Tli Kwi Cho kimberlites

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Abstract

A VTEM survey was flown over the Tli Kwi Cho kimberlite complex in 2004. The voltage data turns negative over the two kimberlitic targets (DO-18 and DO-27). The data have been transferred to Aarhus Geophysics in order to be inverted using the Cole-Cole model. The inversion of the data allowed recovery of chargeable and conductive material, which coincides with the pyroclastic and partially volcaniclastic facies of the DO-27 kimberlite.

Introduction

Tli Kwi Cho is a kimberlite complex, located within the Lac de Gras kimberlite field. The complex consists of two kimberlitic bodies (DO-18 and DO-27). The pipes are situated approximately 350 km northeast of Yellowknife, NWT, Canada. One of the pipes (DO-27) is situated predominantly underneath lake waters (Figure 1).

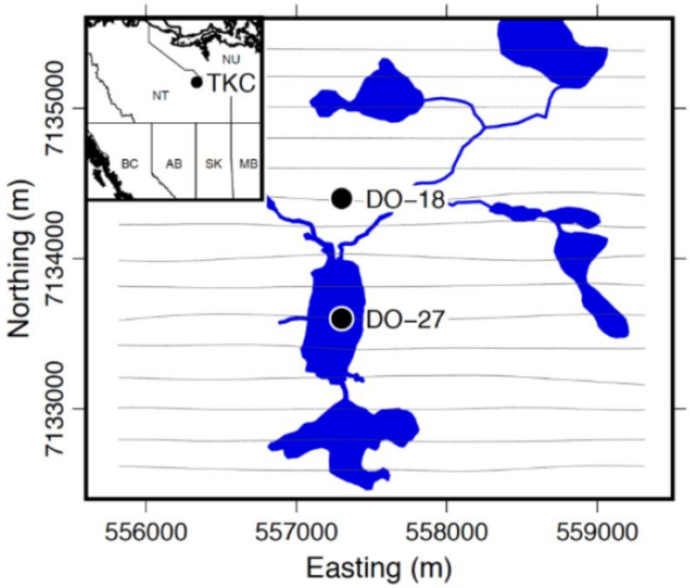

Figure 1. *Location of Tli Kwi Cho kimberlite complex (adapted from Oldenburg and Kang, 2016).*

The kimberlitic complex is hosted within the granites, granodiorites and gneisses of Yellowknife supergroup (Kjarsgaard et al., 2002). Figure 2 shows schematic geological cross-section with different facies of kimberlite marked as following: PK: green pyroclastic facies; VK: black volcaniclastic facies and HK: grey hypabyssal facies. The structure of kimberlite pipe DO-27 is shown in Figure 3.

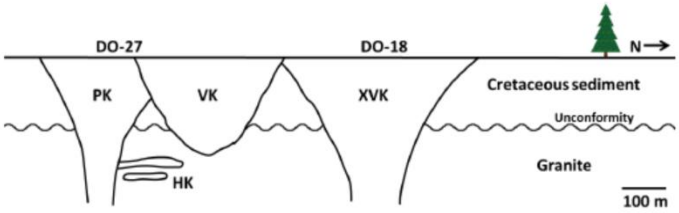

Figure 2. *Schematic geological cross-section drawn in N –S direction across the two kimberlite pipes of Tli Kwi Cho complex (adapted from Devriese et al., 2014).*

