SkyTEM Case Study: The Valen Survey Comparison with VTEM

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SUMMARY

SkyTEM, long established as the world leading technology for hydrogeophysical investigations, is applied globally for resource exploration. Based on the extensive experience obtained over the past decade, SkyTEM has developed the SkyTEM^{508} system with a particular focus on providing the best possible signal-to-noise ratio for anomaly definition in mineral exploration. This calibrated system records accurate and repeatable data with well monitored system parameters.

In this Information Paper we compare the performance of the new SkyTEM^{508} system with that of the VTEM system over the Valen conductor in South Australia. The two systems have approximately the same transmitter moment of ≈ 460,000 NIA, making this the first comparison of SkyTEM and VTEM based on comparable conditions. The comparison demonstrates that the two systems have similar noise levels, but the SkyTEM system has an anomaly amplitude 1.5 - 2 times that of the VTEM system. We attribute this to the faster turnoff of the SkyTEM system (200 µs) that achieves a higher induction in the Valen conductor than possible with the VTEM system with its turnoff time of 1,400 µs.

THE SKYTEM^{508} SYSTEM

SkyTEM has acquired and processed several thousand kilometers of geophysical data for mineral exploration projects worldwide. Originally developed for hydrogeophysical investigations in Denmark, SkyTEM is the world leader for ground water surveys as acknowledged in numerous publications and reports. Recently SkyTEM was selected for the initial phase of the national Indian hydrogeophysical research project AQUIM (Heli-borne Geophysics for Aquifer Mapping) financed by the World Bank and the Indian state.

Hydrogeophysical data are inverted quantitatively to obtain models of subsurface conductivity used for assessment and planning purposes. In order to make critical decisions regarding water resources, very high demands are placed on the accuracy and repeatability of data and availability of reliable information on system parameters: system height and position, pitch and roll, current waveform, signal conditioning, etc.

SkyTEM's on-going research and development programs applied the knowledge and experience gained from engineering the original hydrogeophysical system to further develop the technology to benefit mineral exploration. This was accomplished primarily by increasing the signal-to noise ratio and the result is the SkyTEM^{508} system.

The precision of the SkyTEM system data has been recognized by the resources sector and today the vast majority of the work carried out by SkyTEM is for mineral exploration.

The essential features of the SkyTEM^{508} system are a high transmitter moment of ≈ 460,000 NIA, quick turnoff, state-of-the-art electronics and excellent suppression of microphonics (movement noise), all contributing to the enhancement of geophysical anomalies. In addition, the system has a very rigid frame with altimeters, GPS and inclinometers mounted on the frame itself to provide accurate geometrical parameters. The SkyTEM^{508} system also offers the Dual Moment option, unique to all SkyTEM system configurations. This unique capability provides accurate and unbiased early time measurements that increase the resolution of near surface structures through the Low Moment mode, while not compromising on the depth penetration of the High Moment mode.

Catering to the needs of both hydrogeophysical and mineral surveys, SkyTEM is now a world player with 300,000 line kilometers flown between 2004 and 2012.

In this short Information Paper, we present data from the SkyTEM^{508} system recorded over the Valen conductor located in the Musgrave Province of South Australia's north and compare the results with those obtained with the VTEM system.

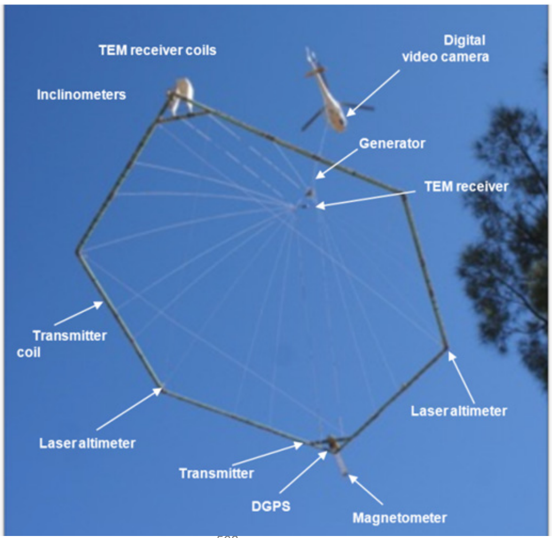

Figure 1: The SkyTEM 508 system at a glance

GEOLOGY OF THE VALEN AREA

The area around the Valen conductor has been surveyed with several airborne systems, including the VTEM and SkyTEM heli-TDEM systems and the TEMPEST and SPECTREM fixed-wing TDEM systems.

