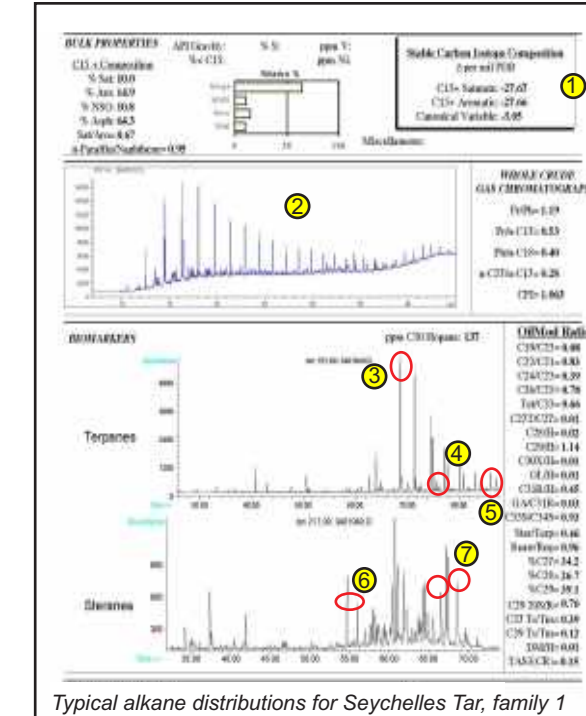


Oil samples and oil show extracts from the limited number of wells and the known seeps are used to help understand the multiphase break up of the East African margin, India and the Seychelles Micro-Continent.

Geochemical data is presented with current plate tectonic reconstruction models to contribute to the understanding of the rifting sequences that were initiated during the Triassic that have resulted in the present day continental settings with seemingly contradictory oil geochemical signatures.

The initial break up of Gondwana started in Permian times however rifting was not successful and a series of intermontaine basins were created in which classic terrestrial source rocks developed (eg Sakamena, and Sakoa formations, Madagascar and the Pindiro Evaporites in Tanzania).



This work would have not been possible without the assistance of the Seychelles Petroleum Corporation (SEPEC) access to the BP core store in Texas, access to GeoMark Research's O.I.L.S database base or funding by Petroquest International and East African Exploration Limited, all of whom I wish to thank.

Upper Palaeozoic, incipient break up

To date evidence for the early failed rift source rocks have not been encountered in Seychelles as the wells drilled thus far have only tagged the top of the exceptionally thick Karoo section. However throughout much of the Western Indian Ocean both Permian coals and Triassic lacustrine shales are recorded. There is also evidence for interior grabens within the Seychelles Plateau and the separation of the Seychelles from both India and Madagascar may also have been related to early Permo-Triassic lines of weakness.

The Tars

Note the elevated C_{29} norHopane peak, presence of Gammacerane and elevated C_{30} Hopane doublet, absence of Oleanane and presence of Diasteranes (as well as carbonate indicators).

The tars are sourced from a mid-to-late mature source rock, with a saline, marl dominated, restricted marine source signature.

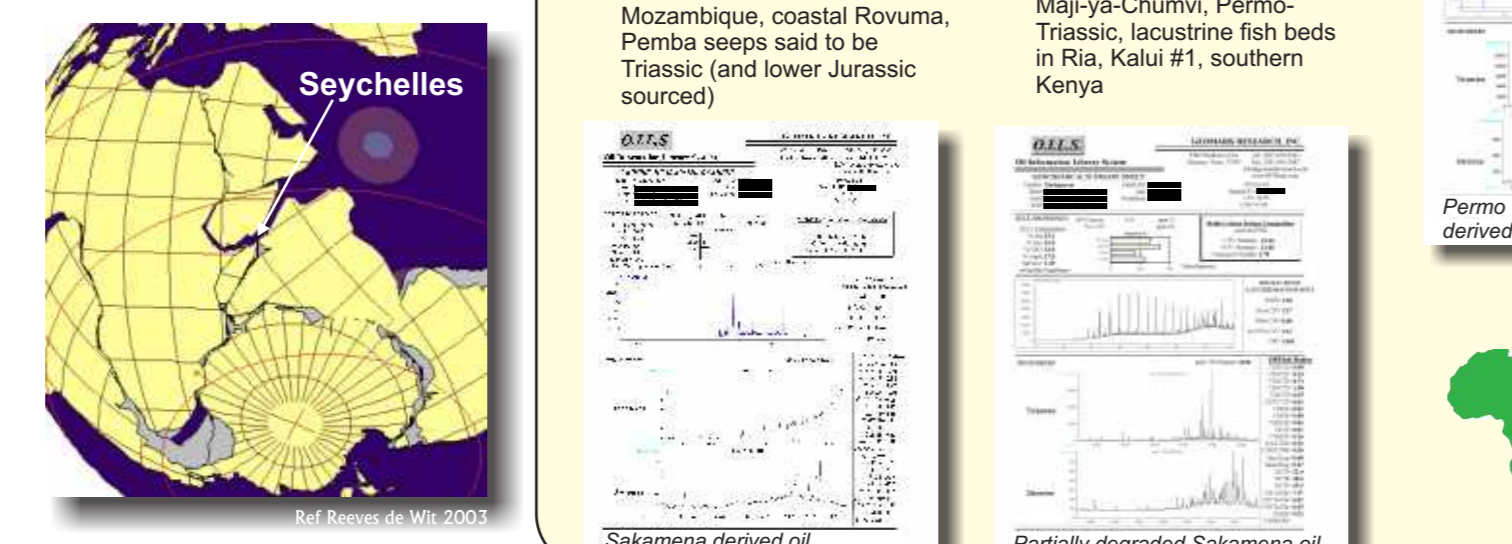
Over 4,500 samples have been collected by SNOE (SEPEC).

