East African Petroleum Conference

Department of
Industry and Resources

Petroleum Exploration and Production Department

Petroleum Geochemistry of the Albertine Graben, Uganda

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Presentation

- Introduction
- Location and Stratigraphy
- Oil and gas seepages
- Source Potential
- Maturation and Generation History
- Conclusions

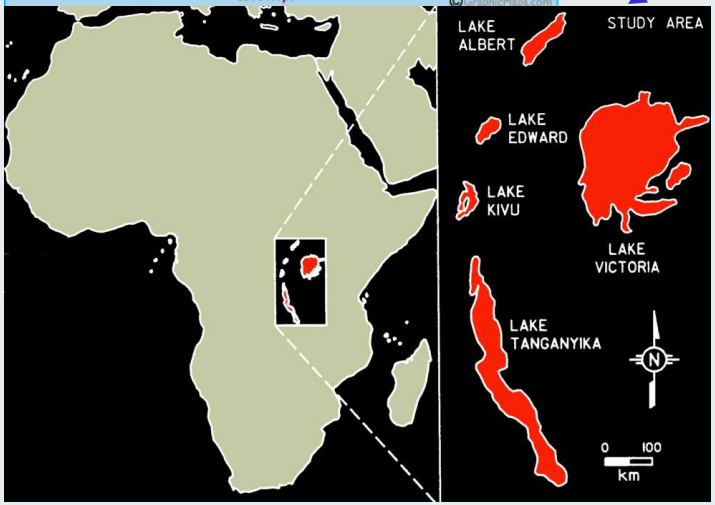
Introduction

- This study is based on:
  - Geochemical data available on oil seepages at Hohwa, Kibiro, Kibuku and Paraa,
    - Composition, Biomarkers, Carbon Isotopes,
  - First subsurface source rock data available from Heritage Turaco 1 cuttings samples.
    - TOC, Headspace Gases, Palynology.

Africa—Great Rift Valley

Gregory Rift

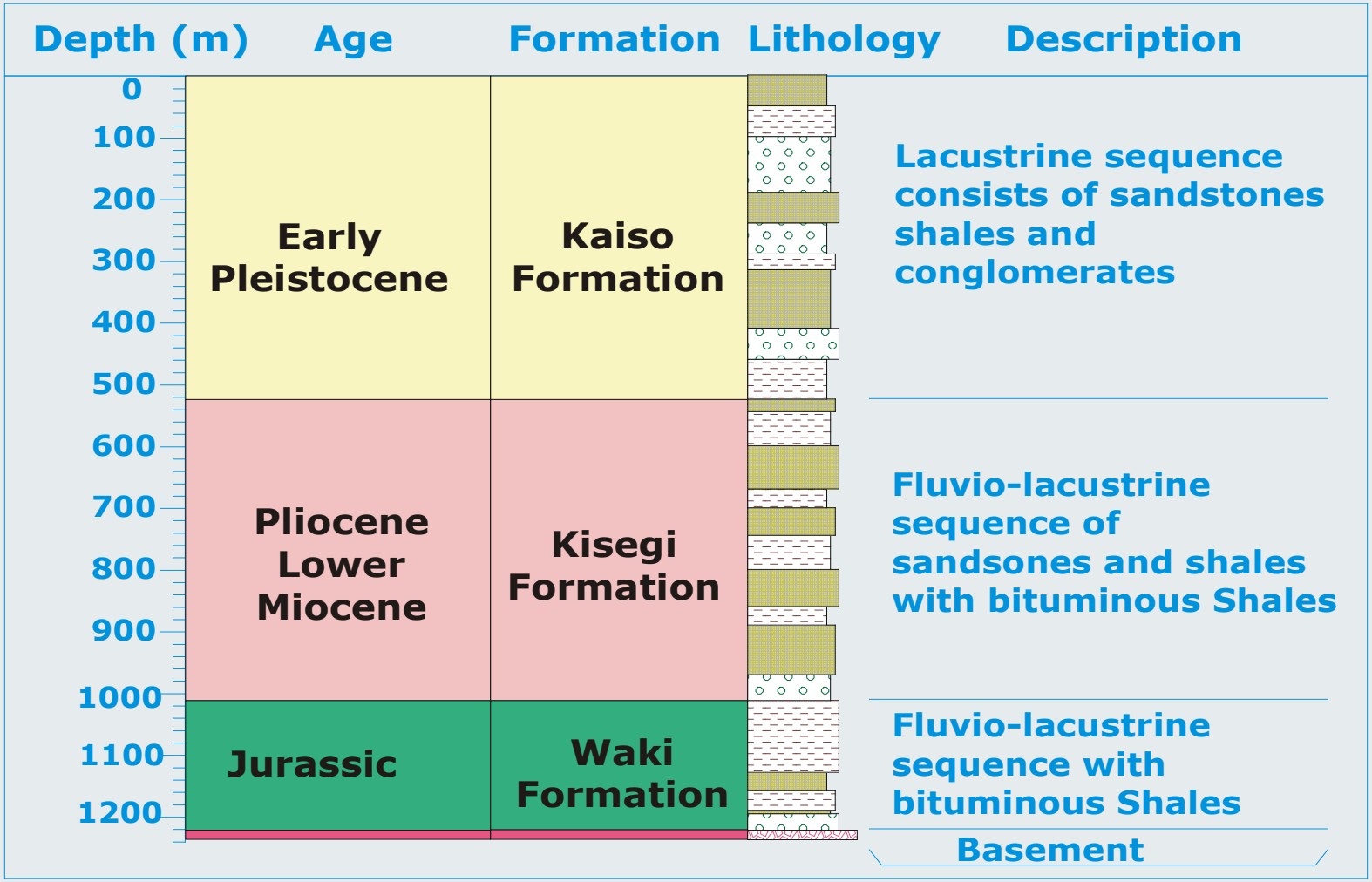
Western Rift



East African Rift System

- Tectonically Controlled Lakes
- Miocene Extension – Lacustrine deposit in many half-grabens:
  - Western Arm - larger and deeper lakes, high runoff, and cover most of the rift floor. Most are long lived and have surface outlets with stratified waters low in dissolved solids
  - Easter Arm (Gregory) - by comparison small, shallow, closed basins with saline, alkaline lakes, extensive volcanism

