

Geochemical Assessment of Basins Along the Western South Atlantic Margin

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Search and Discovery Article #30650 (2020)**

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Abstract

A super-regional review of detailed geochemical data from 1000+ crude oil samples has been applied to extend inferences about hydrocarbon kitchens from the better-known basins of the Brazil margin down to the Patagonian Toe. Multivariate statistical analyses were employed to separate the oils into four broad groups according to source environment that ranged from lacustrine to transitional to marine. Compositional attributes shared by crude oils allowed clustering into smaller sub-groups possibly indicating genetic relationships. Of particular interest is a large cluster of oils whose compositional features suggest an origin from similar mature source rocks deposited in lacustrine fresh to brackish water environments. These oils are distributed from Austral-Magallanes, San Jorge, Neuquen, and Cuyo basins of Argentina to basins offshore and onshore Central Brazil extending north to Para Maranhao. Source age for these oils varies from Triassic/Jurassic in the south to Jurassic/Neocomian in Central Brazil to Aptian in the Equatorial Margin basins of Brazil. Despite limited well coverage (<160 wells) in the shallow waters of the San Jorge, Austral - Malvinas (500,000 km²) and Colorado-Salado (300,000 km²) basins, continental - marine reservoir intervals have been identified. Three plays were selected for further analysis according to their proven, probable and possible petroleum systems: Colorado-Salado Type: NW-SE-trending basins with Paleozoic structural control roughly coast-orthogonal with superimposed coast-parallel structuring related to later South Atlantic opening. Structural trends containing organic-rich intervals include pre-rift Permian and possible syn-rift lacustrine, Tithonian to Barremian facies, buried and sealed by marine Cretaceous high-stand systems tract units. Patagonian Margin toe: Elongate depocenters of Early Cretaceous lacustrine and Valanginian marine intervals tapering to thin condensed sections beneath the shelf from more than 6 km of sediments below the lower slope and rise. Malvinas/Austral: Proven oil sourced in Late Jurassic rifts and Neocomian shallow marine sequences. Similar transgressive Oxfordian age sequences were observed in DSDP-330/Ewing Bank and Tithonian-aged facies have been drilled in the Malvinas basin. These hypotheses were tested against reprocessed seismic (which revealed stratigraphic detail) and advanced potential field compilations which jointly illustrated basin architectures that influenced or even controlled oil family distributions.

Geochemical Assessment of Basins Along the Western South Atlantic Margin

Craig Schiefelbein/GSI

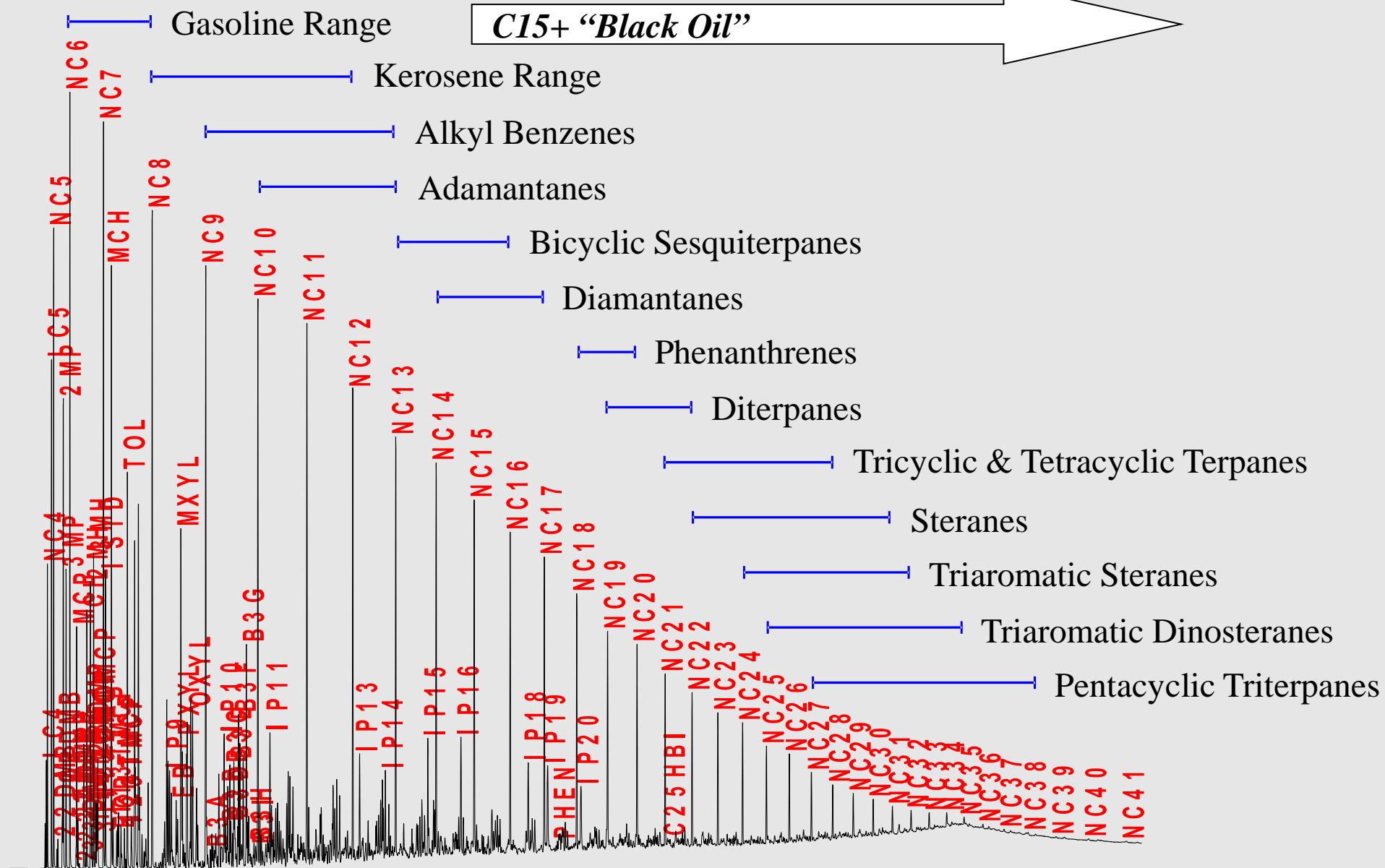
Carlos Urien

William Dickson/DIGs

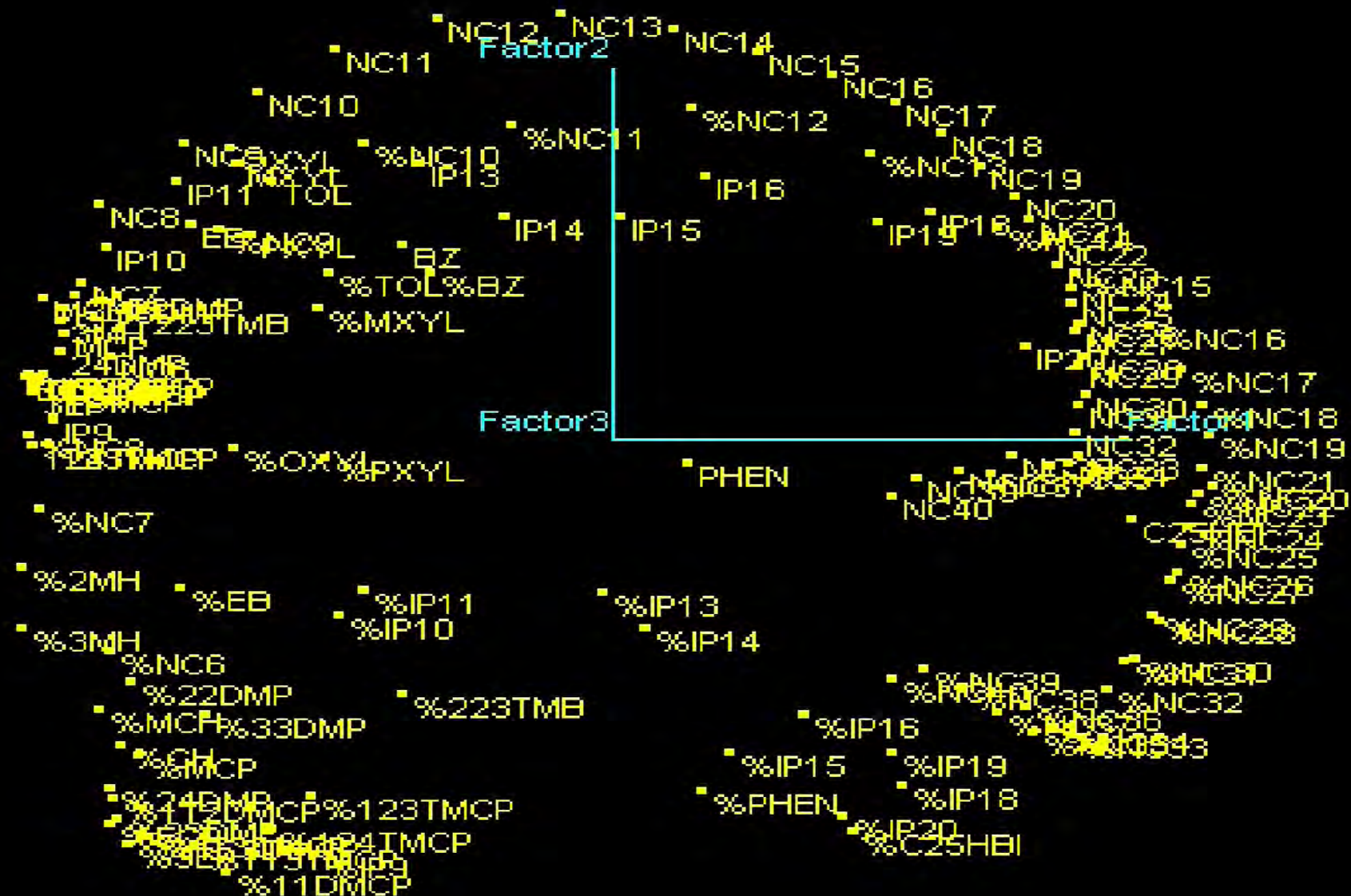
John Zumberge/GeoMark

- Utilize chemical composition data & multi-variate statistics to separate crude oils into compositionally similar groups by source depositional environment & likely age/event
- Acquire & organize “black oil” data: 1130 crude oil samples, western South Atlantic margin, multiple nonexclusive sources
- Iterate on multivariate statistical techniques using hierarchical cluster and principal component analyses
- Winnow sample set, excluding 182 for high maturity, biodegradation, contamination, duplication, and/or other post-generative processes
- Focus on fourteen source dependent parameters for remaining 958 samples
- Check outliers to ensure data integrity, then map, repeat and ultimately integrate and interpret within a multi-disciplinary framework

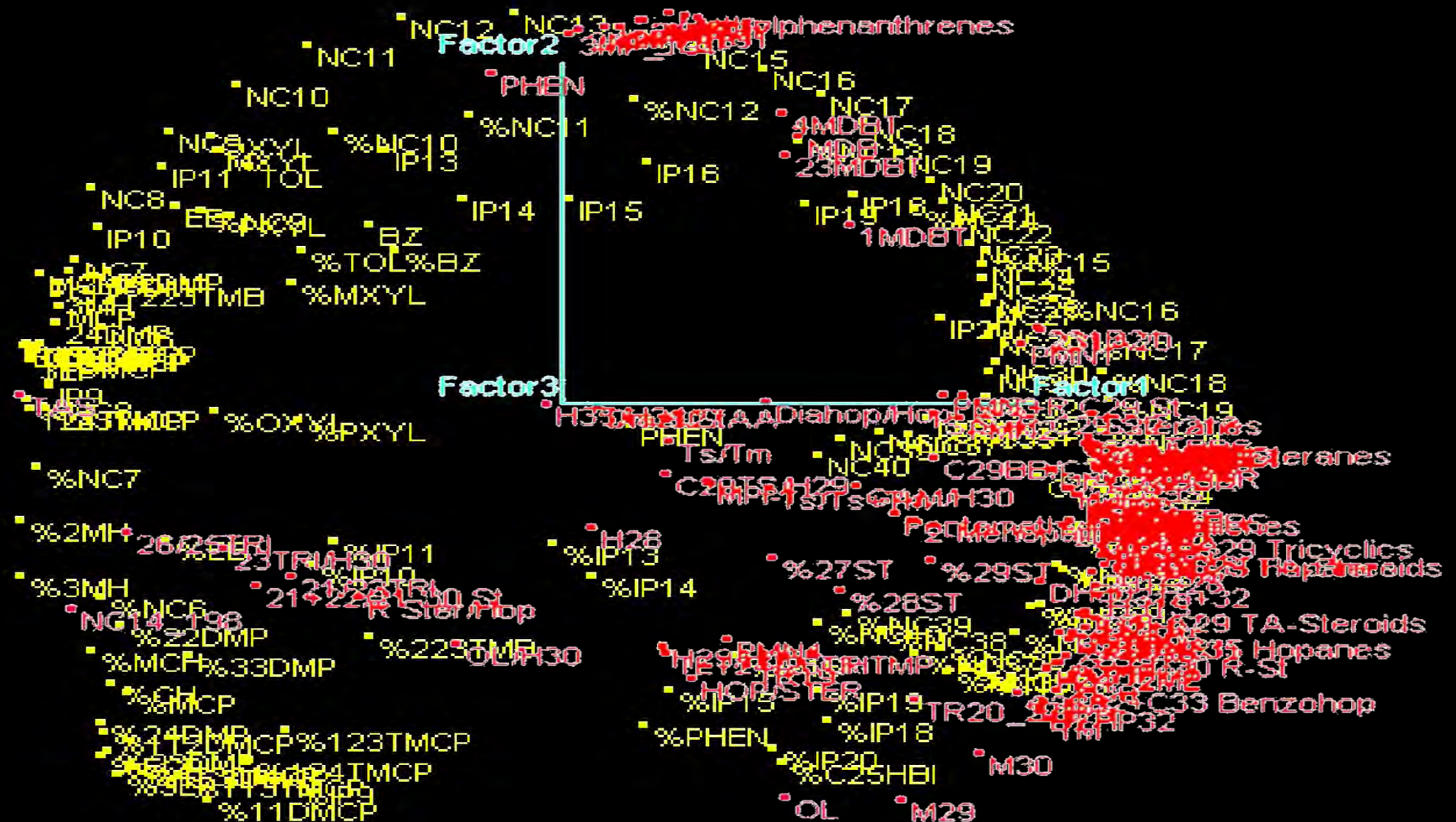
Whole Oil Gas Chromatogram



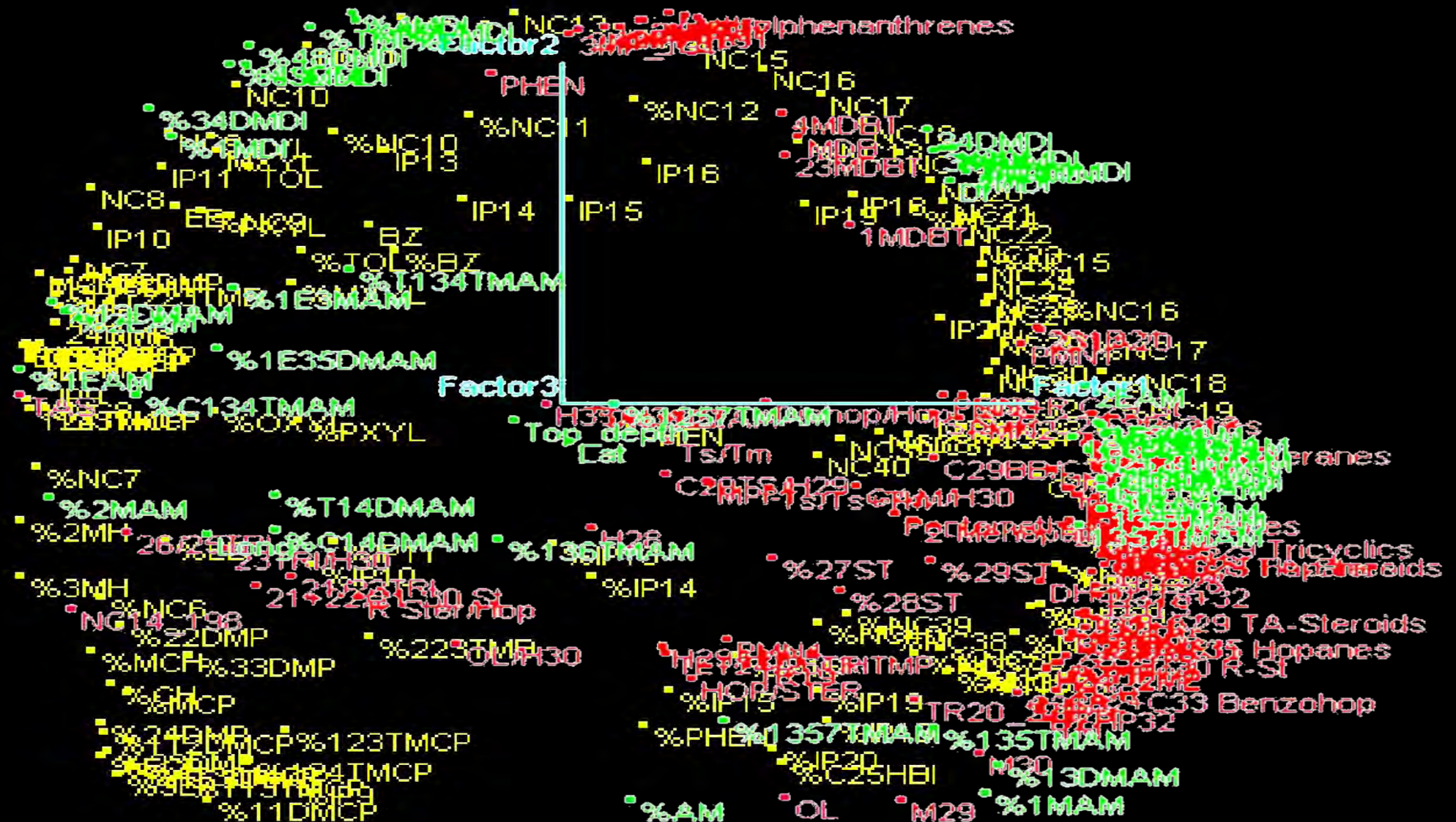
PCA Loadings – All (Ideal World) Data



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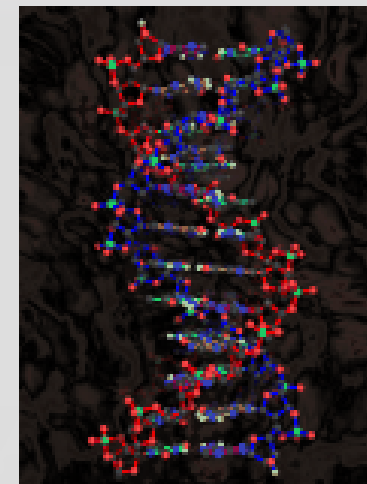


Applying an approach similar to
that used in DNA paternity tests:

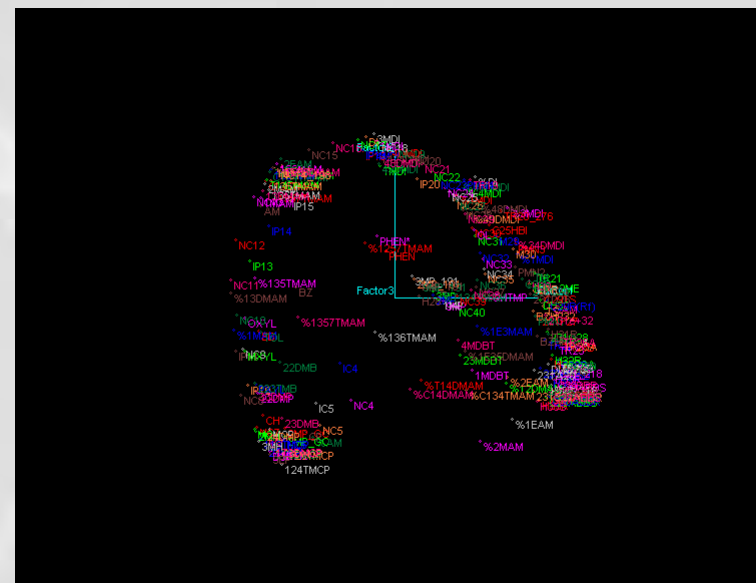
Parent -- sibling

But using quantitative
compositional data to link:

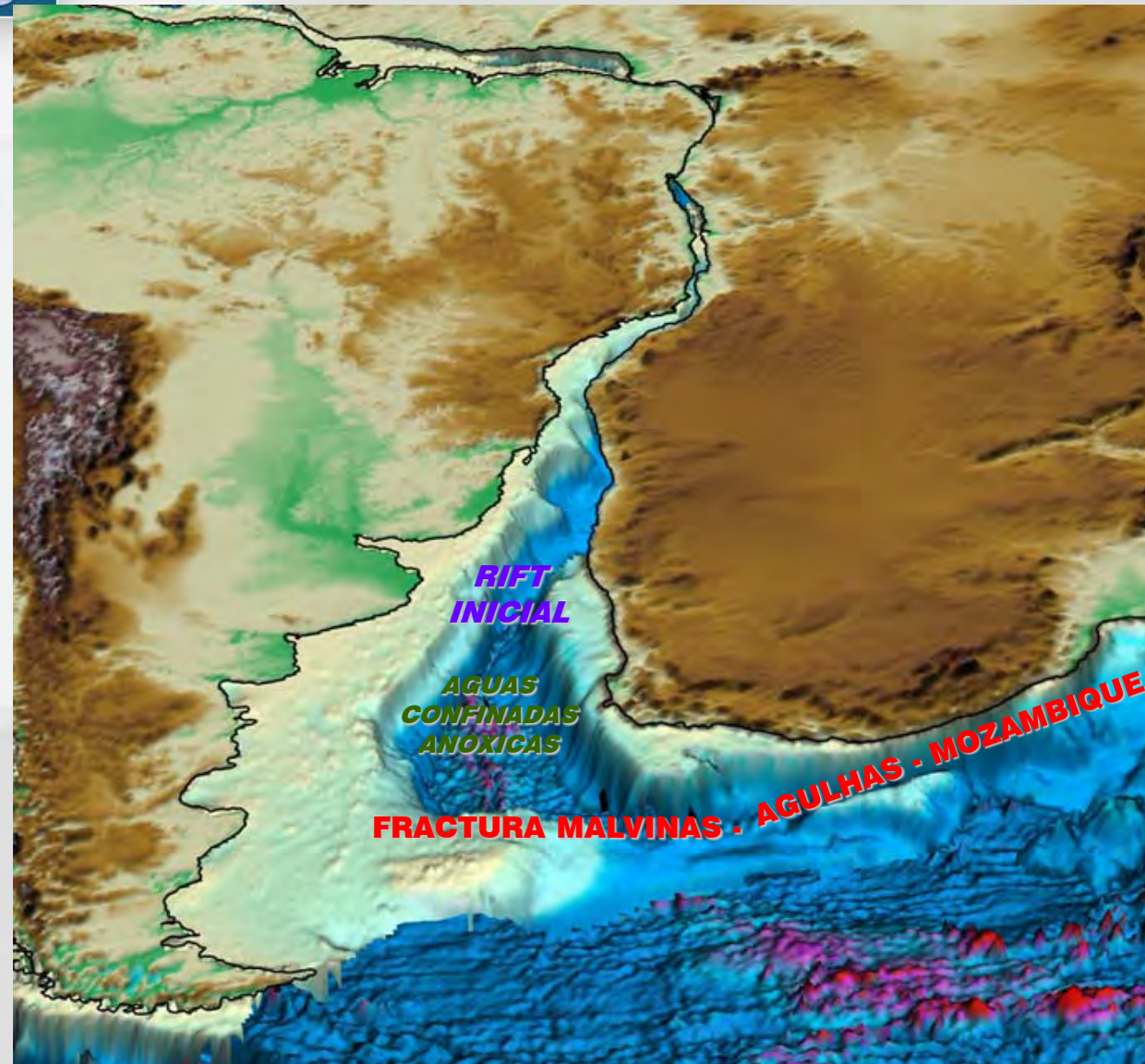
Oils -- source rocks

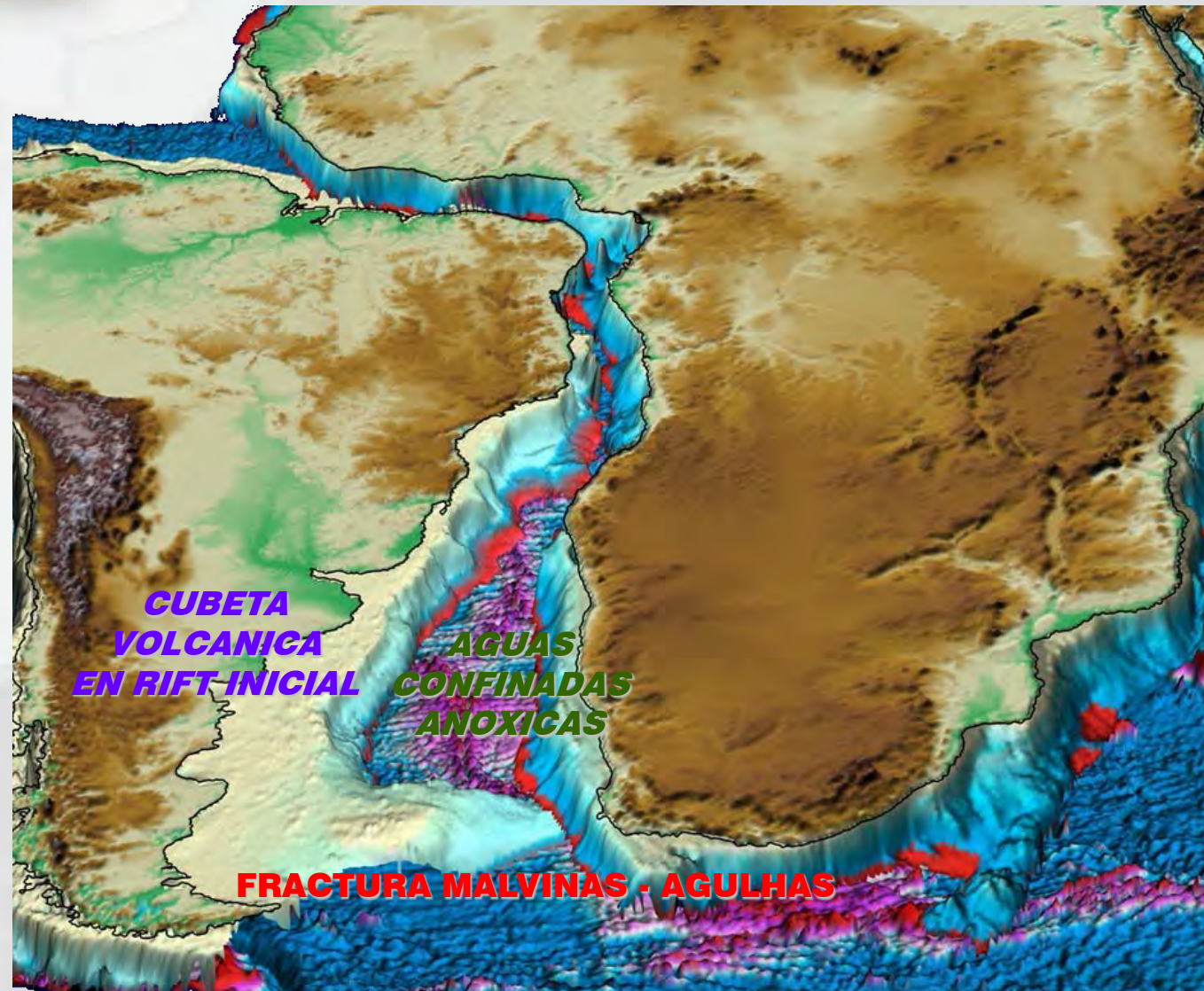


**DNA
Double
Helix**



UPPER JURASSIC - NEOCOMIAN





COVERAGE

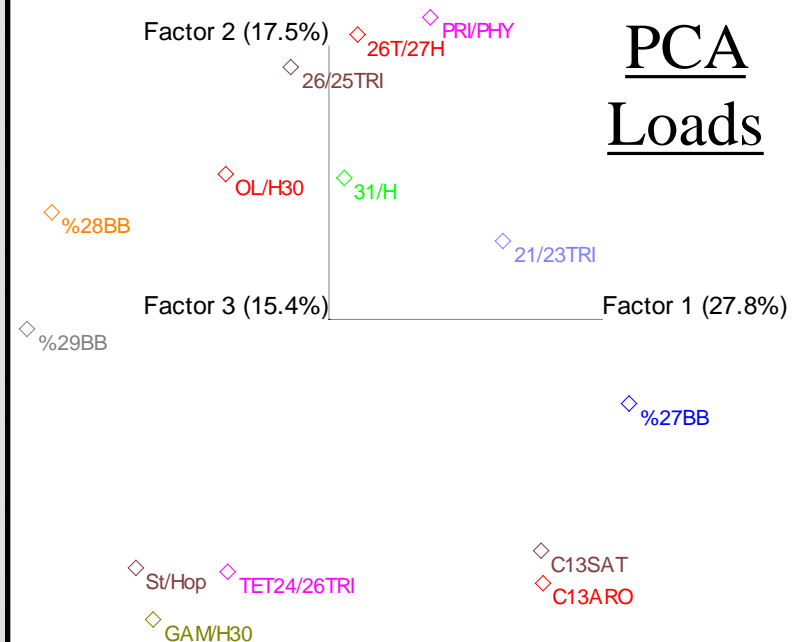
- 1130 Crude Oils
 - 997 Brazil
 - 116 Argentina
 - 9 Chile
 - 5 Suriname
 - 4 Guyana



STUDY AREA

- Coastal Basins
 - Guyana
 - Suriname
 - Brazil
 - Argentina
 - Chile

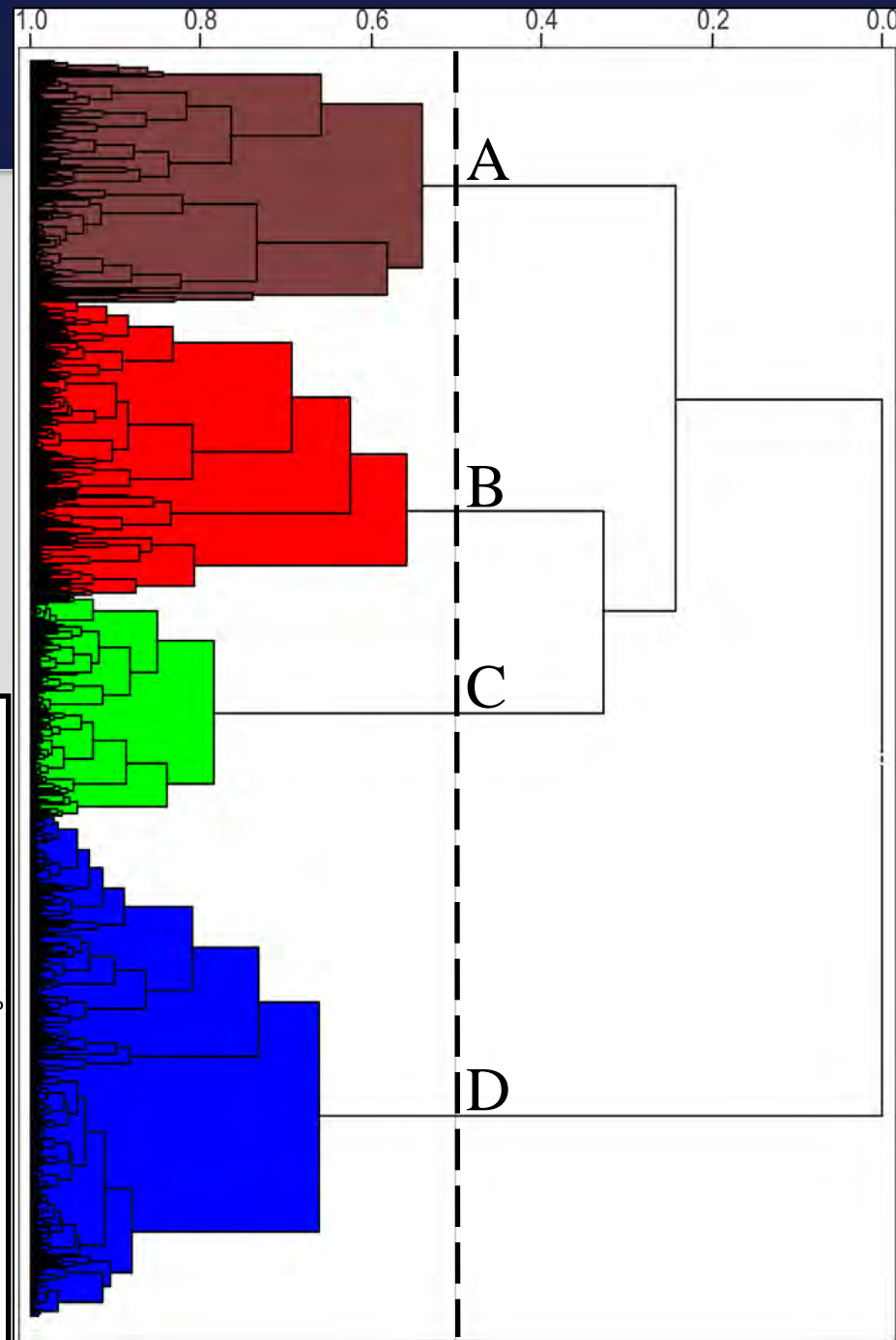
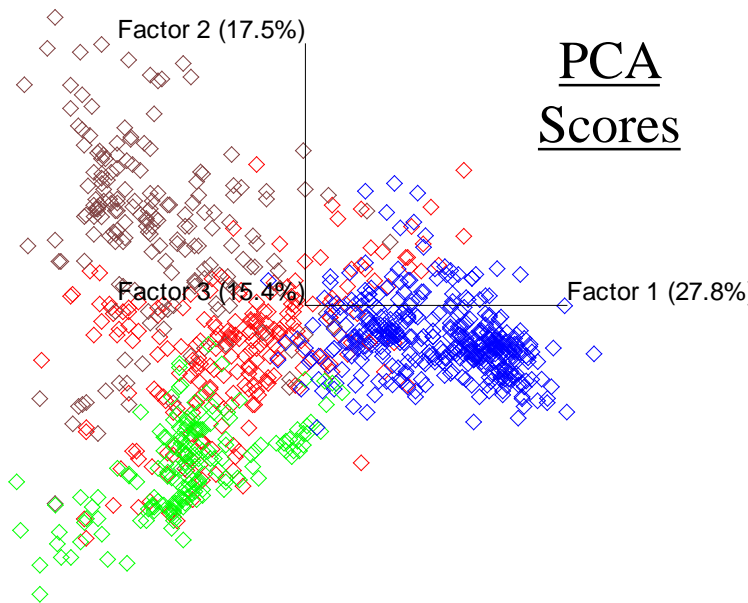
PCA Loads



HCA Dendrogram

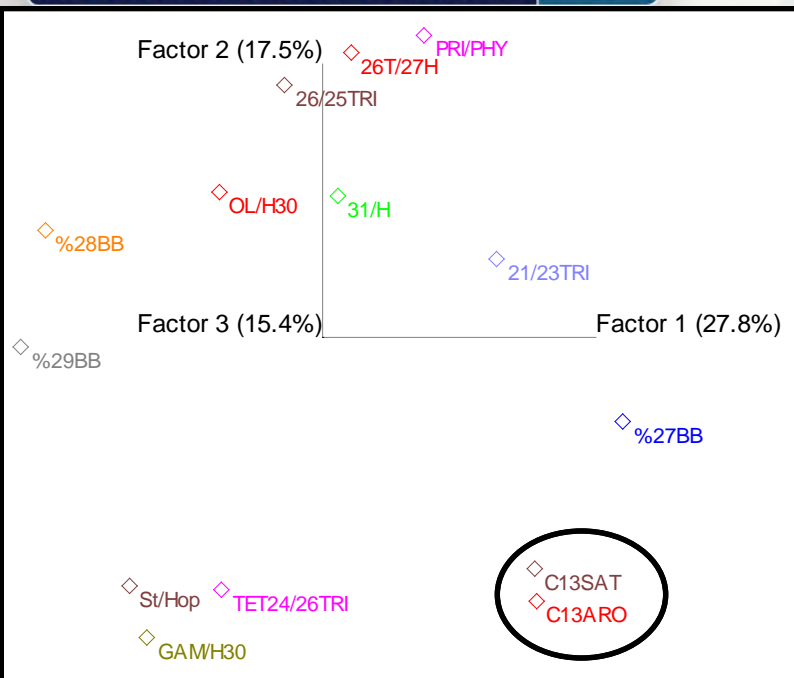
- 1130 Oils
- 182 Excluded
- 958 Oils Used
- 14 Parameters