The coal mined in South Africa and found in Madagascar in Mozambique and Tanzania is of Permian age. The lacustrine Sakamena formation found to the south on Madagascar is believed to be the source of the giant Tsimiroro and Belomanga biodegraded oil deposits (fig GCMS - source contender 1a). The Triassic lacustrine Maji-Chumvi Fish beds were encountered in Ria Kulai #1, southern and conjugate Kenya and the oil shows here from Tanzania (fig GCMS - source contender 1a) are also believed to be derived from a Triassic lacustrine source. It is anticipated that a deeper Karoo exists under Seychelles EEZ; however the Liassic oil biomarker signature is so dominant it would mask any lacustrine oil input, if it were present. Upper Triassic, near exhausted, source rocks were encountered in the Reith Bank #1 well. (TOCs up to 6.7%).

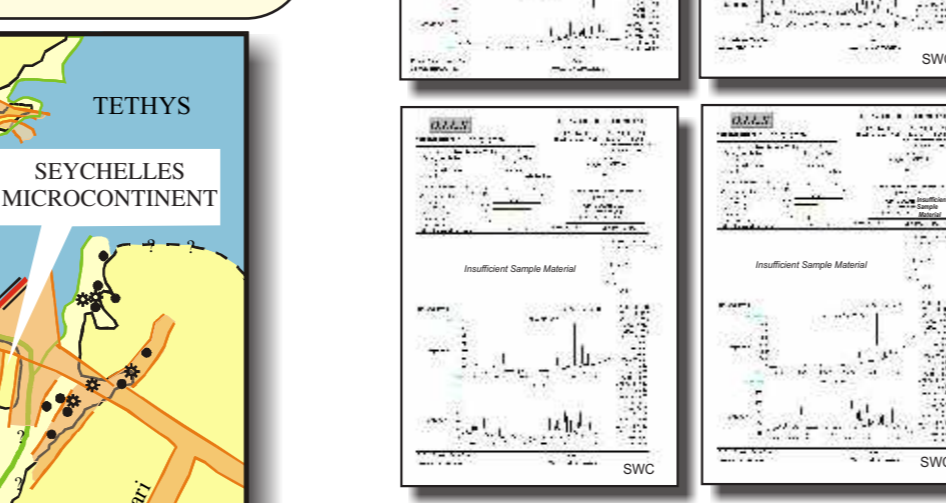
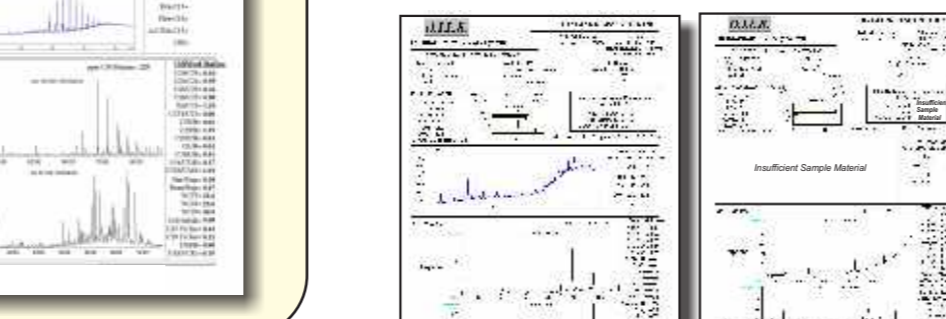
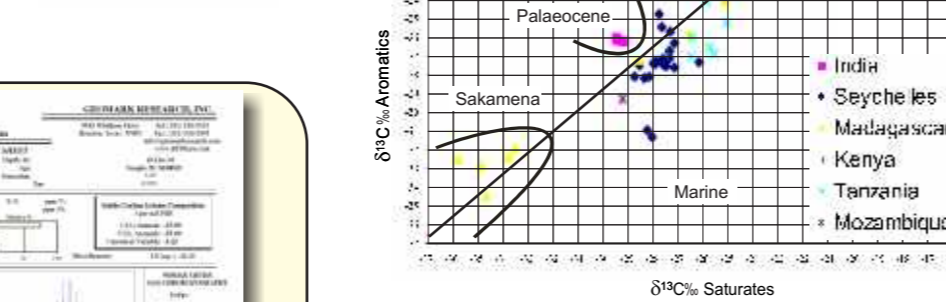
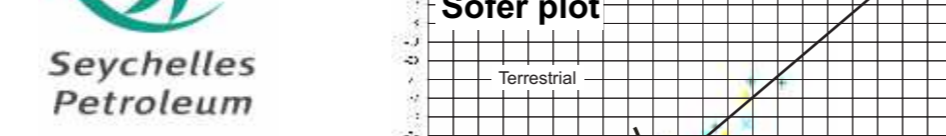
Seychelles' oils (see GCMS) and source rocks seeGCMS) reflect the initial, but successful phase of rifting (200Ma) and the biomarker traces shown here, extracted from side wall cores, clearly show an oil extract with the classic saline, stressed carbonate origins; namely elevated C_{35} Pentakishomohopane doublet, the elevated C_{29} norHopane, Gammacerane and low Diasterane peaks. The same signature can be seen in the majority of the tar balls washed up around the islands.



