Assessment of the PhD Thesis by Petra Maierová

Evolution of the Bohemian Massif: Insights from numerical modeling

The submitted thesis is focused on the numerical modeling of exhumation of felsic high-pressure metamorphic rocks that form a large volume within the crust of the Moldanubian core of the Bohemian Massif. The subject is very timely as the Variscan development of the Bohemian Massif has bee hotly debated also by geoscientists from abroad, namely from Germany, France and Austria. The author investigated an influence of the rate of the Variscan convergence of two crustal blocks on the model evolution, considering radiogenic heating and pressure-temperature conditions in the felsic lower crust, as well as an efficiency of erosion. The modeling has been applied to the southern (Moldanubian) and the northern (Sudetic) parts of the Bohemian Massif. The thesis consists of four major chapters followed by 'Conclusions and perspectives'.

The first chapter presents a brief summary of the geology and tectonic development of the Bohemian Massif and major results of geological and geophysical investigations that constrain the crustal and lithosphere structure. The chapter is complemented by a basic geological terminology, the time scale and by a pressure-temperature diagram of metamorphic facies that are later used in discussing the results of the numerical modeling. This introductory part shows that the author did her best to understand tectonics of the Bohemian Massif and I would like to recommend it for reading to students in geophysics.

The second chapter describes the computational tools the author developed by adapting the open-source Elmer Software (2005) with the aim to set up a numerical model that would fit best the geological observations and provide a new insight into the dynamic development of the felsic metamorphic rocks.

Core of the thesis is formed by Chapters 3 and 4 containing two peer-reviewed papers published in international journals. Chapter 3 describes the numerical model of the late Variscan evolution of the central part of the massif. Deformation of the crust is driven by radiogenic heating in the felsic lower crust, the lateral contraction of the Moldanubian domain due to the convergence with the Saxothuringian plate is followed by an indentation of the rigid Brunovistulian basement into the orogenic root. The model explains major geological events inferred from the geological record in the Moldanubian domain.

Chapter 4 aims to explain by the numerical modeling two contrasting tectonic and metamorphic developments of the southern and the northern parts of the orogen. It has been concluded that the gravity-dominated and fold-dominated models correspond to the structures observed in the Moldanubian and the Sudetes, respectively. I appreciate that besides the conclusive remarks at the end of the thesis the author also expressed her vision of the future steps in the numerical modeling and added the list of abbreviations and notation. The thesis represents very careful work, well organized, with perfect figures and only a few misprints (e.g., 'underthrusted').

I have the following questions/comments that should be addressed by the candidate:

- The title is too ambitious as the thesis deals only with a part of evolution of the Bohemian Massif. Besides, I miss the word 'crustal' evolution.
- I fully agree with the modeling strategy assuming a mechanically strong mantle basement and a weak lower crust (p. 120). However, in this context I do not understand the sentence on p. 35 'The flow of material is solved only in the crustal part, and therefore we neglect the dynamic effect of the mantle flow on the crustal deformation.'

- I do not see anything redrafted in Fig. 1.11 on p. 21, as stated in the caption.

In future modeling I suggest considering the following views/problems:

1. Formation of an orogenic plateau (p. 75) is only one possible consequence of the Variscan orogeny. Other authors (e.g., Franke, 2006) suggest the crustal thickening occurred only in narrow belts and the central Variscides were close to sea level from the late Devonian onwards.
2. How realistic is emplacement of a felsic Saxothuringian crust thrust beneath the Teplá-Barrandian block? How long time can such felsic material survive in the lower crust of the 'hot' Moldanubian core of the Bohemian Massif?
3. Kotková et al. (2011) showed that a deep subduction to ~150 km is needed to explain the presence of microdiamonds in granulites of the Krušné hory Mts. and suggested that tectonometamorphic models involving a deep orogenic crustal root need to be modified.
4. Recent research on the rheology of the continental lithosphere attest to the strength and longevity of its mantle part (e.g., Chen et al., Gondw. Res. 2012). Therefore, I suggest to adopt a whole lithosphere instead of the crustal model.

In conclusion I want to emphasize the well known fact that any modeling is only an approximation to reality. However, the presented thesis yields results that compare favorably with geological structures in nature and significantly contribute to our knowledge of the Variscan development of the Bohemian Massif, that might be applied to other parts of the orogen, namely by the following new results:

- Developing a computational tool for modeling the crustal deformation during a continental collision by adaptation of the open-source Elmer Software (2005).
- Characteristics of the numerical model (timing of the process, pressure-temperature paths, sedimentation, topography of the surface) are in agreement with those inferred from the geological record.
- The modeling contributed to predicting a relation between the prograde pressure-temperature paths and the velocity of continental convergence.
- It reproduced a possibility of laterally forced upwelling of the felsic lower crust and its subsequent sub-horizontal flow over an indentor.
- It showed a possible geotectonic scenario explaining the contrasting character of the Moldanubian and the Sudetes units by the gravity-dominated and fold-dominated models.
- The results are in agreement with the previously expressed opinion that the radiogenic heat in combination with tectonic stresses can provide enough energy for deformation and metamorphism of rocks, without a lithosphere delamination.

I am convinced that the candidate proved by the presented thesis her creative ability for scientific work. Therefore, it is my pleasure to suggest to the commission to accept the thesis as a high-quality scientific product relevant to the PhD level.

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RNDr. Vladislav Babuška, DrSc
Geophysical Institute, Academy of Sciences of the Czech Republic