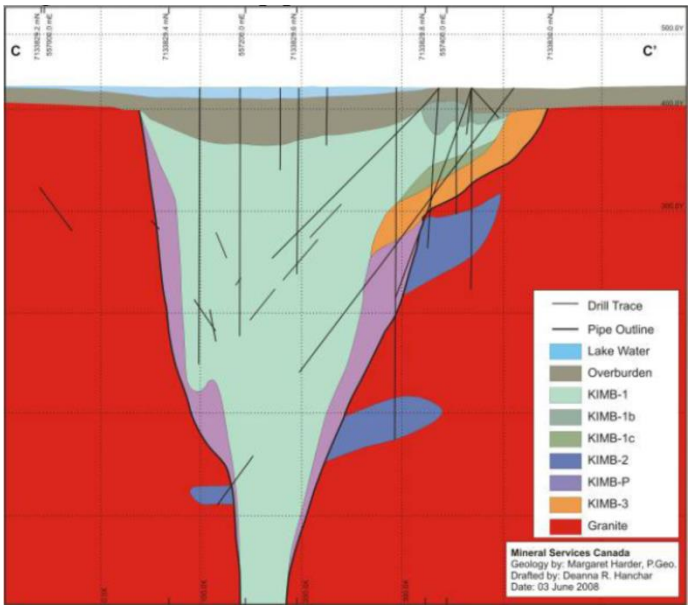

Figure 3. *Structure of DO-27 kimberlite pipe. (adapted from Harder et al., 2008).*

In Figure 3, the diversity of kimberlitic facies is greater, than in Figure 2. In particular, the pyroclastic facies (PK) has been substratified into three units (KIMB-1, KIMB-1b and KIMB-1c); the volcanoclastic facies (VK) has been substratified into two units (KIMB-P and KIMB-3), while KIMB-2 represents intrusive coherent sheets, a unit not present in Figure 2.

Multiple geophysical surveys have been conducted over the prospect since early 90's, including a VTEM survey, which was flown in 2004. Some of the recorded voltage values over the kimberlites are negative, which indicates presence of chargeable material. This is referred to as airborne IP effect (AIP effect) and has been previously described in the literature (Smith and Klein, 1996). Such effects have been recorded over other kimberlites in ground TDEM data (Kamenetsky et al., 2014) and in airborne data (Viezzoli and Kaminski, 2016; Viezzoli et al., 2017).

Measured VTEM data over the DO-18 and DO-27 are shown in Figure 4. In cases with strong negative voltage response, Cole-Cole modelling (Cole and Cole, 1942) can be used to account for IP effects in the data. In this figure dB/dt profiles measured over fight lines 50 (over DO-18) and 150 (over DO-27) are shown. As it can be seen, transients recorded over DO-18 are mainly negative, while transients recorded over DO-27 show both positive and negative voltages.

