

Geological modelling by means of AEM

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The final outcome of an AEM survey could be a comprehensive geological model, which will be a result of accurate processing and inversion workflow. The denser sampling, which can be achieved by means of AEM, makes it feasible to extract the 3D voxels distribution, which may be later imported in the most commonly used geomodelling software (Petrel, Geomodeller, Leapfrog, Geoscience 3D and others). This should be carried out by a team of dedicated professionals (geologists and geophysicists) and should be also supported by available ancillary information (stratigraphic data, seismic data, borehole logs, ERT, etc.).

Figure 1 shows an example of 3D modelling in Sicily, Italy (Santilano et al., 2014), for the VIGOR Project. SkyTEM data were acquired in two large sectors of the island and the example refers to an area which is 300 km² wide and that is located in northcentral Sicily, south of the town of Termini Imerese in the province of Palermo. The area belongs to the “collisional” complex of Sicily, developed along the European-African plate boundary and shows a very complex structural setting. The outcropping rocks belong to different Stratigraphic Structural Units, which constitute the tectonic edifice, unconformably overlaid by sedimentary syntectonic basins later involved in the deformation. An integrated approach was used

for the 3D geological modelling. We analysed geological cartographic data and electrical resistivity data distribution in order to constrain the 3D geological model. Initially we performed an integrated analysis of geological maps and surface AEM data in order to identify the resistivity values of outcropping geological units. These units were grouped into Litho-Electrical (LE) units based on stratigraphic and electrical evidence.

The geological cross-sections (an example is shown at the bottom of the Figure 1) was generated, by interpreting the resistivity profiles and considering the proposed LE classification. The integrated analysis of geological maps and surface resistivity map (mean values from 0 to 5 m b.g.l.), allowed us to recognize six LE units (see legend in Figures 1 and 2 for details). The results were then imported into PETREL, a geological modelling software (Schlumberger). The standard workflow for PETREL software (Schlumberger) consists of three main processes: “Fault Modelling Framework”, “Horizon Modelling” and “Structural Gridding”. The faults inserted in the modelling were those dislocating LE units, and were modelled considering geological data and 3D geophysical data, where high electrical contrasts between hanging wall and footwall were identified. The 3D geological model of the area is made up by regular cell grid with 100 m horizontal spacing, until a depth of about 250m.

The second example is drawn from the hydrogeological modelling of the Spiritwood valley in Manitoba, Canada (Sapia et al., 2014). In this case the software Geoscience 3D was used, in order to extract voxels associated with the main hydrogeological units. For this project was particularly important to resolve the buried valleys hosting deep aquifers, made up by gravel and sands glacial deposits. These buried valleys incised the impermeable shale bedrock, hence assuming complicating geometry. Figure 2 shows a 3D reconstruction of the hydrogeological setting with a cross-section below, showing the complex array of the buried valleys.

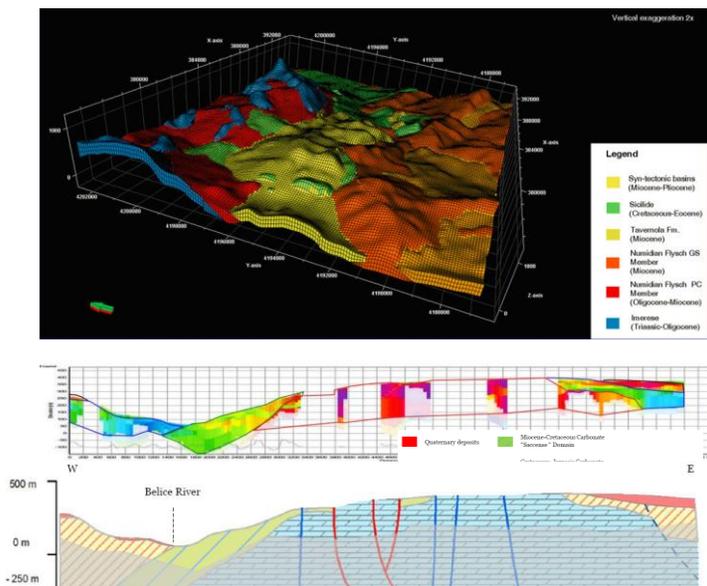


Figure 1. Top to bottom: Example of a 3D geological model built on the geophysical inversion results produced by AarhusINV program; inversion profile; geological cross-section.

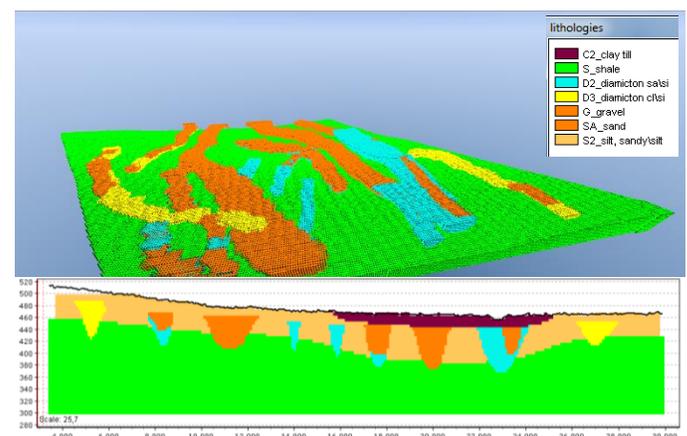


Figure 2. Example of interpolating inversion data into Geoscience 3D.

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