

VMS and Ni-Cu exploration using an integrated geophysical and drilling method

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BIOGRAPHY

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SUMMARY

This case study illustrates the use of an exploration method that leverages modern exploration techniques for deep-seated VMS and Ni-Cu deposits in a 978 km² survey area in the highly prospective Areachap Belt, South Africa.

The exploration method comprises the use of a high power helicopter TEM (“HTEM”) system, a large fixed loop TEM (“FLTEM”) ground system and drilling that are employed in a staged process to keep down risks and costs and more importantly to optimize the chances of discovering viable economic mineral resources.

Based on the HTEM survey 19 high priority VMS targets were detected for ground follow up with FLTEM. The FLTEM data confirmed all of these targets, and 2D plate modelling refined the parameter for optimal drilling of the targets. The first result of the drilling campaign led to the discovery of a significant Ni-Cu deposit.

The prospect of this case study is that the employed method may be useful for certain types of mineral exploration. Provided that the electrical conductivity contrast between the mineralisation and the host rock is sufficient then the use of HTEM and FLTEM is a viable choice. The staged exploration process ensures that potential resources are detected and that risks and costs at each step are kept down.

Key words: helicopter TEM, fixed loop TEM, mineral exploration

INTRODUCTION

In late 2017, the Australian and South African listed minerals explorer Orion Minerals (“Orion”) launched a broader regional program to explore for economically viable volcanogenic massive sulphide (“VMS”) and Ni-Cu deposits on their licenses in the Areachap Belt, Northern Cape, South Africa. For Orion, time, risks and costs were of the essence, so they wanted to take advantage of recent advances in mineral exploration techniques.

This case study describes the exploration method employed by Orion and the results that were achieved.

The exploration method leverages modern techniques within airborne EM and ground geophysics and comprises a staged process: (1) pre-modelling of selected well-known deposits for choosing the appropriate helicopter TEM (“HTEM”) system, (2) execution of a HTEM survey over the entire survey block using a high power system with a large depth of investigation (“DOI”) capability, (3) modelling of anomalies identified in the HTEM survey, (4) ground follow up on identified anomalies using a large fixed loop TEM system (“FLTEM”), and (5) drilling of anomalies/targets with ground confirmation of the HTEM anomalies. Each step of the process is designed to further improve the certainty of the presence of economically viable mineral deposits before moving to the next step.

The survey area is located in the highly prospective Areachap Belt of South Africa (see figure 1).



Figure 1: Location of the Areachap Belt (red star)

Zn- and Cu-rich VMS occurrences are present throughout the Areachap Belt and occur as stratiform/stratabound lenses of variable size in a host of gneisses, amphibolites, and schists (Baillie et al. 2010).

The Areachap Belt is also characterised by the occurrences of Ni-Cu magmatic deposits. Several of these are well-known, for example Jacomynspan, which is a Ni-Cu-PGE intrusion verified down to a depth of more than 500 metres.

The survey area (see figure 2) of around 962 km² was covered with HTEM using a line spacing of 200 m, and in total 6,018 line km (Orion Minerals, 2018a) were flown in only 22 production days. From this survey, 19 high priority VMS targets (“targets”) were identified for ground follow up (Orion Minerals 2018b). Additionally, some well-known mineral occurrences, for example Jacomynspan and Rok Optel, were overflown for quality assurance of the HTEM’s performance and the outcome was satisfactory and confirmed the system’s high DOI.