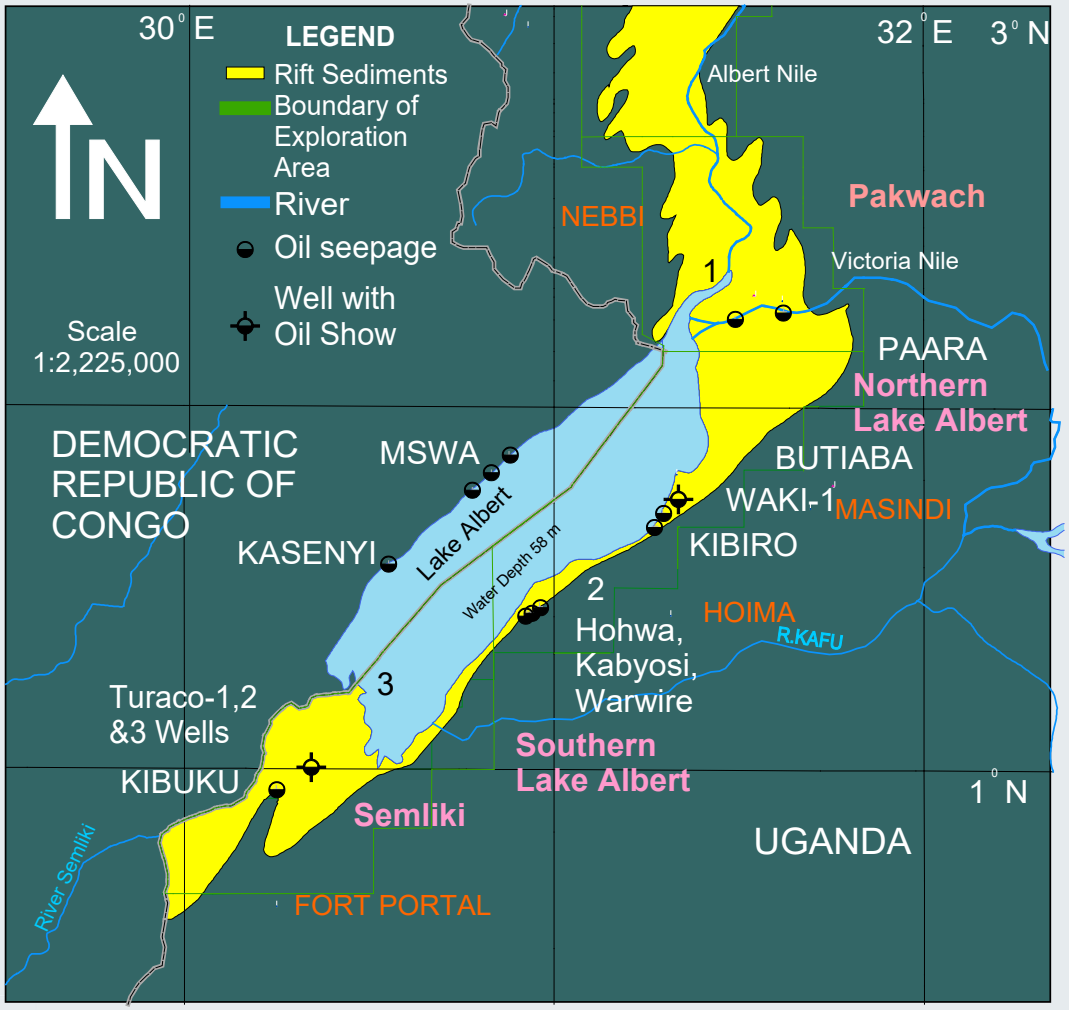
Butiaba Waki 1



Stratigraphy – Waki 1

- Kaiso Formation:
  - Quaternary - Early Pleistocene (1.8 – O.8 Ma). Lacustrine sands, shale, and conglomerates
- Kisegi Formation:
  - Tertiary – Lower Miocene to Pliocene (22 – 1.8 Ma). Fluvio-Lacustrine sands, shales, and bituminous shale
- Waki Formation:
  - Jurassic – Bituminous shales with fluvo-lacustrine clastics

Petroleum Seepages



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Petroleum System Indication

- Many oil seepages are present within the Albertine Graben indicating active petroleum systems. They are present on the western Congo side and eastern Ugandan side of the Lake Albert,
- Surface oil seepages and two wells with oil shows, Waki 1 drilled in 1938 and Turaco 1, 2 & 3 drilled in 2003-4 are shown on this map,
- I have visited Paraa, Kibiro, Hohwa, Kibuku and Sempaya hot springe seepages.

Seepage Analyses

1. Fina Research
2. National Iranian Oil Company
3. Geomark Research Incorporation
4. China National Petroleum Corporation
5. National Oil Corporation of Kenya
6. Robertson Research International
7. Gareth Harriman Geochemical Services
8. Geolab NOR
9. Ocean Grove

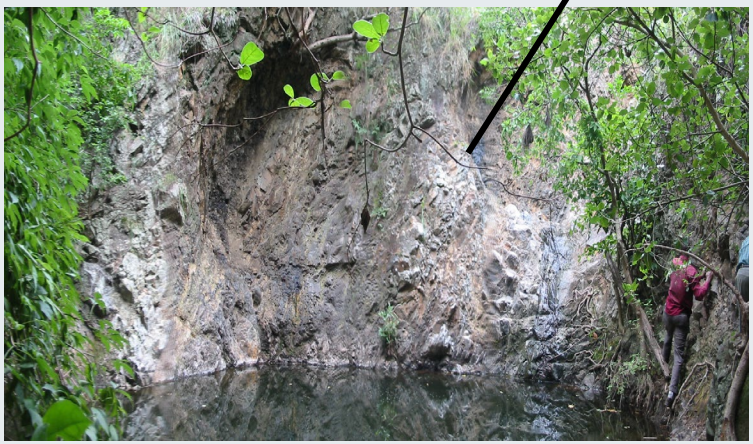
Murchison National Part

- Largest in Uganda 3840 sq. km
- View of Lake Albert from Rift Valley escarpment

- Nile River funnel through 7 m wide gap

Oil Seepages at Paraa, Victoria Nile

Lake Albert, Kabyosi Oil Seep



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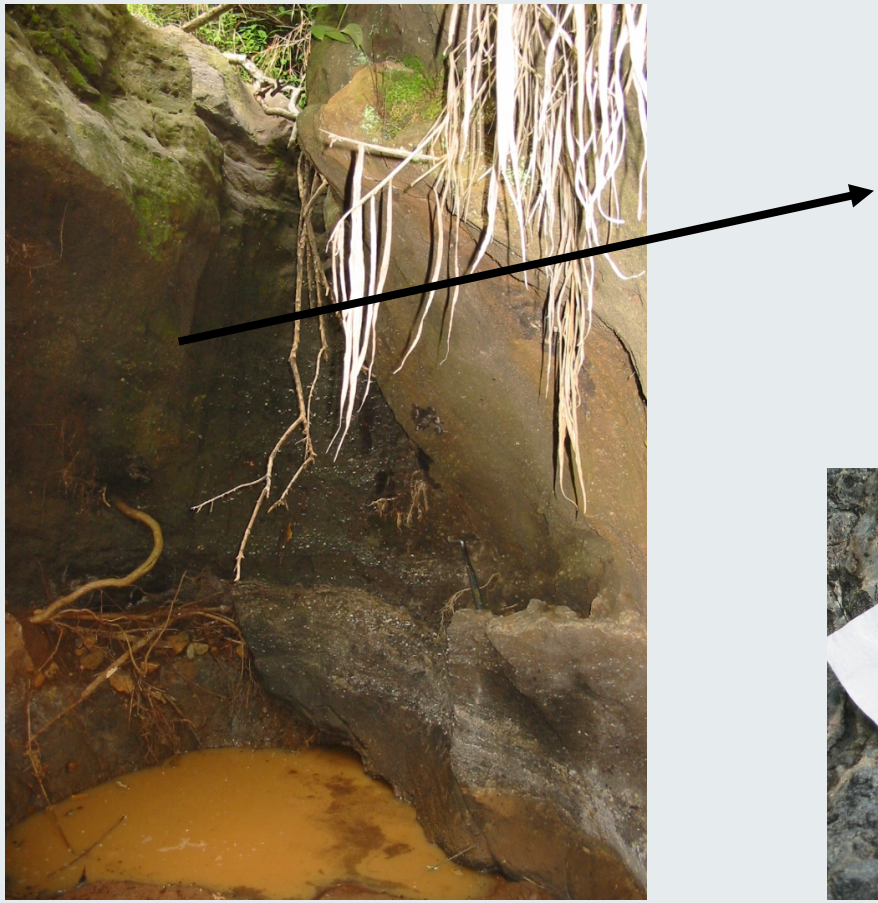
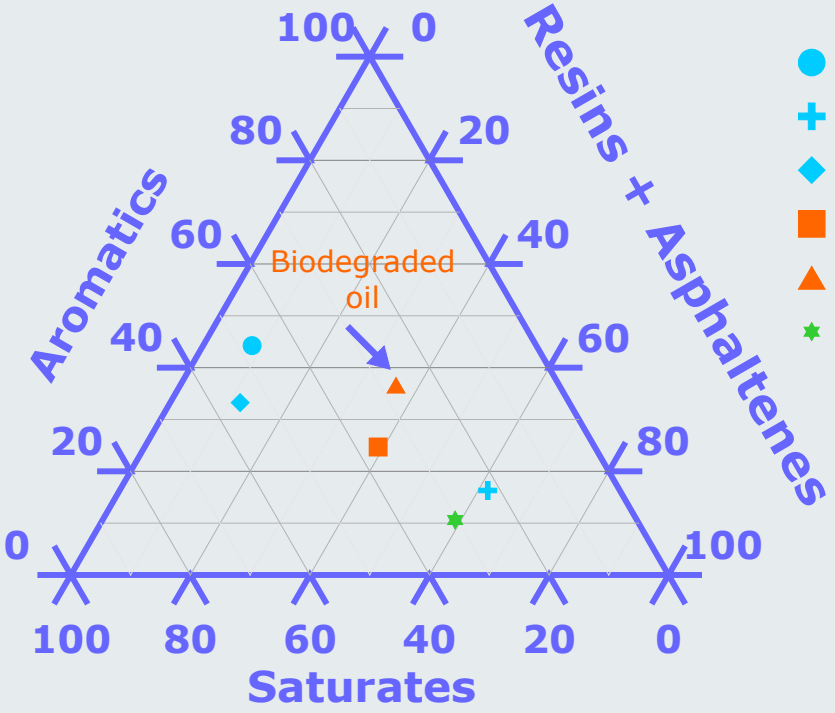
Lake Alert, Hohwa Seepage



