High resolution sequence stratigraphy and geochemistry of Triassic upwelling zone deposits, northern, Alaska: implications for paleoredox conditions and paleoceanography

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Sequence stratigraphic, geochemical, gamma-ray, and ichnofabric (trace fossil) analyses of Triassic rocks in Arctic Alaska provide insight into the sea level history and architecture of facies deposited under fluctuating redox conditions and marine upwelling. Heterogeneous phosphatic, cherty, and organic-rich facies of the Shublik, Otuk, and associated formations record three genetic depositional sequences deposited during the Middle-Upper Triassic. Major transgressive surfaces, facies stacking patterns, and gamma ray data permit high-resolution sequence stratigraphic correlation between Shublik and Otuk outcrops in the northeastern and central Brooks Range. All outcrop sections record distal depositional settings with Shublik facies indicating more proximal environments compared to the Otuk. Sedimentary cycles (parasequences) generally record shoaling upward deposition from environments that were below storm wave base to subtidal environments near or above fairweather wave base.

Geochemical and ichnofabric data provide insight into fluctuating redox conditions during deposition of individual parasequences and parasequence sets. Geochemical parameters used to infer bottom water redox conditions include the Ce anomaly (Ce_{anom}), V, P and TOC levels, and the Ca/Mn ratio of calcic black shales. Facies deposited under low oxygen conditions display a positive Ce_{anom}, higher V compared to P, high TOC (Otuk up to 10%, Shublik up to 6%), Ca/Mn Group III/IV ratios, and a low Ichnofabric Index (II). More oxygenated environments record a negative Ce_{anom}, higher P relative to V, low TOC, Ca/Mn Group I/II ratios, and higher IIs. Diagenetic processes could have altered some of the geochemical signatures but the concordance of geochemical, ichnofabric, and lithofacies indicators of redox conditions support our interpretations. The variations in paleoxygenation recorded here likely resulted from transit of the upwelling-related oxygen minimum zone during relative sea level fluctuations. Additional biostratigraphic data will be needed to constrain the timing of these events but variations within parasequence and parasequence sets (4th-5th order cycles) imply relatively high frequency fluctuations.