Mapping complex hydrogeological structures and parameters by AEM – Part 1

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Airborne EM method can be considered by now a mature tool for Hydrogeophysics, since it is able to produce detailed resistivity mapping with great lateral and vertical resolution, so that to provide an effective improvement of the hydrogeological knowledges. Moreover the parameter sensed by AEM is strictly related to hydraulic conductivity, to hydraulic transmissivity and to salt content of groundwater. Hence, the use of AEM is becoming more and more important for planning hydrogeological studies (at the watershed scale) or productive wells' excavation.

Spiritwood Valley

This case-history deals with the investigation of buried valley aquifers in Canada using airborne TEM techniques, as part of a Groundwater Geoscience Program, by the Geological Survey of Canada. The prospection was performed by an AeroTEM III system, covering 1062 km2 (3000 line km) over the Spiritwood Valley aquifer in southern Manitoba (Oldenborger, 2010a, 2010b).
The AEM dataset provides high resolution results and well-connected geological interpretations, which result in a more detailed and confident description of all of the existing geological structures.
Figure 1 shows the resistivity distribution at an elevation of 415 m a.s.l.: the buried valleys are well resolved as more resistive channels (yellow), incised into the shale bedrock (blue), having a more conductive response. Other minor paleovalleys are highlighted on Figure 2, that represents a 3D visualization derived from AEM results. They show a lower resistivity on Figure 1.

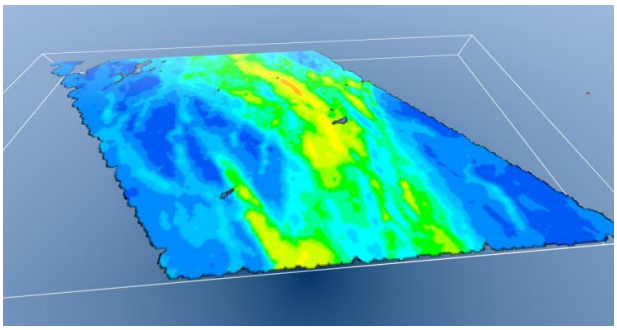

Figure 1

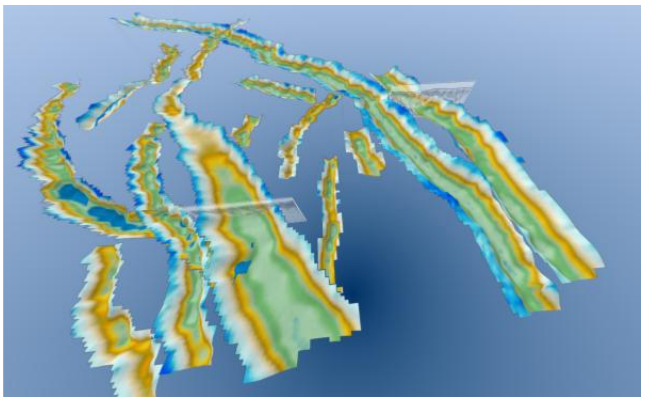

Figure 2

Finally, on Figure 3, a typical cross section, on which the limits of the paloevalleys have been drawn, is shown (top). The different resistivity values are due to variations in filling materials (higher resistivity for coarser layers and lower resistivity for finer ones). On the bottom is shown an interpreted voxel section, with the single paleovalleys units, incising the shale bedrock (purple) and embedded into the glacial drift (light brown). The shallow dark brown unit is interpreted as a more recent sedimentary structure.
The voxels interpretation is very useful to get a quantitative approach to the hydrogeological study of the area, since it is possible to estimate the aquifers' volumes and depths. Moreover it will be an useful tool to run hydrogeological flow modeling. This level of detail is really achievable only by means of an AEM prospection, as the width of some paleovalleys are very low, so that most of the alternative ground geophysical surveys would have not been able to obtain the same results.

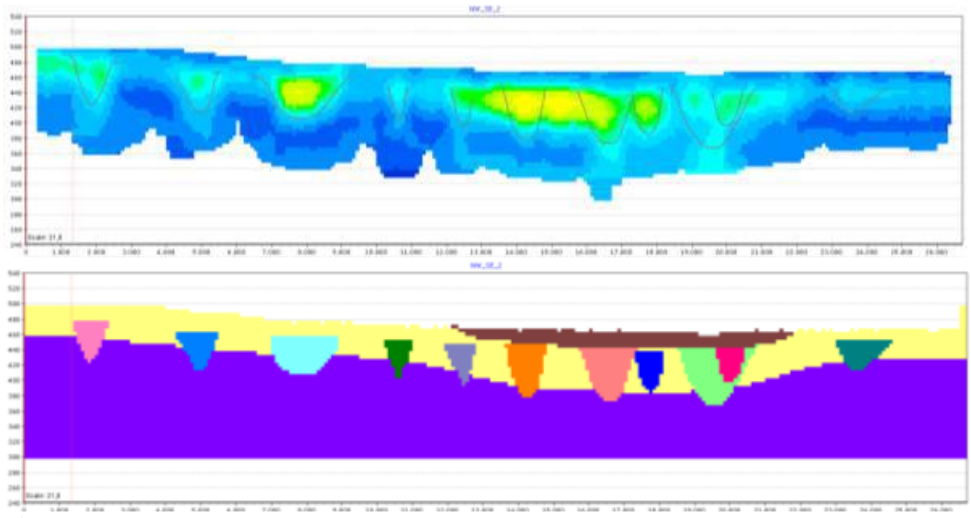

Figure 3