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**Extractive Industries and Sustainable Job Creation**

# Hydrocarbons potential and resources in Sudan

By

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# Republic of Sudan
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# Outlines

- Objectives.
- Introduction.
- Summary.
- Hydrocarbon Potentiality.
  - Sudanese Basins Subdivisions.
  - Key Basins overview.
- Resources.
- Conclusions.
- Forward Plan.

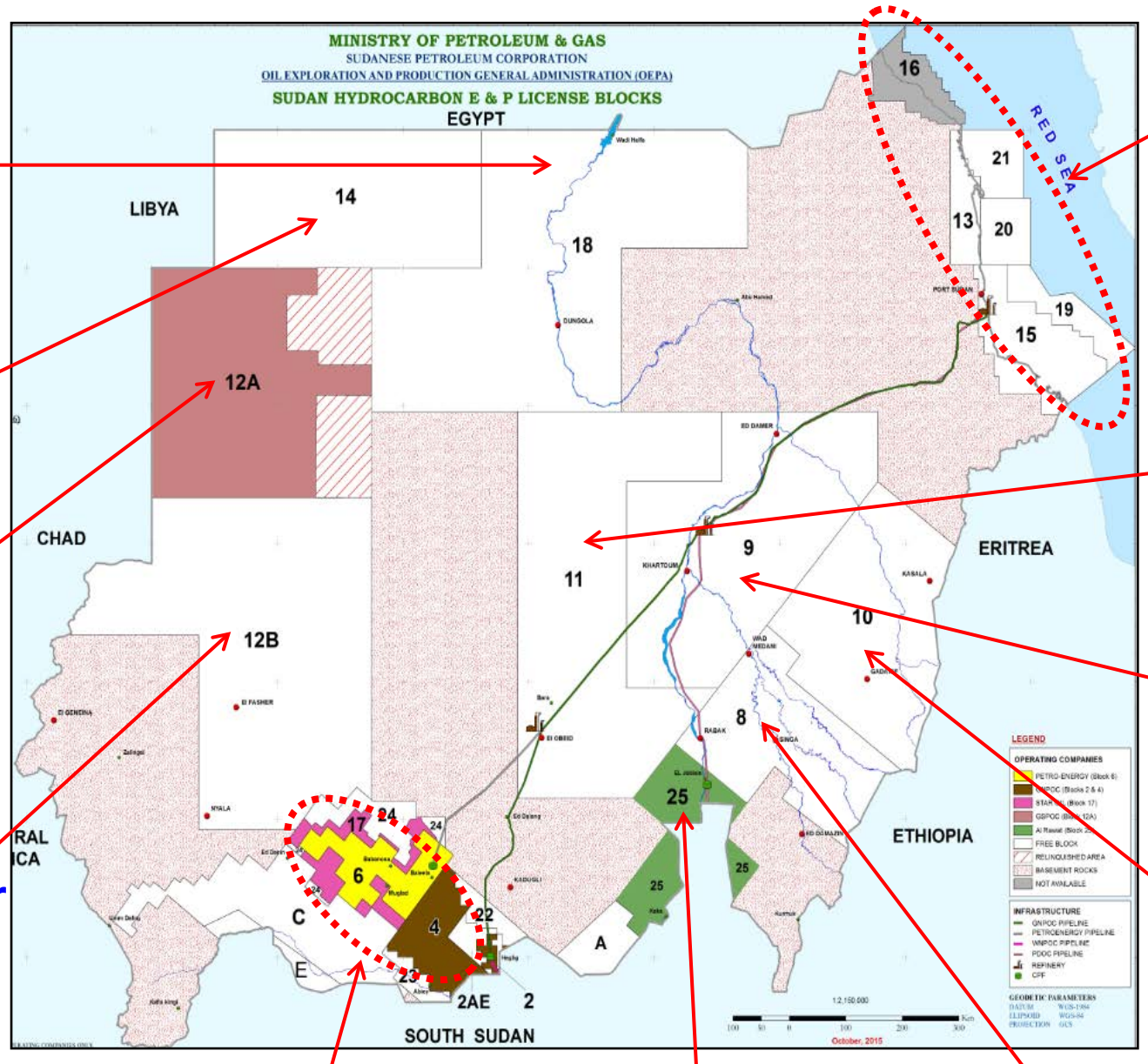
# Objectives

## To highlight :

- ❑ Sudan Hydrocarbon potentiality.
- ❑ Sudan Resources.

# Introduction

## First Oil Export1999




Salima Basin

Misaha Basin

Mourdi Basin

Wadi Hawar Basin

Red Sea Basin

Um Agaga Basin

Khartoum & Atbara basins

Gadarif Basin

Muglad Basin

Rawat Basin

Blue Nile Basin

# Summary

- Sudan is considered one of the top most African hydrocarbon potential countries.

- Nearly twenty hydrocarbon basins do exist:
  - Late Proterozoic-Paleozoic continental sag basins (Misaha, Murdi, Wadi Hawar and Salima).
  - Mesozoic-Cenozoic rift basins (Muglad, Rawat, Khartoum, Blue Nile and Red sea ).

- Most of the Sudanese basins is by far highly under explored due to data scarcity and others logistical constrains.

- Proven petroleum system in the Paleozoic, Mesozoic and Cenozoic.