The Valen prospect is located in the central region of the Musgrave Province in the north-western part of South Australia and is characterized by variably textured mafic units interpreted to belong to the Giles Complex. A number of targets were identified by Musgrave Minerals through a VTEM survey in 2011 and 2012 manifesting as late-time anomalies in the TEM data. Copper-sulphide and nickel-sulphide minerals have been identified in nearby outcrops of the Giles Complex. The overburden in the immediate area is thought to consist mainly of sand, although areas of thick regolith cover linked to paleovalley sediments are also present. The SkyTEM lines 20010 and 20030 presented below pass over some of the major anomalies identified in the VTEM survey.

COMPARING SKYTEM^{508} AND VTEM RESULTS

Here we have chosen to compare the High Moment of the SkyTEM^{508} and the VTEM system with regard to noise level and anomaly amplitudes. This comparison is the first one to be published where the transmitter moments are comparable (unlike the comparison in the Geotech publication: “VTEM Case Study – Comparison with SkyTEM: The Greenland Project”). In this instance, the transmitter moment is ≈ 460,000 NIA for both systems, and we compare off-time dB/dt measurements of the vertical component over two representative lines from the Valen survey: Line 20110 (SkyTEM line reference) where the flight lines coincide completely and Line 20030 where there is an insignificant 9 m offset on average between flight lines. Transmitter turnoff time for the SkyTEM system is ≈ 200 µs while it is ≈ 1400 µs for the VTEM system, and we compare gates with the same delay time relative to the end of the turnoff ramp.

In Figure 2, gates 12 - 35 are plotted for the two systems for Line 22010. It is seen that the SkyTEM anomaly at Easting coordinate 591,850 m has about twice the amplitude of the corresponding VTEM anomaly. Figure 3 is a blow-up of Figure 2 to show that the noise levels are the same for the two systems; only gates 26 - 35 have been plotted and for these gates the SkyTEM anomaly is about 1.5 times that of the VTEM system. In Figures 2 and 3, to the left and right of the anomaly, it is seen that the overburden response is higher for the SkyTEM system than for the VTEM system.

In Figure 4, gates 12 - 35 are plotted for the two systems for Line 20030 where a very narrow anomaly is found. It is seen that the SkyTEM anomaly at Easting coordinate 589,700 m is slightly less than twice that of the VTEM system. Figure 5 is a blow-up of Figure 4 to show that the noise levels are similar for the two systems; only gates 26 - 35 have been plotted and for these gates the SkyTEM anomaly is about 1.5 times that of the VTEM system. In Figures 4 and 5, to the left and right of the anomaly, it is seen that the overburden response is higher for the SkyTEM system than the VTEM system.

With the noise levels being similar, we attribute the higher amplitudes of the SkyTEM anomalies to the fact that the SkyTEM system turns off the transmitter current considerably faster than the VTEM system.

CONCLUSIONS

The new SkyTEM^{508} system is one of the most powerful airborne TEM systems on the market. It has been developed from extensive experience with earlier SkyTEM systems which focused on hydrogeophysical surveys, and possesses the same unrivalled features with regard to calibrated accuracy, repeatability, noise suppression and comprehensive, continuous monitoring of system parameters.

Comparing dB/dt data from the area around the Valen conductor , it is seen that whilst the SkyTEM and VTEM systems have similar noise levels, the anomaly amplitudes of the SkyTEM system are ≈ 2 times those of the VTEM system due to the superior turnoff capability of the SkyTEM system.

Beside the superior anomaly definition, the SkyTEM system also has a higher dB/dt response pertaining to the overburden, about which more detail is defined. This is an advantage in quantitative 3D inversion of the data; lack of information about the overburden can distort the shape and size of the inversion model.

The Valen survey is the first one flown with the new SkyTEM^{508} system. Since this survey was completed, further developments have been implemented and the SkyTEM system now delivers both dB/dt and B data, for both *z*- and *x*-components, in surveys flown for mineral exploration. Furthermore there is an option for optimizing the signal-to-noise ratio by adjusting the on-time and the turnoff time in relation to the time constant of the target conductor.

ACKNOWLEDGEMENTS

The VTEM data were collected by Musgrave Minerals Ltd. and we gratefully acknowledge their contribution to this study. The SkyTEM data discussed here were acquired by the CSIRO and we also acknowledge their willingness to contribute to this comparative study.

