



# PLATEAU UPLIFT, EPEIROGENEY AND CLIMATE CHANGES

## The KALAHARI PLATEAU, a world class laboratory

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M. De Wit

G. Dubois

B. Linol

F. Eckardt

W. Cotterill

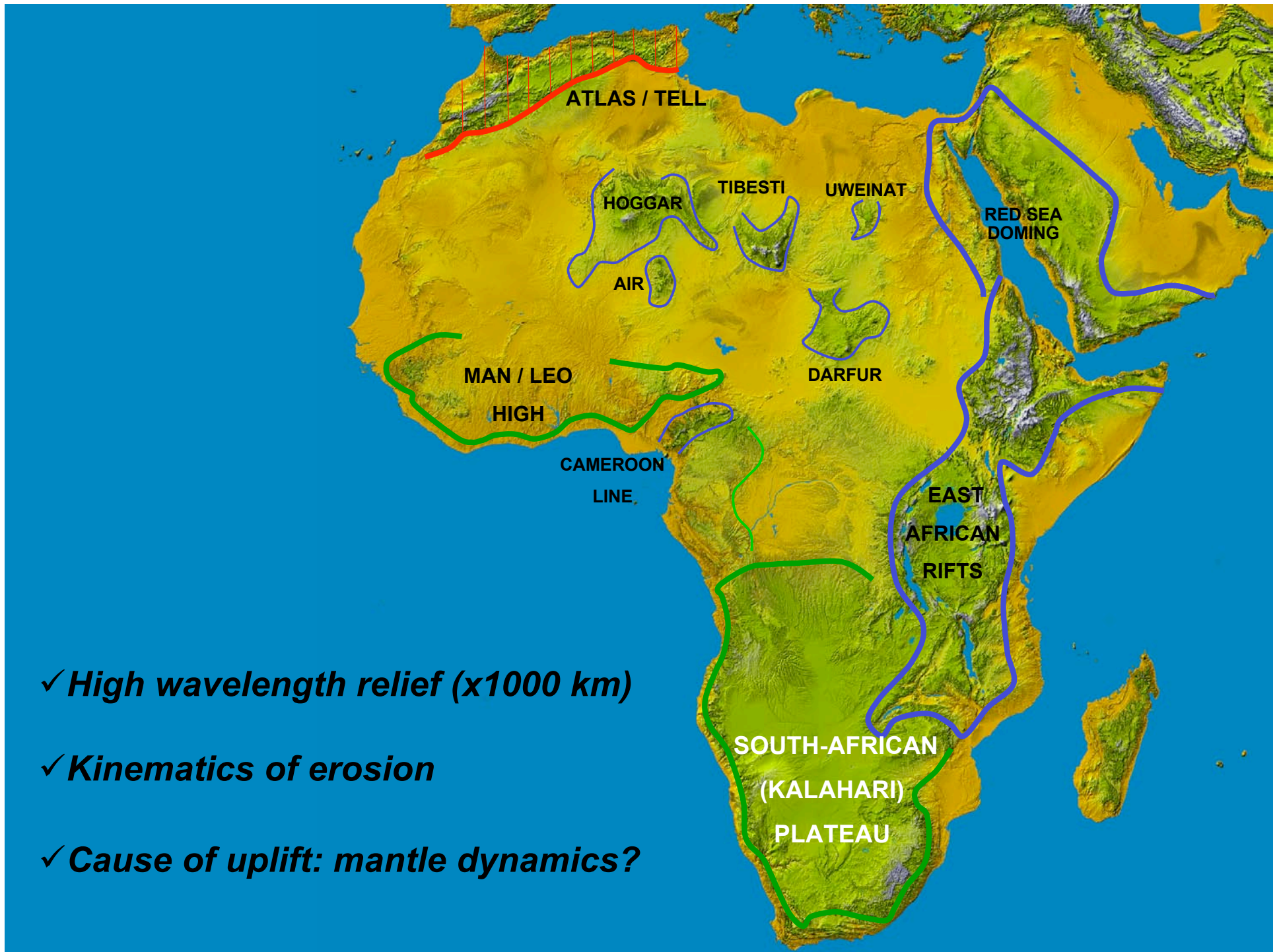
D. Rouby

C. Robin

*Géosciences-Rennes  
Université de Rennes 1*

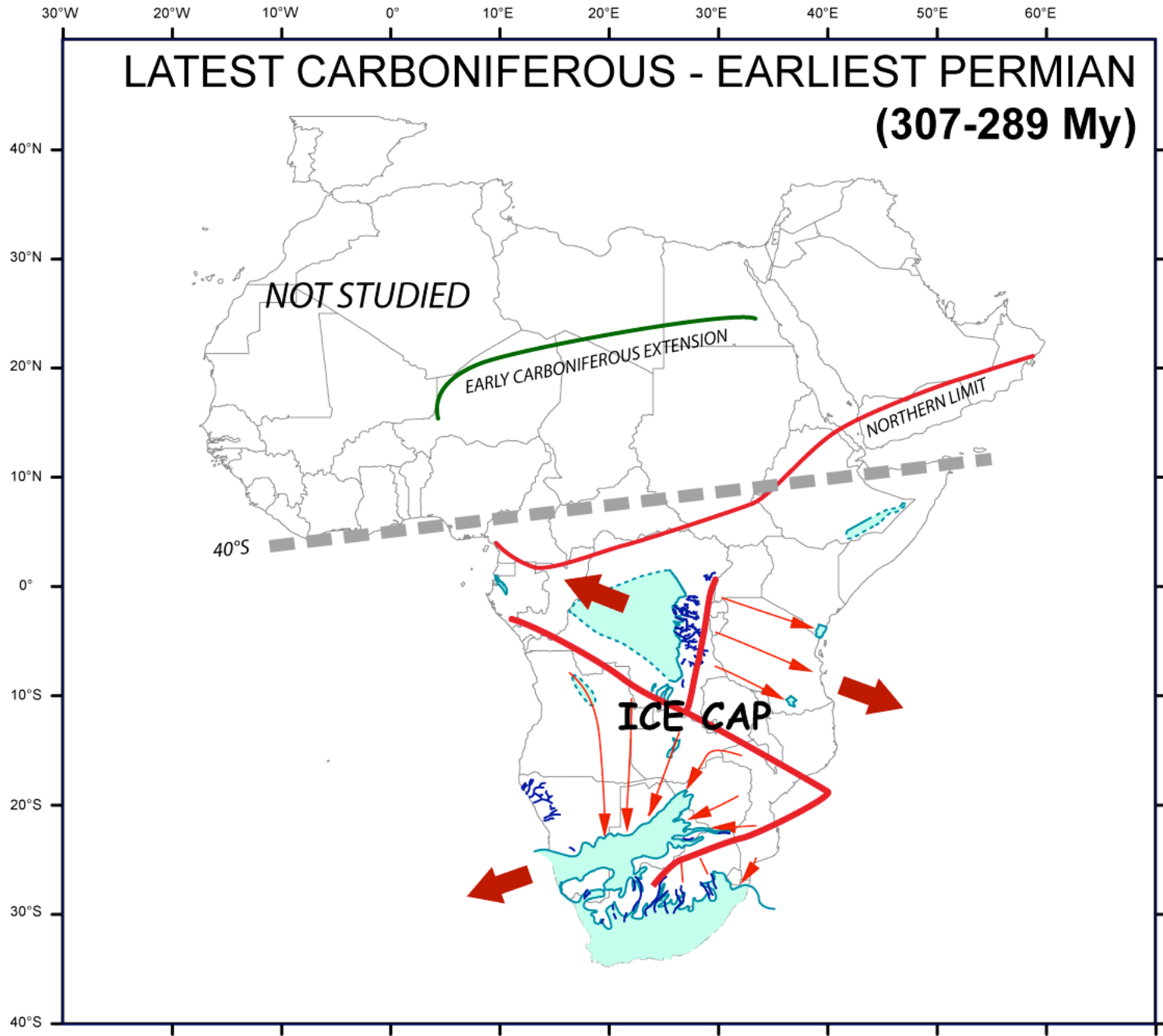
*AEON  
University of Cape Town*





- ✓ *High wavelength relief (x1000 km)*
- ✓ *Kinematics of erosion*
- ✓ *Cause of uplift: mantle dynamics?*

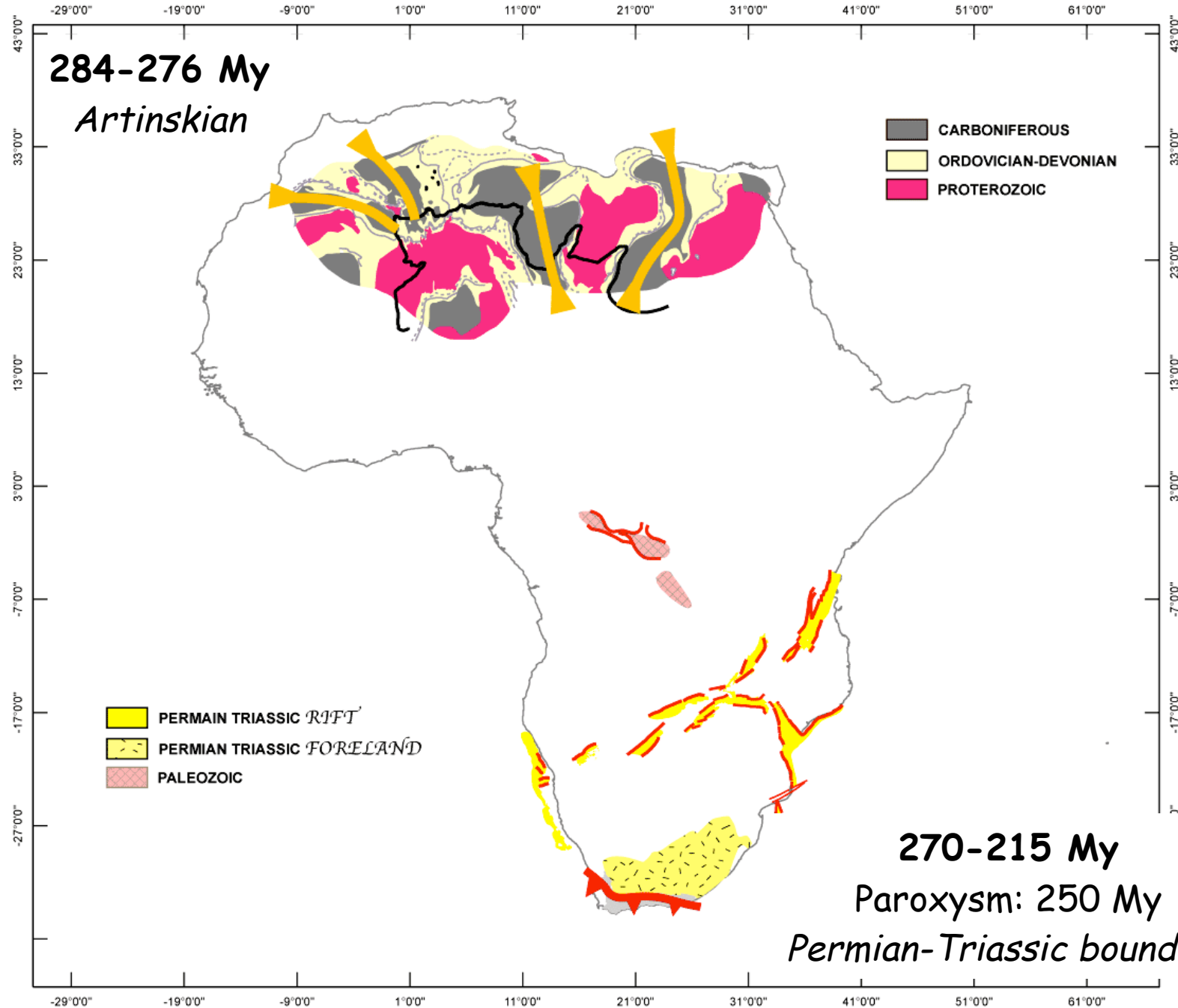




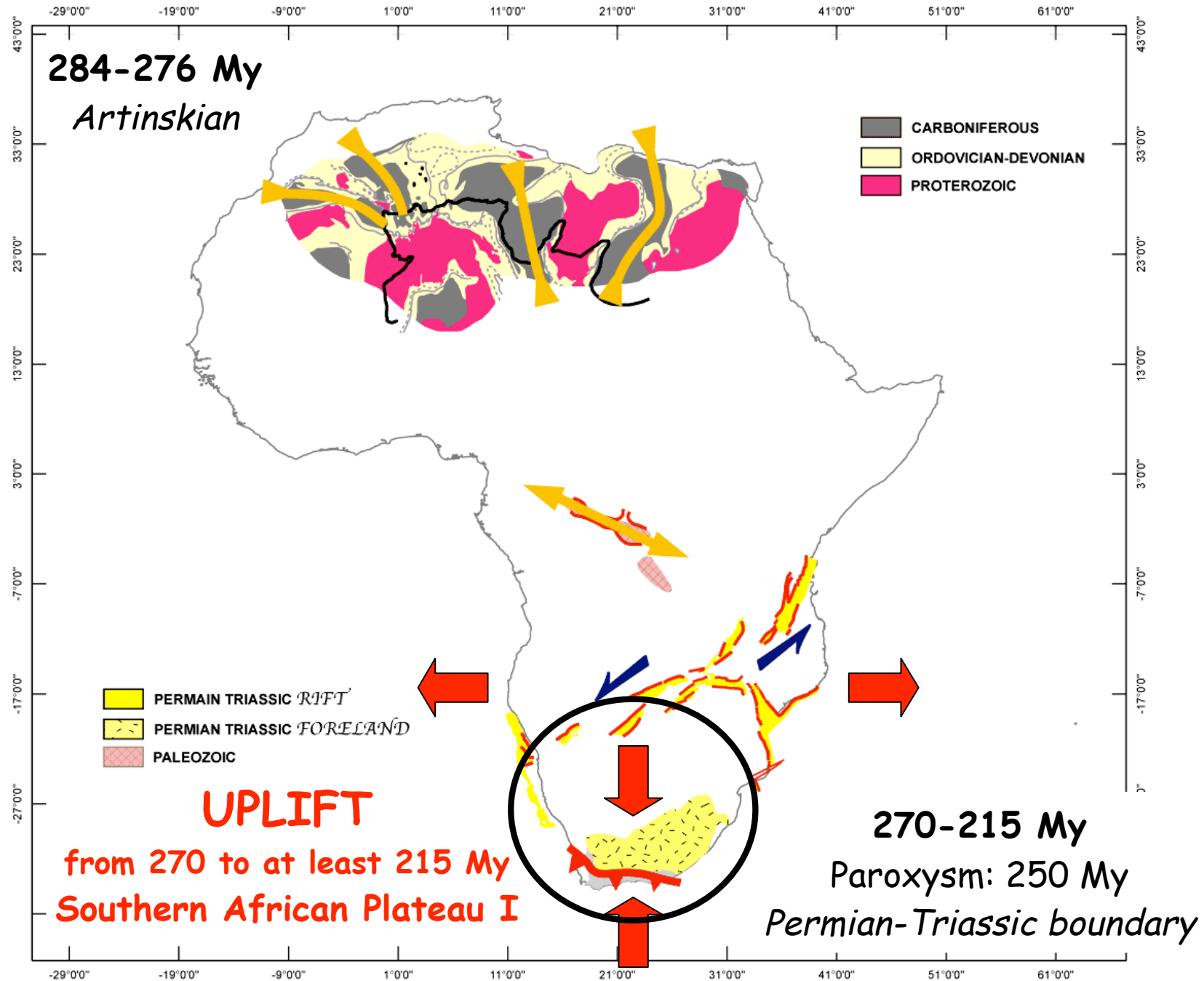
**GLACIATION  
345-290 My**

flooded  
by the sea  
at 285-280 My

# PERMIAN DEFORMATIONS FIRST STEP OF PRESENT-DAY RELIEF



# PERMIAN DEFORMATIONS FIRST STEP OF PRESENT-DAY RELIEF



*KALAHARI PLATEAU UPLIFT*

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# **PASSIVE MARGINS RECORD**

