

PS Regional-Scale Modelling of the Paleozoic Succession Beneath the Athabasca and Cold Lake Oil Sands Areas: Devonian Paleogeography, Evaporite Dissolution, and Controls on Cretaceous Depositional Patterns on the Sub-Cretaceous Unconformity*

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Abstract

Regional-scale lithostratigraphic mapping of the entire Paleozoic succession in northeastern Alberta was undertaken to support the production of a high-resolution 500 × 500 m grid cell 3-dimensional model. The stratigraphic dataset comprises Paleozoic formation- and member-level picks from 1162 wells covering 874 townships. An additional 7188 wells that just “tag” the sub-Cretaceous unconformity were used to construct the structural elevation of that surface. Modelling of Elk Point Group strata in the study area reveals a number of important findings. Precambrian basement paleotopography had a strong control on the distribution of Keg River Formation carbonate buildups and interbuildup basins, which in turn largely controlled the depositional patterns in the Prairie Evaporite Formation. Accretion of the Keg River Formation into banks and bioherms acted to confine early halite accumulation in the central and southern part of the study area within a series of sub-basins, whereas anhydrite accumulated at similar stratigraphic positions to the north of a continuous Keg River bank. Mapping of the Prairie Evaporite Formation, and net-pay mapping of halite and anhydrite therein using modern well control, provides the basis for an updated version of the location and extent of the Prairie Evaporite dissolution scarp, which is a well-known intrastratal dissolution feature that runs NNW-SSE through the study area. The dissolution of more than 200 m thickness of halite from within the Prairie Evaporite Formation resulted in structural compensation and collapse of the overlying Devonian Beaverhill Lake Group. Detailed correlation of new and established member and marker bed stratigraphy from the Prairie Evaporite reveals the pattern of evaporite karst within the halite dissolution scarp, and provides evidence for the top-down removal of halite throughout the study area. A comprehensive and consistent pick database of the sub-Cretaceous unconformity surface was used to construct a paleotopographic model of this important angular unconformity. Detailed lithostratigraphic correlation of the Beaverhill Lake to Wabamun groups permits delineation of the Devonian subcrop at the sub-Cretaceous unconformity. The regional Devonian subcrop model, overlain on the paleotopographic reconstruction of the sub-Cretaceous unconformity, highlights the control that various Devonian strata had on accommodation and depositional patterns in the overlying Lower Mannville Group.

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