Supervisor's review of doctoral project

Slapová deformace ledových měsíců
Tidally induced deformation of icy moons

by Kateřina Pleiner Sládková

I have had the pleasure of knowing Kateřina Pleiner Sládková since 2012, when I first met her as a student in the MSc program in Mathematical Modelling in Physics and Technology at our faculty. During this time, I served as an advisor for her diploma project. Upon graduating in mathematical modeling, Kateřina joined the ranks of geophysicists within a Ph.D. project at Laboratoire de Planétologie et Géosciences in Nantes, France. Regrettably, this project was interrupted after two years, but Kateřina gained important experience from abroad while expanding her programming skills in the process. I am pleased that she chose to continue, starting a new Ph.D. project under my supervision in Prague. Kateřina's resilience and determination have been evident throughout her academic journey, enabling her to overcome various challenges, including instances such as the forced withdrawal of a paper just before submission due to a scientific oversight, for which I take responsibility as her supervisor.

Initially, Kateřina's Ph.D. project aimed to explore the numerical modeling of tidal deformation on icy moons orbiting giant planets within the Solar System. However, her focus soon shifted to investigating the specific role of friction on preexisting faults, a crucial physical mechanism often overlooked in previous studies. Kateřina's research centered on examining the thermal and mechanical implications of friction within a planetary context, with a particular emphasis on Europa and Enceladus.

Two significant contributions from Kateřina's thesis have been published in prestigious (Q1) journals. The first paper introduced a consistent modeling approach to the so-called "tidal walking" process, identifying it as a plausible explanation for observed lateral offsets on strike-slip faults on Europa's surface. In the second paper, Kateřina expanded the numerical code developed within our planetary science group, to investigate the impact of friction on the system of south-polar faults within Enceladus's shell, providing the first estimates of its contribution to dissipative heat generation. Additionally, I wish to highlight a noteworthy aspect of the thesis that remains unpublished, despite its clear potential for publication. Kateřina's reevaluation of a seminal paper by F. Nimmo (2002), focusing on the modeling of tidally-induced strike-slip motions and associated heating at faults on Europa, challenges the previously suggested significant meltwater production beneath such faults. Last but not least, Kateřina also made significant progress in incorporating more realistic (rate and rate-and-state) friction models into the adopted continuum framework, showing promising potential for future exploration.

Methodologically, Kateřina's research involved the development of tailored mathematical models mainly within the open-source finite element library FEniCS. This encompassed both the creation of novel models and the refinement of existing ones, alongside their integration. While the core of her work revolved around mathematical modeling and computational analysis, Kateřina demonstrated a keen understanding of the underlying physics, enabling her to offer insightful interpretations of the results and to effectively communicate them in publications, in her thesis, as well as in presentations at seminars and conference talks. During the work on her Ph.D. project, Kateřina also gained experience in funding management, receiving a 3-year project from the Grant Agency of Charles University.

All this considered, I firmly believe that Kateřina Pleiner Sládková has demonstrated her ability to conduct independent scientific research, and her submitted thesis undoubtedly qualifies her for the award of a Ph.D. degree.

Prague, March 19, 2024 doc. RNDr. Ondřej Souček, Ph.D.