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Review and evaluation of habilitation thesis by Dr. Zbyněk Engel

**“Vývoj horského zalednění ve svrchním kvartéru a jeho význam při určování změn
přírodního prostředí”**

Introduction

The habilitation thesis of Dr Zbyněk Engel consists of 14 papers published in the period 2007–2016 in peer-reviewed international journals, preceded by a commentary in which the candidate sets the context for the individual contributions, summarizes the main findings and presents the significance of his work for the field of glacial geomorphology, Quaternary history and recent environmental change related to glacier behaviour. The papers are divided into three sections, focused respectively on: (1) research methods in glacial geomorphology, (2) palaeogeography of mountain glaciation in Central European mountains, (3) ongoing environmental changes related to glacier advances and decay. The first section consists of four papers published in 2007–2012, the remaining two comprise five papers each.

For the assessment of the thesis it is of utmost importance to emphasize that all 14 papers were published in international journals, including those with high impact factor above 2.5 (e.g. *Earth Surfaces Processes and Landforms*, *Geomorphology*, *Quaternary Science Reviews*, *Catena*). These journals are all known from applying rigorous peer-review process and strict quality control. Therefore, it does not seem necessary to me to go into details of each paper and the datasets which they are based on, as this has been subject to scrupulous review at the stage of submission, review and revision. Rather, I am going to focus on broader issues emerging from these papers which directly answer questions to be addressed by the reviewer of habilitation thesis and which are most relevant in the context of final recommendation whether the thesis is a sufficient basis for promotion to the position of associate professor. Thus, in my opinion the habilitation thesis, besides being scientifically sound – as is the case, should demonstrate abilities and skills expected from people occupying high academic posts. Consequently, the review is arranged in five parts, focused on: (1)

significance of presented research, (2) thematic scope and diversity of methods, (3) geographical scope, (4) publication strategy, (5) ability to team work.

1. Significance of research – originality and added value

This is the crucial part of the assessment as it relates to the ability of the candidate to contribute to the progress in science, to open new research avenues, and to guide young researchers in the future. I have no reservations to say that research presented by Dr. Engel is significant and relevant, and that due to his efforts our understanding of problems of late Quaternary mountain glaciation in Central Europe is much clearer than before, especially regarding chronology of glacier advances and retreat phases.

Before Dr. Engel started his research in the Karkonosze Mountains, the extent of glaciers was roughly known but its timing remained very speculative, based on morphological correlations and thermoluminescence dating of questionable value. Combination of various methods of dating glacial features (sediments, exposed surfaces), both directly and indirectly, coupled with results of detailed field geomorphological analysis, helped to constrain chronology of the last glaciation in the Karkonosze, both on the southern (Czech) and northern (Polish) side. Moreover, this research demonstrated that previously held views that glacier extent during LGM (Last Glacial Maximum) was essentially limited to cirques was incorrect and nearly all glacial morphology preserved in the valleys dates to LGM (paper V).

In a similar way, using modern techniques to establish rock surface exposure ages, Dr. Engel working in collaboration with other researchers, was able to provide the first quantitative constraints on the timing of glaciation in the northern part of the Bohemian Forest (paper VIII). Here too it was demonstrated that glaciation occurred during the Last Glacial Maximum, in several phases of retreat and re-advance. Finally, an analogous approach to the mountain glaciation in the Slovak part of the Tatra Mountains resulted in significant findings related to the extent of glaciers during the LGM, chronology of subsequent re-advances, and patterns of ice mass loss during deglaciation (paper VI). Our understanding of palaeogeographical evolution of the glaciated valleys in the Tatra Mountains was also significantly enhanced through another study (paper IX) in which surface exposure ages for rock slope failures were provided for the first time in this regionally important mountain range. While some mass movements were directly related to deglaciation, others lagged behind which demonstrates the complexity of slope response to deglaciation.