# Summary

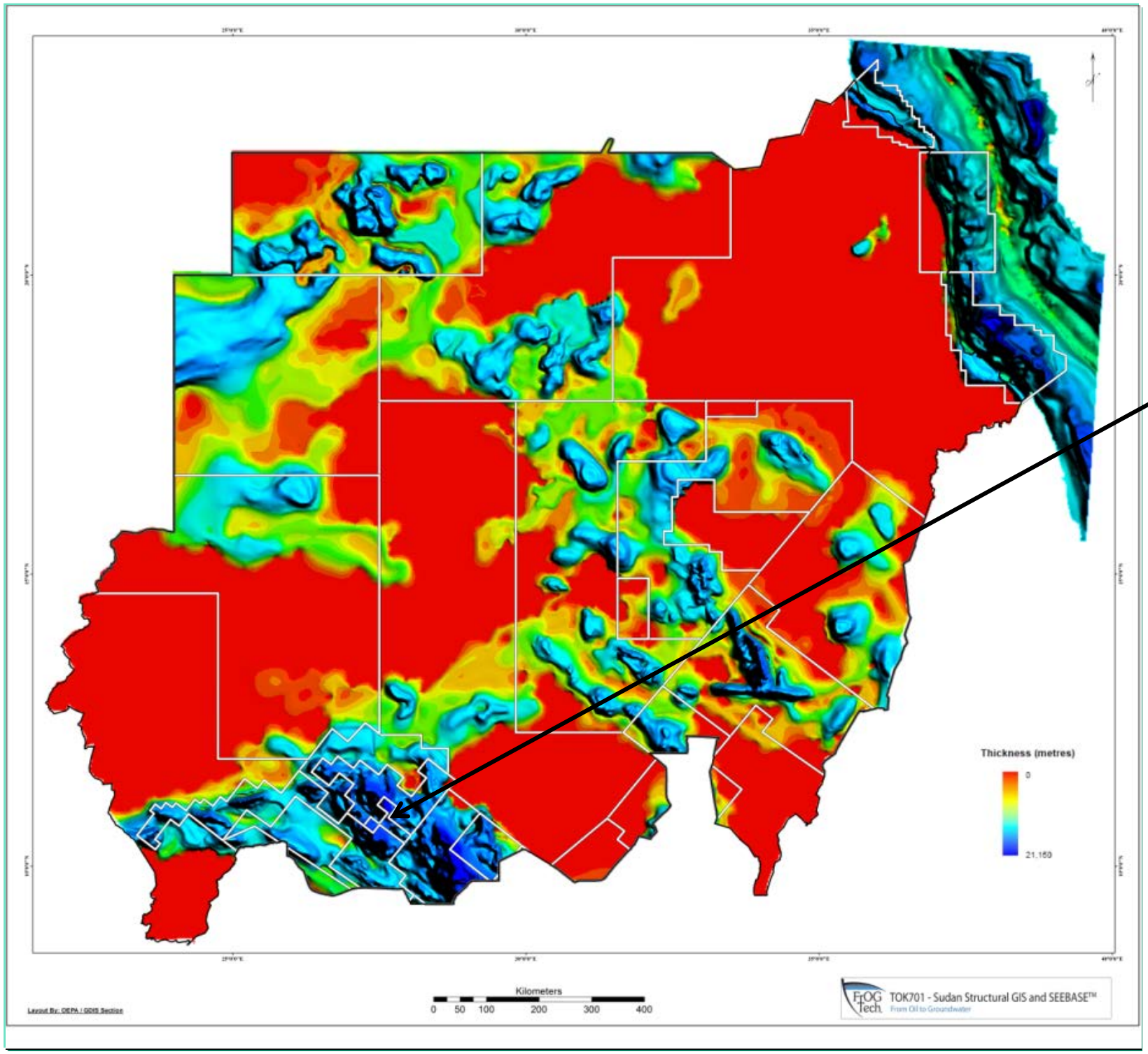
- Sudanese basins could be classified into:
  - Producing (1 basin ).
  - Early exploration stage basins:
    - ➢ Have proven petroleum systems with some discoveries ( 5 basins: Rawat, Red Sea, Blue Nile, Um Agaga and Khartoum basins).
    - ➢ Have proven petroleum systems but no notable discoveries yet been made e.g. Mourdi Basin.
  - Frontier basins.

# Summary

- Considerable amount of hydrocarbon has been discovered in Sudan, from structural traps identified in rift basins:
  - OIIP of 6,575 MMSTB.
  - GIIP of 2,658 BSCF*.
- The country's speculative oil in place resource is totaling to 23,604 MMSTB.
- Recently, few unconventional plays have been tested such as basement and tight sands.
- Some compelling evidences from recent studies indicate that the Upper Cretaceous of the Muglad basin might be working particularly in the central part which is expected to add more resources.

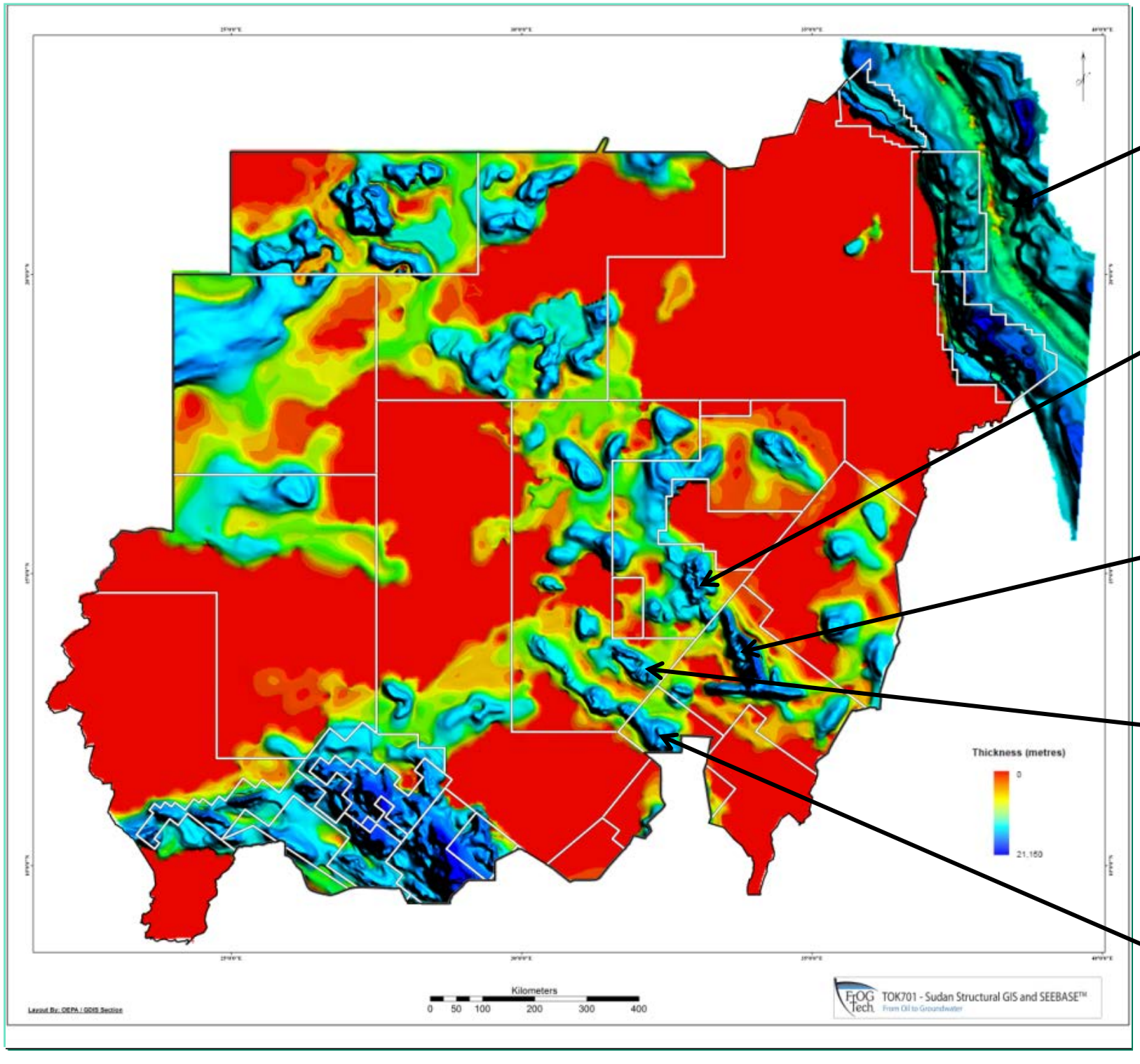
* **This came only by chance during the hunt for Oil.**

