The Mesozoic West and Central African Rift System: Qualitative Evaluation*

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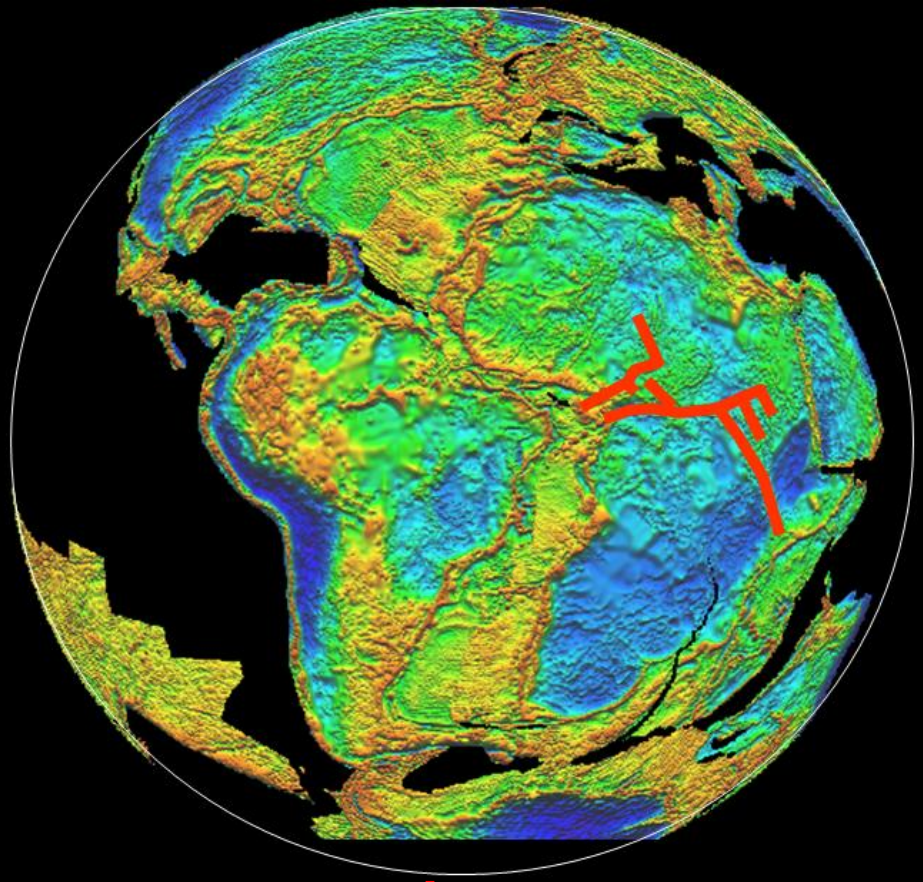
Abstract

Africa underwent a series of rifting phases as Gondwana fragmented. The Mesozoic basins of central Africa form a network of passive rift basins that bisect Africa from the Atlantic Ocean to the Indian Ocean. The combined length of these basins exceeds 7,000 km, with sedimentary thicknesses ranging from 14 km in the Termit Trough, eastern Niger, up to 7.5 km for the southern Chad basins (Doba, Doseo and Salamat basins), to in excess of 13 km for the Muglad basin, Sudan. Since these rift basins represent a zone of lithospheric weakness within the African plate, changes in the plate stress and movement have resulted in deformation being focused within this zone. Thus plate tectonic processes affecting the African plate have been recorded by the stratigraphy within the basins. The rift basins reveal a poly-phase development with synchronous stratigraphic events being recorded in each of the basins. At this time, only the major deformational events can be correlated with changes in plate movement within the oceanic domain due to the limited resolution that the oceanic crustal fabric has in recording such events.

This presentation addresses both the mega tectonic setting of this rift system as well as focusing on the basin architecture of the southern Chad basins of Central Africa. For decades, these basins have been known to contain oil and it is only with the construction of the 1,070 km Chad-Cameroon oil pipeline from Kome (Doba basin) through Belabo to Kribi on the Atlantic coast of Cameroon, that oil companies are now able to develop this hydrocarbon province. The excellent regional coverage of gravity and aeromagnetic data has allowed the spatial extent, geometry and depth of these basins to be mapped. Well and seismic data have been used to control the model inversion.

AAPG International Conference and Exhibition 26-29 October 2008 in Cape Town, South Africa
Session: Intracontinental African rift systems: the puzzles, challenges and petroleum potential"

The Mesozoic West and Central African Rift System: Qualitative Evaluation



by
J Derek Fairhead

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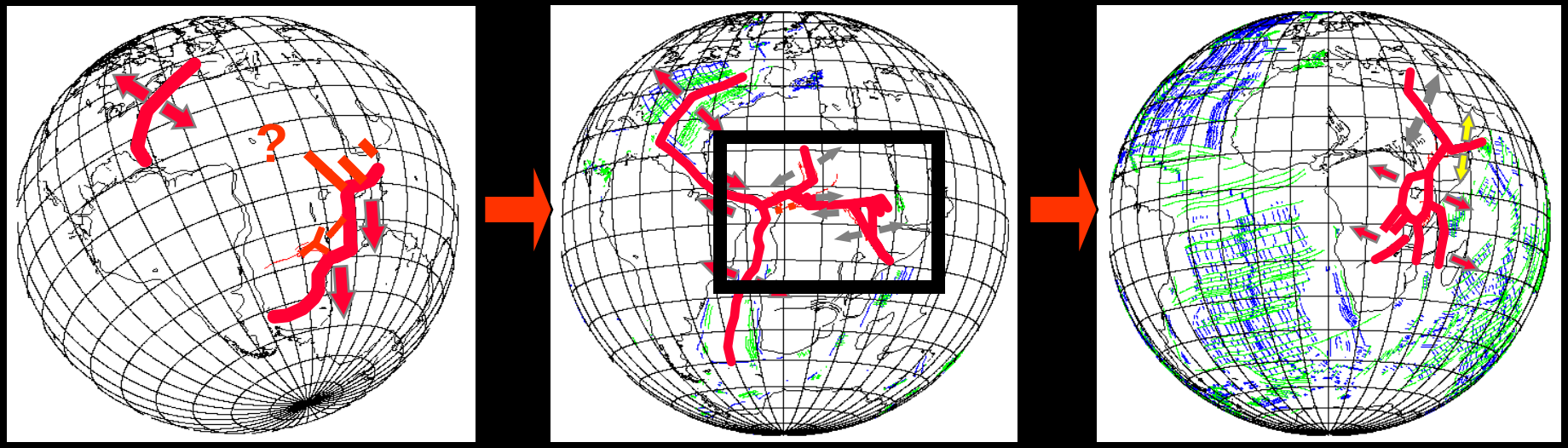
The Mesozoic West and Central African Rift System

Talk Outline

- Regional plate tectonic setting
- To obtain a good African/South American plate fit requires removing crustal extension along margins and having deformable plates
- There is a strong link between plate tectonics and the poly- phase rift development as seen in the sequence stratigraphy of the basins
- Integrated geol/geophys study of southern Chad basins allows the determination of basin structure & depth to basement

Evolution of basins in Africa

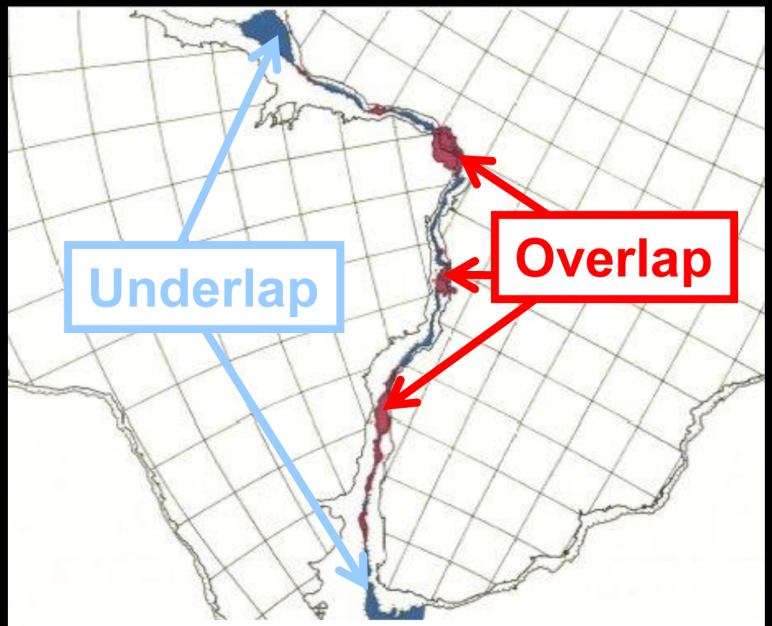


Jurassic **Cretaceous** **Tertiary-Present**

MESSAGE: The development of African rifts is intimately related to plate tectonics and passive continental margins development as Gondwana fragmented

