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# Tracing Fluid-Rock Interactions and Continental Breakup in the Central South Atlantic

**CRISTIANO LANA**[1] AND IGOR FIGUEIREDO[2]

[1]Stellenbosch University
[2]The Open University

The timing of continental breakup in the Central South Atlantic is a key issue in plate tectonics, with implications for mantle dynamics, passive margin evolution, hydrocarbon systems, and ocean circulation. Establishing a chronology of lithospheric separation is crucial for understanding how rifting evolved from initial extension to full oceanization, shaping sedimentary basins and the deposition of key stratigraphic markers such as the Aptian evaporites. However, significant discrepancies persist regarding breakup timing. Some geophysical studies suggest early breakup and oceanic crust formation at ~134 Ma, placing evaporite deposition in a post-breakup sag phase, while tectonic modelling indicate full lithospheric separation occurred later, with seafloor spreading fully established after 119 Ma or after 113 Ma.

This study integrates U-Pb dating, Sr isotopes, and trace-element analyses to constrain timing/fluid sources of carbonate deposition during rifting and post-breakup stages. The formation of Aptian lakes, driven by syn-rift tectonic activity, led to the deposition of Mg-clays with calcite spherulites, crystal shrub limestones ($^{87}Sr/^{86}Sr$ = 0.7120–0.7140), which later transitioned into travertine and spring-fed carbonate deposits influenced by episodic hydrothermal pulses ($^{87}Sr/^{86}Sr$ = 0.7100–0.7105). This period saw a dynamic interplay of diagenetic processes and fault-controlled carbonate precipitation, paving the way for the deposition of the evaporites. U-Pb dating of these pre-evaporite carbonates constrains their formation to a 4-million-year period of diagenesis/tectonic activity between 124.8 ± 2.6 Ma – 119.8 ± 1.5 Ma. REE+Y PAAS-normalized patterns and Sr isotopes indicate deposition was influenced by lacustrine to transitional conditions, evaporation, and continental groundwater input, with mixing of hydrothermal fluids.

Carbonates preserved within the evaporite layer ($^{87}Sr/^{86}Sr$ = 0.7090), dated at 119.2±1.6 Ma and 119.18±0.79 Ma and carbonated deposited immediately above ($^{87}Sr/^{86}Sr$ = 0.7070–0.7080) (117–114 Ma) mark a transition from restricted lacustrine to marine carbonate deposition and the view that oceanic crust postdates evaporite deposition (~119 Ma). The stratigraphy combined with Sr and U-Pb data are in direct conflict with models placing breakup at ~134 Ma. Hydrothermal circulation triggered extensive replacement, dissolution, and calcite/dolomite cementation from 117.9 ± 1.3 Ma to 80.4 ± 2.4 Ma, influencing reservoir properties and providing a temporal framework for fluid migration linked to basin evolution.