## **Cretaceous Uplifts**

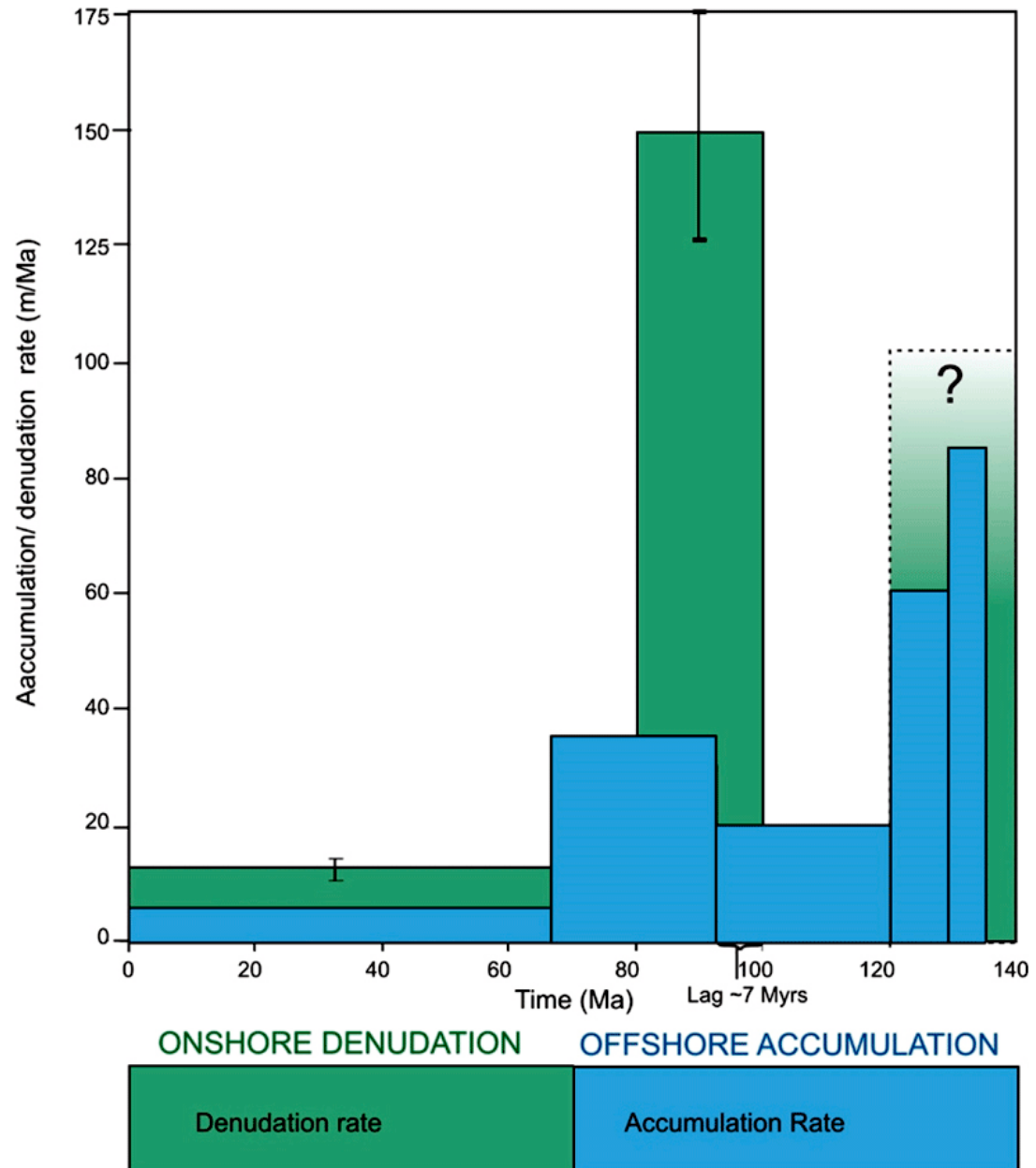
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Aknowledgements : **South African Petroleum Agency**

- *J. Virljoen*
- *D. Van der Spuy*

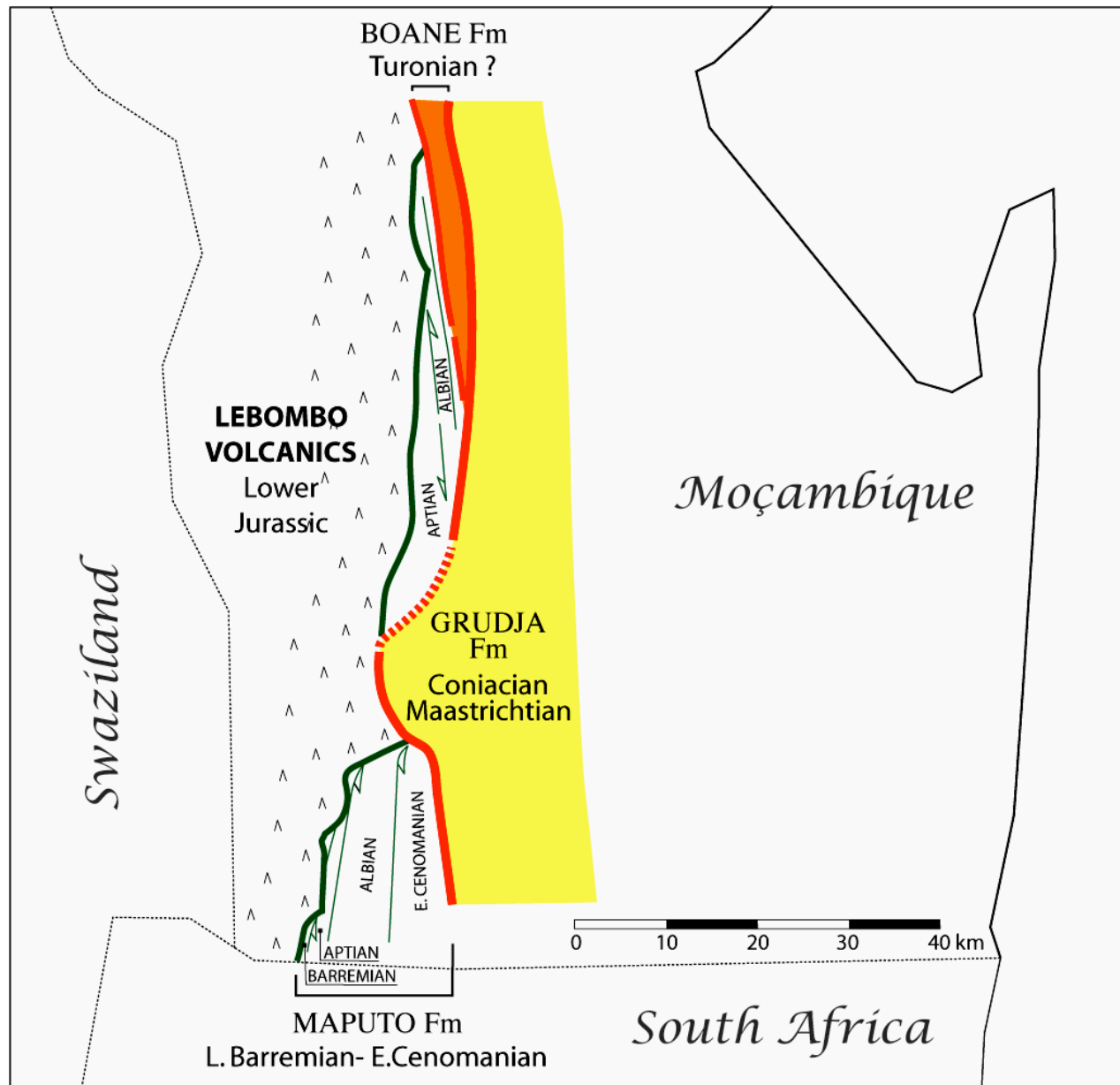
# OFFSHORE ACCUMULATION vs. ONSHORE DENUDATION

## CAPE BASINS



(Tinker *et al.*, 2008a)

# FIELD MAPPING - MAPUTALAND



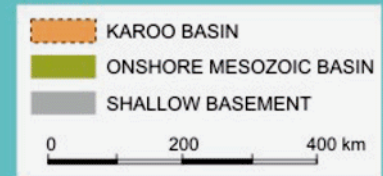
✓ Ante-Barremian paleorelief

✓ Turonian truncation (fluvial) of the basement

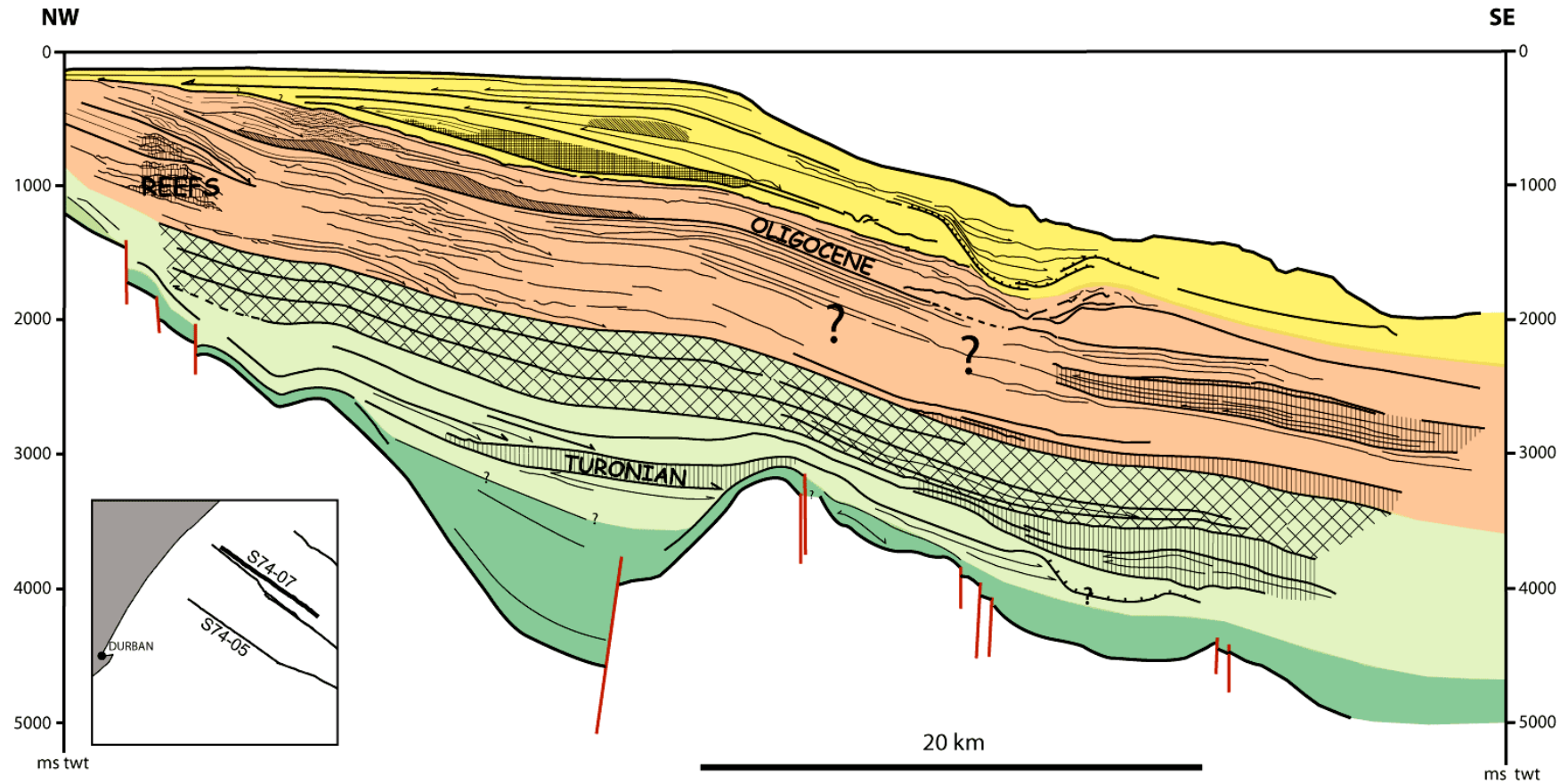
✓ Coniacian incision



# SOUTH AFRICAN PHANEROZOIC BASINS



# DURBAN BASIN - Seismic stratigraphy



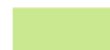
**Hemipelagites**



**NEOGENE**



**PALEOGENE**



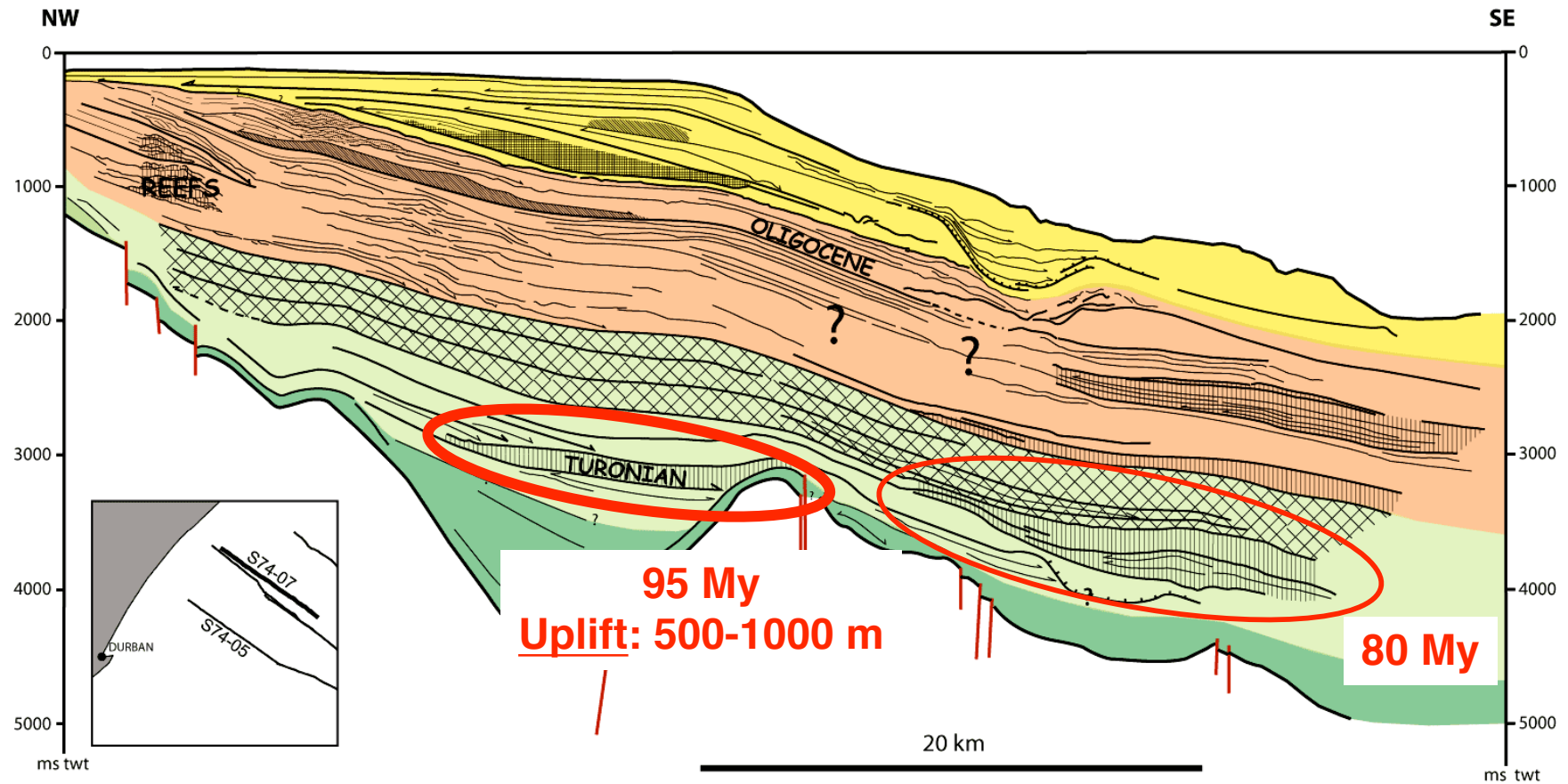
**LATE**



**EARLY**

**CRETACEOUS**

# DURBAN BASIN: Deep-sea fans due to major relative sea-level falls



 **Hemipelagites**

 **NEOGENE**

 **PALEOGENE**

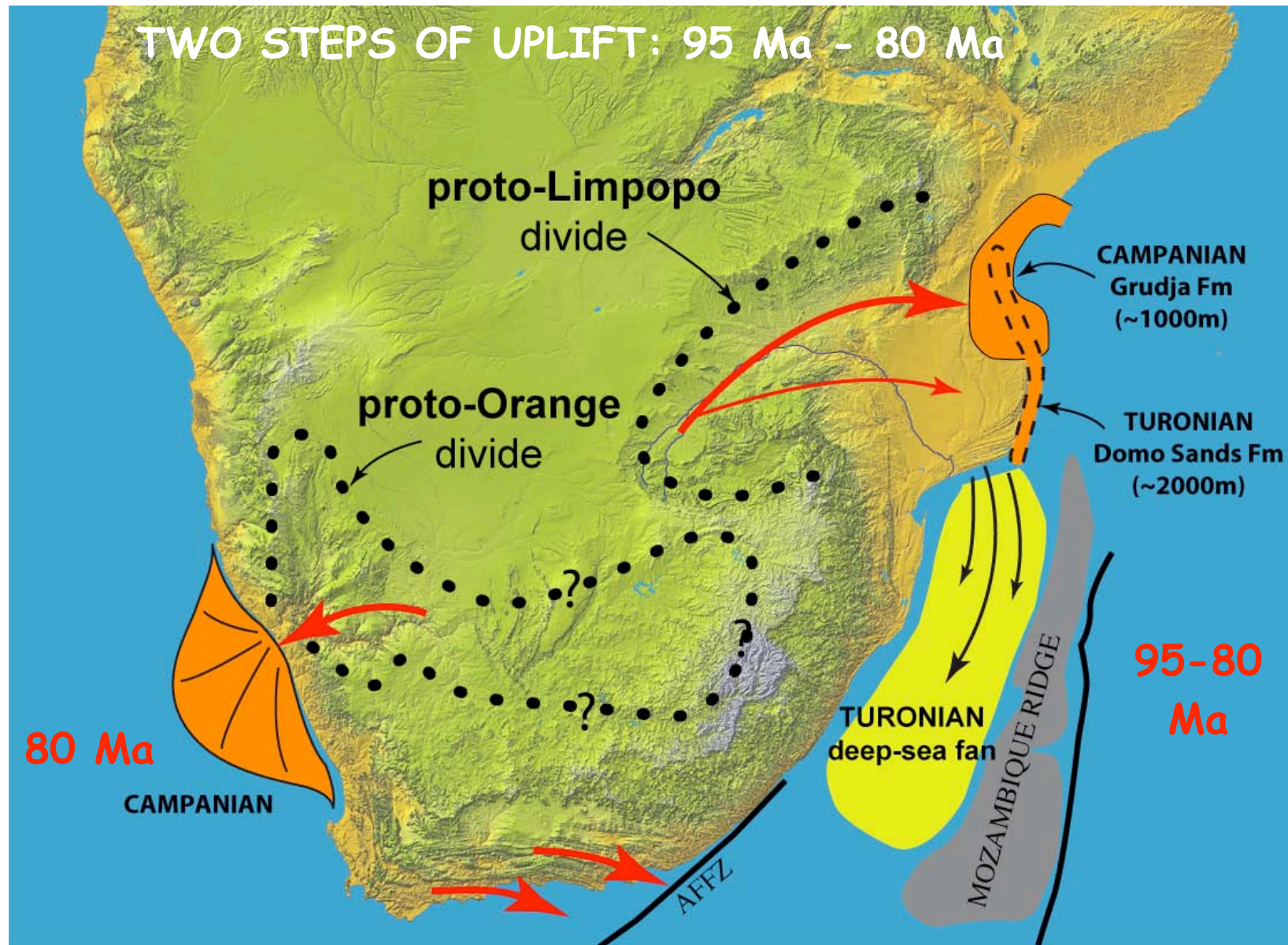
 **LATE**

 **EARLY**

**CRETACEOUS**



# THE UPPER CRETACEOUS UPLIFT OF THE SOUTH AFRICAN PLATEAU



*KALAHARI PLATEAU UPLIFT*

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# **MAPPING PLANATION SURFACES**