# Producing Basin



# Early Exploration stage basins

## Proven Petroleum System + discoveries




Red Sea

Khartoum

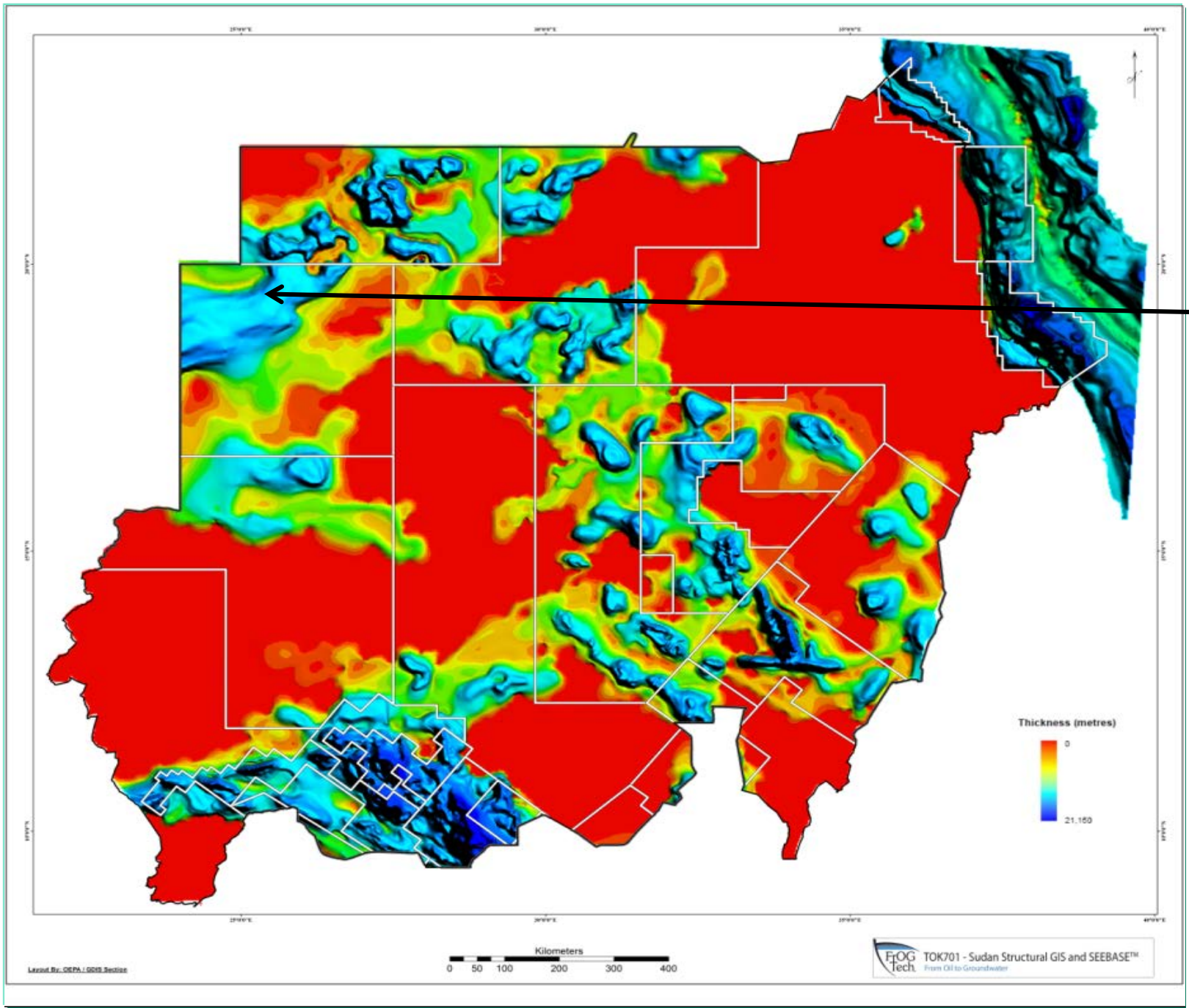
Blue Nile

Um Agaga

Rawat

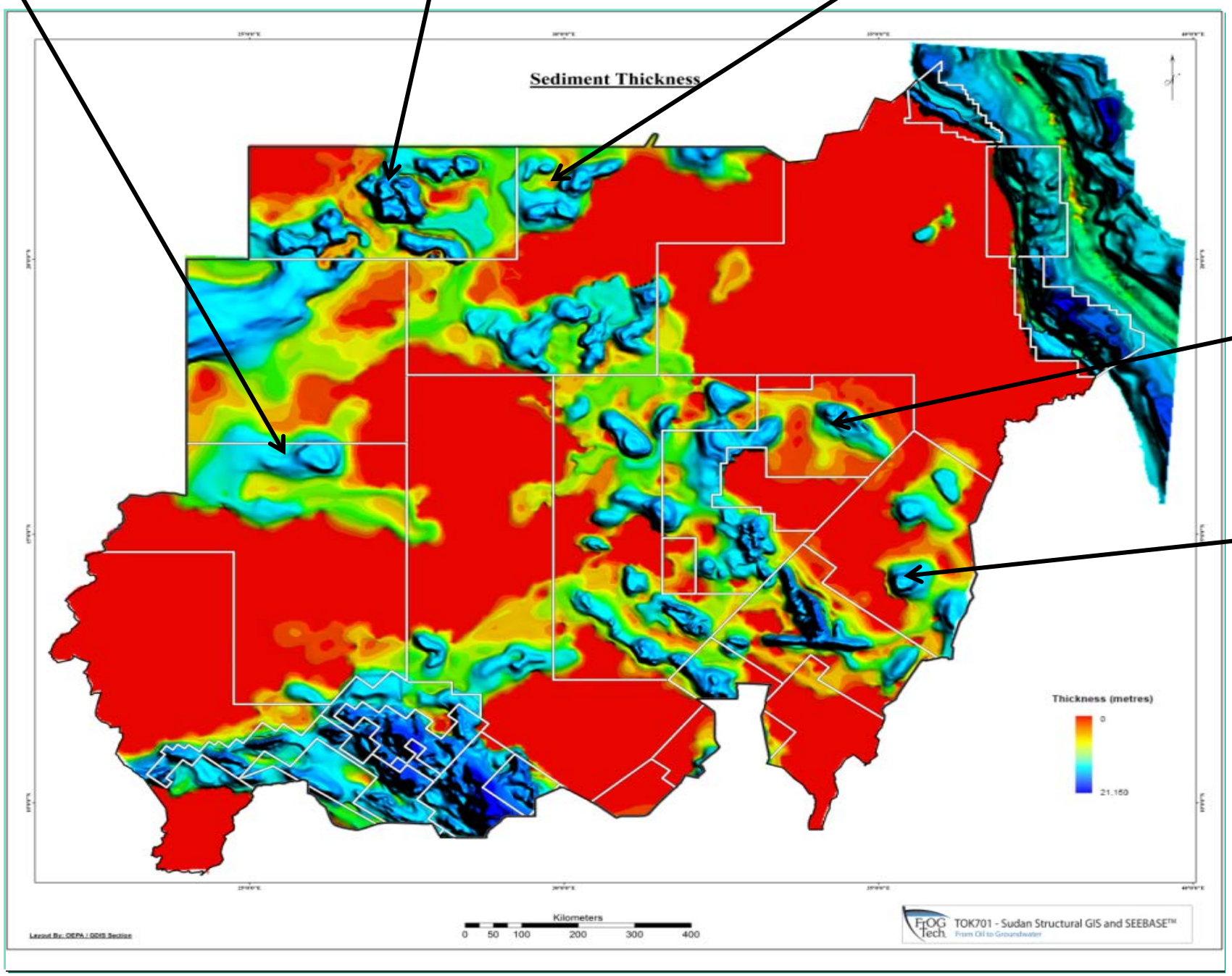
