

Establishing a core-based stratigraphic framework for the Mannville and Colorado groups in the Athabasca Region, NE Alberta, Canada

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Introduction

Over the past 100 years, several stratigraphic studies have been conducted in the Athabasca Oil Sands region by academic, industry, and governmental geoscientists. The application of different stratigraphic methods (e.g. lithostratigraphy, allostratigraphy, sequence stratigraphy) employed by these researchers, in conjunction with the inherent geological complexity of strata, and variable preservation due to glaciation has resulted in historical inconsistencies in the placement of lithostratigraphic tops. To date, the Alberta Energy Regulator (AER) has relied on amalgamating pick data of various vintages from different interpreters and therefore it can be quite challenging to evaluate stratigraphic picks for any given well in the Athabasca region. Furthermore, the AER has limited access to high quality core photographs to evaluate wireline interpretations. Existing core descriptions were typically completed on an ad hoc basis, or as part of regional studies (e.g. Hein et al., 2001; AEUB, 2003). These regional stratigraphic studies have focused on Mannville Group units in the main Athabasca fairway, almost exclusively in the eastern half of the Athabasca region (Figure 1).

Over the past year, the Alberta Geological Survey (AGS) has undertaken a regional core-based study in the western Athabasca region where the stratigraphic framework is less-defined. Data collected and/or produced include high-resolution core photographs, detailed geological core descriptions at a resolution of one to four wells per township (depending on data availability), stratigraphic picks (lithostratigraphic and sequence stratigraphic where possible) within the Mannville (McMurray, Wabiskaw, Clearwater, Grand Rapids) and Colorado (Westgate, Pelican, Joli Fou) groups. This project's overarching goal is to produce a consistent, single-source regional stratigraphic framework available to the AER and various stakeholders.

Dataset and Workflow

The foundational data type for identifying stratigraphic tops within the Mannville and Colorado group consist of core logs ($n = 97$) and high-quality core photos ($n = 292$). The spatial distribution of this data is shown in Figure 1. From a total of 29,333 available core, the final dataset was chosen based upon several criteria, including 1) vintage (post 1989), 2) stratigraphic coverage, 3) quality of accompanying petrophysical curves, 4) presence/absence of core analysis, 5) core condition (slabbed vs whole), and 6) storage location. An attempt was made to select one core (if available) from every township. In stratigraphically complex areas up to 4 wells may have been selected. The distribution in total metres per formation/member are shown in Figure 2. As shown in this chart, core availability is biased heavily toward Mannville Group units, in particular the McMurray, Wabiskaw, and Clearwater. All data submitted to the Alberta Energy Regulator (e.g., core porosity & permeability, XRD, XRF, palynology) were inventoried and amalgamated for all wells falling within the Athabasca Stratigraphic Framework (ASF) boundaries.

Core were logged and photographed over about 4 months in the summer of 2023. Concomitant with core logging, AGS staff conducted an extensive literature review including academic, governmental, and publicly available industry data. These data were used, with core observations, to inform the placement of stratigraphic tops within the regional framework. Currently, AGS staff are correlating stratigraphic surfaces at a resolution of one well per section (if possible) for a maximum of 36 wells per section. Upon completion of these correlations isopach maps for each formation/member included in the framework will be completed.