Lake Albert, Kibiro Oil Seep

Semliki Basin Seepages & Shows

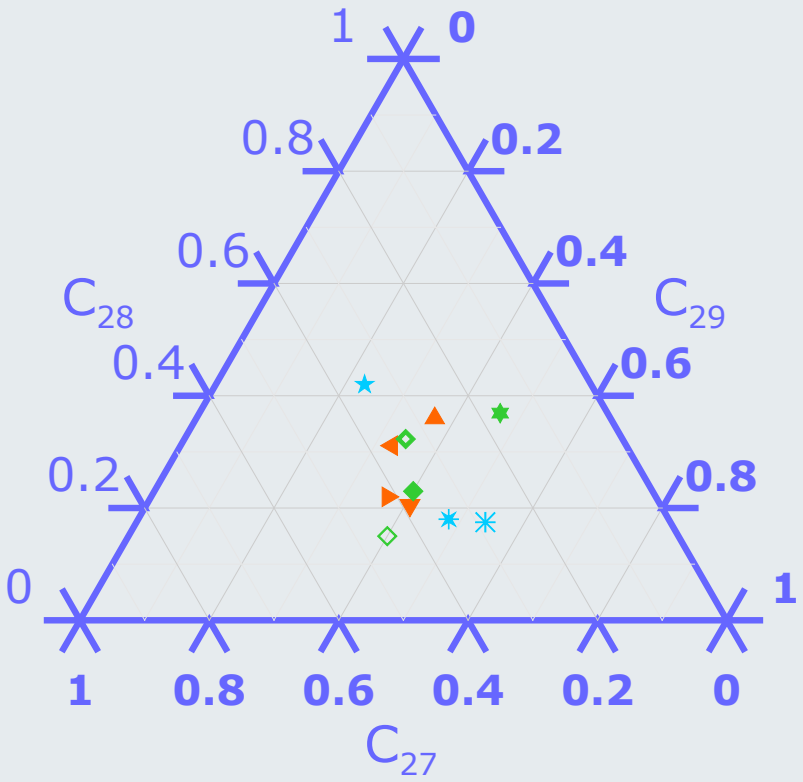
Hydrocarbon Distributions



Seepages

- Kibuku - Ocean Grove
- Kibuku - Robertson Resarch
- Kibuku - Geomark
- Kibiro - GHG
- Kibiro - Geomark
- Paara - Geomark

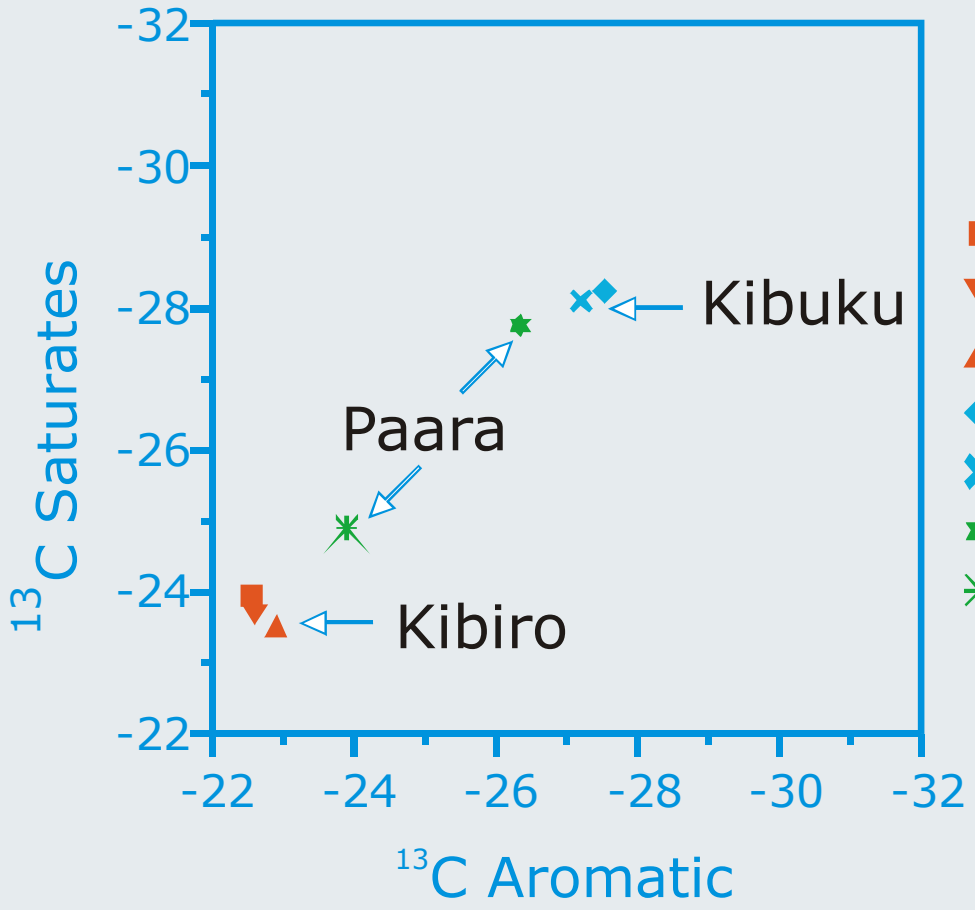
Sterane Biomarkers



Seepages

- Kibiro - GHC
- Kibiro - Geomark
- Kibiro - Seep - CNODC
- Kibiro - Asphalene - CNODC
- Paara - GHG
- Paara - Geomark
- Paara - Seep - CNODC
- Paara - Asphaltene - CNODC
- Kibuku - Geomark
- Kibuku - CNODC
- Kibuku - OceanGrove

