Solid Earth Discuss.,
https://doi.org/10.5194/se-2018-37-RC2, 2018

Solid Earth Discussions
Open Access
EGU

Interactive comment on "Channel flow, tectonic overpressure, and exhumation of high-pressure rocks in the Greater Himalayas" *by* Fernando O. Marques et al.

Anonymous Referee #2

Received and published: 21 June 2018

The study presented here investigates the applicability of the upward-tapering channel (UTC) model to understand the dynamics of the Greater Himalayan Sequence (GHS). In particular, the authors perform 2D numerical simulations of UTC to explain multiple pieces of evidence for the GHS, including inverted metamorphic grade in the channel, formation and exhumation of HP/UHP rocks close to the South Tibetan Detachment (STD), fault kinematics or tectonic overpressure.

The UTC simulates a flat-ramp geometry of the main underthrust faults (MCT and STD). Simulations predict that a UTC can account for high tectonic overpressure (>2), and exhumation of HP and UHP rocks along the channel's hanging wall. They also

Printer-friendly version

Discussion paper

constrain the GHS's viscosity to be less than 10ˆ21Pa.s

The authors also perform an insightful sensitivity analysis of the overpressure factor (TOP) to the parameters and factors varied, which include: the slab-parallel velocity, the channel viscosity, the geometry of the channel (mouth width, angle), and fixed or viscously deformable channel walls. Thus, they discuss the theoretical values of overpressure, and find that tectonic overpressure increases exponentially with decrease in UTC's mouth width, and with increase in underthrusting velocity and channel viscosity.

The manuscript has a well defined structure, with clear and well documented results and conclusions. I recommend the manuscript to be published in Solid Earth with minor modifications, and I provide below some comments that can be easily be addressed.

Some questions:

1. Have the authors tried running simulations with variable density walls in cases with deformable walls (i.e. channel density different from wall density)? How will that affect the pressure field?

2. What are the boundary conditions at the top of the channel (i.e. free surface/outflux)? I could not find this mentioned anywhere in the text.

Minor points:

Paragraph 124-130: the magnitude of the effective viscosity. What are the limitations of choosing an effective viscosity approach vs an Arrhenius approach? i.e. non-linear effect.

Line 152-153: 1-2 sentences with the main conclusion from Marques et al 2018 could help the readers here.

Line 164: Reference for "has been accepted as a simple but effective approximation. . ."

Line 168: References for COMSOL

Line 239: The authors can extend this section further by comparing the effect on TOP of all these factors (see Fig 3,4). Which one has the strongest effect? This can open a discussion on how these factors evolved/change in time in the Himalayan region. Viscosity?

Line 261: Yes, alpha affects the flow pattern, but not so much the TOP. Why is it that?

Line 279: Is it not clear how the transpression was calculated/set. A schematic/clearer sentence is needed.

Line 311: The hanging-wall-channel interface is no-slip (i.e. u=0). Because the footwall-channel interface has a prescribed U0. Or is that not the case?

Line 323: The TOP/pressure can be plotted in Figure 8B for evidence.

Section 3.5: Yes, an important condition, but the authors show no results. A figure with these simulations results can be added to the Appendix.

Line 351: Possible configurations: parallel-sided and downward tapering - what are the differences and the outcomes, limitations? Not all readers are familiar with the details of these models.

Paragraph 383-393: There is previous work to suggest that pressure-depth conversion in subducted rocks is not necessarily correct (i.e. Yamato and Brun, 2016). Should add some references.

Line 429: Experiments not shown.

Line 462: How does this estimate of viscosity in the channel relate to previous published estimates?

Paragraph 473-478: References for these hypotheses.

Paragraph 479-494: The authors list the proposed models for exhumation of HP and UHP rocks across various tectonic settings/orogens (with different geometries, rheol-

Printer-friendly version

Discussion paper

ogy, boundary conditions). The UTC model can be applied to the Himalayas, but it's not clear that it can be considered a unified model in other settings. The authors should make that clearer.

Figure 1: C) Numerical model setup. Since boundary conditions (moving/fixed walls, bottom boundary conditions) are important in this study, it would be useful if they could be represented graphically in Figure 1C.

Figure 2: D) the plots are confusing because they do not have the same vertical axis.

Figure 3,4: Each simulation gave 3 values for TOP at different depths. What do these values represent? i.e. maximum/average TOP at the respective depth? same vertical axis would be desirable (currently apparent) and would allow comparison of factors on the overpressure. For example, which factor has the strongest effect on TOP? Green points are not distinct enough from blue markers.

Figure 5: What are the other reference parameters for these simulations? viscosity, Wm* etc.

Figure 6: missing panel B (possibly just a format/download issue)

Figure 7: How much transpression in this case? How was the transpression calculated from the velocity profile? Figure 8B: TOP should also be plotted in this case, and the case with viscosity contrast 1e2.

Interactive comment on Solid Earth Discuss., https://doi.org/10.5194/se-2018-37, 2018.

Printer-friendly version

Discussion paper