

Executive Summary

Two hundred and eight well cuttings from 57 wells in the Great Campos Basin have been analyzed geochemically to evaluate organic richness and hydrocarbon-generating potential, thermal maturity and organic facies. The samples are from Lower Cretaceous (Barremian) to Lower Tertiary (Paleocene) sequences and represent sedimentation during the three megasequences common to Brazilian marginal basins - rift, transitional and drift.

Organic-rich source rocks with high TOC and excellent oil generation potential were identified in the Early to Middle Cretaceous sediments that represent the lacustrine phase of the rift development. These are represented by the Lagoa Feia Formation in the Campos sub-basin and the Mariricu Formation in the Espírito Santo sub-basin. The organic matter preserved in these two formations is composed of Type I and Type II kerogen and has excellent oil generation potential. Younger sediments from the Late Cretaceous to Early Tertiary that represent the marine phase of the Drift Megasequence have lower (average) TOC contents. Preserved organic matter in these consists of Type II and Type III kerogen with lower (but still significant) oil generation potential. Representing this source rock type are the Itajaí-Açu Formation in the Santos sub-basin, and the Macae and to some extent the Ubatuba Formations in the Campos sub-basin. In the Espírito Santo sub-basin the Regência and Urucatuca Formations contain organic-rich intervals with TOC that rivals the Itajaí-Açu. Organic matter in the Urucatuca is composed mostly of Type III - Type IV kerogen and has potential primarily for gas and light oil. The Florianopolis-Itanhaem, and the Jureia-Santos and Marambaia Formations in the Santos sub-basin have low TOC and contain mostly Type III kerogen with very limited hydrocarbon potential.

Thermal maturity in the three sub-basins has been evaluated using vitrinite reflectance (%Ro), Rock-Eval TMAX and several maturity sensitive biomarkers ratios. All three methods indicate that the Santos sub-basin has the lowest geothermal gradient. Vitrinite reflectance and TMAX indicate that the Espírito Santo sub-basin has the highest geothermal gradient, with the Campos intermediate. Based on vitrinite data, the onset of oil generation (Ro = 0.6%) in the Santos sub-basin occurs at a present-day depth of 4,100-4,200m and peak oil generation (Ro = 0.9-1.0%) at 5,800-5,900m present-day. In the Espírito Santo onset occurs at 3,300-3,400m and maximum at 5,100-5,200m. In the Campos Basin the range is 3,800-3,900m for onset and 5,600-5,700m for maximum oil generation. With possible exception of some of the deeper Lagoa Feia and Itajaí-Açu samples, the majority of samples analyzed are immature to early mature with respect to hydrocarbon generation.

Triterpane and sterane biomarkers in organic extracts from the Lagoa Feia and Mariricu Formations are characteristic of a brackish water - lacustrine depositional system. However, source-specific biomarker ratios in the extracts do not conform exactly to the range of values that define lacustrine oils recovered in the Campos and Espírito Santo sub-basins. This is thought to be a result of the low and variable maturity of the intervals analyzed and the inherent variability of lacustrine organic facies. Despite these variations, biomarker distributions in some of the extracts show a striking resemblance to those of individual oils, suggesting similar source facies.

In contrast, triterpane and sterane biomarkers in extracts from some of the more thermally-mature Itajaí-Açu samples show a strong affinity to Santos marine oils

correlated to Cenomanian-Turonian source rocks, suggesting a genetic relationship. These distributions are consistent with algal-rich, marine siliciclastic lithofacies. One Itajaí-Açu sample from the southern portion of the sub-basin appears to be stained with hydrocarbons originating from lacustrine source rocks. This implies the presence of generative lacustrine facies in this portion of the sub-basin; previous reports of lacustrine and mixed lacustrine/marine oils in Santos had been limited to oils from the north.

Biomarkers in organic extracts from the Macae and Ubatuba Formations in the Campos sub-basin are characteristic of marine deposition, in some cases under upwelling conditions. Oleanane was detected in several Urucutuca Formation samples from the Espírito Santo sub-basin, suggesting a land derived organic input in otherwise marine sedimentation. Oleanane was also reported in several Espírito Santo marine oils, suggesting either minor source contributions from the Urucutuca Formation or incorporation of this biomarker in the oils during migration.

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