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Informational and wavelet methodologies for combined analysis of geophysical data within the ISTIMES project

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The complexity of investigated geophysical problems with the ISTIMES (Transport Infrastructures Surveillance and Monitoring by Electromagnetic Sensing)" and the known ambiguity of the interpretation of geophysical observations call for an integration of different geophysical methods and their possible combination with the geological means (mapping, drilling, mining, etc.).

At a specified accuracy of geophysical methods and characteristics of the objects, technique of integrated interpretation is of primary importance for developing geophysical methods integration. The same refers to obtaining particular information from the separate method results and to the formulation of requirements to this particular information. For this purpose reliable informational and statistical criteria were used. The particular information can be obtained in terms of physical sources corresponding to various classes of geological (environmental or technical) objects. The integrated interpretation providing intersection of classes makes it possible to single out one or several geological targets, which form a solution of the geological objective sought for. In some cases only the comparison of fields measured by various geophysical methods leads to an "informational jump", which results in singling out the objects of search. Sometimes only estimation of the amount of the corresponding information containing in observations may substantiate the presence of an object of the desired class. These estimations are especially convenient for the integrated interpretation, as they provide means for operating on the data obtained by various methods and expressed in common (informational) unit. The target is singled out by maximum information obtained from the set of geophysical methods. Three different modifications of the informational integration of geophysical fields were tested both on real field examples and on numerous models with computing GPR images, gravity and magnetic fields (piezoelectric effects will be added to the computations at the nearest future).

Another applied approach is the advanced wavelet packet analysis (WPA). We choose to characterize the geometric events in the merged data curves via the representation of the curves in the Fourier domain. The assumption is that each of the data sets is characterized by the number of dominating scale bands. A perfect tool to reveal these characteristic scale bands is provided by the WPA. Once implemented, the wavelet packet transform of a signal yields highly redundant partitions of the frequency domain. The transform consists of an iterative application to a signal (curve) a pair (highpass - lowpass) of quadrature mirror filters. The developed WPA has been applied to synthesized gravity, magnetic and GPR data computed for geological models affiliated to two classes. The first one contains cavity (e.g. karst terrain), and the second one the models without cavity. The data were embedded into 3-dimensional space where data related to the C (cavity) subsurface are well separated from the N (non-cavity) data. This 3D set of the data representatives can be used as a reference set for the classification of newly arriving data.

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