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From Airborne EM to Geology, some examples

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Introduction
Airborne Electro Magnetics (AEM) provide a model of the 3-dimensional distribution of resistivity of the subsurface. These resistivity models were used for delineating geological structures (e.g. Buried Valleys and salt domes) and for geohydrological modeling of aquifers (sandy sediments) and aquitards (clayey sediments). Most of the interpretation of the AEM has been carried out manually, by interpretation of 2 and 3-dimensional resistivity models into geological units by a skilled geologists / geophysicist.
The manual interpretation is tiresome, takes a long time and is prone to subjective choices of the interpreter. Therefore, semi-automatic interpretation of AEM resistivity models into geological units is a recent research topic. Two examples are presented that show how resistivity, as obtained from AEM, can be "converted" to useful geological / geohydrolocal models.

Statistical relation between borehole data and resistivity
In the northeastern part of the Netherlands, the 3D distribution of clay deposits - formed in a glacio-lacustrine environment with buried glacial valleys - was modelled. Boreholes with description of lithology, were linked to AEM resistivity. First, 1D AEM resistivity models from each individual sounding were interpolated to cover the entire study area, resulting in a 3-dimensional model of resistivity. For each interval of clay and sand in the boreholes, the corresponding resistivity was extracted from the 3D resistivity model. Linear regression was used to link the clay and non-clay proportion in each borehole interval to the Ln(resistivity). This regression is then used to "convert" the 3D resistivity model into proportion of clay for the entire study area. This so-called "soft information" is combined with the "hard data" (boreholes) to model the proportion of clay for the entire study area using geostatistical simulation techniques (Sequential Indicator Simulation with collocated co-kriging). 100 realizations of the 3-dimensional distribution of clay and sand were calculated giving an appreciation of the variability of the 3-dimensional distribution of clay and sand. Each realization was input into a groundwatermodel to assess the protection the of the clay against pollution from the surface.

Artificial Neural Networks
AEM resistivity models in an area in Northern part of the Netherlands were interpreted by Artificial Neural Networks (ANN) to obtain a 3-dimensional model of a glacial till deposit that is important in geohydrological modeling. The groundwater in the study area was brackish to saline, causing the AEM resistivity model to be dominated by the low resistivity of the groundwater. After conducting Electrical Cone Penetration Tests (ECPTs) it became clear that the glacial till showed a distinct, non-linear, pattern of resistivity, that was discriminating it from the surrounding sediments. The patterns, found in the ECPTs were used to train an ANN and was consequently applied to the resistivity model that was derived from the AEM. The result was a 3-dimensional model of the probability of having the glacial till, which was checked against boreholes and proved to be quite reasonable.

Conclusion
Resistivity derived from AEM can be linked to geological features in a number of ways. Besides manual interpretation, statistical techniques are used, either in the form of regression or by means of Neural Networks, to extract geological and geohydrological meaningful interpretations from the resistivity model.