

International Scientific Conference

50<sup>th</sup> Anniversary of the Founding of the Geophysical Observatory of Addis Ababa University

*The Geodynamics of Afar and the Ethiopian Rifts*  
*Geophysics, Geohazard Challenges and Resources*

The Oil and Gas Possibilities of the Ethiopian  
Tertiary Rift System

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## Steven Teshome's christening, 1976

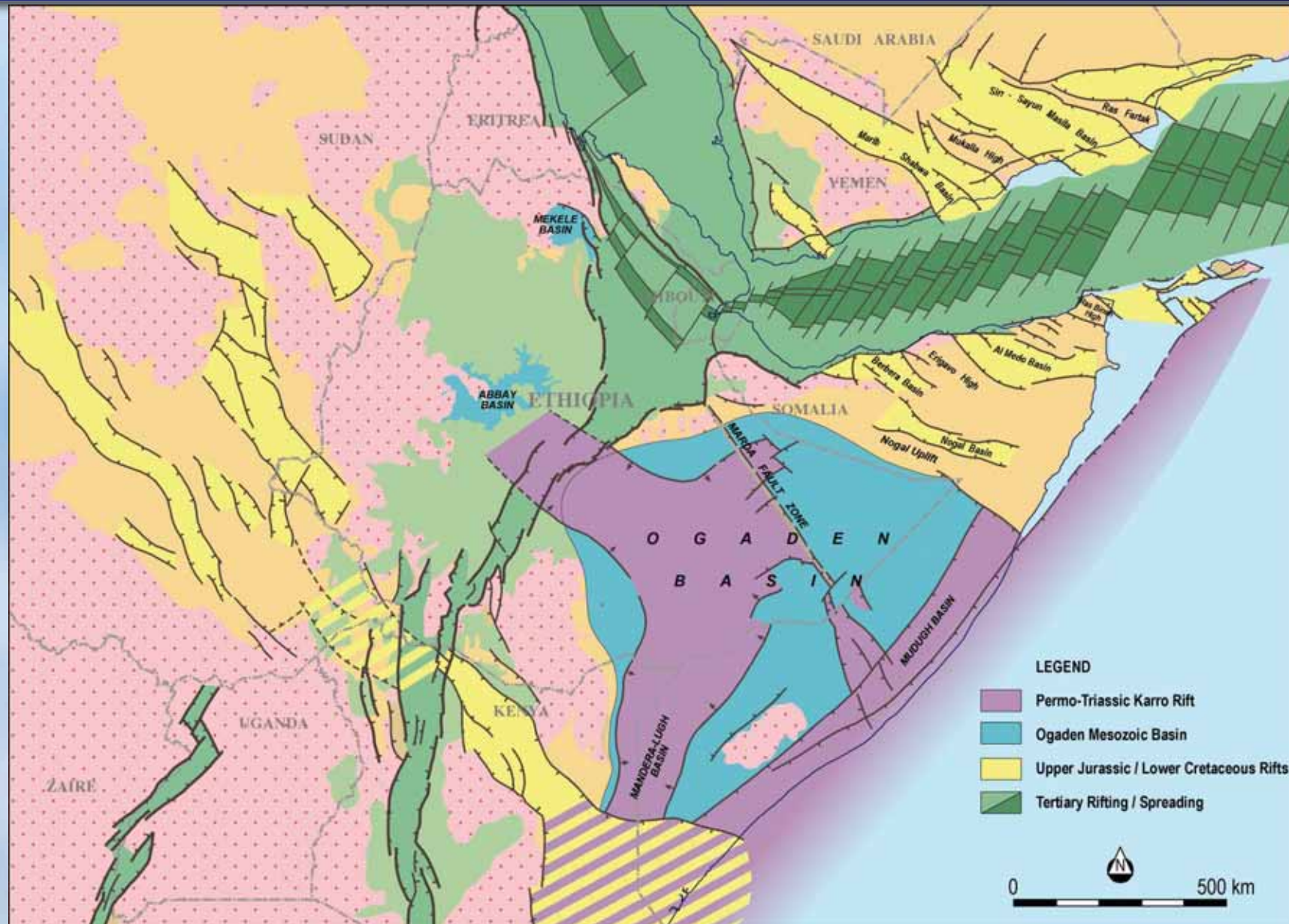
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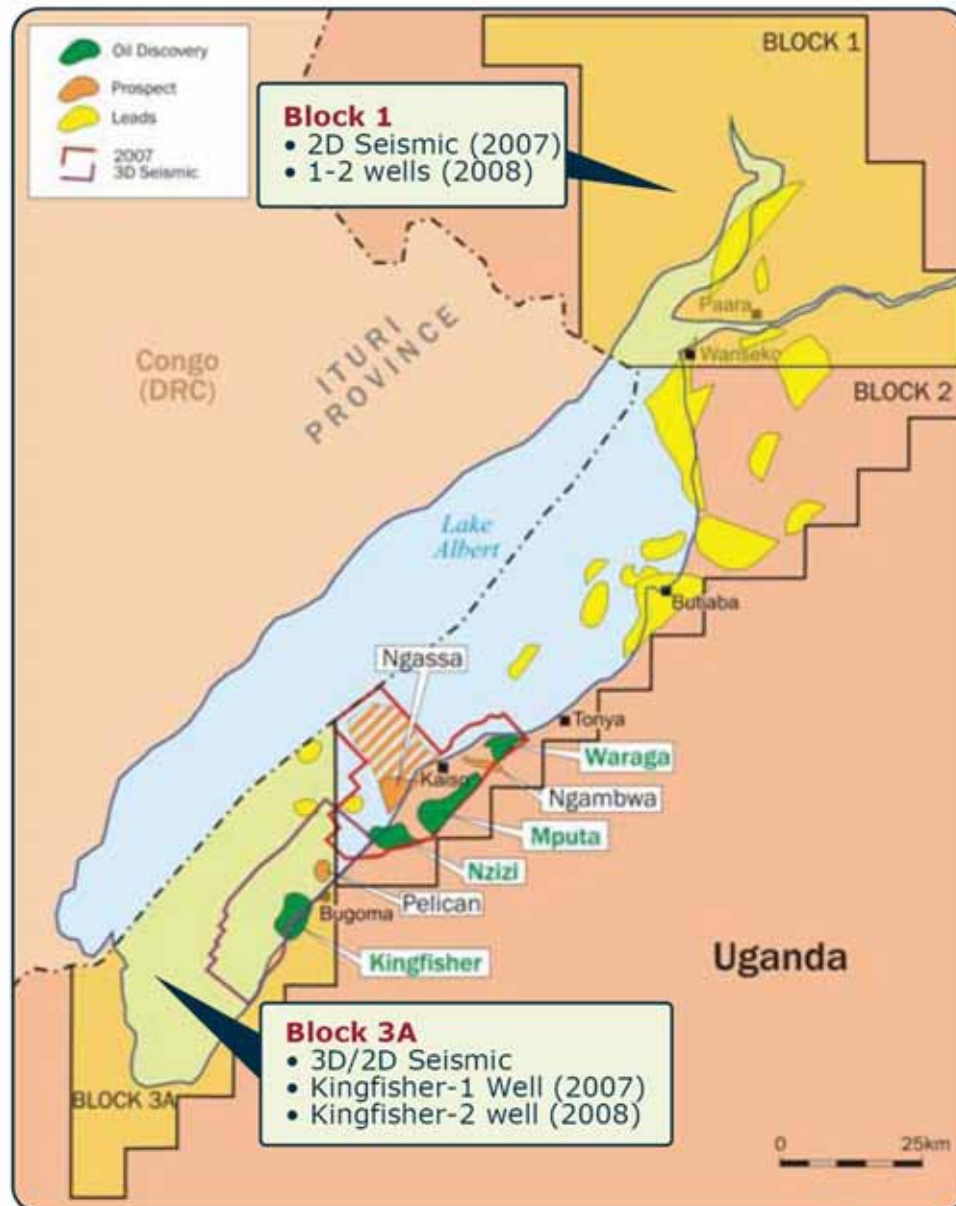
# Rift Systems in the Ethiopian Region

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# Lake Albert oil discoveries, Uganda

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- Discoveries in 2005 (Waraga and Mputa) and 2006 (Kingfisher, Nzizi)

- Mainly light (33-37API oil)

- Estimated proven reserves 100-250 MMbbl

- First oil production planned for 2009

- 4000 bbl/d

- 2000 bbl/d trucked to Kampala

- 2000 bbl/d to run 50 Mw plant from 2010

- Export development will require proven reserves of 300 MMbbl to finance pipeline 1200 km to Mombasa