PCA Scores

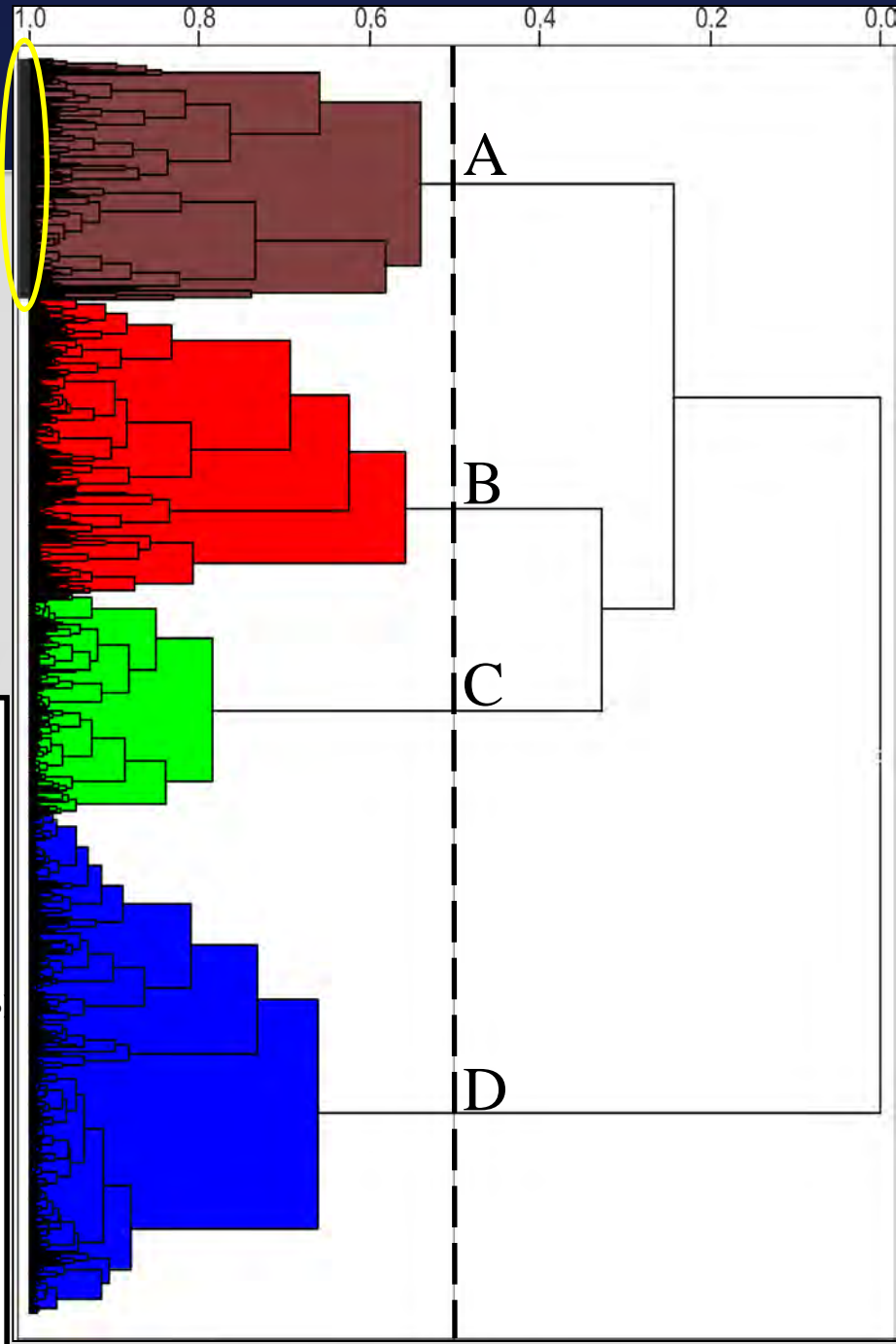
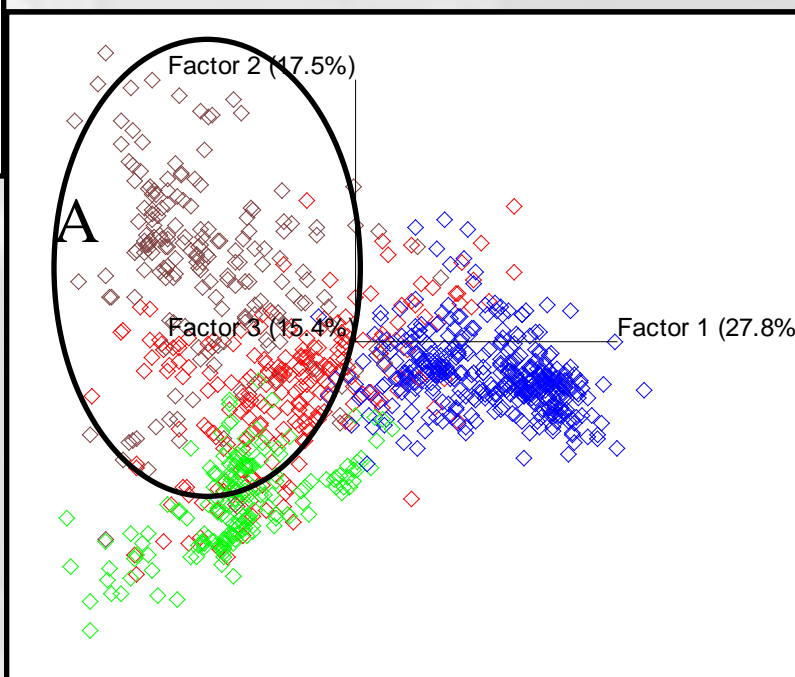


PCA Results

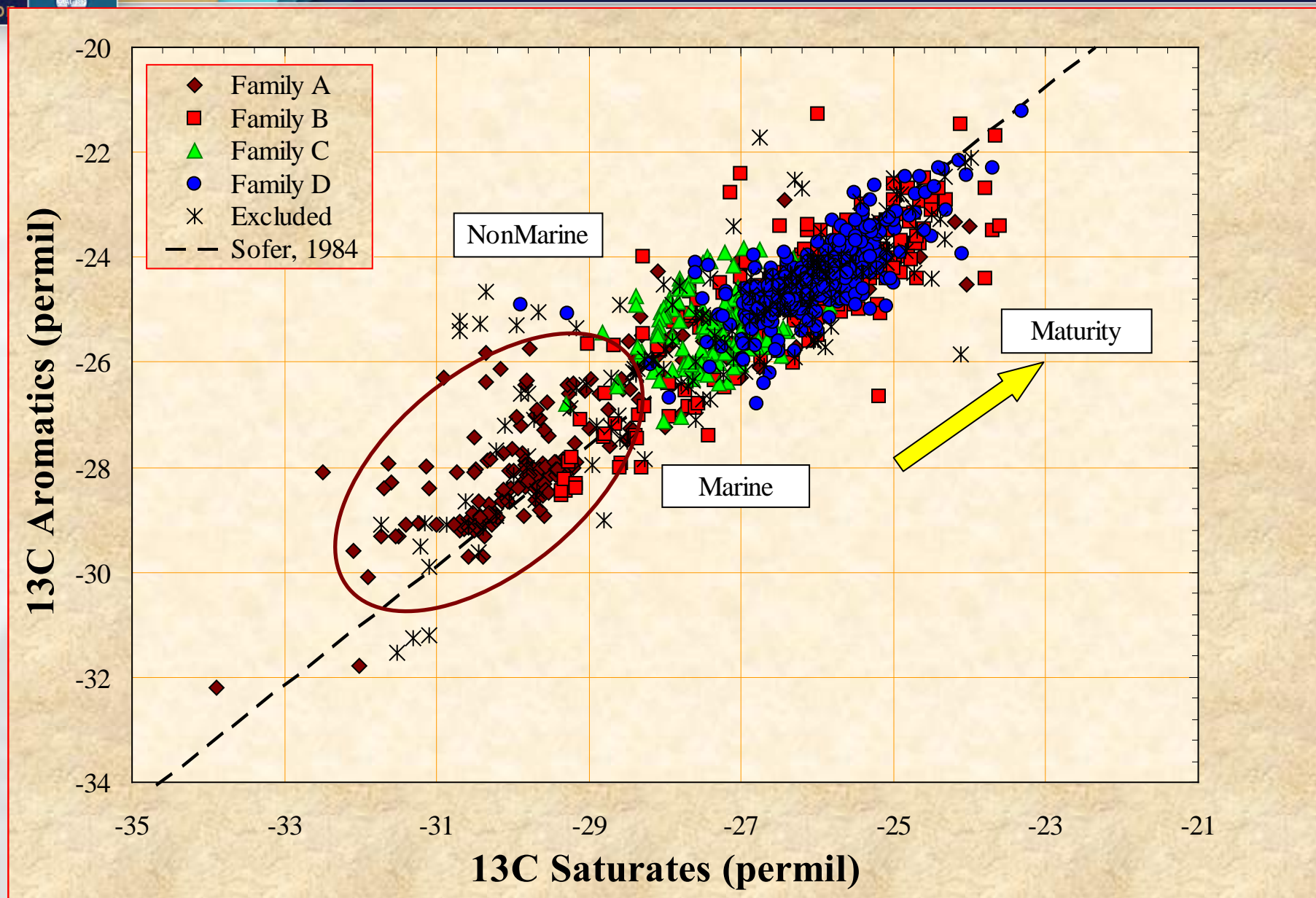
- 60%/PC3
- 77%/PC5



Family A
(184 Oils)

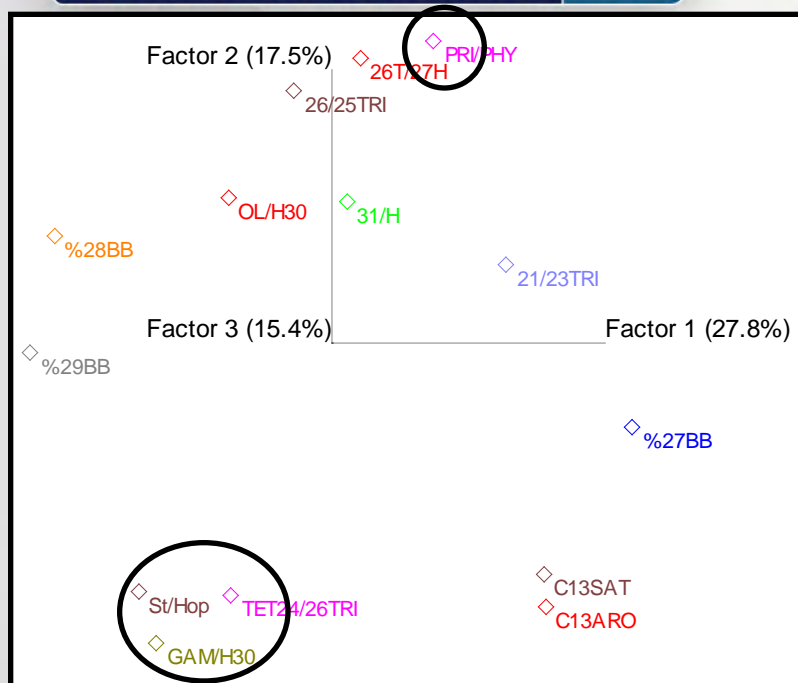


Family A

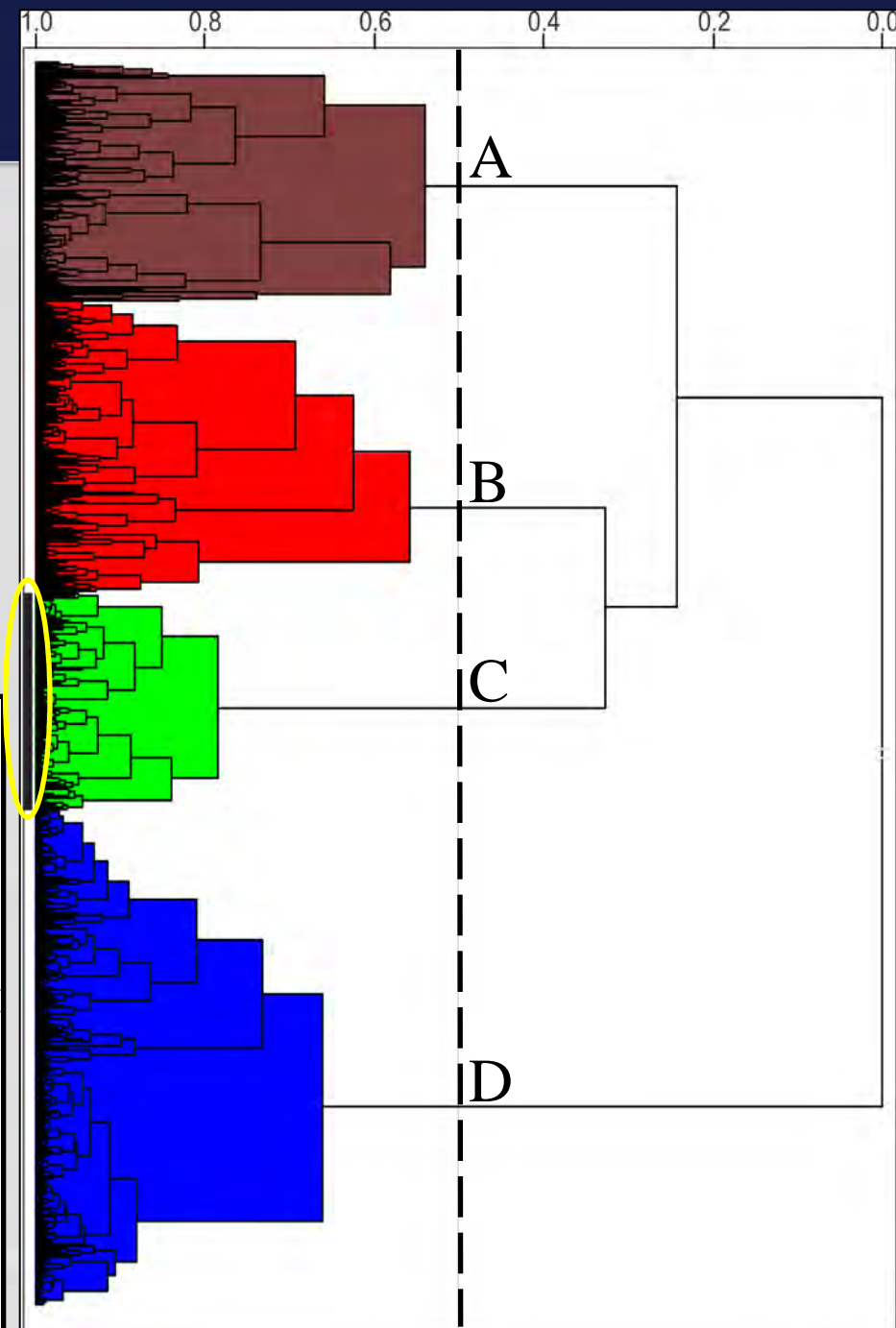
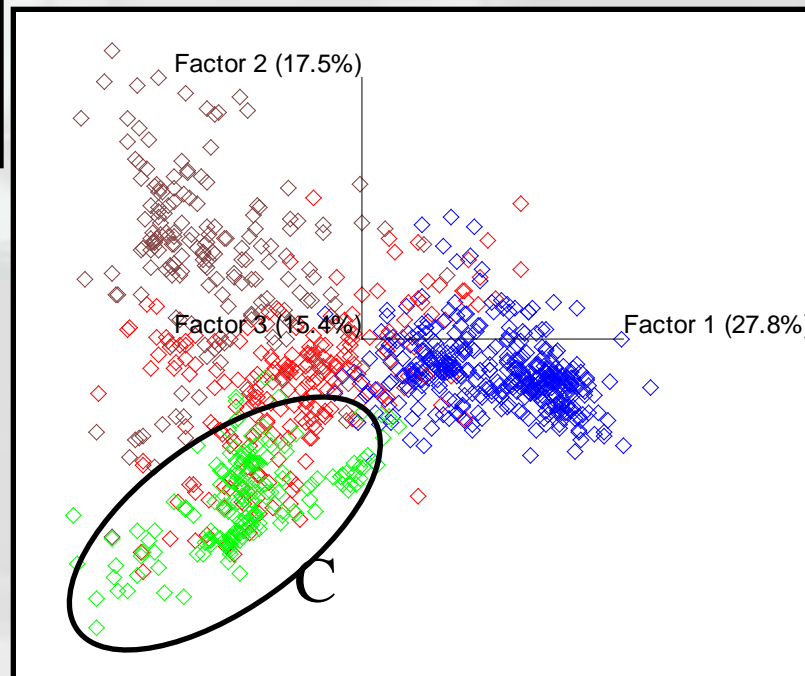


Family A

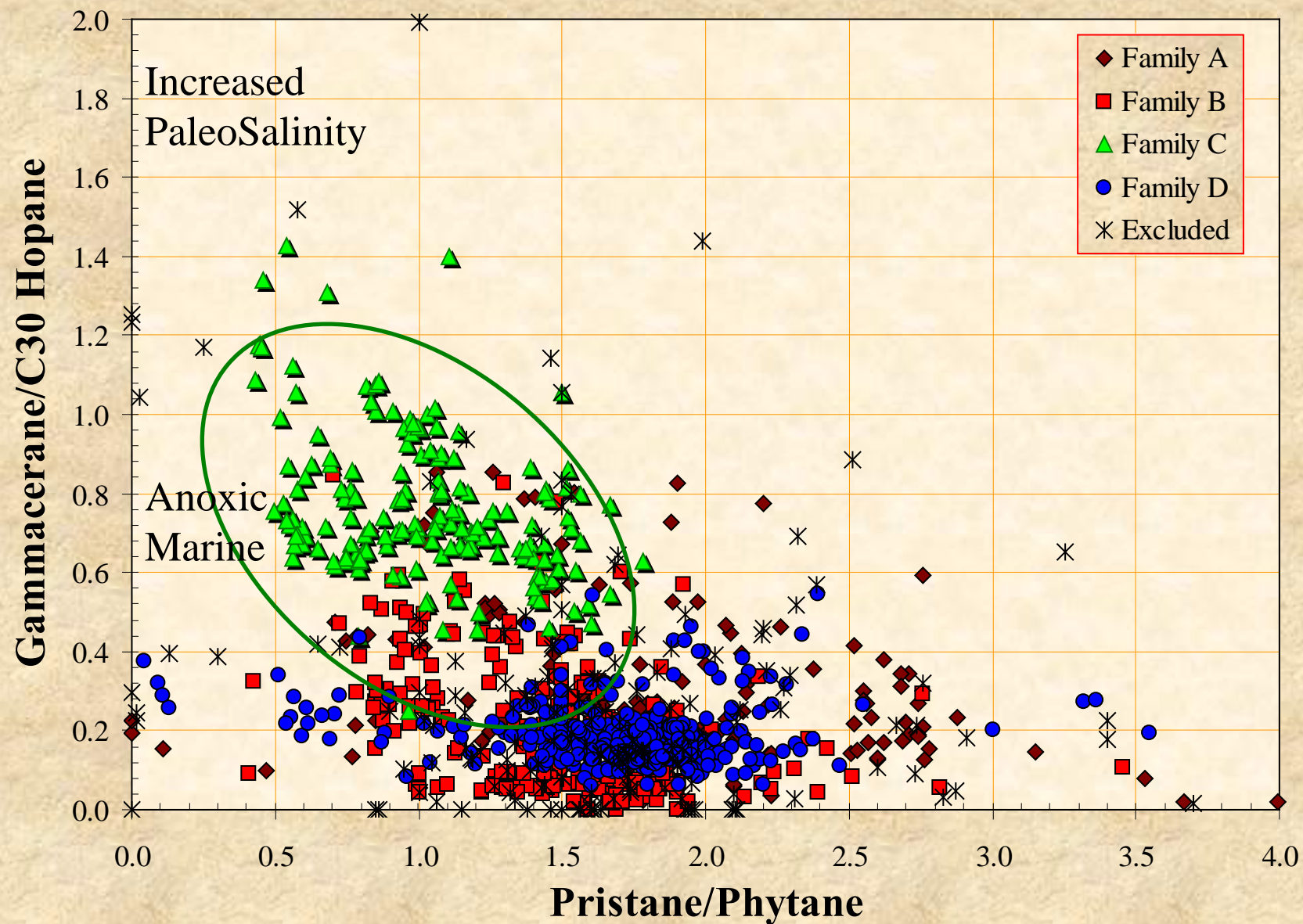




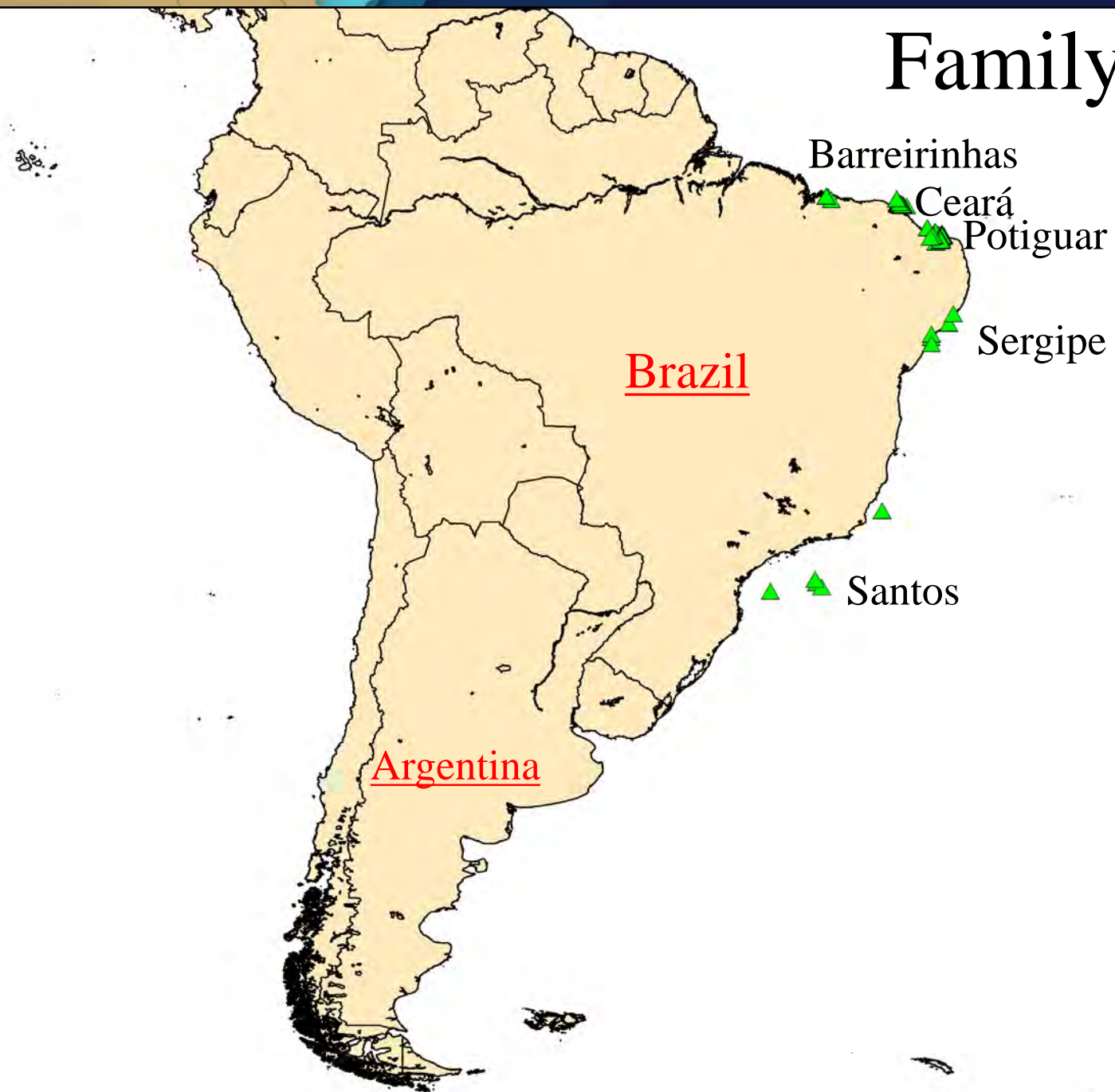
Family C (167 Oils)