# Early Exploration stage basins

## Proven Petroleum System + No discovery yet

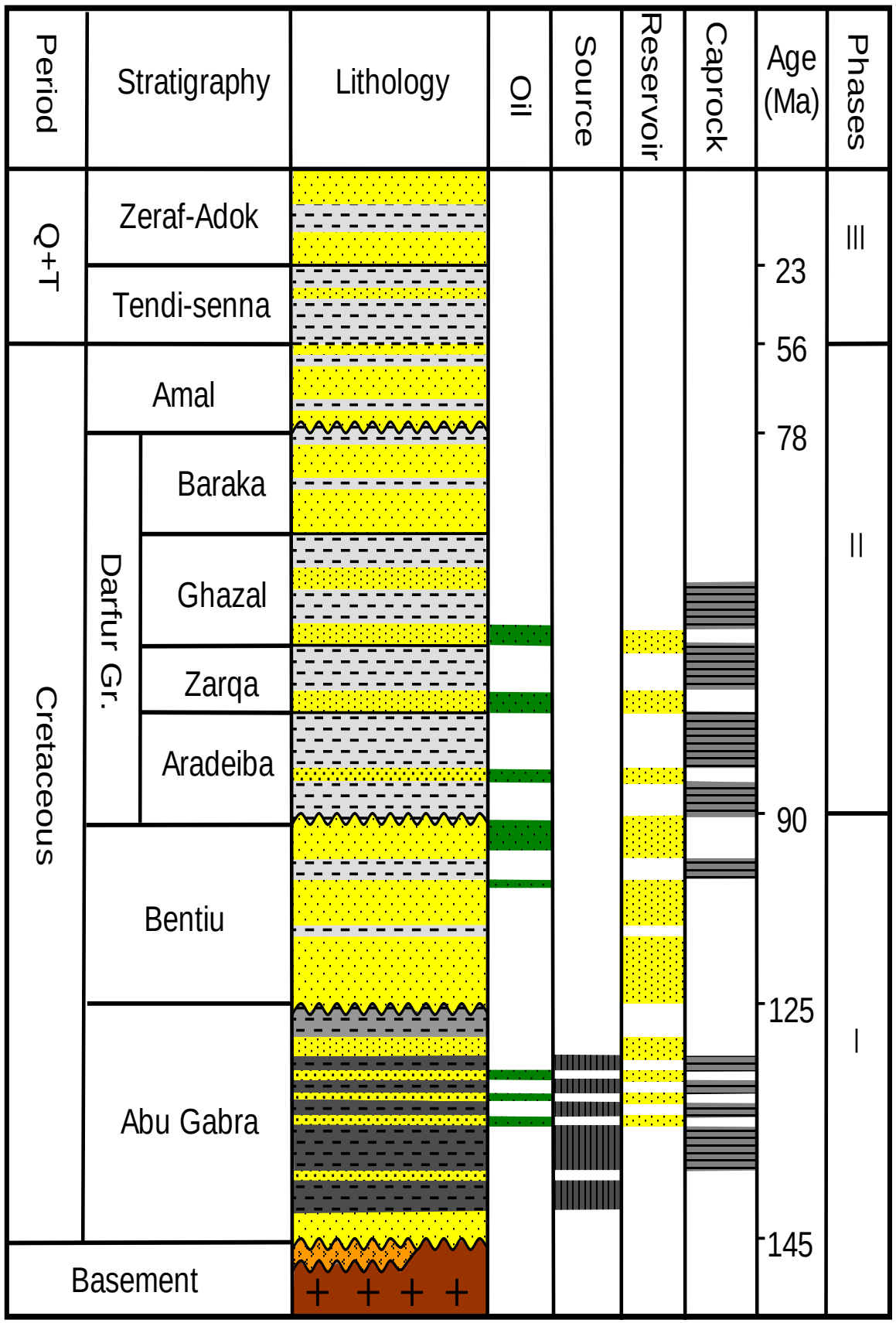



❑ Mourdi

# Frontier basins



# Muglad - Producing Basin




**Age: Cretaceous/ Jurassic?