## The bad news

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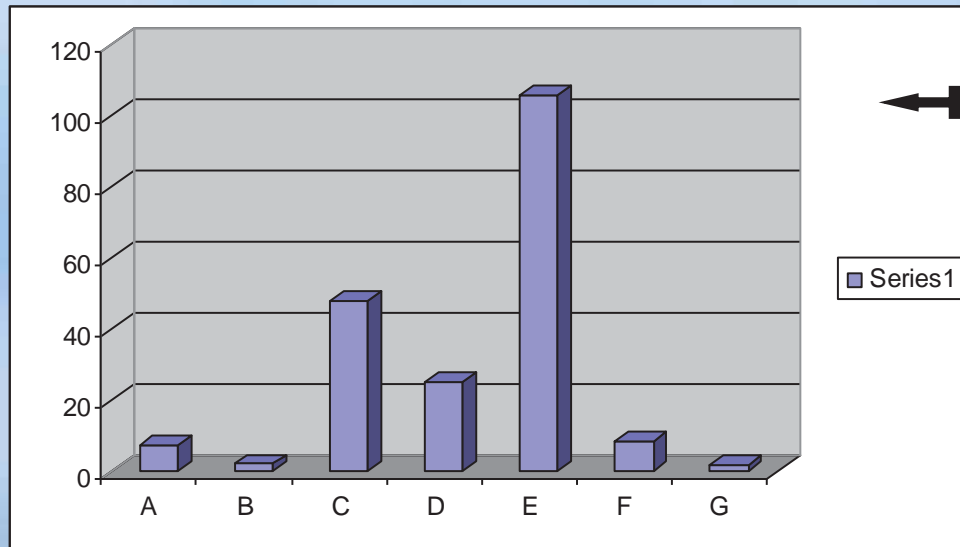
- Waxy oil has a pour point (temperature below which it is solid) of 39°C

- Oil must be moved in heated trucks or heated pipeline

- If the temperature in the truck or pipeline drops below 39°C, the oil will set solid.

# Hydrocarbon Potential of Rift Basins

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**Histogram of oil found in various rift settings in rift basins (billion bbl)**

**A = cratonic rift, continental fill**

**B = cratonic rift, marine fill**

**C = cratonic rift and sag basin, continental**

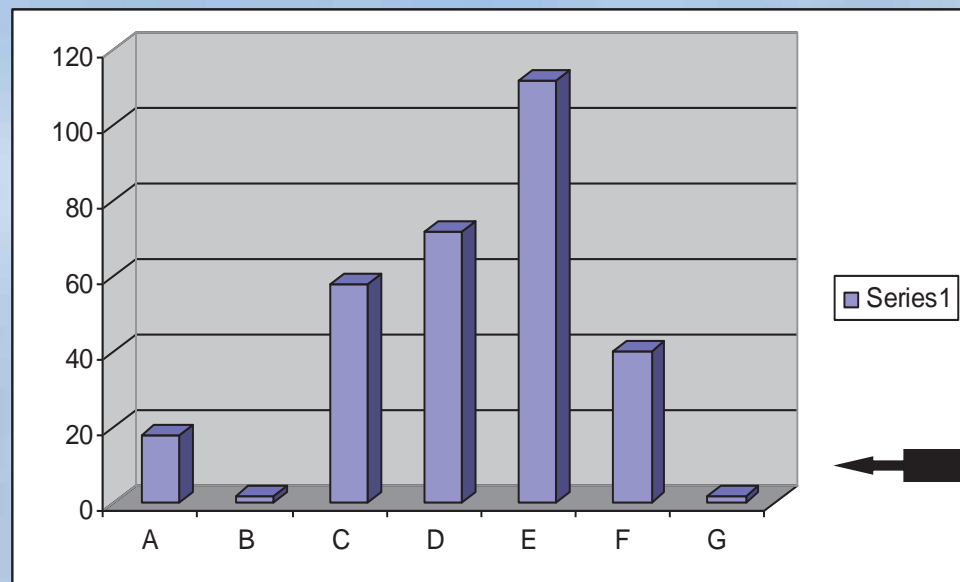
**D = cratonic rift, continental; marine sag basin**

**E = cratonic rift and sag basin, marine**

**F = cratonic rift, continental; passive margin**

**G = cratonic rift, marine; passive margin**

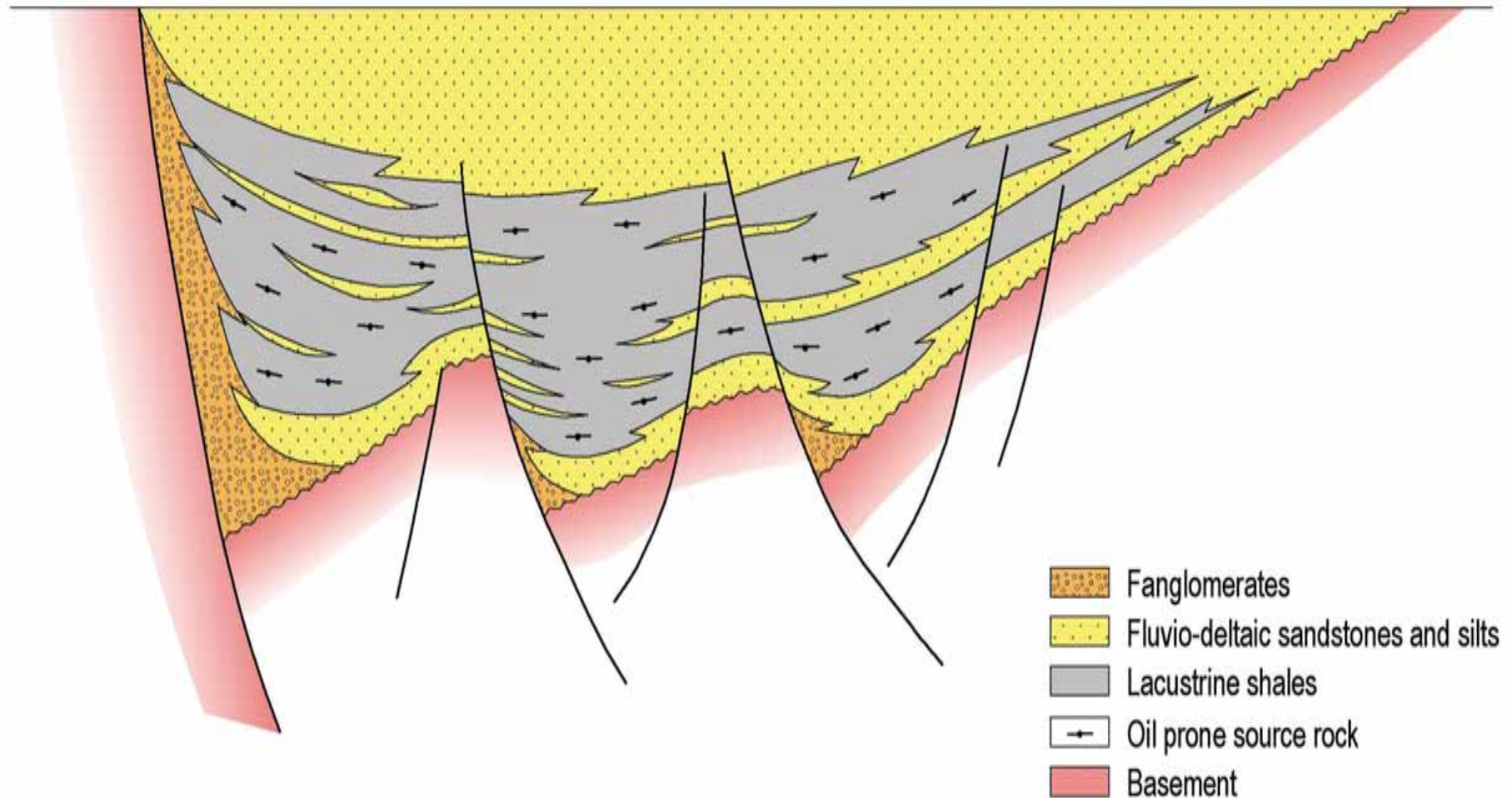
**Cratonic rifts with continental fill contain >7.5 billion bbl worldwide**