Family C

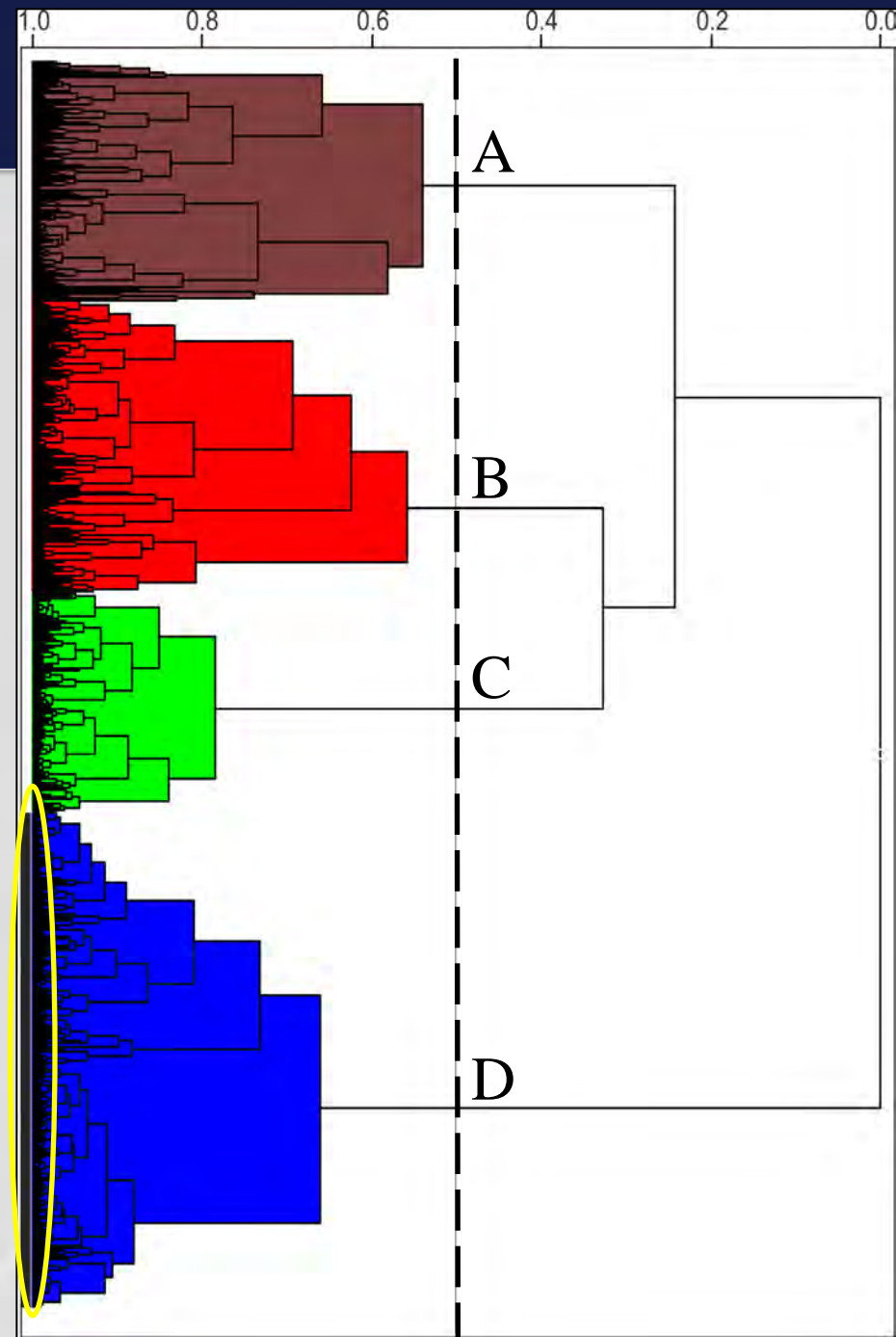
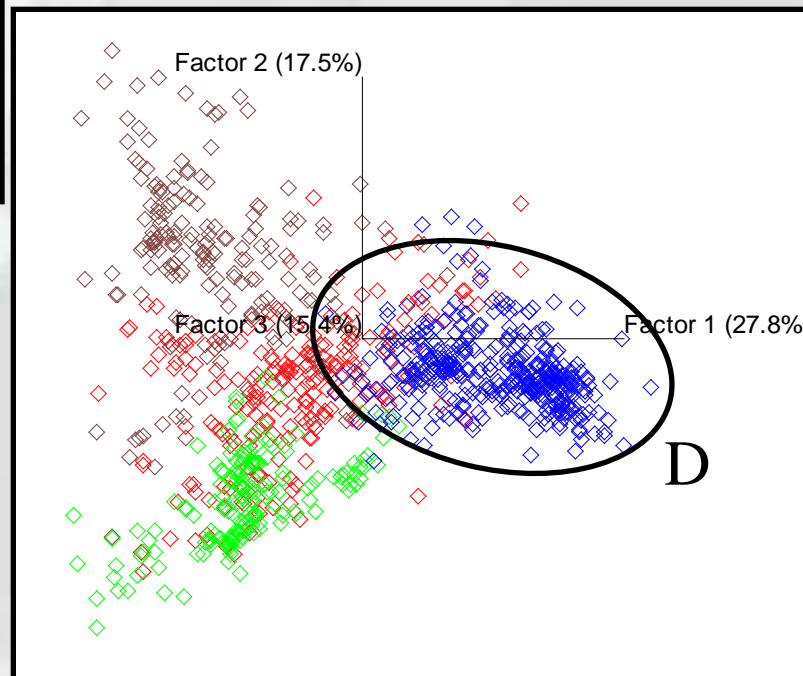
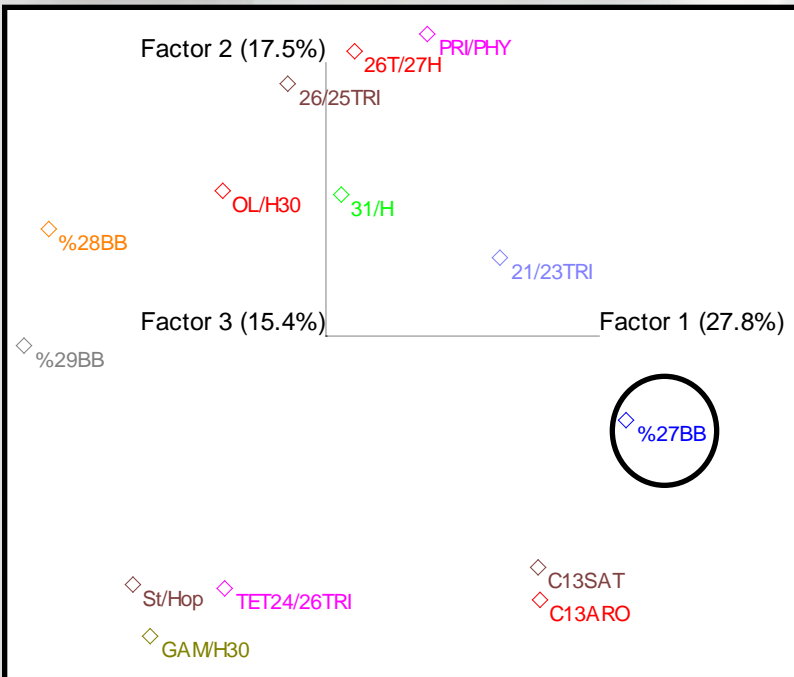


Family C

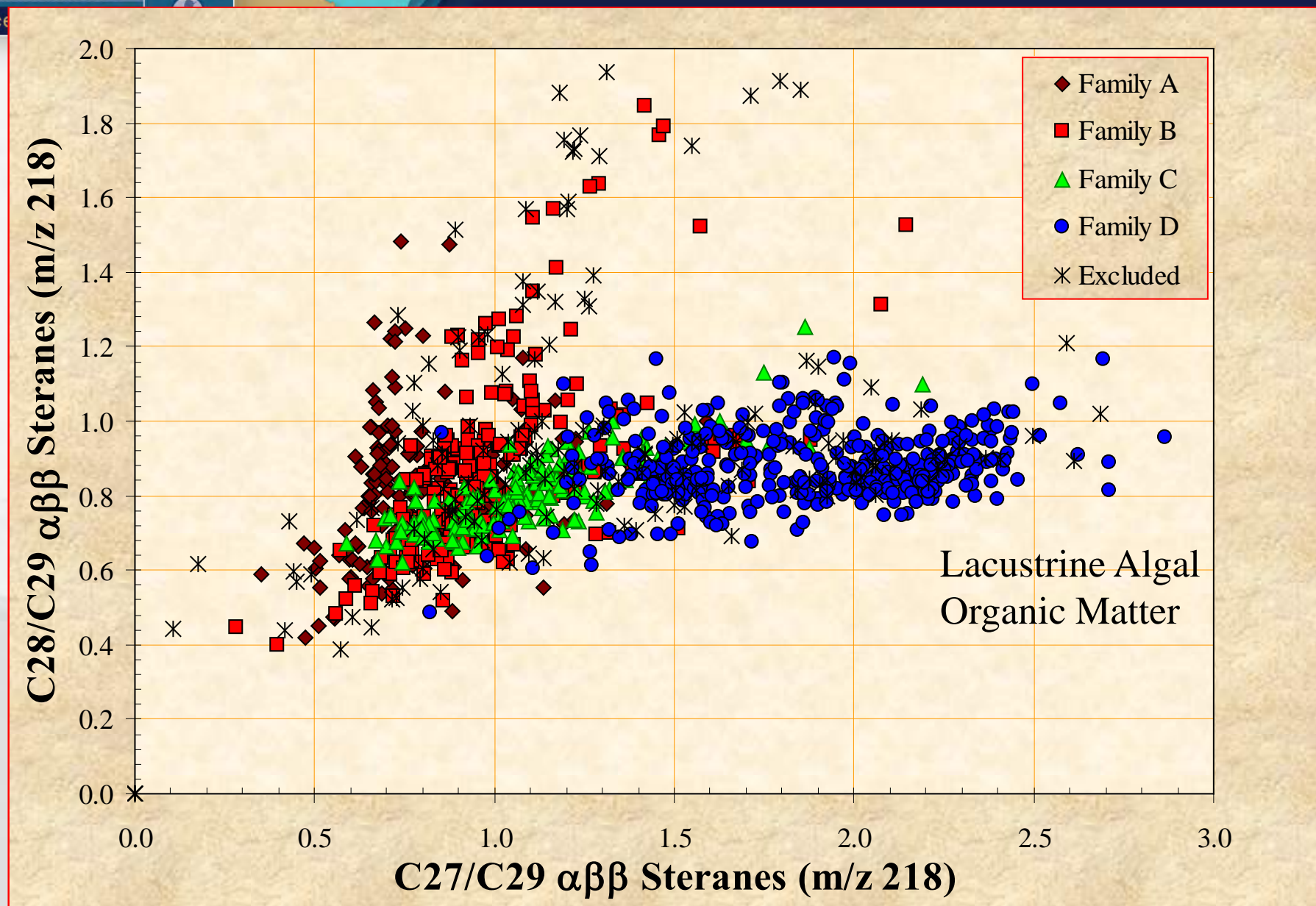




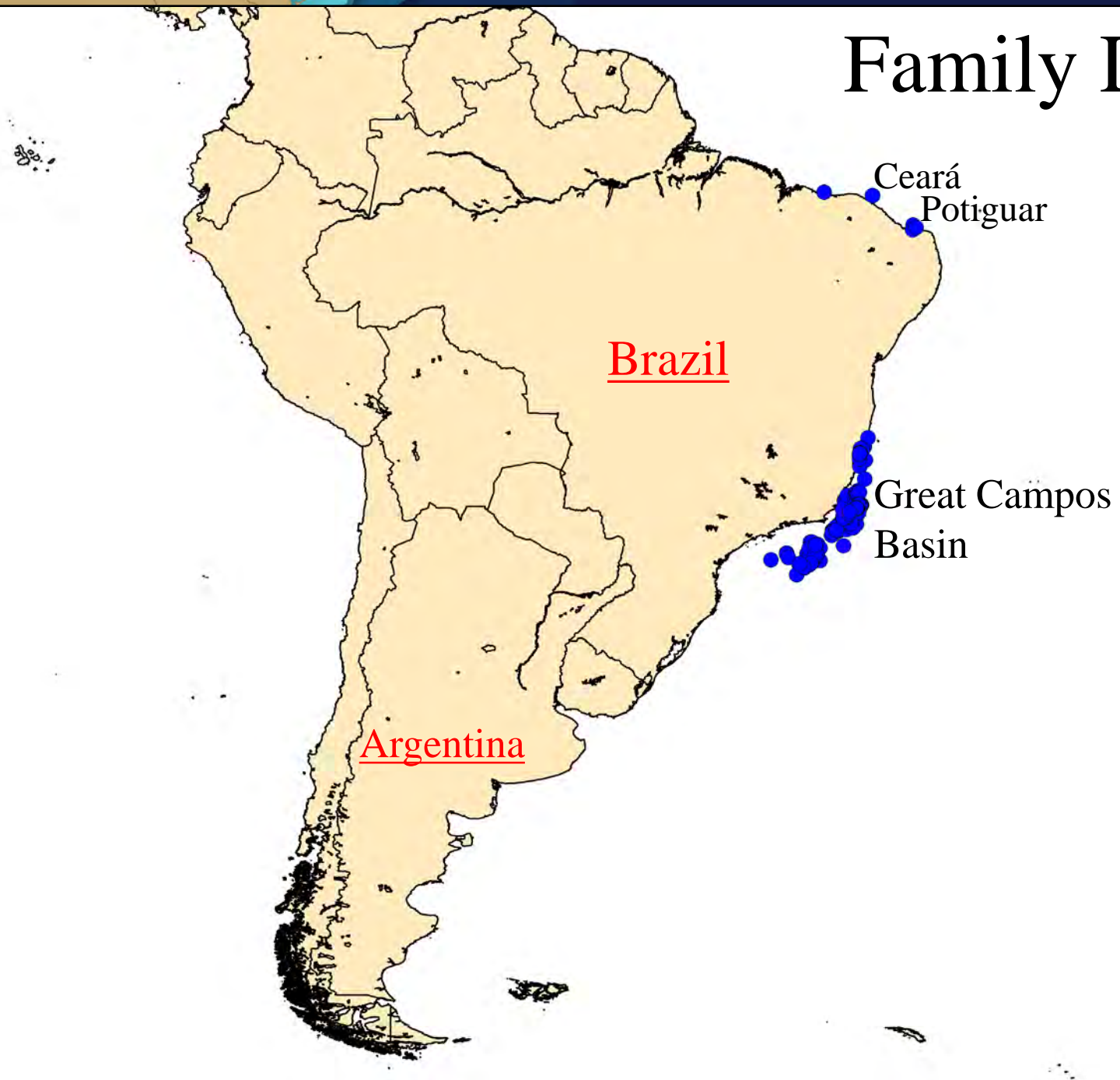
Family D (382 Oils)

