Different uses of ancillary information in AEM data modeling for increased output accuracy

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investments involved, are particularly well suited for integration with other data. The latter are usually borehole geophysical, stratigraphical and hydrogeological logs, seismic, geoelectric (ERT), ground TEM, MT, and, lately, MRS. Data integration, in geophysics, is a loose term. In our opinion, it can represent two main approaches: integration a-priori and a-posteriori, and also a blend of the two.

In *a-posteriori* case, the AEM data are processed and inverted alone, then the output models are integrated with other data, for comparison, or to derive more refined products (e.g., water salinity, units thickness, etc…). They usually rest on experimental correlations obtained between locally AEM derived models and ancillary data, and then extrapolated within reasonable areas. Beside increasing the degree of acceptance of the geophysical results, the integration and production of derived products also greatly enhance the usefulness of the geophysics to the end users.

In the *a-priori* approach, on the contrary, the ancillary information is used as extra input to the inversion of the AEM data. It enters the global objective function being minimized, with a value(s) and uncertainty associated to it. These a-priori information range from soft, e.g., the degree of spatial variability (more or less regularization, smooth versus sharp boundaries) expected, to harder ones, e.g., borehole resistivity log/seismic horizons that needs to be honored. As a case on the use of a-priori, we show AeroTEM data inversion, improved by adding the information about the depth to the bedrock shale. The depth, which was obtained from the seismic, was applied given as values and associated (low) uncertainties. Figure 1 shows the seismic profile, and the results of the AeroTEM data inversions with and without a-priori. The a-priori allowed mapping the bottom of the buried valleys, as expected. They also cause an increase in the resistivity of the sediments above the bedrock shale, from approximately 30-40 Ohm m to to 50-80 Ohm m. This increase is consistent with available geological information and with the analysis of the shallow seismic reflectors that suggest large amount of coarse sediments.

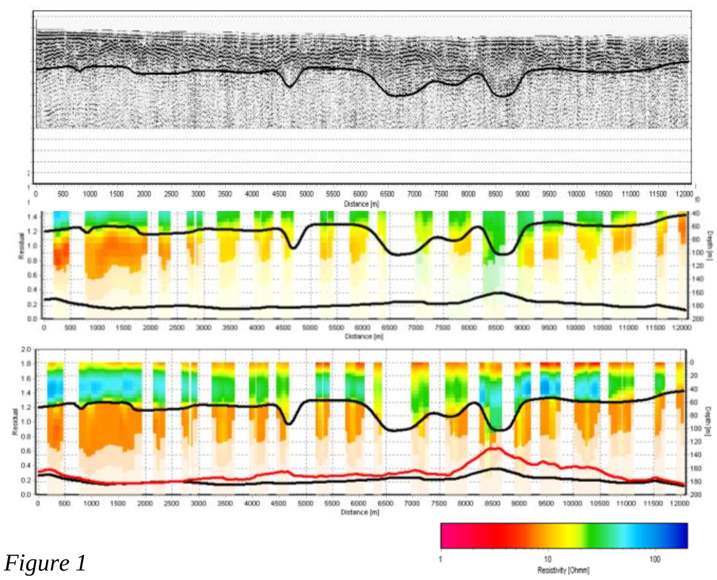

Figure 1

There is then an intermediate third way, which we call *iterative calibration*. The AEM data are first processed and inverted alone, then compared to reliable ancillary data, and then, in presence of meaningful disagreement with them, adjusted and inverted again until the desired agreement is reached. This data was acquired with the "full waveform" VTEM system, which records usable gates at much earlier times (nominal approx. 20μs after end or ramp) than previous versions of the VTEM system. We performed processing and inversion of the given data, and compared the outcome with the available resistivity sections from ERT data, over coincident lines. The results (top panel Figure 2) show a good agreement with ERT from approximately 30 m of depth, and downwards. The VTEM results overestimate the conductivity of the near surface layers. Beside ERT, also the other geological information from the area point to the fact that the first layer should not be so conductive. We decide to try to recalibrate the dataset, using the ancillary information as a sort of reference model. The reasons for this discrepancy can be many, but should not be lack of sensitivity of this AEM system. We forward modeled what the VTEM system should have seen over that part of the survey. The results hinted at the fact that there was too much signal in the early times of the measured transient. We therefore applied increasing time shifts to the Rx time gates, and re-inverted the data, until we obtained the desired lvel of fit between VTEM results and ERT (lower panel of Figure 2). The excellent fit with ERT, both near surface and at depth, was obtained with a time shift of -21 μs. This is our tentative calibration factor.

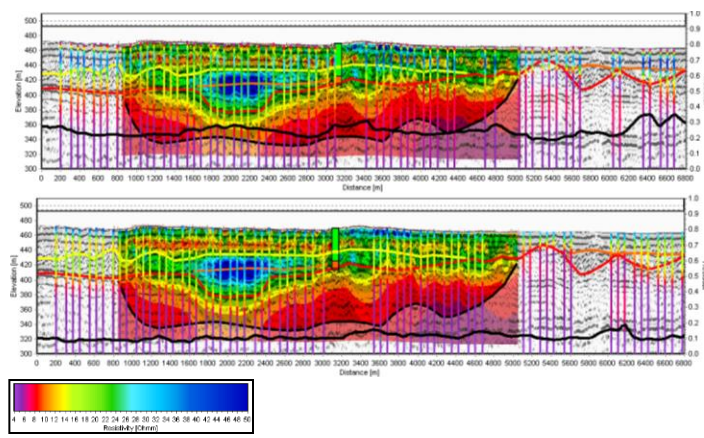

Figure 2

We then applied the same calibration time shift to the entire survey, and compared the outcome with the information available in other areas. Specifically, with seismic and borehole data.

In conclusion, there are several strategies for integrating ancillary information with AEM data. Provided that the ancillary information are relevant, of good quality, and treated as nothing but another data point, which carries an uncertainty, there is the potential for a much improved output. The benefit can be to derive a by-product, to obtain a model with lower uncertainty, a model fitting all data, a recalibrated dataset.