**Histogram of hydrocarbon reserves/km2 (bbl /km2)**

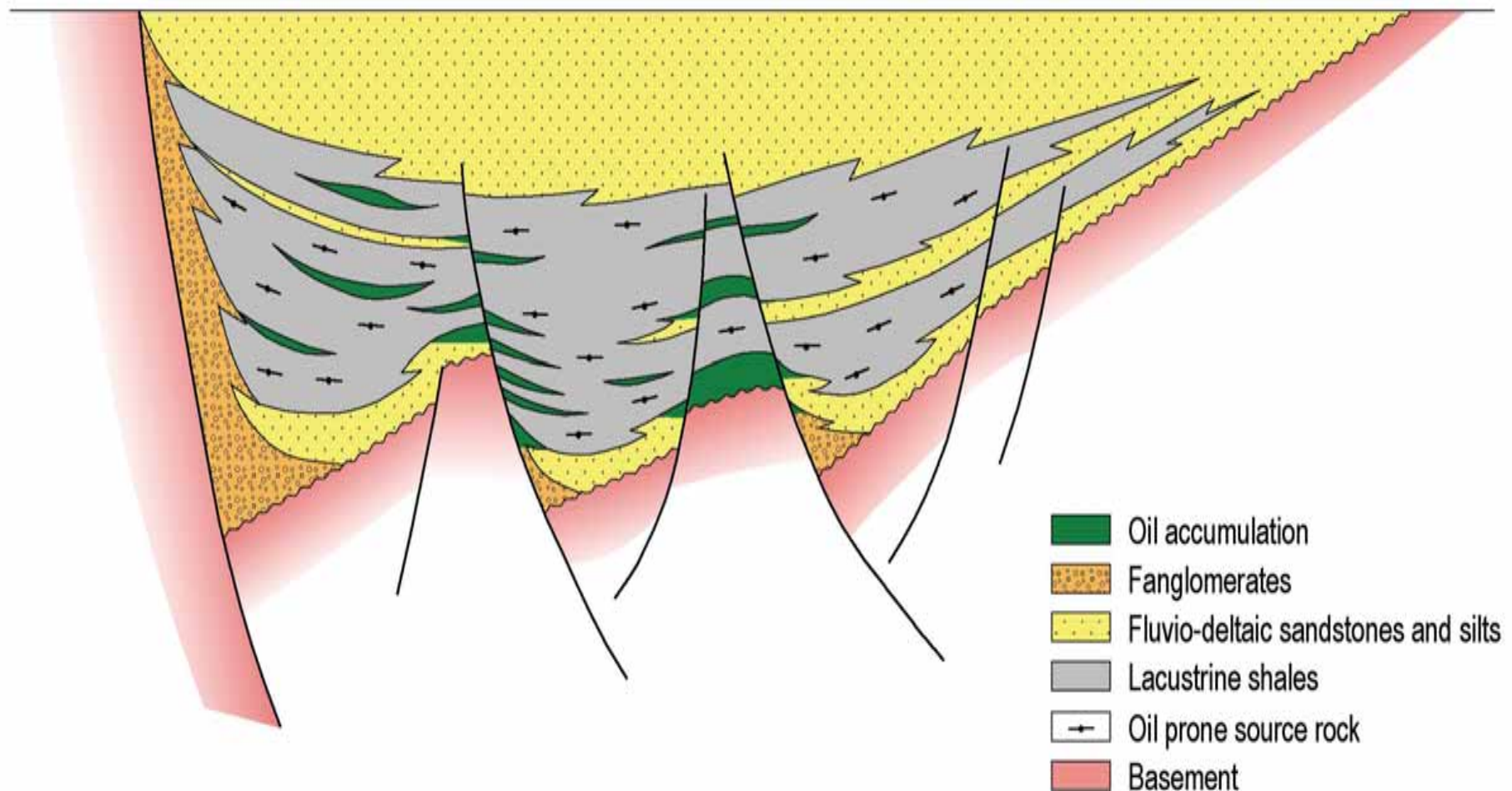
# Schematic model of rift basin sedimentation

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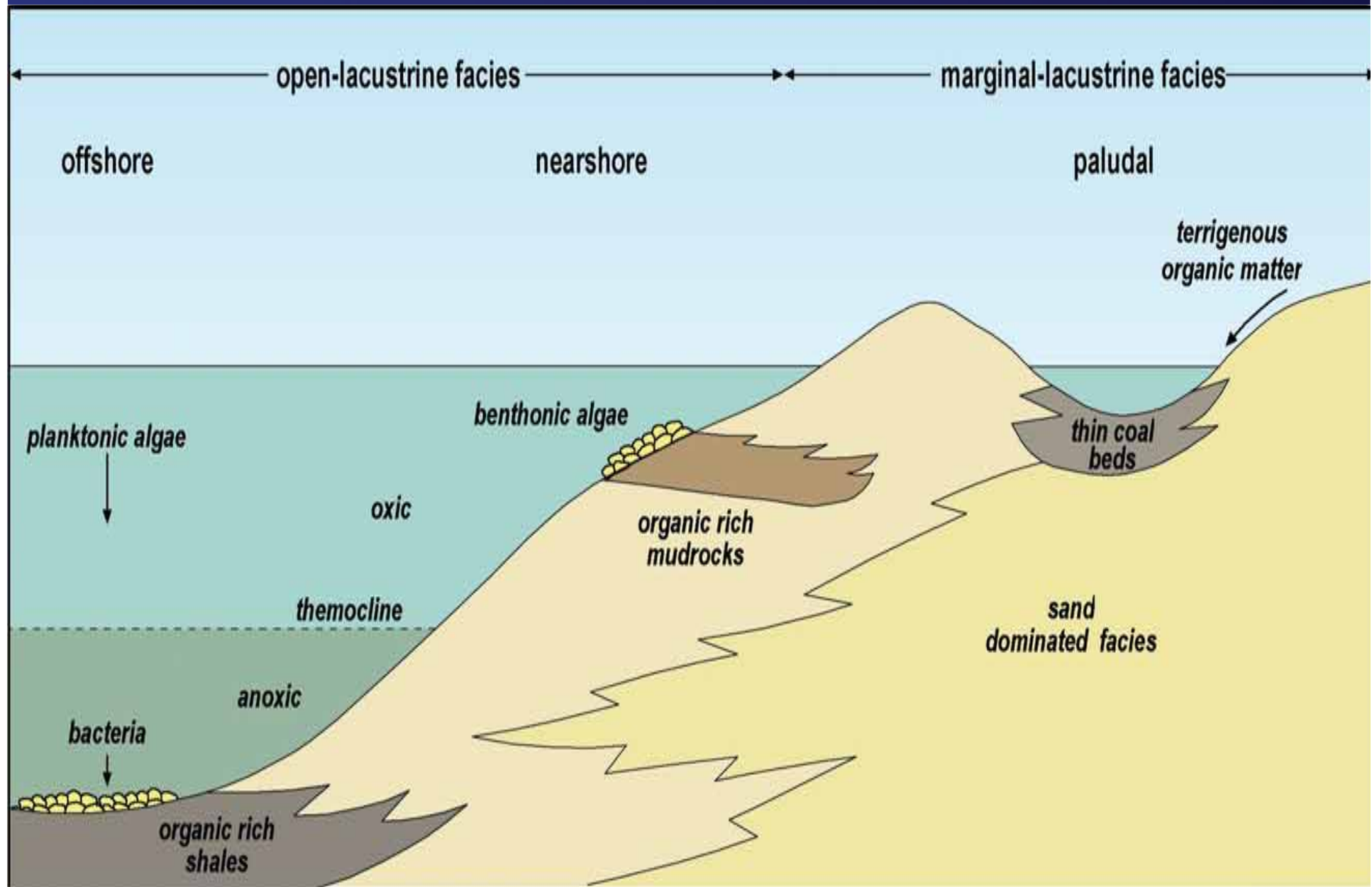


