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The review of the Doctoral thesis by Mgr. Petr Dědeček -

There are several interesting scientific problems to be resolved in using borehole temperature logs and records in the scientific studies of present and paleoclimate. What is the coherence between the Ground Surface Temperature (SAT), Surface Air Temperature (SAT), soil temperatures and solar radiation? Have anthropogenic land changes at borehole sites and climate stations affected temperature trends? These are very important research subjects for the climatology and for the paleoclimatology? Testing of the coherence between ground surface temperatures (GST) history reconstructed from borehole temperature - depth (T-z) profiles, surface air temperatures (SAT) records, soil temperature changes, and solar radiation variability with time are essential for the so called 'Borehole Paleoclimatology" (terminus used by Bodri and Čermak in their 2007 Elsevier published book on "A new method on how to reconstruct climate").

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Doctoral Thesis authored by Mgr. Petr Dědeček titled "Transient temperature field of the shallow subsurface and its sources" (Czech title: "Nestacionární teplotní pole pod zemským povrchem a jeho zdroje") consist of the research material well described and well illustrated in logical order in numerous chapters and sub-chapters. These are: Preface; Abstract; Introduction; Data set description in Czechia (Prague), Slovenia and Portugal researched sites; Transient temperature signal in shallow subsurface; Thermal diffusivity from subsurface temperature series (this one consisting of sub-chapters on Estimation based on the error function solution of the heat conduction equation, Estimation based on periodical boundary condition, Conduction-Convection (CCA) algorithm, Spectral analysis of data and Calculation of TD and parameter W); Chapter on Impact of anthropogenic structures on subsurface temperature field (with subchapters on, Numerical modeling, Borehole GFU-2 in Prague, Borehole Še-1 in Šempeter); Conclusions; Acknowledgements; List of papers included in the thesis; References and

Supplement (papers included in the thesis). The PDFs of the Thesis and of the “Summary of the Doctoral thesis” (autoreferát Dědeček) and PDFs of the published papers in high impact peer - reviewed journals were also available to me and read.

In the thesis Petr Dědeček takes on the problem of the influence of climate and "anthropogenic disturbing" signals caused by human activities affecting the transient component of the subsurface temperature field. He approaches the problem head on. He investigates various factors and mechanisms forming the transient component of subsurface temperature field. Long-term air and ground temperature series and repeated temperature logs from several boreholes in Czech Republic, Slovenia and Portugal are processed by Petr Dědeček to distinguish and describe possible sources of transient signals in subsurface temperature field. The role of the “Urban Heat Island” effect is studied for the deep borehole situated inside the built-up areas.

The observational part of the study contains monitoring of long-term warming of subsurface in several observatories, and of the subsurface temperature field (Spořilov and Šempeter).

The work contains newly developed algorithms essential in the calculation of thermal diffusivity from long-term temperature series up to the depth of annual temperature variations. It also enabled study of the effect of possible convective heat transfer which is included. It was shown that heat transfer by conduction dominates in the vadose zone which is very important finding.

The initial impulse for investigation was monitoring of long-term warming of subsurface in several observatories operated by GFU. Discovering that the greatest warming in the borehole situated at the campus of the Institute did not correspond with regional climate change was a first important step. Since this borehole is situated inside the built-up area, it was clear that the Urban Heat Island effect plays a role. Observed discrepancy between the regional climate change and observed temperature response in subsurface studied in two urban areas - in Prague and in Šempeter (Slovenia) was explained and quantified.

The 3D numerical modeling enabled detection and quantification of the impact of local anthropogenic structures and regional climatic changes on subsurface temperature field in cases

of Spořilov and Šempeter boreholes. There the strong influence of human activity on subsurface temperature field is discovered. The main achievement is splitting the transient component of the present-day temperature depth profiles into the climatic and anthropogenic signals.

