Review of Doctoral Thesis:
Tidally induced deformation of icy moons by Katerina Pleiner Sladkova

Summary: This thesis describes several studies related to the mechanical process of fault motion within the context of icy moons Europa and Enceladus, and a discussion of friction, which applies directly to the modeling efforts. I found the work to provide valuable extensions of existing models and/or hypotheses for the behavior of faults on icy moons. I fully support the acceptance of this thesis and the advancement of Katerina Pleiner Sladkova to PhD.

Findings:

1) On the topic of melt production via shear heating, I am curious as to the differences and similarities between this work and the recent studies by Hammond et al. (2020; 2022; 2023). Those studies also investigate how periodic tidal forcing on a Europan fault could drive heating and melt generation. It is quite common for different research groups to tackle the same problem, and even come to different conclusions, so I have no concerns about the value of the project. My interest is in understanding the differences in the modeling approaches and the extent to which the results agree or disagree.

2) Across all of the modeling projects, a Maxwell rheology is assumed for the ice shell. Qualitatively, how might the results differ if an Andrade rheology (e.g., Shoji et al., 2013; Walker and Rhoden, 2022) were assumed instead? Similarly, the ice shell is modeled as convecting, but it is also plausible that Europa has a conducting ice shell (e.g., Walker and Rhoden, 2022). Were any models attempted using a fully conductive ice shell? How does the assumption of convection affect the results?

3) The study of tidal walking on Europa seems to show that it is an unlikely mechanism for generating the observed offsets on Europa. What are the alternative methods? Also, how do offsets continue to develop over many orbital periods if the lower part of the fault is always locked? Would the ice shell mechanically separate at the depth where the fault is locked?

4) The tidal walking model for Europa and the tidal modification of the Tiger Stripes on Enceladus are fundamentally driven by the same process, but the thesis does not make any direct comparisons between the two studies. Is the asymmetry in stress described for Enceladus equivalent to the idea of tidal walking, in which one shear direction is associated with tension – enabling slip – while the other is associated with compression? Should we expect a background stress on Europa? Europa has dense networks of fractures, although we do not currently know if they are active contemporaneously; should Europa's fractures be modeled as sets, akin to the Tiger Stripes?

Works cited:

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Hammond, N.P., Collins, G.C., Goodman, J.C., Walker, C., Chivers, C., McCarthy, C., Zaman, M. (2023) Assessing the relationship between fault morphology and shear heating on Europa. 54th LPSC, #2806, https://www.hou.usra.edu/meetings/lpsc2023/pdf/1866.pdf

Shoji, D., Hussmann, H., Kurita, K., Sohl, F. (2013) Ice rheology and tidal heating of Enceladus. Icarus 226, 10-19, https://doi.org/10.1016/j.icarus.2013.05.004

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