3D crustal model for the volcanic-rifted margin of Suriname and the non-volcanic margin of Guyana with implications for Jurassic-Cretaceous source rock maturity

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Summary

Understanding the distribution and maturity of Jurassic-Aptian source rocks along the hydrocarbon-prolific Guyana-Suriname margin requires understanding of its plate tectonic history, crustal structure, basement crustal types and their radiogenic heat production, heat flow history, stratigraphic evolution, and variations in overburden thickness. This study integrates seismic reflection and potential fields data to create a 3D model for the across-strike, continent-oceanic transition (COT) from the Guyana craton to the oceanic crust and the along-strike transition between the hotspot-influenced volcanic-rifted margin of the Demerara Plateau in Suriname to the non-volcanic, rifted margin in Guyana.

To create this 3D model of the Guyana-Suriname margin, we performed a 3D gravity inversion of the Moho constrained by seismic reflection and refraction controls integrated with a lateral velocity-density sedimentary inversion to a 2D KPSTM seismic grid.

In the seaward-dip direction, the **non-volcanic rifted margin of central and northern Guyana** consists of: 1) the 40-28-km thick, continental crust of the Guiana craton; 2) a 169-275-km wide, highly-tapered, necked zone of thinned continental crust with two parallel rift zones (Commewijne, Guyana); 3) oceanic crust that ranges in thickness from 10-15 km with an inferred Jurassic age; and 4) the outer limit of the Jurassic oceanic crust is marked by the Demerara fracture zone that juxtaposes Jurassic oceanic crust of the Guyana basin with post-Aptian Cretaceous oceanic crust of the Equatorial Atlantic.

In the seaward-dip direction, the **volcanic-rifted margin of Guyana-Suriname** consists of: 1) the 40-21-km thick continental crust of the Guiana craton; 2) the 22-km-wide Commewijne rift, 3) the 25-km-thick SDR section related to the Demerara hotspot that locally created a 289-km-wide volcanic margin in Suriname and whose top has been dated as late Jurassic (173 Ma) (Basile et al., 2020); and 4) the outer limit of the Jurassic oceanic crust is marked by the Demerara fracture zone that juxtaposes late Jurassic SDRs of the Demerara Plateau with post-Aptian Cretaceous oceanic crust of the Equatorial Atlantic. In the margin-parallel strike direction, the volcanic-rifted margin of Suriname consists of: 1): the thinned continental crust and oceanic crust flexed to the southeast beneath the load of the Demerara hotspot; 2) SDR units are thicker to the southeast (25-6 km) and thin to the northwest and disappear beneath central Guyana.

This model revealed three distinct regions along the strike of the Guyana-Suriname margin: 1) SDRs thin to the NW from 25-6 km over a range of 163 km. 2) Beneath these SDRs, the lower oceanic and thinned-oceanic crust dips to the southeast as a flexural response to the loading of the syn-rift SDRs related to the late Jurassic Demerara hotspot.

Hydrocarbon implications from this study include: 1) Late Jurassic source may be present in rifts of northern and central Guyana but are unlikely to be present in the volcanic-rifted margin of Suriname; 2) Our maturity modeling indicates that maturity Cenomaian-Turonian source rocks on oceanic crust is limited; 4) Our maturity modeling shows that the flexed area marking the transition between the non-volcanic and volcanic margins formed a prominent basin low and sediment pathway (Berbice canyon) that promoted maturity in this area due to increased overburden thickness; 5) our model is validated by the distribution of productive wells and their gas-oil ratios.

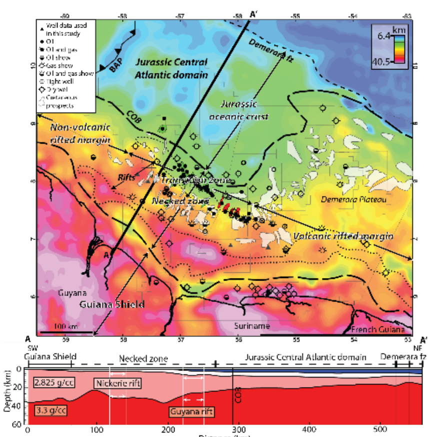

Figure 1: (a) Model of crustal thickness, including volcanics, volcanics based on gravity inversion. (b) Cross-section of 3D crustal model showing crustal tapering and rifts extending SW-NE from central Guyana and oceanic crust of Jurassic age.

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