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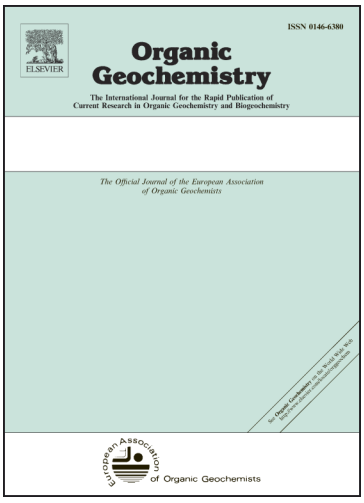

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Suppression of Vitrinite Reflectance by Bitumen Generated from Liptinite During Hydrous Pyrolysis of Artificial Source Rock

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ABSTRACT

Mean random vitrinite reflectance (R_o) is the most widely accepted method to determine thermal maturity of coal and other sedimentary rocks. However, oil-immersion R_o of polished rock or kerogen samples is commonly lower than R_o values measured in samples from adjacent vitrinite-rich coals that have undergone the same level of thermal stress. So-called suppressed R_o values have also been observed in hydrous pyrolysis experiments designed to simulate petroleum formation. Various hypotheses to explain R_o suppression, such as sorption of products generated from liptinite during maturation, diagenetic formation of perhydrous vitrinite or overpressure, remain controversial. To experimentally test for suppression of vitrinite reflectance, artificial rock was prepared using silica and a calcined blend of limestone and clay with various proportions of thermally immature vitrinite-rich Wyodak-Anderson coal and liptinite-rich kerogen isolated from the oil-prone Parachute Creek Member of the Green River Formation. The samples were subjected to hydrous pyrolysis for 72 hr. at isothermal temperatures of 300°C, 330°C, and 350°C to simulate burial maturation. Compared to artificial rock that contains only coal, samples with different proportions of oil-prone kerogen show distinct suppression of calibrated R_o at 300°C and 330°C. The reflectance of solid bitumen generated during heating of the samples is lower than that of the associated vitrinite and does not interfere with the R_o measurements. These results provide the first experimental evidence that R_o suppression occurs in vitrinite mixed with liptinite-rich kerogen in a rock matrix. Although the precise chemical mechanism for R_o suppression by liptinite remains unclear, free radicals generated from solid bitumen and associated volatile products during maturation of liptinite may contribute to termination reactions that slow the aromatization and rearrangement of polyaromatic sheets in vitrinite, thus suppressing R_o. This mechanism does not preclude R_o suppression that might result from overpressure or differences in redox conditions during diagenesis.

Keywords: vitrinite reflectance; suppression; liptinite; hydrous pyrolysis; artificial rock