PermoTriassic



The Seychelles Oils



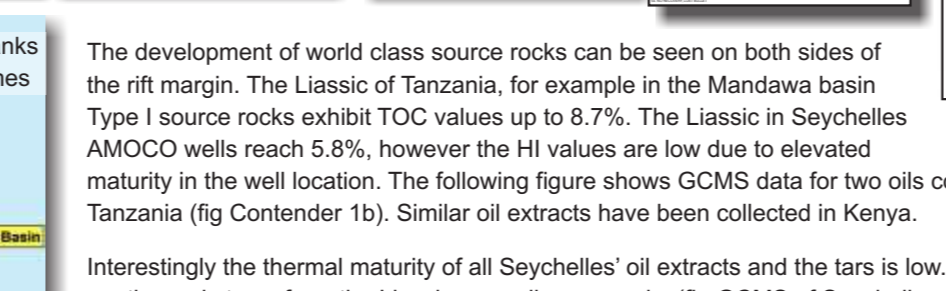
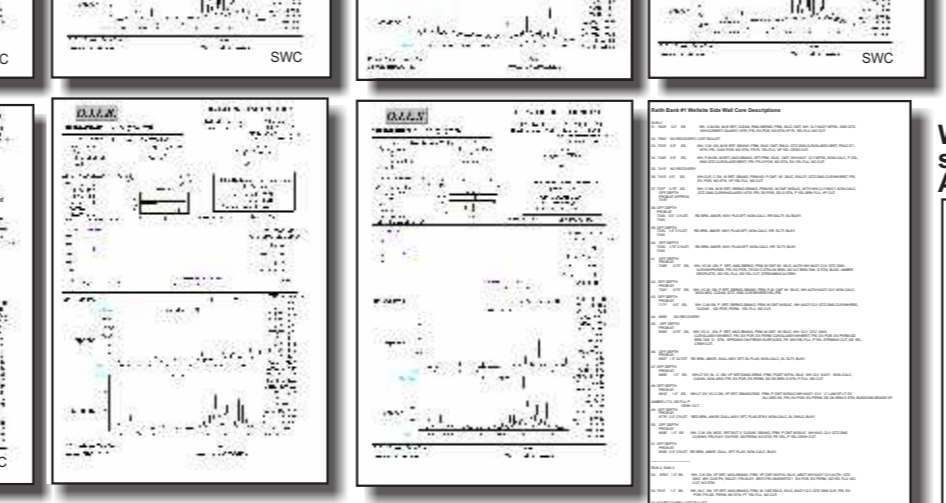
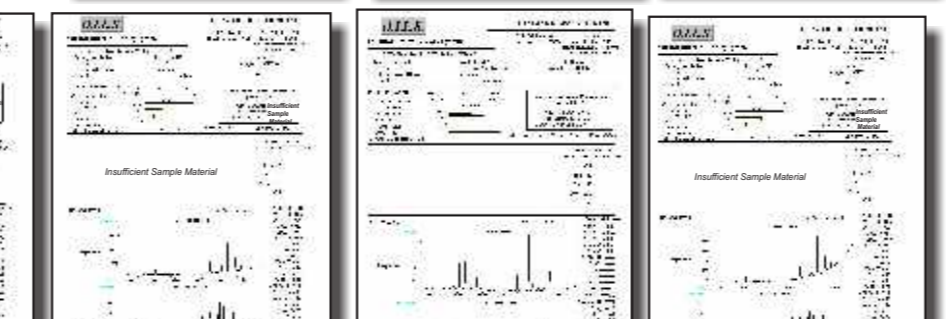
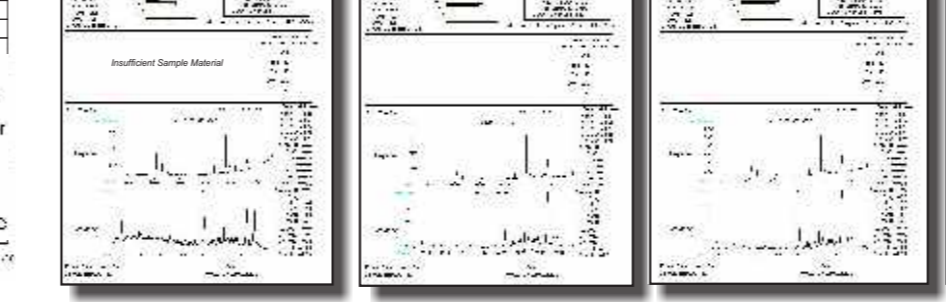
Contender 1a

Oils, Madagascar & Tanzania

- Lacustrine derived oil
- Low maturity oil
- Other occurrences: Mozambique, coastal Rovuma, Pemba seeps said to be Triassic (and lower Jurassic sourced)

