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Bulk, Biomarker, Isotopic and Kinetic Variability of the Cretaceous Source Rocks in the Bambuca Creek Section, Upper Magdalena Basin (Colombia): Paleoenvironmental Controls and Exploratory Implications

The Cretaceous (Albian/Turonian) marine marls and shales of the Villeta Group are the main source rocks of the Upper Magdalena Basin (UMB). With discovered oil reserves of 631MMbbl, the UMB is located between the Central and Eastern Andean Cordilleras, southern Colombia. Aiming to assess stratigraphic and geochemical variability of these source rocks, 240 rock samples from a thermally immature 700m-thick outcrop section (Bambuca Creek) were submitted to total organic carbon, Rock-Eval, GC, GC-MS, isotopic, kinetic and visual kerogen analyses. High TOC contents (1-18%), hydrogen indices around 400-600mgHC/gTOC and dominance of amorphous organic matter point to a prevalence of type II kerogen. Systematic variations in organic matter quality and contents, carbon isotope ratios of organic extracts, and relative abundance of biomarker compounds along the studied section reflect paleoenvironmental changes and correspond closely to a sequence stratigraphic model defined using sedimentological criteria. A multivariate statistical approach of molecular data allowed the characterization of distinct organic facies and provided basis for a refinement of oil-source rock correlation in the UMB. A significant kinetic variability unrelated to a kerogen classification based on hydrogen indices was found. Kinetic simulations under constant heating rates indicate that kerogen conversion within distinct source rock levels might be out of phase (about 10-20M.y.), making petroleum generation history longer and more complex than if a uniform kinetic behavior is considered for entire source rock section.