# 3D Inversion of Time-Domain Electromagnetic Data for Ground Water Aquifers

## Introduction

Airborne time-domain electromagnetic (AEM) surveys have been shown to be an effective tool for ground water aquifer imaging. The data are difficult to invert in 3D because of the number of sources and the size and scales of the computational domain. To solve the 3D AEM inverse problem we partition the forward problem into multiple meshes. Each mesh spans the full computational domain but uses fine mesh cells around the selected transmitters and receivers. This mesh refinement methodology results in a forward modelling mesh that has far fewer cells than the full inversion mesh. Since the forward modelling operation is the bottleneck for AEM inversions, this procedure results in a highly parallel algorithm that can handle arbitrarily large datasets and can deal with many scales of detail in the data. The advanced 3D inversion capabilities of Computational Geosciences Inc. (CGI) are demonstrated on a SkyTEM field dataset from the Horn River Basin in British Columbia. From the Petrel Robertson Consulting Ltd. Phase II Report, Devonian shales

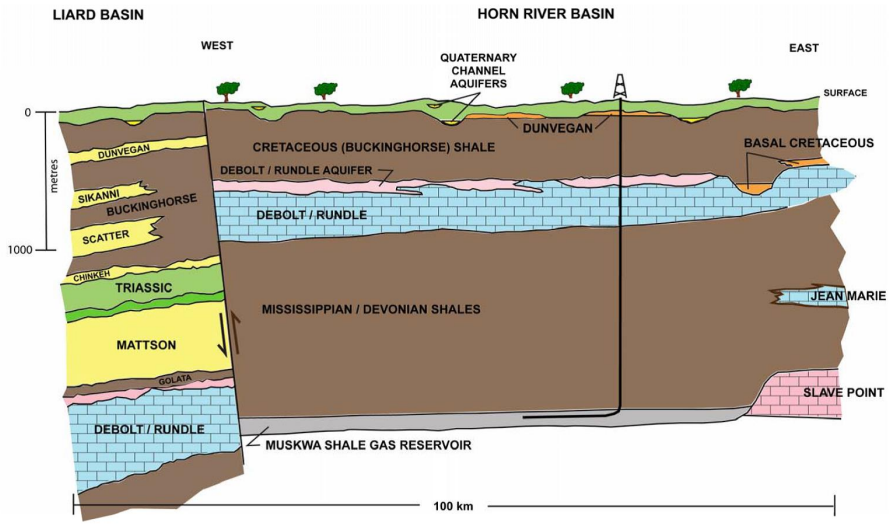


Figure 1: Stratigraphic cross-section of the Horn River Basin and adjacent Liard Basin (figure reproduced from (PRCL, 2010))

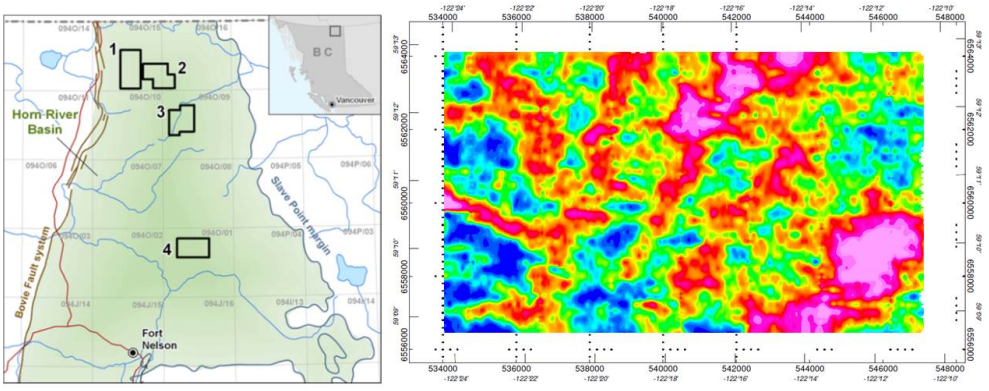


Figure 2: **Left) Location of the Horn River AEM blocks. Right) High Moment Z component time gate 12 response (1.79 ms) from the Imperial block.**

Tel: + 604 827 5777
2386 East Mall, Suite 112B
Vancouver British Columbia Canada V6T 1Z3

**Computational Geosciences Inc.**
www.compgeoinc.com

in the Horn River Basin in northeastern British Columbia host one of the largest shale gas plays in North America. The huge demand for both water sources and sinks has made the identification and characterization of subsurface aquifers a top priority for those looking to develop the shale gas resource in the Horn River Basin (PRCL, 2011). Figure 1 shows a stratigraphic cross-section of the Horn River Basin with the near surface quaternary channel aquifers. In October 2008, Geoscience BC started the Horn River Basin Aquifer Project with the goal of understanding the hydro-geologic conditions in the area, to investigate potential aquifers in the Horn River Basin, and to quantify and map reservoir capacity and productivity potential.