**

**Tectonic Evolution: Extensional ,Three Rift cycles.**

**Size: 200*800 km**
**Sedimentary thickness: ~15km**

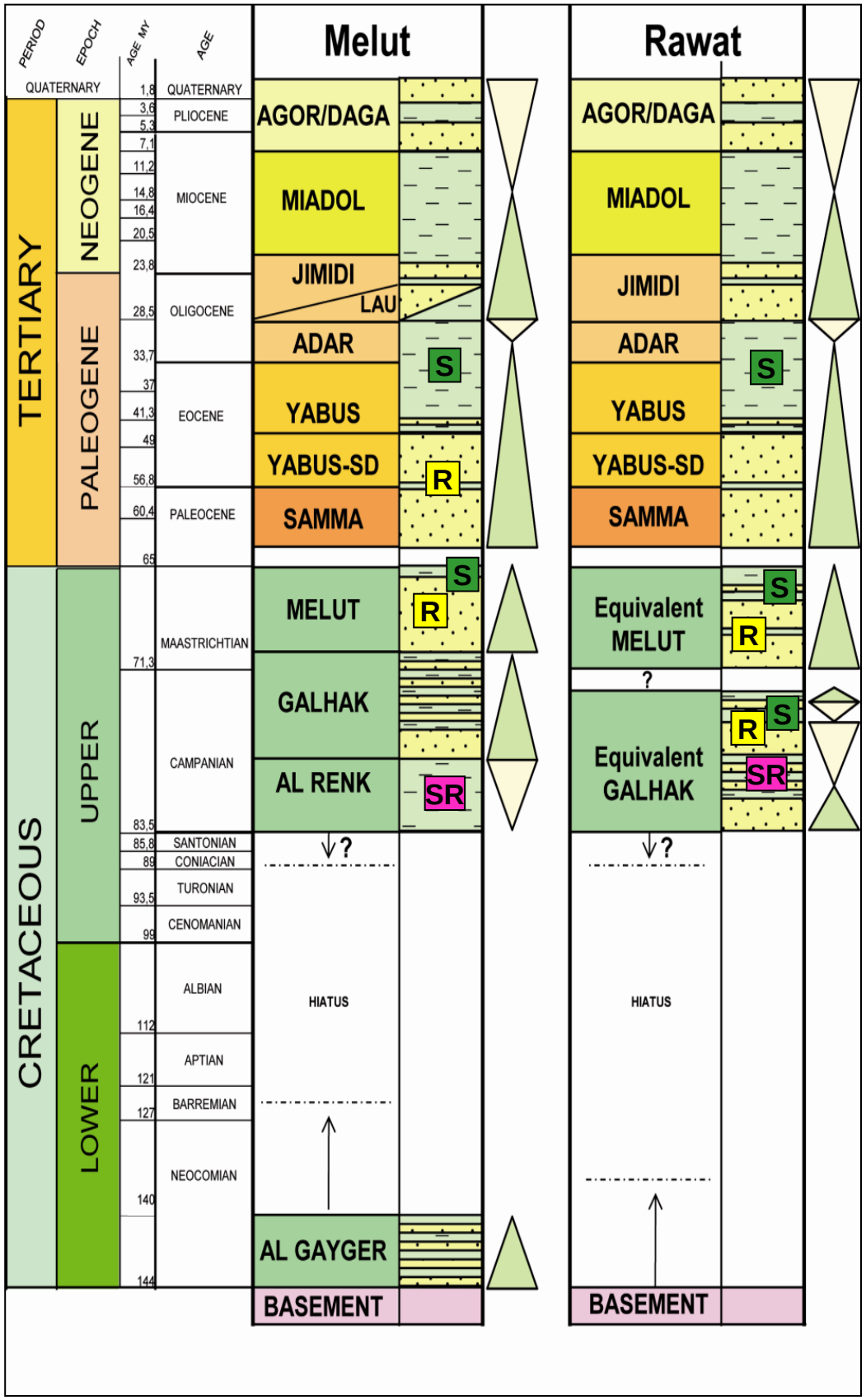
**Petroleum System/s:**
**1- Early Cretaceous (Proven).**
**2- Late Cretaceous (anticipated).**