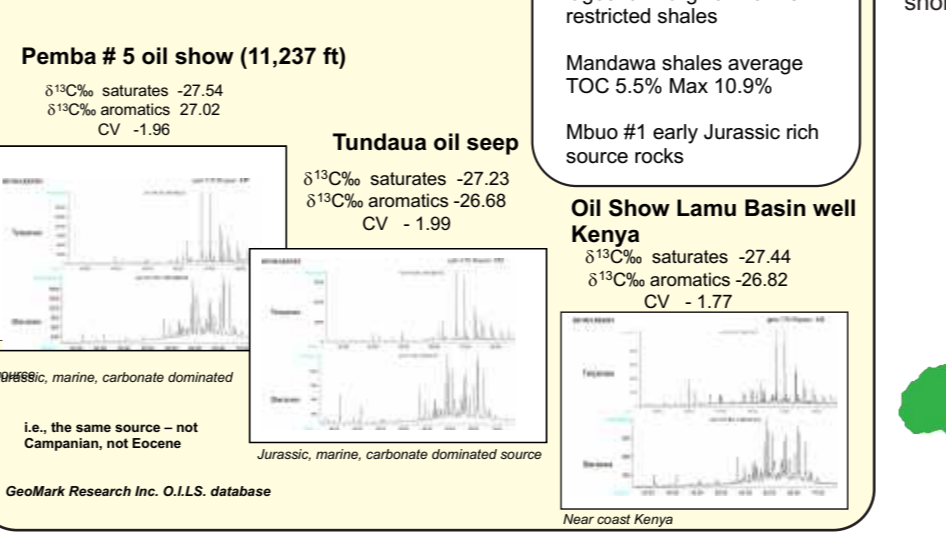


The Seychelles source rocks

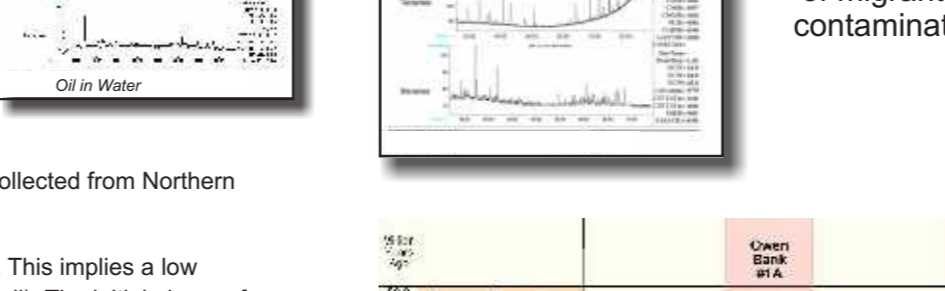
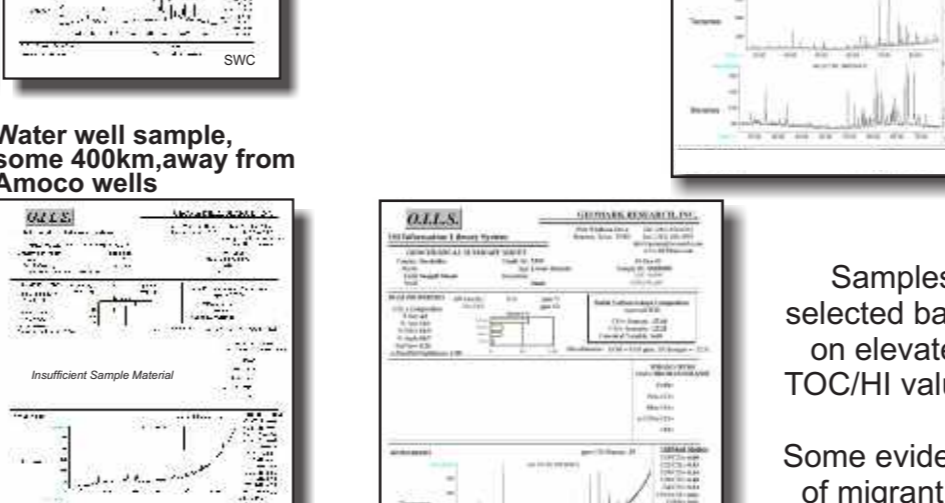
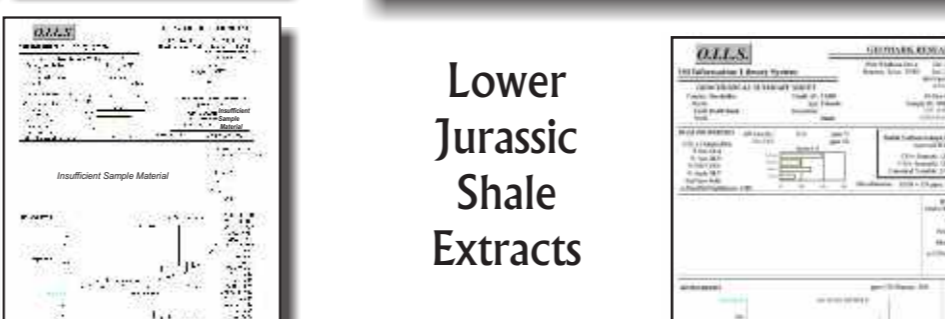
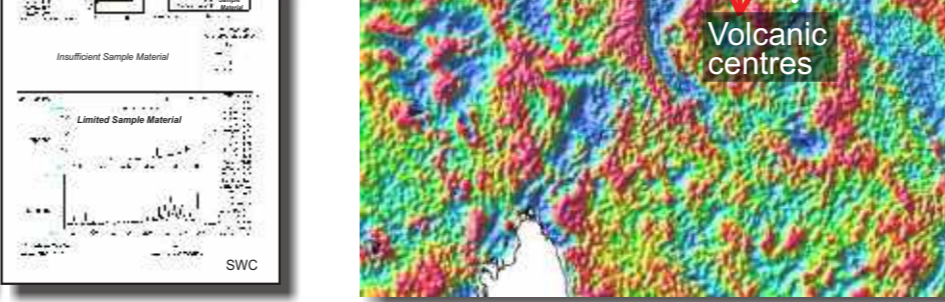
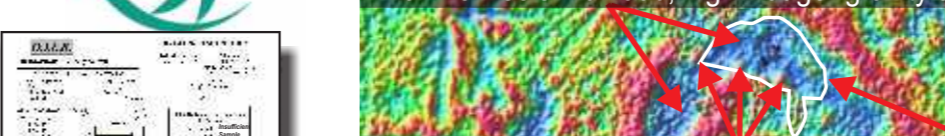


