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Picking the bedrock top in the Fort McMurray/Muskeg Mountain Region

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Introduction

An understanding of the sub-Cenozoic unconformity (bedrock topography), as well as the thickness and nature of the overlying sediments, is important for the understanding of caprock integrity and migration of fluids, and thus plays an integral role in the management of the oil sands. The bedrock topography of the oil sands region north of Fort McMurray was most recently mapped by AGS geologists (Andriashek and Atkinson, 2007) based on the geotechnical borehole data, water well records, outcrops, and oil and gas logs. This work showed the location of incised, sand filled channels and Quaternary sediments upwards of 150m. In the decade following there has been more extensive drilling, coupled with regulatory changes requiring logging to surface, leading to an increase in availability of these data over a larger area. Additionally, industry coring and EM surveys reported in EIAs and journal publications (e.g. Dawson et al. 2018) provide a wealth of data beyond that which existed for the previous AGS study. This increase in volume of data led the AGS to reexamine the bedrock surface in the region, particularly in areas where data limitations affected the earlier study. This poster highlights the criteria used for picking the bedrock top in logs and illustrates examples of the nature of the bedrock contact provided from cores.

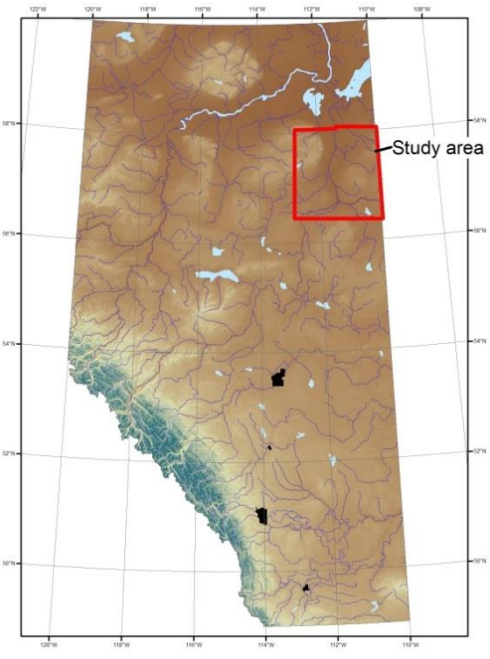

Figure 1. Location of study area.

Methodology

Criteria for selecting the bedrock top are variable depending on the bedrock formation (Fig. 2), and the character of the overlying Cenozoic (inferred as Quaternary aged) sediments. Picking of the bedrock top in well logs was influenced by the examination cores (n=67) distributed primarily in middle of the study area, over the north side of the Muskeg Mountain. Generally, if the bedrock top occurs on a subcrop of Clearwater Fm. shale, the Quaternary sandy tills are relatively easy to pick on the gamma log. Because the Grand Rapids and McMurray formations contain numerous sand bodies, picking using the same gamma log criteria is less effective, and hence the neutron and density logs were employed for picking this contact, with some exceptions. For example, because of the comminution

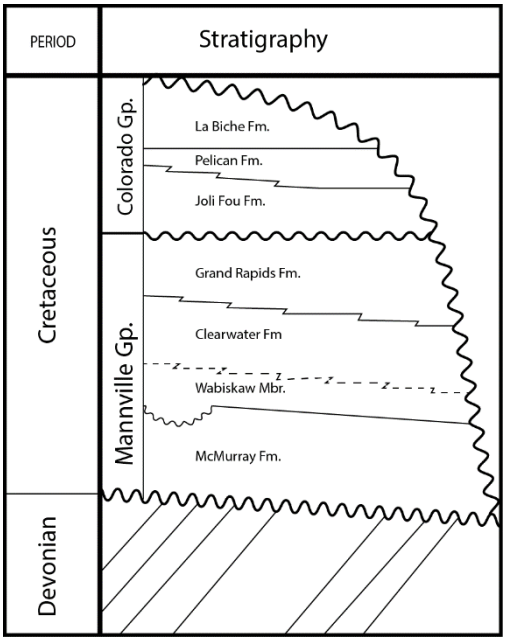

Figure 2. Generalized stratigraphy of the study area (modified after Andriashek and Atkinson, 2006)

of local bedrock into the till that progressively declines in concentration from the contact, a similar gradual shift in the logs (neutron and density, Fig. 3) may also be observed.