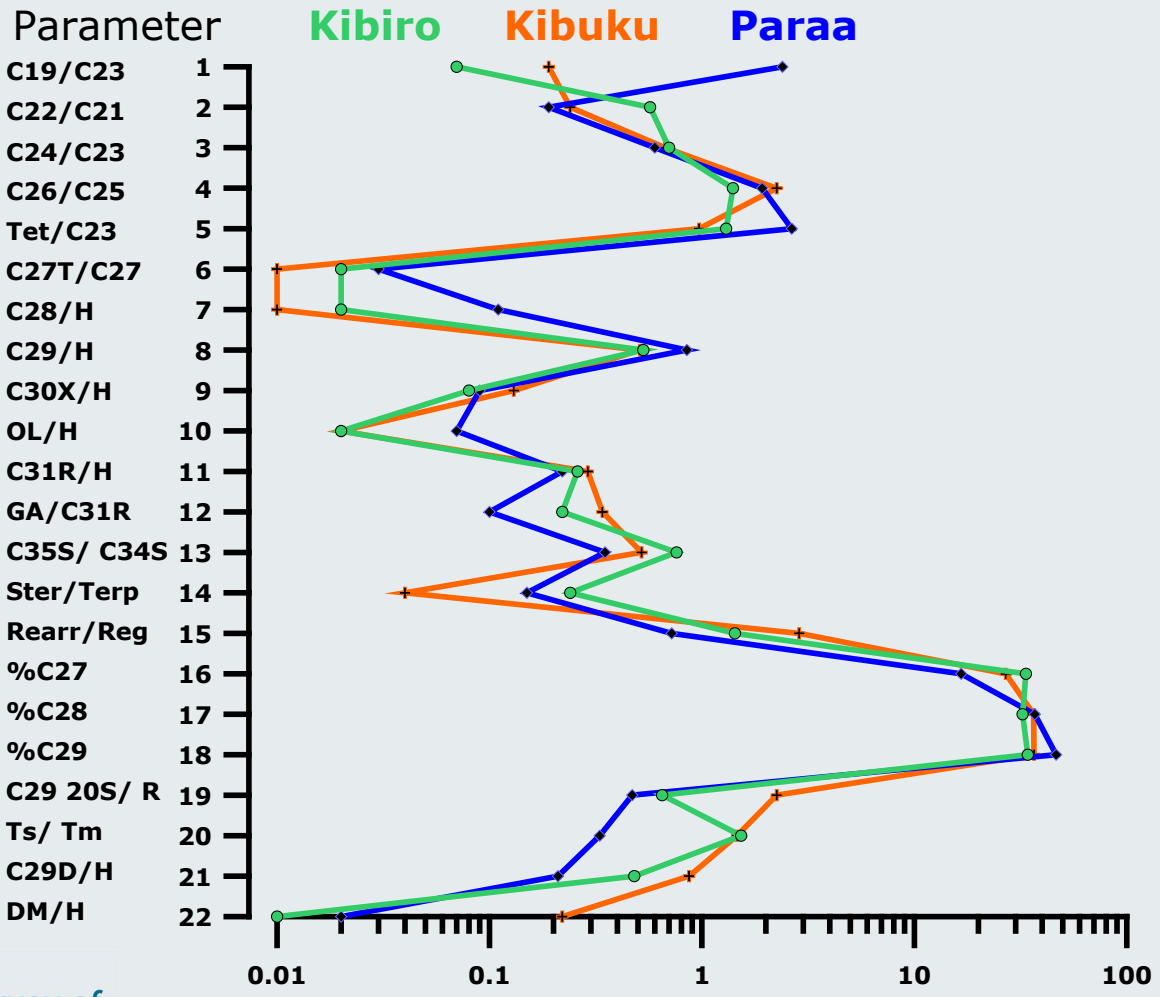
Carbon Isotopes



Seepages

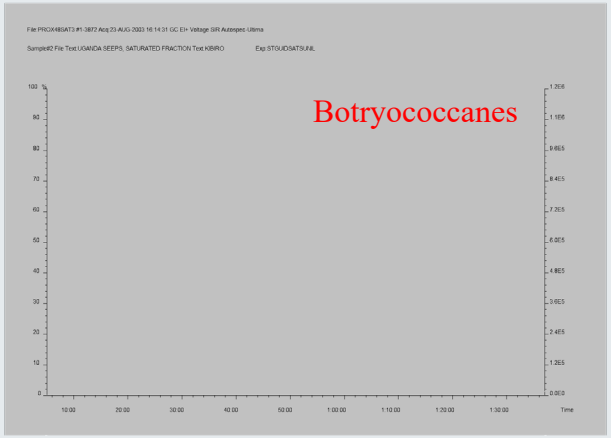
- Kibiro - GHG
- Kibiro - CNODC
- Kibiro - Geomark
- Kibuku - Geomark
- Kibuku - CNODC
- Paara - Geomark
- Paara - CNODC

Geomark Biomarkers

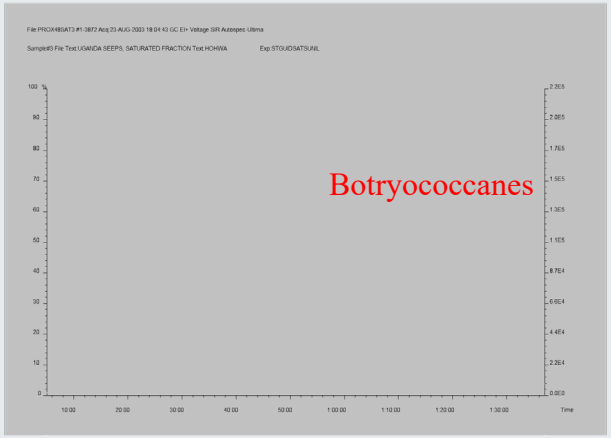


Botryococcanes–Geolab NOR

- Kibiro Oil Seep



- Hohwa Oil Seep



Seepages Geochemistry Data

Name of Seep Description	Paraa seep	Kibiro seep	Kibuku seep	Hohwa Oil Sands
Organic Matter Type	Non-Marine	Algal type 1	Marine/Terrestrial	Non-marine/Algae
Depositional Environment	Lacustrine	Lacustrine	Estuarine/Bay	Lacustrine
Degradation	Moderate	Extensive	Moderate	Moderate to Strong
Source Rock Maturity	Moderate to Mature	Early to Middle Mature	Early Mature	Early – mid mature
Source Rock Age	--	No older than Jurassic	Post Early Cretaceous	_
% Sat:Arom:Polars	--	22:17:60	50:25:20	18:20:28 (sat/aro ≈1)
Carbon Isotope (PPT-PDB)	--	-23.8	-27.9	_
Pr/Ph	--	--	6.2-6.7	_
Steranes %C27:C28:C29	37:23:40	35:42:23	28:24:48	_
Ts/Tm	1.63	1.46	0.3	_
Diasterane Index	1.47	1.43	--	_

Seepages — Conclusions

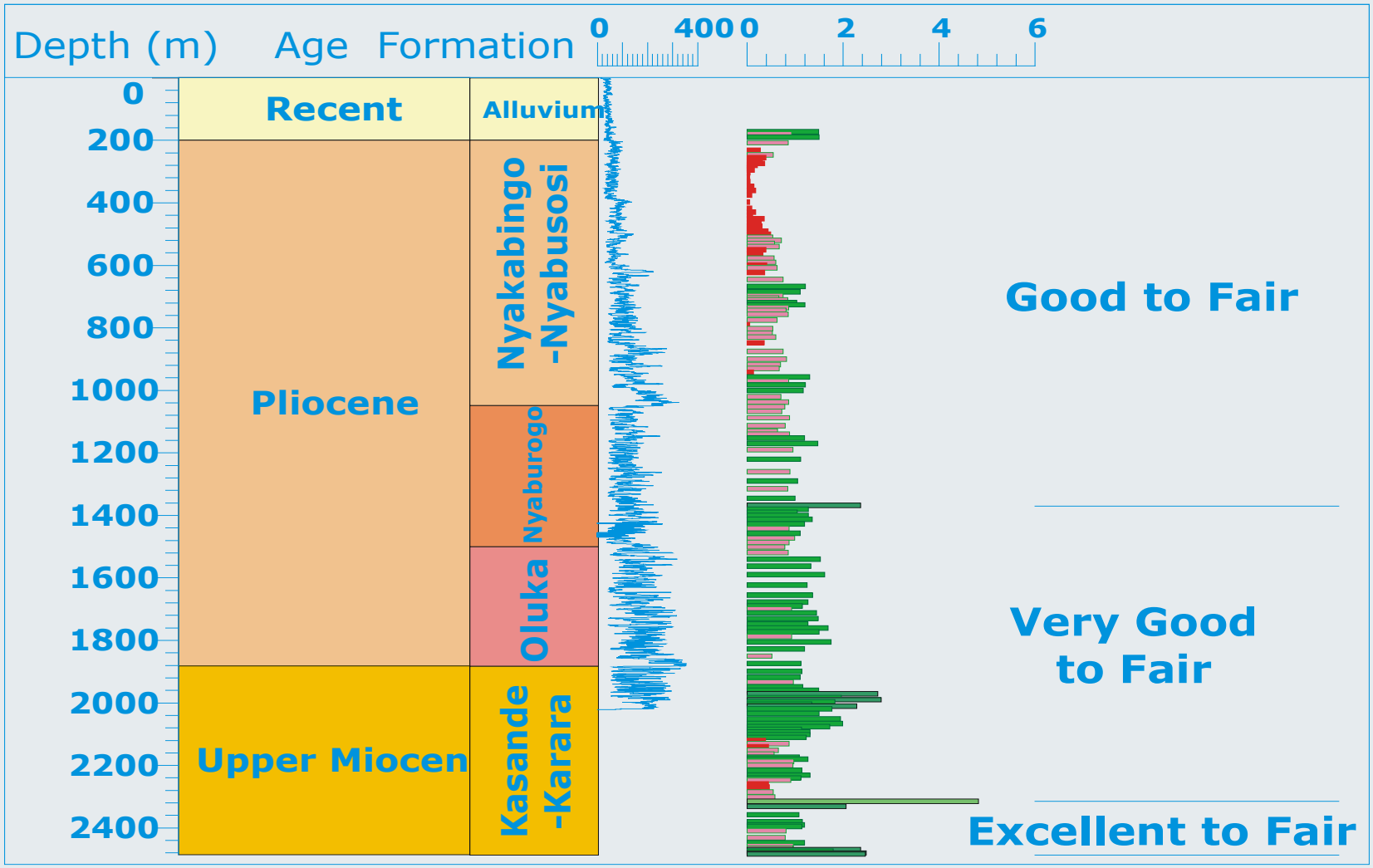
- The Hohwa, Kibiro, Kibuku and Paraa oil seepages indicate active petroleum systems within the Albertine Graben, yet their source and likely charge volume remain elusive.
- Biomarkers and carbon isotope data from these seepages indicate varying maturation, biodegradation, and source maturity, but all are sourced from lacustrine source pods possibly of Cretaceous–Tertiary age but older sources are possible.