## Schematic rift model showing possible oil accumulations

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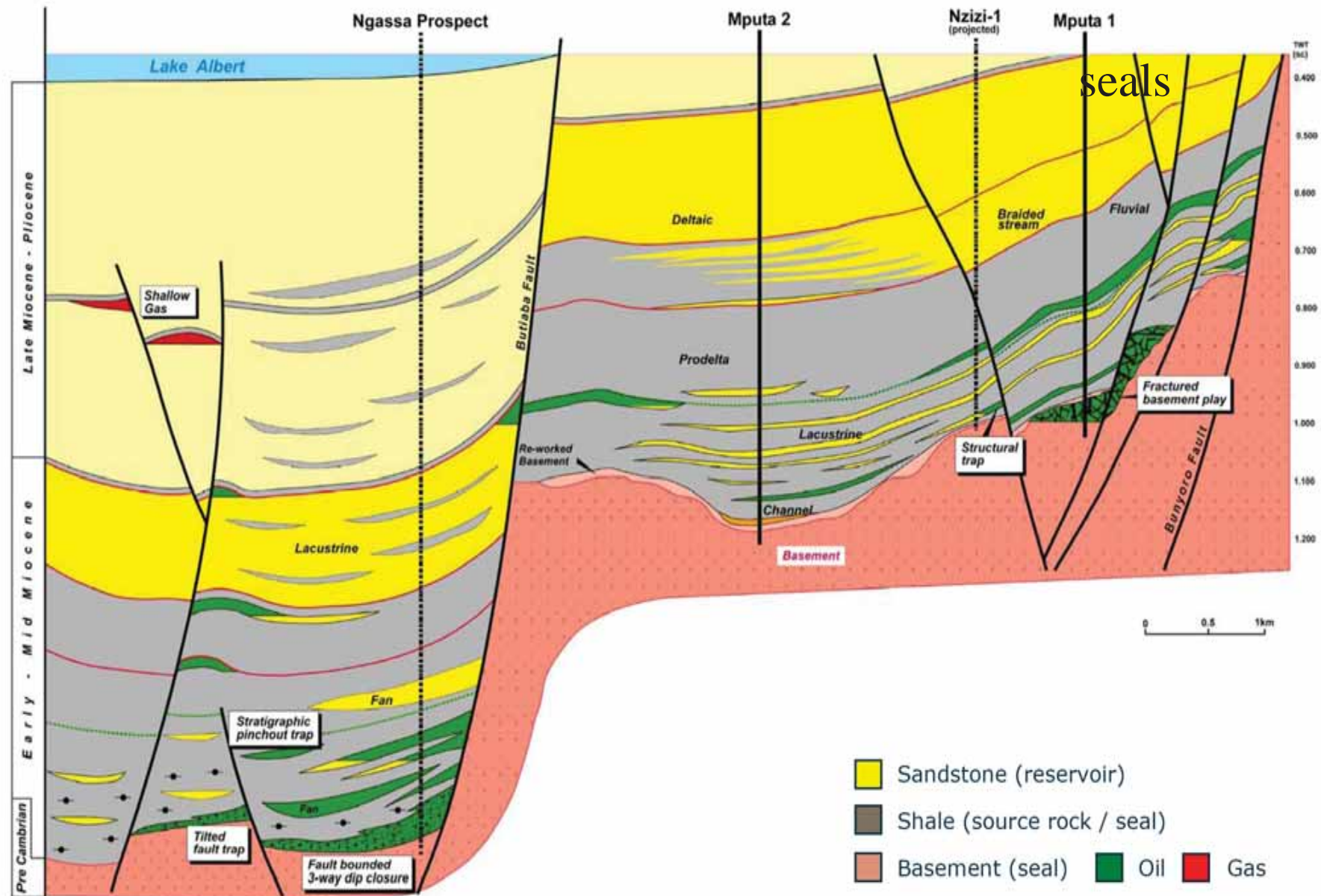






# Discoveries and play types, Albert Rift, Uganda

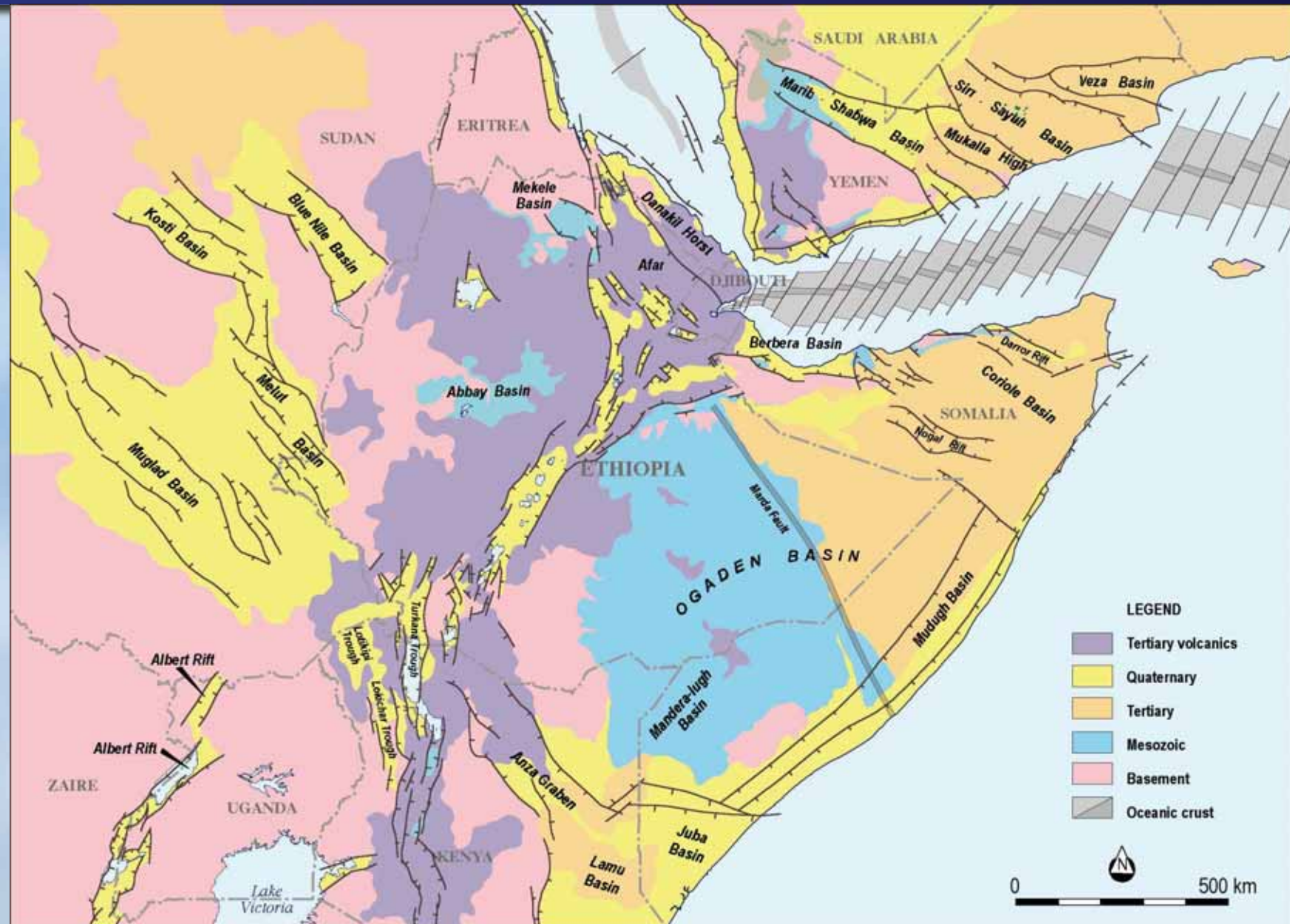
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# Ethiopia Tertiary Rift System

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# Ethiopia

- Eastern Rift System
- Eocene – Recent
- Extension of 30-40 km
- Extensive pre-rift volcanism
- Extensive syn-rift volcanism
- Thick volcanic section



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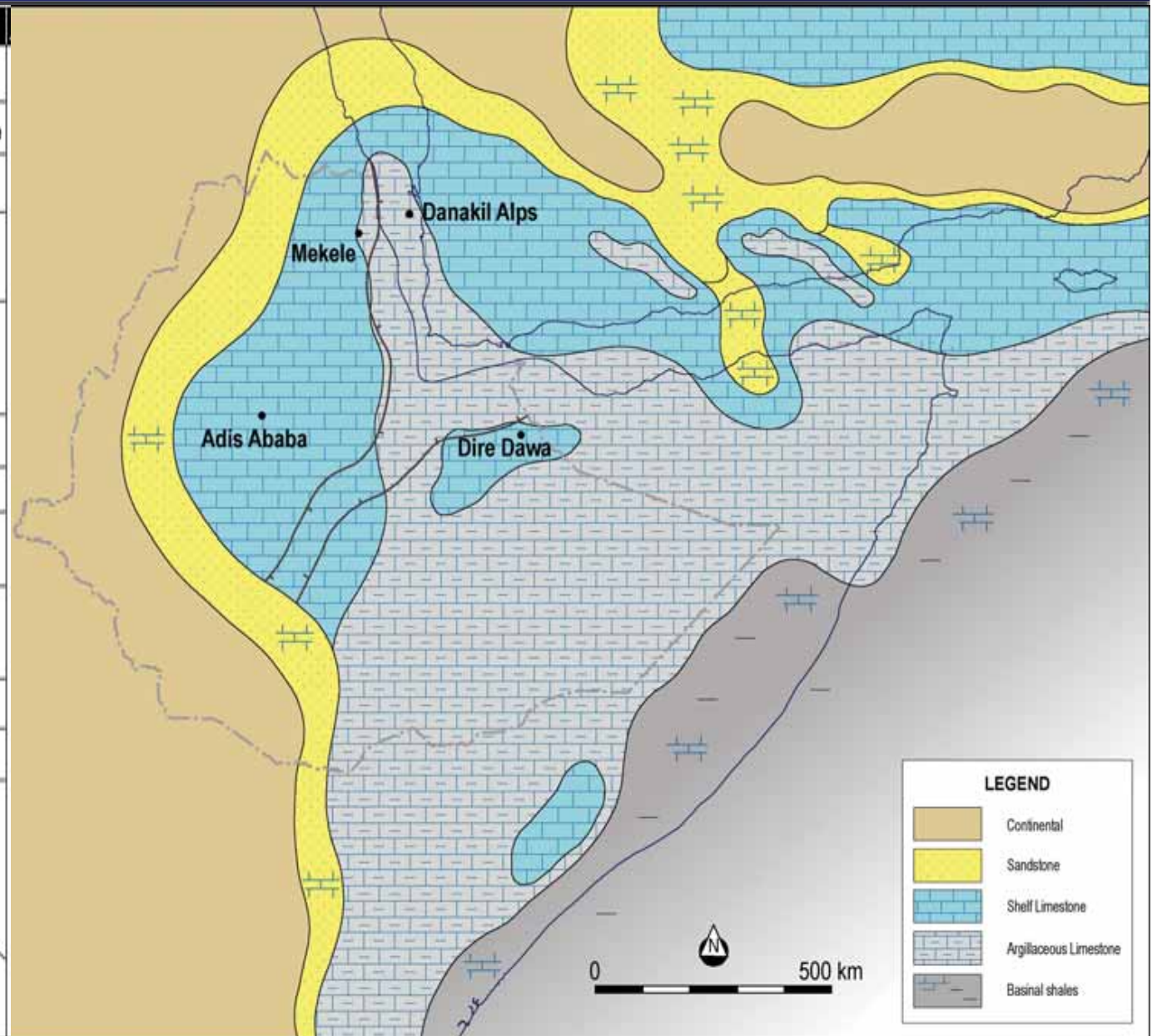