Rigid plates do not allow tight fit

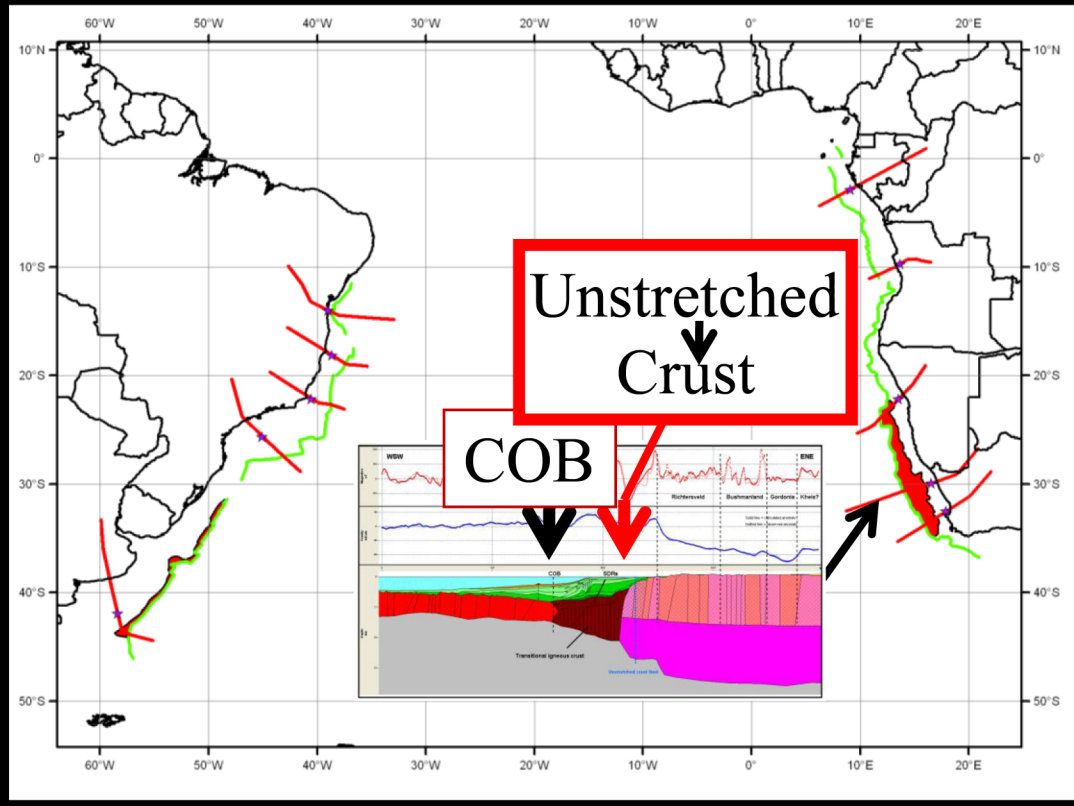
OLD



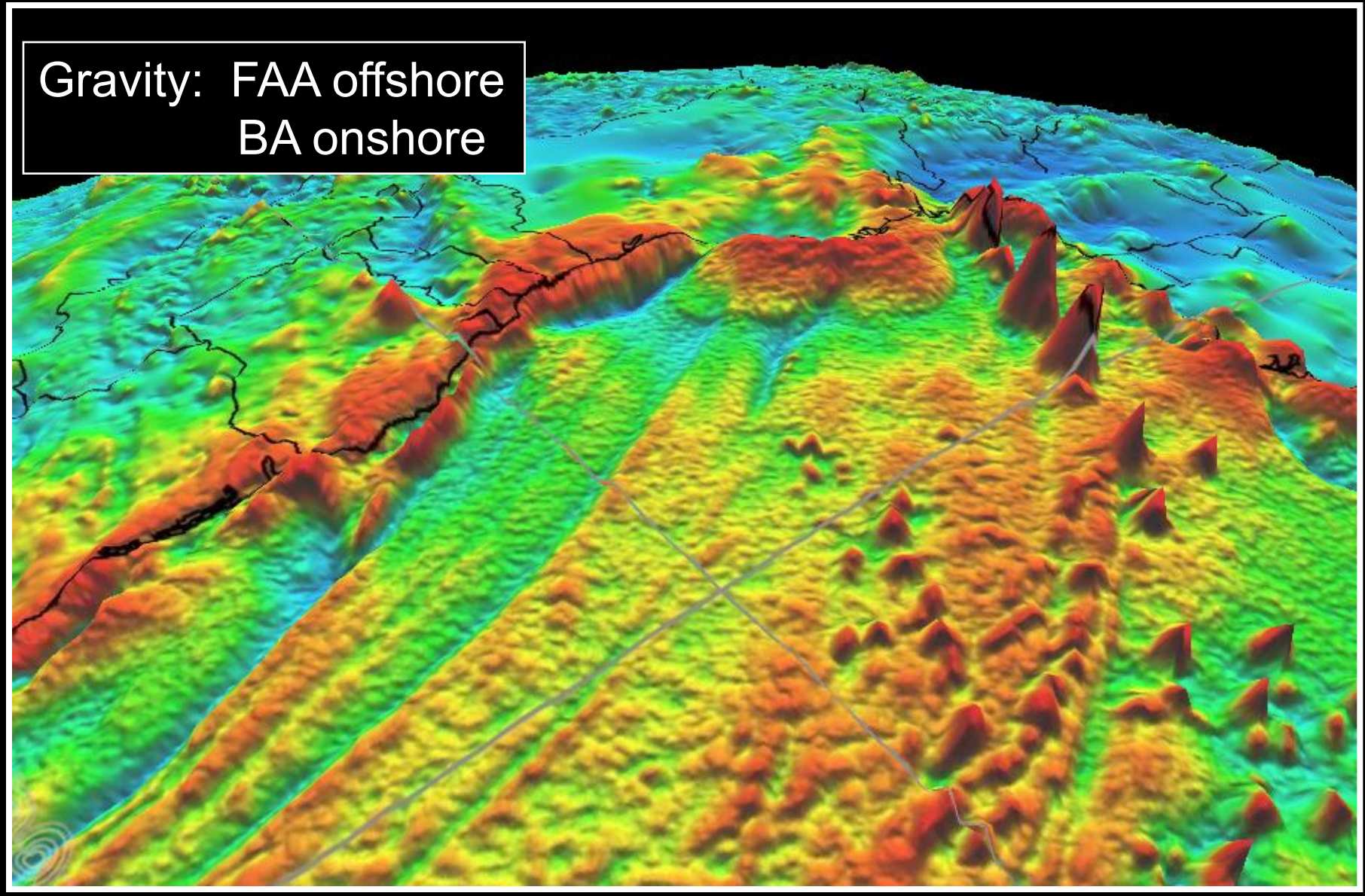
Fit of 3,000ft bathymetry

Bullard Everett & Smith, 1965

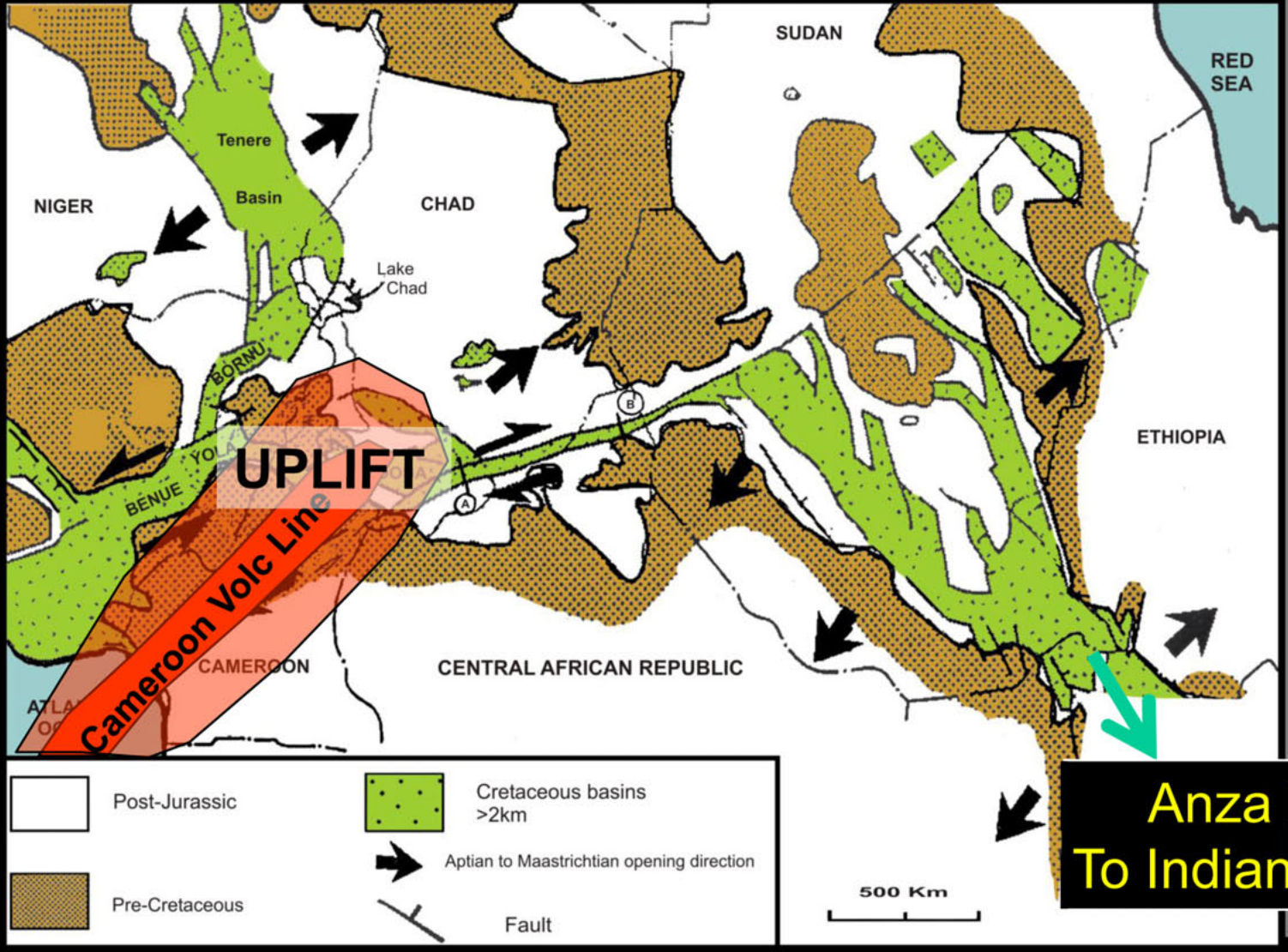
Modern (GETECH)



