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Combining organic petrography with molecular and isotope geochemistry to decode sources of amorphous organic matter in Eocene lacustrine shales from the saline Qianjiang Formation

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The distinctive characteristics of intra-salt deposits from the Eocene Qianjiang Formation, Jianghan Basin, China, have fostered enduring interest as an exemplar of source rocks formed in hypersaline lacustrine environments [1,2]. A crucial gap in the understanding of hypersaline settings is how temporal variations in microbial communities influence organic matter (OM) composition and control inputs of liptinite derived from bacteria and algae [3,4]. Modeling analysis [5] was employed to evaluate the proportions of different types of amorphous OM (AOM) from petrographic images. This approach revealed a close correspondence between OM types and biomarker sterane/hopane ratios (St/H), reflecting the relative contributions of primary producers (steranes) and bacterial communities (hopanes) to preserved AOM. Furthermore, integrating molecular and isotope characteristics with results from organic petrographic modeling attests to discrete roles for algae and bacteria in the formation and preservation of oil-prone OM (liptinite) associated with the cyclical wet and dry episodes influencing hypersaline lacustrine deposits in the Jianghan Basin. Episodes of water stratification, characterized by an increase in the supply of algal OM, tend to favor preservation of AOM with lower d^{13}C values during wetter intervals. By contrast, increased evaporation during drier intervals leads to a decrease in AOM contributions and enhanced OM degradation by aerobic bacteria communities and halophilic archaea, resulting in higher d^{13}C values. Seasonal mixing of the water column also disrupted stratification, enhancing productivity and generating AOM with high St/H ratios and increased d^{13}C values, augmented by AOM sourced from land plants. Episodes of freshwater influx fueled changes in phytoplankton and contributed terrestrial detritus that diluted sedimentary OM. It may also have promoted stratification, aiding preservation of AOM. Thus, the combination of organic petrography with molecular and isotopic techniques affords valuable insights of temporal changes in AOM reflecting the dynamic interactions among terrestrial, planktonic, and bacterial sources of OM in the hypersaline Qianjiang Formation, which may be echoed in the depositional features of shale deposits from similar environmental settings.

References:

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