# Ogaden Stratigraphy and Uarandab Formation Paleogeography

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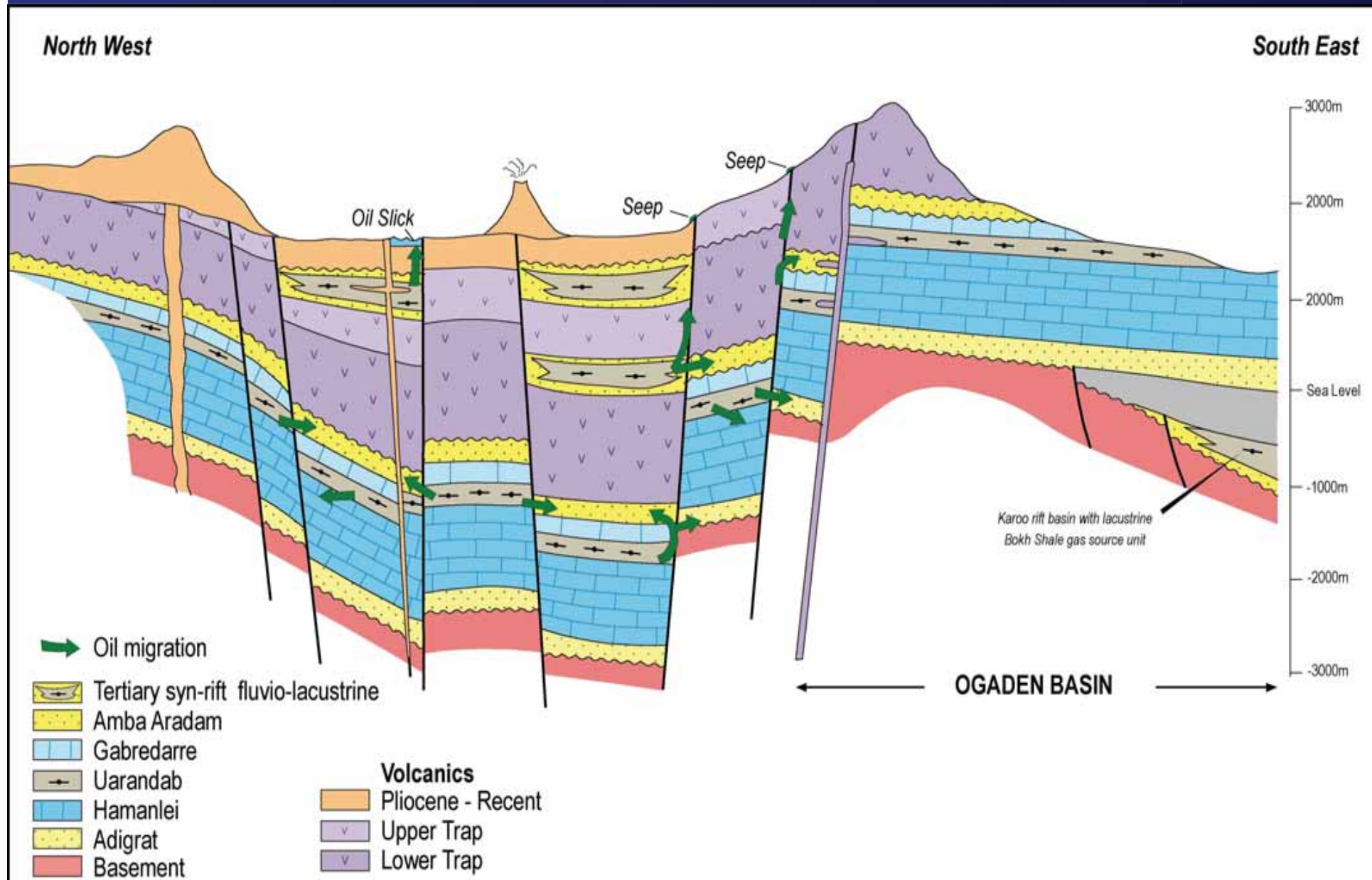
APPROXIMATE AGE	LITHOSTRATIGRAPHY	LITHOLOGY	DEPOSITIONAL ENVIRONMENT
Eocene - Palaeocene	Taleh Auradu		Open marine
	Jessoma		Fluvial to marginal marine
Maastrichtian to Cenomanian	Belet Uen		Open marine
	Ferfer		Shallow open marine to restricted lagoonal
Albian to Aptian	Mustahil FM		Shallow open marine to restricted lagoonal
	Main Gypsum		Shallow open marine to restricted lagoonal
Barremian to Valanginian	L. Gorrahei		Shallow open marine
	Gabbredarre FM		Open marine
Berriasian to ? L. Oxfordian	Uarandab FM		Shallow open marine
	Upper Hamanlei		Open marine
? E. Oxfordian to Callovian	Middle Hamanlei		Shallow open marine
	Lower Hamanlei		Marginal marine to sabkha
Bathonian to Early Jurassic	Transition		Open marine
	Adigrat FM		Fluvial to marine
Triassic to ? Late Permian	Gumboro FM		Fluvial
	Bokh FM		Fluvial
Early Palaeozoic and Older	Calub FM		Lacustrine
	Basement		Fluvial





# Schematic cross-section, Main Ethiopian Rift

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# Were Ilu seep

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Geochemical analyses of the oil from the Were Ilu seep suggests it is derived from either a marine shale or a salty lacustrine facies.

The depositional environment was anoxic but nearshore, as indicated by a high terrestrial organic content.

