GEOTECH
AIRBORNE GEOPHYSICAL SURVEYS

VTEM Case Study – Comparison with SkyTEM: The Greenland Project

Introduction

This case-study concerns a direct survey comparison between the VTEM and SkyTEM helicopter EM systems over the Maniitsoq region's Greenland Norite Belt (GNB), in western Greenland.

The Maniitsoq area is underlain predominantly by highly deformed and metamorphosed Archean gneisses. Supracrustal rocks comprise about 10% of the area and consist mainly of amphibolite (metamorphosed and deformed volcano-sedimentary sequences). Most of the nickel discovered to date is associated with younger, undeformed norite intrusions that are concentrated in (but not restricted to) a 15 km wide by 75 km long "J"-shaped belt, referred to as the Greenland Norite Belt (GNB), which rims a large, complex known as the Finnefjeld Gneiss Complex.

In 1995 Cominco Ltd, in conjunction with the Geological Survey of Denmark and Greenland (GEUS), flew a large portion of the GNB with the **GeoTEM fixed wing**, airborne EM system. Relatively few EM anomalies were detected. Helicopter EM surveying of the GNB by **SkyTEM** Surveys ApS of Denmark took place in mid-September to early October of 2011. Later, a **VTEM** survey (Geotech Ltd.), covering some parts of the SkyTEM block, was completed in June, 2012.

The results showed that the VTEM system, by comparison, detected many more highly conductive targets than did SkyTEM, as shown in Figure 1, due to VTEM's low noise levels, high dipole moment, optimized waveform, broad bandwidth and significant depth of investigation. The tests also showed that, in contrast to SkyTEM, VTEM data provided more reliable information about weak and shallow conductors.

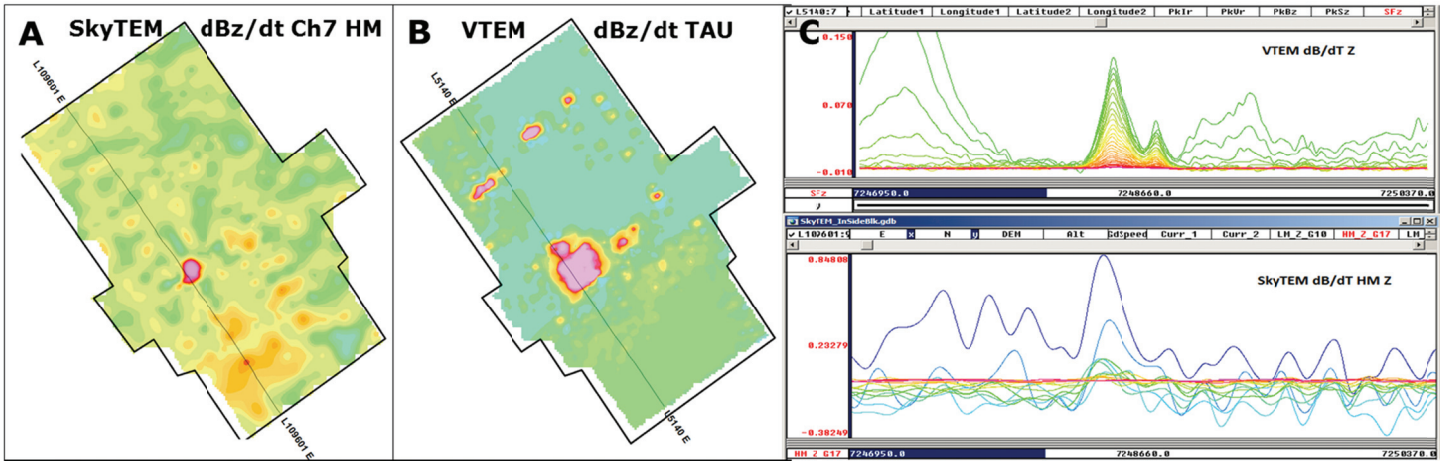

Figure 1: A) SkyTEM helicopter EM system vertical secondary field plan view results (dBz/dt ch7 high-moment) over bedrock targets from part of GNB survey area; B) corresponding VTEM system vertical component of EM field time-constant over same area; C) dBz/dt multi-channel EM decay profiles for VTEM & SkyTEM system over a coincicent line shown in Figure 1A & 1B (courtesy North American Nickel Inc.).