Link between ocean and continental tectonics

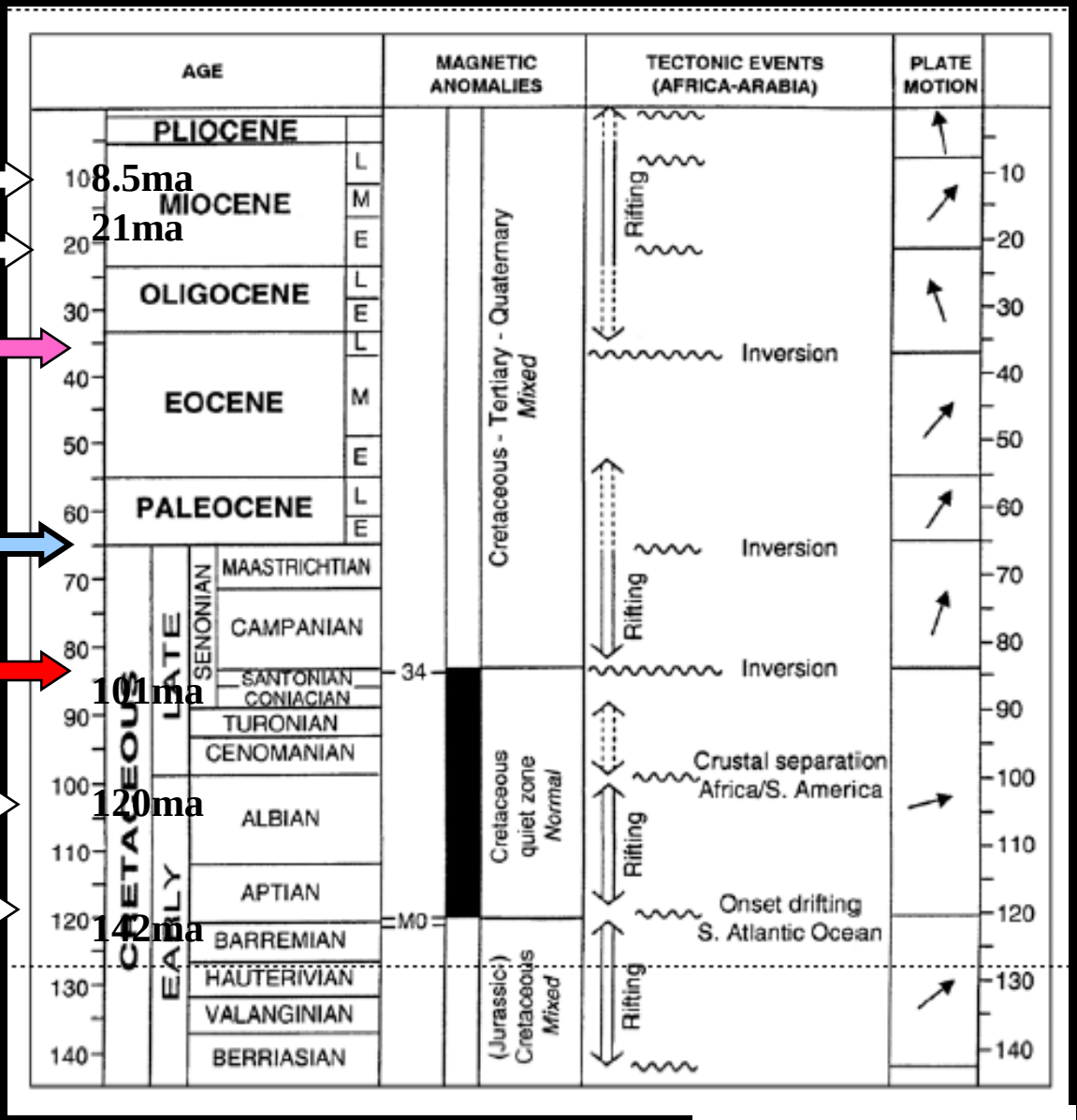


West and Central African Rift System



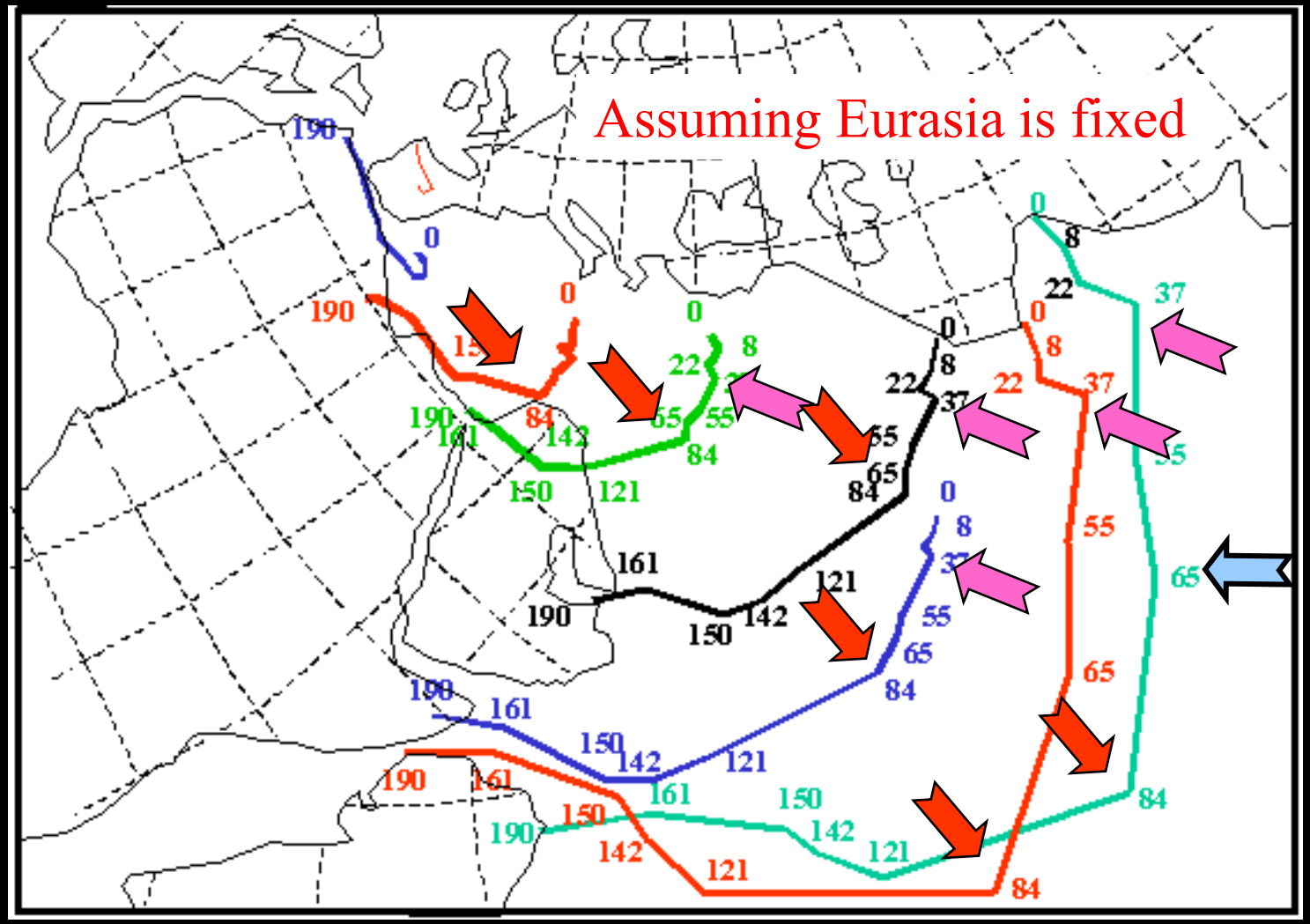
Tectonic correlation chart Jurassic to Recent for WCARS

seen in oceans?