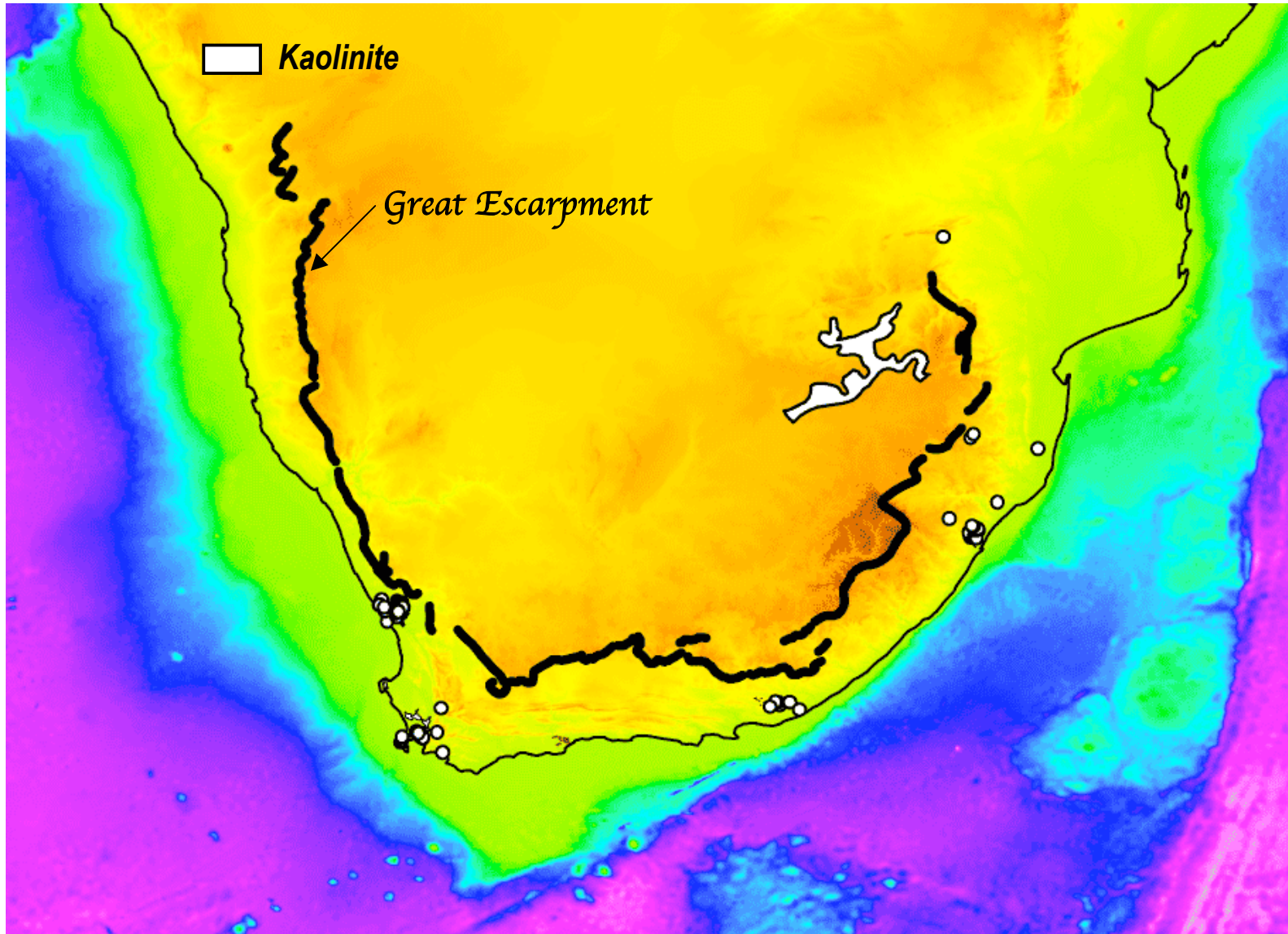
## **Oligocene - Present-day evolution**

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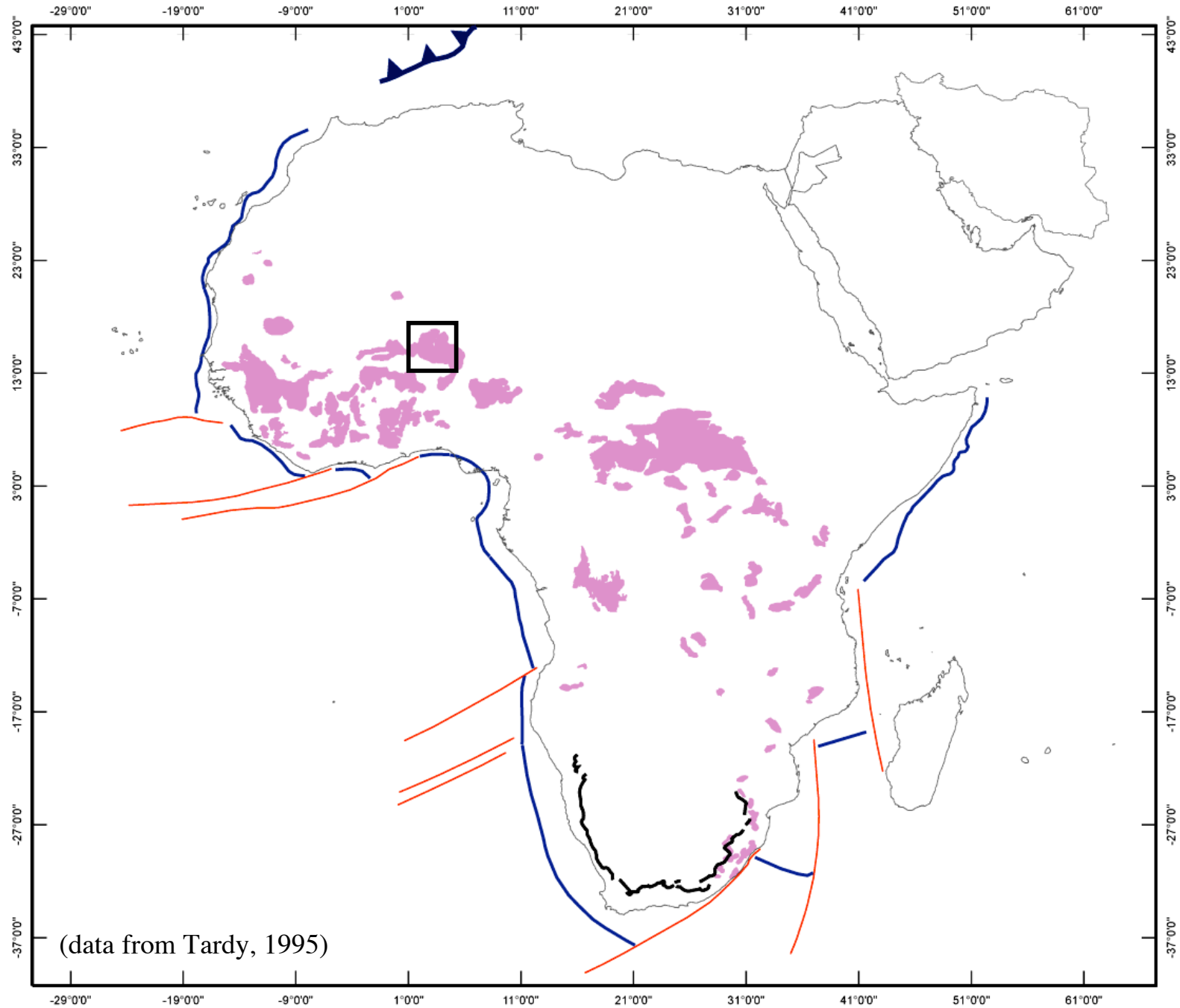


# KAOLINITE DISTRIBUTION MAP

## LATERITES OCCURED AFTER THE GREAT ESCARPMENT RETREAT



# LATERITES ET BAUXITES DISTRIBUTION

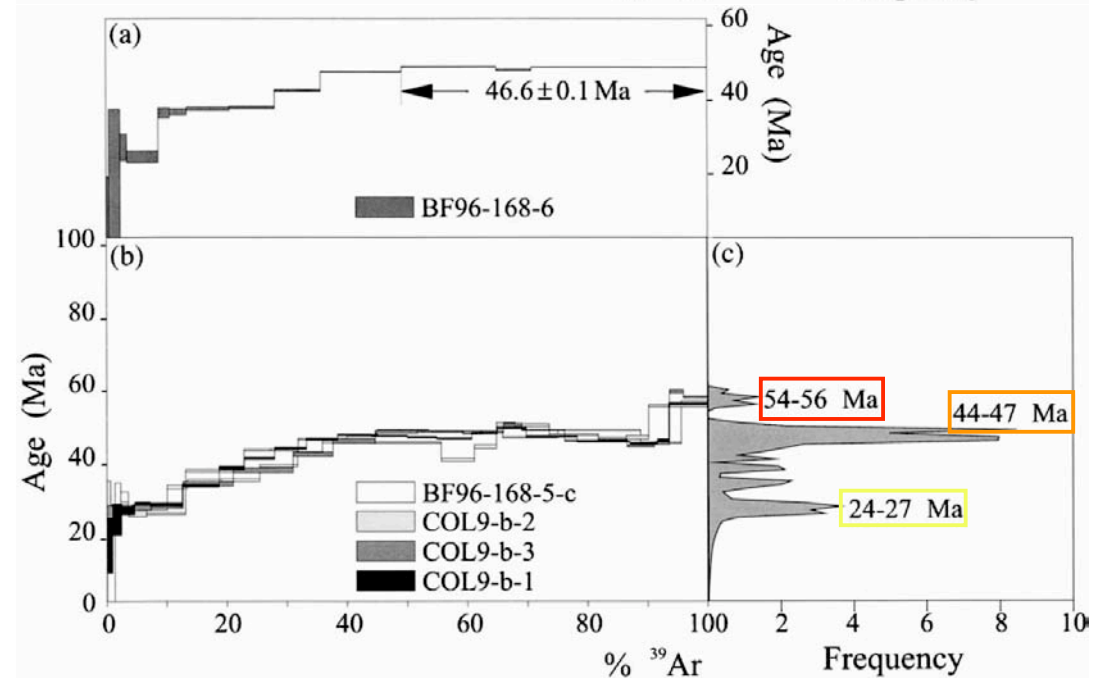
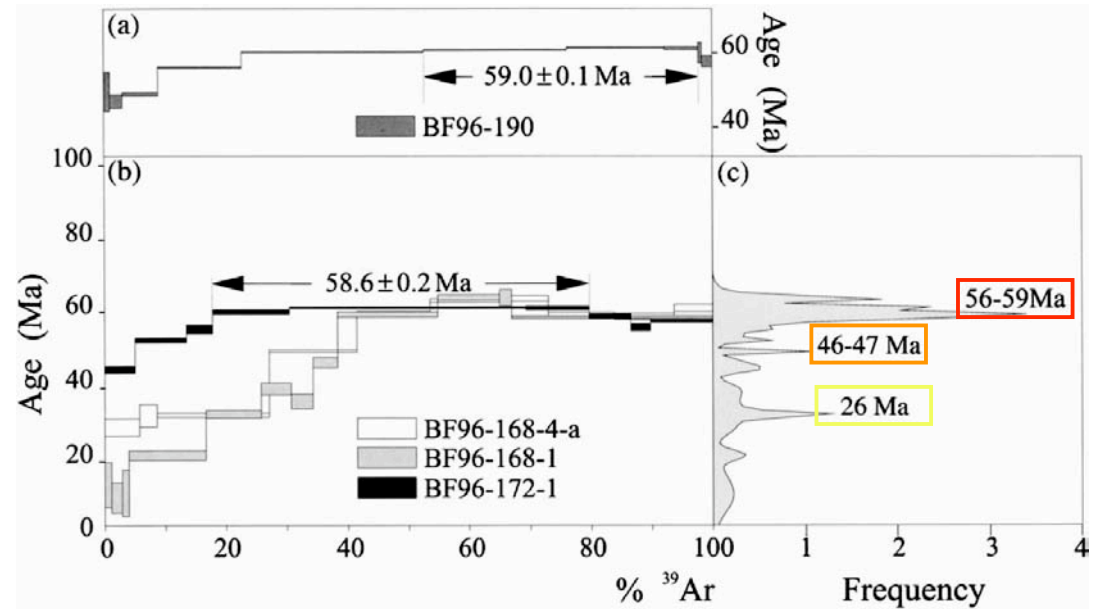


# DATING PALEOWEATHERINGS

## CRYPTOMELANE PISOLITES

$^{39}\text{K}$ - $^{40}\text{K}$

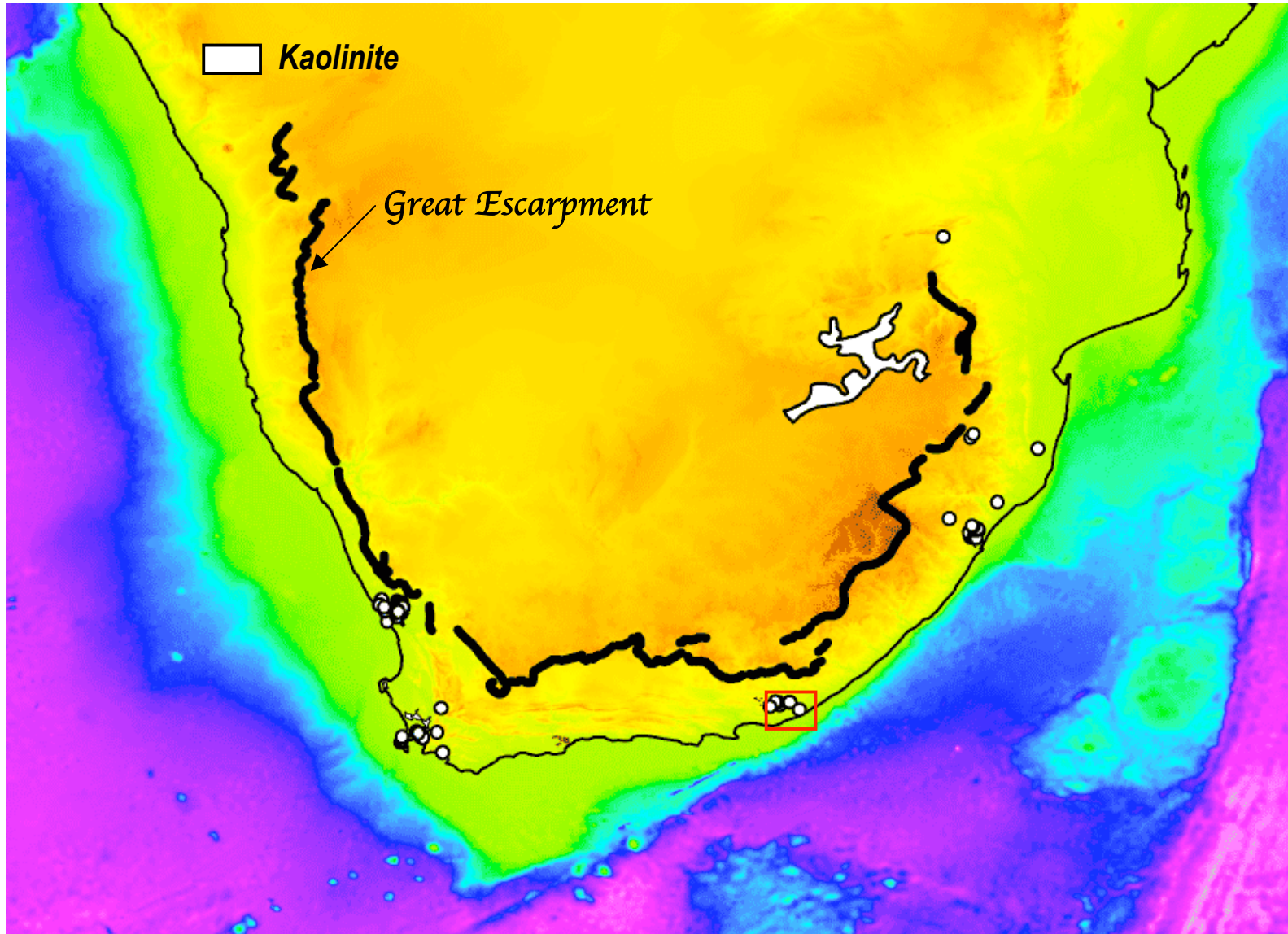
BURKINA-FASO



(Colin *et al.*, 2005)