The reliability of the early time EM response can be checked over some shallow conductive sediments. An area of GNB with lake-bottom sediments has been chosen for such a comparison. As shown in Figure 2 and Figure 3, below, the VTEM early times are more reliable, stable and repeatable between time gates, as well as corresponding perfectly to the lakes – unlike SkyTEM in most cases.

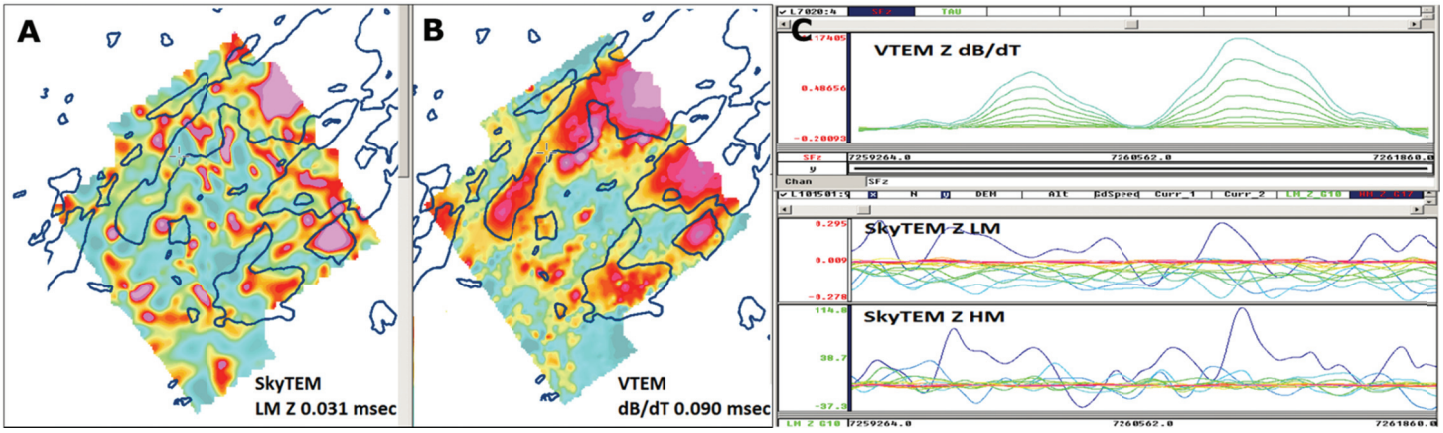

Figure 2: A) SkyTEM helicopter EM system vertical secondary field plan view results (dBz/dt 0.031msec low-moment) over GNB region showing outline of lakes; B) corresponding VTEM system early channel vertical component dBz/dt data over same area as Fig. A; C) dBz/dt multi-channel EM decay profiles for VTEM & SkyTEM system over a coincident line from Figure 2A & 2B (courtesy North American Nickel Inc.).

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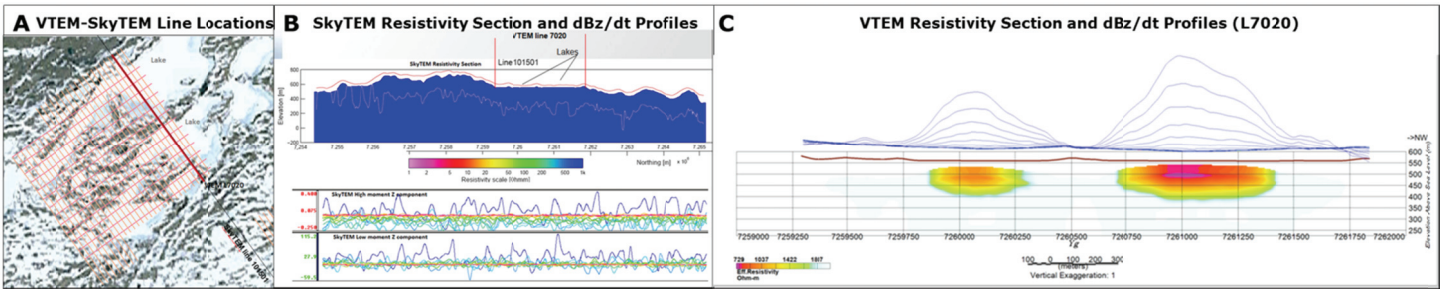

Figure 3: A) SkyTEM survey grid and location of coincident VTEM survey line (L7020); B) SkyTEM resistivity section (above) and corresponding high moment and low moment dBz/dt profiles (below) over line-segment overlapping VTEM survey ; C) VTEM dBz/dt multi-channel EM decay profiles and RDI resistivity section for SkyTEM line overlap (courtesy North American Nickel Inc.).

