How 1-D modelling can be useful for Mining

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The debate regarding the need for full 3D inversion in semilayered environments is intensifying, and the issue is the subject of ongoing research. We accept that full 3D inversion has an important although, as yet, largely unproven role in the interpretation of AEM data in complex geological settings, and that there are new approaches that represent a significant step forward towards making it practical. However, we contend that their observation does not adequately reflect the capabilities of accurate 1D inversion methods. We believe that methods based on 1D forward responses have a valuable and continuing role in extracting useful information, not only for geological and hydrogeological purposes, but also for some of the mining targets.

We use the Spatially Constrained Inversion (SCI) methodology that is a quasi 3D inversion, based on a 1D forward response, with 3D spatial constraints. The spatial constraints allow prior information (e.g., the expected geological variability of the area, or the downhole conductivity) to migrate across the entire dataset. The output models balance the information present locally within the individual TEM soundings with the ones carried by the constraints. The SCI has a demonstrated applicability in semilayered environments, but we got interesting results also in the case of narrow, steeping targets (typical of the mining applications): the Anomaly A, in Figure 1, shows a VMS deposit in the Middle East. Moreover it must be stressed the high lateral resolution of our inversion in delineating complex geological and tectonic features, causing very abrupt resistivity variations.

Qfx are Ancient alluvial fans; Ktq is the Thaqab Formation (conglomerate, sandstone, shale); SE2 area Basalts and andesites; Gu' is a Gabbro and diorite stock; SE1 are Basalts; SD are Dolerite and basalt dyke; TRmb1c is the Marbat Formation (chert and shale).

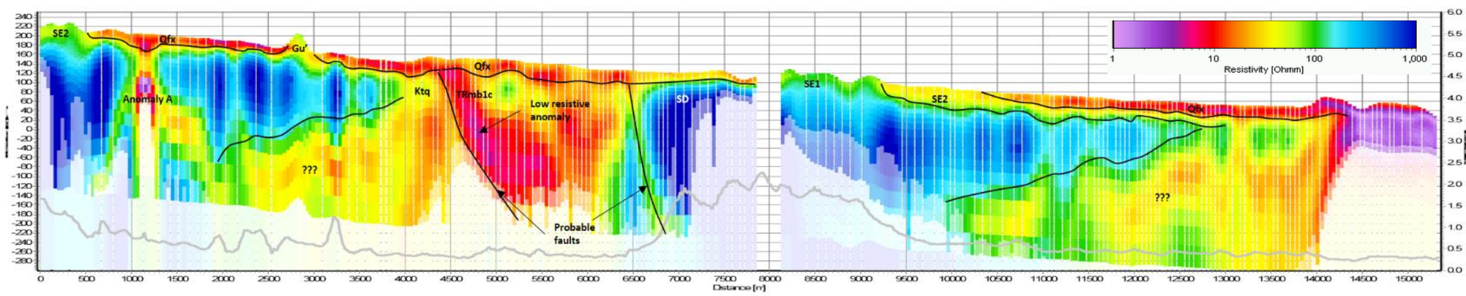

Figure 1

Figure 2 shows the good resolution of another VMS target. The EM data was duly processed and then inverted to both multi-layers (smooth) and few layers (blocky) inversion. Blocky and smooth inversions provide complementary results. The smooth inversion is suitable for recovering the subtler variations in the 3D resistivity distribution, but it tends to smear vertically the electrical transitions, due to the regularization needed with many layers. The blocky inversion, on the contrary, does not require vertical regularization, and therefore renders with higher accuracy the actual vertical layering and absolute values of resistivity and depths (thicknesses) of the different electrical layers. Figure 2 and shows the results of smooth and blocky inversion, with the outlay of the deposit overlaid over the resistivity sections. Notice that both inversions were run completely free, without any conditioning (in form of a-priori) from the known geometry of the deposit. The results show very good agreement with the depth, thickness and dip of the deposit.

In this geological setting, we note that the assumption that each observation can be modeled with 1D forward responses and spatial constraints describing its relation to its neighbours, and that the subsurface is represented as a series of horizontal layers, holds well, particularly at the scale of the footprint of the AEM systems considered.

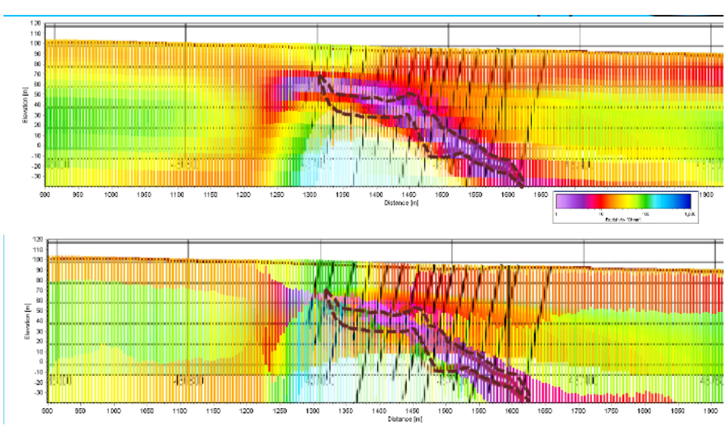

Figure 2

Courtesy of Mawarid Mining