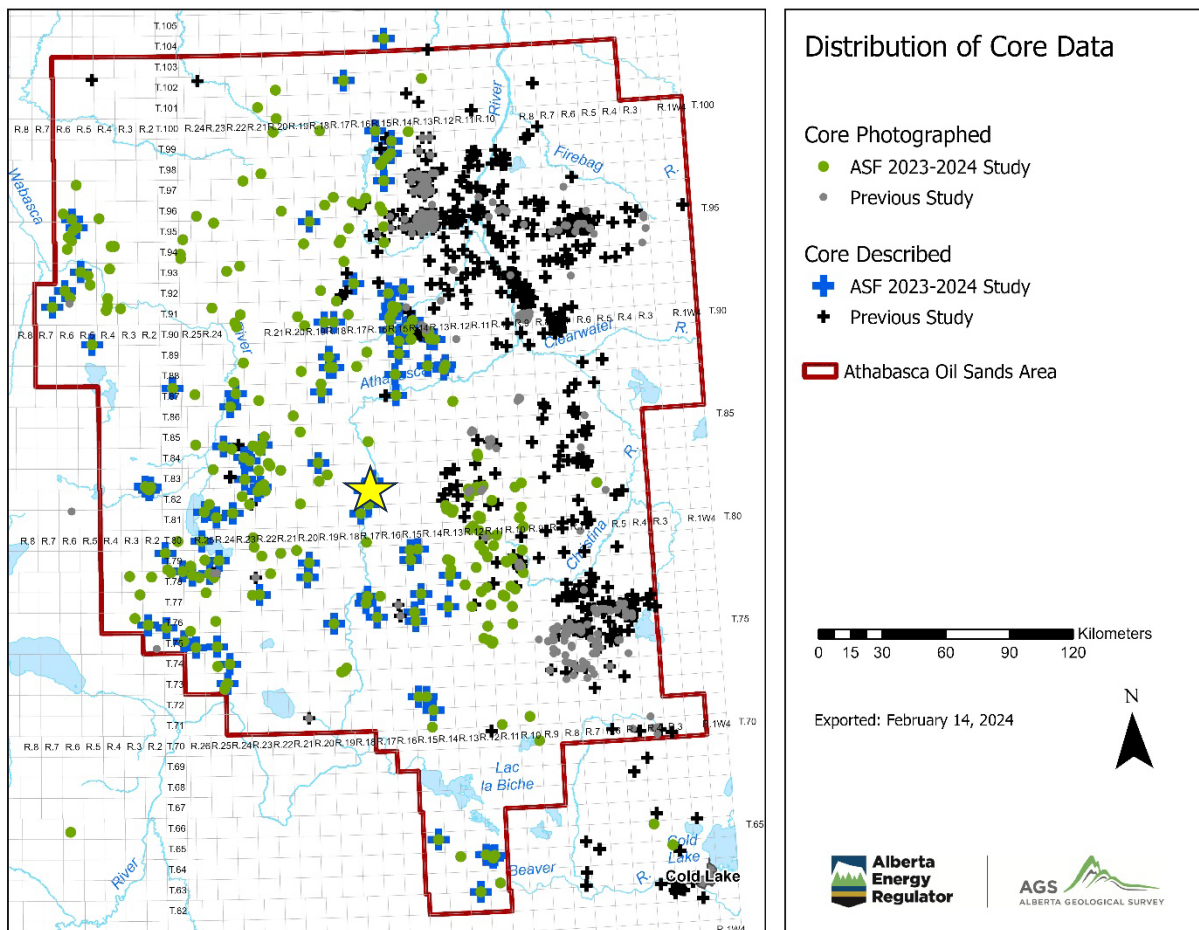


Figure 1) Distribution of core logs produced (blue crosses) and photographs obtained (green dots) during the 2023-2024 ASF study. Grey dots and black crosses represent data compiled from previous AGS project. The yellow star indicates the location of 1AA/01-04-082-17W4 illustrated in Figure 3.

Progress and Future Work

At the time of writing, AGS staff have completed 97 core descriptions, acquired high-resolution photographs for 292 wells, and made several thousand stratigraphic picks. Figure 3 provides an example of a core log produced by AGS staff for well 1AA/01-04-082-17W4 which intersects the entire Joli Fou, Mannville, and upper part of the underlying Devonian strata. Such stratigraphic wells are rare but provide excellent type wells for regional correlations. This presentation

summarizes work completed to date and enhancements to the AGS' Core Data Interactive Map (<https://ags.aer.ca/publication/iam-014>) which is a valuable resource for oil sands data. Also being compiled for public release is a comprehensive geological report that will include: 1) detailed sedimentological descriptions and interpretations of all facies associations documented in core, each with a corresponding type log and facies plate, 2) documentation of the criteria used to justify stratigraphic top placement, each with a corresponding type log, and 3) a series of regional cross-sections intersecting wells where stratigraphic picks are tied to core. This document will be periodically updated as more data is gathered and evaluated.

