different spots and spreads over an area approximately half the size of a football field.

At Kibuku, drops of live oil can be seen emanating from the cliff and saturation extends into the upper 30cm of the weathered base. A strong hydrocarbon odour is noted from the cliff and oil films are found in the small pools of water adjacent to the cliff.

At Kibiro, oil saturated sands are present at the shores of Lake Albert. Core samples reveal two meters of tar saturated sediments overlying nearly four meters of water wet sand through which viscous oil floated. About 85 meters from this exposure are two boreholes from which heavy asphalting oil flows freely.

Oil impregnated sandstones and fractured gneisses have been found along the Kabyosi, Warwire and Hohwa, river gorges respectively in the Kaiso – Tonya relay ramp, along the shores of Lake Albert. Gas and oil seepages have also been found at Runga and along the Sonso River in the Kibiro – Butiaba area (Figures 12 and 13).

Analysis of samples from these seeps indicates that two different types of depositional environments for source rocks exist in the basin. These are fresh water lacustrine and saline to hypersaline lacustrine.

The presence of Botryococcaceae which are synthesized by Botryococcus braunii, a fresh water green alga, indicates a lacustrine environment source rock with Type - 1 Algal dominated Kerogen for the Kibiro seep while the sterane ratios and the presence of Oleanane indicate contribution of higher land plants for the Kibuku seep. Table 3 shows the geochemical parameters for four of the oil seeps.

Subsurface (in wells)

Shows of heavy asphaltic oil were found in shallow test holes drilled near Kibiro on the lake Albert shoreline during the 1940's. These oil shows were spread out over 100m in each well, with irregular saturation of 15.9 API black oil. The richer sands in the wells were encountered at 27-30m, 113-130m and 133-138m. Gas was logged at 27m and 137m. The Wiki-1B well had a one meter zone of 31.4 API rich oil show at depths of 1169m (Haris et al 1956).

Three zones tested in the Waraga-1 well during 2006 gave flow rates ranging between 1,200-1,792 bopd with API values of 31° and 33.8° respectively. Two zones tested in the Mputa-1 well also in 2006, gave a combined flow rate of 1,100bopd and oil quality of 31.8° - 33.3° (Figure 14).

Basement rocks along the escarpment and rift flanks of the Graben comprise mostly gneisses, granitic gneisses and quartzites. Their breakdown, due to weathering, and subsequent transportation and deposition into the basin have yielded good reservoir quality rift sediments.

Coarse clastics constitute much of the Kisegi and Kaiso beds. They are interbedded with siltstones and shales that would provide seals. Porosities