Source Rock Evaluation

- The evaluation of petroleum source rock is based on geochemical analyses undertaken by Petroleum Exploration and Production Department (PEPD),
- On cuttings samples from Turaco 1,
- Total organic carbon (TOC),
- Headspace-gas, and
- Palynofacies analyses.

TOC Analysis at PEPD

Turaco 1—Organic Richness



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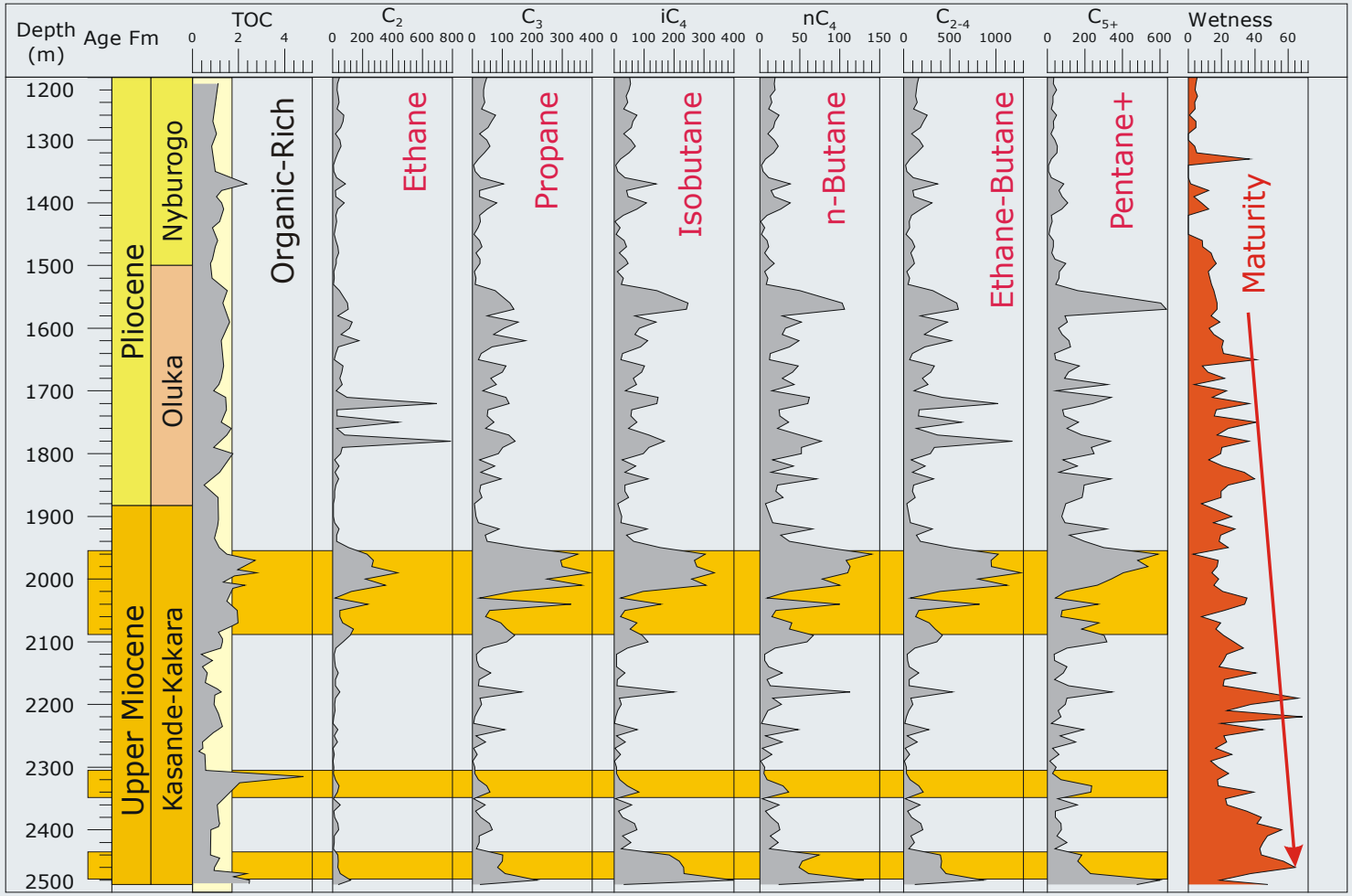
Turaco 1
Organic Richness—Headspace Gases



