Petroleum Systems Asymmetry Across the South Atlantic Equatorial Margins

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Abstract Body: An iterative cycle of petroleum systems interpretations provides two supporting lines of evidence of the asymmetric opening of the Atlantic Equatorial Margins: the tectono-structural evolution and hydrocarbon geochemistry.

Research on evolution of Atlantic ocean crust and margin basins has clarified the tectono-structural history of the conjugate passive margins and associated Equatorial Transform Margins. Given the prominent structural asymmetry of the passive margins, we anticipated asymmetry along the Equatorial Margin. We investigated the region with new compilations of high resolution geophysical data and comparisons of oil geochemistries from both margins.

An initial suite of 1467 oil samples spanned the southern Central Atlantic plus Equatorial and South Atlantic margins. After analysis to establish a South Atlantic framework, we selected a subset of 387 samples from the Equatorial Margins. Reliability tests of oil family assignments continued by inspecting spatial relationships versus basin shapes. Tectono-structural interpretation from our geophysical data and published knowledge of basin and reservoir temperatures helped define where there was sufficient burial depth for maturity of each source and where structural features would block or guide hydrocarbon migration. Non-Cretaceous sourced oils like those of the Niger Delta (Tertiary) or Dahomey Embayment (Paleozoic) were excluded and after twenty iterations, the set was reduced to 284 oils. Fourteen (14) parameters accounted for 65% of sample variance and five broad groups of compositionally similar oils (A - E) were identified of which only Family E is represented along the West African Transform (WAT) Margin.

Equatorial Atlantic opening was asymmetric with deep monoclinal basins along the WAT Margin between St Paul and Chain Fracture Zones while the Brazilian-Guyanan conjugates retained most of the early syn-rift architecture. Hence the opening asymmetry a) biased the location of potential lacustrine (early to mid-Cretaceous pre-rift to early syn-rift) source and b) locally narrowed the width of optimal marine (Mid to Late Cretaceous post-rift) kitchens. The latter, where rapidly buried offshore Ivory Coast-Ghana, contribute to a risk of late charge from light hydrocarbons. Finding a rich, more oil-prone lacustrine source would be a surprise along the WAT Margin where we see minor evidence of mixed source, possibly lacustrine stringers within an alluvial to marine setting.