Evolution of a regional interconnected diagenetic aquifer in the Lower Prairie Evaporite of northeast Alberta.

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The Prairie Evaporite Formation of northeast Alberta comprises a thick, dominantly evaporitic succession, deposited in the middle reaches of the Keg River-Winnipegosis basin. It has generally been regarded as lacking any significant widespread porous units and the regional Keg River Formation has been regarded as the main interconnected aquifer in the area. In past years this aquifer was referred to as the Methy Formation, a now obsolete stratigraphic term. In the present study, the Prairie Evaporite section east of the Athabasca River Valley has been subdivided into two informal units: an uppermost Prairie 'Collapse' and a lower Prairie 'Intact'.

Core examination reveals that the very earliest Prairie Evaporite sediments deposited on the top of the Keg River ramp consisted of laminated dolomudstones. This is in stark contrast to the bioturbated and often fossiliferous Keg River ramp. These laminated Prairie dolomites incorporate increasing interlaminations of anhydrite precipitated in the upper parts of a series of 'brining-upward' cycles. Eventually anhydrite becomes the dominant lithology of the 'brining-upward' cycles precipitated in the basin. Consequently, on petrophysical logs, the top of the Keg River is often picked incorrectly at the base of the first thick (recognizable) anhydrite.

The 'brining-upward' dolomite-anhydrite cycles persist to the point that halite then becomes the dominant precipitate. This level defines the top of the Prairie 'Intact'. In uncollapsed sections to the west, halite then comprises the dominant lithology of the upper Prairie evaporite section. It is this highly soluble component that is removed by dissolution updip to the east, such that east of the Athabasca River Valley, no depositional halite remains in the Prairie Evaporite section. Instead a contorted and brecciated section of anhydrites and dolomites comprises the remaining remnant; here termed the Prairie 'Collapse'. Individual dolomite horizons in the Prairie 'Collapse' are consequently disconnected and 'patchy' in occurrence, in contrast to the Prairie 'Intact', where these beds remain interconnected regionally being only absent when Keg River reefal buildups occur in the section.

Initial porosity and permeability in these Prairie 'Intact' dololaminites is only moderate (15%, 3 md). However, during certain dissolution phases these levels were pathways for fluids coming from the nearby subcrop. Examination of core from the Prairie 'Intact', including a number of lost circulation intervals, revealed that these dololaminites exhibited various stages of dedolomitization, solution collapse and brecciation. Dedolomitization occurs in near surface environments at low temperatures and pressures in mixed carbonate-gypsum systems, where dolomite solubility is enhanced. The rapid dissolution of gypsum forces calcite to become supersaturated and it begins to precipitate, further enhancing the solubility of dolomite.

Consequently, the movement of these calcium-charged fluids through the Prairie Evaporite laminites results in the development of considerable amounts of solution porosity and they take on enhanced aquifer properties. However, dedolomitization did not occur uniformly within these original sheet-like deposits, but rather followed narrow fairways, possibly reflecting preferential hydraulic pathways. Lack of deep Devonian control hampers detailed mapping of these pathways.

Palynology undertaken on these dedolomite zones showed them to contain Cretaceous bisaccate pollen, associating them with fluid flow associated with deposition of the fluvial Lower McMurray Formation. At present, these 'diagenetic' aquifer levels contain cold climate glacial recharge waters, suggesting that they continue to be an aquifer in the area.

Present hydrogeological evidence indicates the dynamic interconnectivity of this hitherto unrecognized aquifer over distances of up to two townships. It is absent in areas of Keg River reefal development and is a less effective aquifer, where not dedolomitized.

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