Deep-probing time-domain electromagnetic helicopter-based system (HTEM)

Per Gisselø (SkyTEM Surveys)

Can you tell us about yourself and your company?

SkyTEM Surveys ApS (SkyTEM) was established in 2004 as a spin-off company from the University of Aarhus, Denmark. The company was established with the purpose of commercializing the helicopter-borne electromagnetic system developed for mapping the groundwater resources and their protection. Since the beginning SkyTEM has maintained a close collaboration with partners in the academic world. SkyTEM has continued the development of the airborne electromagnetic system and has entered the world of mineral exploration. Over the years SkyTEM has collected more than 1,000,000 km of airborne data on all seven continents of the world.

I joined SkyTEM in 2007 with a background in geology. I started out as a field operator of the SkyTEM system and went on to work on data processing, interpretation and project management. Since 2012 I have been head of operations overseeing all the SkyTEM operations around the world.

What is the main task of SkyTEM within the Smart Exploration project?

SkyTEM was happy to join the Smart Exploration project. Most of our involvement with academia had been within the hydrogeophysical community. We did see this project to improve our interaction with the mineral exploration community in Europe. The purpose of the developments made on the SkyTEM system was to enhance the depth of penetration of the airborne EM system. In addition, I have been a member of the executive board and the leader of work package 2 that is concerned with the development of the prototypes within Smart Exploration. The development work started at the onset of the Smart Exploration project. The first version of the prototype was ready for validation 18 months into the project.

What is the main drive behind this development work?

With the vast majority of near surface deposits having being discovered there is a need to explore deeper. To improve the SkyTEM systems’ ability to look deeper has been the main motive.

Can you please tell us more about this new HTEM system?

Within the Smart Exploration project SkyTEM has focused on the development of their airborne EM systems to increase their maximum depth of investigation. In order to bring the developments to the market within a short timeframe they have been implemented on the SkyTEM312HP platform. The high power TEM transmitter delivers a maximum current of 250 Ampere in each transmitter turn. The 12 turns mounted on the SkyTEM300-series compact frame, with an area of 342 m², deliver a combined magnetic dipole moment of approximately 1,000,000 Am².

Developments on the transmitter side have focused on lowering the operational base frequency to 6.25 Hz. This has two benefits. Firstly, the on-time duration can be increased which results in a higher signal response from the ground, especially at late times. Secondly, it allows for later off-time measurements to be recorded (~60 ms) which typically relate to even deeper features in the ground. A new design of the receiver coil suspension system has been implemented, which reduces the effect of the motion induced noise at the base frequency of 6.25 Hz and thereby allows for a good signal-to-noise ratio.

Has the HTEM prototype made a distinct difference for the industry vs current systems?

The ability to operate the SkyTEM system at 6.25 Hz is a unique operating capability.

The validation survey with the SkyTEM system operating at 6.25 Hz base frequency was flown in June 2019 at the Blötberget Mine Site, Ludvika, Sweden.
Due to lack of design specifications from the supplier of the components, it has been necessary to make these tests on our own. One of the results of the bench tests did emphasize the need of a more efficient cooling system for the transmitter. The updated cooling system has been designed and produced to overcome this challenge.

Are there any environmental or safety risks of this system?

One of the major benefits with airborne surveys is that they are non-invasive and do not impact on the local environment. The methodology works in the same way as an MRI-scanner in hospitals. The strength of the electromagnetic field is well below the public health recommendation and in the same range as that of an electrified train.

Can you please elaborate on the collaboration in this work?

SkyTEM has solely developed this new HTEM system, but it has being tested at the mine sites of the project partners. The possibility to validate the prototype on a dedicated validation site with a large amount of background information has been very important in order to complete the prototype development.

What are your future plans with this prototype?

With the addition of this new capability of the SkyTEM system we expect to raise our market share for the mineral exploration industry. After the validation survey in Sweden we have flown two commercial surveys in the same region for both public and private clients. The prototype is being marketed through our sales team, that already has a large network in the worldwide mineral exploration industry. SkyTEM is a geophysical service provider and we are ready to sell surveys with the new system, while the system itself is not for sale.

Blötberget Mine Site (Figure 1) of project partner Nordic Iron Ore in Sweden. Figure 2 shows the gate plots of the Z-component plotted along the flight lines overlain with the decay curve above the peak anomaly. The anomaly has a clear signal well above the noise signal all the way to the latest gate time at 60 ms only obtained through the 6.25 base frequency operation.

After the successful Blötberget test flights, adjustments were made and the prototype has also flown on one of the INFACT (another EU funded project) test sites. The system will be further validated at two of the Smart Exploration validation sites in Greece (brownfield) and Kosovo (greenfield) with the support of local project partners by the end of the year.

What difference can this system bring and to which industries?

The possibility of operating the SkyTEM system at 6.25 Hz brings two advantages to deep-seated mineral exploration. Firstly, there will be an ability to explore deeper than previously possible with airborne EM systems. Secondly the resolution of partially known deep-seated exploration targets can be enhanced.

Moreover, all industries that use the difference in the resistivity of the geological materials will have the potential to use the system. In addition to the mining industry, the industries with the need for deep exploration such as the oil and gas and geothermal industries can benefit from this system besides mapping of host rocks for CO₂ storage, and deep seated groundwater resources.

What has been the main challenge for this development work?

A Bench Test has been developed to provide both a platform to test the firmware and hardware for operating 6.25 Hz. As the transmitter was initially designed for 25 Hz operation, critically different components needed to be tested. The bench test has allowed us to begin these investigations and test single components to get endurance data from the monitored operation.

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