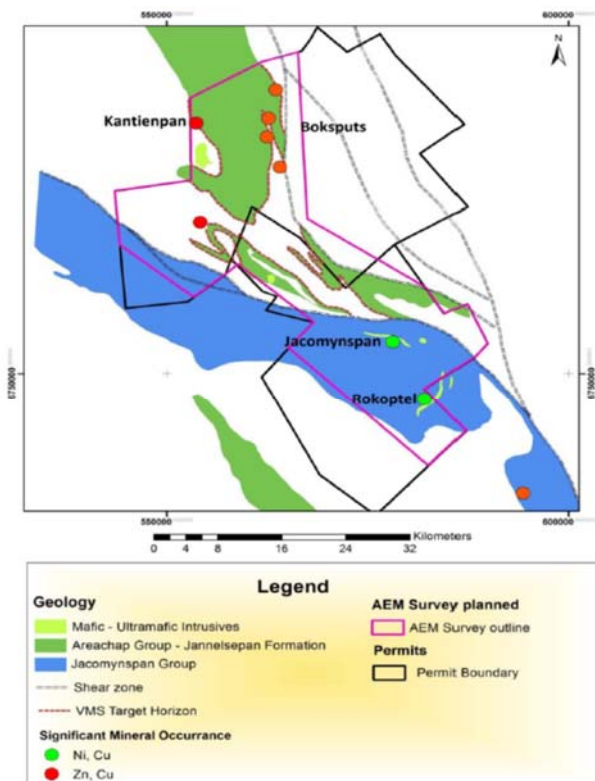


Figure 2: The Survey area (AEM Survey outline). Known mineral deposits are shown with green and red dots.

All 19 targets were modelled, and FLTEM soundings over these anomalies were performed along profile lines guided by the results from the HTEM data. Subsequently, FLTEM data was modelled to inform the drilling of the targets predicated on the results of geophysical investigations.

Within a short time-span and at substantially lowered risk and cost, Orion was able to design a drilling campaign guided by solid data on the location of targets and firm parameters for how to drill them most effectively. At the time of writing, the drilling campaign is still ongoing and few results have come through (conclusive results are expected to be available at the time of the AEGC 2019).

METHOD AND RESULTS

The principal idea behind the method is to employ a HTEM system to cover the entire survey block with sufficient density to ensure that all significant anomalies are detected.

Because new deposits were expected to be deep-seated like many of the previously identified, the HTEM system had to offer a significant DOI. SkyTEM312 HP described below was identified as a suitable candidate and modelling was carried out to confirm this assumption. The modelling was performed as both 1D-modelling (Aarhus Workbench), and 2D plate modelling (EMIT's Maxwell) predicated on SkyTEM312 HP system specifications and noise levels.

SkyTEM312 HP is a relatively new HTEM system and is optimized for deep mineral exploration. It has a peak dipole-moment of 1,000,000 Am² and a receiver coil suspension system with an exceptionally low noise level. In combination, these features offer a signal-to-noise ratio that enables operation with a 12.5 Hz base frequency (50 Hz power grid). With a pulse width of 8 ms, the 12.5 Hz base frequency affords 32 ms off-time data (see figure. 3) and a significantly improved

characterisation of conductors in comparison with the modest 15 ms off-time data enabled by the standard 25 Hz systems. This system is built on a lightweight 340 m² frame and is engineered for fuel-saving and high manoeuvrability in even rough terrain.

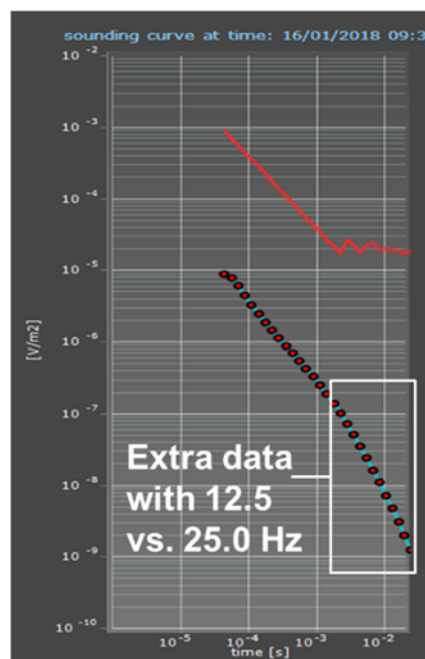


Figure 3: 32 ms off-time HTEM decay curve (red dots) over a discrete conductor. The figure shows the additional time gates obtained with the 12.5 Hz compared to the 25.0 Hz base frequency.

The high-resolution HTEM survey (“SkyTEM survey”) was performed at a modest 80 km/h, and 19 targets were identified for follow up (see figure. 4).

