MUNI SCI Geografický ústav

Review of the Doctoral dissertation by

Benjamin James Stoker

„The dynamics of the north-western Laurentide Ice Sheet margin“

submitted to receive Ph.D. in the Study program: Physical Geography and Geoecology

at the Faculty of Science, Charles University, Prague

The presented doctoral dissertation summarises the new findings of the author and associated team on the past changes of the north-western margin of the past Laurentide Ice Sheet in the northern Interior Plains and Mackenzie Mountains, where it coalesced with Cordilleran Ice Sheet and local mountain glaciers. The new findings were separately published (or are under review) in four scientific papers, where Benjamin is the main author of three of them and contributed substantially to all of them. These papers were published in Journal of Maps and The Cryosphere, highly ranked journals in the field of Physical Geography. The dissertation is composed as commented set of four papers with a well-structured overview with clear motivation and objectives. The formal, scientific and linguistic quality of the dissertation is excellent. From this point of view, the dissertation meets all criteria for such monographs. Besides, the new exposure ages, detailed maps, reconstructions and models bring new pieces of information about the timing and extent of the north-western sector of the Laurentide Ice Sheet during the last climate cycle. Despite the fact that I am quite reserved about the use of remote mapping in geomorphology (it fails in putting together the landforms and sediments in sediment-landforms associations, which is a cornerstone of landsystem approach), I completely understand that such large areas cannot be processed objectively better than using remote sensing and Benjamin with co-authors made this very well. The data presented in this thesis has clearly shown the rapid thinning and subsequent disappearance of the NAISC in the saddle area between the Laurentide and Cordilleran ice sheets during the Bølling–Allerød warm interval. The new deglaciation ages and chronological model presented here match better with climate history and show much more dynamic nature of the ice sheet margin than previously thought.

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Despite the new chronological results presented in this thesis, the vast area of north-western sector of Laurentide Ice Sheet remains highly understudied and Benjamin is very much aware of this pointing to unresolved and/or understudied topics and areas, where future research is needed to bring a more complex and robust deglaciation stories.

I only have a few minor comments, which are marginal and have no effect on the excellent level of the presented dissertation. Besides, some points need further discussion (see also my comments in the annotated pdf of the Ph.D. thesis). Some statements in the introductory parts of the thesis are rather strict for the amount of data available, I would prefer slightly down-tuned wording at some places.

Besides, I place some questions and am happy to discuss these points during the Ph.D. thesis defence. I have not found how thick were the samples for TCN dating and from which surface they were taken. I was rather confused by the statement that erratic boulders with a better rounding, which underwent longer transport (not specified whether it was glacial, or for example fluvial transport) have lower inherited content of TCN – could you explain it to me? You have also stated that the selection of different scaling methods has a minimal (~2%) effect on the calculated exposure age. I do not think this is correct, as most scaling methods does not account for scaling of muons production.

Do you have any proof for limited weathering of the surface, such as preserved striations on the surface of boulders, Schmidt hammer tested surface hardness, or others? Or is it just your assumption based on the regional climate and environment? How do you know that the environmental conditions have not changed between the exposure and the present? I think there are numerous factors (beside the glacial isostatic adjustment, the use of which I really acknowledge!), which should be taken in account. I think that you should provide proofs rather than general statements. You have stated that the warming during the Bølling–Allerød caused an expansion of the ablation area as the ELA lowered. I think this is the other way around, isn't it? Can you also comment on how your results matches with those recently published by Reyes et al. (2024) in QSR?

You have also outlined some possible direction of research to improve our understanding of the timing, extent and number of glaciations that occurred in north-western Canada throughout the Quaternary. From the viewpoint of similar research knowledge in

European context, I would like to ask on the probability of preservation of the traces of previous glaciations and their reconstructions in the Interior Plains, as advances of ice sheets generally destroy most of the products of previous glaciation.

The inheritance issue discussed in your future work section of the thesis is interesting and I would really like to know more, including to see the banana plot and discuss the relevant Be-10 and Al-26 ages against those with inherited TCN content based on paired approach. Would this discussion be possible during the Ph.D. thesis defence?

My general conclusion as the reviewer of this doctoral dissertation is as follows: with the submitted doctoral dissertation, Benjamin James Stoker clearly demonstrated independent creative ability in the field of Physical Geography and Geoecology and I can recommend the submitted thesis for defence with a clear conscience.

v Hronově, 13.3.2024

Doc. Mgr. Daniel Nývlt, Ph.D.

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