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2-D Joint inversion of VES and gravity data - Application to the Chaves graben

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In recent years the interest in inversion techniques that use data from multiple methods of geophysical prospecting in a single process has increased. This procedure allows us to combine the strengths of the different methods to diminish the inefficiencies of each one individually. The work presented here shows a case study of the application of a 2D technique which simultaneously inverts VES and gravity data for layered medium. This technique was already tested both with synthetic and real data with very promising results.

The technique uses the global optimization method of simulated annealing to determine the depth of the interfaces of a layered medium, as well as the resistivity of each layer. The density of the layers is assumed to be known. To test the advantages, if any, of the use of a joint inversion technical over a single data methodology we inverted the same data separately, and then applied the joint inversion and compared the results.

The study area is located in northern Portugal, in the vicinity of the city of Chaves, and consists of a graben embedded in post and syntectonic Hercynian granite and Silurian metamorphic rocks. The graben is roughly oval shapped, and it is filled with sedimentary series dating from the Miocene. There is an important hydrogeological thermal system controlled by a complex fault system. There are some hot springs and drillings where temperatures of about 50 to 78°C have been measured. Since there is no volcanism in the region, the presence of hot water has to be related to deep circulation. There is also a cold shallower aquifer used mainly for agricultural purposes.

This work was made to 1) further test the methodology and 2) to determine the depth and main features of the bedrock underneath the sediments, and try to find out a bit more about the structure of the sedimentary filling. Two profiles crossing the graben along its larger and smaller axes were chosen to apply the method.

The results show that the addition of resistivity data allows a better definition of the bedrock. In fact, even though the VES's soundings do not reach the depth of this interface, the fact that they allow a better definition of the shallower structures contributes for a more accurate positioning of the deeper structures seen only by gravity data. As for resistivity results, this method does not appear to solve some equivalence problems. This is expected, as the gravity data points are distributed to far apart to resolve the depths sampled by the VES's soundings.