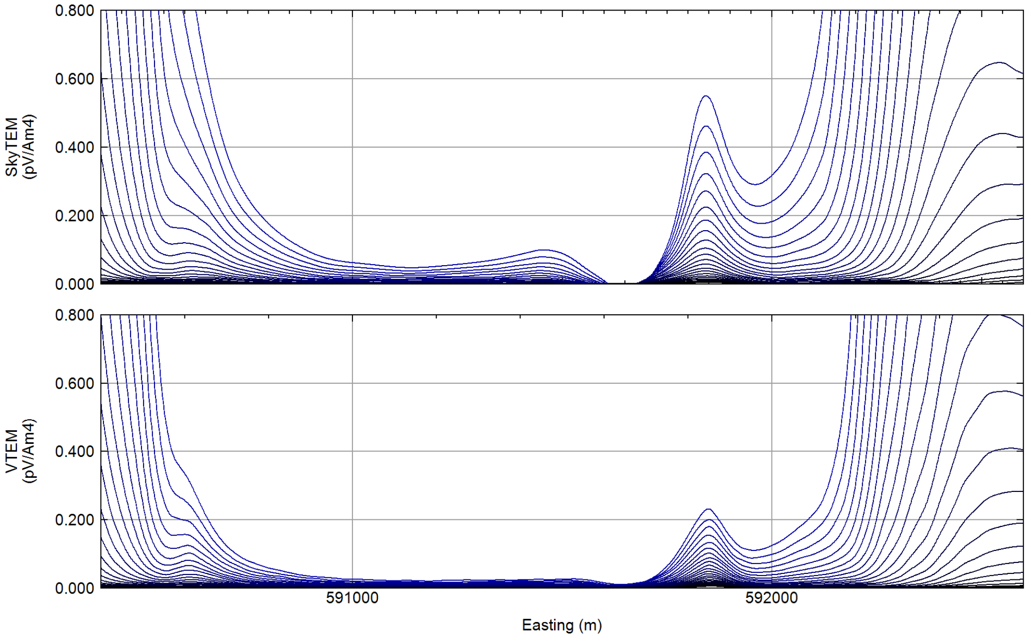

Figure 2: Line 20010, gates 12-35 (see Table 1) for the SkyTEM^{508} system (top panel) and the VTEM system (bottom panel)

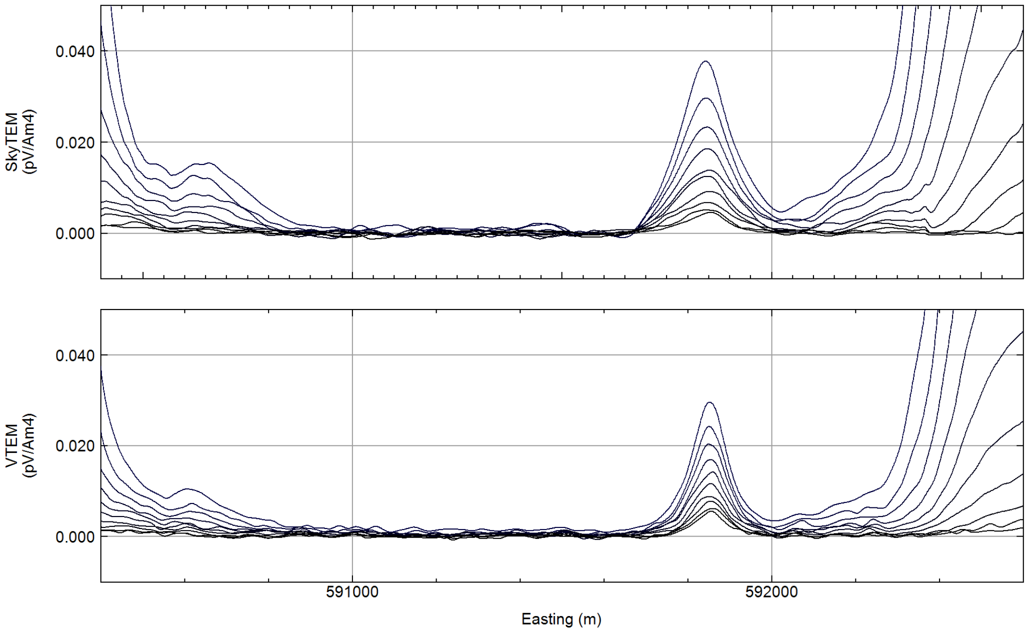

Figure 3: Line 20010, gates 26-35 (see Table 1) for the SkyTEM[508] system (top panel) and the VTEM system (bottom panel).