An additional complexity to picking the bedrock top is that the nature of the contact is variable. In some cores the contact is a sharp boundary from diamict to undisturbed bedrock. In others cores the bedrock appeared contorted and/or fractured for a few metres beneath the first occurrence of Quaternary sediment. At other sites displaced bedrock with a thin layer (0.1-3 m) of diamict sits above to the bedrock top. Many wells also have rafts of displaced bedrock higher up the sequence, potentially leading to misinterpretation of the bedrock top.

A further improvement on of the bedrock topography relates to the publication of an EM survey over the McKay Plain (SW portion of the study area). This survey provides insights on the location of buried channels, while some reference channels provide insights into the nature of sediments within those channels.

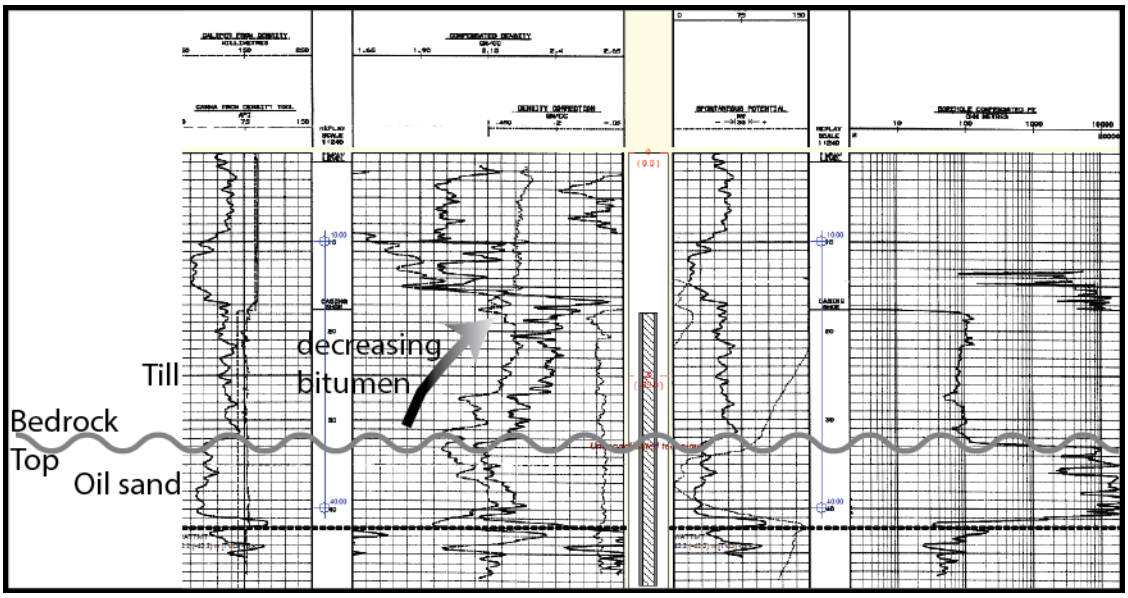

Fig. 3 Example (8-7-98-6W4) of till containing high oil sand at base, and progressively less from contact. Rather than an abrupt shift in the neutron curve, the shift is more gradual as the concentration of bitumen decreases up hole.

Results

With consideration of these complexities, the bedrock top was picked from over 2500 wells in addition to the thousands of tops previously reported in Andriashek and Atkinson (2006). In some cases those picks had to be updated based on the observations from cores. This new pick set will be used to generate a new bedrock topography map of the region.

This work highlights the importance of calibrating log interpretation with examination of cores. Furthermore, because of the variable nature of the sub-Cenozoic contact an understanding of the general sequence of bedrock units is also required.

References

Andriashek, L.D. and Atkinson N. 2007. Buried Channels and Glacial Drift Aquifers in the Fort McMurray Region, Northeast Alberta. EUB/AGS Earth Sciences Report 2007-01.

Dawson, J., Perrin, R., and Henderson, J. 2018. A cost effective approach to regional and site-specific aquifer exploration using combined airborne and ground electromagnetics. CSEG Recorder, 20-24.