Hydrogeological mapping - DC-soundings versus transient electromagnetic soundings.

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Thomsen *et al*. (2004) *"demonstrates why dense mapping with newly developed geophysical measurement methods -- accords geophysics a highly central role in the forthcoming hydrogeological mapping"*, and thus legitimate a new mapping in Denmark that cost an estimated 120 million euro (€). However their conclusion, that *"surface mapping with the new geophysical methods, combined with better interpretation programmes, has shown that it is time to do away with the old way of using geophysics"*, seem a little premature.

Aquifers in Denmark often occur as buried valleys eroded into the pre-Quaternary substratum. As the buried valleys are typically 100–200 m deep and often up to 1 km wide, they are difficult to delineate using (shallow) boreholes. This has been investigated by Thomsen *et al*. (2004) in a test area north of Aarhus (see figure).

On this basis Thomsen *et al.* concludes that the transient electromagnetic soundings (TEM) measurements *"enable the bed of the buried valleys to be determined and provide a rough measure of the extent to which the valleys are filled with sand or clay"* and *"that the new structures identified have now been verified by boreholes"*.
The same area was however mapped by DC-soundings in 1970-73 (Schrøder 1974). As seen in map B the buried valleys were found in this survey.

A low resistivity substratum gives a good signal with TEM, so there is not much difference between the TEM and the DC maps. However the DC-soundings give much better information on sand layers above the substratum, especially the top of the sand layer is very well defined (as demonstrated in (Schrøder 1974)), and it is foremost the mapping of the aquifers that is of hydrogeological interest. It should also be mentioned that the sand-aquifer in *"the new structures identified "* like the buried valley at Ristrup (the red X on the maps), - on which the only new major water work in Aarhus is based – was already found by DC-soundings and verified by borehole in 1972 .

Finally it should be noted that the DC-soundings also mapped the limestone aquifer (not mapped by TEM), below the Tertiary clays. In (Schrøder 1974, fig.2.4 – the profile marked with red on map B) it is seen that the DC-soundings gives very reliable indication on both the top of the Tertiary clays as well as the top of the underlying limestone aquifer.
Interpretation of geo-electrics is problematic due to noise and the derived ambiguity. However classical Schlumberger DC- soundings have still the advantage of very low noise level. And automatic and semi-automatic programs, that allows inclusion of geological a priory knowledge in the interpretation, was already developed for the 1970-73 survey (Johansen and Schrøder 1973). So - as showed by the test area - even ten times more soundings/km^2 and 30 years of new knowhow didn't provide better results.

References:

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