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Anthropogenic component of the subsurface temperature field: observed and synthetic examples

P. Dedecek (1), J. Safanda (1), P. Heidinger (2), I. Kukkonen (3) and D.Rajver (4)

(1) Institute of Geophysics, Prague, Czech Republic, (2) Geophysical Institute, University of Karlsruhe, Germany, (3) Geological Survey of Finland, Espoo, Finland (4) Geological Survey of Slovenia, Ljubljana, Slovenia (pd@ig.cas.cz)

One of the uncertainties encountered in applying the method of the past climate reconstruction from a transient component of the present-day temperature-depth profiles is a possible signature of anthropogenic structures in the subsurface temperature field in borehole surroundings. If present and unaccounted for, this component can distort appreciably results of the reconstructions. We show examples of both measured and simulated temperature-depth profiles bearing such a signature.

We address different kinds of anthropogenic influence on the subsurface temperature field and suggest ways how to distinguish and separate the natural transient component caused by climate change from anthropogenic factors with the aim to make results of the borehole paleoclimatology more reliable.

The temperature profiles from five boreholes in (i) Prague, Czech Republic, within the campus of the Geophysical Institute, located on a rim of a large agglomeration, (ii) ©empeter, Slovenia, in a middle size urban area, close to a big sports hall, (iii) Eyreville, USA, in the rural area of the Chesapeake Bay impact structure, but situated close to a house with asphalted parking place, (iv) Espoo, Finland, within the campus of the Geological Survey, below one of the buildings and (v) Outokumpu, Finland, in a small clearing surrounded mostly by forest, are used to demonstrate the effect of different kinds of surfaces and anthropogenic structures on the subsurface temperatures in various geological and climatic conditions. All the five profiles show a distinct minimum in a different depth and of a different amplitude depending on the onset time of the anthropogenic change and the amplitude of the ground surface temperature change caused by these events. E.g. the anthropogenic disturbance of the temperature field reaches a depth of 100 m in the case of Espoo, where the first buildings in borehole surroundings were built more than 50 years ago. On the contrary, the minimum temperature was observed in 35 m in Chesapeake, where the house and asphalt areas were built only 7 year before the logging. We used our observations to simulate the above mentioned effects by solving numerically the heat conduction equation in appropriate geothermal models.