After René Guiraud

Plate motions



Relative motion of Africa wrt Eurasia

Plate motions

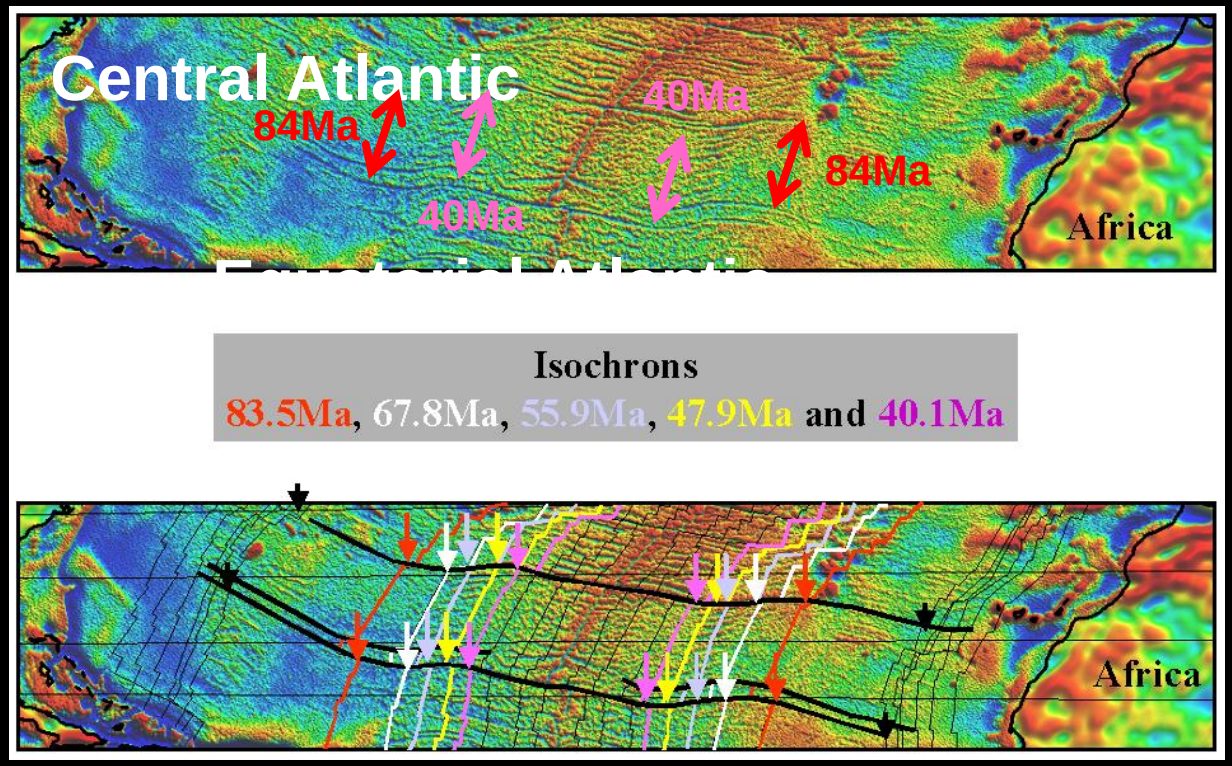
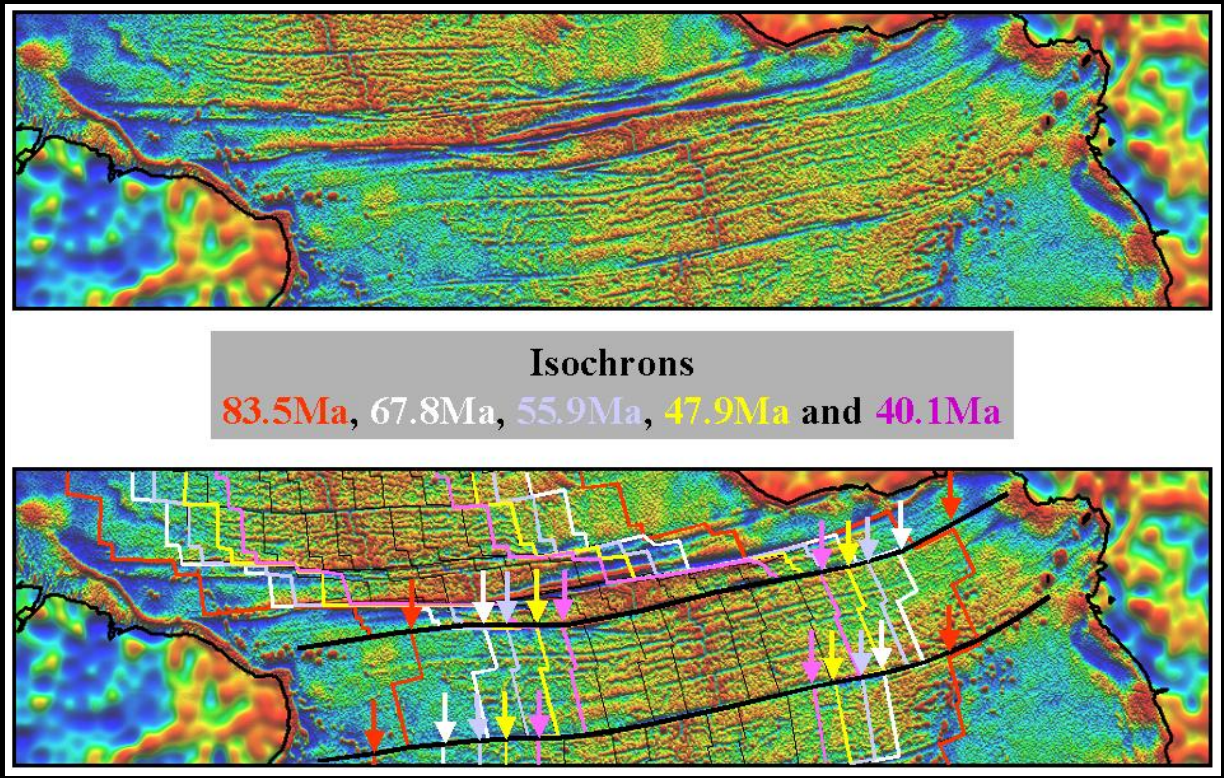
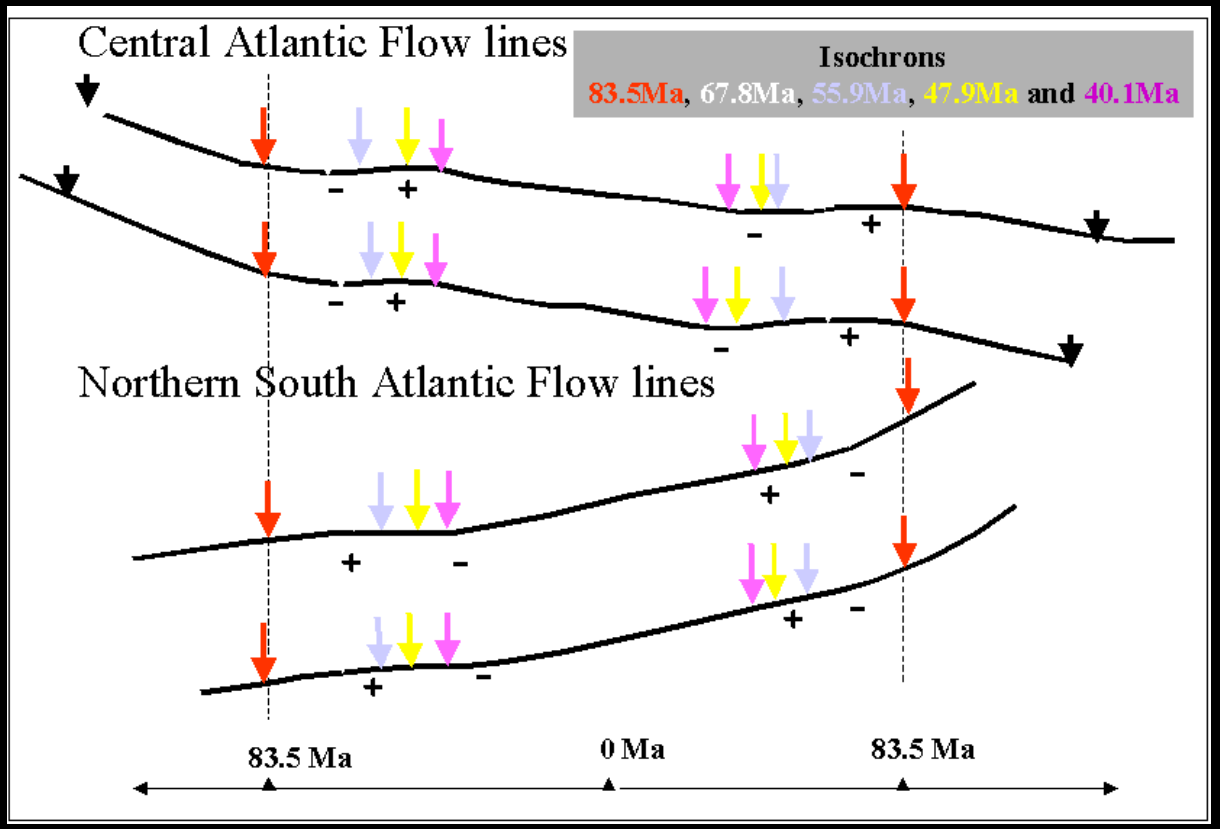


