SAGA-AEM 2013 EXTENDED ABSTRACT

EXTENDED ABSTRACT FOR: AEM

AUTHORS: RAYMOND CARON[1], CLAIRE SAMSON[1], MICHEL CHOUTEAU[2], MARTIN BATES[3]

AFFILIATION: [1] Carleton University, Ottawa, Canada

[2] École Polytechnique, Montréal, Canada

[3] Sander Geophysics Limited, Ottawa, Canada

CONTACT E-MAIL: RAYMOND_CARON@CARLETON.CA, CLAIRE_SAMSON@CARLETON.CA

DATE: APRIL 24, 2013

PRELIMINARY DESIGN PARAMETERS FOR A HTEM SYSTEM DEDICATED TO OVERBURDEN MAPPING

A helicopter-borne transient electromagnetic (HTEM) survey system is being designed with characteristics suitable to map glaciolacustrine overburden overlying Precambrian bedrock for the purpose of correcting airborne gravity measurements for lateral variations in overburden thickness. The HTEM system parameters such as transmitter power and waveform are optimized for overburden mapping, by using forward modelling and inversion. This paper will discuss some inversion results that test the capability of the system at resolving the thickness of an overburden under multi-layer geological scenarios.

Introduction

Large areas of the Precambrian shield in Canada, such as in the Abitibi mining region, are covered with a thick glaciolacustrine overburden. This overburden complicates mineral exploration efforts by masking the bedrock surface and increasing the cost of exploration through expensive drilling programs. It also reduces the resolution of potential-field exploration methods by obscuring changes in bedrock topography that are known to change independently from the topography at surface. With respect to the gravity method, changes in bedrock topography can also create anomalies of the same size and magnitude of, and be mistaken for, mineral deposits (Chen and Macnae 1997).

HTEM System Parameters

In this paper, we suggest design parameters for a HTEM system specifically dedicated to overburden mapping with the goal of using the recorded data to correct airborne gravity data for lateral variations in overburden thickness. The proposed HTEM system is a single-turn in-loop system where the transmitter and receiver are in the same plane but offset by 7m. The 7m-radius circular transmitter is energized by a square waveform with a 100 A current running at a maximum duty time duration of 0.5 ms. The transmitter moment is 15,400 A/m^2.

HTEM Modelling and Inversion

The system parameters were optimized through forward modelling and inversions that were conducted using AirBeo of the P223F EM open source code suite developed by the Commonwealth Scientific and Industrial Research Organization (CSIRO). AirBeo calculates the forward EM response for 1D layered earth models and inverts survey data in terms of n layers (Chen and Raiche 1998).

The parameters were tested using geological scenarios based on the geology prevalent throughout the Abitibi mining region. Previous electromagnetic surveys in this area identified 3 classes of glaciolacustrine sediments above the bedrock. These units of clay, sand, and till have an average resistivity of 47.3 ± 6.7 Ω•m, 251 ± 70 Ω•m, and 123 ± 35 Ω•m respectively (Palacky 1992). The bedrock was assigned a resistivity of 10,000 Ω•m.

Forward modelling of the EM response of the proposed system of various 2-layer, 3-layer and 4-layer geological scenarios were conducted and then inverted in order to determine the capabilities and limitations of the HTEM system. Noise was added to the response of the forward model following the process outlined in Auken et al. 2008 in order to simulate field conditions. The inversion methodology takes advantage of the highly resistive character of the bedrock and the typical location of clay above till within the sedimentary sequence. The methodology first assumes a 2-layer case which returns an estimate of the resistivity and thickness of the 1st layer. This information, in turn, is used to constrain the 3-layer and 4-layer inversions. For these simple cases, the system was able to resolve the overall thickness of the overburden within 10%.

EM responses of geological scenarios composed of 5 to 8 layers with intercalations of clay, sand and till were inverted, with noise, with the same methodology. For these more complex cases, the tests showed that multiple layers are better resolved when using a similar number of layers in the inversion as in the geological model. However most important is that for any case of layering, the overburden thickness is resolved within 10% of its true value and the difference between the inverted depth and the true depth is randomly distributed.

Concluding remarks

This preliminary study indicates that the proposed HTEM system is likely to be able to resolve the overall thickness of a glaciolacustrine overburden overlying resistive Precambrian bedrock. Resolving individual layers within the sedimentary sequence is a much more challenging problem that will be addressed in the near future by performing 2D inversions.

Cited Literature

Auken, E., Christiansen, A.V., Jacobsen, L.H., and Sorensen, K.I., 2008, A resolution study of buried valleys using laterally constrained inversion of TEM Data: Journal of Applied Geophysics, 65, 10-20.

Chen, J. and Macnae, J.C., 1997, Terrain corrections are critical for airborne gravity gradiometer data: Exploration Geophysics, 28, 21-25.

Chen, J. and Raiche, A., 1998, Inverting AEM data using a damped eigenparameter method: Exploration Geophysics, 29, 128-132.

Palacky, G.J., 1992, Inversion of horizontal-loop electromagnetic field data: Case histories from Ontario and Northwest Territories, Canada: SEG Technical Program Expanded Abstracts 1992, 457-460.