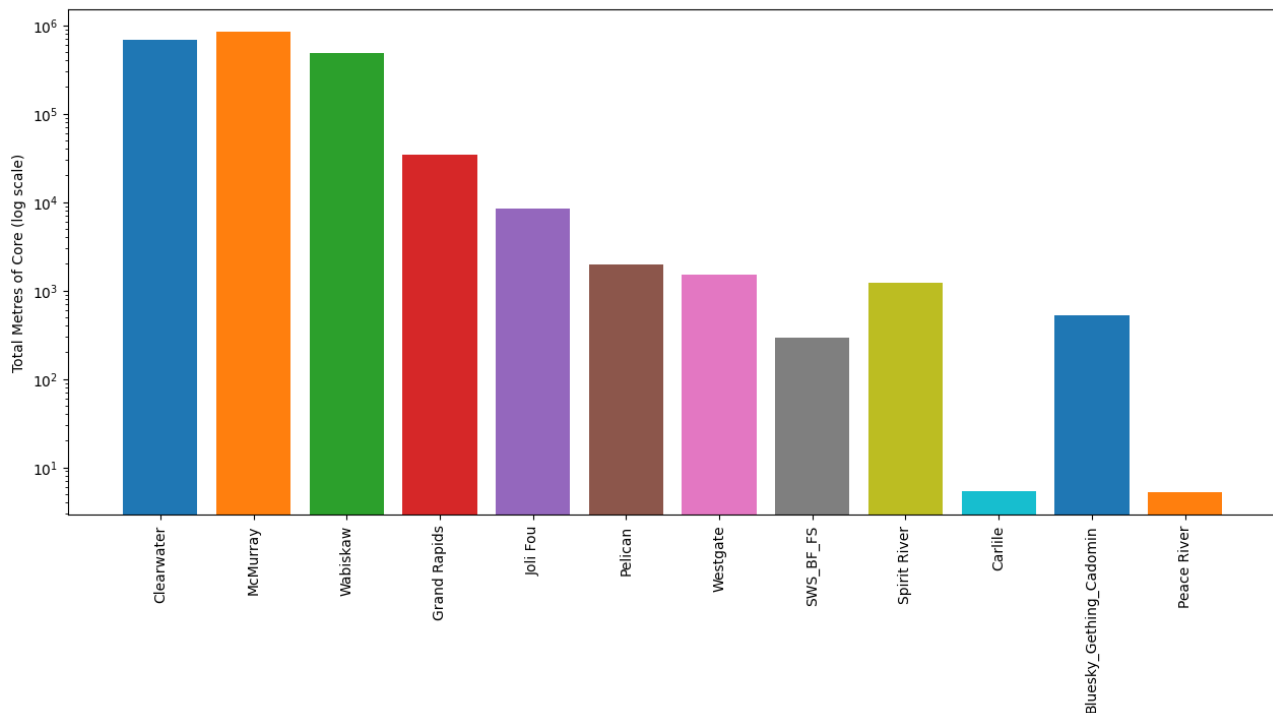


Figure 2) Total metres of core per unit in the Athabasca study area. Units were assigned to core based on calculating the intersection between Geological Framework of Alberta surfaces and core depths. The upper plot has a logarithmic scale, and the lower plot is on a linear scale. These plots demonstrate that most core coverage occurs in the McMurray, Wabiskaw and Clearwater formations (~600,000 metres each). There is significantly less data associated with Colorado Group units (e.g. Joli Fou, Pelican, Westgate formations). The relative lack of core data in the Colorado unit makes picks challenging to quality control on a regional scale.