# KAOLINITE DISTRIBUTION MAP

## LATERITES OCCURED AFTER THE GREAT ESCARPMENT RETREAT





**SOUTH GRAHAMSTOWN: an incised planation surface (Birbury Surface)**





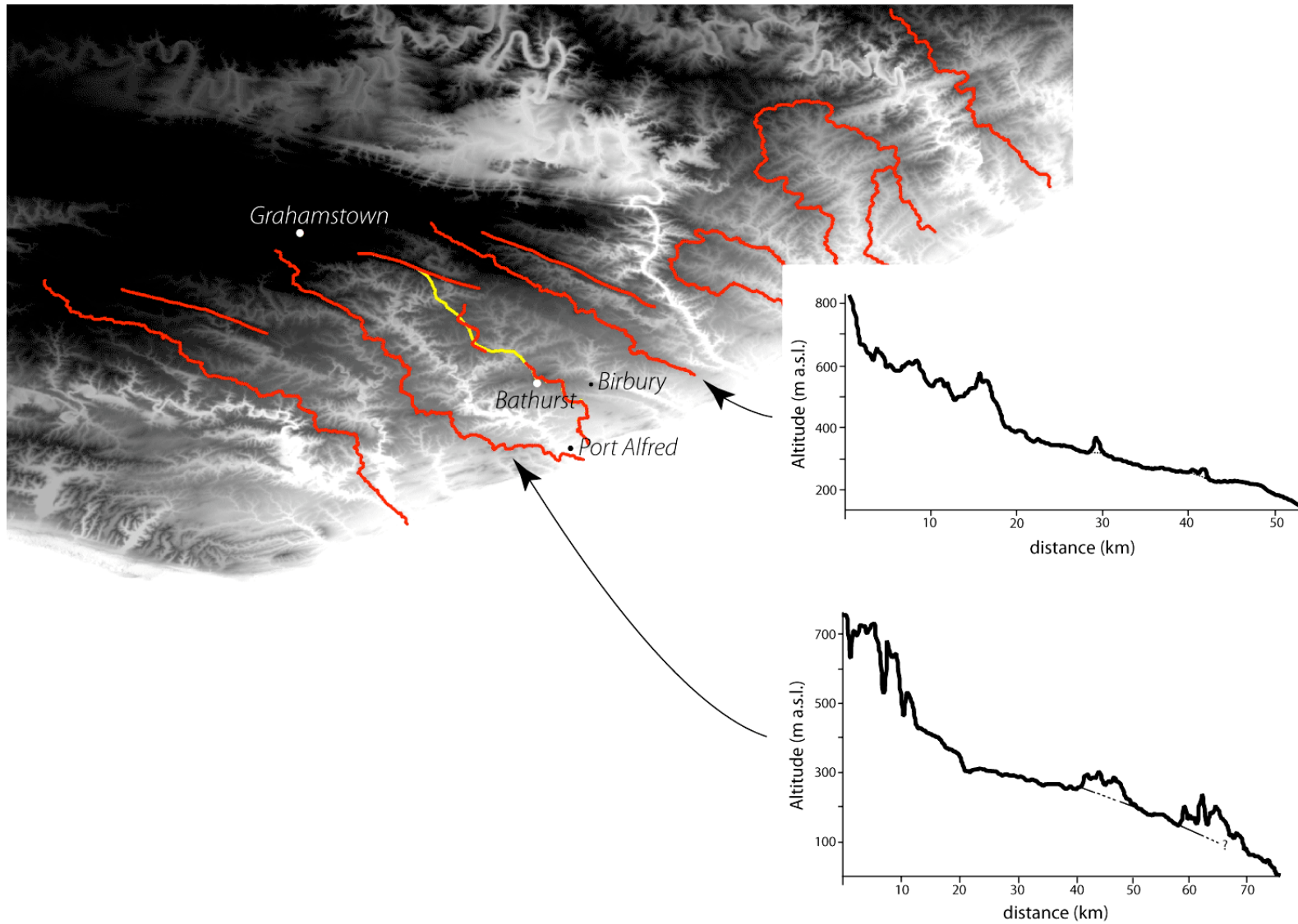
**EOCENE  
SHALLOW  
MARINE  
LIMESTONES**



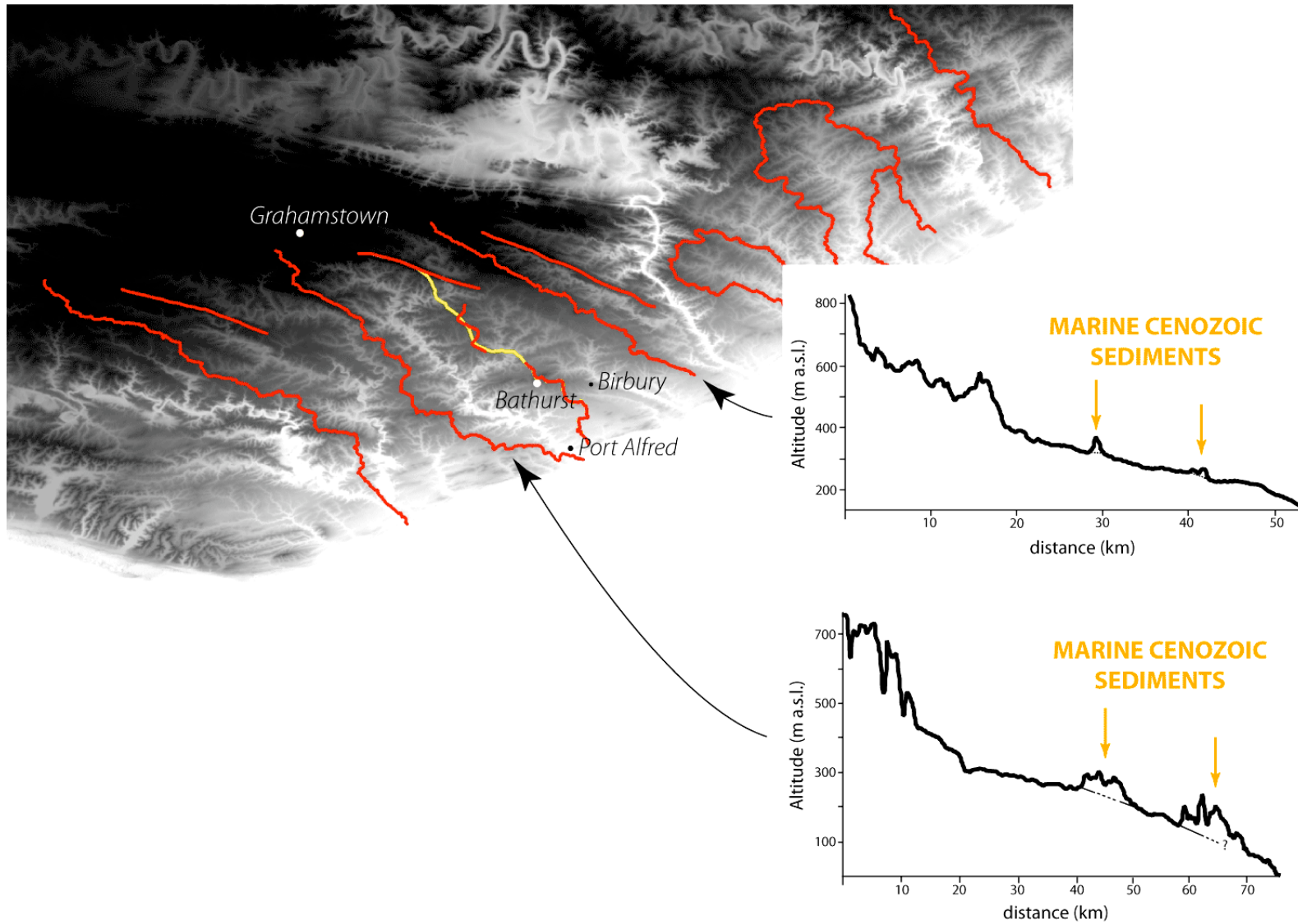
*Birbury  
type-section*



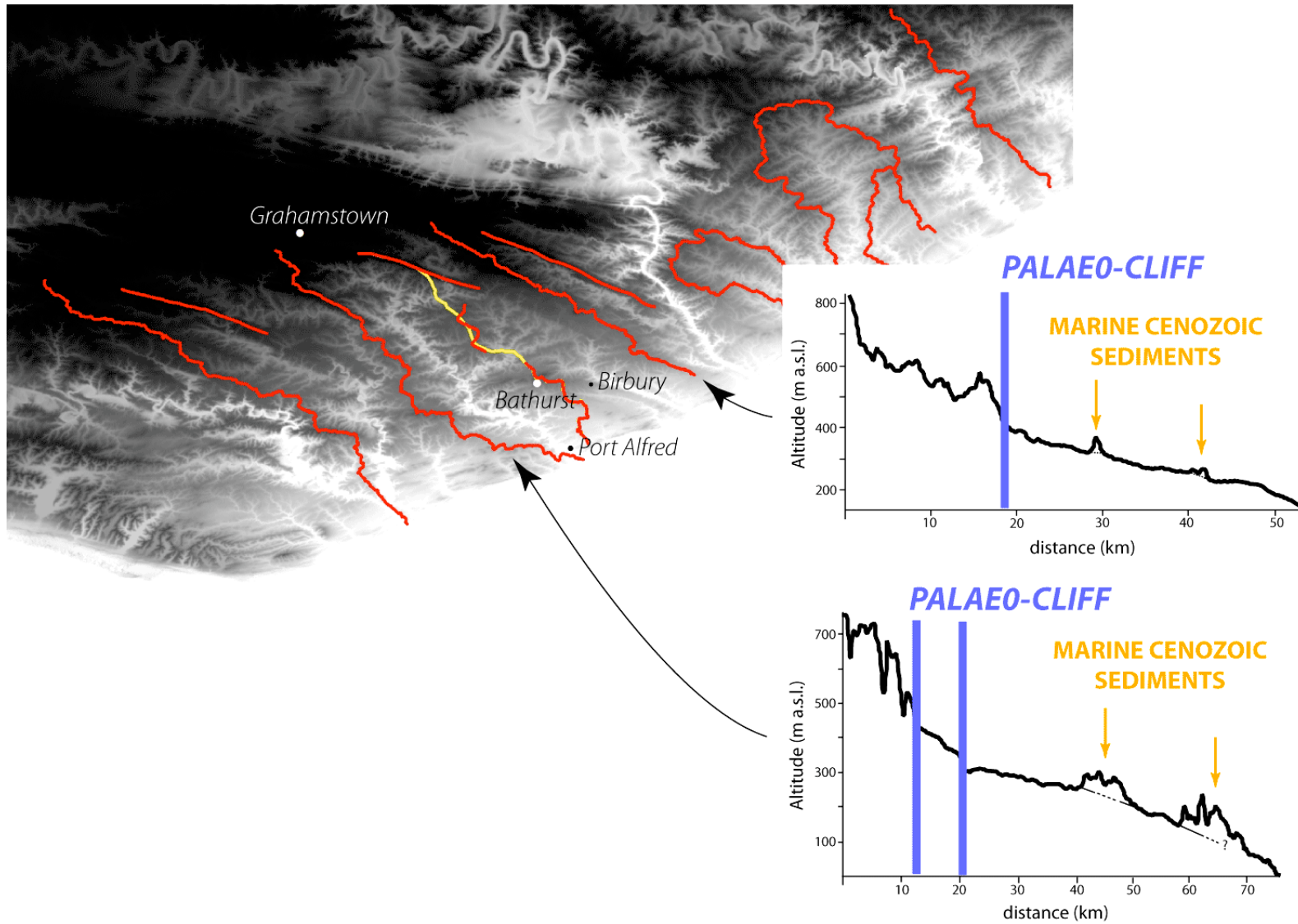
# CHARACTERIZATION OF A MARINE PLANATION SURFACE



# CHARACTERIZATION OF A MARINE PLANATION SURFACE

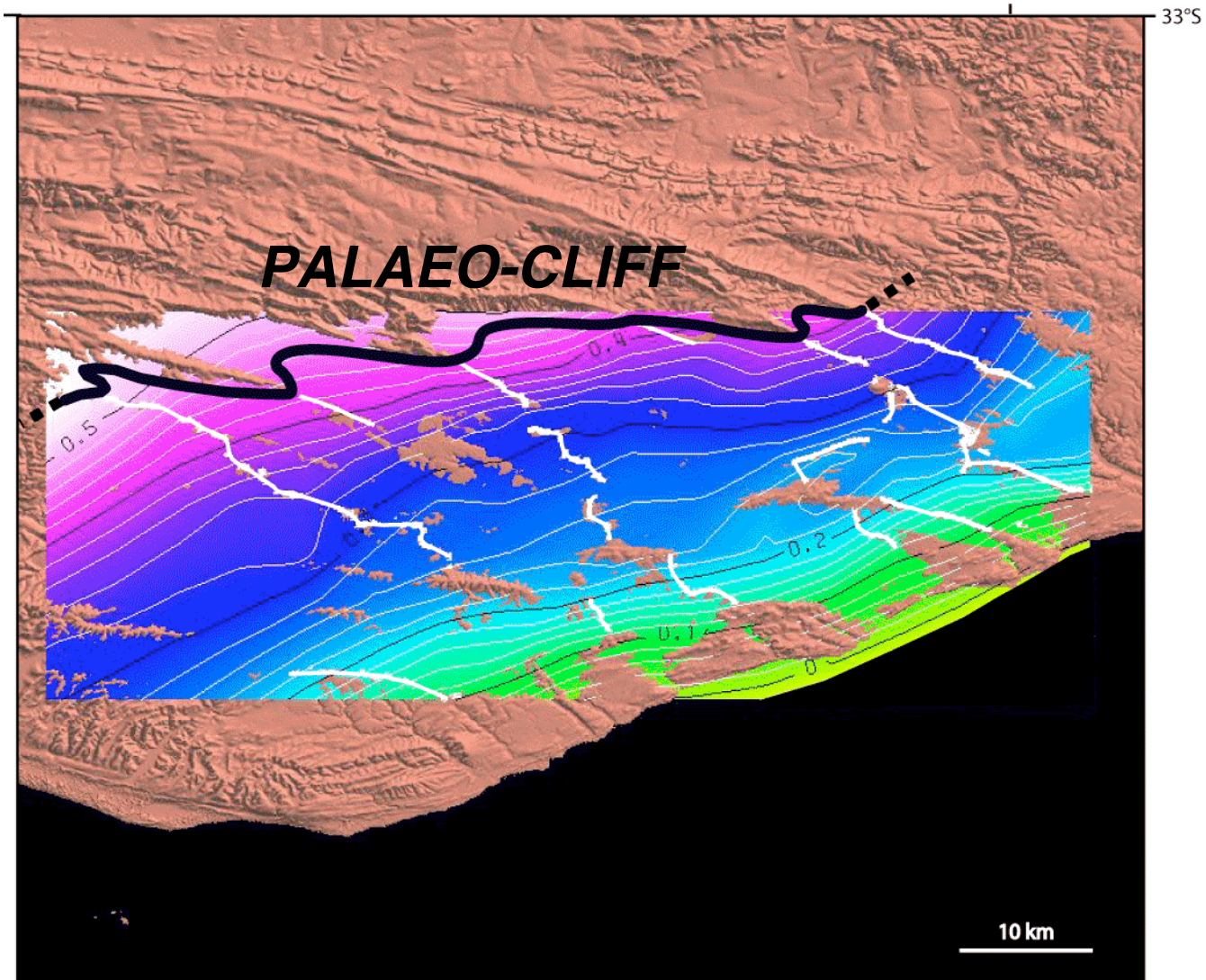


# CHARACTERIZATION OF A MARINE PLANATION SURFACE





# BIRBURY MARINE SURFACE : PRESENT-DAY ELEVATION

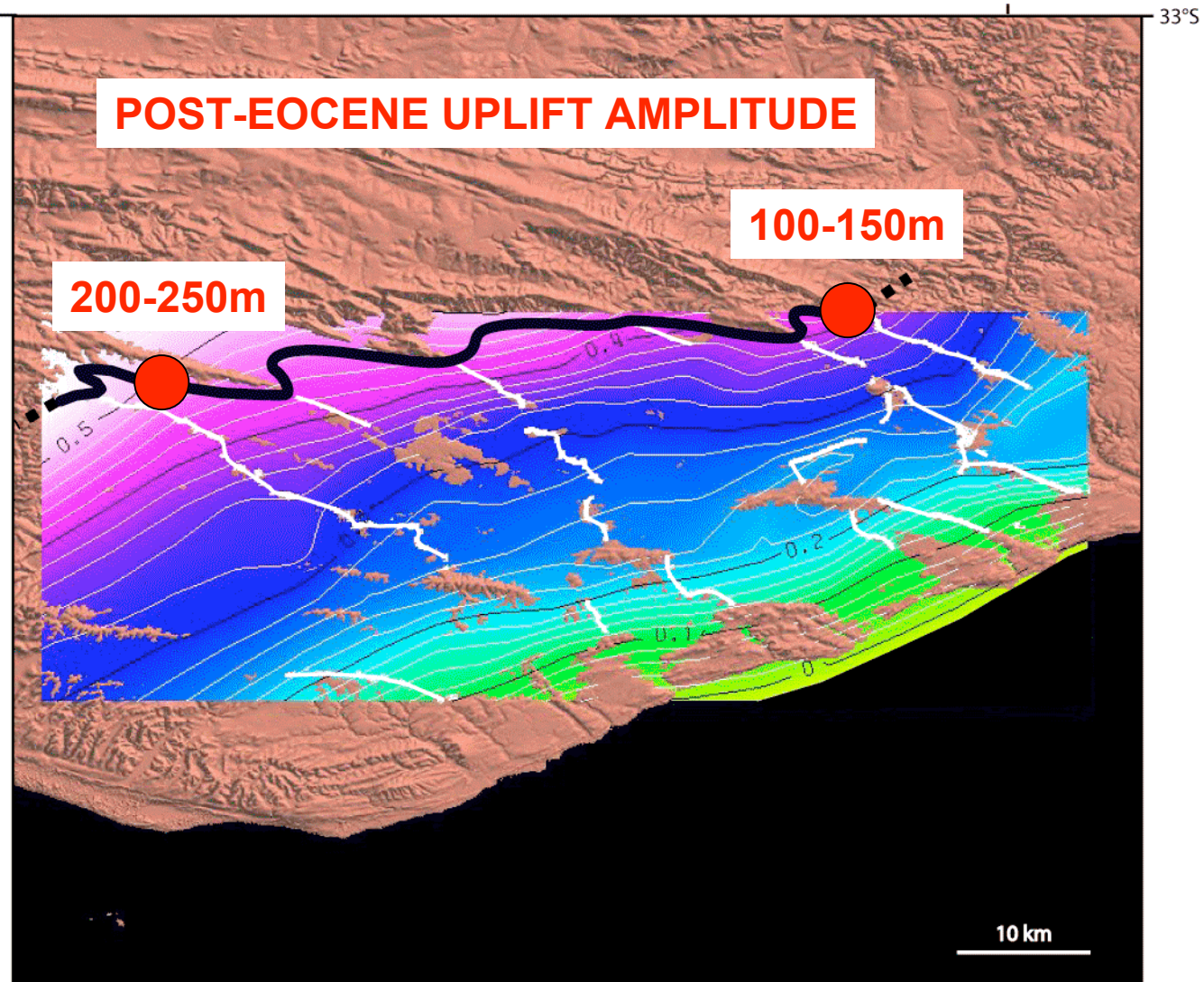



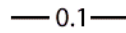


- PALAEO-CLIFF**
- 0.1 — Present-day elevation of the Eocene marine surface (km)**
- Preserved sediments above the marine surface**
- Crestlines : palaeosurface remnants**