Contender 1b

Western Indian Ocean Margin, Lower Mesozoic Oils; Tanzania, Kenya

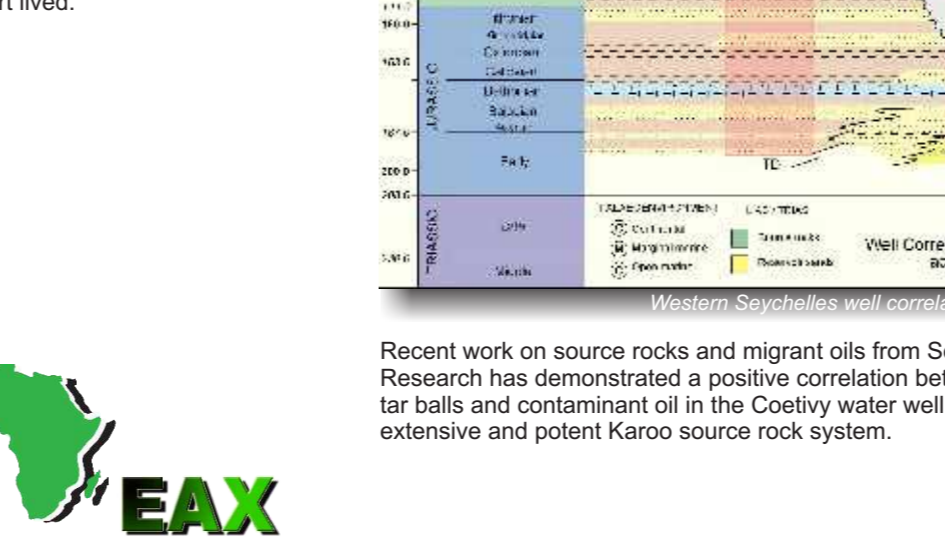


Seychelles source rocks

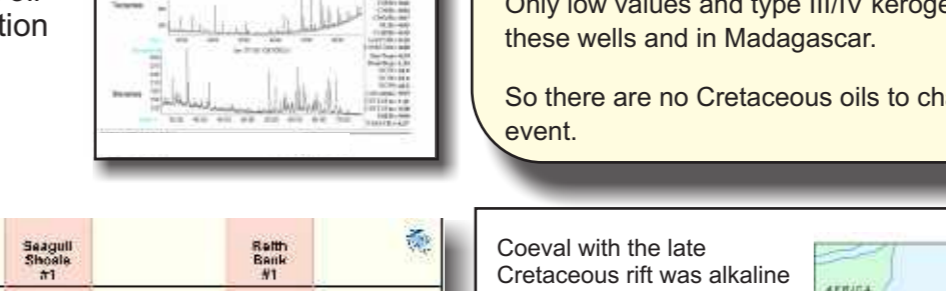
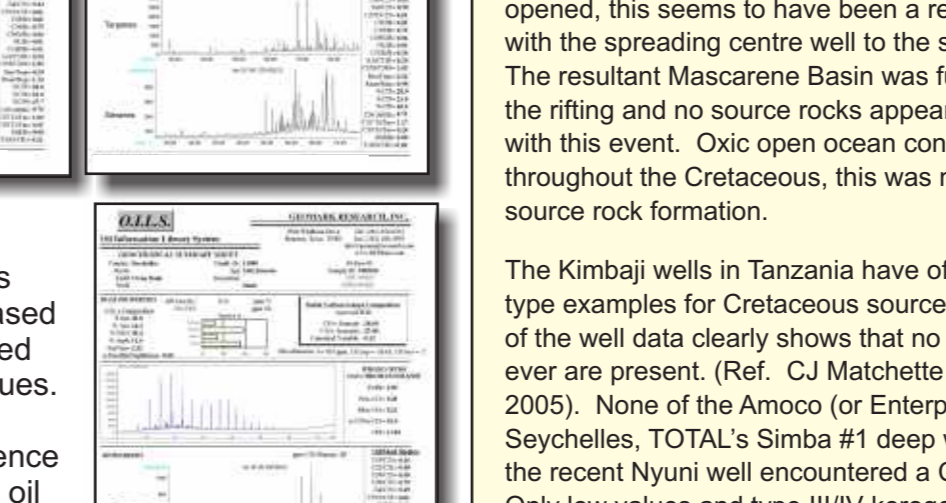
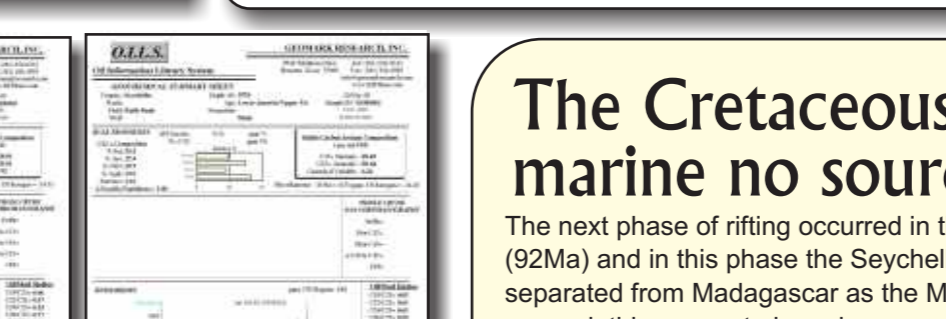
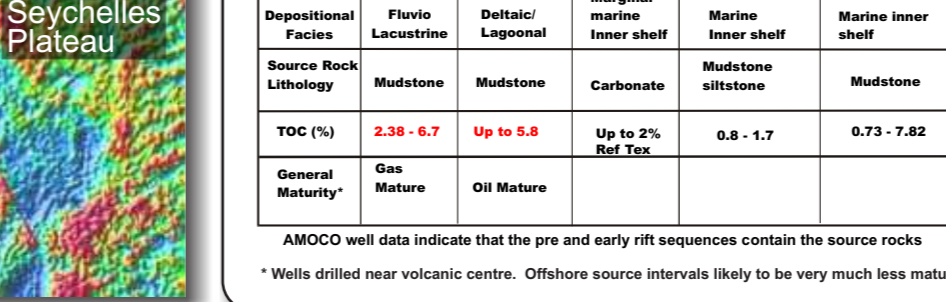


