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EXTREMELY LOW FREQUENCY (ELF) EM SYSTEM

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The extremely low frequency electromagnetic system (ELF) is a new ground geophysical technique, closely related to Geotech's ZTEM. The ELF unit is very portable and cut lines are not necessary. Daily production for a two-person crew of typically between two and four line-km per day depending on terrain, station spacing and geomagnetic conditions. The ELF measures vertical and horizontal components of the natural time-varying geomagnetic field originating primarily from global lightning activity. The system calculates the tilt angle or tipper of the magnetic fields from 11 to 1440 Hz which is sensitive to 2D and 3D conductivity contrasts. The system is designed to image resistivity from depths of 10 metres to 2 kilometers, dependent on the host conductivity structure and offers a very cost-effective alternative to other deep EM imaging techniques such as MT / CSAMT / large-loop TEM.

Three test cases were surveyed by Aurora in 2011.

Below are Figure 1 and Figure 2 showing ELF data and CSAMT derived 2D conductivity inversions from Rackla Metal's Sixty Mile Property, an intrusion-related gold project. The data from the ELF is a plan view while the CSAMT inversion is in section view. The ability to directly use raw ELF data allows for timely exploration decisions and this is a distinct advantage of the ELF.

There is agreement between the two surveys. The main conductor at the end of the line is well imaged in both surveys and several of the more resistive features resolved in the CSAMT inversions are also imaged by the ELF-EM system. The higher frequency data on L19, representative of more shallow conductivity structure, mimic the near surface CSAMT inversion results well. The comparison for the lower frequency is more complicated as the inversion produces conductivities at discrete depths while the ELF-EM depth penetration is dependent on the conductivity structure and is an integrated effect. An inversion of the ELF-EM data would be more appropriate to directly compare against the CSAMT inversion.

A test was also done over the polymetallic, silver-rich Keg property of Silver Range

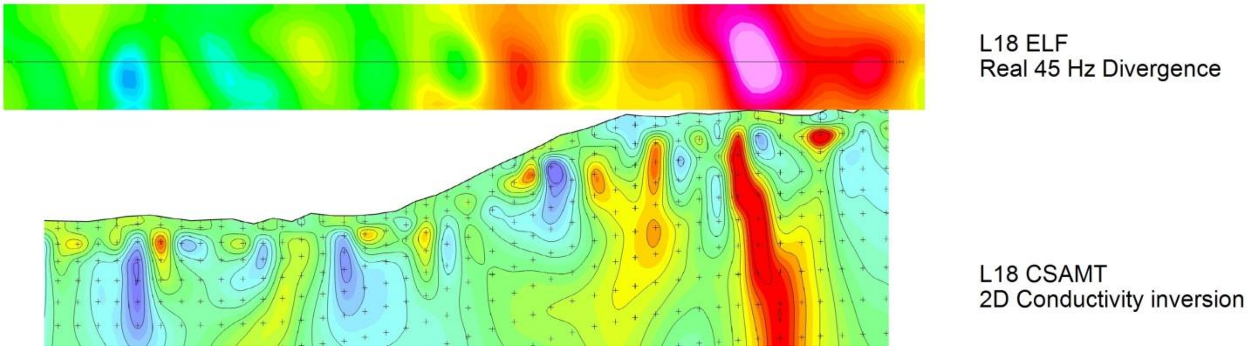

Figure 1 – L18 ELF data (plan) and CSAMT inversion (section). The line is 1050 m long and there is no vertical exaggeration in the section.