# BIRBURY MARINE SURFACE : PRESENT-DAY ELEVATION

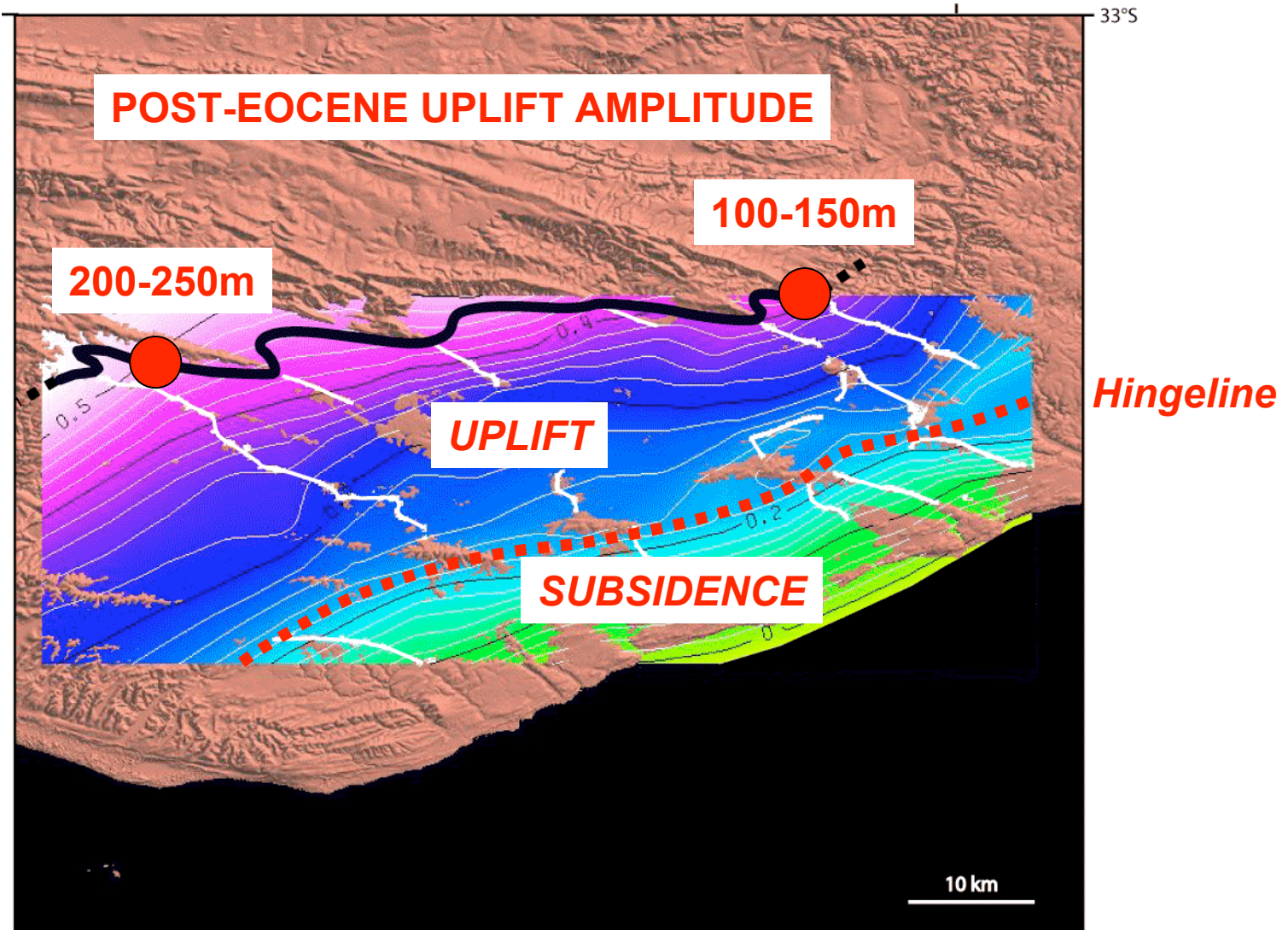
EOCENE  
SEA-LEVEL  
+200-250m



-  **PALAEO-CLIFF**
-  0.1 Present-day elevation of the Eocene marine surface (km)
-  Preserved sediments above the marine surface
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# BIRBURY MARINE SURFACE : PRESENT-DAY ELEVATION

EOCENE  
SEA-LEVEL  
+200-250m



- PALAEO-CLIFF
- 0.1 —** Present-day elevation of the Eocene marine surface (km)
- Preserved sediments above the marine surface
- Crestlines : palaeosurface remnants

*KALAHARI PLATEAU UPLIFT*

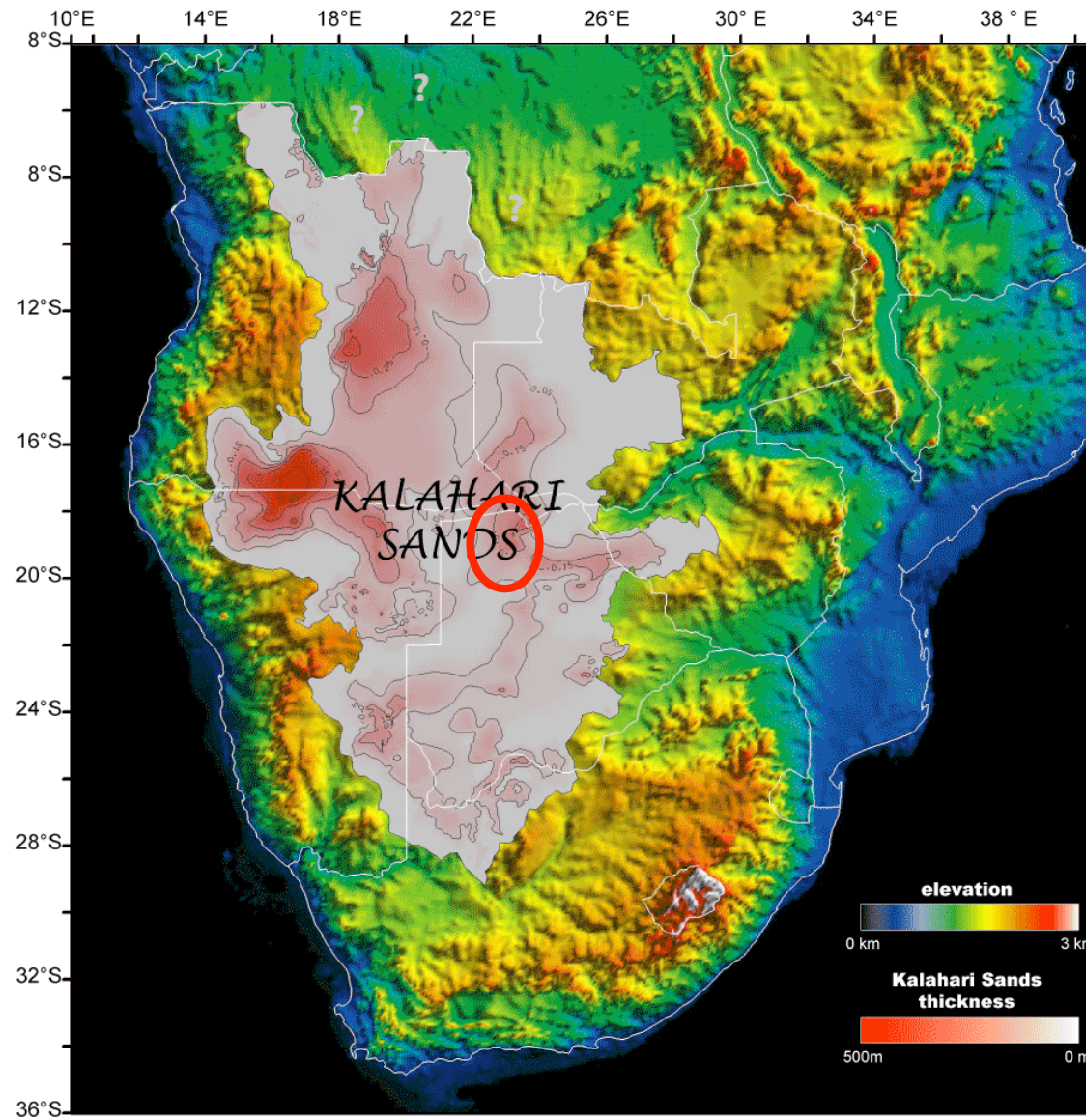
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# **KALAHARI DESERT INFILLING**

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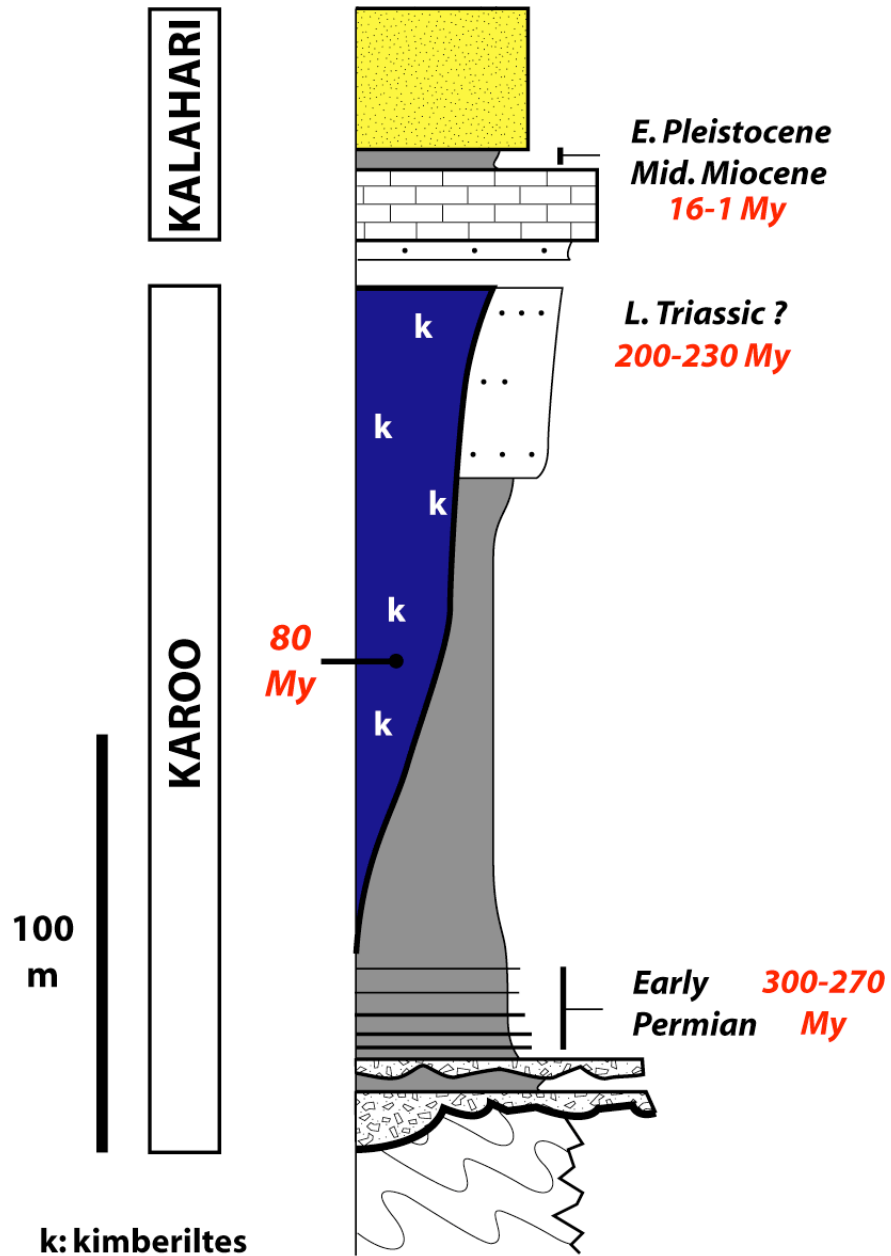


# KALAHARI SANDS INTRACONTINENTAL BASIN



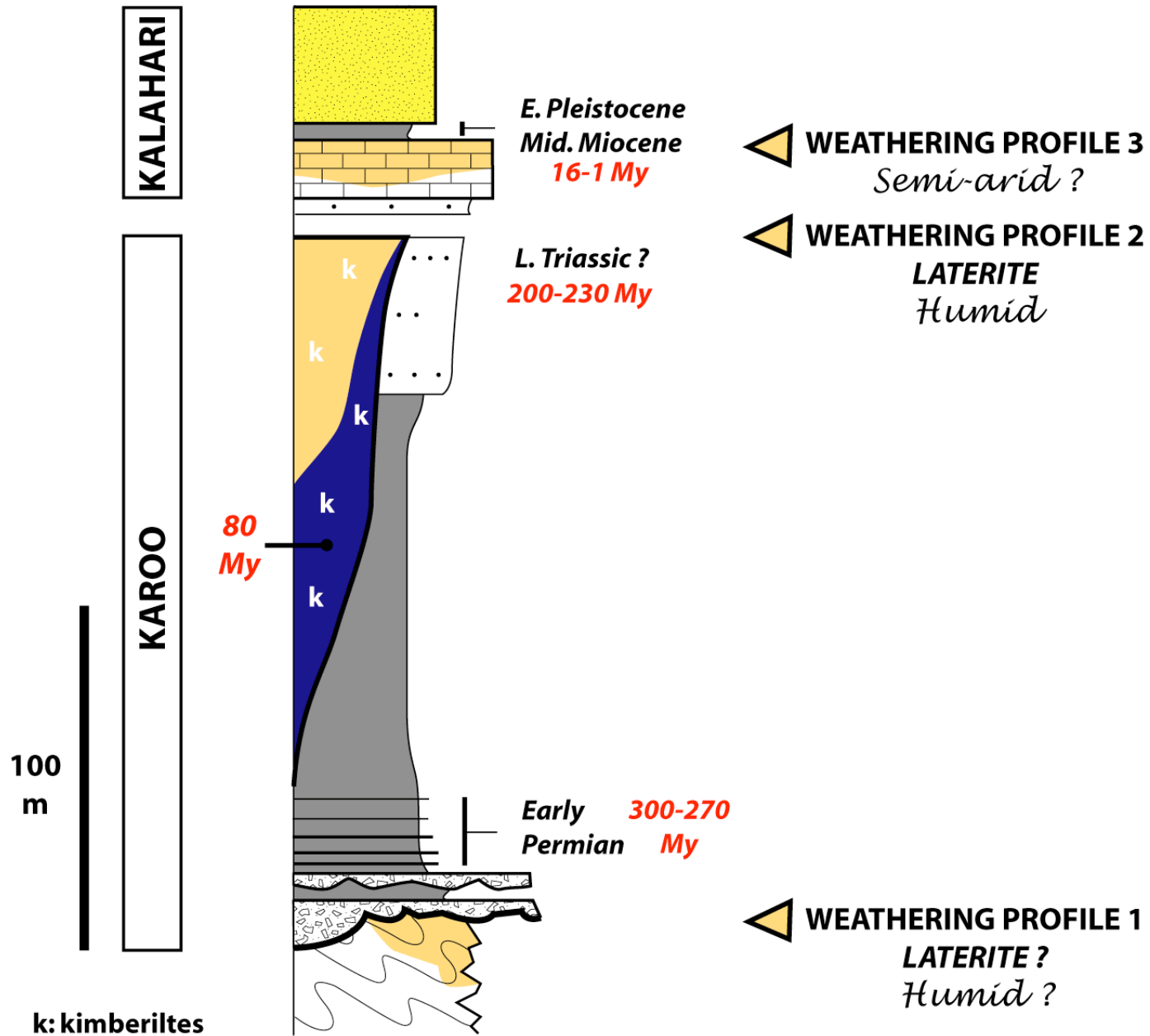
(data from Haddon & McCarthy, 2005)

# NW BOTSWANA DRILLINGS





# NW BOTSWANA DRILLINGS



*KALAHARI PLATEAU UPLIFT*

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## **TIMING OF UPLIFT**

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# TIMING OF THE KALAHARI PLATEAU UPLIFT

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- 345-290 My** Glaciation  
Marine flooding over the Kalahari (285-280 My)
- ~ 250 My** Uplift I  
*Cape Fold Belt (270-215 My)*
- 140-120 My** Uplift II  
*Atlantic and Indian Oceans opening*
- 95-80 My** Uplift III - paroxysm
- 40-35 My** Uplift IV - eastern part of the Plateau



A topographic map of the African continent is shown in the background, with elevation indicated by colors from green (low) to brown (high). The map is overlaid with three horizontal yellow bands containing text. The title 'DENUDATION RATE THROUGH TIME' is centered at the top in a yellow band.