**Proven Play types:**
**1- Structural traps.**
**2- Basement.**
**3- Tight sands**

**Expected Play types:**
**1- Stratigraphic trap.**
**2- Shale Gas.**

**Resources:**
**Discovered Resources**
**OIIP = 6,501 MMSTB**
**GIIP =2,017 BSCF**
**Undiscovered Resources**
**OIIP = 12,453 MMSTB**

# Rawat (Proven Petroleum System + discoveries)




**Age: Cretaceous**

**Tectonic Evolution:**
**Extensional ,Three Rift cycles.**

**Size: ~11,170 km2**
**Sed. thickness: ~ 6 km**

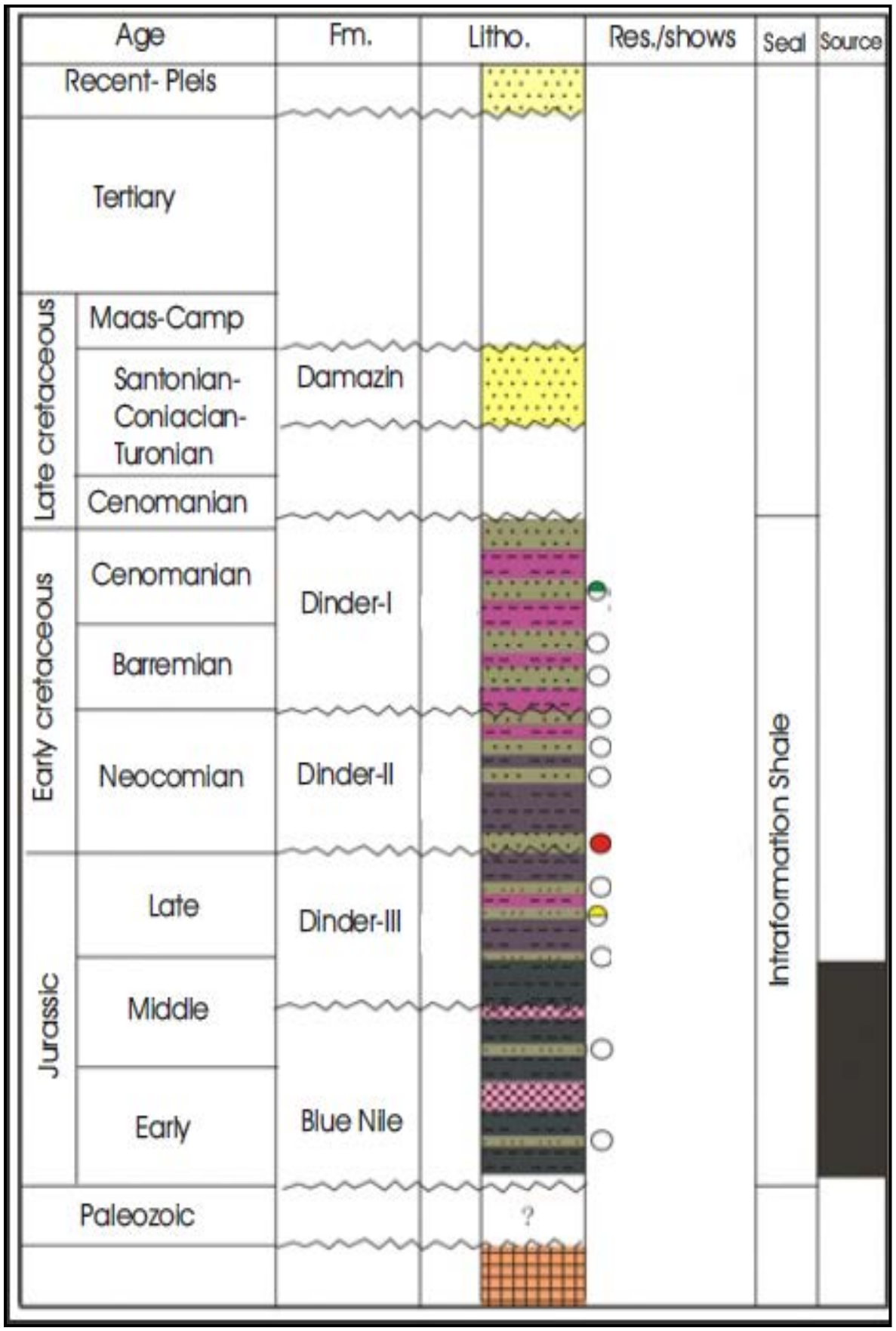
**Petroleum System/s:**
**1- Cretaceous (Proven).**

