Evolution of the Bohemian Massif: Insights from numerical modeling by Petra Maierová

A statement of PhD thesis supervisor

The evolution of the Bohemian Massif has so far been constrained mostly by geological and geophysical data. Although the geophysical data yield important information about the internal structure of the domain, their physical interpretation is often non-unique (with gravimetric models being a typical example) and they do not yet provide a sufficiently clear picture of the crustal part of the Bohemian Massif. The geological record contains information about the conditions the rocks were exposed to but this information is fragmentary, complex and often difficult to decipher. As a consequence, the evolution scenarios so far proposed for the Bohemian Massif are purely qualitative and not properly anchored in physical theory. In her PhD thesis, Petra Maierová attempts to overcome this limitation by presenting a numerical tool which solves the equations governing the thermal and strain evolution of a crustal block in 2d Cartesian geometry. This tool can be used to simulate the geological evolution of a crustal domain under specified boundary conditions and thus to assess the physical admissibility of a given geological model.

In the geological part of the thesis Petra Maierová followed recommendations of Ondrej Lexa and Karel Schulmann. She attended geology lessons in the Faculty of Science and participated in several field trips (Corsica, Norway etc.). Her present-day knowledge of geology (definitely exceptional among the geophysics students at the Faculty of Mathematics and Physics) is well demonstrated in Chapter 1 of the thesis where she gives an overview of the Bohemian Massif geology and discusses the available geophysical data.

The skill of Petra Maierová in numerics and computing is demonstrated in Chapter 2 of the thesis where she describes the physical theory and her modifications and improvements of the open-source software of Elmer. These modifications include markers, free surface, its correction for erosion and sedimentation, complex non-Newtonian and brittle rheologies and elastic flexure of the lithosphere. The numerical tests of the code are carefully documented and provide the reader with a useful set of benchmarks. I would like to emphasize that my role in preparing the numerical code was negligible and Petra did all the programming work quite independently. The numerical code presented in the thesis is unique in the territory of the Czech Republic and is comparable in complexity and resolution with the similar codes used in the top laboratories in Europe and the US.

The modeling part of the thesis concentrates on testing the conceptual model of the Variscan evolution of the Bohemian Massif developed by Schulmann and co-workers. The results are presented in the form of two already published papers in Chapter 3 and 4. Petra Maierová follows the modeling strategy proposed for investigation of the hot orogens by Chris Beaumont's group: She focuses on the crustal deformation and assumes that the processes in the mantle can be reasonably well mimicked in terms of suitably chosen boundary conditions. The starting point of the simulation corresponds to the situation where the Saxothuringian upper crust, rich in radioactive elements, is emplaced beneath the future Moldanubian crust. Petra Maierová demonstrates that the horizontal compression of such a domain (either due to subduction of the Saxothuringian continent and/or due to indentation of Brunia from the other side) leads to formation of granulites and their exhumation under the p-T conditions that are in agreement with the observation. The only questionable part of the model is the assumption of the Saxothuringian felsic material underplating the Moldanubian crust. This initial state, determining the behavior of the system during the compressional phase, is based on the concept of *relamination* which has been debated in geological literature since the late 80s. Although some kind of relamination is required by geological and geochemical data in many regions of the world, the mechanical feasibility of this process remains unclear and the relamination itself has never been satisfactorily reproduced by numerical simulations.

Besides her work on the numerical model of the Bohemian Massif, Petra Maierová also participated in the European project *c2c* (Crust to core: the fate of subducted material). In the framework of this project she spent five months at BGI Bayreuth. Her paper on the effect of realistic conductivity on the temperature distribution in subducting slabs (not included in the thesis) has been recently published in *J. Geophys. Res.*

To conclude, Petra Maierová is a gifted young researcher who is able to do sophisticated geophysical modeling that incorporates complex geological information. Her PhD thesis clearly demonstrates that the cooperation between geologists and geophysicists is possible even in the Czech Republic, where these two disciplines have so far developed rather independently, and that this cooperation can contribute to a better understanding of orogenic processes.

I recommend the thesis for the defense.

In Prague, December 4, 2012 *Dr. Ondřej Čadek*