# DENUDATION RATE THROUGH TIME

**16-0 My**

**1-3 m/My**

*1mm per millenium*

**65-35 My**

**10-15 m/My**

*1mm per century*

**95-80 My**

**175-125 m/My**

*1-2mm per decade*

# PERSPECTIVES

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- ✓ **DATING THE BASE OF THE KALAHARI « BASIN » INFILLING**
- ✓ **DATING THE PALAEOWEATHERINGS**
- ✓ **SEQUENCE STRATIGRAPHIC MEASUREMENT OF THE UPLIFT**
- ✓ **HIGH RESOLUTION SEDIMENTATION BUDGET : ONSHORE - OFFSHORE**
- ✓ **PALAEO TOPOGRAPHY AT TIME OF KAROO FLOOD BASALT**
- ✓ **MODELLING THE EROSION : PHYSICAL vs. CHEMICAL**





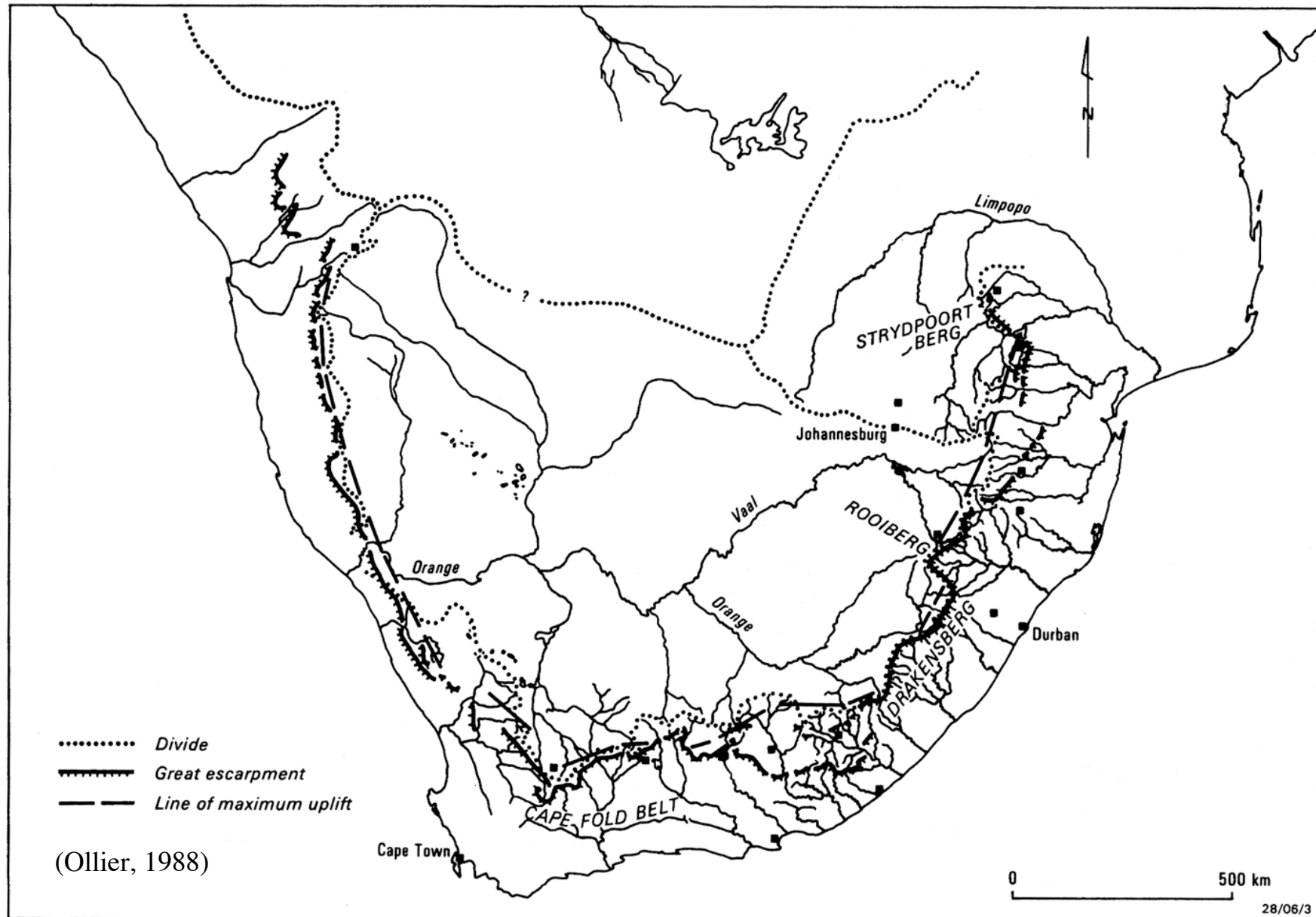
# TIMING OF THE SOUTH AFRICAN PLATEAU UPLIFT?

KALAHARI

A topographic map of southern Africa, showing the Kalahari plateau in the center and the Great Escarpment along the southern coast. The map uses a color gradient from green (low elevation) to yellow and orange (high elevation). The Great Escarpment is a prominent feature along the southern coast, marked with a white arrow. The word 'KALAHARI' is written in yellow text across the central plateau. The background is a solid blue color.

Great Escarpment

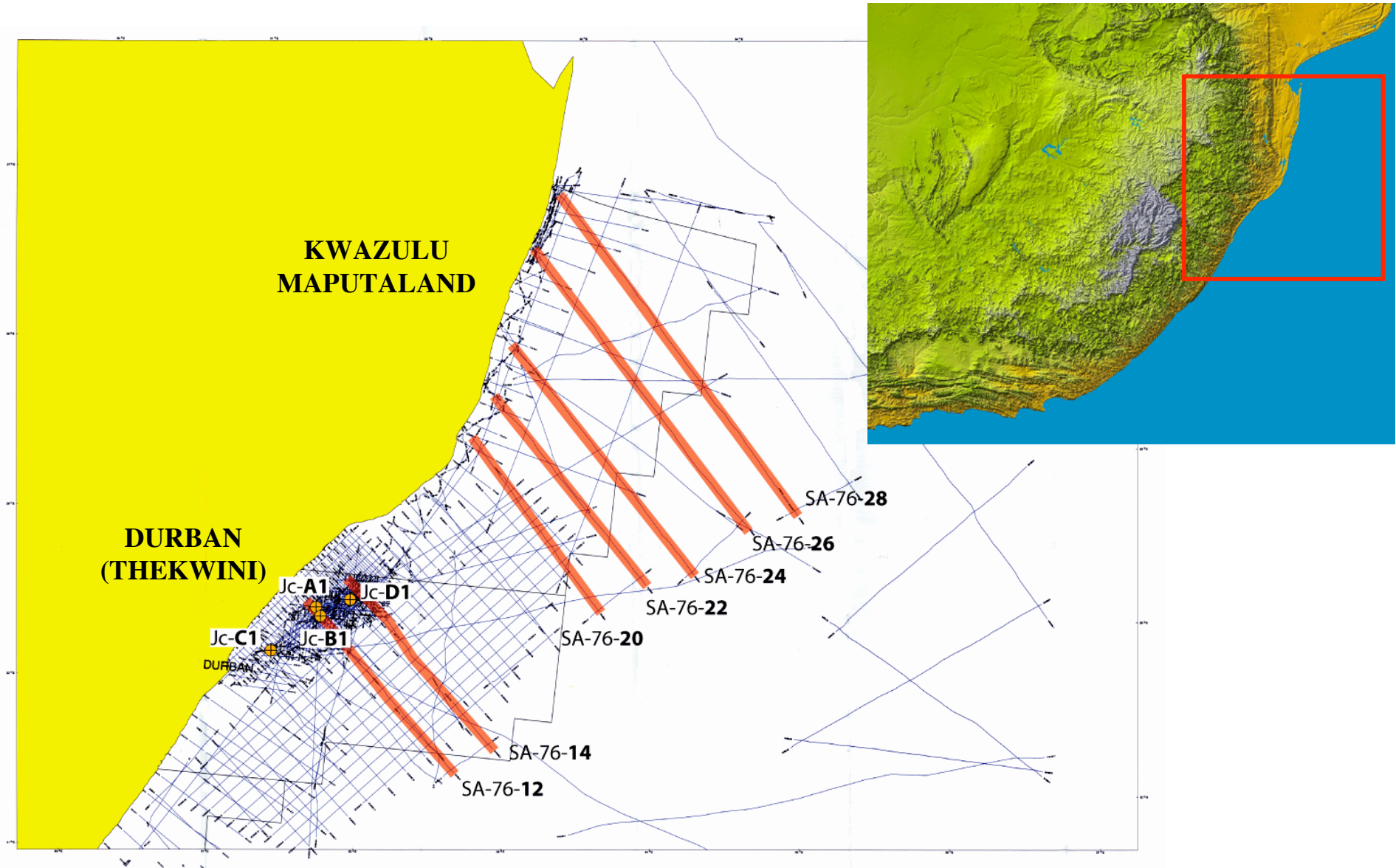
# THE GREAT ESCARPMENT OF SOUTH AFRICA





# KWAZULU - MAPUTALAND MARGIN: OFFSHORE STUDIES

## DATA





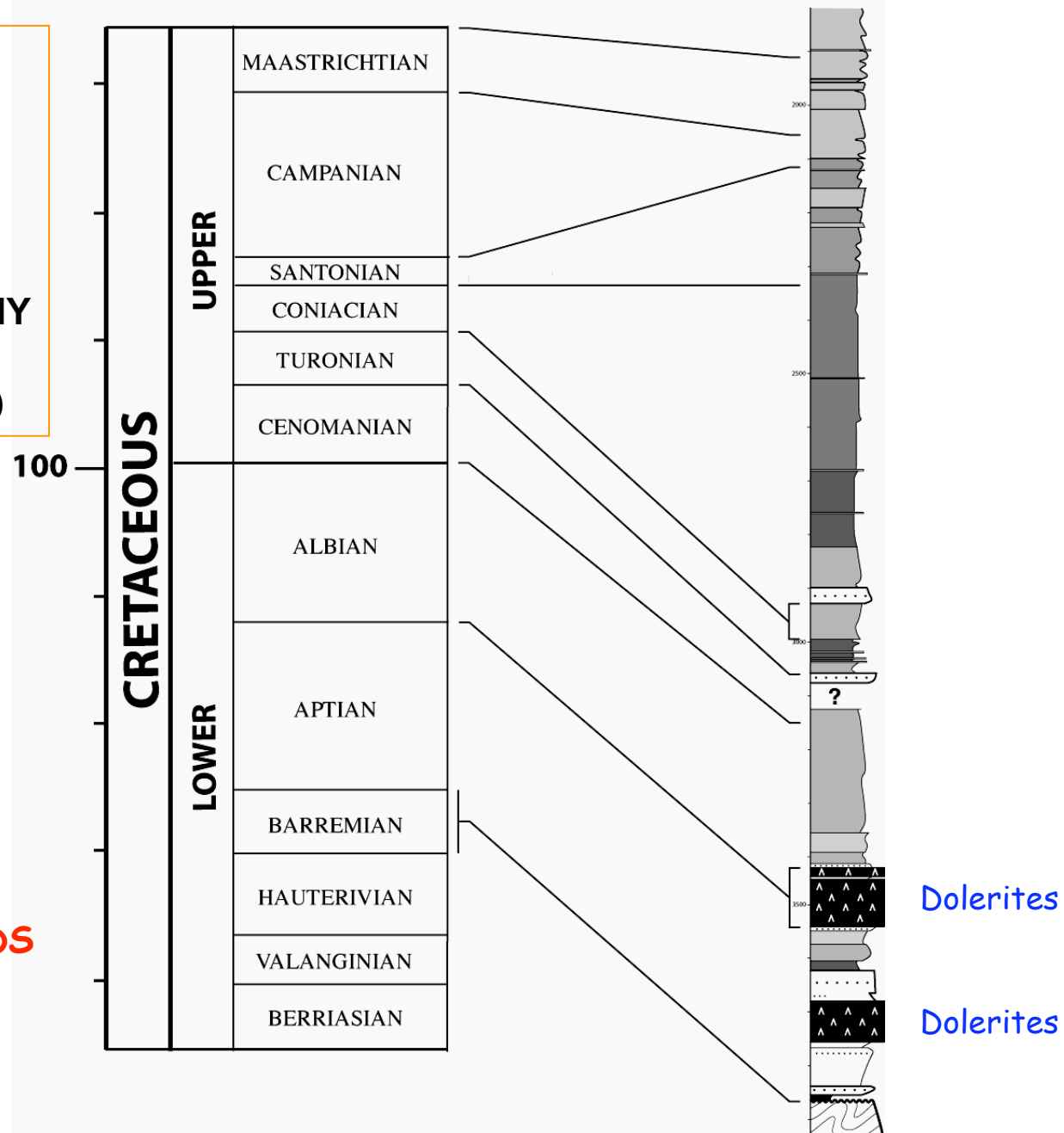
# DURBAN (THEKWINI) BASIN

Jc B1

- LITHOLOGY**
- ✓ Well-logs
  - ✓ Masterlog  
*(reinterpreted from outcrops)*
- BIOSTRATIGRAPHY**
- ✓ McMillan  
*(SAPetroleum)*