Contender 1b

Western Indian Ocean Margin, Lower Mesozoic Oils; Tanzania, Kenya

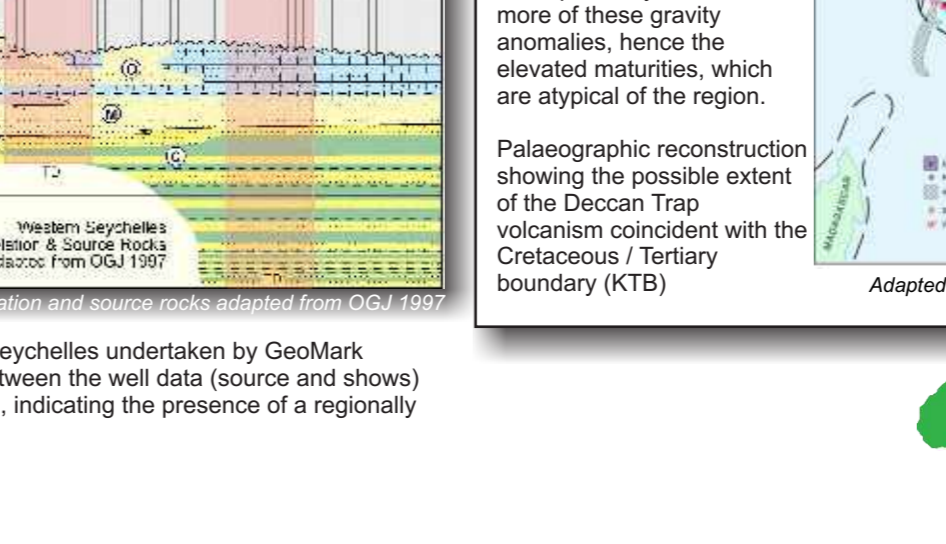


The Tertiary

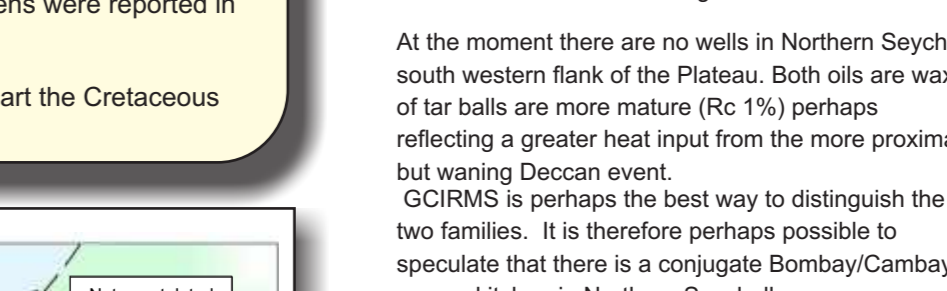
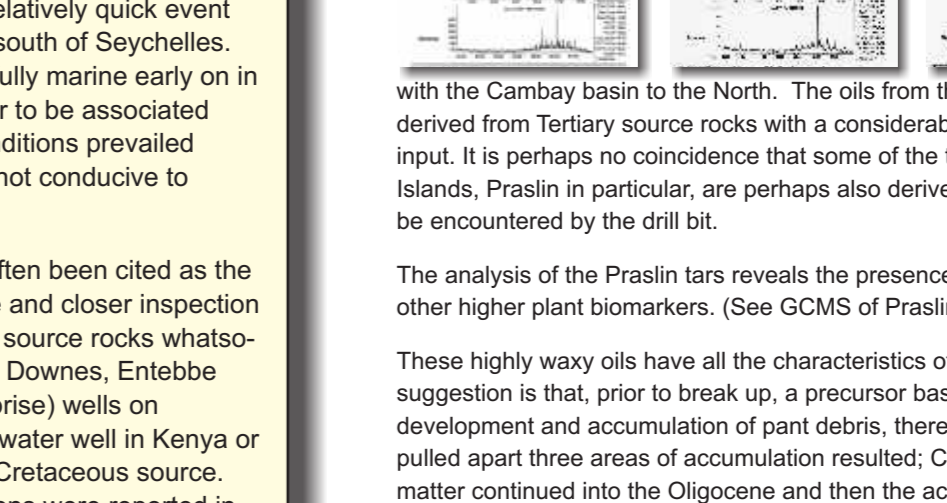
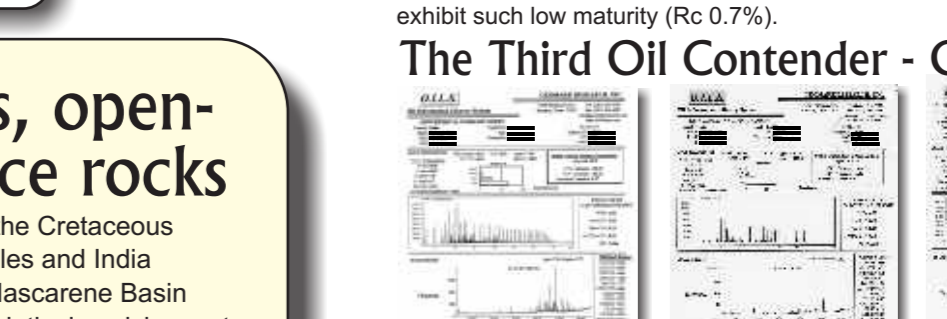
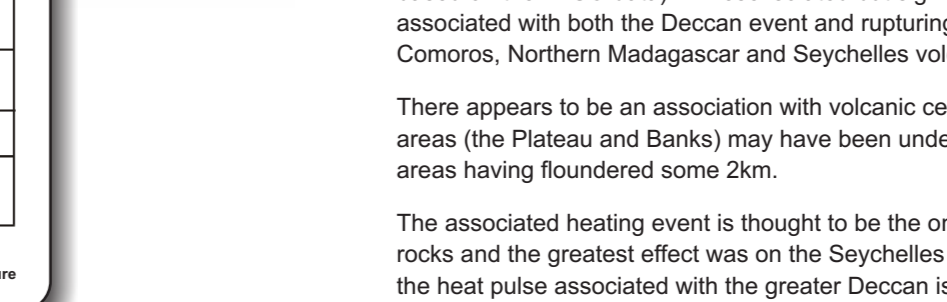
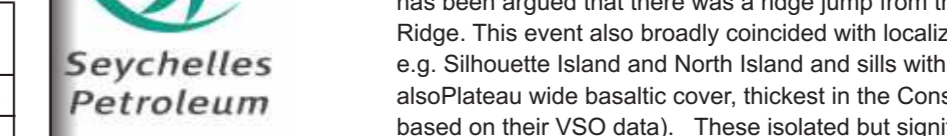