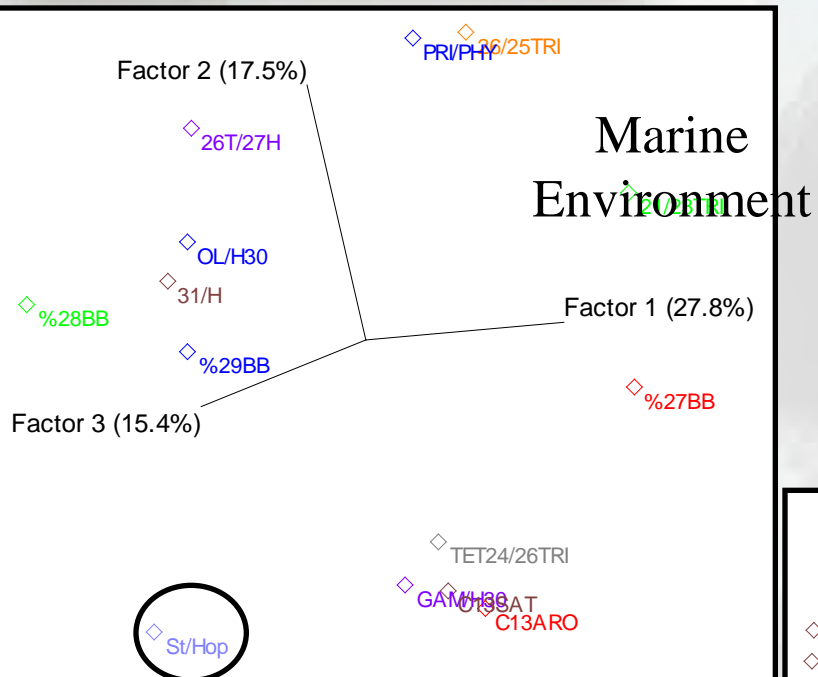


Family D

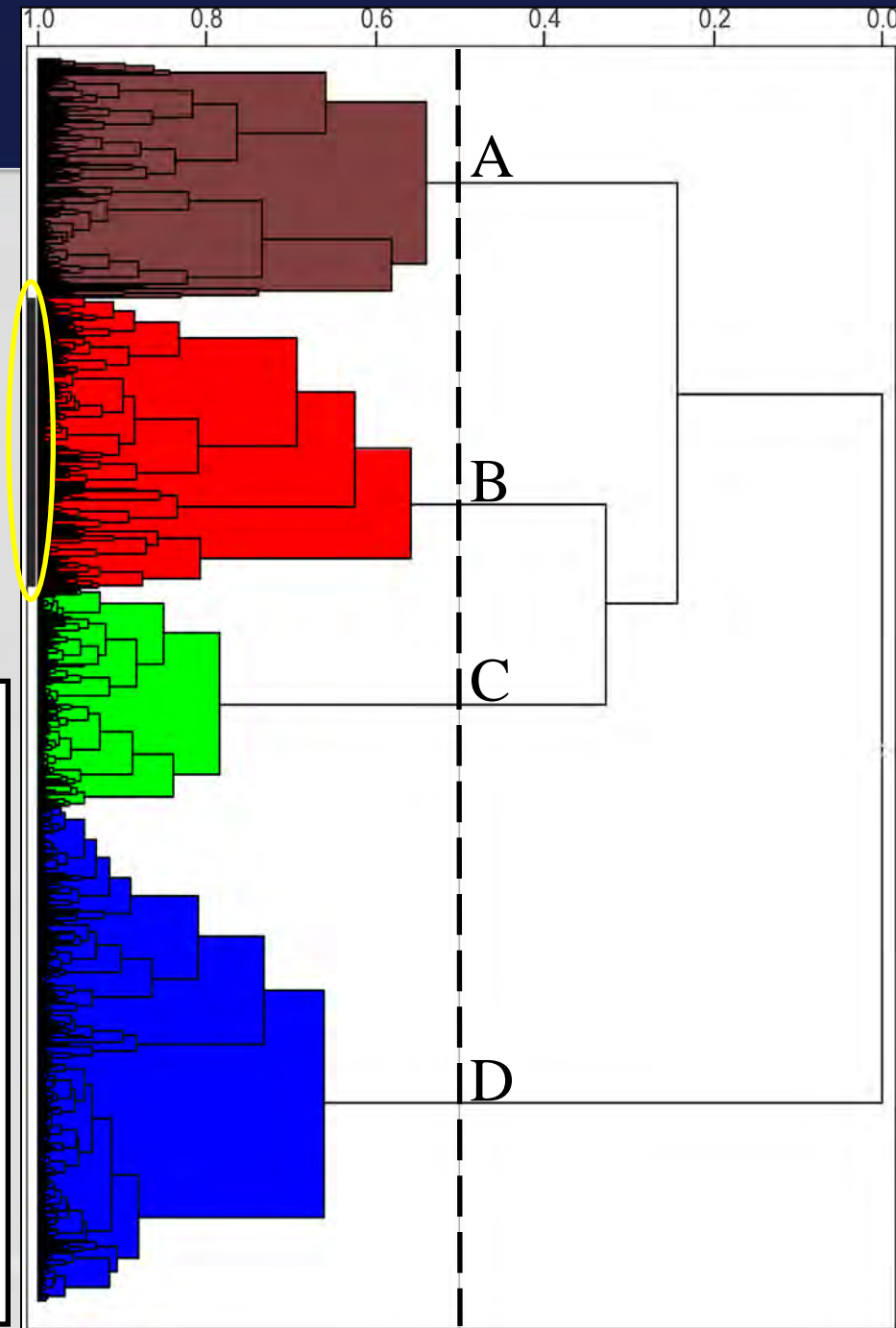
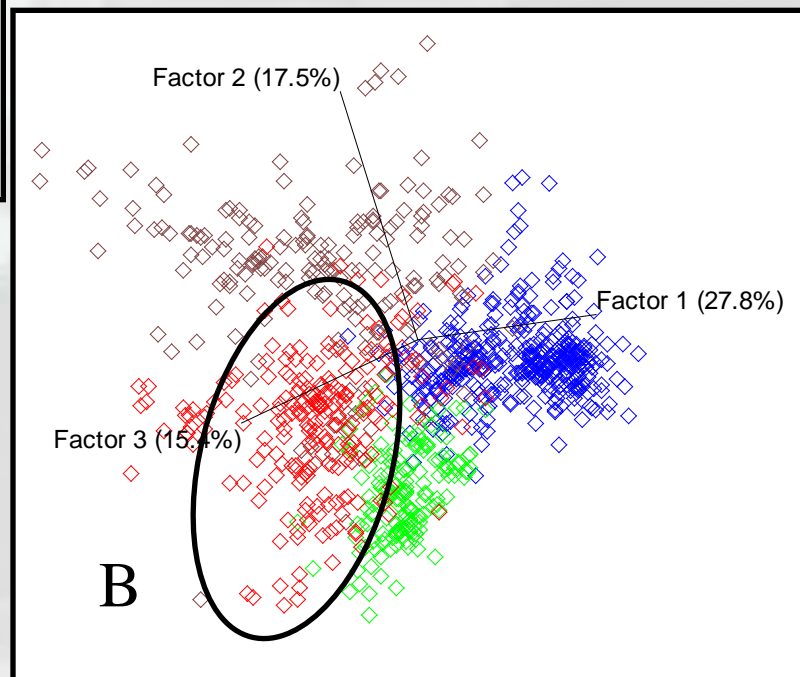


Family D

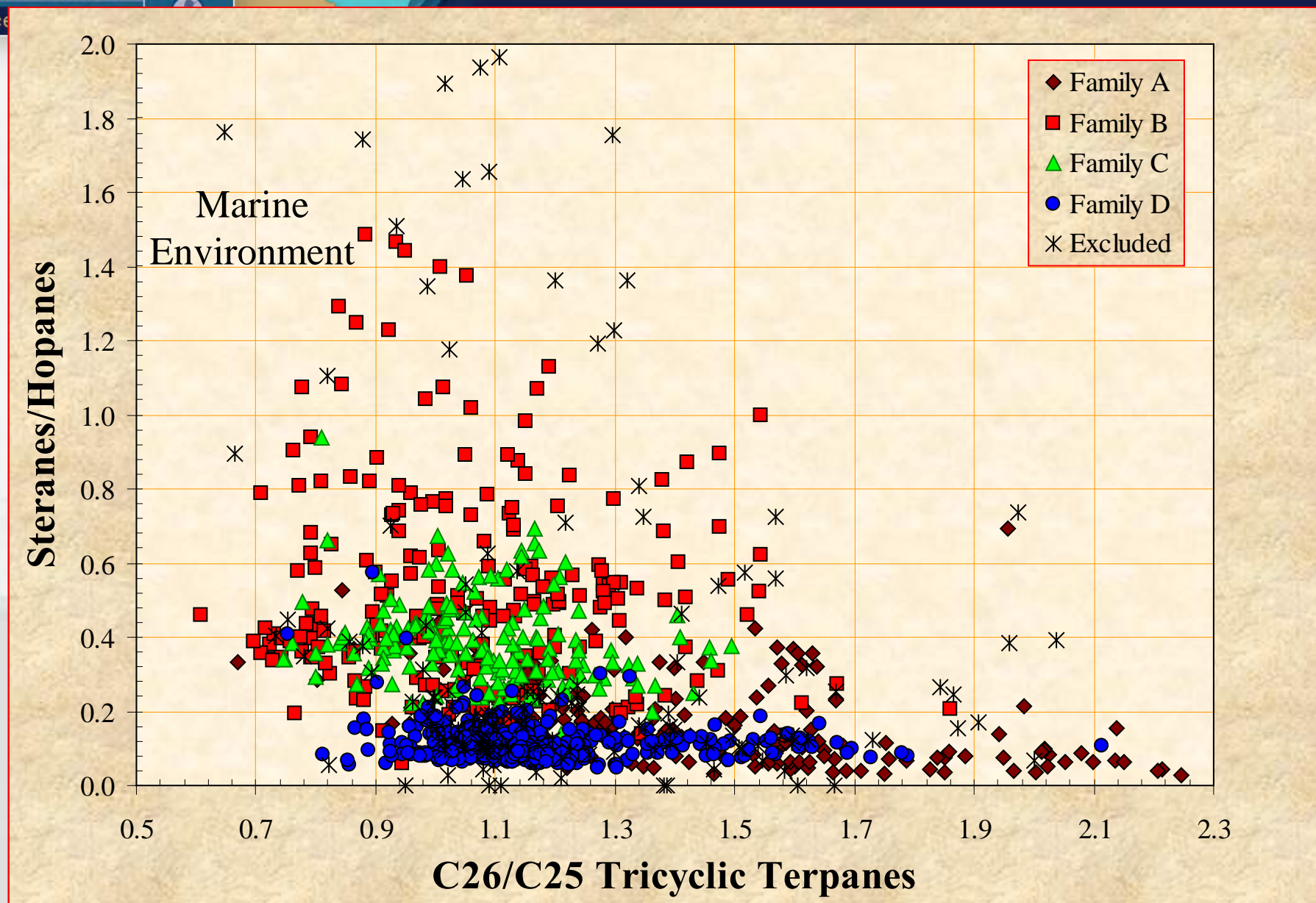




Family B (225 Oils)