VTEM-SkyTEM Noise-Level Comparison

A highly resistive part of a line was chosen for the noise comparison between the VTEM and SkyTEM systems, shown using the same scales (units converted to pV/(A*m^4). The differences are clearly obvious, with the SkyTEM being 20-25 times noisier in late-times and 18-20 times noisier in early times, as compared to VTEM, as shown in Figure 4, below:

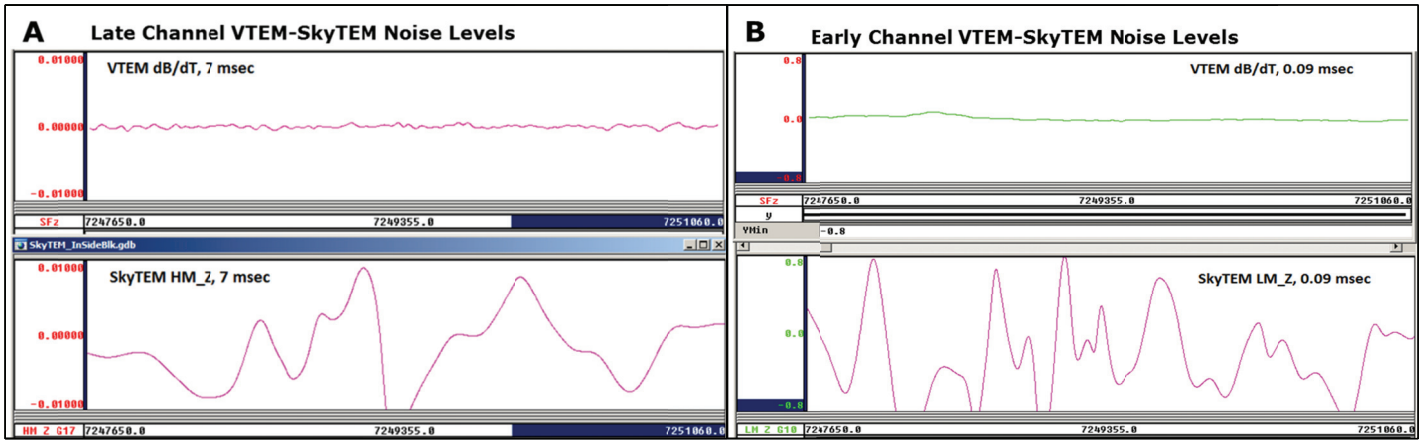

Figure 4 - VTEM-SkyTEM noise level comparison over resistive bedrock region at GNB: A) late-channel dBz/dt profile at 7msec for VTEM vs. SkyTEM high moment channel, shown at identical vertical scale, and B) early-channel at 0.09msec for VTEM vs. SkyTEM low-moment channel data.

Conclusion

The current direct survey comparison in the GNB area of Greenland has highlighted the following differences between the VTEM and SkyTEM systems:

1) The estimated depth of investigation (DOI) of the VTEM system exceeds the SkyTEM DOI by a factor of 4-5 times. The SkyTEM system is not able to detect highly conductive targets below depths of 100-150 metres.
2) The VTEM system's resistivity resolution, conductivity range and sensitivity are much higher in comparison with SkyTEM.
3) VTEM system provides reliable responses from weak and shallow conductors whereas SkyTEM system is not sensitive to this class of conductors.
4) SkyTEM late time noise is greater than VTEM late time noise by a factor of 20-25 times.
5) SkyTEM early time noise is greater than VTEM early time noise by a factor of 18-20 times.
6) Over the same 140 sq. km area, as many as 25-28 targets, sufficiently reliable for modeling, were obtained from the VTEM data.
7) In marked contrast, only 7-8 targets were obtained from SkyTEM data, including 3-4 that were only conditionally appropriate for modeling.