Geoscientific
Model Development
Discussions

Interactive comment on
"Thermo-hydro-mechanical processes in fractured rock formations during glacial advance" *by* A. P. S. Selvadurai et al.

Anonymous Referee #2

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General comments:

This study delivers profound results on the thermo-hydro-mechanical response of a fracture network situated in a host rock undergoing a small glacier advance of an ice-sheet. It evaluates long-term changes in pressure and temperature, as well as induced stress changes and displacement. The manuscript puts great emphasis on technical aspects of the numerical models and discusses nicely the generated model results. The comparison of HM and THM processes on a fractured network is a very nice and new aspect of this manuscript. In my view, especially the generated mean effective stress distribution is a highlight of this study.

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Major criticism is that for a reader it is not immediately clear on which specific geological setting the numerical study is based on or whether it is a purely conceptual. Along with that are some missing justifications/explanations for input parameters as in section 3.3 and 3.5.

Overall the study is well structured, clear and results are illustrated in a satisfying way. The manuscript is recommended for eventual publication with minor revisions as followed:

Specific comments to text:

P.7352 / Line 25: add a short comment on what specific geological setting the fracture network is based on (Ref. about the DECOVALEX Project?) or whether it is purely conceptual setting. This would help to understand the chosen material properties in section 3.5.

P. 7356 / Line 10: maybe short justification for chosen subglacial temperature (warm/temperate glacier).

P. 7356 / Line 17: even if fractures include any type of separation in rock (joint & faults), maybe worth specifying here that fracture network represent a specific large-scale fault network, and any small-scale joints are neglected.

Section 3.1: Is a model depth of 1700m sufficient to neglect boundary effects at the bottom? Does the influence, especially of the mechanical load, not penetrate deeper than 1700m for e.g. along large-scale structures as presented here in this study? [Referring here to a study, which analyses the purely mechanical aspect of the problem (Ustaszewksi et al., 2008 Composite faults in the Swiss Alps formed by the interplay of tectonics, gravitation and postglacial rebound ...) over a scale of 5 km depth.]

P 7362 / Line 15-23: I suggest revising that paragraph for the relevance of the full presented problem.

P 7363 / Line 5-11: I suggest revising that paragraph for the relevance of the full

presented problem.

P. 7363 / Line 15-18: Can glacier change be simplified on sliding and volume change? A glacier undergoes also ductile creep / flow. Although assuming a constant shape seems like a fair assumption for this specific problem.

P 7364 / Line 8: Since glacier velocity seems like an important parameter for the model, a short Ref. here might be useful to justify the chosen value. Are 5900y for 7500m glacier advance in realistic ranges as other studies might estimate for past glaciation cycles?

P 7371 / Line 12 and equation (11+14): Temperature change is caused by glacier advance with the presented prescribed function. Does this equation take into account that the approximated/smoothed glacier thickness (as shown in Figure 3) covers the bedrock much earlier than it would without the smoothed approximation?

P 7374 / Line 2: Should it not be (thermo-mechanical) rather than (hydro-mechanical) there, or did I misread the content?

Specific comments to figures:

Figure 1: Please distinguish better the two shown glacier stage (for e.g. dashed line)

Figure 5: Tough to see the difference between the bottom figure and top. Maybe plotting beside "Custom" mesh results, just the calculated difference in vertical fluid velocity between the two meshes?

Figure 9/10/12: Cross-profiles (as shown in Figure 6) through the fractured region could be very interesting for the reader especially for vertical displacement (Figure 9) and distribution of mean effective stress (Figure 10 & 12)

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