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Mudrock Chemical Characterization Using Energy Dispersive XRF Technique, Paleocondition Reconstruction Applications

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Summary

This study investigated the inorganic geochemistry of the upper Cretaceous fine-grained sediments from east-central Saskatchewan (Townships 47-50 and ranges 5-11 west of the second meridian) to characterize the paleo-depositional environment and the source rock and reservoir potential of the strata. These mixed siliciclastic and carbonate–rich deposits were deposited along the eastern margin of the Western Interior Seaway (WIS). Organic–lean and non–calcareous clay-rich mudrock of the Cenomanian Belle Fourche Member is overlain by the Turonian Second White Specks Formation comprised of stacked parasequences of organic–rich, calcareous mudstone coarsening up to shallow water calcarenite beds. The overlying Carlile Formation is also a carbonaceous mudstone, but its non–calcareous character represents a likely major change in oceanographic conditions within the WIS. These different suits of mudrock facies display different hydrocarbon source and reservoir properties.

Core samples were taken from multiple boreholes recently drilled in the Pasquia Hills area, east-central Saskatchewan. About 500 manually crushed samples were analyzed using ED-XRF technique, *Innov-X* model *X-5000,* to acquire elemental concentrations of the studied mudrocks. Sampling was done depending on the scale of micro and macro facies variability (1 cm to 50 cm) to characterize the degree of heterogeneity of the strata. Mineral concentrations were estimated through normalization and calibration was done using standards and based on XRD and thin-section mineralogy data.

Chemical element logs, created from the XRF data, show that each stratigraphic unit is characterized by distinct compositions, patterns and vertical trends in elemental concentrations of the studied section. Laterally, wells across the study area show relatively similar elemental composition/concentration. Single and multiple elemental/mineralogical trends reveal fundamental details about changes regarding depositional environment, oceanographic conditions, climate, relative sea-level, and sediment source. Elements including Ti, Th, Zr and Rb are terrestrial signal indicators and show several sedimentary cycles within the sequences. Also, high Sr concentrations pinpoint highly cemented intervals, which indicate possible subaerial unconformity or extreme low sedimentation rate. V/Ti ratio can be used as a signal for illite/smectite-rich intervals. Association of different elements (Mn, Sr, Mg and Na) with carbonate minerals reveals water salinity and water temperature at the time of deposition. Integration of inorganic and organic (Rock-Eval) data determines the degree of productivity, oxidation state and organic preservation potential. Results of this research suggest geochemical proxies can be used as robust tools for understanding sedimentary processes and oceanographic changes in mudrock sedimentary systems.

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