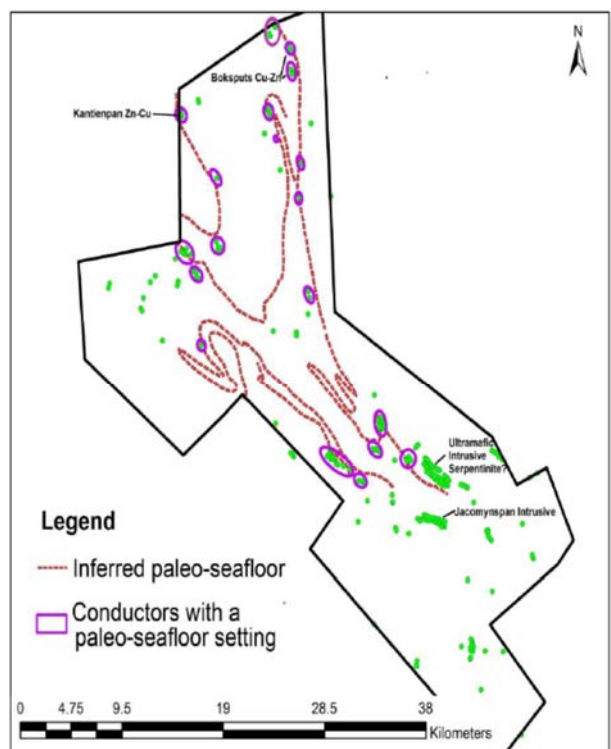


Figure 4: 19 high priority VMS targets (purple circles) identified in the SkyTEM survey. The green spots show identified anomalies.

The high priority anomalies identified in the SkyTEM survey were subsequently 2D plate modelled to furnish the parameters for conducting the follow up on the targets with FLTEM.

The use of the FLTEM system has several advantages. Firstly, an extremely high dipole-moment of up to 76,500,000 Am² is generated employing a peak current of 120A and large TEM loops of 600x800 m or 750x850 m. Secondly, the noise level can be efficiently suppressed by acquiring an appropriate stack size of TEM decays at each sounding location. Thirdly, a 1.0 Hz base frequency affords very long off-time data of up to 250 ms to be measured. In combination the high dipole moment, the low noise level and the 250 ms off-time data offer considerable DOI and characterisation of targets of more than 750 m in depth.

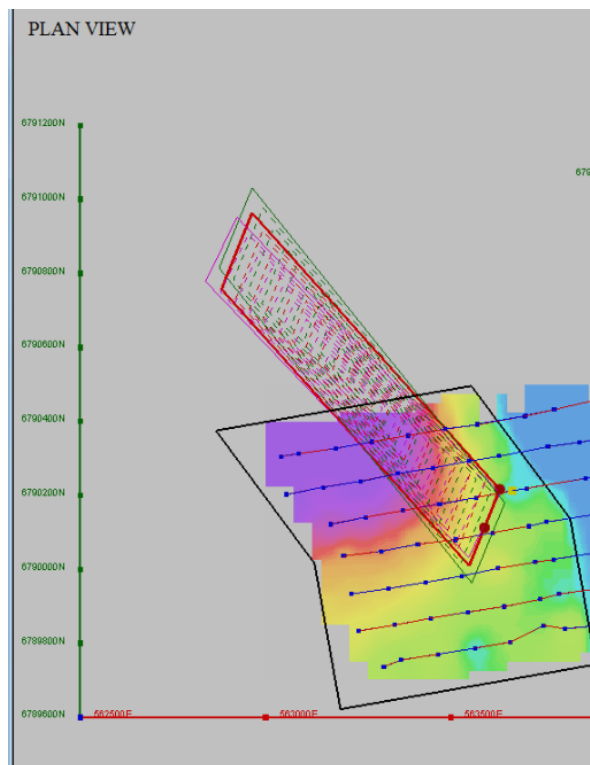


Figure 5: Modelled plates (with dashed lines) based on FLTEM data. Blue dots show FLTEM sounding locations spaced with 50-100 m and profile lines with 100-150 m.