Family B

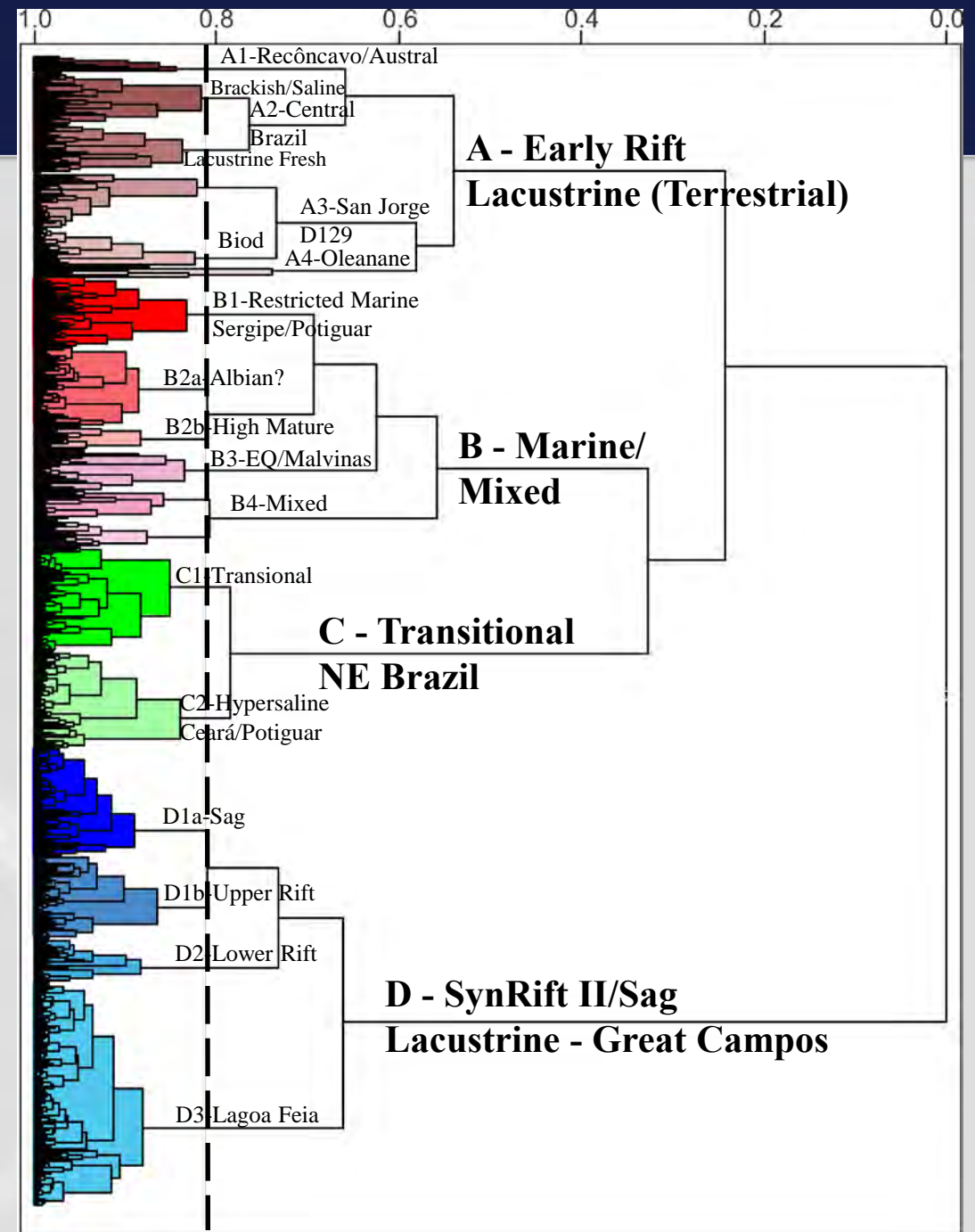


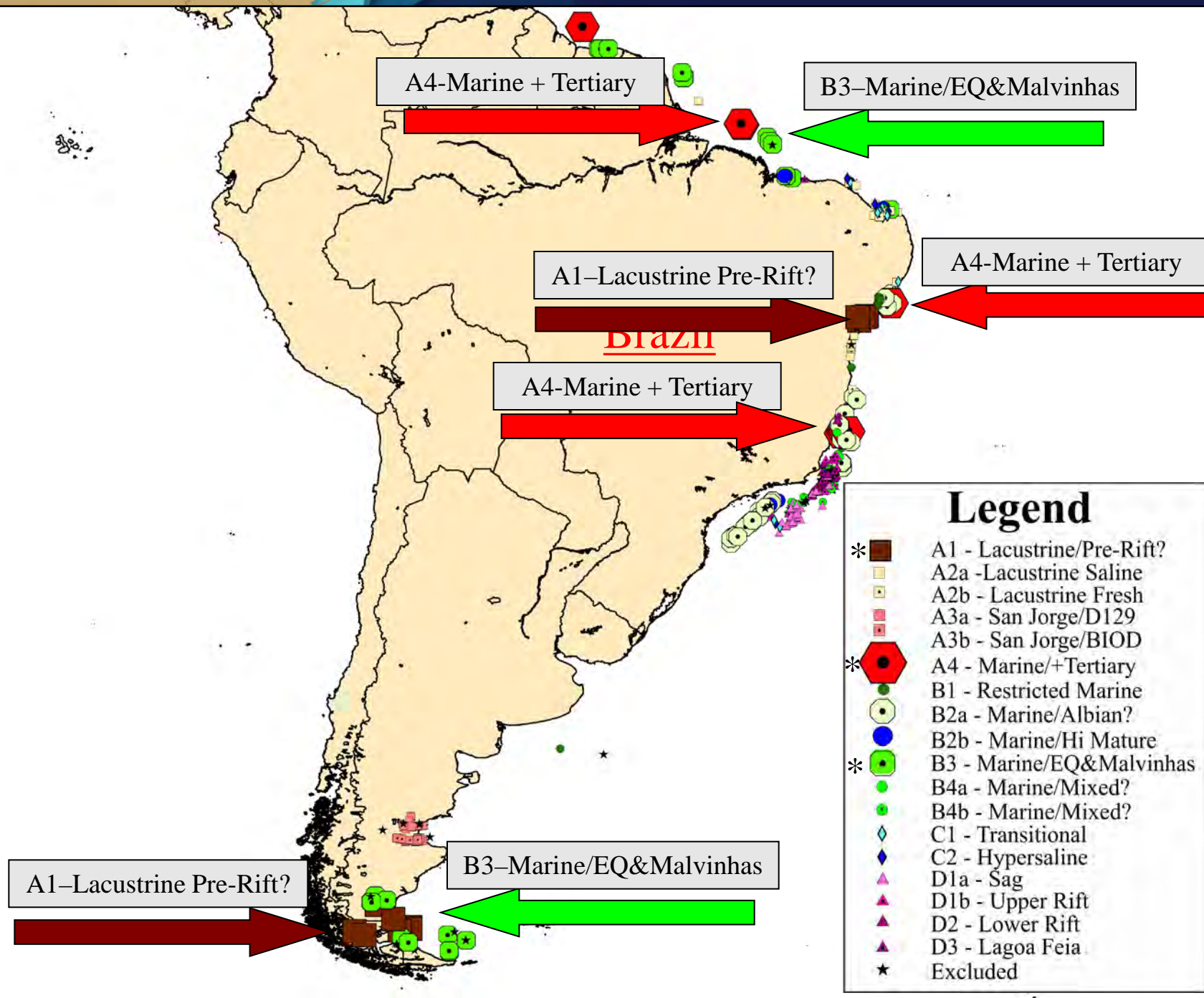


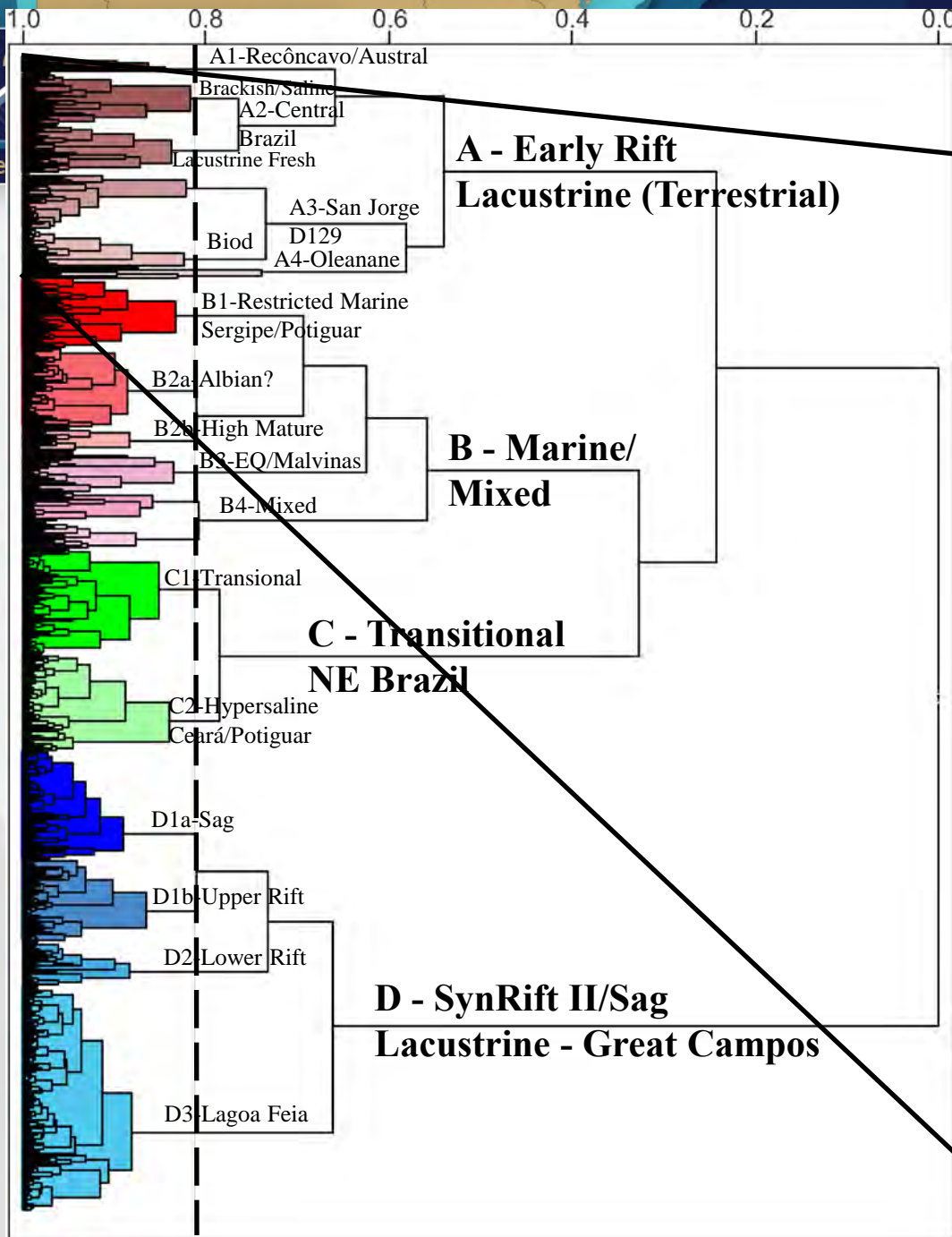
Family B

HCA Dendrogram @ 0.8

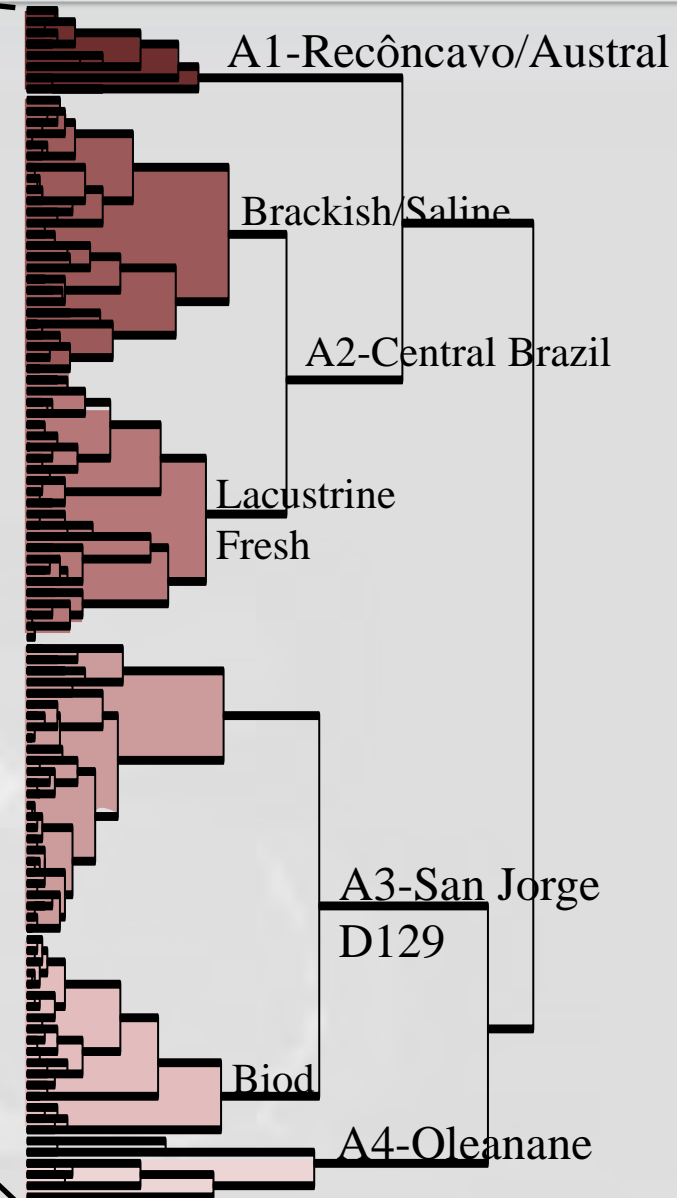
- 1130 Oils
- 182 Excluded
- 14 Parameters
- 60%/PC3
- 77%/PC5
- 18 Sub-Families at 0.812

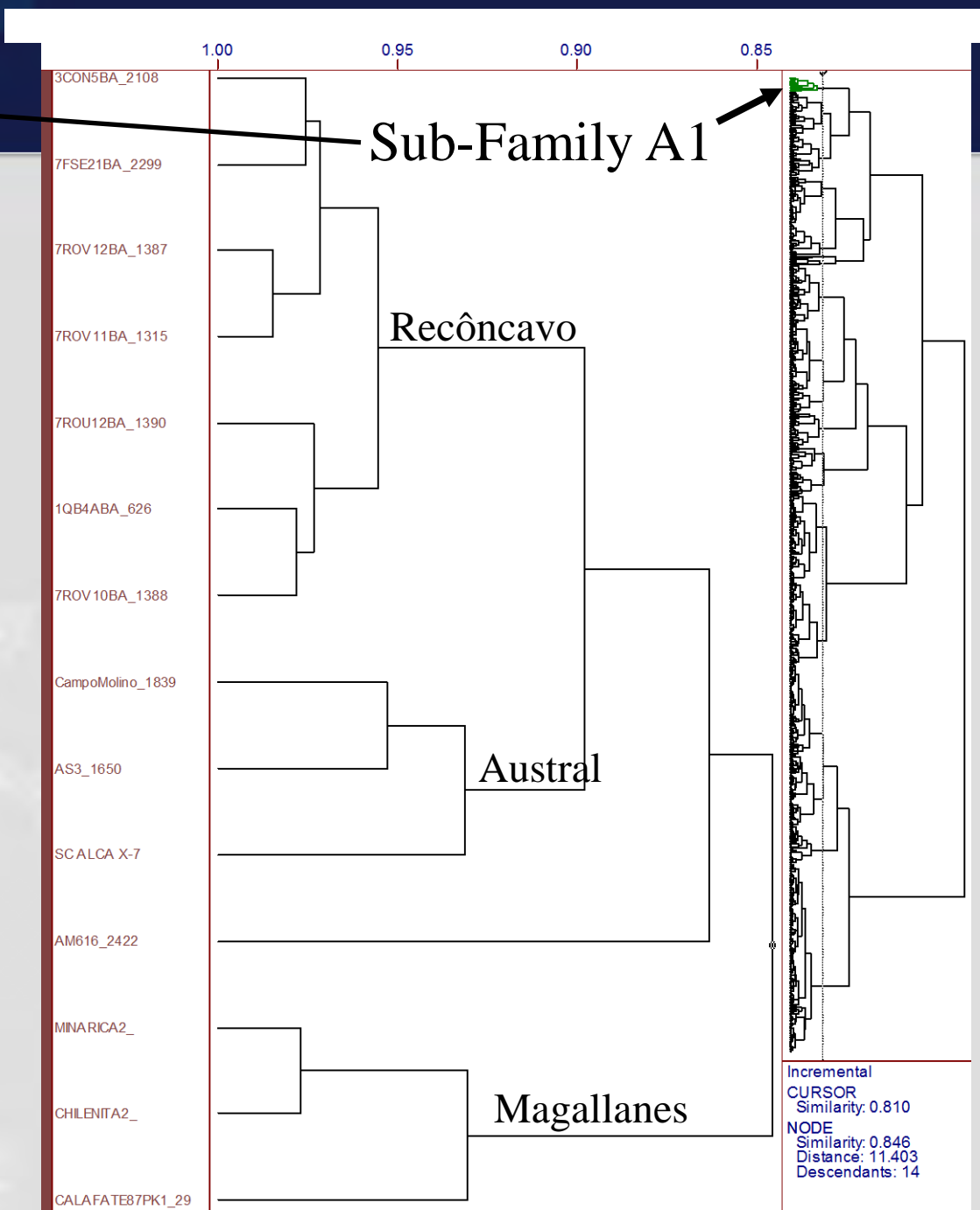
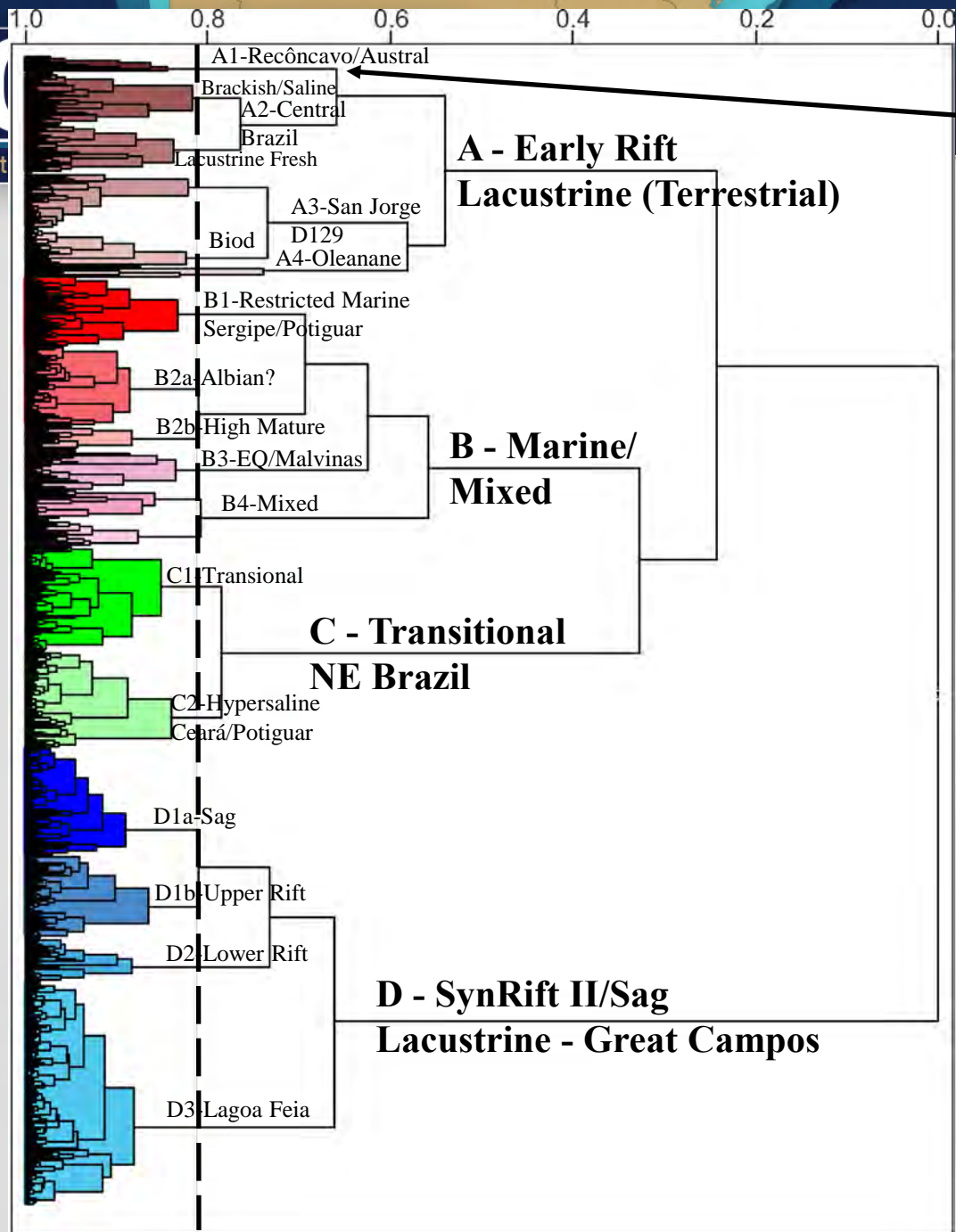




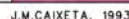


Family A – Early Rift

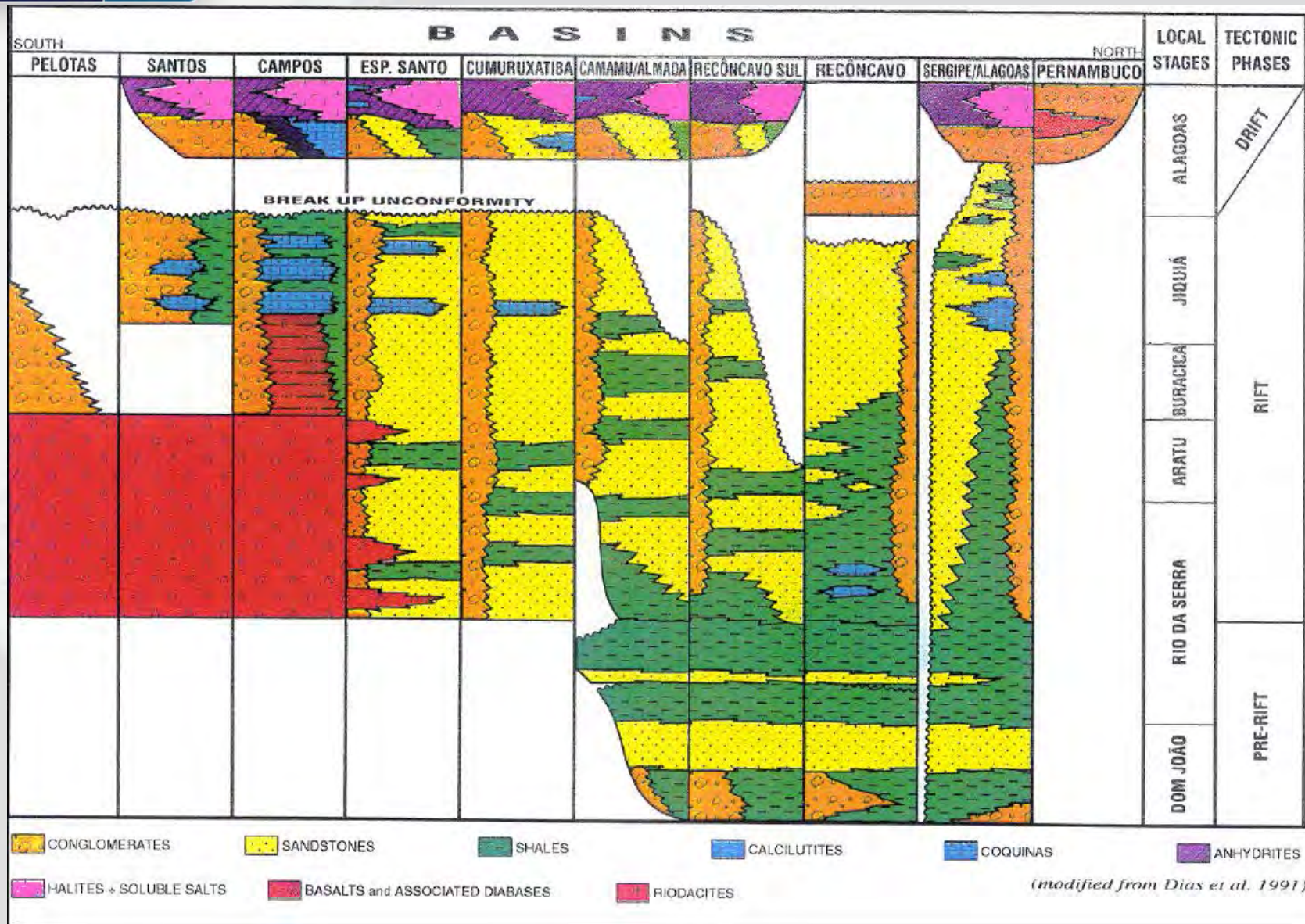




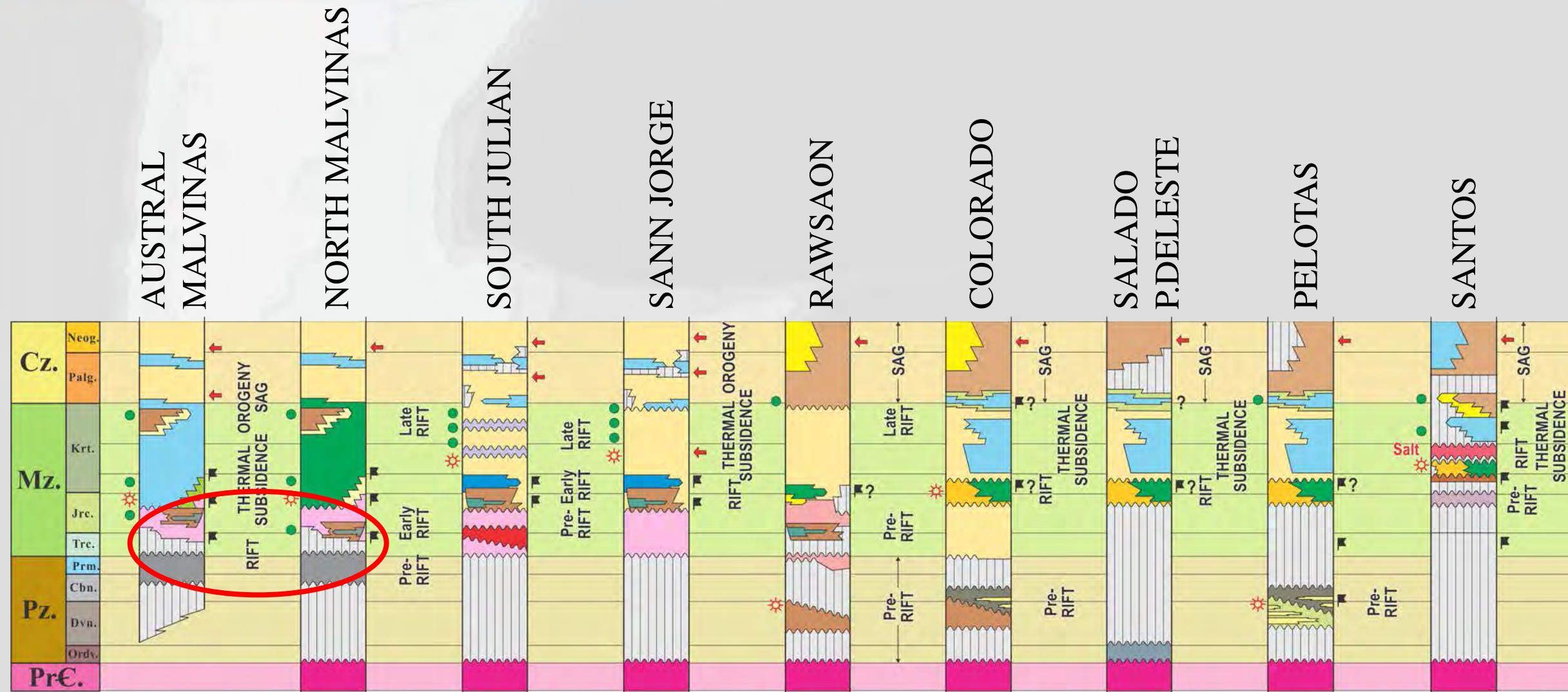
Recôncavo Basin Schematic Stratigraphic Chart