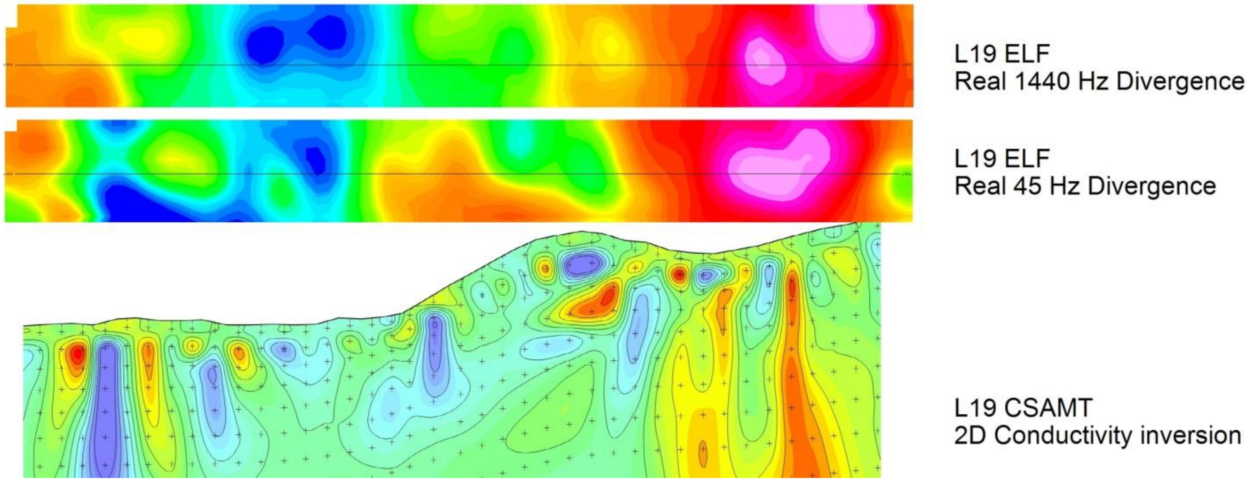

Figure 2 – L19 ELF data (plan) and CSAMT inversion (section). The line is 975 m long and there is no vertical exaggeration in the section.

Resources where prior DC resistivity had been surveyed as shown in Figure 3. The tilt angle was calculated in the 090 direction, the same direction as the strike of the Keg Main Zone. A 5 point positive Fraser filter and then a 5 fid low pass filter were applied and then selected frequencies were profiled. The main conductive zone at station 1500 was well imaged by the higher frequencies of the ELF-EM system. The shallow contact at station 1450 is dominant and the more subtle conductivity high at station 1650 is imaged as a shoulder on the tilt angle anomaly. This conductive zone is not obvious in the lower frequency 22 Hz data, suggesting that this feature does not extend at depth. Assuming the average resistivity is 100 Ohm-m in this area, the skin depth of 22 Hz - a reasonable order of magnitude estimate for the depth of investigation - would be approximately 1100 metres. This is beyond the reasonable depth of investigation of the DC resistivity survey (n=20, 50 m dipoles) so this hypothesis is neither supported nor rejected by the DC inversion / data.

