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Enrichment Mechanism of Organic Matter in Marine Shale under Complex Tectonic Settings: Insights from the Wufeng-Longmaxi Formations in Northern Guizhou

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The Late Ordovician–Early Silurian Wufeng-Longmaxi Formations are critical sedimentary archives in South China, recording pivotal climatic, oceanographic, and tectonic events that shaped the evolution of marine ecosystems and organic carbon sequestration during this key interval in Earth history. Previous studies of the Wufeng-Longmaxi Formation shales have been mainly focused on the sections in the Sichuan Basin. The sections in the northern Guizhou region in South China, which were deposited in a much more complex tectonic setting than that in the Sichuan Basin, have been less studied. Here, major and trace element analyses were carried out to investigate the sedimentary paleoclimate, paleosalinity, paleoredox conditions, and paleoproductivity of the Wufeng-Longmaxi Formations shales in the northern Guizhou region, aiming to constrain the organic matter enrichment mechanism in complex tectonic environments. The results show that organic-rich shales of the Wufeng-Longmaxi Formations in northern Guizhou were deposited under a warm and humid climate in relatively low-salinity waters with relatively high paleoproductivity. The Wufeng and the 1st member of the Longmaxi Formation were deposited in an anoxic–dysoxic environment, which was subsequently shifted to a dysoxic–oxic environment during the deposition of the 2nd member of the Longmaxi Formation. Different from the Sichuan Basin, the Wufeng–Long 1 members in northern Guizhou were confined by peripheral ancient lands and submarine uplifts, characterized by relatively shallow water depths and a quiet, strongly segmented, closed to a semi-closed lagoonal environment. The Long 2 member shows a more open water environment compared with the Wufeng–Long 1 members. Such changes in the sedimentary environment improve our understanding of organic matter enrichment mechanisms in tectonically complex settings and provide insights for marine shale oil and gas exploration in similar basins worldwide.