**NO CLAYS**

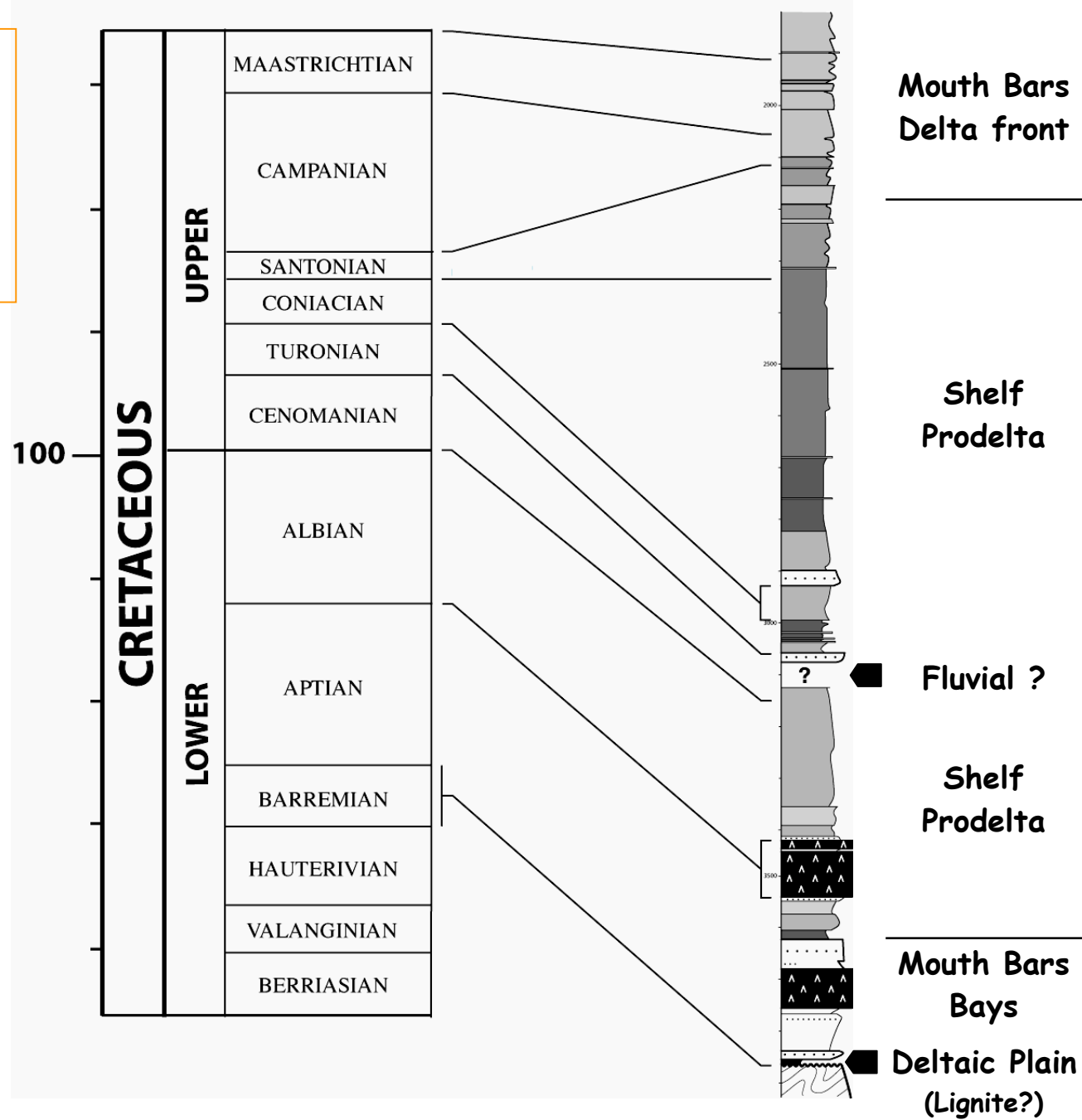
**SILTS  
to  
VERY FINE SANDS**



# DURBAN (THEKWINI) BASIN

Jc B1

**SEDIMENTARY ENVIRONMENTS**  
Well-logs facies based on outcrop studies

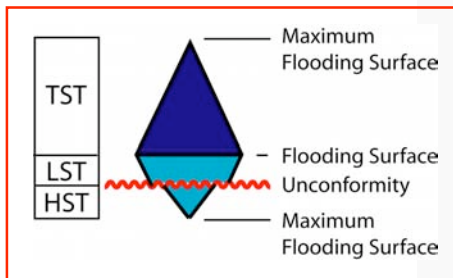
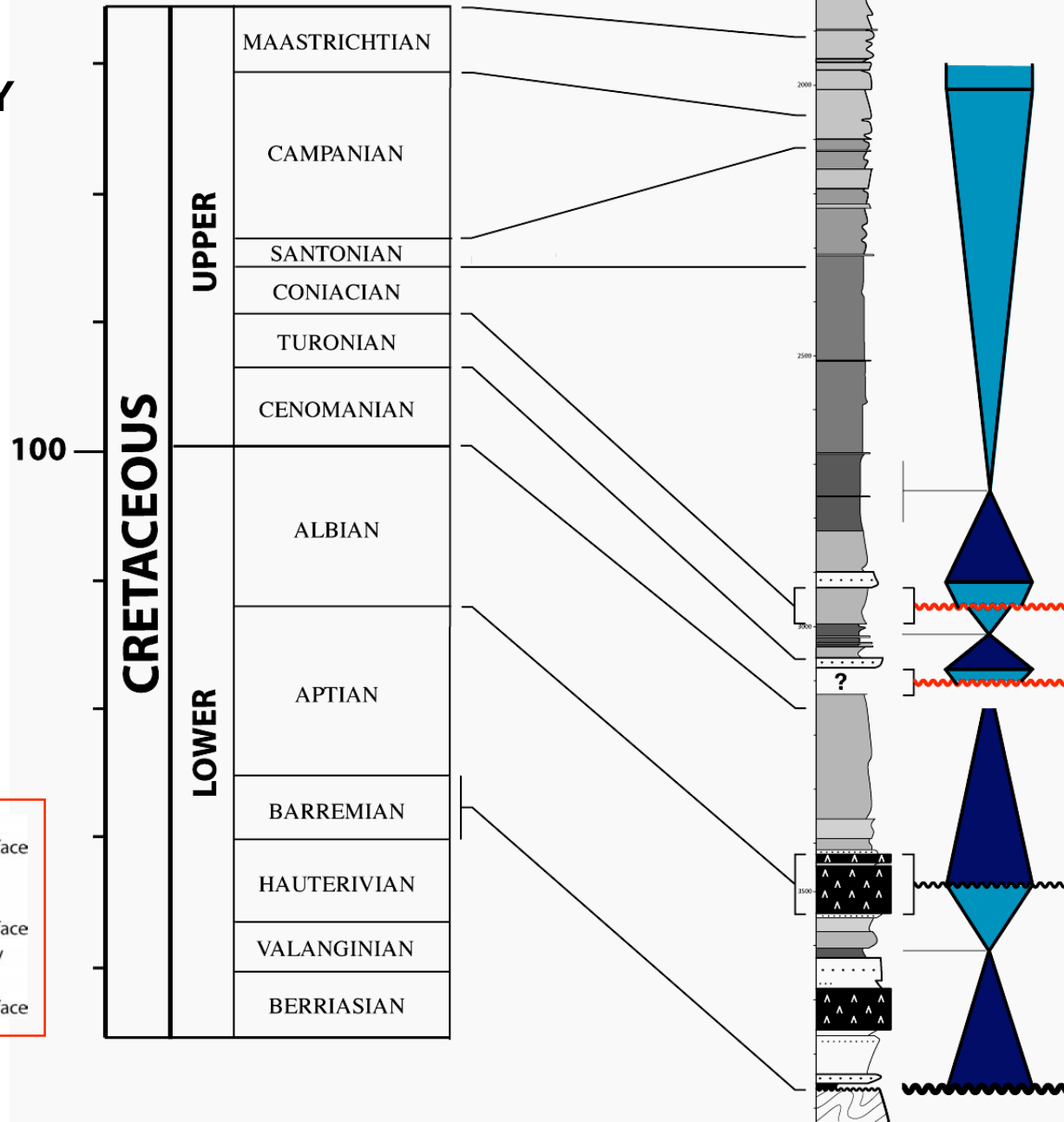


**FLUVIAL-DOMINATED DELTA**

# DURBAN (THEKWINI) BASIN

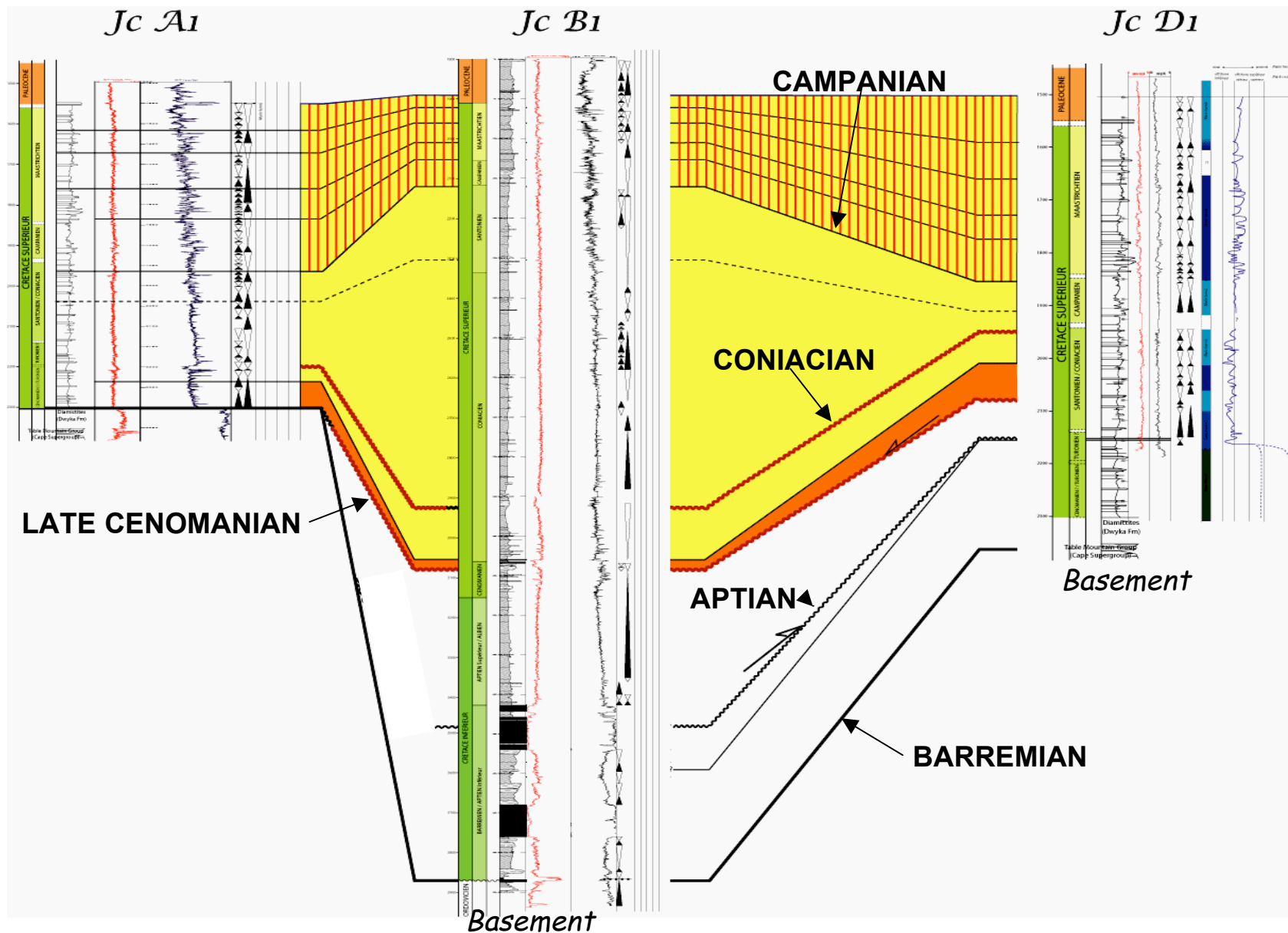
Jc B1

## SEQUENCE STRATIGRAPHY





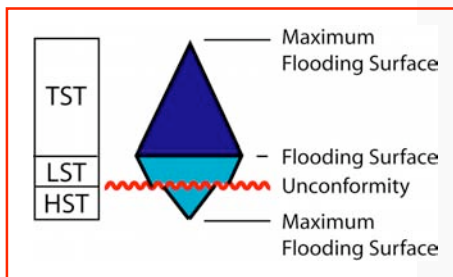
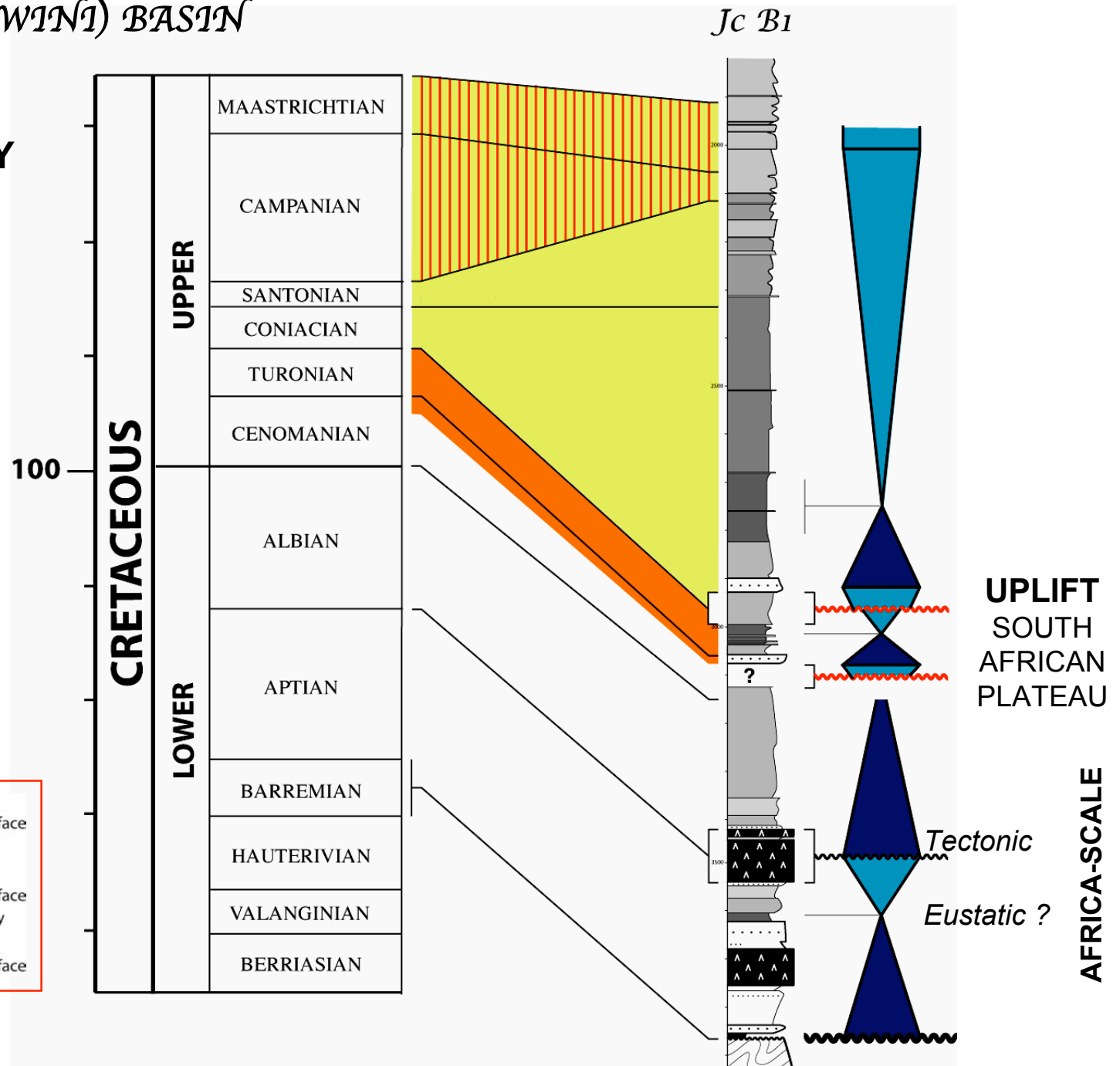
# DURBAN (THEKWINI) BASIN: Wells correlation



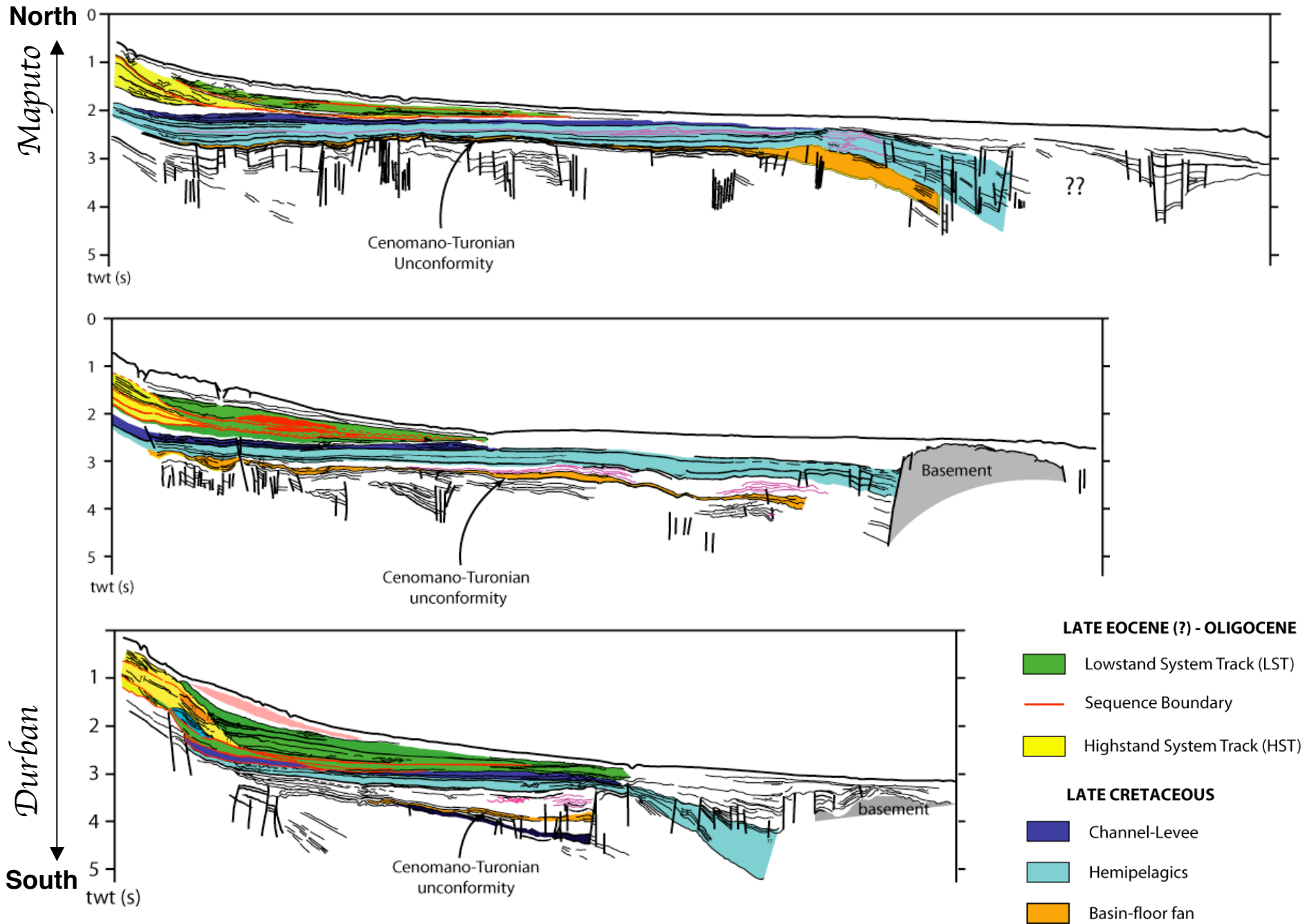
# DURBAN (THEKWINI) BASIN

Jc B1

## SEQUENCE STRATIGRAPHY

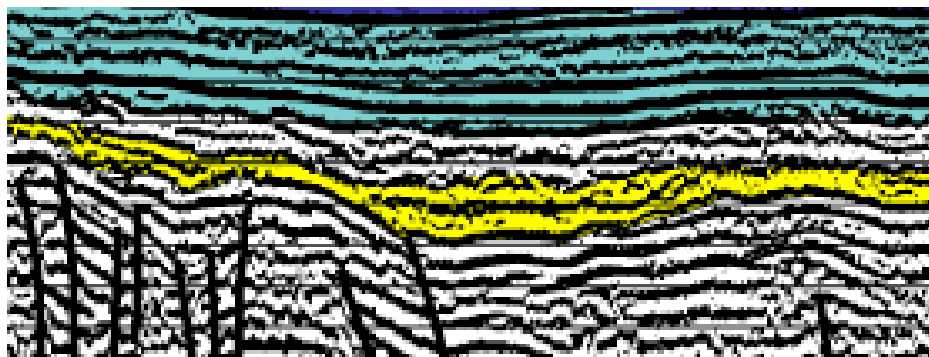
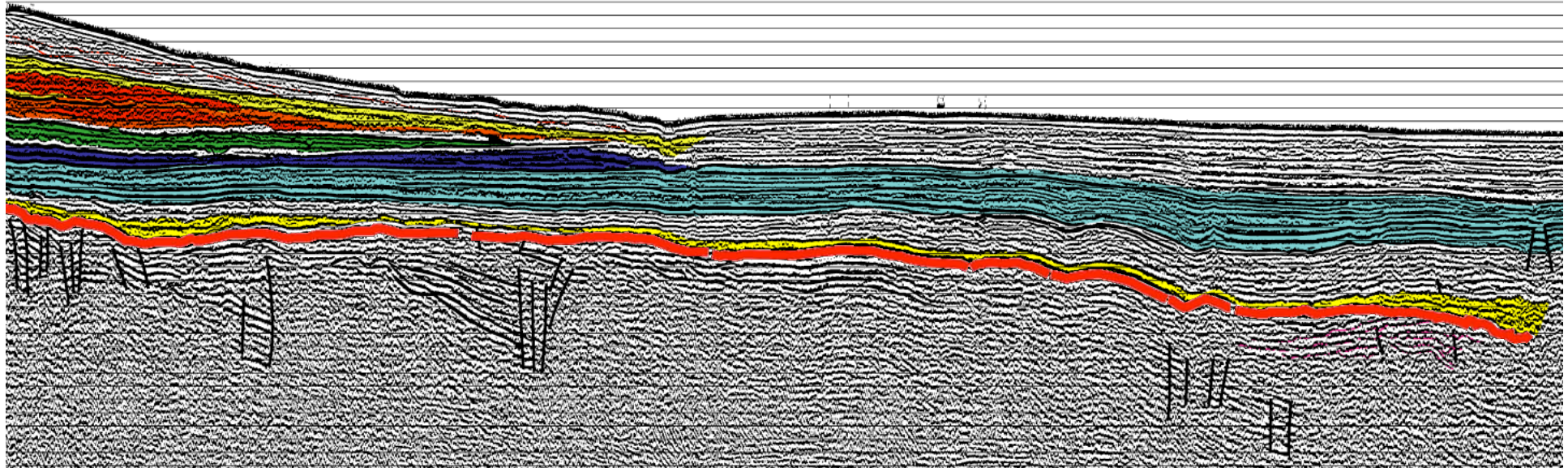