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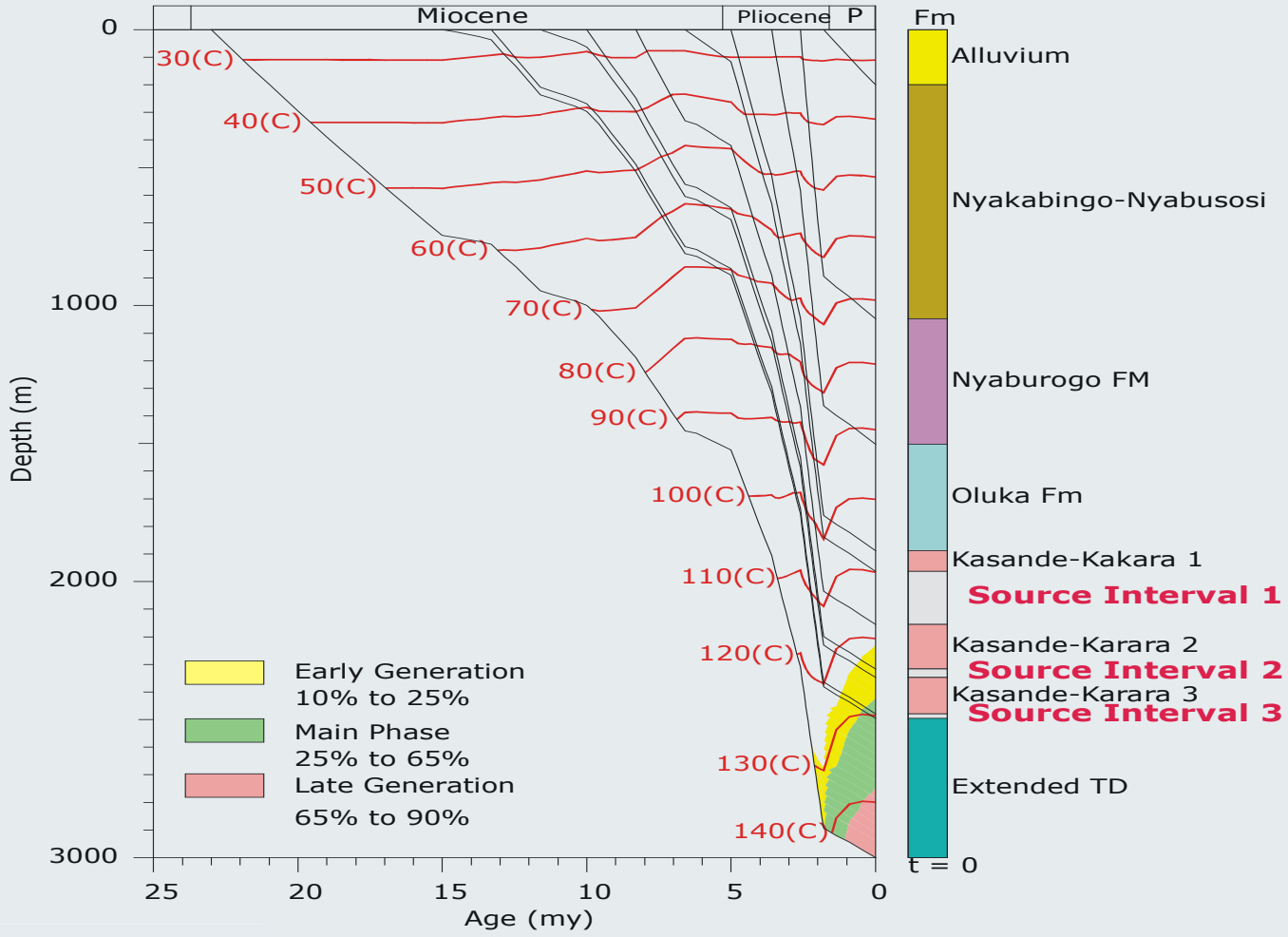
Turaco 1 – Burial History



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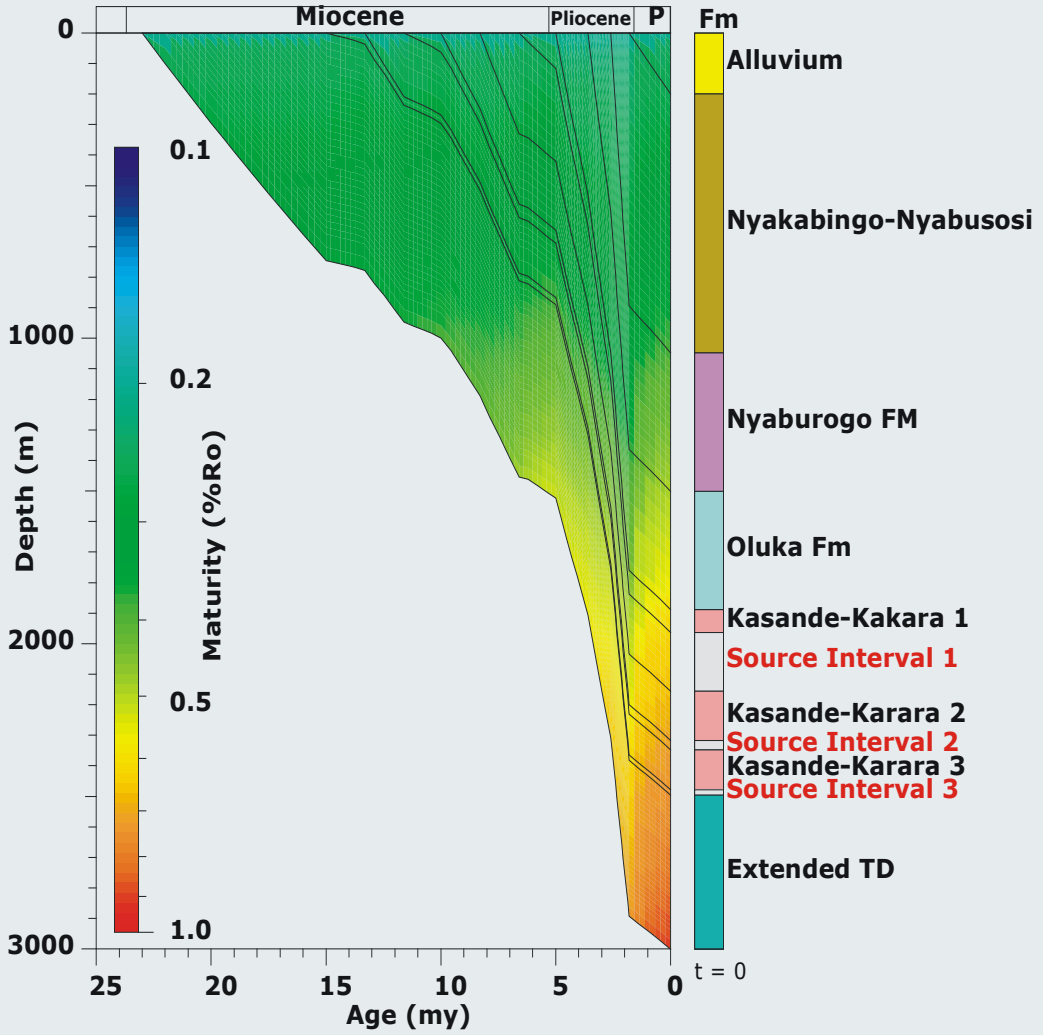
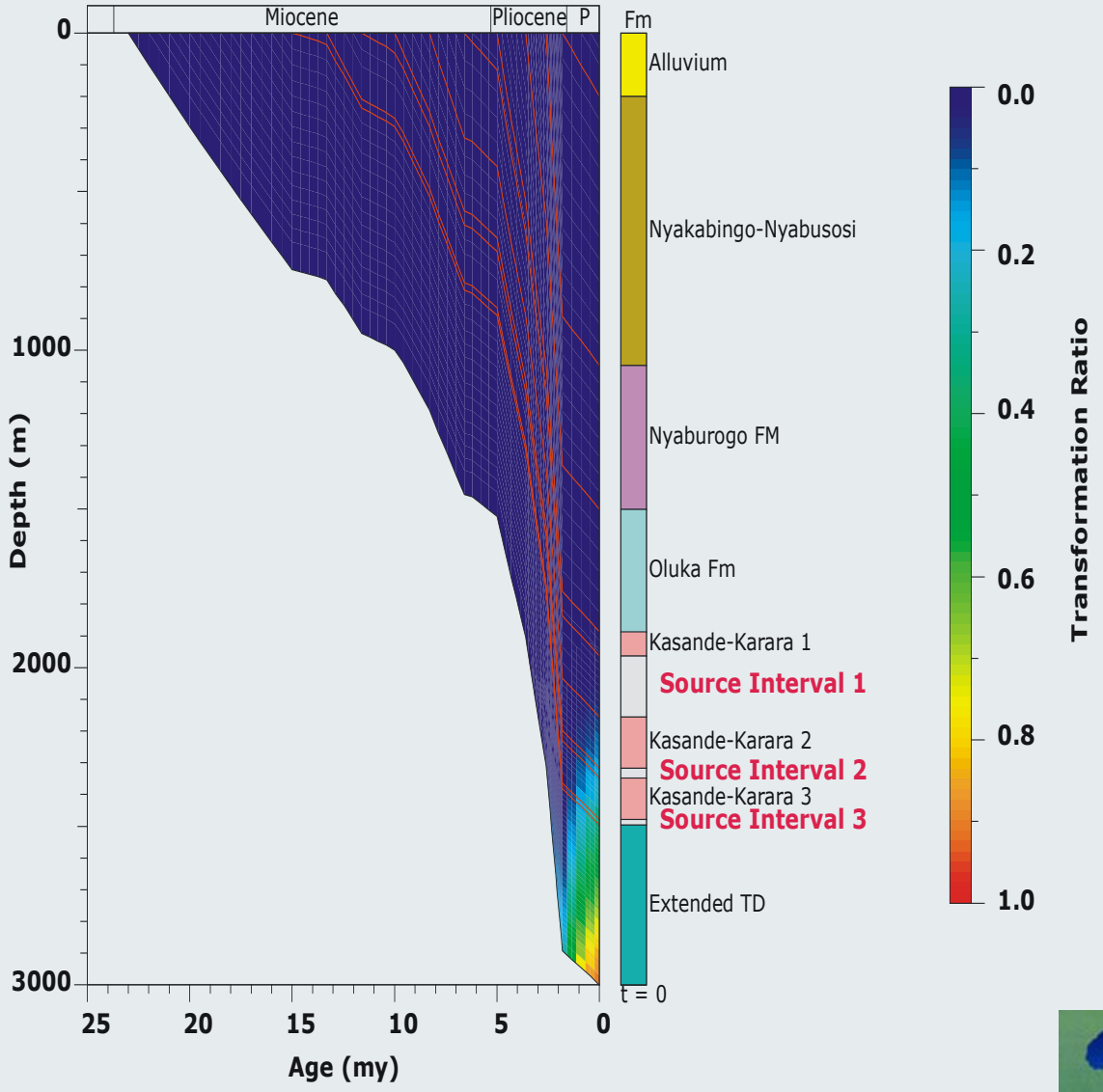
Turaco 1 – Maturity (VR)