Plate motions



Isochrons
83.5Ma, 67.8Ma, 55.9Ma, 47.9Ma and 40.1Ma

Plate motions

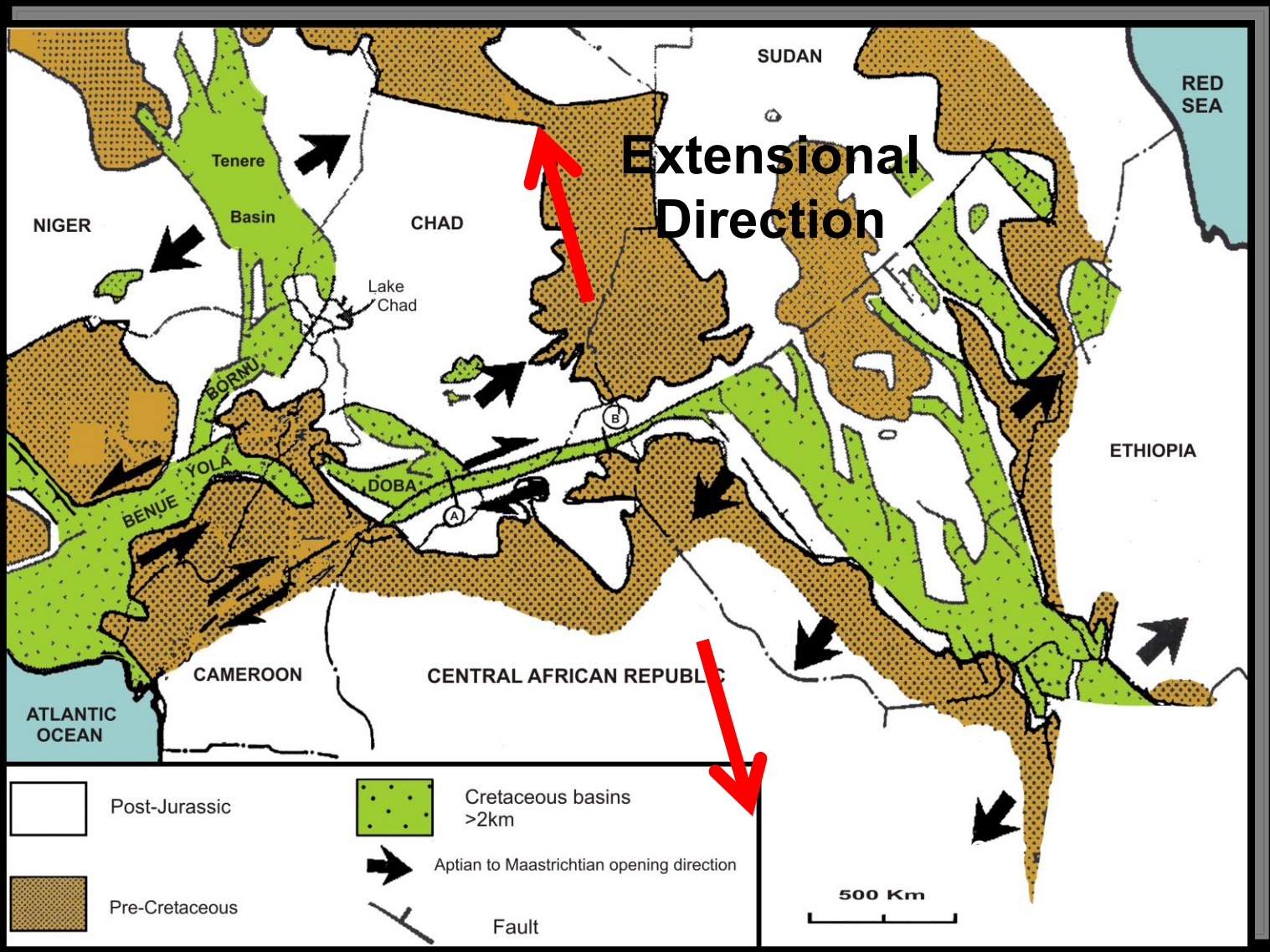


Differences taken up by deformation in Caribbean and South America

Differences taken up by deformation in Africa

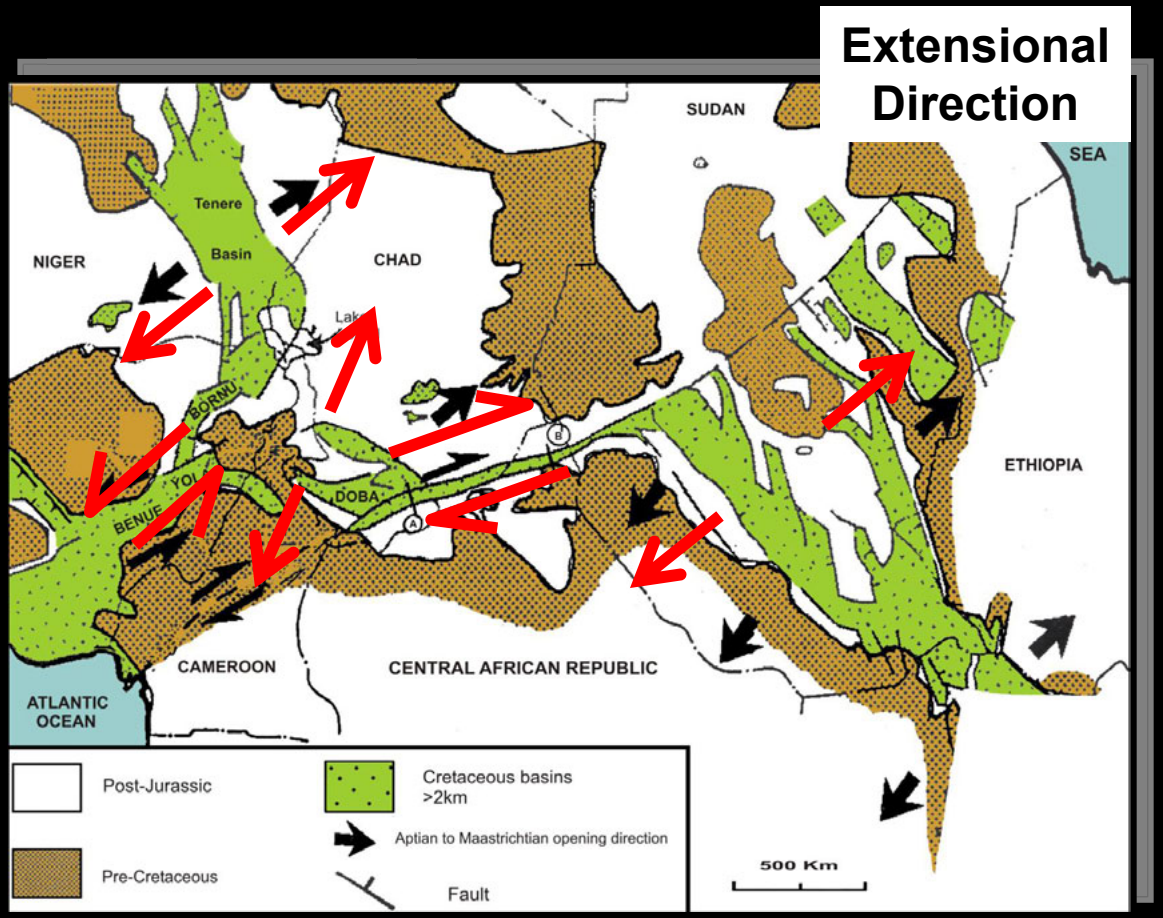
The Poly-Phase Evolution of the C African Rift System