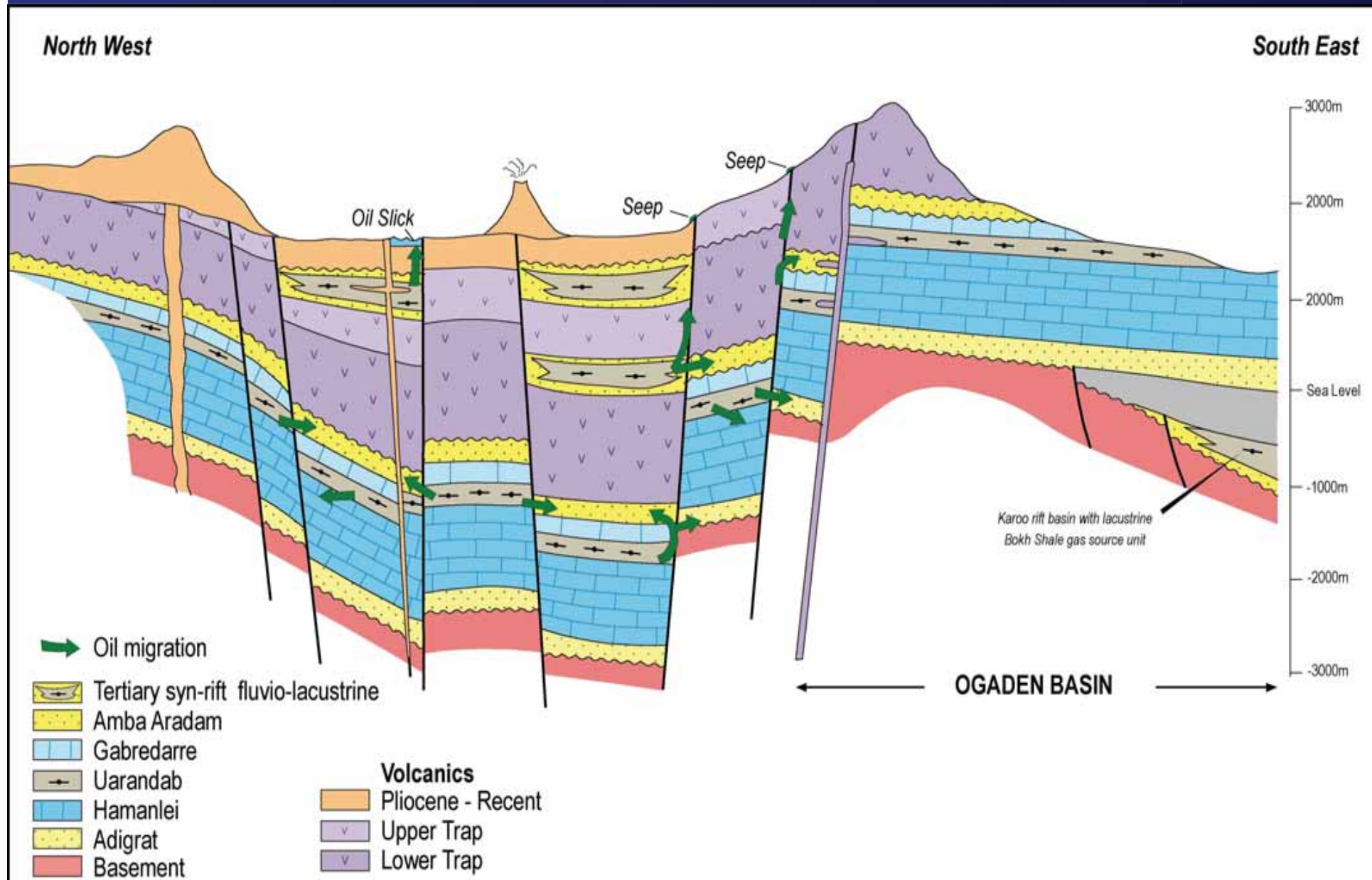
There is no data available on likely age of the shale





# Schematic cross-section, Main Ethiopian Rift

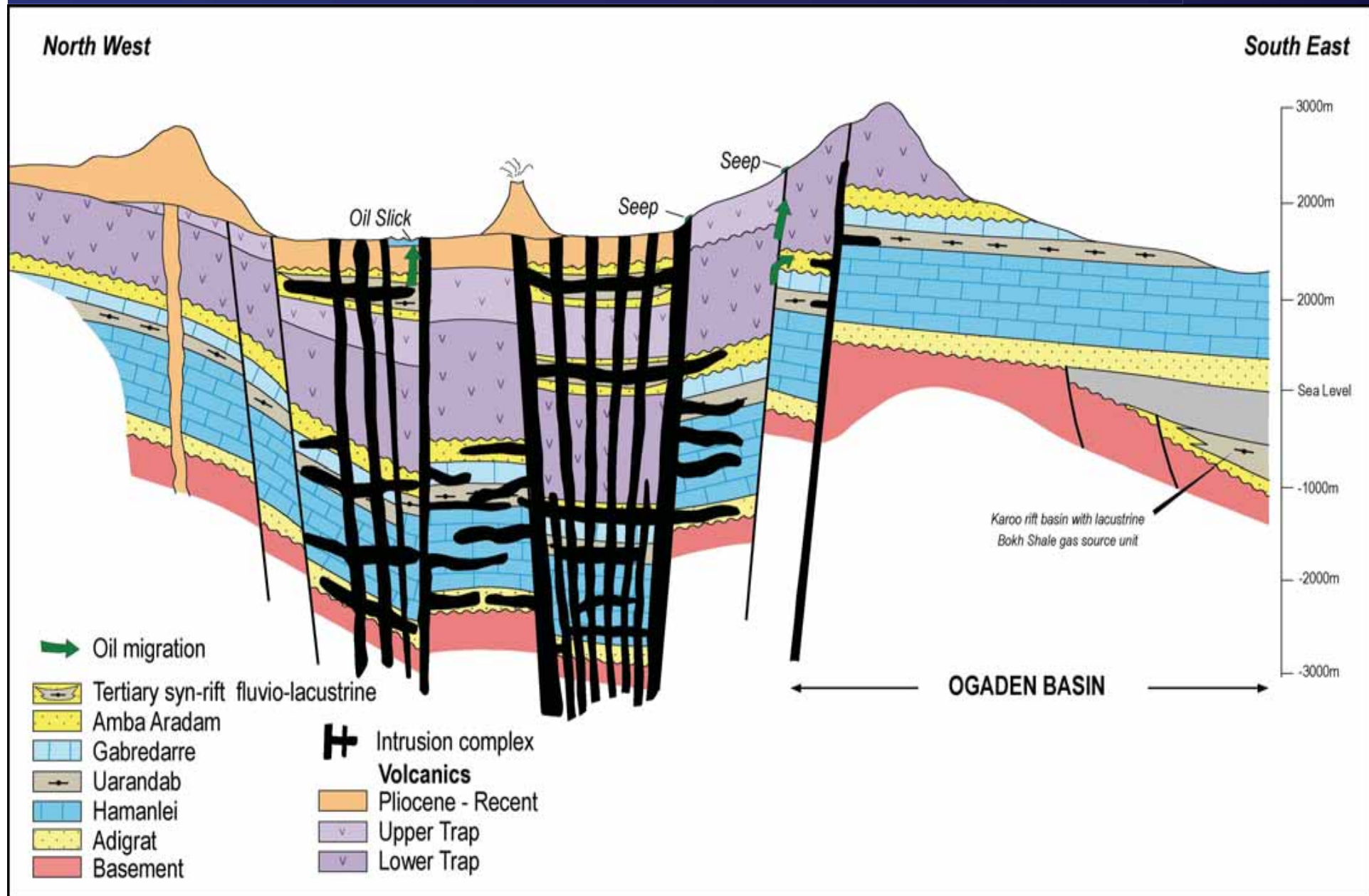
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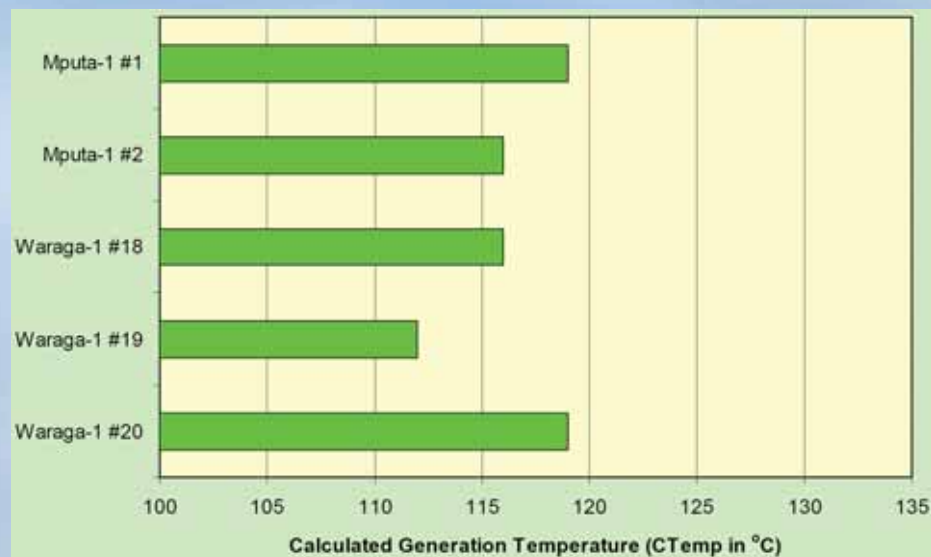
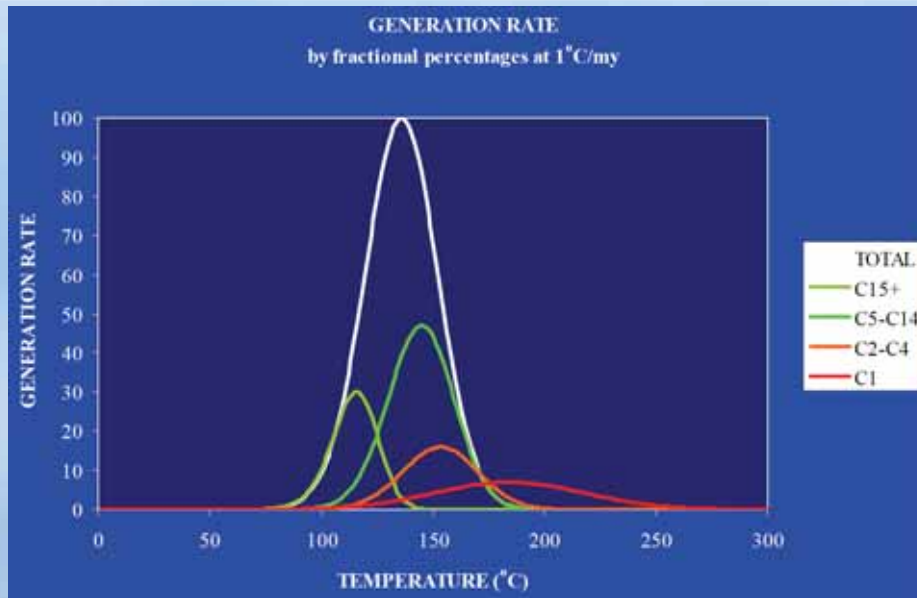
# Xn – the bad news