The FLTEM soundings for each target were carried out utilising an optimal coupled loop along profile lines with orientations guided by the modelling of SkyTEM data (see figure. 5). Consistently, the FLTEM soundings confirmed the targets identified in the SkyTEM survey.

The acquired FLTEM data was subsequently 2D plate modelled to obtain a reliable characterisation of the target (figure 3 and 4). This type of modelling, in comparison with the modelling of HTEM data, will often provide improved parameters for drilling targets. The reasons are (1) that FLTEM has a superior DOI compared to HTEM, (2) the profile lines can, based on the SkyTEM survey results, be oriented in such a way to provide the optimum coupling with the target, and (3) the line spacing is kept closer than what for exploration budget considerations are feasible for the SkyTEM survey.

As figure 5 indicates, the plate parameters are reasonably consistent for the different profile lines, which was a general observation that also applies to other modelled targets.

The FLTEM data sets constituted a reliable basis for prioritizing drill targets and setting up a drilling program. One of the first results coming through from Orion's drilling program is intersections of Ni-Cu mineralizations at Rok Optel (Orion Minerals 2018c).

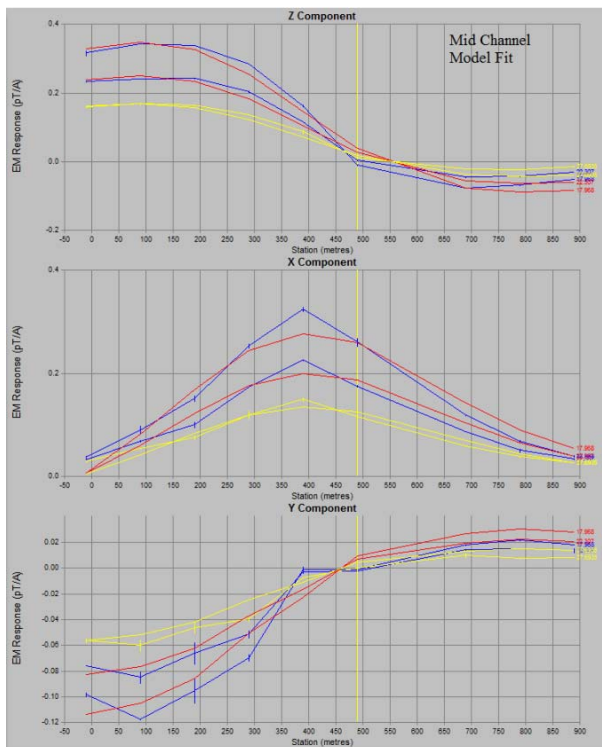


Figure 6: 2D plate modelling results for each of the 7 profile lines shown in figure 3. Each curve represents a mid-channel gate along one profile line.

Drillings OROD001 and OROD002 confirmed the SkyTEM anomalies and FLTEM conductors and detected significant Ni-Cu mineralizations. Figure 7 shows the geochemical results from four intersections from OROD001.

Drill Hole	Cut Off	From m	Width m	Ni Tenor wt%	Cu Tenor wt%
OROD001	0.2% Ni	201.05	8.99	3.80	2.58
OROD001	0.2% Ni	292.09	7.29	9.29	3.65
OROD001	0.3% Ni	297.44	1.94	10.22	3.86
OROD001	0.5% Ni	201.05	1.22	2.90	3.66

Figure 7: Drilling results from 4 intersections from drill hole OROD001.

CONCLUSIONS

Orion carried out an integrated helicopter TEM and large fixed loop ground TEM exploration program to optimize and fast track the chances of finding VMS and Ni-CuS deposits of economic value and providing the optimal parameters for drilling of identified targets. The program was performed employing modern techniques comprising the SkyTEM312 HP system and a FLTEM system and both proved to be time and cost efficient. Within 6 months from the start of the program, 19 high primary VMS and Ni-CuS targets were identified, and a comprehensive drilling program was drawn up for follow up.

This case study suggests that provided the mineral deposits of interests have a sufficient conductivity contrast to the host rock, this staged method can be highly cost-efficient, and it also

optimizes the chances of a successful outcome both in terms of discoveries and lowering of the risks and costs.

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