Geophysical Research Abstracts, Vol. 9, 00913, 2007
SRef-ID: 1607-7962/gra/EGU2007-A-00913
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Wavelet analysis of spatial temperature waves: a new approach to the study of the Earth's interior

A.V. Khristoforov, N.N. Khristoforova, B.T. Burganov
Kazan State University, Kazan, Russia (akhristo@ksu.ru / +78432924454)

The report focuses on the results of the wavelet analysis of temperature distributions in boreholes. The most common feature of the experimental data is the presence of periodic spatial temperature waves overlapping well temperature distributions. Temperature waves have been found both in the complex laminated structures and in the relatively homogeneous strata, irrespective of the composition, age or origin of the rocks. These oscillations spread through the entire rock mass penetrated by the wells and provide information about the rock properties. The wavelet analysis allows the identification of spatial temperature waves and tracing their characteristics throughout the geological environment as well. The authors have correlated the wavegrams with the well logging data acquired in several hundreds of wells to find out that spatial characteristics of these waves are defined by the geological structure. The wave phases have been found to be associated with stratigraphic and lithologic boundaries in the rock sequence penetrated by the well. Certain phase values appeared to be tied to a certain depth or a boundary dividing rock strata of different thermal conductivities. As shown by the analysis of the mass thermogram data overwhelming majority of extrema and inflection points of the temperature waves correspond to lithostratigraphic boundaries. The shorter the mode's wave length, the more detailed data on the geological environment can be acquired. For instance, short lengths temperature waves can indicate the position of the oil and gas reservoirs. Spatial temperature waves are considered to be a feature of the Earth's thermal regime and their analysis provides a new instrument for the Earth's crust studies.