The presented research is in a new and emerging field with broad application and significant potential scientific payoff in integrating modern day and paleo-climate research. What is the coherence between the between ground surface temperatures GST, SAT, soil temperatures and solar radiation? Have anthropogenic land changes at the SAT - GST monitoring stations and borehole sites affected temperature trends? These are very important issues. It is important for testing coherence GST reconstructed from borehole temperature - depth (T-z) profiles and surface air temperature SAT.

Mgr. Petr Dědeček shows his skills and capabilities in mathematical processing and 3D modelling dealing with most difficult and complicated issues of long-term air and ground temperature series and repeated temperature logs from several boreholes. This allowed him to distinguish between different sources of transient signals in subsurface temperature field. Estimation of the soil and bedrock thermal diffusivity from long-term temperature records results are presented and compared. Results proved that on the annual time scale the convective heat transfer did not contribute significantly to the temperature-time variations monitored in the uppermost 10-m depth zone and that the influence of moisture changes on subsurface temperature field noticeably appears only in the upper 5 cm of soil. This is very important finding for the analyzed stations and sites in which repeated deep temperature logs done. It has much broader world - wide importance for use of repeated well temperature logs and their inversion in resolving past climate.

Using 3D numerical modelling a direct human impact on the subsurface temperature warming was proved and contributions of individual anthropogenic structures to this change evaluated. The separation of climatic signals versus influence of anthropogenic structures to this change was made possible. The novelty of this dissertation is resolving the influence of urbanization based on 3D modelling and interpretation of measurements. This influence was proven to have have crucial influence on transient component of subsurface temperature. Mgr. Petr Dědeček

work makes us understand above normal warming found in the boreholes situated at the urbanized areas like in case of the well at the campus of the GFZ Institute or in another case of the Slovenian borehole. What is climatic warming and what is anthropogenic land change influence is now well quantified.

Mgr. Petr Dedecek's work has profound importance for borehole paleoclimatology and interpretation of results of inversions of the continental deep temperature logs (in NOAA data base) for the paleoclimatic GST histories for the last half a millennium. The influence of convective water flow upon temperature -depth was shown to be of second order at least for the upper 10 cm of the soil. Results of Mgr. Petr Dědeček's work proved that on the annual time scale the convective heat transfer did not contribute significantly to the temperature-time variations monitored in the uppermost 10-m depth zone and that the influence of moisture changes on subsurface temperature field noticeably appears only in the upper 5 cm of soil. These findings, findings about urbanization influence (this reviewed thesis) and previous about influence of land clearing (Majorowicz and Skinner 1977) and clear cutting for lumber industry in forests (Lewis and Wang 1992) all show that in many cases signal of warming seen in well temperature records is only a part of the observed transient. The remaining one comes from non-climatic sources. In such places temperature depth transients observed in deep boreholes logs cannot be interpreted solely as climatic change signal.

This calls for correcting some of the continental GST histories from inversions of boreholes temperature logs in the NOAA and IHFC IASPEI maintained data base (Huang et al. 2000). Which ones of that data base would combine anthropogenic and climatic warming signal, and which are purely paleoclimatic signal? This is the problem for future analysis. The 'borehole paleoclimatology' based warming rates for last five centuries when compared to other paleoclimatic proxies show much higher climatic warming (Huang et al, 2000). Elimination of the well log data from recently urbanized areas or well temperature logs from boreholes in the areas being deforested, cleaned for farming would be one way to get these aside from ones in unaltered terrains showing undisturbed climatic signal. The other attempt would be to distinguish for many suspected borehole sites the anthropogenic influence from the climatic signal as done by 3D modelling showed by Mgr. Petr Dědeček. His work is important for 'borehole

paleoclimatology' for many urban and land altered sites. These up till now are included in the world continental data base and inverted into GST histories as purely paleoclimatic. Some are biased by the land change due to anthropogenic activities and such is well proven for the cases studied by this reviewed thesis.

Based on the submitted dissertation thesis, I propose that **Mgr. Petr Dědeček** be awarded a PhD.

J.A.Majorowicz