**Proven Play types:**
**1- Structural traps.**
**2- Tight sands**

**Expected Play types:**
**1- Stratigraphic trap.**

**Resources:**
**Discovered Resources**
**OIIP = 37 MMSTB**
**Undiscovered Resources**
**OIIP = 386 MMSTB**

# Blue Nile (Proven Petroleum System + discoveries)




**Age: Jurassic**

**Tectonic Evolution:**
**Extensional ,One Rift cycle.**

**Size: 40*155 km**
**Sedimentary thickness:~ 7km**

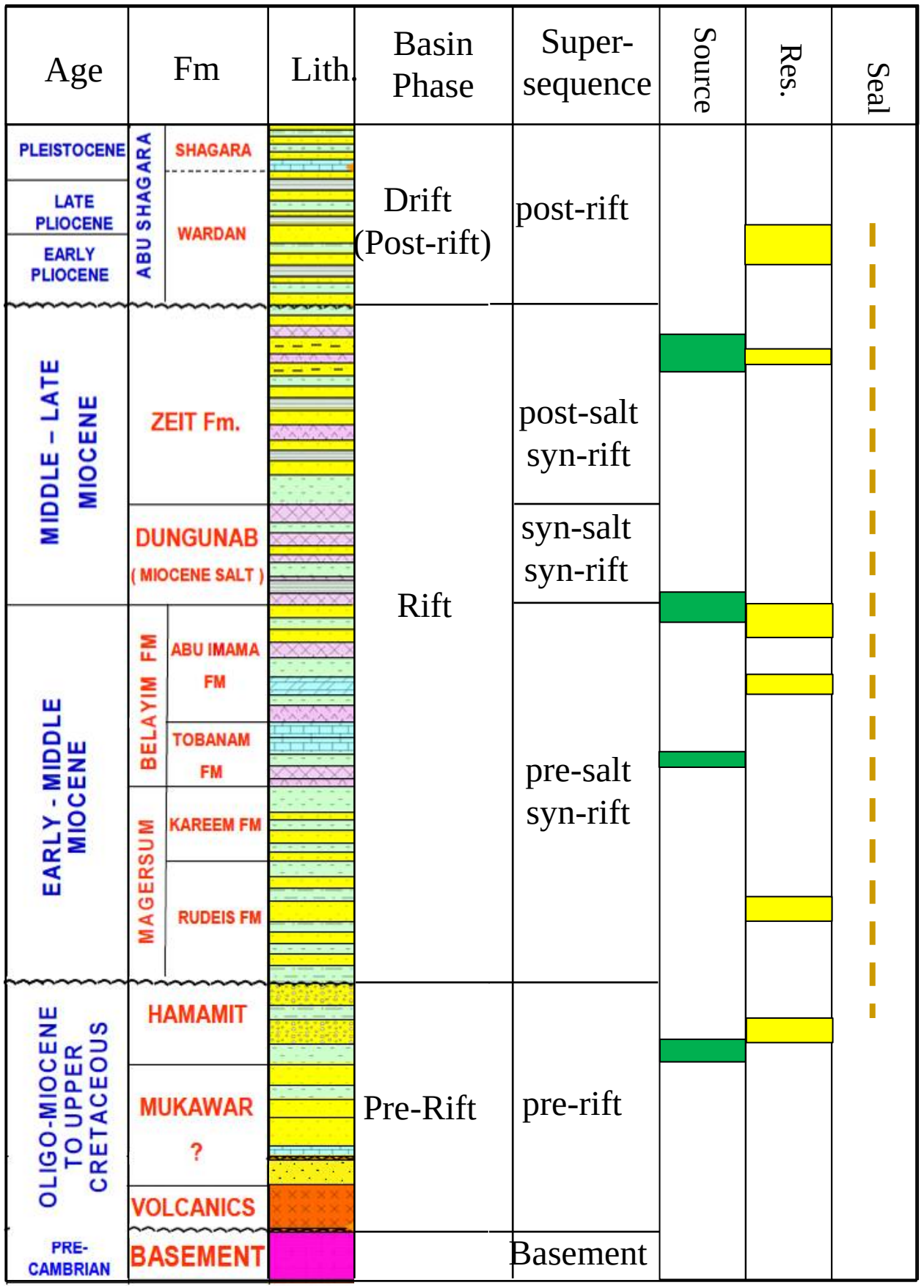
**Petroleum System/s:**
**1- Jurassic- Cretaceous.**

**Proven Play types:**
**1- Structural traps.**
**2- Tight sands**

**Expected Play types:**
**1- Stratigraphic trap.**
**2- Shale Gas.**

**Resources:**
**Discovered Resources**
**OIIP = 1 MMSTB**
**GIIP = 116 BSCF**

# Red Sea (Proven Petroleum System + discoveries)




**Age: Tertiary**

**Tectonic Evolution:**
**Extensional ,One Rift cycle.**

**Size: 300 *1700 km**
**Sed. thickness: ~ 7km**

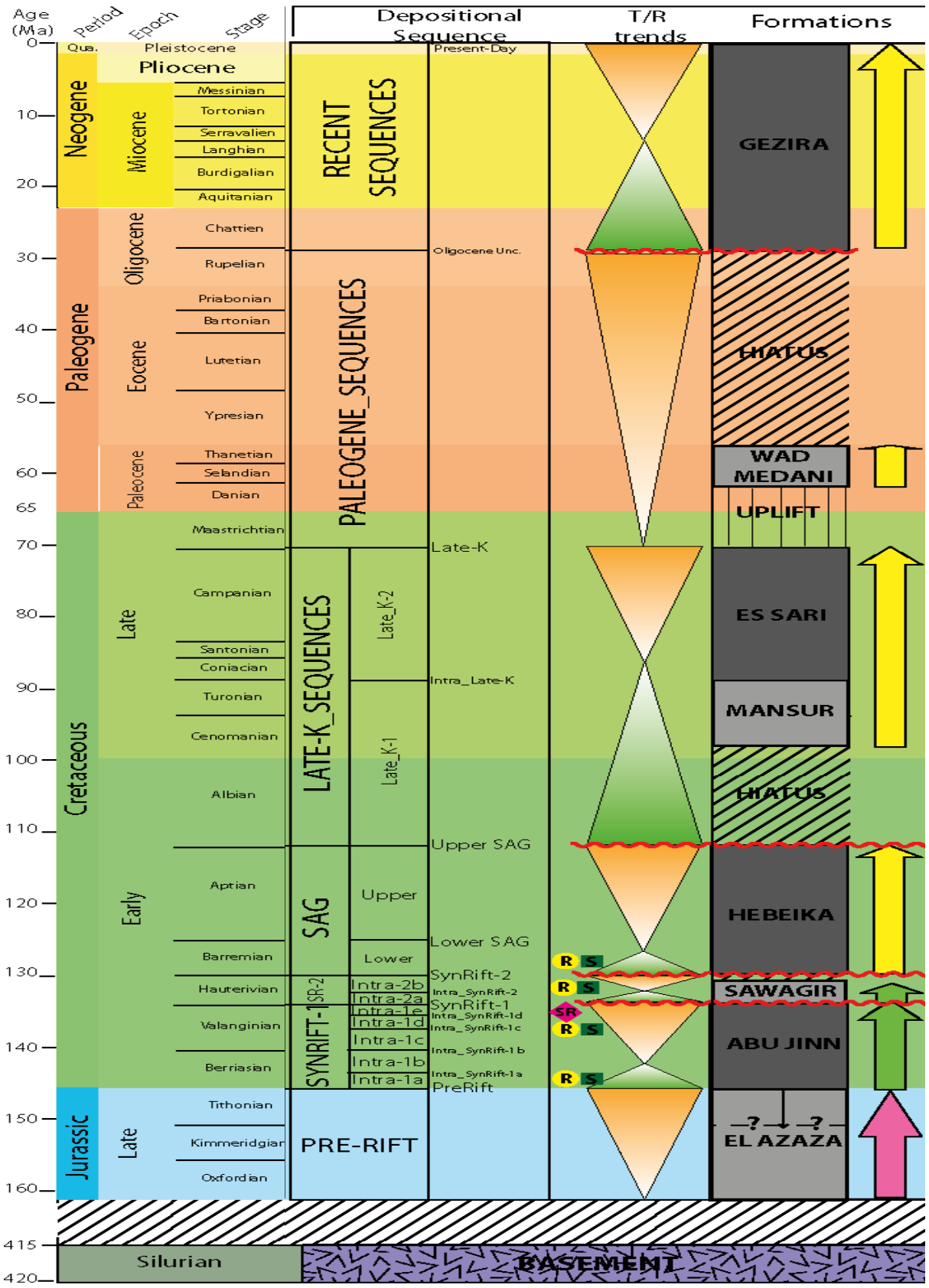
**Petroleum System/s:**
**1- Tertiary.**