Turaco 1 – Transformation Ratio



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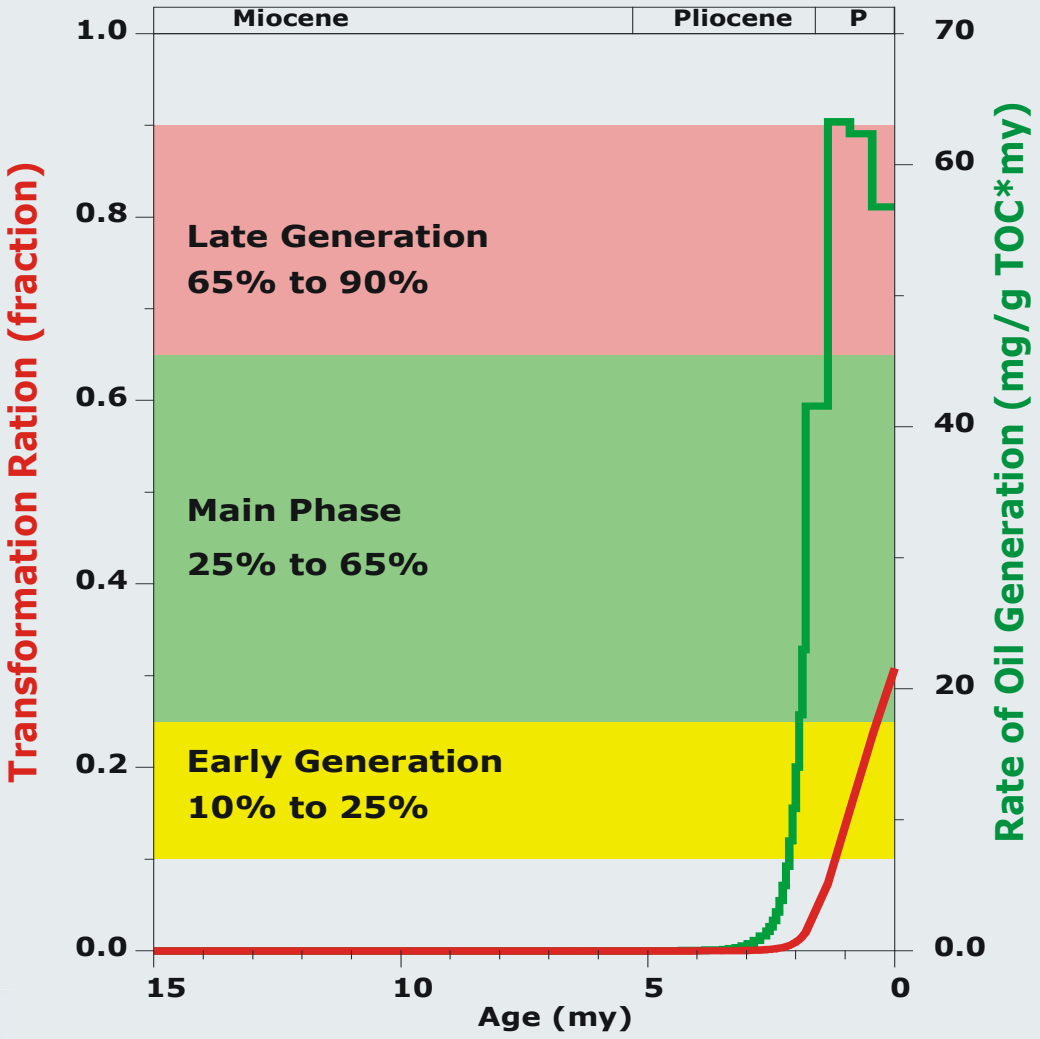
Turaco 1 – Generation Timing



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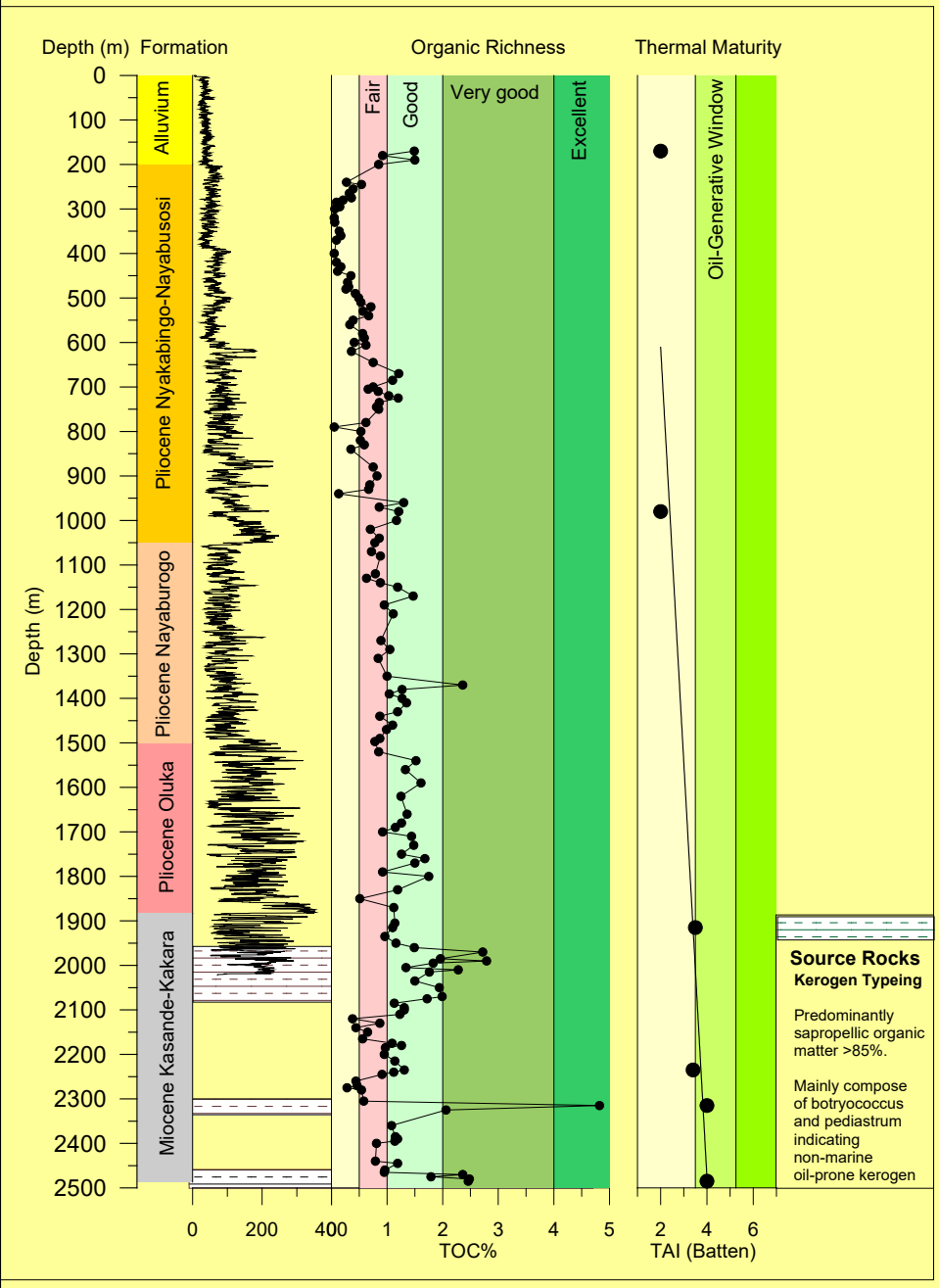
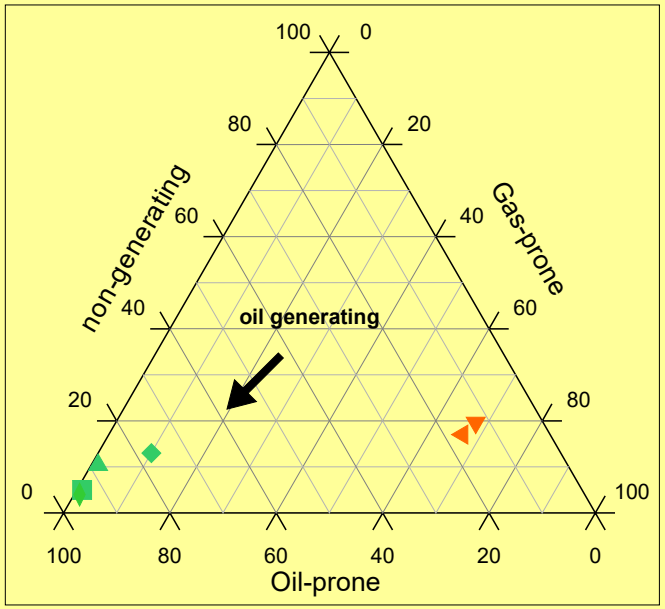