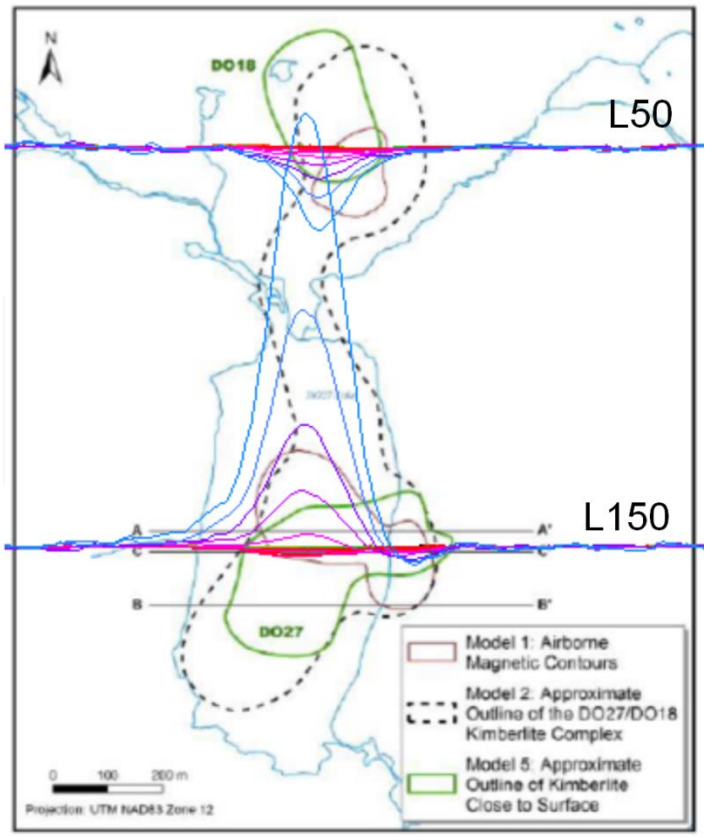

Figure 4. *Recorder VTEM voltages over line 50 (DO-18) and line 150 (DO-27).*

SCI inversion in IP mode

In 2016, the VTEM data set flown over the Tli Kwi Cho complex was transferred to Aarhus Geophysics. The data were inverted using Spatially Constrained Inversion approach (SCI, Viezzoli et al., 2008), modified as per Fiandaca et al. (2012) in order to accommodate Cole-Cole modelling. The results of the inversion were incorporated in Geoscene 3D (Figures 5 and 6).

In Figure 5 an interpolated resistivity section is shown over DO-27 kimberlite, while the recovered chargeability is shown in Figure 6. It should be however mentioned, that the depth of investigation (DOI) is different for these parameters and therefore the interpreted depth of chargeability distribution is smaller.

Recovered physical properties were further used to construct shells set to 200 Ohm m for resistivity (Figure 7) and to 120 mV/V for chargeability (Figure 8).

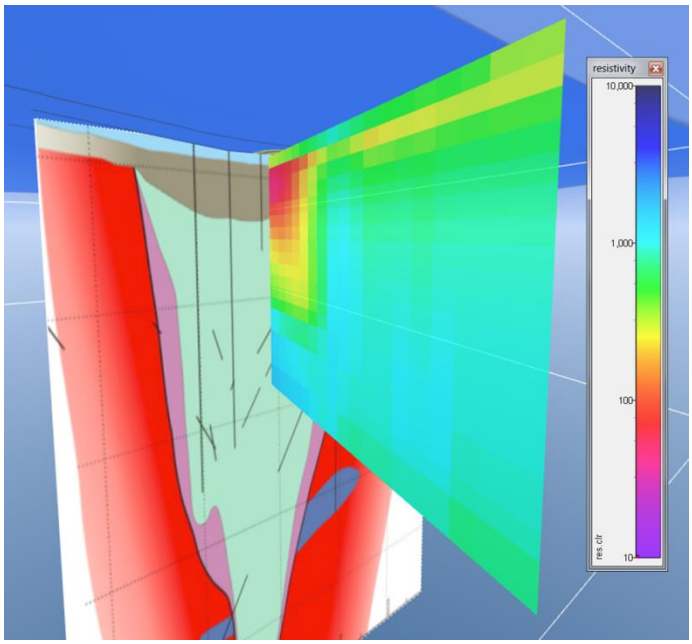

Figure 5. *Interpolated electrical resistivity recovered from IP-mode SCI inversion of VTEM data flown over DO-27 kimberlite.*

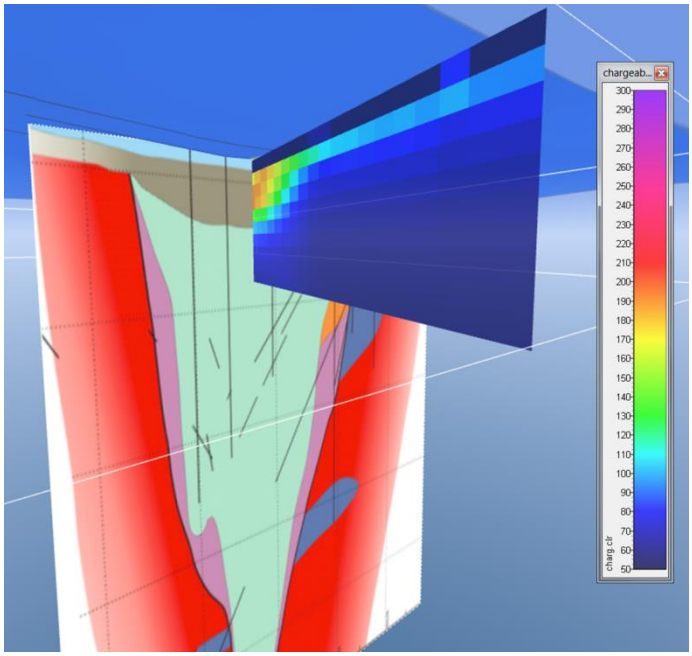

Figure 6. *Interpolated chargeability recovered from IP-mode SCI inversion of VTEM data flown over DO-27 kimberlite.*