Contender 1b

Western Indian Ocean Margin, Lower Mesozoic Oils; Tanzania, Kenya

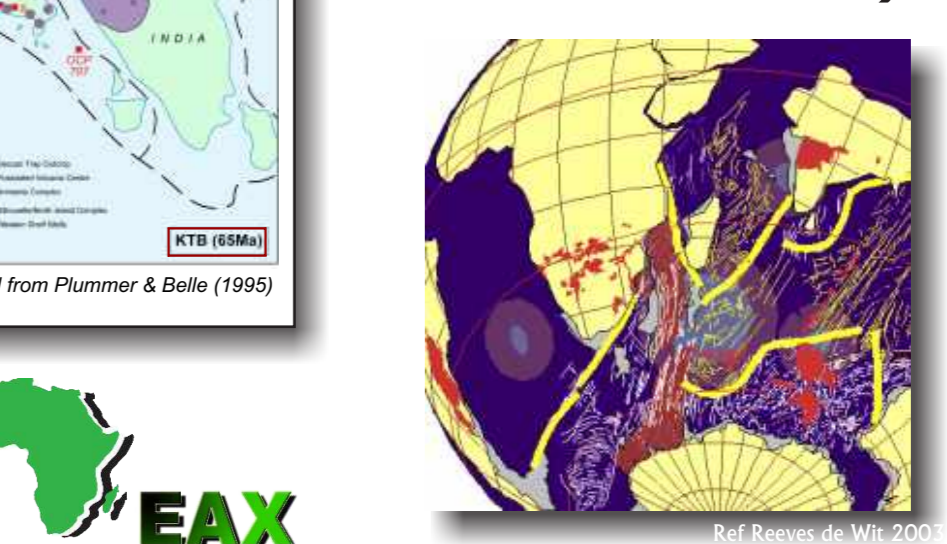


The Cretaceous, open-marine no source rocks

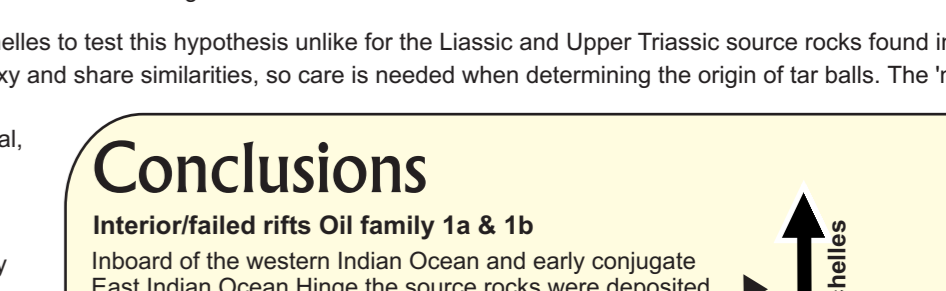
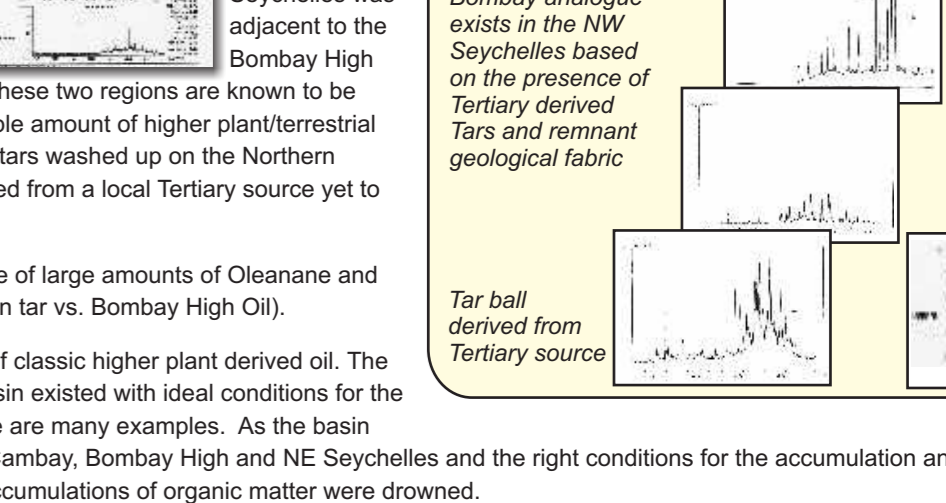
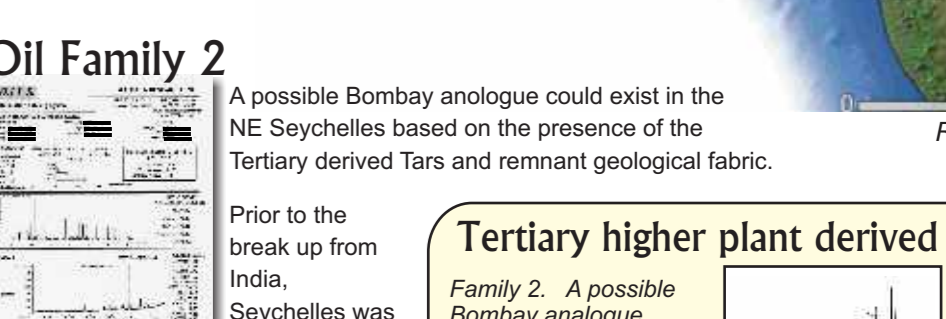
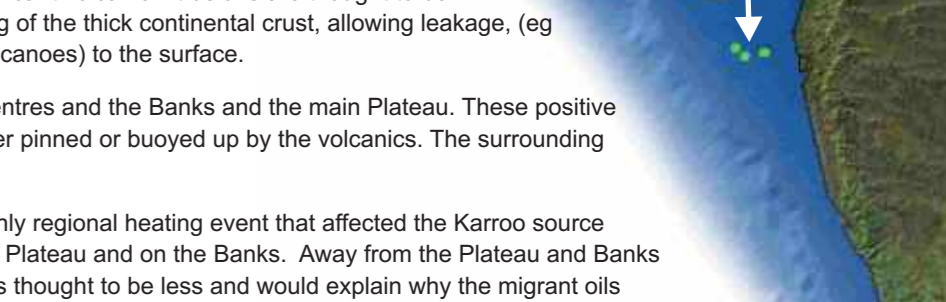
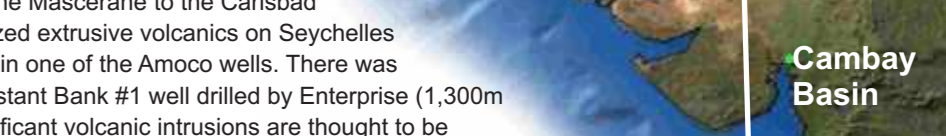