Barremian ~120Ma



The Poly-Phase Evolution of the C African Rift System

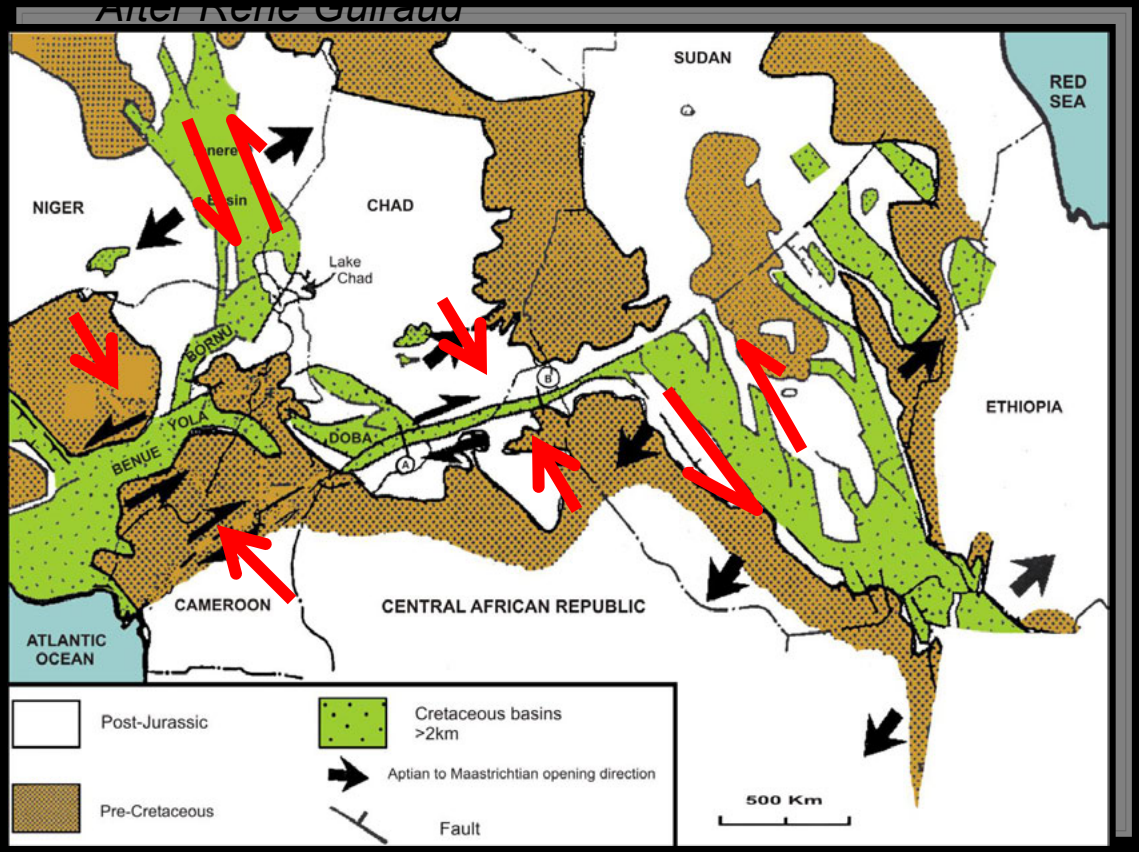
Aptian-Albian ~101 Ma



Change of Stress directions → Basin opening changes

The Poly-Phase Evolution of the C African Rift System

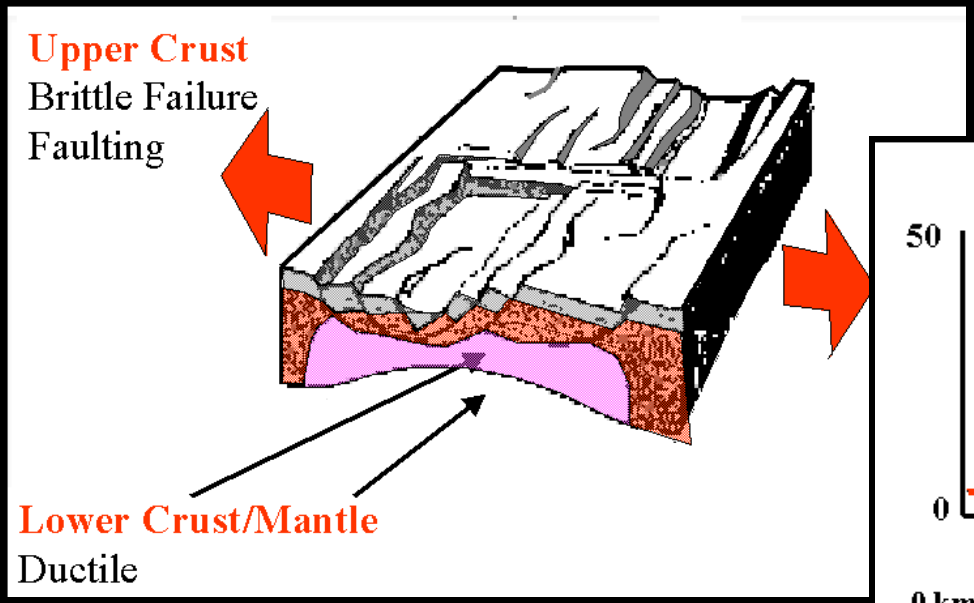
Late Santonian inversion 84 Ma

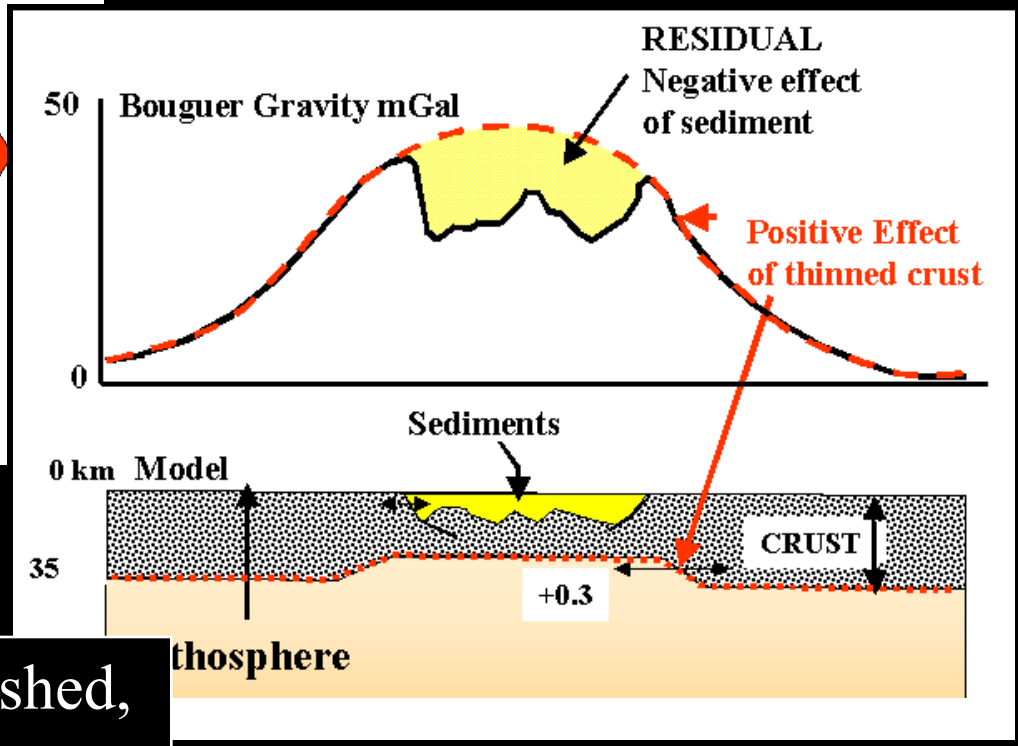


Major change of Euler pole/Plate interactions → Compression

Passive Rifting

Important:
Behaviour of the crust under tension

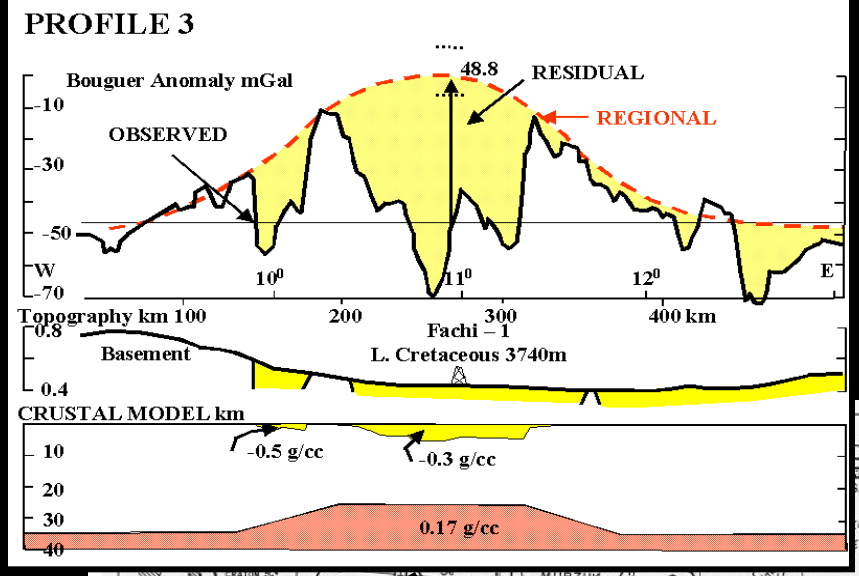


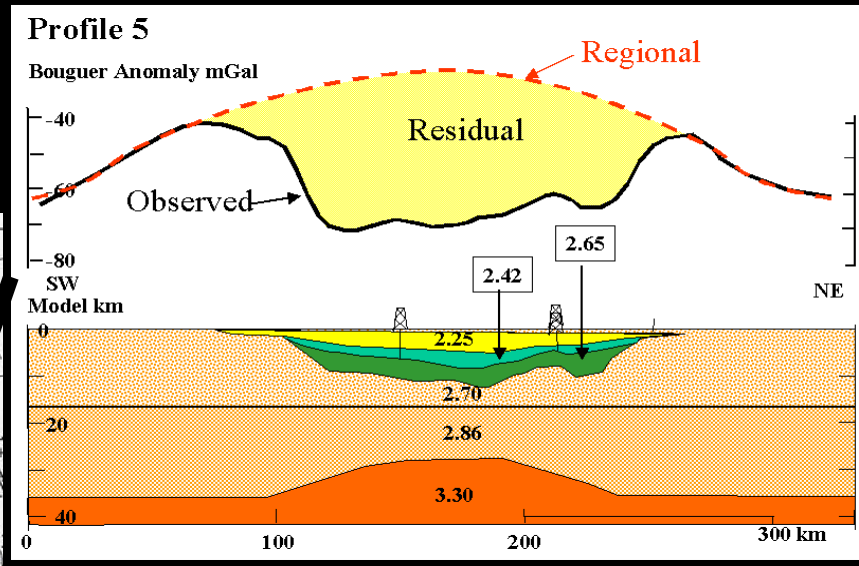


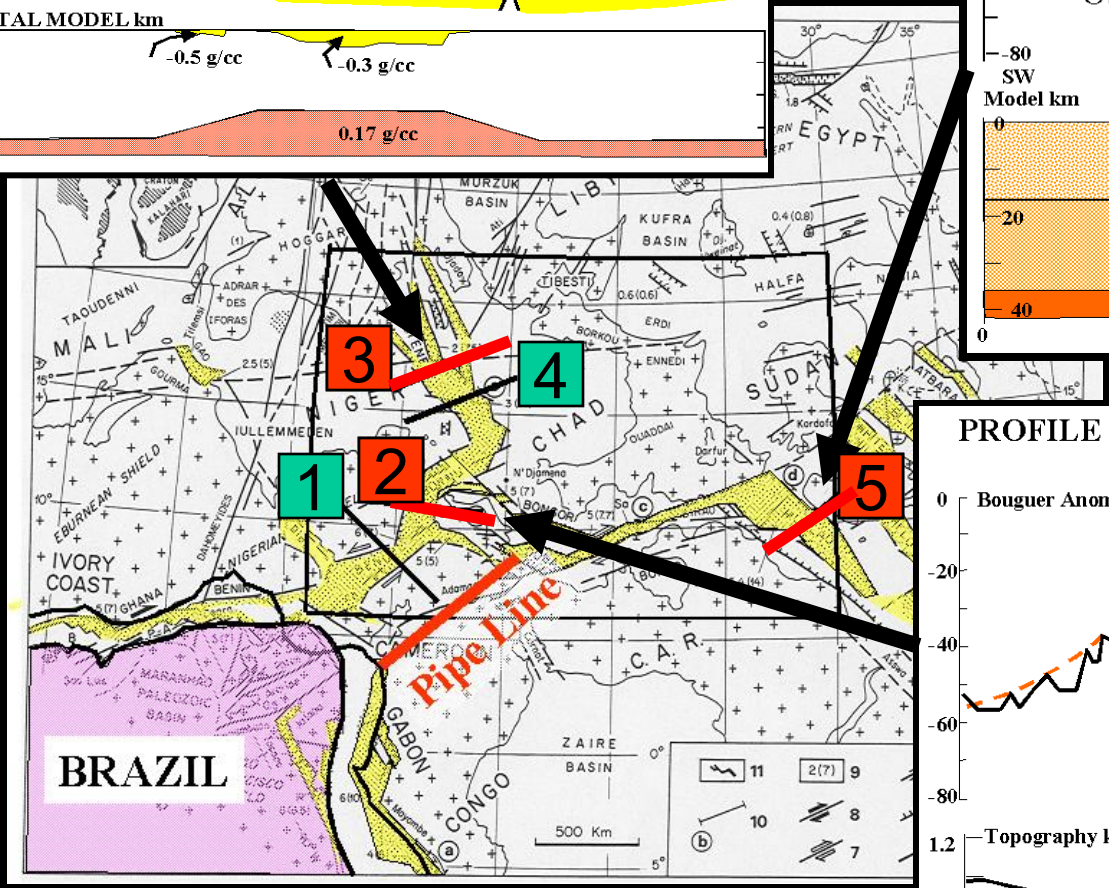
Once rift has been established, it is now a crustal weak spot for deformation to focus into

