Evaluation of 1D and 2D geological interpretations of potential field using wavelet transform analysis

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Gravimetry and magnetism are the most basic of the potential-field methods. However, geological interpretations are not easily evaluated in terms of reliability or ambiguity since potential fields of the Earth arise from the integrated effects of several sources at various scales.

Multi-scale analysis of multi-dimensionnal signals using the Wavelet Transform (WT) could help to dissociate the shallow and local source effects from the deeper and regional ones. Our contribution will briefly introduce the formalism of WT and the choice of the mother function (Morlet, Paul and DOG) from which wavelets are derived by dilatation and translation. We then present an optimised algorithm leading to a meaningful local and multi-scale decomposition of the potential fields.

The algorithm has been applied to 1D and 2D synthetic data sets to illustrate its effectiveness. It permits to extract the different components of the potential field in terms of location and scale, as well as the depth extension and geometry of the sources (geological bodies). This is realized combining information from the modulus, the real part of the wavelet transform and statistical significance tests. Finally, we extended the analysis to gravity and magnetic surveys accross some granitic plutons. The algorithm is able to detect features in the background that are not easily seen in the original data and helps to determine the dip of the structures (such as faults or geological edges) and to discriminate between bodies of different densities or magnetization.

In the broader sense, the space-scale representation of the potential-field data is essential to provide quantitative information about the characteristics (scale, location, depth and shape) of the causative bodies of the anomalies. Hence, it helps to reduce the ambiguity in the geological interpretation of potential fields and can be easily used to evaluate forward and/or inversion procedures.