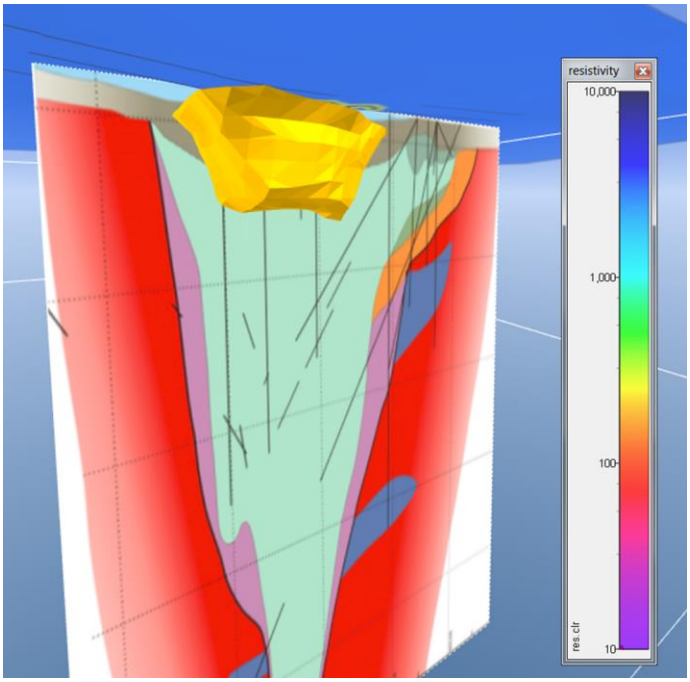

Figure 7. *Shell constructed around 200 Ohm m resistivity values, recovered from the SCI inversion.*

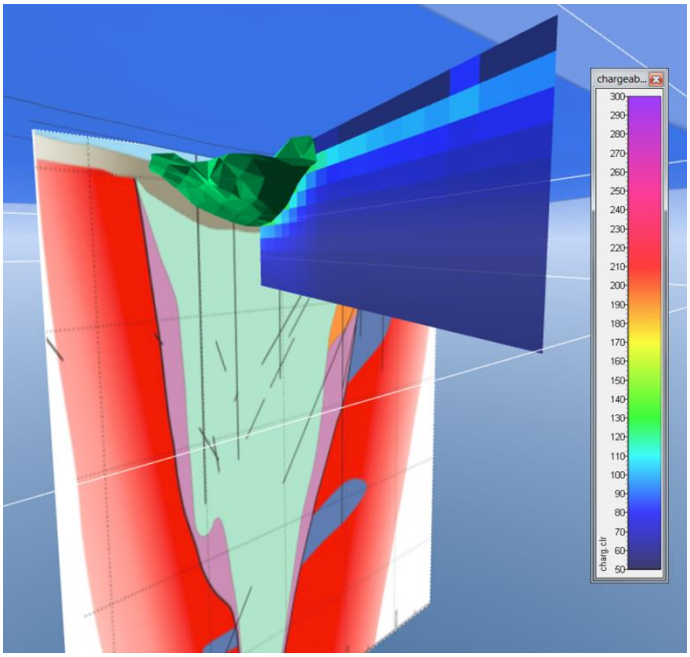

Figure 8. *Shell constructed around 120 Ohm m chargeability values, recovered from the SCI inversion.*

Conclusions

Analyzing the inversion results it becomes conclusive that the SCI inversion is imaging the upper part of kimberlite and the clay-rich overburden as electrically conductive (< 200 Ohm m), while the chargeable material is limited to the clay-rich overburden. The conductive upper part of the kimberlite may be such due to high degree of fractures. Overall the inversion was successful in modelling the VTEM data with IP effect and recovering the Cole-Cole parameters from the data.

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