Goldschmidt 2026 Abstract
https://doi.org/10.46427/gold2026.37322

Depositional controls on rock-hosted lithium in mudstones of the Duperow Formation, Williston Basin (SW Manitoba)

PATRICIA E FRAINO AND MICHELLE P.B NICOLAS
Manitoba Geological Survey

Anomalous lithium concentrations in carbonate–evaporite basinal brines of the Upper Devonian Duperow Formation (Williston Basin, Canada) cannot be explained by seawater evaporation or evaporite dissolution alone and therefore require identification of additional lithium sources. External contributions from underlying formations are limited by thick anhydrite seals within individual carbonate–evaporite cycles, which restrict vertical fluid migration and emphasize the importance of evaluating intraformational sources.

Major, minor, and trace element concentrations were analyzed from compositionally distinct lithofacies to assess whether platform architecture governs lithium distribution within the host rock. Limestone and evaporite facies contain low lithium values (<2 ppm). In contrast, mudstones exhibit distinct lithium concentrations that vary systematically with depositional environment. Clastic mudstones in restricted supratidal and lagoonal settings contain 50–115 ppm Li. Dolomitic mudstones in intertidal settings contain 15–50 ppm Li, whereas open-marine lime mudstones contain <5 ppm. Major elements commonly associated with clay and silicate minerals (Al, Si, K, and Na) increase systematically from subtidal to intertidal and supratidal environments and closely mirror lithium distribution. The covariation of lithium with these elements across depositional environments indicates that lithium distribution is governed by detrital clay mineral abundance and input.

The observed facies-dependent lithium concentrations reflect platform-scale hydrodynamic filtering of detrital clay minerals supplied by windblown dust and ephemeral fluvial systems along an arid coastline. In open-marine subtidal settings, wave and storm currents winnowed fine-grained material, limiting clay accumulation. Detrital clay minerals preferentially accumulated in low-energy intertidal and supratidal interiors, where restricted circulation promoted settling of clay minerals and reduced export of fine-grained material. This selective retention developed a progressive landward lithium enrichment consistent with enhanced clay mineral accumulation under restricted circulation.

These results demonstrate that platform architecture may exert an important control on clay mineral distribution within intraformational mudstones, influencing rock-hosted lithium availability prior to rock–fluid interactions in an intracratonic carbonate–evaporite system.