Regional-scale Modelling of the Sub-Cretaceous Unconformity Surface in Northern and Central Alberta: Elevation, Subcrop Zero-edge Delineation, and Paleotopographic Reconstruction

Introduction

Creating a 3-dimensional geological framework model of the Alberta subsurface is a major project currently underway at the Alberta Geological Survey. One major component of this model is the "sub-Cretaceous" unconformity surface, which represents a significant period of non-deposition and erosion in the Alberta foreland basin initiated after deposition of Upper Jurassic/lowermost Cretaceous sediments. This unconformity surface formed a major control on the accommodation space and subsequent deposition of the overlying Lower Cretaceous Mannville Group and equivalent strata in the Athabasca, Peace River, and Cold Lake Oil Sands areas due to varying and complex topography generated on the angular unconformity. Previous sub-Cretaceous unconformity models were built using datasets from multiple sources, resulting in a variable quality surface due to inconsistent picking criteria between sources, co-located data, and clustered data distribution. In order to decrease uncertainty in this important regional surface, a new dataset is being created using high quality log picks with an improved spatial distribution. The dataset for this project area was geostatistically analyzed to identify any potential outliers prior to modelling the elevation of the unconformity surface. Paleotopography of the unconformity surface was generated by removing the dominant regional trend from the elevation surface, which created a residual surface that represents the topography of the unconformity surface prior to the deposition of Mannville Group and equivalent strata.

Earlier modelling of the sub-Cretaceous unconformity surface, zero-edge delineation of subcropping units, and paleotopographic reconstruction has been combined with recently completed detailed work on Paleozoic strata in the lower Athabasca region, providing an expanded regional view of the sub-Cretaceous unconformity in the subsurface of the Alberta Basin.

Study Area

Figure 1: Study area location.

- Study area expands from previously mapped project areas to include the Lower Athabasca Regional Plan (LARP) area and encompass the 3 major oil sands areas of Alberta.

Well Control

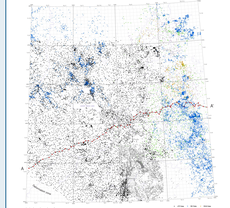


Figure 2: Well data distribution

- Dataset contains 28,841 data points.
- Data with source: ZTP, TEH or BH are high quality data points.
- Areas containing data with unidentified subcropping formation or sparse data distribution, requires verification.

Source	Subcropping Formation	Count
AGS - ZTP	Identified	11,442
AGS - TEH	Identified	1,674
AGS - BH	Undentified	6,534
AGS - Other	Needs Verification	6,201
NYMAP	Needs Verification	2,990
RDS	Needs Verification	400
	Total	28,841

Stratigraphy

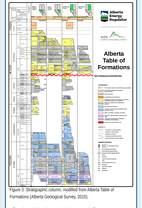
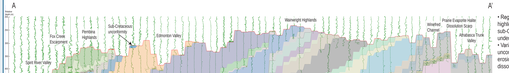


Figure 3: Stratigraphic column, modified from Alberta Table of Formations (Alberta Geological Survey, 2015).

- Stratigraphic units eroded by the sub-Cretaceous unconformity range from the Upper Jurassic/Lower Cretaceous Nikanassin Formation to the Middle Devonian Keg River Formation.
- Due to the variable extents of the stratigraphic units within the study area and the angular relationship of underlying units, not all formations are truncated by the sub-Cretaceous unconformity.

Cross-sections


A
A'
Fox Creek Escarpment
Pembina Highlands
Sub-Cretaceous unconformity
Edmonton Valley
Wainwright Highlands
Prairie Evaporite Halite Dissolution Scarp
Athabasca Trunk Valley
Saint River Valley
Datum = Base of Fish Scales or approximate stratigraphic equivalent
Equally-spaced wellbores
Cairns Fm.
Nikanassin Fm.
Fernie Fm. (undifferentiated)
Gordondale Mb. (Fernie Fm.)
Bickerdike Fm.
Bellloy Fm.
Gething Fm.
Gething Fm.
Gething Lake Fm.
Gething Fm.
Gething Fm.
Gething