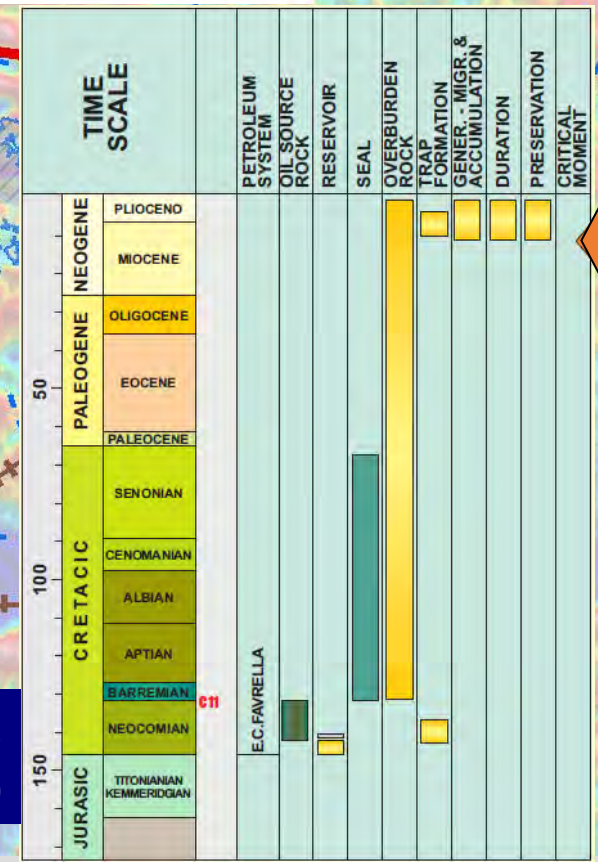
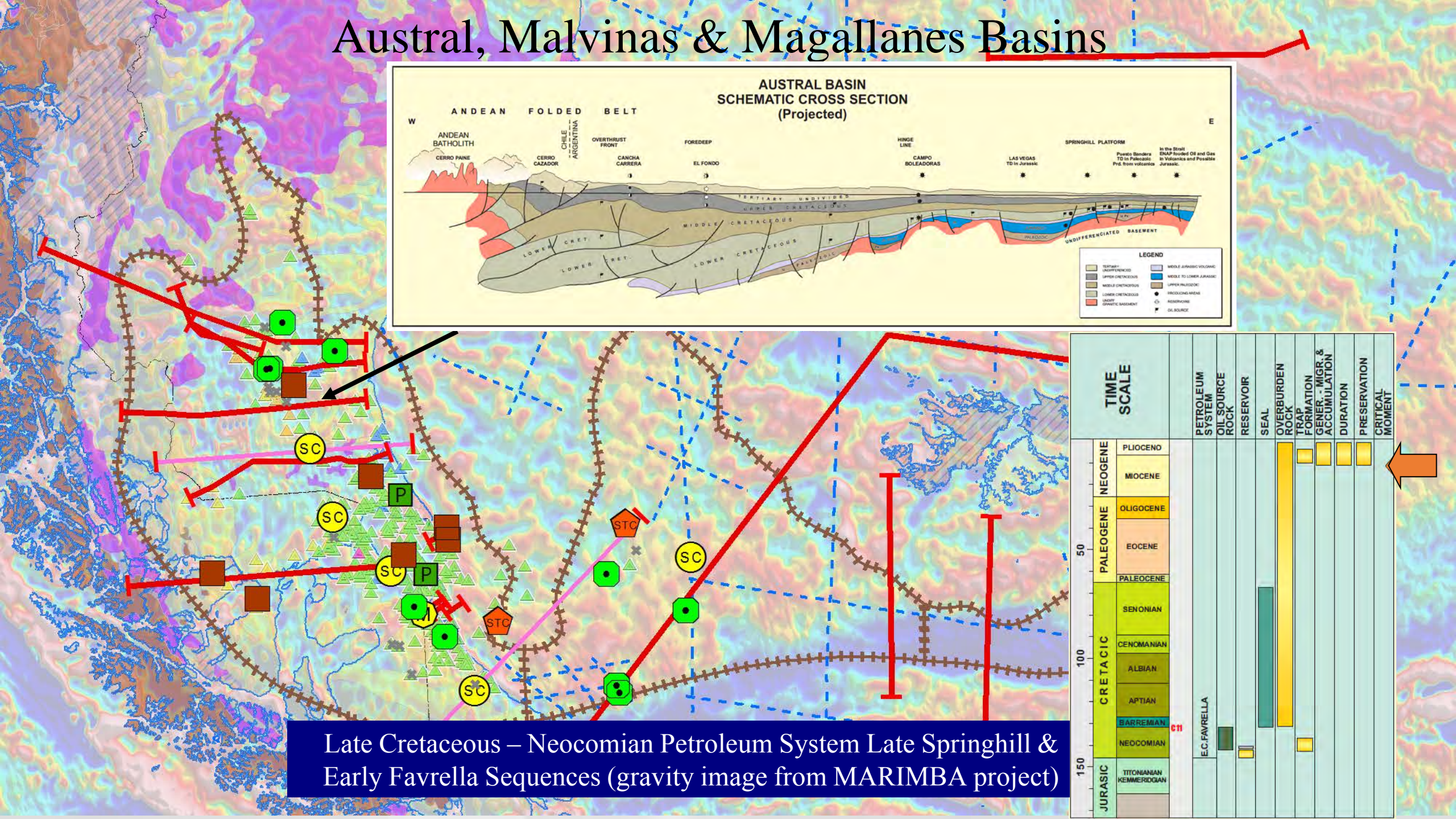
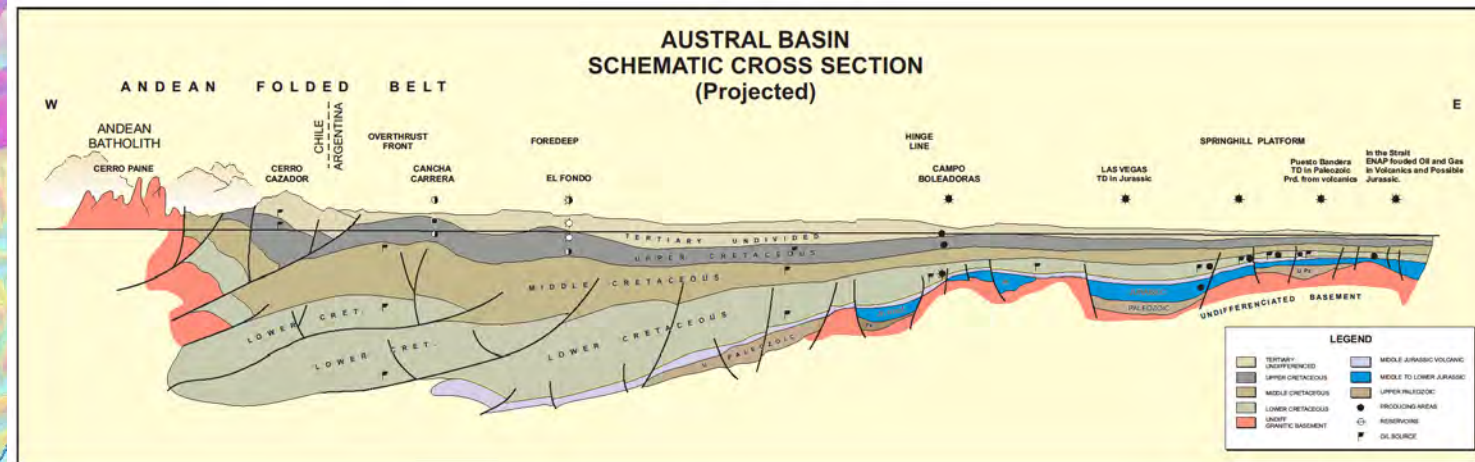
Simplified Lithologic and Chronostratigraphic Chart in the Brazilian Basins of the South American Rift



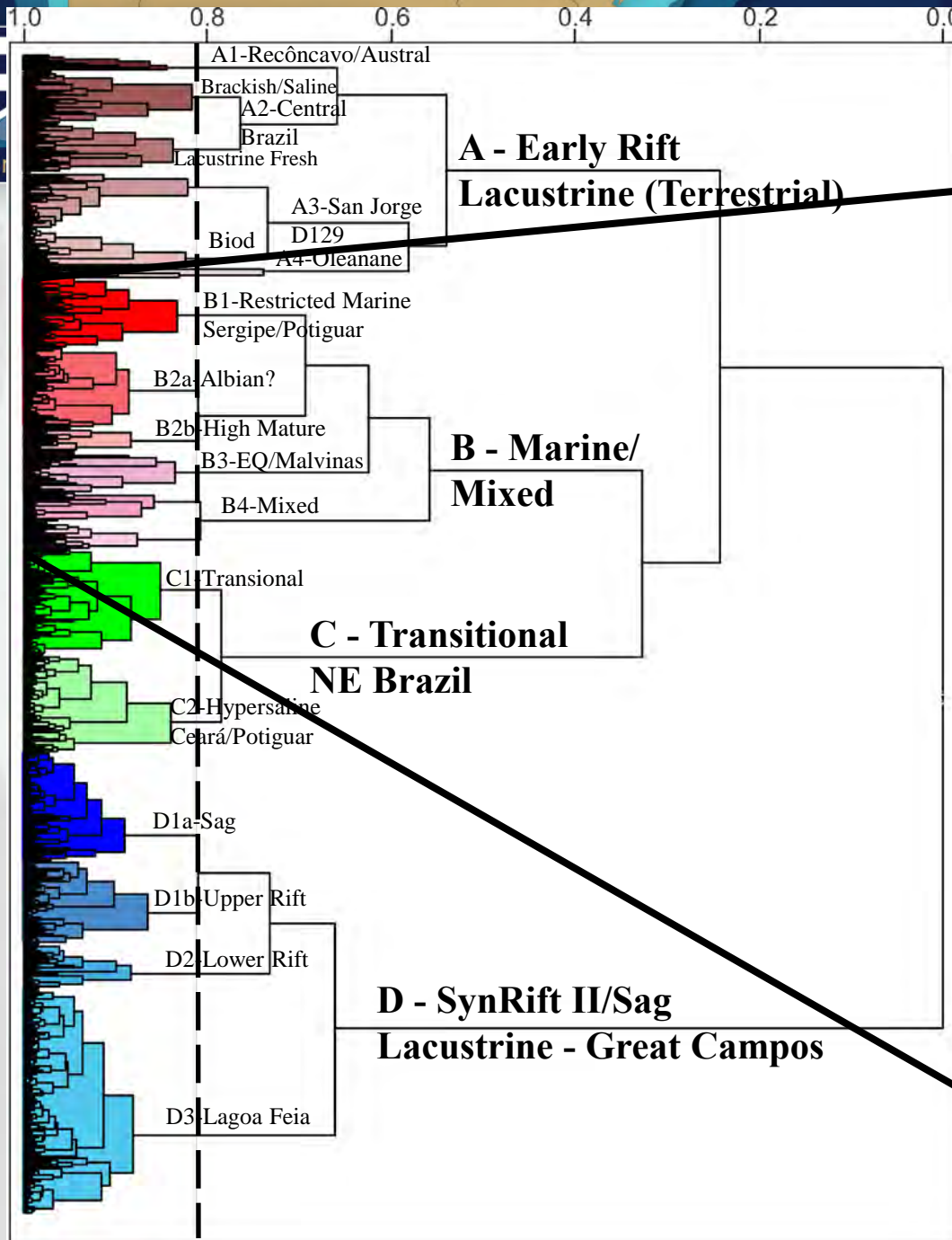
Simplified Lithologic and Chronostratigraphic Chart in the Argentine Basins of the South American Rift



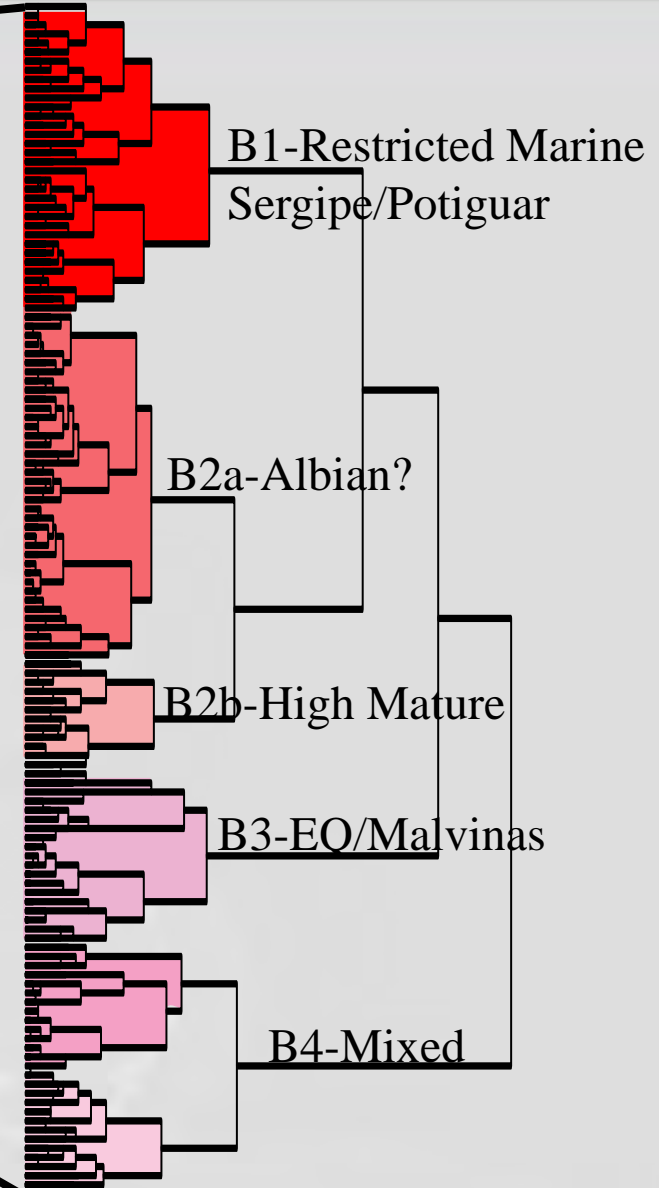
Austral, Malvinas & Magallanes Basins

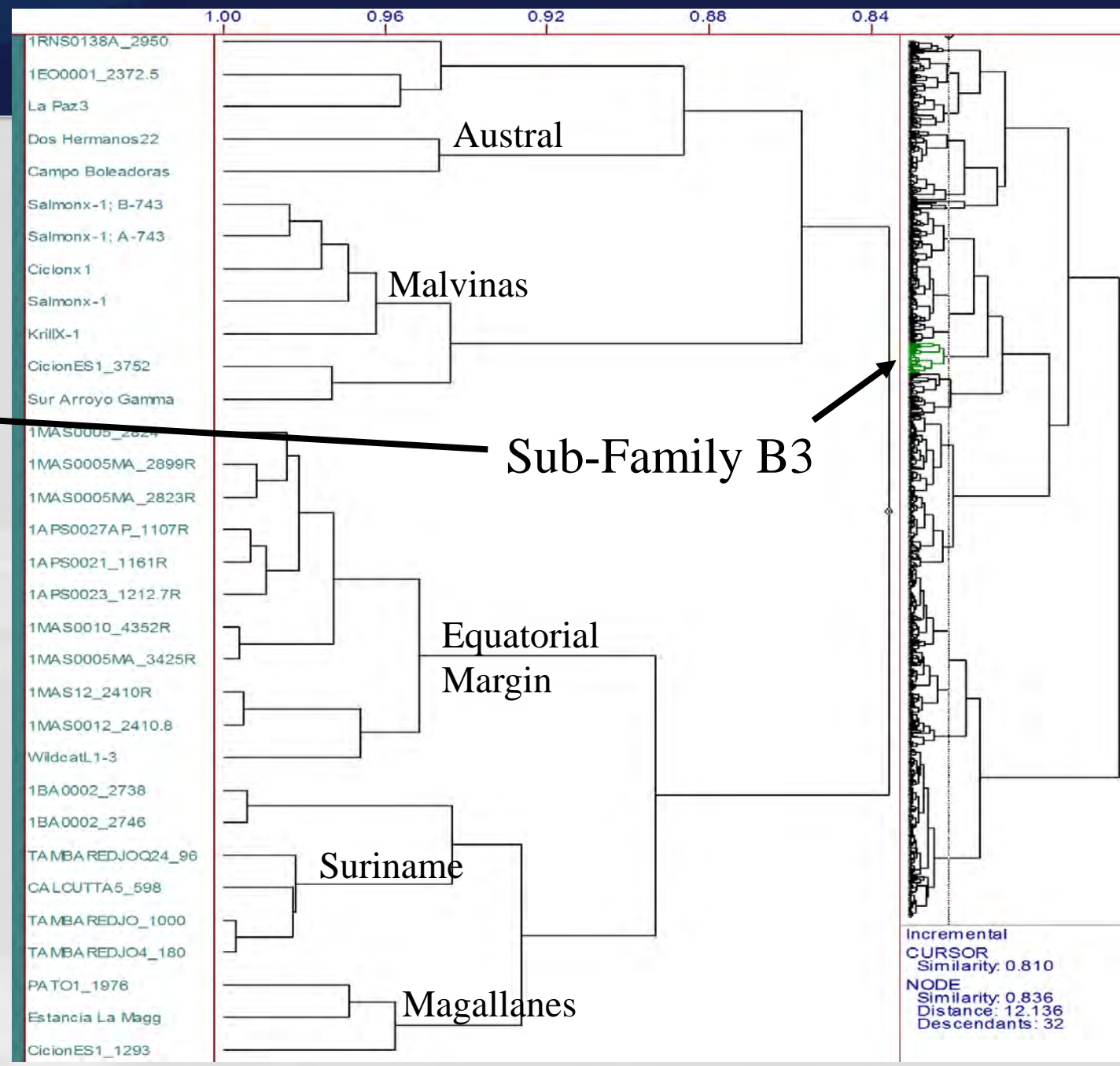
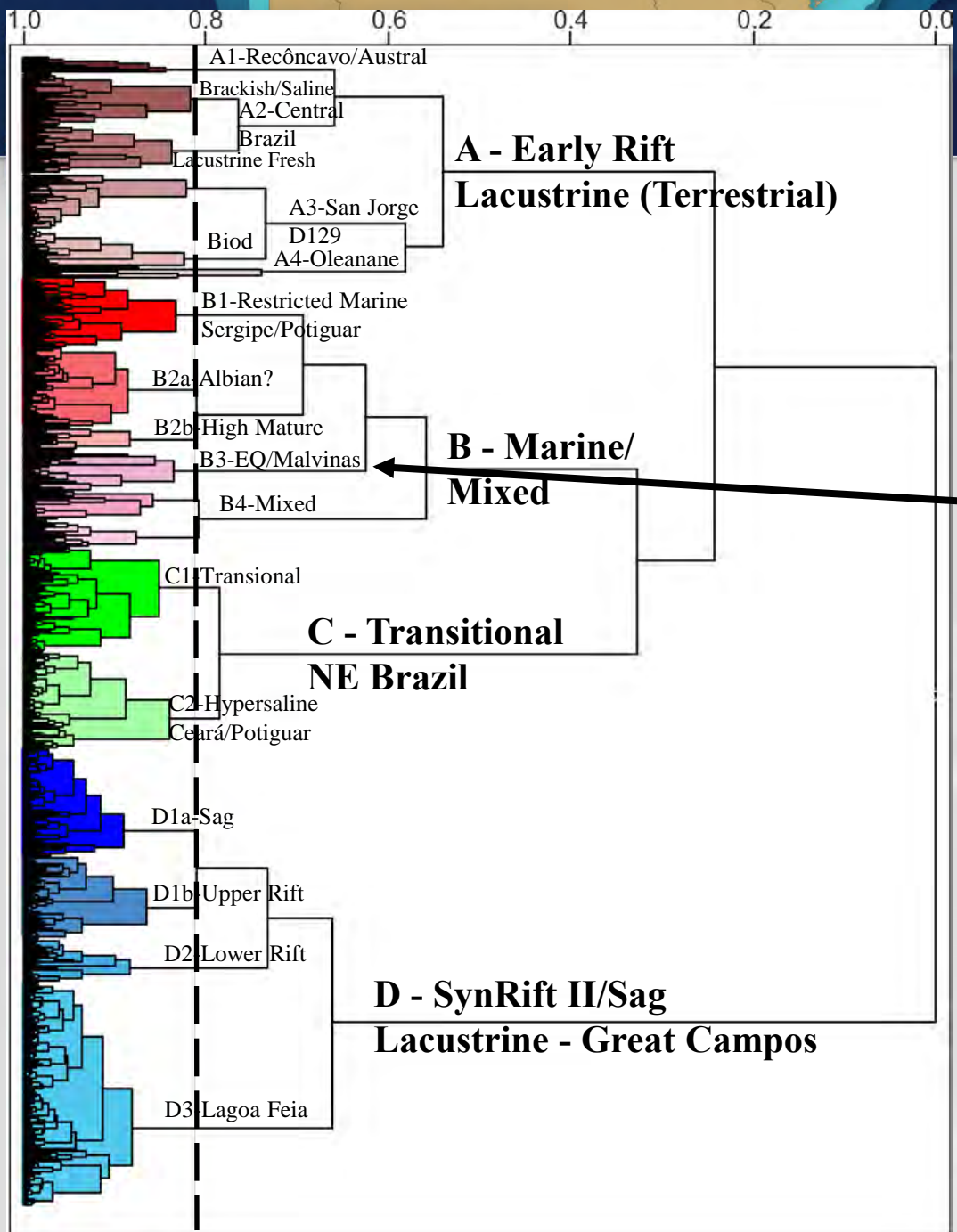