## Horn River Shale Gas Inversions

In 2011 the second phase of the project commenced with the goal of continuing the collection and integration of data from deep saline aquifers (PRCL, 2011), as well as examining the use of airborne electromagnetic data to map near-surface groundwater. In April 2011 SkyTEM completed AEM data acquisition over 4 blocks (Stone Mountain - Block 1, Quicksilver - Block 2, EOG - Block 3, Imperial - Block 4). In total over 2400 line-km of AEM and magnetics data were collected using 200 m line spacing. Figure 2 shows the location

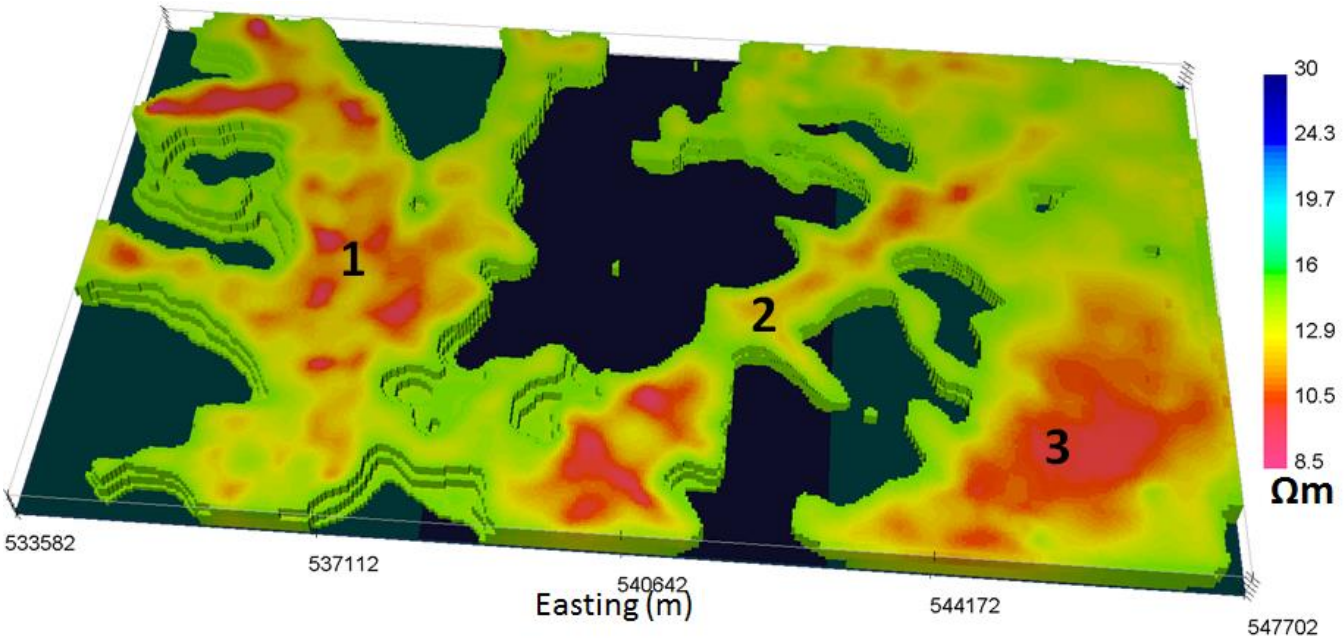


Figure 3: 3D Inversion of SkyTEM data from the Horn River Imperial Block at an elevation of 342 to 292 m above mean sea level (approximately 80 – 130 m below the surface). Regions 1 and 2 are potential quaternary channel aquifers and region 3 is likely the conductive Buckinghorse Shale unit.

of the Horn River Basin project and an example of the SkyTEM high moment Z component data. The data over the Imperial block were inverted in 3D, and Figure 3 shows the 3D resistivity model with a restive cutoff to only show the cells that are less resistive than 15 Ωm. Several interesting conductive features linked to groundwater aquifers are imaged. The inversion result identifies regions 1 and 2 as shown on Figure 3 as potential quaternary channel aquifers. Region 3 is interpreted as the conductive Buckinghorse Shale unit.

## References

Petrel Robertson Consulting Ltd, Horn River Basin Aquifer Characterization Geological Report, Prepared for Horn River Basin Producers Group Geoscience BC, January 2010

Petrel Robertson Consulting Ltd, Horn River Basin Aquifer Characterization Project Phase 2 Geological Report, Prepared for Horn River Basin Producers Group Geoscience BC, September 2011