Another line of research in which the results of Dr. Engel's work proved highly significant relates to environmental changes during and, especially, after deglaciation in the Karkonosze Mountains (papers III and VII). Prior to his work, little had been known about the Holocene history in the most elevated part of the mountain range and very few chronological constraints were available. The research carried out by the applicant on sediments from a vanished lake in Labský důl demonstrated the usefulness of multi-proxy approach and refined Holocene climatic history, including identification of colder and warmer intervals. This work will become a benchmark paper (actually, it already serves as such) for anyone dealing in the Holocene history of the West Sudetes in the future.

Regarding methods used, Dr. Engel contributed significantly to the application and interpretation of Schmidt hammer intact rock strength approach. He used the technique in various studies, including those not selected for the habilitation thesis, and was able to offer valuable methodical improvements of the method. The added value relates mainly to two issues: (a) demonstration how intact strength changes with depth and (b) the impact of grinding (i.e. removal of the upper few millimeters of rock) on rock hardness testing (paper I). It was shown that grinding decreases the values of the coefficient of variation and hence, allows for obtaining more reliable data. Also, it was shown that the R-value remains stable in the upper 5 cm of rock or so. However, there are technical and conservation-related limitations involved if these recommendations are to follow, which is probably why examples of pre-treatment grinding are uncommon. In another paper (paper II), actually the earliest in the set (dated 2007), Dr. Engel attempted correlation between Schmidt hammer readings and ^{10}Be exposure ages for moraines, as a basis to establish SH-based chronology, giving foundations to the method of Schmidt Hammer Relative Age Dating, widely applied today. The importance of this paper is testified by a high number of citations (13, without self-citations). Finally, Dr. Engel contributed to better understanding of the meaning of *k*-value used in geomorphometric characteristic of glacial cirques (paper IV).

Not being a glaciologist, I feel less competent to assess the wider significance of papers contained in the part III of the thesis which deals with contemporary environmental change in high mountain (South America, Central Asia) and polar environments (Antarctica). Nevertheless, all these papers are well-structured, methodically sound, provide new data and some of them have important practical dimension, as they relate to the issue of natural hazards which may occur in recently deglaciated terrains, such as lake outbursts or slope failures.

In this context it is appropriate to comment about citations of Dr. Engel's papers comprised in the habilitation thesis. According to Web of Science (retrieved 6 November 2016), these 14 papers have been cited (excluding self-citations) 128 times, with the number of citations ranging from 25 (paper VII) to 2 (paper X). Paper IX was published in 2016 and it is not realistic to expect any citations at this stage. These numerical indices indicate good reception of academic work of Dr. Engel and his results are referred to both in the context of methods and interpretations, as well as in regional studies in Central Europe, Central Asia and Antarctica.

To sum up, papers presented in the habilitation thesis are significant contributions to various fields of geosciences as is evident from both their content and reception by the international community.

2. Thematic scope and methods

One needs to acknowledge the wide range of research interests of Dr. Engel, as demonstrated in his habilitation thesis. Although his general field of inquiry is glacial geomorphology and palaeogeography, there are so many sub-fields within this general theme that one can easily become a specialist in a very narrow research topic. Dr. Engel did not fall in this trap and continues research tackling various problems and using different methods, each requiring separate skills and expertise. Thus, the thesis shows his competence in glacial geomorphology and analysis of glacial landforms (papers IV, V, VI, VII), proglacial environments (papers XII, XIV), mass movements (papers VI, IX, X), sedimentary record of past mountain environments (papers III, VII), current glacier behaviour and its impact on other components of the environment (papers XI, XII, XIII), direct dating of glacial events (papers V, VI, VIII, IX), evaluation of rock strength and its deterioration through time (papers I, II) and natural hazards (papers X, XIV).

Likewise, and related to the above, multitude of methods used in research is a characteristic signature of Dr. Engel's activity. They include field description and analysis of landforms related to various surface processes (glacial, periglacial, glacialfluvial, gravitational), statistical analysis of quantitative data, interpretation of results of cosmogenic ages, testing rock surfaces using Schmidt hammer, calculation of mass balance of glaciers, and geomorphometry.

