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Applying Airborne Electromagnetics for Shallow Aquifer Exploration

Michael De Luca *Jane Dawson*
Brion Energy *DMT Geosciences*

Summary

Shallow groundwater water sources are often deposited in quaternary sediments that are very complex in nature and challenging to map. Traditional mapping and exploration methods to delineate these features are often time consuming, costly, and provide uncertain results. Airborne electromagnetic (EM) techniques have proven effective in delineating these aquifers over extensive geographic areas in a very timely and cost effective manner.

Brion Energy Corporation (Brion), in collaboration with DMT Geosciences Ltd. (DMT), has employed these techniques to identify shallow groundwater sources near our assets. Once these sources have been located more traditional methods have been employed to verify and assess the aquifers. Some paleo-channels are often complex in shape and can pose additional challenges when drilling. For these circumstances, additional relatively low cost ground based EM methods (Time Domain Electromagnetics, or TDEM) can be applied to confirm a shallow aquifer drilling target to improve drilling and well testing success.

Introduction

Steam assisted processes for oil recovery are becoming more common. The water necessary to generate steam for these processes is on the order of 3 barrels of water for every barrel of oil. It is therefore important to identify groundwater supplies sufficient to meet these water needs. One very important source of groundwater is Quaternary aquifer systems . Since 1996, the Government of Alberta (GoA) has conducted studies of these aquifer systems in the Northern Athabasca Oil Sands area, (Andriashek, 2001; Andriashek and Atkinson, 2007). Further and more accurate delineation of the aquifer systems can benefit drill targeting and lower the over all cost of defining a water supply.

DMT Geosciences Ltd (DMT) approached Brion to use airborne and ground electromagnetics (EM) to map buried Quaternary deposits to detect potential groundwater sources. From 2008 to 2011, Brion and DMT conducted a series of surveys to map the Quaternary channels/deposits within Brion's Oilsands Area both refining and expanding the western limits of the GoA study area.

Theory and/or Method

Electromagnetic (EM) methods are a category of geophysical techniques that resolves electrical resistivity in the earth's subsurface. There are two general categories of EM surveys: frequency domain (FEM) and time domain(TEM). In general, FEM techniques map to a shallower depth than TEM surveys. Both techniques can be applied either as a ground survey or as an airborne survey. Airborne sureveys have the advantage of allowing large areas to be surveyed efficiently. Ground surveys, while more time consuming,

generally have a higher resolution due to the proximity of the transmitter to the ground surface. The success of the EM methods to delineate subsurface strata is dependent on the degree of contrast in the electrical properties of successive lithologies, target thickness and depth of occurance.

Coarse grained sediments, such as those composing aquifer formations, are generally expected to have higher electrical resistivity than those in the fine grained sediments of an aquitard. For this reason EM surveys, both in its airborne and ground form, are well suited for mapping aquifers.

Examples

In total eight airborne surveys were collected over the Brion leases. Data were processed using an inversion technique to better define depths to the top and bottom of the potential water-bearing zones and identify changes in resistivity along the paleo-channels. These resistivity changes are thought to be related to changes in grained size and saturation levels.

Data from these surveys were compiled to create the regional map shown in Figure 1. In this figure, pinks and reds highlight areas of higher resistivity and are therefore interpreted as coarser grained regions. Paleo-channels stand out clearly as high resistivity linear features.

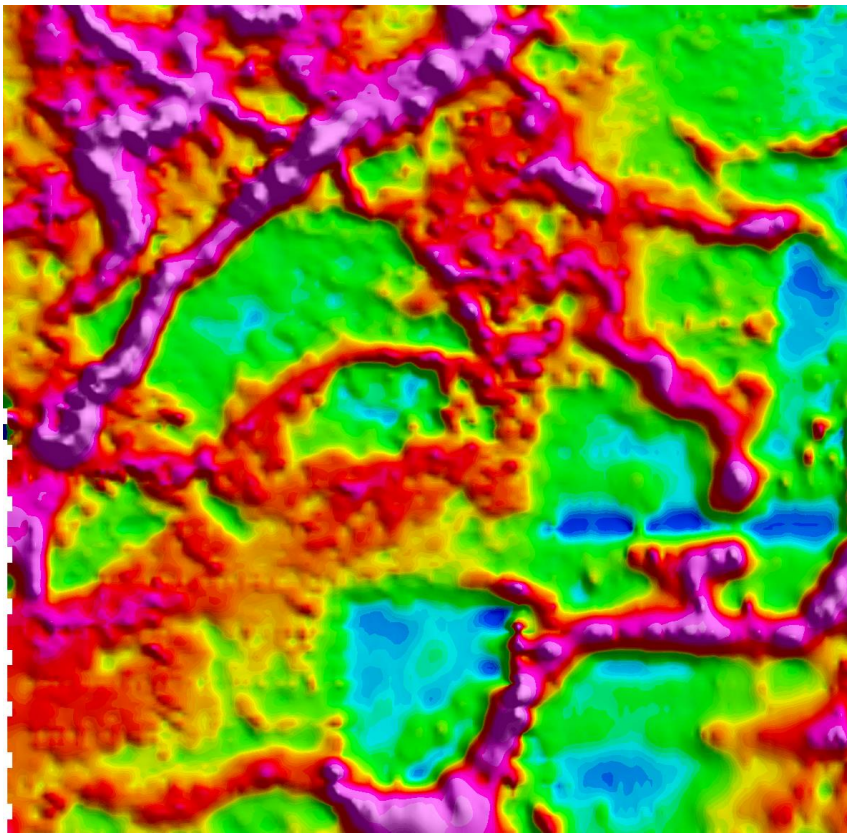

Figure 1 Compilation map of airborne electromagnetic surveys over the Brion leases

The processed airborne data was used to target drill holes and improve the success rate of the drilling program for identifying aquifer potential. In more complex channels, ground EM surveys were carried out to increase resolution and further the understanding of the channel structure.

Conclusions

The electromagnetic technique, both airborne and ground , has been valuable and successful for Quaternary groundwater source exploration. DMT Geosciences was able to provide Brion with multiple opportunities to expand the regional geologic understanding of the Brion oilsands asset area. Brion has applied innovative and low cost technologies that have proven invaluable to the water supplies for their operations .

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