**Proven Play types:**
**1- Structural traps.**

**Expected Play types:**
**1- Stratigraphic trap.**

**Resources:**
**Discovered Resources**
**OIIP = 37 MMSTB**
**GIIP = 525 BSCF**
**Undiscovered Resources**
**OIIP = 8,381 MMSTB**

# Khartoum (Proven Petroleum System + discoveries)




**Age: Jurassic**

**Tectonic Evolution:**
**Extensional ,Two Rift cycles.**

**Size: 40*70 km**
**Sed. thickness: ~ 5.5 km**

**Petroleum System/s:**
**1- Cretaceous (Proven).**

**Proven Play types:**
**1- Structural traps.**

**Expected Play types:**
**1- Stratigraphic trap.**

**Resources:**
**Discovered Resources**
**Oil.**
**Undiscovered Resources**
**OIIP = 620 MMSTB**

# Um Agaga (Proven Petroleum System + discoveries)

## UM AGAG STRATIGRAPHIC SCHEME

| Period | Epoch | Formations | Biostrat | Tectonic Cycles | Deposition Environments |
|---|---|---|---|---|---|
| NEOGENE | Miocene | Um Rawaba | | | |
| PALEOGENE | Eocene Oligocene | Um Elkheir | *Proxapertites cursus*<br>*Spinizonocolpites echinatus*<br>*Proxapertites operculatus*<br>*Diltoidospora sp*<br>*Proxapertites operculatus* | Third rift cycle | Non marine fluvial environment grading to shallow lacustrine |
| PALEOGENE | Paleocene | Upper Baza | *Spinizonocolpites echinatus*<br>*Retidiporites sp*<br>*Retidiporites magdalenensis*<br>*Monocolpopllenites sphaeroidites*<br>*Proxapertites cursus*<br>*Longapertites cf.Vaneendenburgi*<br>*Aruacaria sp*<br>*Proxapertites operculatus*<br>*Diltoidospora sp* | | Fluvio - deltaic sequences |
| PALEOGENE | Paleocene | Lower Baza | | | |
| CRETACEOUS | Campanian - Maastrichtian | Al Baja | *Echitriporites trianguliformis*<br>*Periretisyncolpites giganateus*<br>*Zlivisporis blanensis*<br>*Proteacidites sigalii*<br>*Monocolpites marginatus*<br>*Scabratriporites simpliformis*<br>*Pediculisporis reticulates* | Second rift cycle | Shallow lacustrine to overbank deposits |
| CRETACEOUS | Campanian - Maastrichtian | Taba | | | Fluvio - deltaic sequences |
| CRETACEOUS | Turonian - Santonian | Dasis | *Droseridites senonicus*<br>*Tricolpites giganteus*<br>*Zlivisporis blanesis*<br>*Tubistephanocolpites* | First rift cycle | Open lacustrine |
| CRETACEOUS | Turonian - Santonian | Hurriya | | | Non marine fluvial environment grading to shallow lacustrine |
| | | Basement | | | |

Petroleum System: Source, Reservoir, Seal

**Age: Cretaceous**

**Tectonic Evolution: Extensional , three Rift cycles.**

**Size: ~30*80 km**
**Sed. thickness: ~ 5 km**

**Petroleum System/s:**
**1- Cretaceous (Proven).**

**Proven Play types:**
**1- Structural traps.**

**Expected Play types:**
**1- Stratigraphic trap.**

**Resources:**
**Discovered Resources**
**Oil.**
**Undiscovered Resources**
**OIIP = 597 MMSTB**

# Sudan Resources

| Basin | Discovered Resources | | Undiscovered Resources (SR) |
|---|---|---|---|
| | OIIP (MMSTB) | GIIP (BSCF) | OIIP (MMSTB) |
| Muglad | 6,501 | 2,017 | 12,453 |
| Rawat | 37 | | 386 |
| Red Sea | 37 | 525 | 8,381 |
| Blue Nile | 1 | 116 | |
| Um Agaga Basin | | | 597 |
| Khartoum Basin | | | 620 |
| Mourdi Basin | | | 1,167 |
| Total | 6,575 | 2,658 | 23,604 |

# Conclusions

- Tremendous achievements in the HC exploration and development sector has been made in Sudan for the past five decades.

- Until before the South Sudan separation in 2011, Sudan was ranked No. 6 top oil producer in Africa after Egypt (Africa Pedia).

- The reported Undiscovered Resource figures are highly underestimated due to the fact that most of the Sudanese basins are currently not well explored.

- Huge HC resources are expected to be uncovered through literal and wise exploration practices with the advantage of technological advancement.

# Forward Plan

- More efforts are needed to think out of the box and consider testing new plays e.g. stratigraphic traps, basement, shale gas and tight reservoir.

- Application of up-to-date technologies in order to minimize basins exploration and development risks and maximize the resources.


Thank You!