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References

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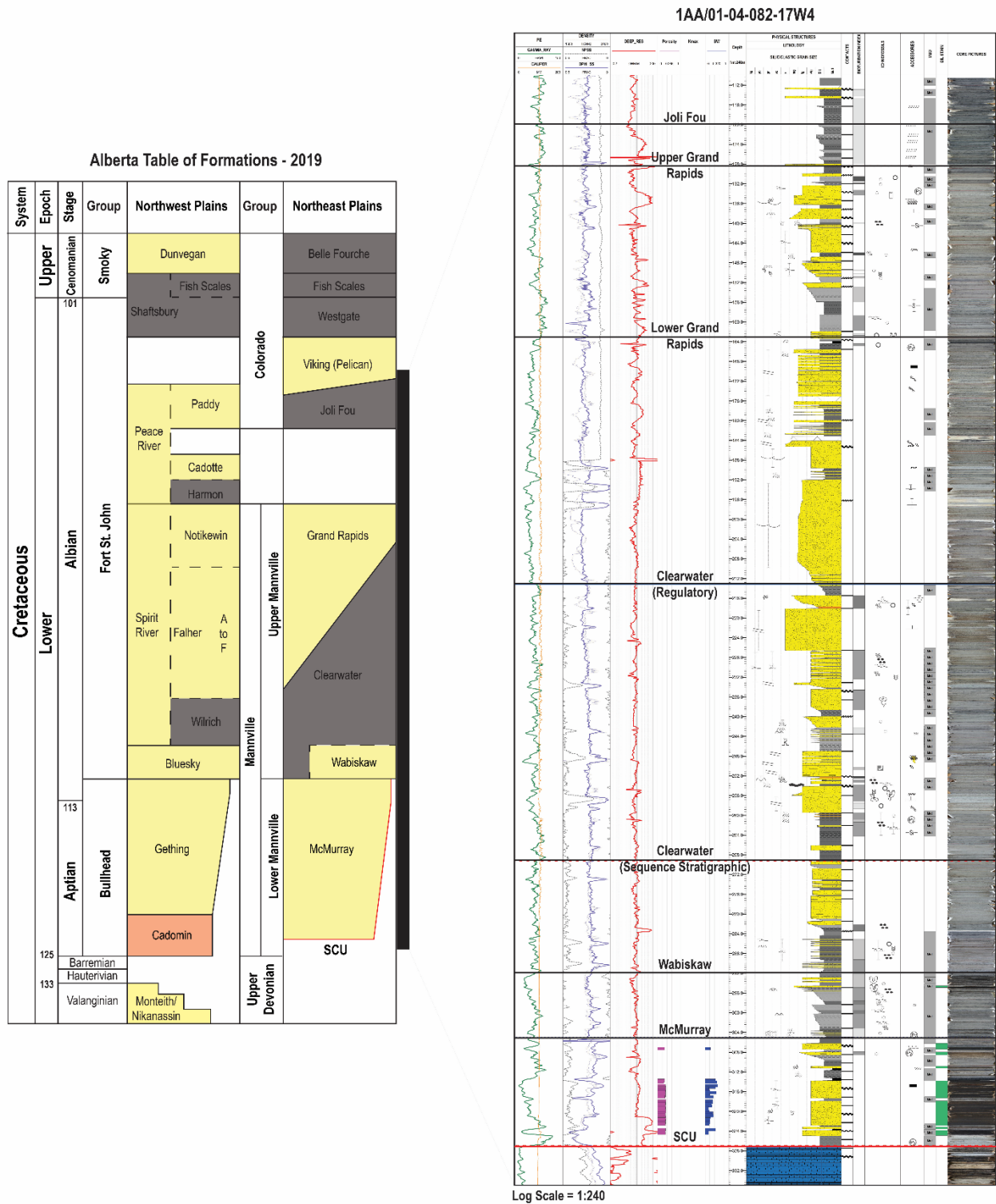


Figure 3) Stratigraphic column for the Northwest and Northeast Plains of Alberta and core log for 1AA/01-04-082-17W4 illustrating the placement of the McMurray Formation, Wabiskaw Member, Clearwater (sequence stratigraphic and regulatory), Lower and Upper Grand Rapids, and Joli Fou tops. Stratigraphic chart is modified from the Alberta Table of Formations, 2019.