Extending the range of conductivities detected by the Spectrem AEM System

Peter Leggatt[1],

1. Spectrem Air Limited (peter@spectrem.co.za)

ABSTRACT

The SPECTREM AEM system [Annan A.P. 1986] generates the step response of the ground to a repetitive sequence of transmitter steps switching from positive to negative and back again. Apart from the intervals where the transmitter is in transition it is always on. This means that the ground response and the transmitter signal are present in the receiver at the same time. In order to retrieve the secondary signal alone the transmitter signal must be removed from the receiver secondary signal.

Unlike a ground system like UTEM [West G.F. 1984] which also measures the secondary step response and the primary field at the same time, both the receiver and transmitter positions are fixed during the recording and the amplitude of the transmitter can thus be computed from the geometry. For a towed bird system like SPECTREM, this method cannot be used to compute the amplitude of any component of the transmitter primary at the bird as the relative positions, and rotations, of the transmitter and receiver coils are constantly changing. For a particular component (say Z) at the receiver the amplitude of the primary signal can change by a few percent from one reading to another while the changes in the secondary (ground) signal are of the order of a few hundred ppm. That is, the secondary signal of interest is buried in a not dissimilar transmitter signal three orders of magnitude larger.

The traditional method SPECTREM uses for the real time processing performed in flight is to assume that near the end of each half cycle, the secondary signal due to the transmitter transition (step at the start of the half cycle has more or less decayed away and this late time signal can be regarded as primary signal only, and when subtracted from all the preceding data in the half cycle the result is deemed to be the actual secondary signal.

By choosing lower base frequencies for the transmitter the separation of this late time signal from the transmitter switch- over is increased and so better estimate of the primary field is obtained, as more of the secondary signal will have died away.

At a base frequency of 25 Hz the transmitter signal changes sign every 0.02 seconds (two transitions per cycle). Assuming the secondary signal at 0.02 seconds is just at the noise level of 100 ppm then, for an inductive limit secondary signal amplitude of say 25% of the primary field the decay constant must be less than about 3700 microseconds. Any decay rate slower than this will have a secondary signal amplitude at 0.02 second delay time, greater than the noise level and by subtracting this (non zero) signal together with the true primary signal from the preceding data it will cause them to be under estimated.

If one assumes a 50,000 microsecond decay constant and the same inductive limit amplitude as the previous example, the late time amplitude at 0.02 seconds delay would be is 167,580 ppm and so all the preceding secondary data will be reduced in amplitude by this amount when it is subtracted along with the true primary. This is likely to push the signal below the noise level for nearly all the data, apart from some at early times. This results in the anomaly being unlikely to be selected as a target for further work. So the really good conductor (think Nickel) is then effectively, rejected due to poor processing.

Several techniques for computing a better estimate of the primary field will be demonstrated, as well as the one currently in use by SPECTREM, (and currently being improved upon) together with illustrations on actual field data.

Key words: Spectrem, AEM, conductivity