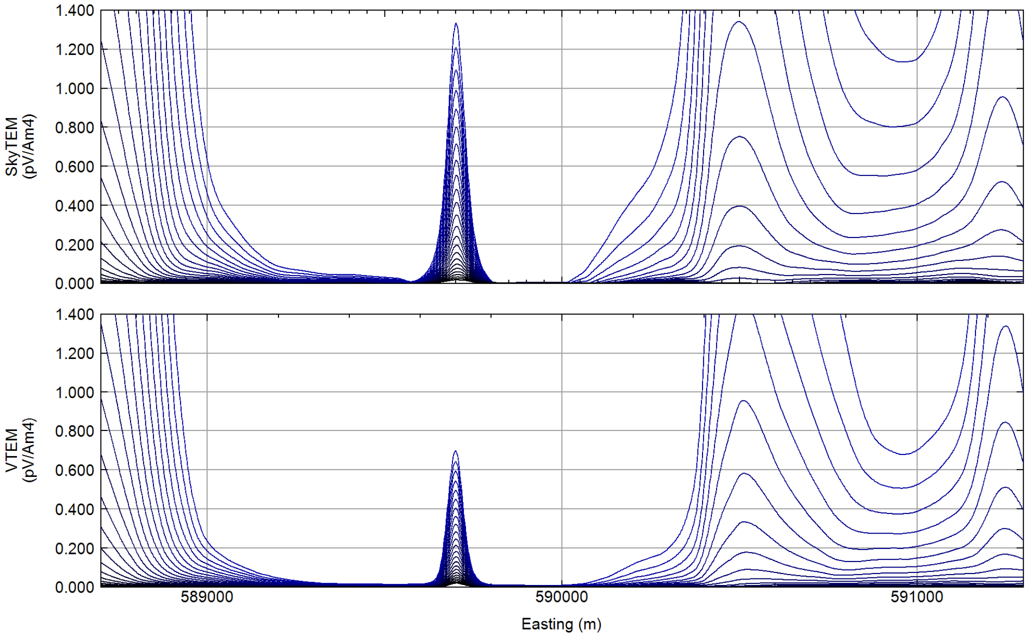

Figure 4: Line 20030, gates 12-35 (see Table 1) for the SkyTEM[508] system (top panel) and the VTEM system (bottom panel).

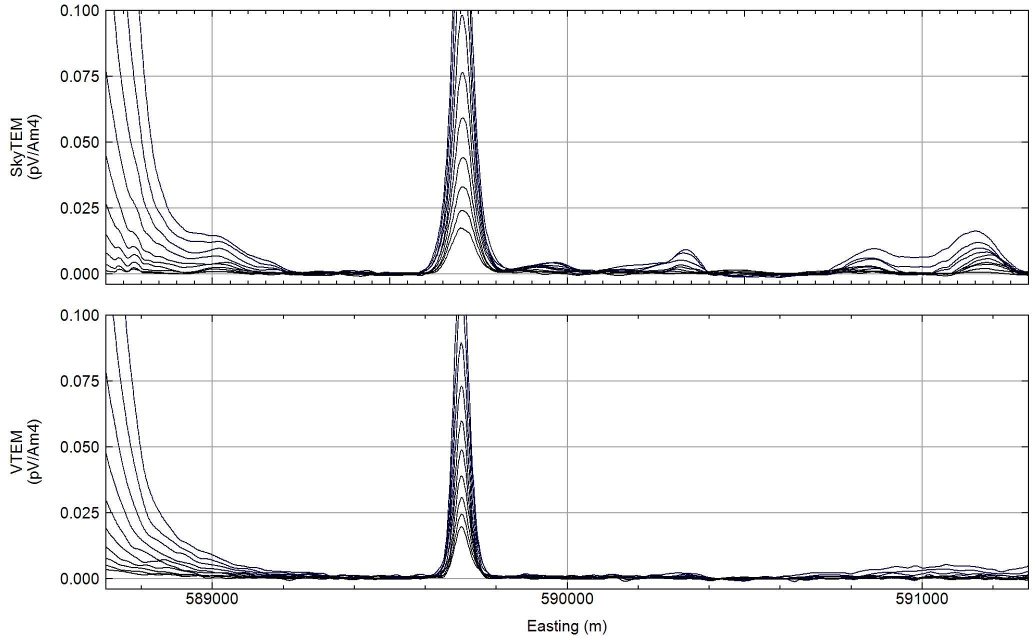

Figure 5: Line 20030, gates 26-35 (see Table 1) for the SkyTEM[508] system (top panel) and the VTEM system (bottom panel)..

Gate #	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17
Gate Center Time µs	86	96	110	126	145	167	192	220	253	290	333	383	440	505	580	667	766	880

18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35
1010	1161	1333	1531	1760	2021	2323	2667	3063	3521	4042	4641	5333	6125	7036	8083	9286	10667

Table 1: Gate center times measured after the end of the turnoff ramp