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A new approach to the study of the Earth's interior: wavelet analysis of well thermograms and temperature waves

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Very important information on the lithosphere including its thermal regime can be acquired through the wavelet analysis of well thermograms. Geothermal studies have been conducted by the authors in 1400 deep wells with a steady thermal regime on the East European Platform and in other regions. The thermogram of any well contains an individual pattern of spatial periodic temperature variations (modes), – temperature waves. The wavelet analysis of thermograms allowed the identification of spatial temperature waves and tracing their characteristics throughout the geological environment as well. 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. The authors have correlated the wavegrams with the well logging data acquired in several hundreds of wells to find out that these waves actually exist and that their spatial characteristics are defined by the geological structure. This fact indicates that the temperature waves are not an abstraction or a result of the mathematical treatment of thermograms. 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. There is no doubt that the spectrum and spatial characteristics of temperature waves are affected by the same heat and mass transfer processes in the interior as those defining the thermogram features. Although the thermograms reflect integral characteristics of these processes, the waves that have been identified in them will probably allow the differentiation of each process. 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.