# KWAZULU-MAPUTALAND BASIN

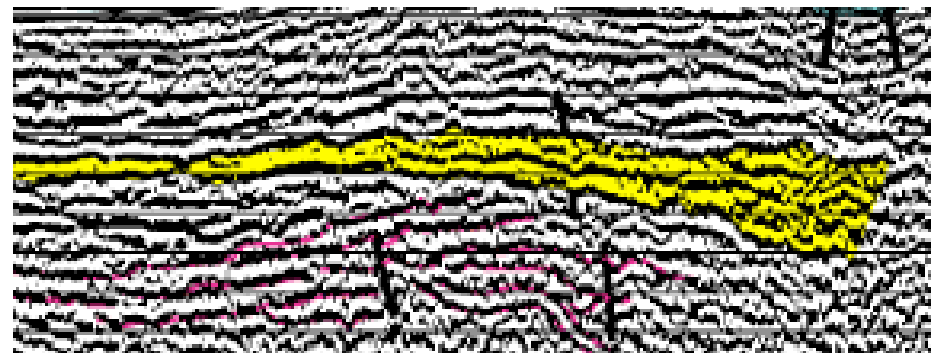




# TOP CENOMANIAN UNCONCONFORMITY

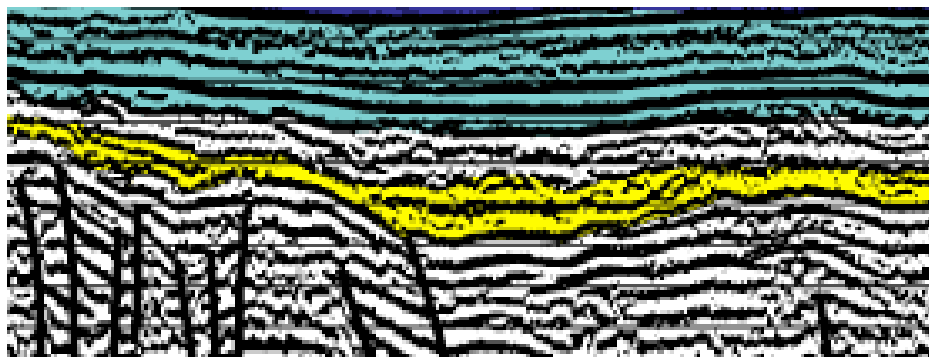
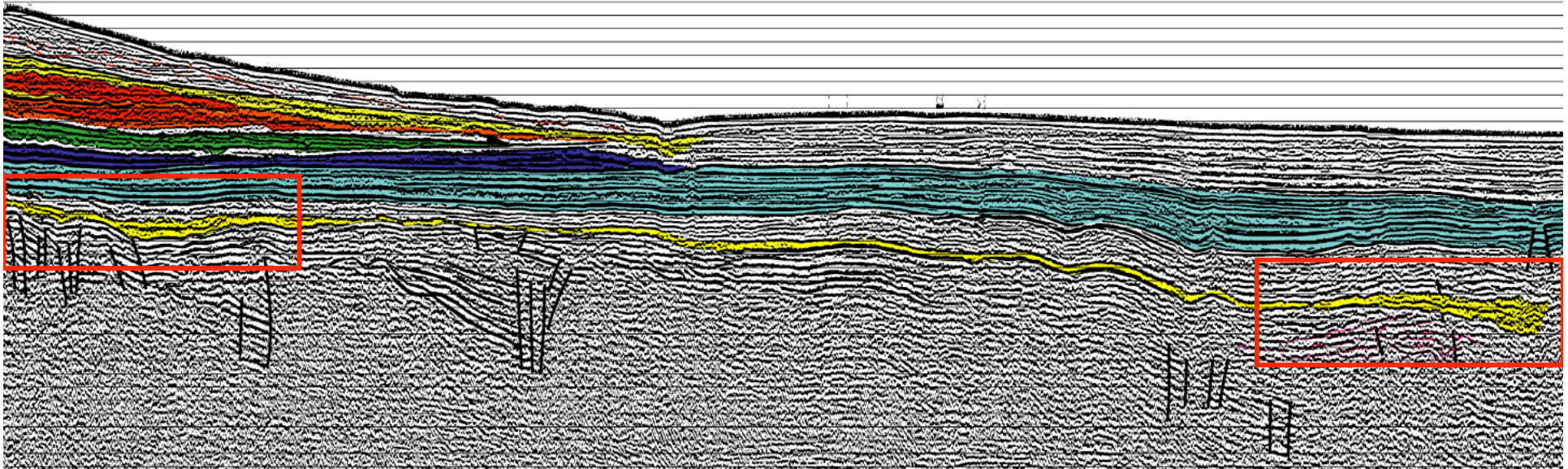


**INCISED CHANNELS**

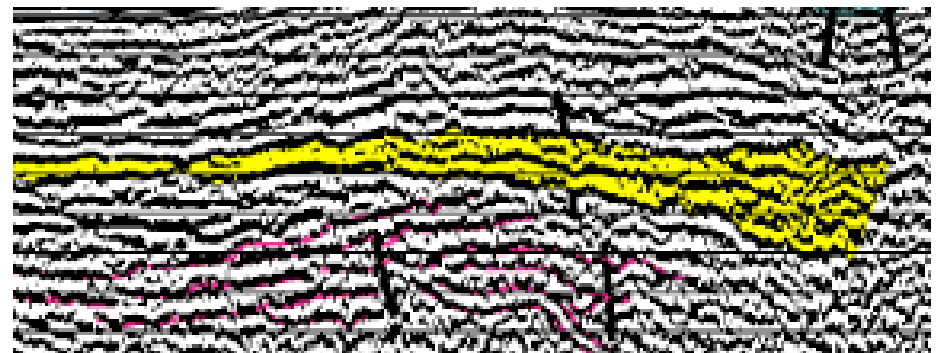


**BASIN FLOOR FANS**

# TOP CENOMANIAN UNCONFORMITY



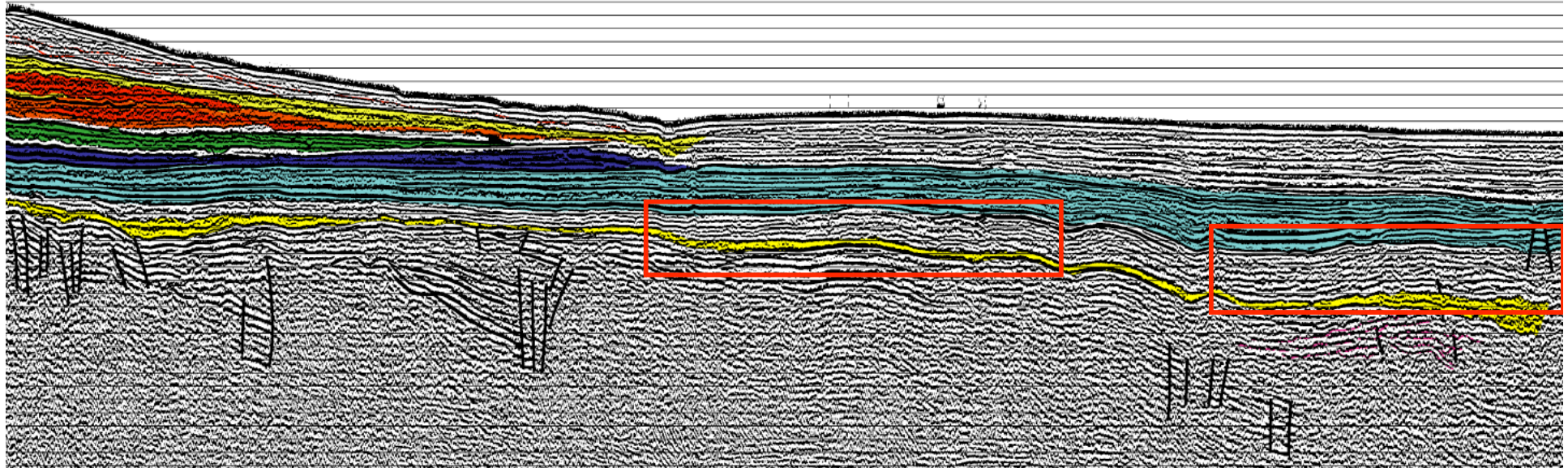
**INCISED CHANNELS**



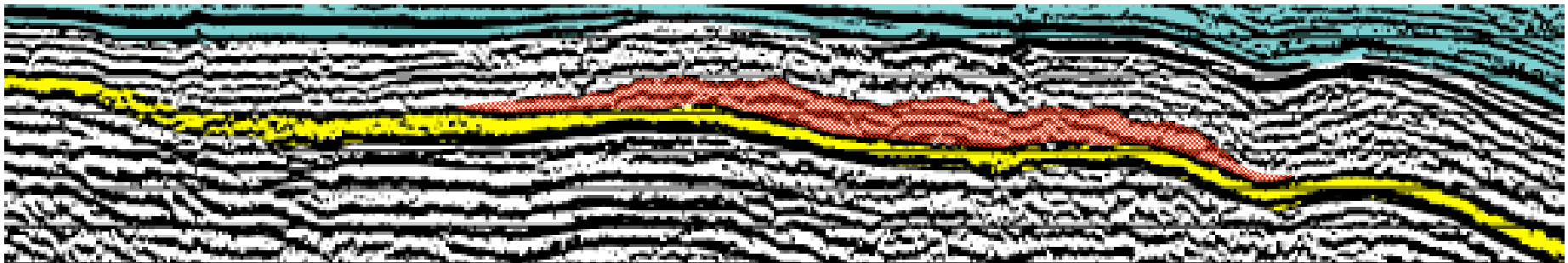
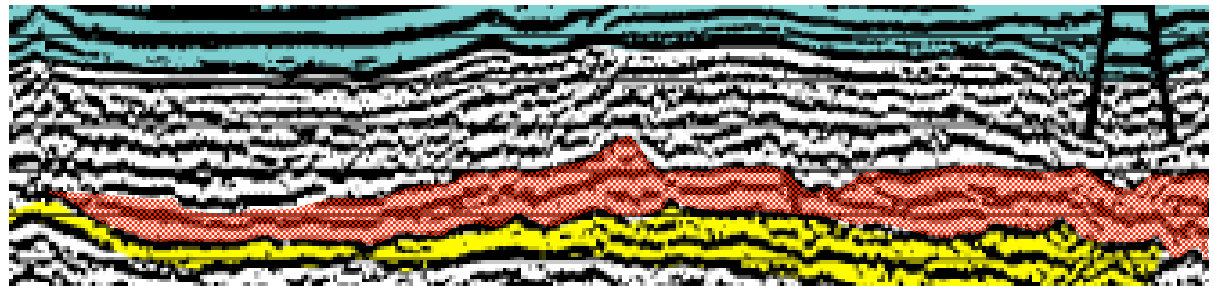
**BASIN FLOOR FANS**



# TOP CENOMANIAN UNCONFORMITY INFILLING

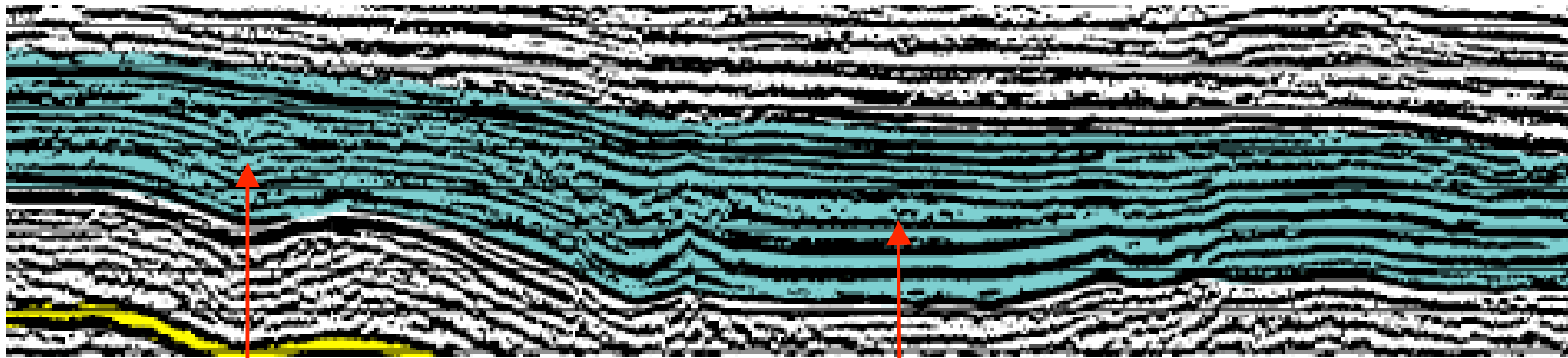
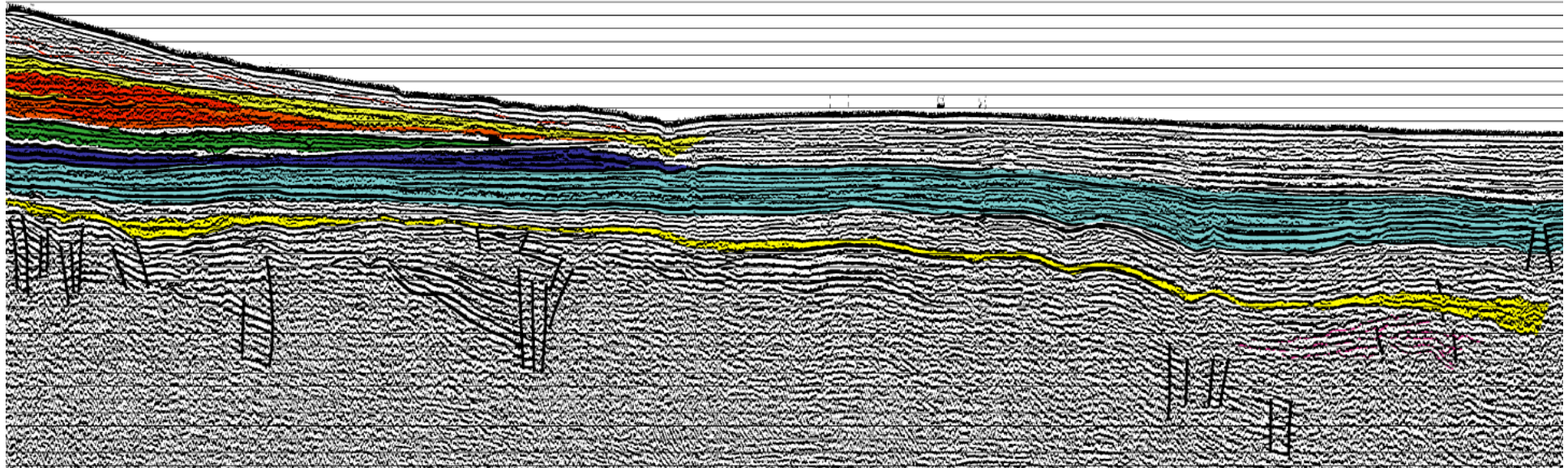


PROXIMAL LOBES





# UPPERMOST CRETACEOUS: MAINLY HEMIPELAGITES



**SMALL CHANNELS**

**DEBRIS FLOWS or SMALL LOBES**



# KWAZULU-MAPUTALAND BASIN

