Airborne IP

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The occurrence of negative voltage values, or abnormal increased decay rates in central AEM systems is considered to be caused IP effects. Figure 1 shows an example of AEM data affected by IP, with a clear sign reversal. Figure 2 (left side) shows a typical transient with the crossover at about 0,8 msec.

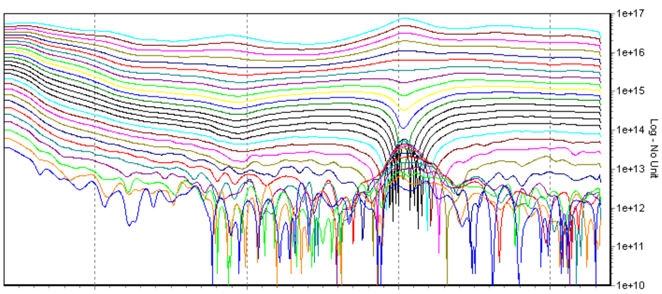

Figure 1

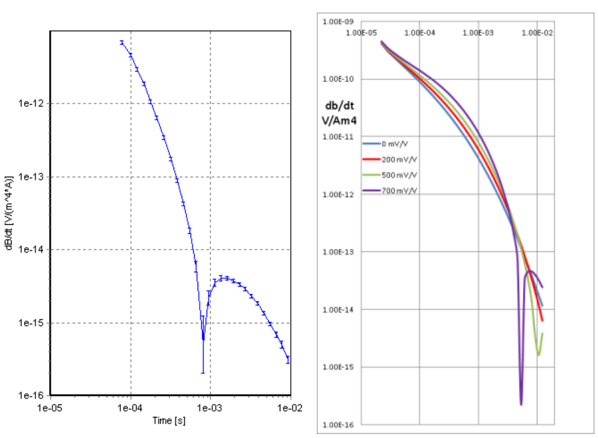

Figure 2

The common approach has been, so far, to neglect negative values, or use them as indicators in the decay where noise levels are lower than to those of signal. But this approach a) will rarely get rid of the whole IP effect, as the transients are often distorted before they go negative, and b) throws away information about the subsurface that could be relevant to the geological modelling and interpretation of the targets. Modelling all the IP parameters and inverting for them is a difficult, yet better approach, aiming at honouring the observations. Even though it is a badly ill posed problem, using constraints and apriori information to reduce the model space, it is possible to recover some the IP models from AEM data, and to match observations. By means of AarhusInv inversion code (previously known as em1dinv), modified as per Fiandaca et al. (2012), we can invert also considering chargeability parameters. We can in fact solve for Complex Impedance, using the model of Cole-Cole, providing combined estimation of ρ, c, m and τ . Care must be exerted with data preparation, regularization and choice of starting models. For example, c and τ are bound to be very poorly determined, and so need to be treated with caution and can be fixed to nominal values.

Figure 2 (right side) shows a synthetic model that considers different values for the chargeability: it is evident a shift towards earliest times, when the chargeability increases, and this explains why the IP effect can be often masked from the noise.

As an example of application of our code, we show the results of processing AEM data collected in the Abra deposit, Australia, a lead-dominated base metal orebody, located in the eastern part of the Capricorn orogeny. On Figure 3 we compare the geological cross-section, in which the main mineralizations were intercepted by many boreholes (darker lines along the drillings), with Airborne resistivity (bottom left corner) modelled considering IP effect, Airborne IP (top right corner) and Ground Spectral IP (bottom right corner). The red and black banded zone, overlaying the mineralization, has low resistivity (5-10 ohm-m) and was offset by a normal fault, well imaged by the sharp lateral resistivity constrast. The relatively high chargeability (32-35 mV/V) is correlated with higher content of lead and copper, while the maximum values (> 40 mV/V) are modelled for the shallow overburden, possibly due to iron rich covering. Ground Spectral IP confirms the high chargeability of the deposit, while it is not able to resolve the shallower chargeable overburden: maybe this is due to the large spacing of the electrodes (Notice the different units of Airborne and Ground IP). The black lines shows the Depth of Investigation.

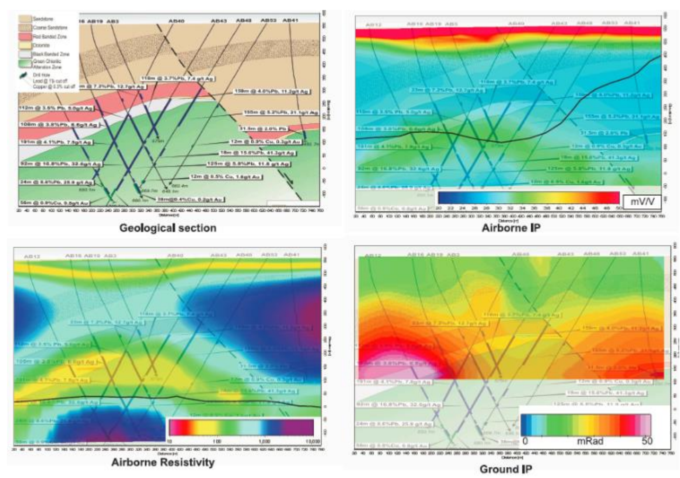

Figure 3

The main outcome of our studies are that modelling IP:

1) The resistivity (conductivity) of the subsurface recovered is in better agreement with ancillary geological and geophysical (geoelectrical) information. The resistivity sections do not display exceedingly high resistivity values, and match better the near surface geology.
2) Shallow chargeable anomalies can be recovered with a fair degree of confidence. We will discuss on the possibility of recovering, in favourable conditions, deeper chargeable anomalies.

We contend that correcting accurately for IP and recovering IP-free resistivity (conductivity) sections (point 1 above) is also very important, and perhaps more easily acceptable because easier to check.