Late Cretaceous – Neocomian Petroleum System Late Springhill & Early Favrella Sequences (gravity image from MARIMBA project)

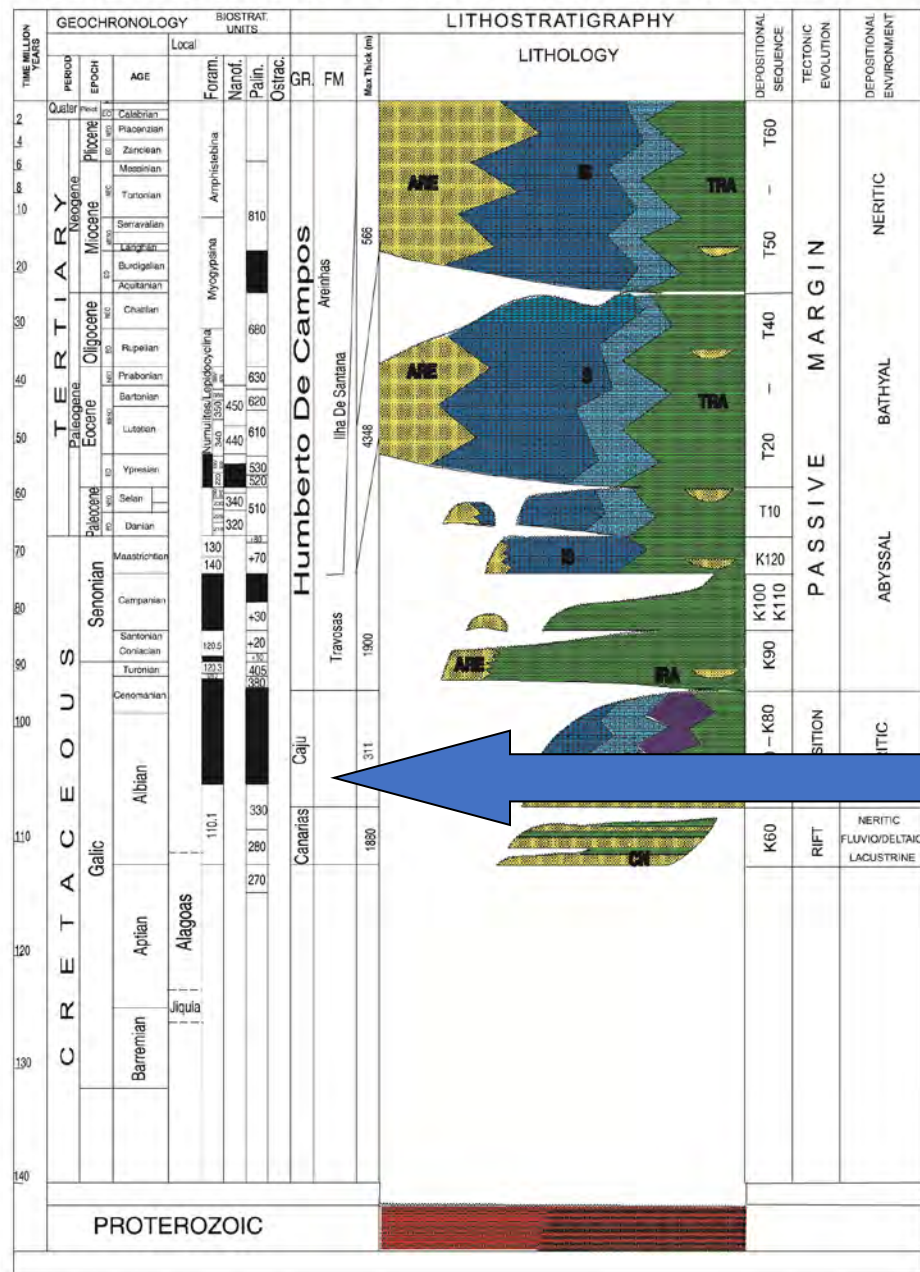


Family B - Marine/ Mixed

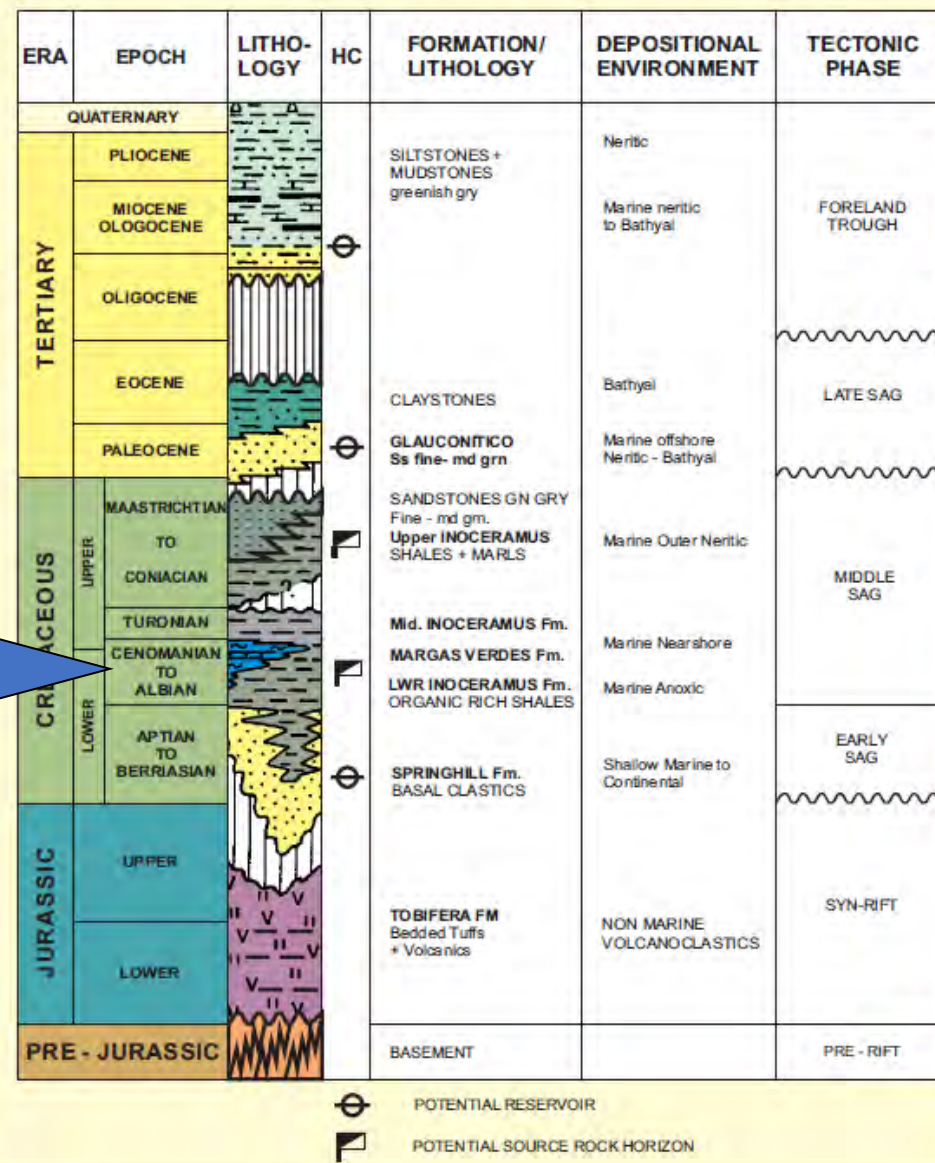


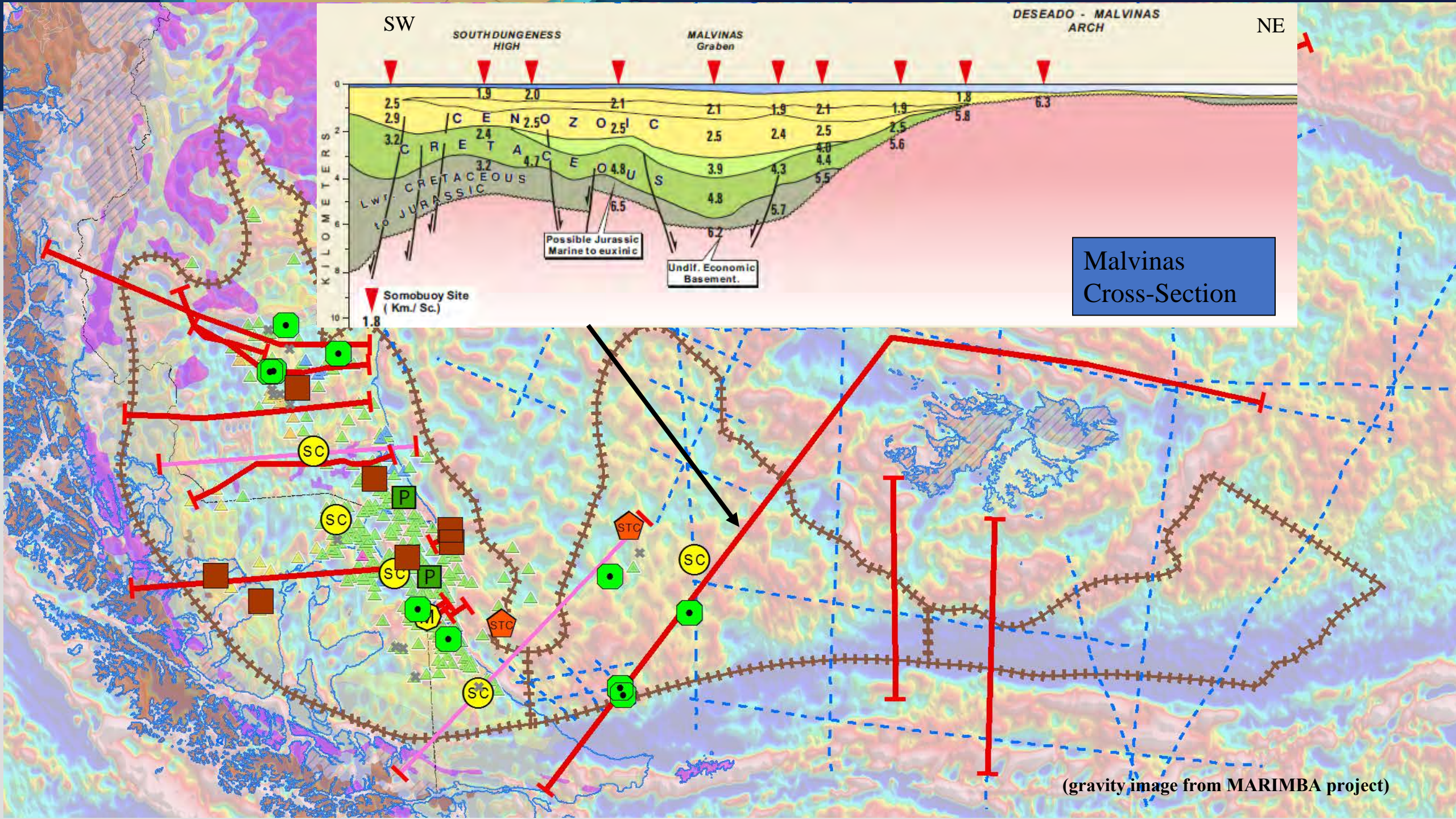


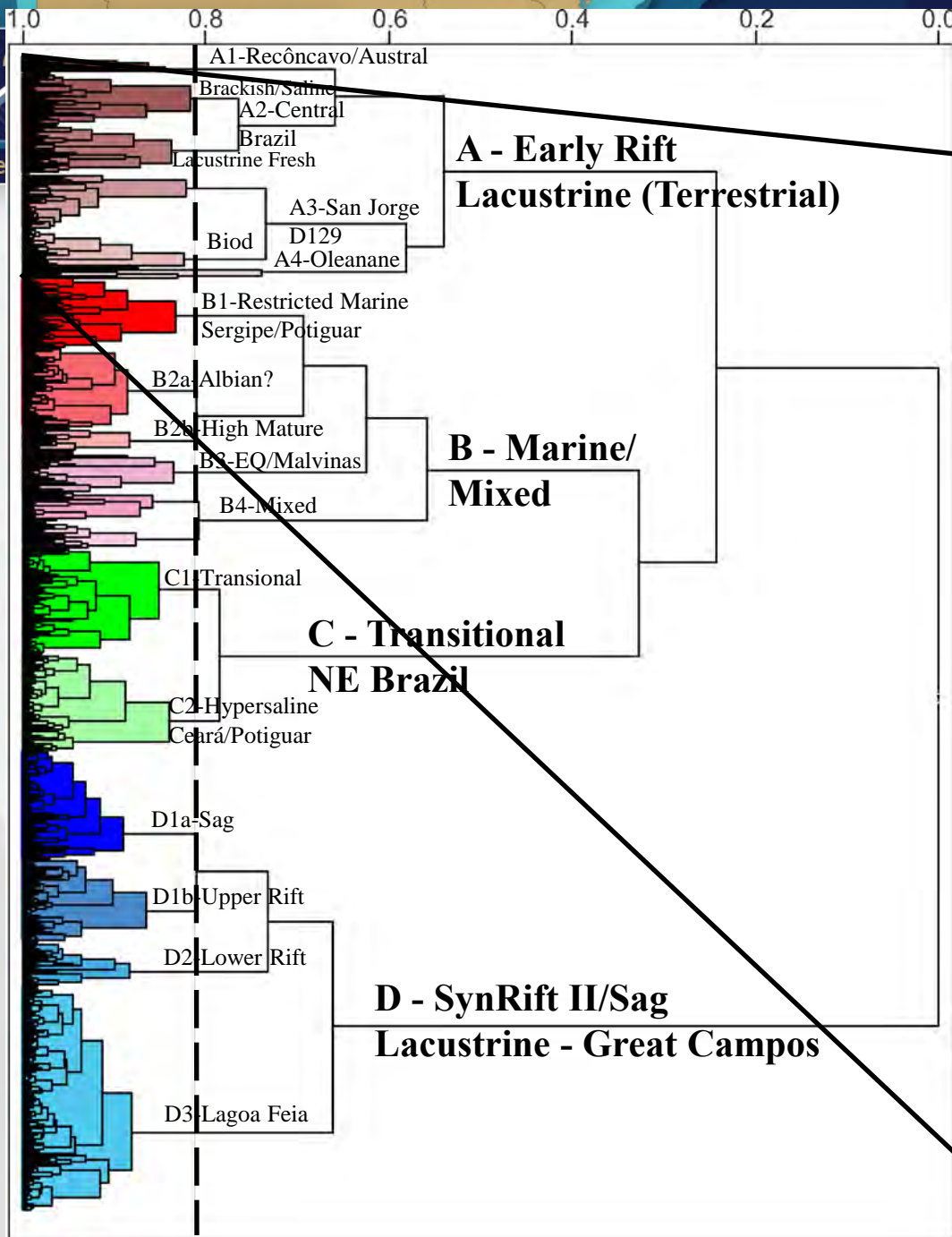
SCHEMATIC STRATIGRAPHIC CHART - PARA MARANHÃO BASIN



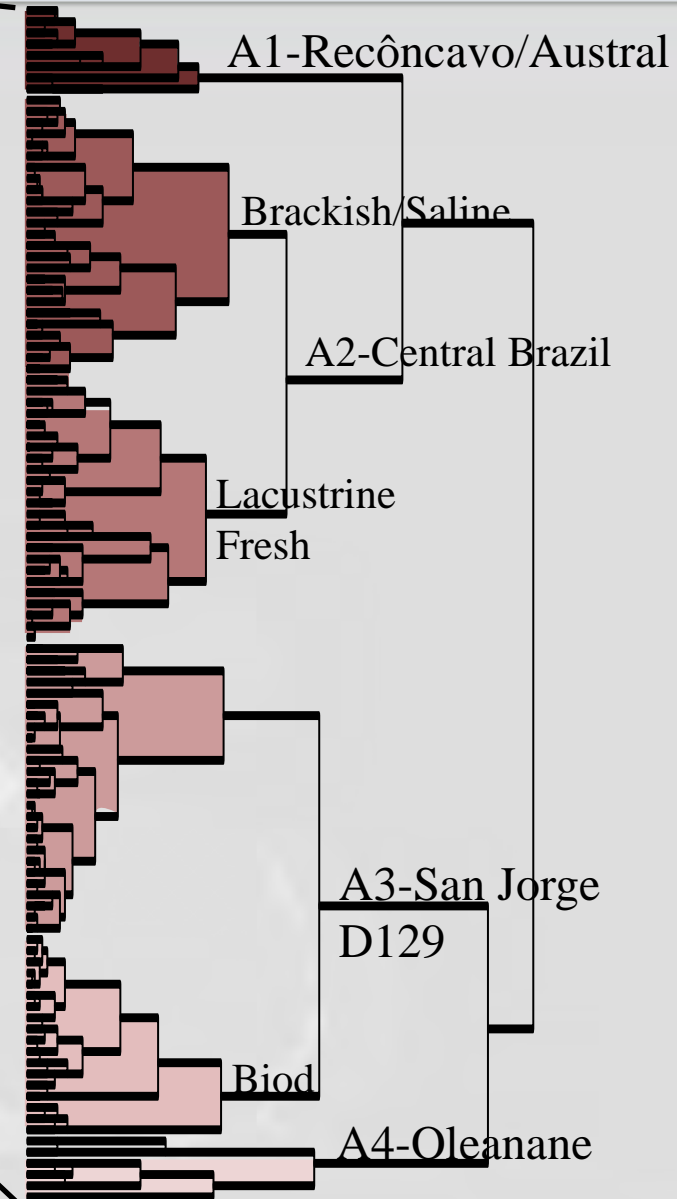
MALVINAS BASIN Stratigraphic Column







Family A – Early Rift



- Statistical evaluation of chemical data for 1130 oils from eastern South America allows for separation into four broad groups or families according to source depositional environment and age
- Four groups include oils derived from lacustrine source rocks deposited during early (A) and late rift (D) lacustrine and/or sag, transitional (C) and marine (B) environments
- Results suggest a possible Pre-Rift lacustrine source in Recôncavo (?) that is similar to early rift source active in Austral Basin (Late Springhill & Early Favrella Sequences)
- Albian (Caju Fm) derived oils from Foz do Amazonas and Para Maranhão that are broadly related to marine-derived (Margas Vertes; Lower Inoceramus) oils from Austral and Malvinas, appear to be genetically related to oils from Cote d'Ivoire
- Evidence of input from younger Tertiary terrestrial-influenced (oleanane; angiosperms) source rocks is found offshore Guyana, Foz do Amazonas, Espírito Santo and Sergipe