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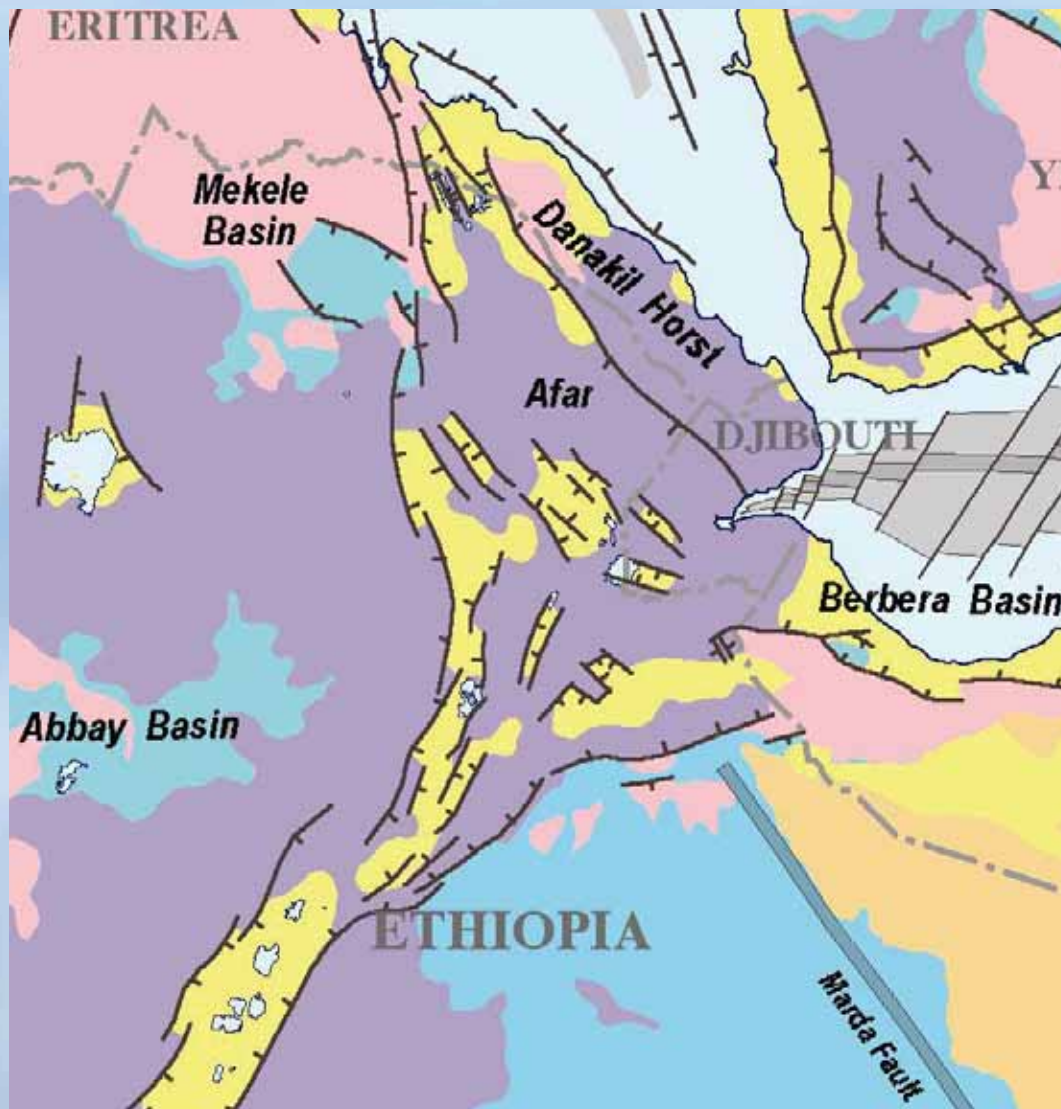


# Thermal issue in Ethiopia rifts

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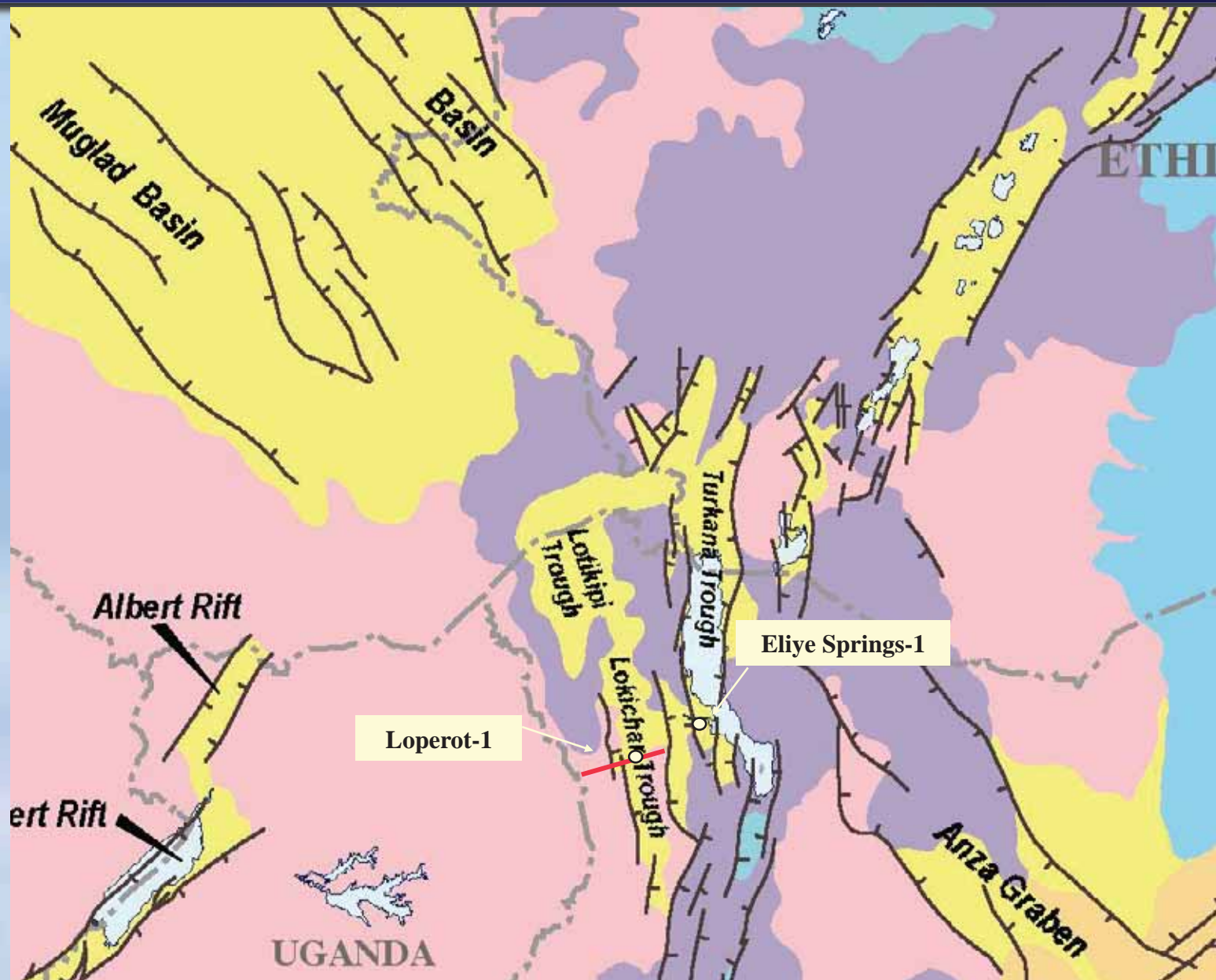
- Tectonism and magmatism have created high temperatures in the Afar and Ethiopian rift
- Limited temperature data from geothermal wells reveals thermal levels destructive to hydrocarbons
  - Tendaho: 320°C at 2200 m
  - Langanno: 270°C at 2100 m
- Oil generation peaks in the range 110°C to 160°C and most is reduced to methane by 200°C
- These high temperatures cannot be generalized over the entire rift and Afar area but intuitively a high thermal regime would be expected over much of the area.





