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How Links Between Complex Earth Systems Processes and Sequence Stratigraphy Constrained Organic Carbon Burial in the Early Cenomanian Mowry Shale, Wyoming, USA

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Summary

The early Cenomanian Mowry Shale is an organic-rich mudstone that is a key source for many petroleum systems in the western United States. The Mowry's source rock facies are heterogeneous, but the controls on this heterogeneity are not well understood. This work investigates source rock properties of the Mowry through an integrated analysis of sedimentology, stratigraphy, paleontology, and inorganic geochemistry. Organic carbon in the Mowry does not follow typical sequence stratigraphic assumptions. The best source rock facies relates to the highstand systems tract, and high marine anoxia appears to relate to less organic carbon content. At relative sea level highs, paleoproductivity was lessened by a lack of fluvial nutrients reaching distal portions of the basin. As relative sea level fell, anoxia and productivity increased resulting in high organic carbon burial rates. However, as relative sea level continued to fall, the seaway became restricted, photic zone anoxia developed, and productivity, and ultimately organic carbon deposition declined. Thus, the Mowry shows paradoxical relationships between low organic carbon in pelagic sections along maximum flooding surfaces but increasing organic content with traction sedimentation in highstand systems tracts. The relationship with sequence stratigraphy suggests that this feature of the Mowry should be predictable, and therefore it should be possible to better constrain source rock heterogeneity for unconventional exploration or development.

Theory / Method / Workflow

I investigated a set of USGS data from a Mowry core in the Powder River Basin, Wyoming USA. I used several analytical techniques, including a detrended correspondence analysis to compare different data types to understand Earth system processes.

Results, Observations, Conclusions

Results suggest that as the Mowry Sea became more anoxic, organic carbon burial lessened due to a decline in paleoproductivity. Organic content of the Mowry is low along maximum flooding surfaces, likely due to a decline in fluvial nutrient input into the distal Mowry basin. Productivity and anoxia increase with increased clay content and evidence of traction sedimentation in the highstand systems tract. As relative sea level continued to fall, there is evidence of photic zone anoxia which related to a subsequent decline in organic carbon burial. Therefore, the Mowry seems to have a paradoxical relationship between higher traction sedimentation, relative sea level fall, and higher organic carbon burial until the sea became too restricted, photic zone anoxia developed, and productivity declined.

Novel/Additive Information

This work shows how complex Earth systems linkages controlled organic carbon burial in the Mowry Sea. It shows that productivity and preservation of organic material are closely tied to sequence stratigraphy, but not in the ways we previously assumed. The results of this study can be used to build predictive models of organic carbon content in the Mowry for use in petroleum exploration and development programs.

Acknowledgements

Data used in this study are from the USGS Core Research Center (Denver, CO, USA).

References

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