Oil sands reservoirs detection

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AEM can provide direct detection of shallow oil reservoirs, as in the case of oil sands. This example refers to HELITEM and GEOTEM MULTIPULSE systems flown over an oil sand deposit at Fort McMurray, Alberta, Canada (see Chen et al., 2014 for more details). The area is covered by about 35 m of moderately conductive glacial till embedded with thin layers of more conductive clay/silt beds. The glacial till is underlain by a 35 to 40 m thick Grand Rapids sandstone, which is relatively resistive. Beneath the sandstone is the Clearwater Formation, a thick (60 – 80 m) layer of marine shale which represents the main conductor in the test area. Underneath the Clearwater shale is the Fort McMurray formation which hosts the oil sands deposit. Beneath the Fort McMurray formation is the Devonian limestone which is underlain by a layer of salt. Sinkholes exist in the limestone which may serve as channels for the salt water to migrate from the salt layer to the oil sands formation above the limestone. Figure 1 shows a typical geological cross-section of the area.

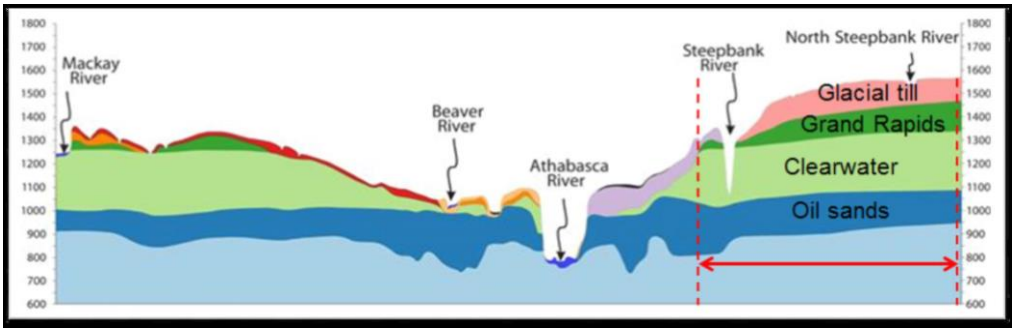

Figure 1

Figure 2 shows a comparison among EMFlow (top), CDI (bottom) and our Workbench (middle) processing and inversion, as reported by Chen et al. (2014). First of all, we culled the data affected by coupling, while the EMFlow and CGG proprietary CDI imaging (similar to EMFlow) kept these data, but it means that the conductive structures are artefacts. Another important difference is the most "geological" meaning of our inversion, with a better resolution e.g. of top and bottom of the Clearwater shale. Aarhus Workbench results image better the shallower structures, within the glacial till, so that it is able to resolve potential surficial aquifers, that were completely missed by the CDI section. On the contrary, it seems that EMFlow is able to resolve these smaller targets, but it introduces a uniform resistive shallow layer, covering all the area, that is not confirmed by the geological knowledges.

One relevant outcome is the deep conductor within the Fort McMurray oil sands formation (marked by the red arrow), which nature is unknown. As some sinkholes can occur in the Devonian limestone underlying the oil sands formation, it could be interpreted a salt water intrusion, coming from the deeper salt layer beneath the limestone. Once again, our inversion code is able to image better this structure.

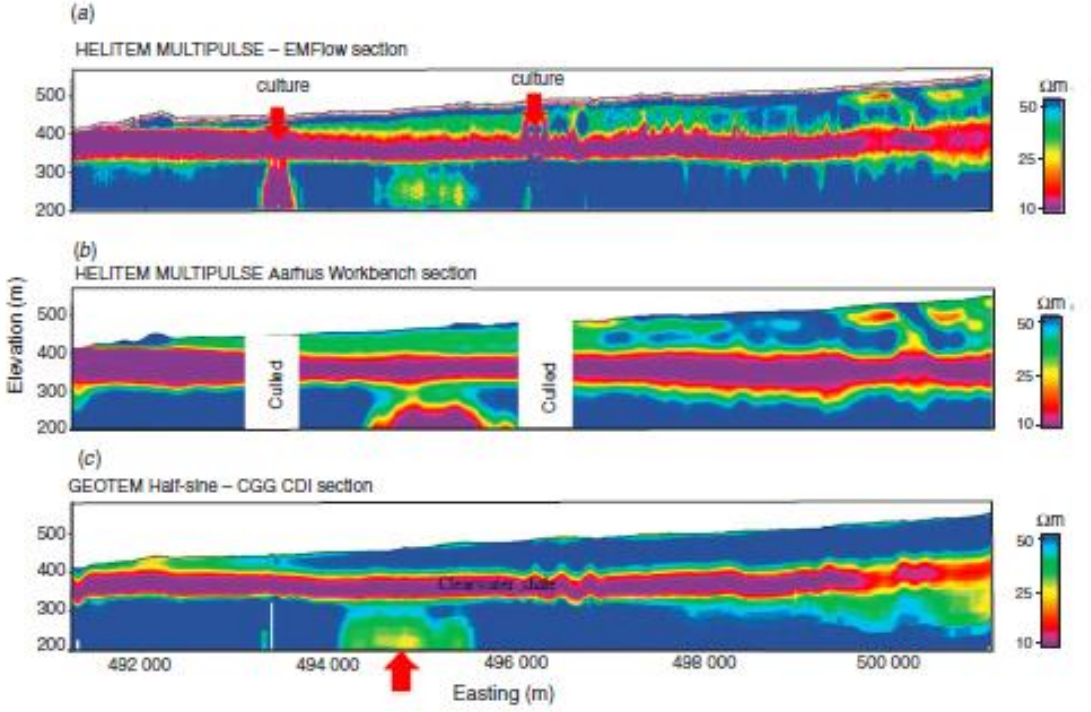

Figure 2