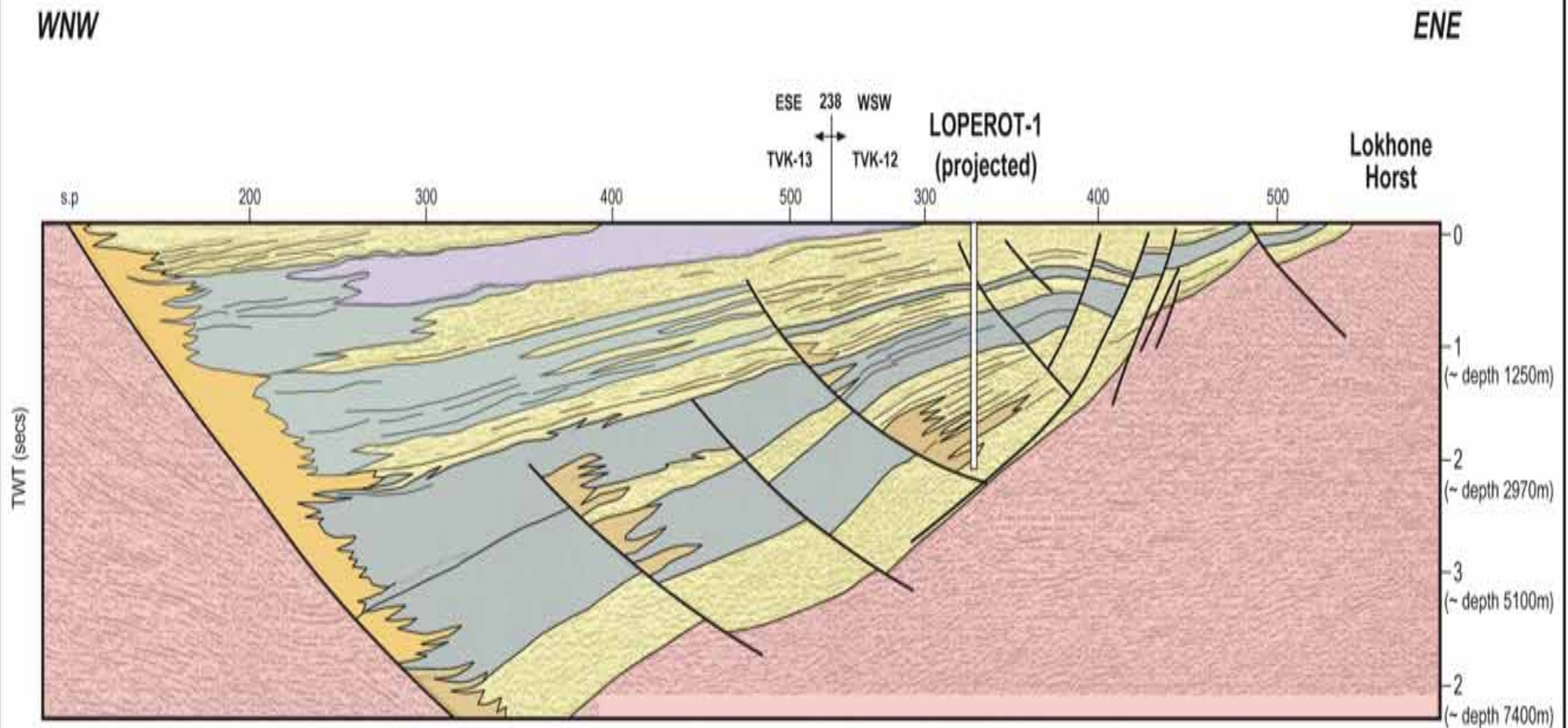
# Turkana-Chew Bahir Rift area

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# Loperot-1, Lokichar Basin

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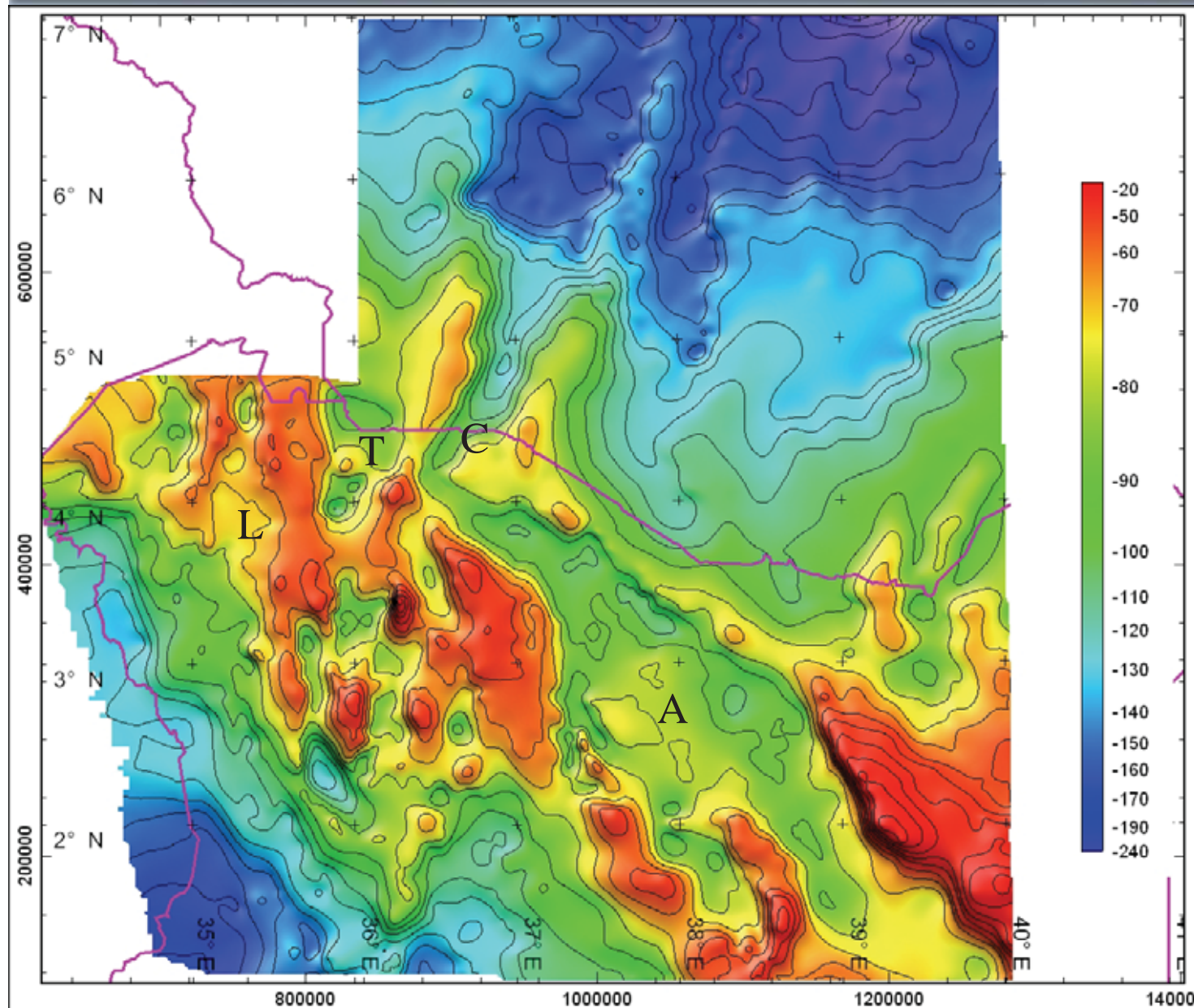
Intervals where seismic data shows through are predominantly sand-prone sections or Precambrian basement.

- |   |                                  |                           |
|---|----------------------------------|---------------------------|
| Fan deposits (deep water fans to alluvial fans) | Fine grained lacustrine deposits | Middle Miocene lava flows |
| Sandstone                                       | Basement                         |                           |



## Om0/Turkana rifts area, Bouguer Gravity map

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# Petroleum exploration permits in Ethiopia

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