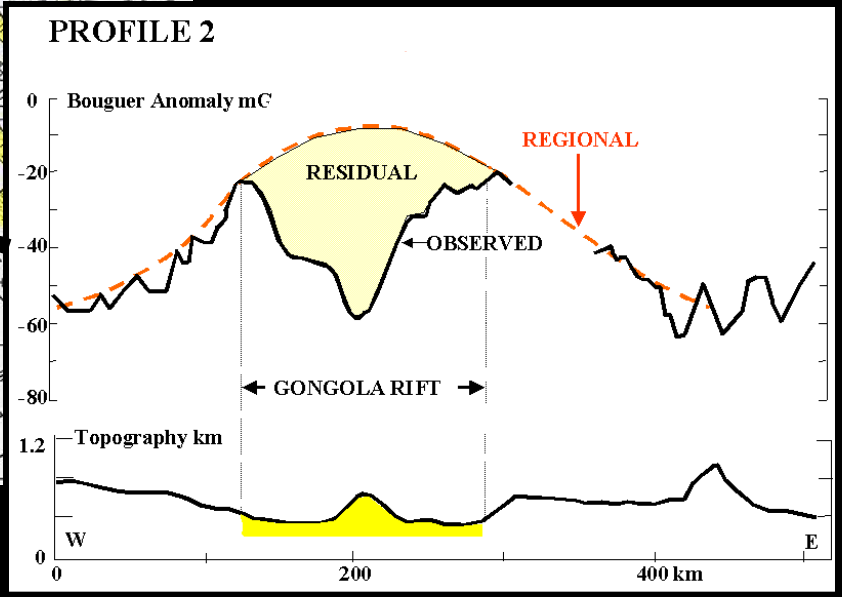
Gravity Response

Passive Rifting



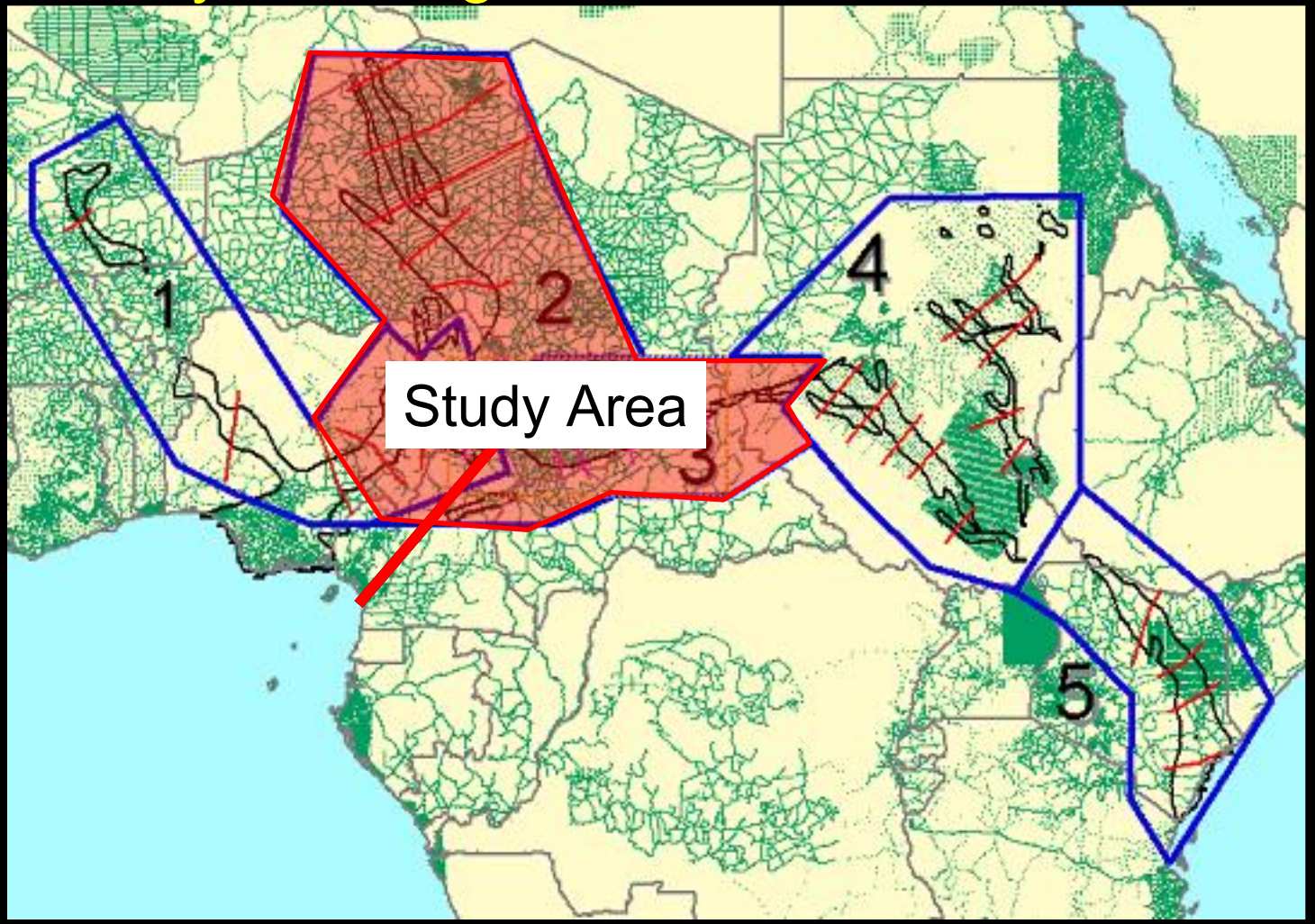






Geophysical Interpretation Study: Data Used

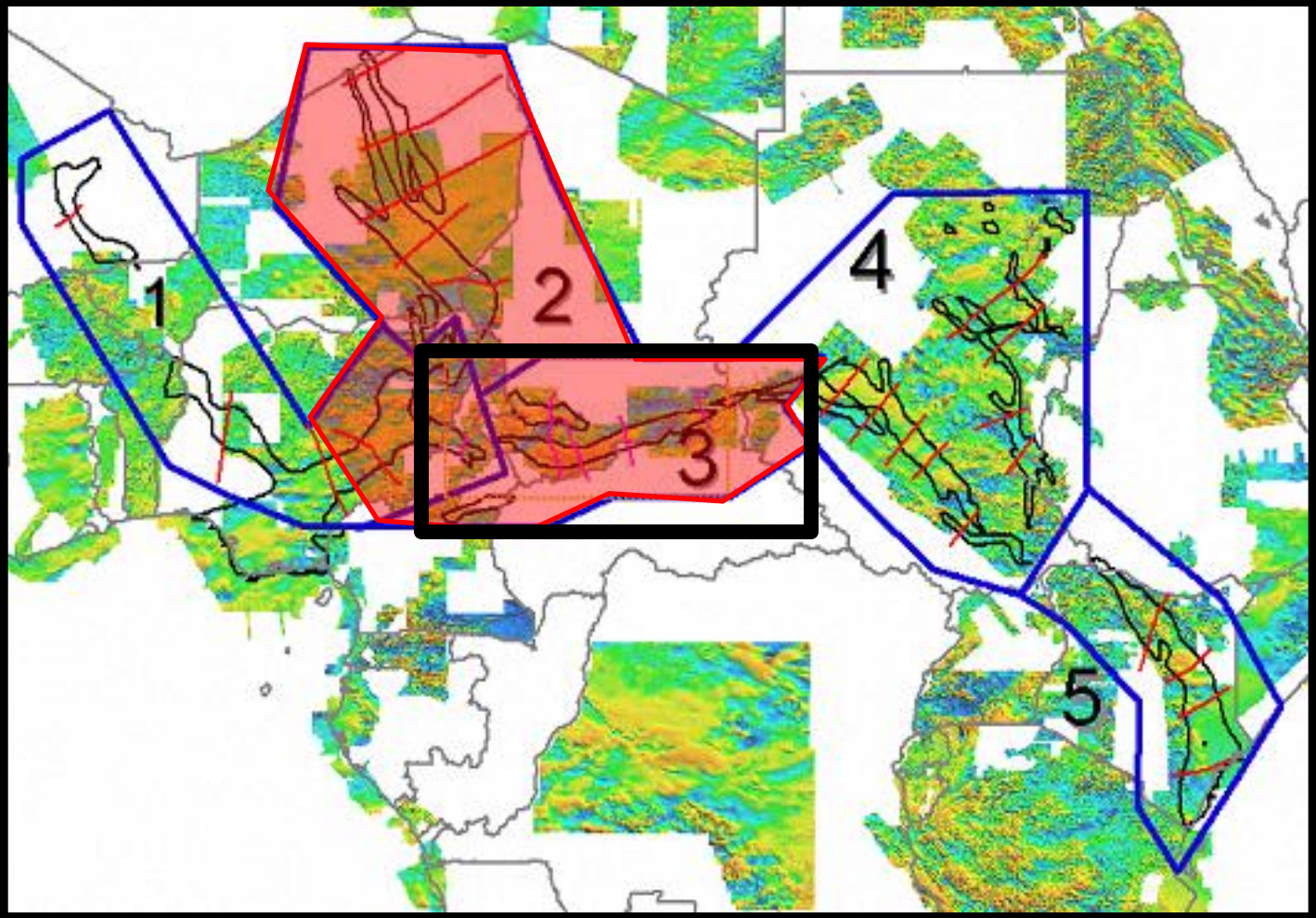
Gravity Coverage



Study Areas 2 & 3 completed

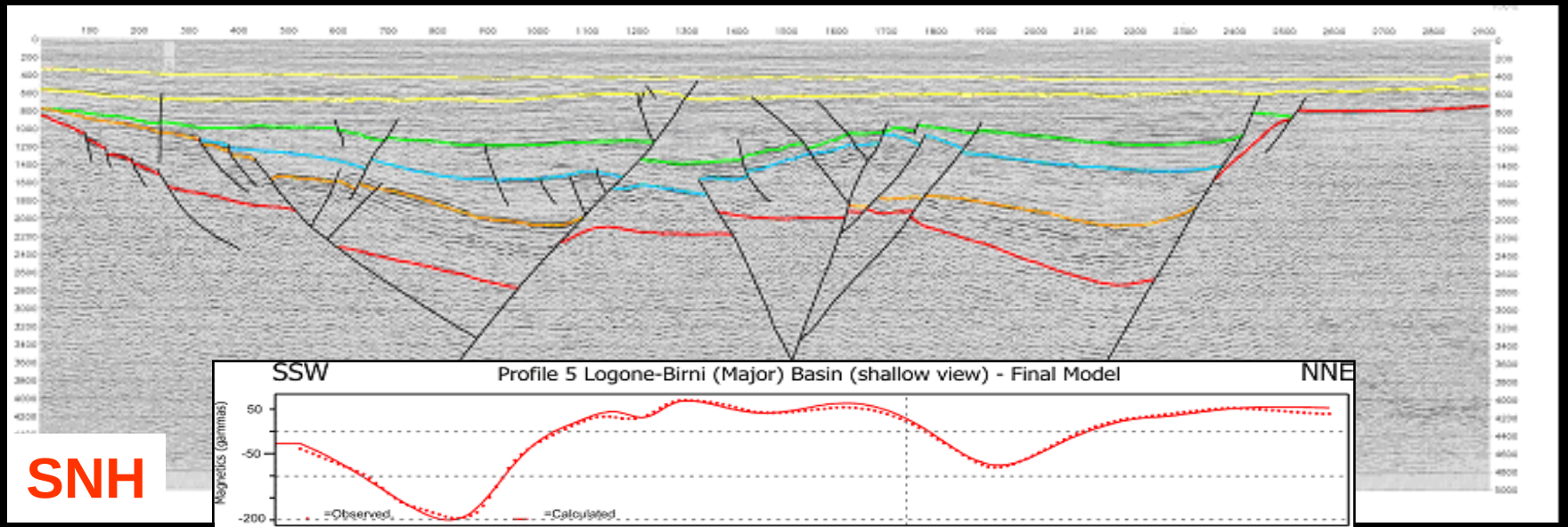
Geophysical Interpretation Study: Data Used

Aeromagnetic Coverage

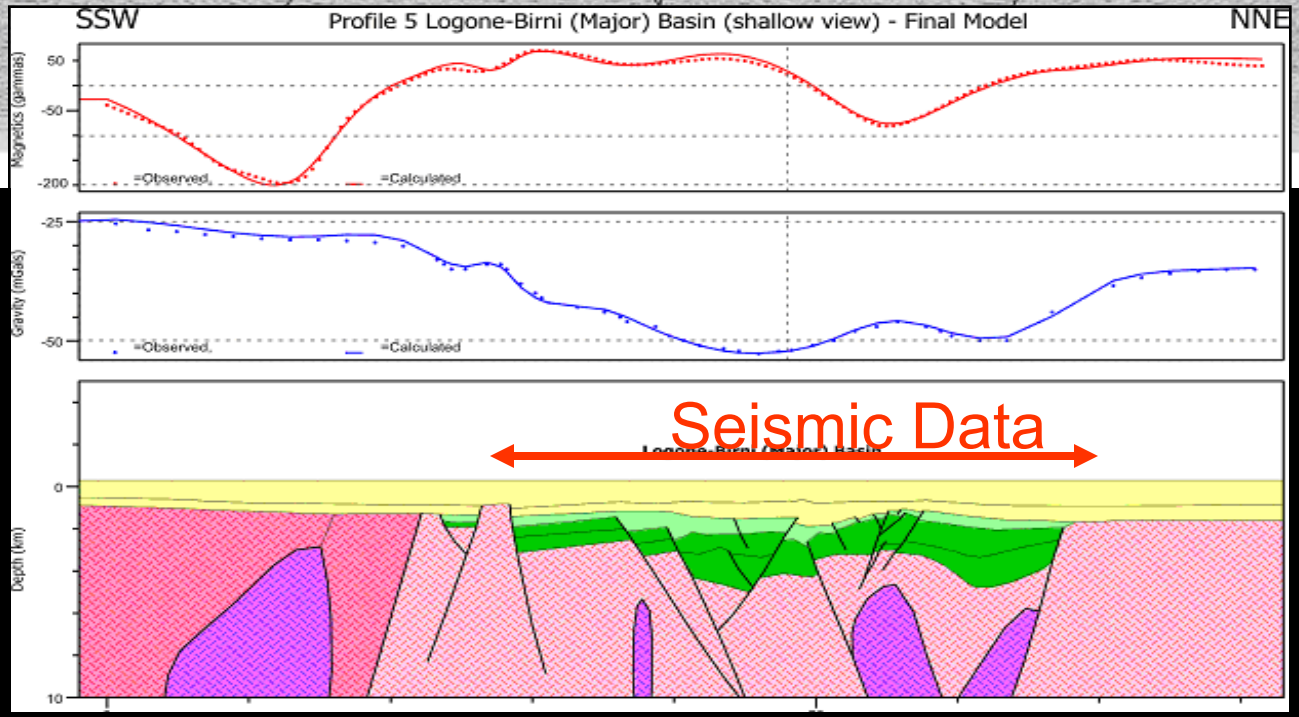


2D Interpretation Grav/Mag/Seismic/Wells

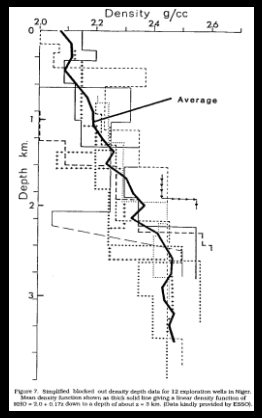
Profile 5 Logone-Birni Basin



SNH



Density Logs



Study Findings

- The Southern Chad Basin System has proven oil reserves now being exploited via the new pipe line through Cameroon.

- This study defines the close link between changes in plate motions, poly-phase basin development and basin stratigraphy.

- The interpretation of the gravity and aeromagnetic data, constrained by well and seismic data, provides the means of spatially mapping the structure and depth of the rift basins.

Reference

Bullard, E.C., J.E. Everett and A.G. Smith, 1965, The fit of the continents around the Atlantic, *in* A Symposium on Continental Drift: Royal Society of London Philosophical Transactions, Series A, 258, p. 41-51.