3. Geographical scope

Another strong point of Dr. Engel's career, and the habilitation thesis in particular, is the wide geographical scope of research. Papers comprised in the thesis document research activity in the native Czechia (Krkonoše, Jizerské hory, Šumava), in Slovakia (Tatra Mountains), Kyrgyzstan (Tian Shan), Peru (the Andes) and Antarctica. In each of these areas not only geographical conditions are different – requiring constant self-education and broadening of background knowledge, but logistical conditions are different too, often they are difficult ones. To cope with the latter, organizational skills are necessary and the long list of papers emerging from research abroad (not limited to the habilitation thesis) shows that Dr. Engel was able to overcome logistical problems and produced high-quality final products.

Having said that, I also observe that the key area of his research are the West Sudetes, where Pleistocene glaciers and periglacial processes significantly shaped the relief (6 out of 14 papers explore this region). This is good and Dr. Engel has become a leading expert in the Quaternary history of the region and I am sure he has already identified further research problems to explore in the near future.

4. Publication strategy

Not uncommonly, valuable research results do not reach wider scientific community because their authors follow wrong publication strategy, publishing in local and/or inappropriate journals, or as book chapters difficult to reach. This is not the case of the thesis by Dr. Engel who should be praised for his clear understanding that the right place to publish is one of the keys to success. Essentially each journal he chose as publication outlet enjoys high esteem in geomorphological and Quaternary research community. Titles such as *Geomorphology*, *Catena*, *Earth Surfaces Processes and Landforms*, *Quaternary Science Reviews* or *Landslides* are all synonymous with high quality of research. I need also to emphasize that publications in these journals are not singular events. For Dr. Engel, presentation in a high-impact journal is a norm. Among 14 papers comprising the thesis *Geomorphology* features twice, *Quaternary Science Reviews* – three times, *Journal of Glaciology* – twice. Likewise, the fact that the thesis comprises of papers published in 10 different international journals shows that the candidate is not 'one journal person' – another valuable indicator of Dr. Engel's position in the academic community.

5. Ability to team work

The final point I intend to address in the evaluation is the ability to work in multidisciplinary teams as this is clearly the way science is proceeding now and surely will continue to do so in the future. The fourteen papers comprising the thesis make it clear that Dr. Engel is very good in team work, acting as both a leader and a valuable contributor. Out of those fourteen papers, he is the senior author of eight papers and in five other cases emerges as the second author. Besides, this shows that in each example his contribution was of crucial significance.

For the thesis he worked with as many as 28 co-authors representing several nationalities. These people added various fields of expertise, necessary to solve research problems identified and tackled by Dr. Engel. Among his collaborators are specialists in stable isotope analysis, cosmogenic surface exposure dating, sedimentology, palynology, mass movements, hydrology, Quaternary geology and others. In my opinion, joint work with such a wide range of people demonstrates the right approach to research, good interpersonal skills, and clear vision of how research projects have to be structured to achieve credible results. Nevertheless, it was usually the role of Dr. Engel to assemble data provided by specialists in different field, to critically analyze them and then to put together towards a synthesis that can be published.

Conclusions

To conclude, I have no doubts that the habilitation thesis of Dr. Zbyněk Engel meets the standards set for this academic degree and fully demonstrates his ability to conduct good science. Therefore, he fully deserves to be nominated for the associate professor position in physical geography. The main strengths of the thesis include the wide thematic and geographical scope of interests within the general field of glacial geomorphology, Quaternary studies and contemporary environmental change, application of novel approaches and modern techniques to solve research problems, both old and new, involvement in multidisciplinary and multinational research tasks and teams, and the fact that in more than half of the papers Dr. Engel was a senior author. Last but not least, Dr. Engel is clearly aware that good research results need to be presented at appropriate venues to reach the research community in an

effective way. In this context, it is most impressive to note that the thesis consists of as many as 14 international papers, in prestigious journals, appearing regularly over the last decade. Surely, Dr. Engel as an associate professor will be one of the pillars of the research units where he will be based.

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