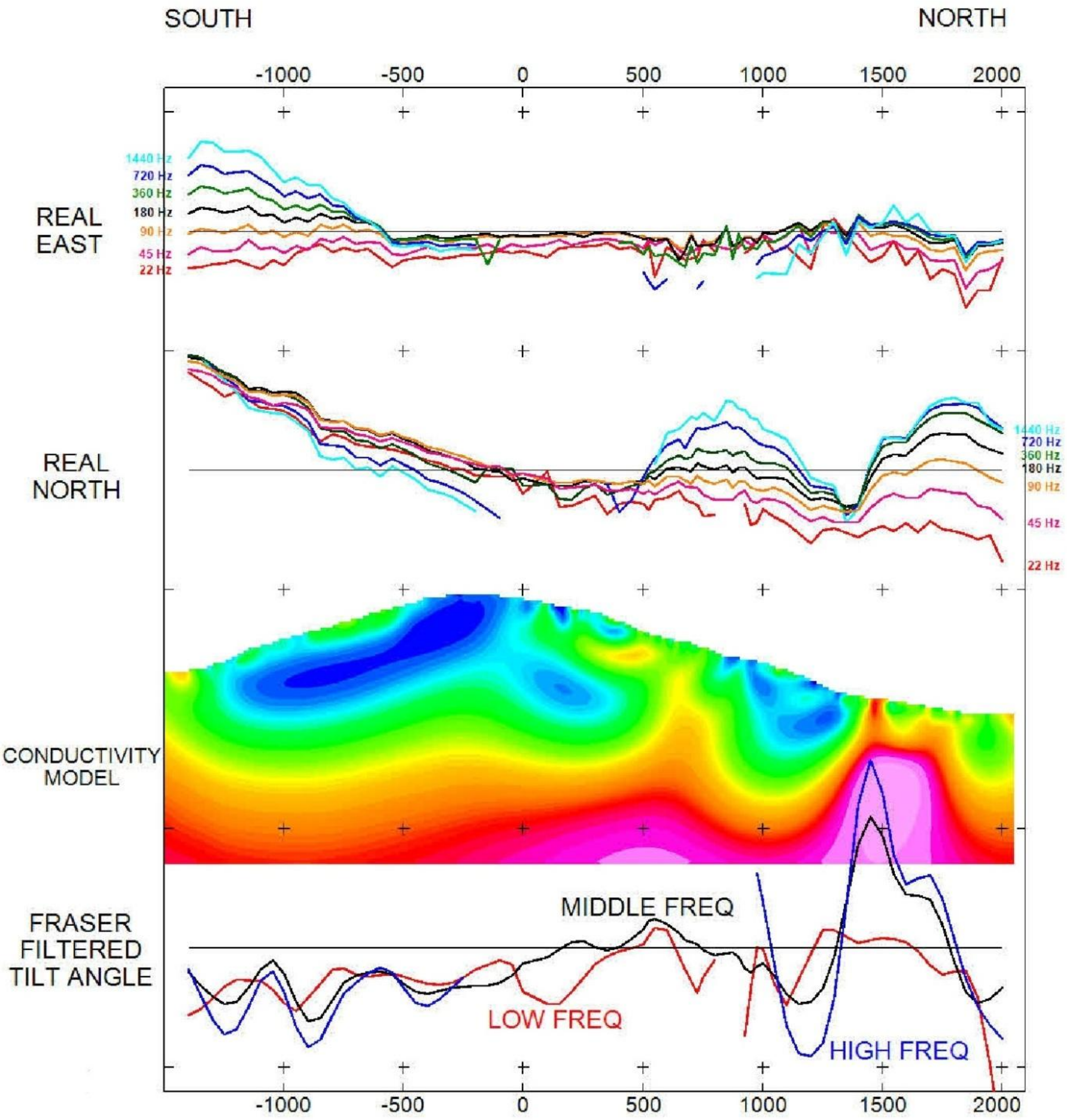

Figure 3 – Profiles of ELF data with a DC inversion (section).

The more modest conductive zone at station 500 is marginally imaged by the 180 Hz data. The higher frequency data also appears to image this conductor, but data coverage is lacking because of poor high frequency signal at that point in the survey. The lower frequency data does not resolve this conductor indicating it is a relatively shallow feature, which is consistent with the DC resistivity data.

The real part of the east component of the ELF-EM data changes character at station -500; to the south the results are frequency dependent while in the north they are frequency independent. The frequency dependent area to the south coincides with structure (possible faults or contacts) seen in the Fraser-filtered tilt data which were not imaged by the conductivity inversion. These are interpreted to be off-line features.

The real part of the north component of the ELF-EM data changes character abruptly at station 400. To the south of 400, the results are not frequency dependent while in the north the vertical field increased with frequency. A tilt to the magnetic field is caused by 2D and 3Dvariations in conductivity and the frequency dependence to the north is interpreted to represent variability with depth of the conductive inhomogeneities.