Contender 1b

Western Indian Ocean Margin, Lower Mesozoic Oils; Tanzania, Kenya

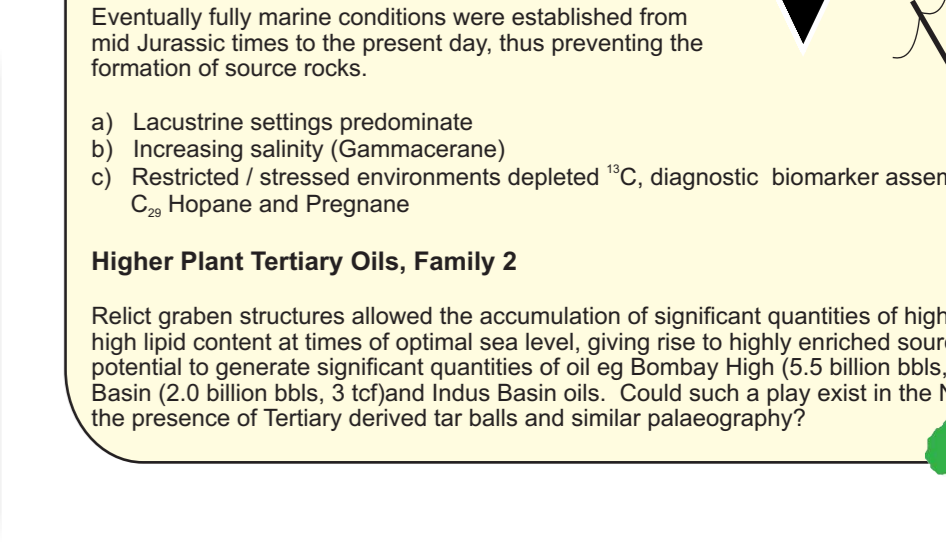


The Third Oil Contender - Oil Family 2



Contender 1b

Western Indian Ocean Margin, Lower Mesozoic Oils; Tanzania, Kenya



Conclusions

Interior/failed rifts Oil family 1a & 1b

Inboard of the western Indian Ocean and early conjugate East Indian Ocean Hinge the source rocks were deposited in interior / failed rifts (eg Selous, Ruvo, Mandawa, Ruvuma, Lamu, etc) and the presence of these intermontaine basins can be evidenced through analysis of the resultant oils. (Tsimiroro and Bemolanga 26 billion bbls.)

As rifting became successful through the early Jurassic, progressively less stressed environments prevailed, resulting in oils with a marine carbonate signature.

Eventually fully marine conditions were established from mid Jurassic times to the present day, thus preventing the formation of source rocks.

a) Lacustrine settings predominate
b) Increasing salinity (Gammacerane)
c) Restricted / stressed environments depleted ^{13}C , diagnostic biomarker assemblages: C_{29} Hopanes, C_{30} Hopane and Pregnane

Higher Plant Tertiary Oils, Family 2

Relict gran structures allowed the accumulation of significant quantities of higher plant matter with high lipid content at times of optimal sea level, giving rise to highly enriched source rocks and the potential to generate significant quantities of oil (eg Bombay High (5.5 billion bbls, 15.8 tcf) Cambay Basin (2.0 billion bbls, 3 tcf) and Indus Basin oils. Could such a play exist in the NE Seychelles given the presence of Tertiary derived tar balls and similar palaeogeography?

