Geophysical Research Abstracts,
Vol. 10, EGU2008-A-03371, 2008
SRef-ID: 1607-7962/gra/EGU2008-A-03371
EGU General Assembly 2008

Thermal instability of the fluid column in a borehole, application to the Yaxcopoil hole

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For better understanding of temperature state in the subsurface, temperature-depth logs can be suitably completed by high-resolution long-run temperature-time monitoring at selected depths. Observational evidence proved that even when a borehole is in stabilized conditions, temperature data may exhibit certain unrest resembling irregular oscillations of the order of thousandths or even first hundredths of degree. With the knowledge based on systematic studies performed in an experimental test hole covering temperature-time series of day-to-months length, we focused on a field verification of previous results. Temperature was monitored in rather complicated hydrogeological conditions in the deep Yaxcopoil-1 hole (Chicxulub impact structure). Two experiments are reported: (i) 18-day monitoring when the logger was located in the center of the temperature anomaly produced by the cold wave slowly propagating downwards and (ii) simultaneous three-loggers 20-day monitoring with loggers located above, in and below the anomaly. All observed temperature time series displayed intermittent oscillations of temperature with sharp gradients and large fluctuations over all observed time scales. While the "upper" and "lower" records revealed quasi-periodic temperature oscillations, the "central" record shows fast temperature oscillations with strong up-and-down reversals, all with amplitude up to first tenths of degree. It can be shown that a fluid in a borehole, subject to thermal gradient, is stable as far as the gradient remains below certain critical value. At higher Rayleigh numbers the periodic character of oscillations characteristic for "quiescent" regime is superseded by stochastic features. This "oscillatory" convection occurs due to insta-

bility of the horizontal boundary layers. In the specific case of the Yaxcopoil hole, the time series above and below the cold-wave part contain a component produced by the tidal forcing (the fact which was not observed in the previous studies), which dominates here over the high frequency domain (periods from 10-15 min to 1 min), which exhibit scaling behavior. This pattern changes for the center part of the old-wave, tidal forcing is still present, but composes only $\sim$3% of the signal and the downward migration of the cold wave does not affect this component.