Multiphase solution removal of the Prairie Evaporite Formation in northeast Alberta (Implications for the oil sands mining community).

Stoakes, F.A., Verhoef, M. and Mahood, R.
Stoakes Consulting Group Ltd. (SCG), Shell Canada Energy and Shell Canada Energy

The Middle Devonian Prairie Evaporite section in northeast Alberta is comprised of a thick, up to 270 metre, succession of dolomites, anhydrites and halites. These were deposited as chemically precipitated sediments in the middle reaches of the pre-existing Keg River-Winnipegosis basin. The geologic section thins rapidly towards the basin margin to the east as a result of subsurface dissolution and because of its inherently soluble nature the unit does not occur in outcrop.

Dissolution of the Prairie Evaporite section took place as a result of the influx of fresh waters primarily introduced along the eroding basin margin. This type of dissolution is often referred to as hypogenic karst, as it takes place beneath a relatively intact overlying section.

Based on stratigraphic studies undertaken on the Middle Devonian and overlying Cretaceous McMurray section, at least 3 phases of dissolution collapse are recognized:

- Phase 1: Middle Jurassic to Early Cretaceous accompanying uplift and erosion associated with the Laramide Orogeny and the formation of the pre-Cretaceous unconformity.
- Phase 2: Early Cretaceous during deposition of the Lower McMurray.
- Phase 3: Latest Tertiary during the latest cycle of uplift and erosion when glacial waters entered along the basin margin.

The three phases outlined above reduced the overall Prairie Evaporite section from 270 metres to less than 18 metres in thickness through the progressive and systematic removal of the soluble elements.

Phase 1 removed the majority of the halite component resulting in a dip reversal of the overlying Middle to Upper Devonian sediments prior to final formation of the pre-Cretaceous unconformity surface.

Phase 2 reflects the renewed introduction into the section of fresh waters associated with fluvial deposition of the Lower Cretaceous McMurray Formation. The collapsed Prairie Evaporite section contains abundant evidence of these Cretaceous waters in the form of Cretaceous shale and bisaccate pollen. Sediment loading and continued dissolution during the Lower McMurray caused areas of increased sediment accommodation and structured the pre-Cretaceous unconformity along with the underlying post-Prairie Evaporite section.

Phase 3 relates to the influx into the Middle Devonian of glacial melt waters. Isotope evidence indicates that waters presently residing in the Middle Devonian sections east of the Athabasca River Valley are cold climate glacial recharge waters varying in age from 7,000 to 40,000 years BP.

The presence of fibrous gypsum (satin spar) in a number of units attests to the movement of these glacial melt waters through the section acting to hydrate much of the remaining anhydrite in the Prairie Evaporite section. It remains as gypsum only at shallow burial depths below which it reverts to

anhydrite. Consequently its' abundant presence in the Middle Devonian section can only be associated with the present day (post-Eocene) burial situation.

The elevation of the pre-Cretaceous unconformity surface, in concert with detailed correlations in the McMurray section, can be used to infer the stratigraphic architecture of the underlying Middle Devonian section.

A more detailed understanding of the relative timing and patterns of collapse in the Prairie Evaporite Formation marks an important step forward in understanding the location and evolution of hydraulic pathways in the Middle Devonian section.

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