Turaco 1 Geochemistry base on total organic carbon and palynofacies analyses



Miocene Petroleum System, Albertine Graben indicated by geochemistry and Palynology of oil seepages and source rocks

Prospectively

- Sedimentary deposit exceed 6000 m,
- First deep well drilled in 1938 (1237 m) with reported oil shows,
- Three deep wells drilled in 2002-4 by Heritage (~3000 m) with shows, gas flow and encouraging results,
- Live oil shows and Favourable Geology.

Sedimentary Basins

- Rhino Camp Basin (EA 5)
- Pakwach Basin (EA 1)
  - Paraa oil shows
- Northern Lake Albert Basin (EA 2)
  - Waki 1 Well with oil show
  - Kibiro oil show
- Southern Lake Albert Semliki Basin (EA 3)
  - Kibuku oil show
  - Turaco Wells shows
- Lakes Edward-George Basin (EA 4)

Conclusions

- Organic-rich shale beds are present between 1965–2110 m (115 m thick) and 2465–2487 m (+22 m thick) within the Upper Miocene Kasande-Kakara Formation,
- Organic richness of these beds is up to 4.8% TOC, and
- Palynofloras from four samples indicate a mature, non-marine, oil-prone lacustrine facies of Miocene age.

Conclusions

- These organic-rich shale beds demonstrate the presence of a high quality oil-prone source within the basin, that are in the early stages of the oil-generative window in Turaco 1,
- Such beds could have generated significant quantity of oil and gas in deeper parts of the basin,
- where they should be at peak maturity, and imply a Miocene petroleum system within the Albertine Graben.

Recommendations

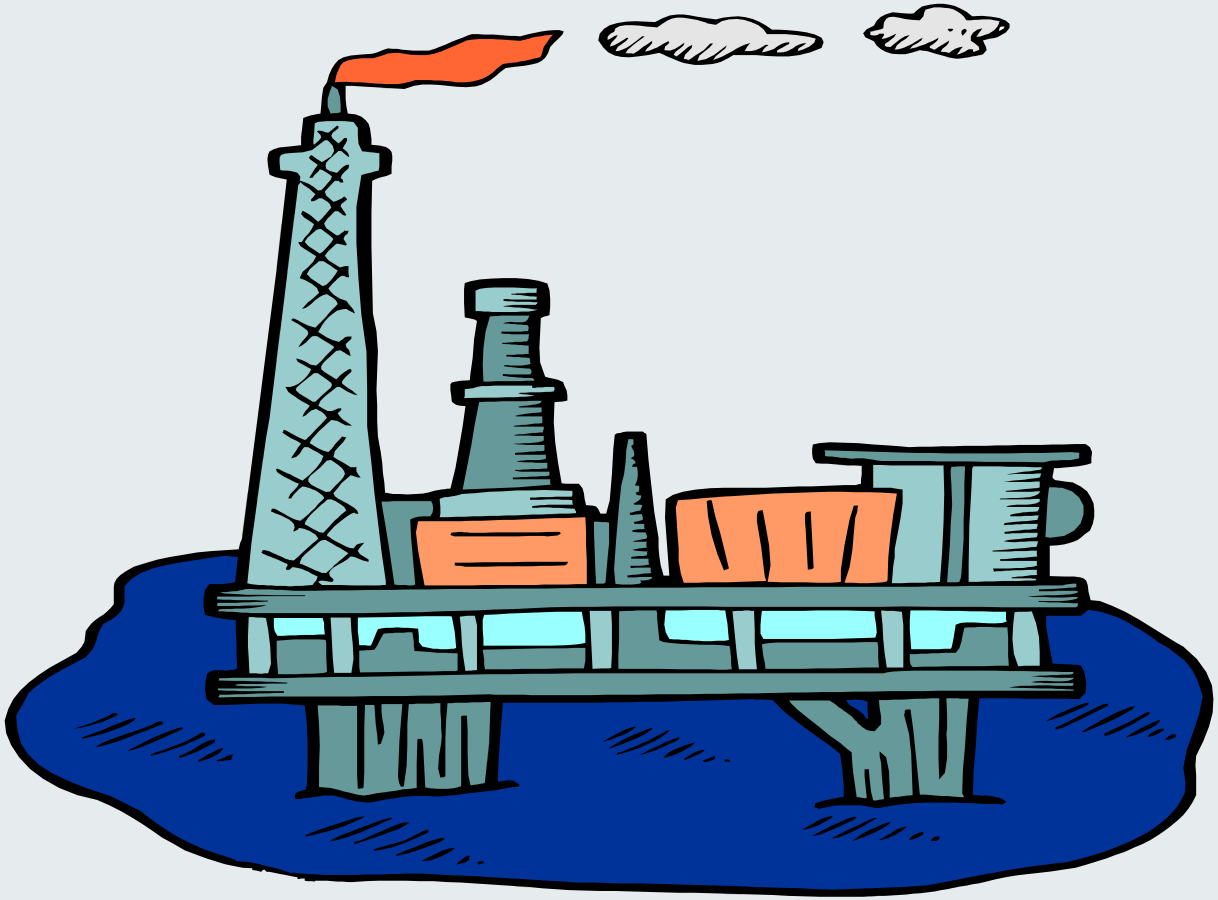
Petroleum Geochemistry and Biostratigraphy of East Africa: Kenya, Tanzania and Uganda

- The East African Rift System (EARS) and the coastal basins of East Africa are the main focus for oil and gas exploration that require systematic evaluation of their petroleum systems.

- The regional petroleum geochemical and biostratigraphic study is the first essential stage to evaluate oil and gas potential of these basins.

Research, training and team building project

Thanks



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