A final test was done over a geothermal target where there is no other corroborating geophysical data. Figure 4 shows the tilt of the tipper as arrows and the divergence of 180 Hz data relative to the location of the hot spring at surface. The tilt of the tipper tends to zero and the divergence has a maximum over a conductor. The technique clearly defines a conductive trend associated with the hot spring and illustrates the advantage of collecting a grid of data instead of single profiles. The ELF shares characteristics with VLF-EM surveying - both exciting fields are planar - but unlike VLF-EM, the field is not associated with a particular direction, facilitating 2D and 3D surveys. The frequency is also lower than VLF allowing much deeper depth penetration.

There are several advantages to an ELF survey in cost, logistics and discovery potential:

- The ELF is very portable and suitable for rugged terrain. Neither cut lines nor wire loops are necessary.
- Only a small crew (1 to 2) is required to operate the ELF system keeping support costs low.
- Data is directly interpretable. Not having to establish cut lines allows the survey to be immediately responsive to interim results.
- Occupation times are short leading to excellent production (two to four line-km / day).
- Depth penetration is very good.

The ELF EM system offers a very cost-effective alternative to other deep EM techniques such as MT, CSAMT or large-loop TEM.

Permission to use data from Rackla Metals Inc. and Silver Range Resources is gratefully acknowledged.

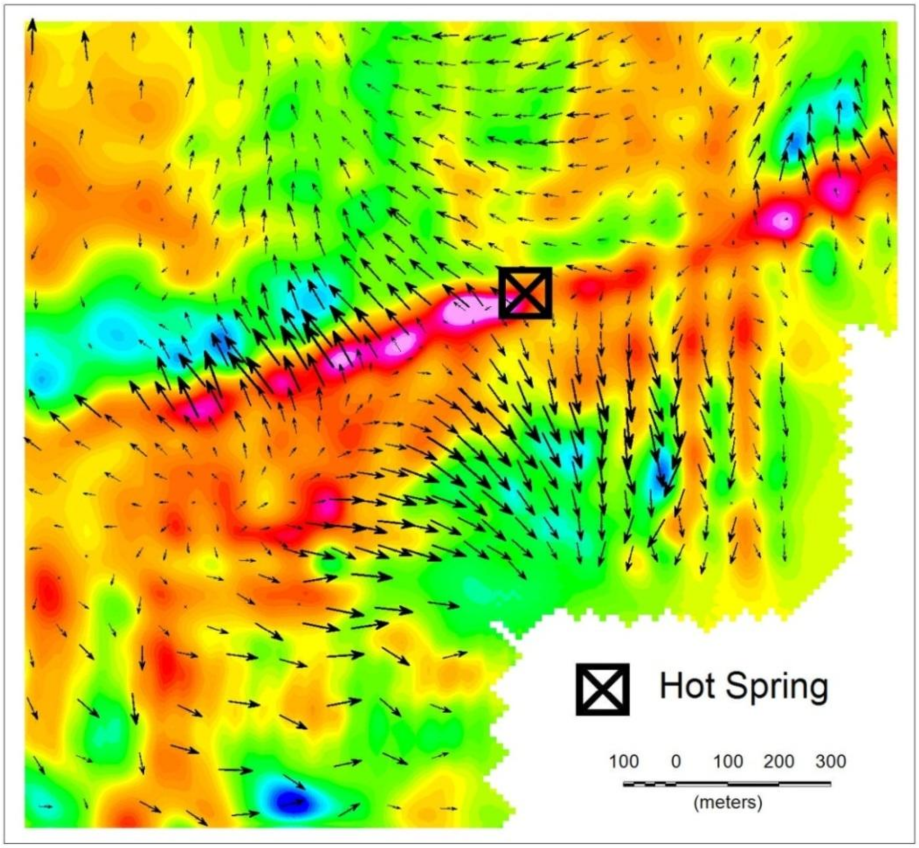

Figure 4 – A geothermal target with the ELF data in plan view