Searching for the hidden vent locations for the lava flows southwest of Arsia Mons

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Introduction

The lava flow field southwest of Arsia Mons volcano has a complex history with numerous overlapping flows [1]. Many, if not the majority, of these are not fully visible and none trace back to a possible vent source. A lack of a point of origin presents interesting volcanological questions such as "how long are these flows?" and "do they have a common source location/mechanism?". The lack of a known starting point also adversely impacts modeling to determine rheological properties or eruption conditions. Rowland et al., 2002 [2] made an initial attempt to address this issue for lava flows around Elysium Mons using the FLOWGO [3] rheological model in an iterative approach. They varied the starting channel position along the slopes of Elysium Mons and the starting channel dimensions (width and depth). To determine if the best model fit, the final mapped flow width was compared to the model's final width. Here, we refine that approach by using an updated version of FLOWGO [4-5], varying the starting channel width and applying it to channelized flows in the SW Arsia Mons flow field to determine their origin. The same approach of comparing the final flow width between modeled and measured flows is again used to confirm the model has accurately represented the flow dimensions.

Data & Modeling

- Identification and measurements of the lava flows was done using the Thermal Emission Imaging System (THEMIS), and Context Camera (CTX) data, respectively. Fourteen candidate lava flows were identified and four were mapped and modeled thus far (Figure 1a).
- Depth and slope profiles for each lava flow were determined using the Mars Orbiting Laser Altimeter (MOLA) Precision Experiment Data Point Records (PEDR).
- Modeling of the lava flows was done in two steps using the FLOWGO thermo-rheological model modified for Martian conditions [6].
  - Step 1: Refinement of the model parameters in order to best match the measured lava flow length.
  - Step 2: Iterating the starting channel width to approximate expected channel dimensions further up slope.
- In order to confirm the model fit, the ending measured channel width is compared to the modeled channel width. Upon the best model fit, the new flow distance is projected upslope following the regional slope, aspect, and trends of surrounding flows.

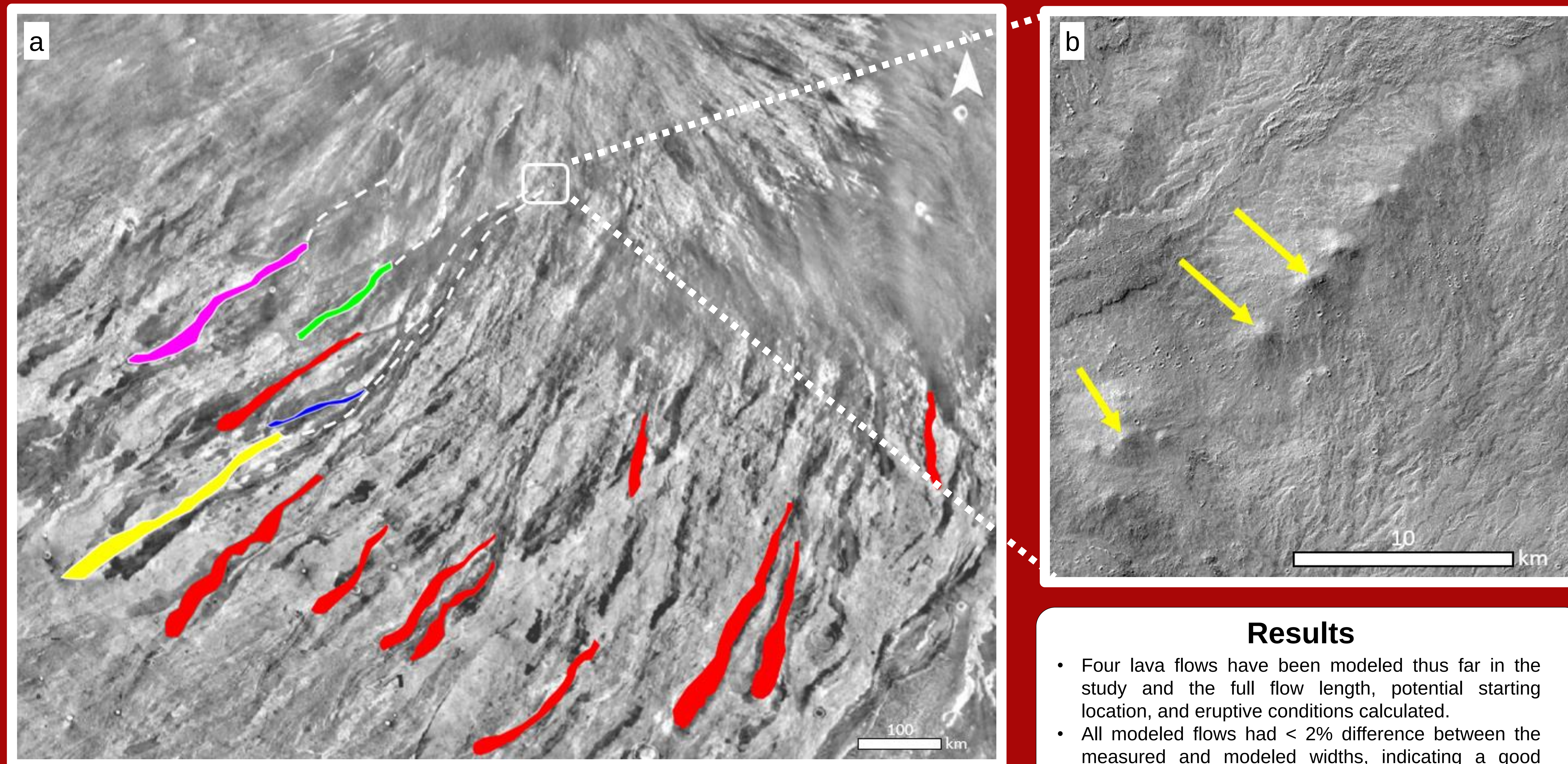

Figure 1: (a) THEMIS nighttime infrared 100m global mosaic base map with the channelized lava flows outlined. Flows in red are future candidates for modeling, whereas the four currently modeled flows are colored yellow, blue, green and magenta. The dotted lines extending from these four flows are the modeled full flow lengths. The white box is the region shown in (b). (b) CTX image of potential vent structures (identified with yellow arrows) from which two of the modeled lava flows may have originated. The two hypothesis for these structures are either multiple outbreak overflows from a lava tube or a series of vents originating from a dike emplacement. More detailed investigations of these features are ongoing.

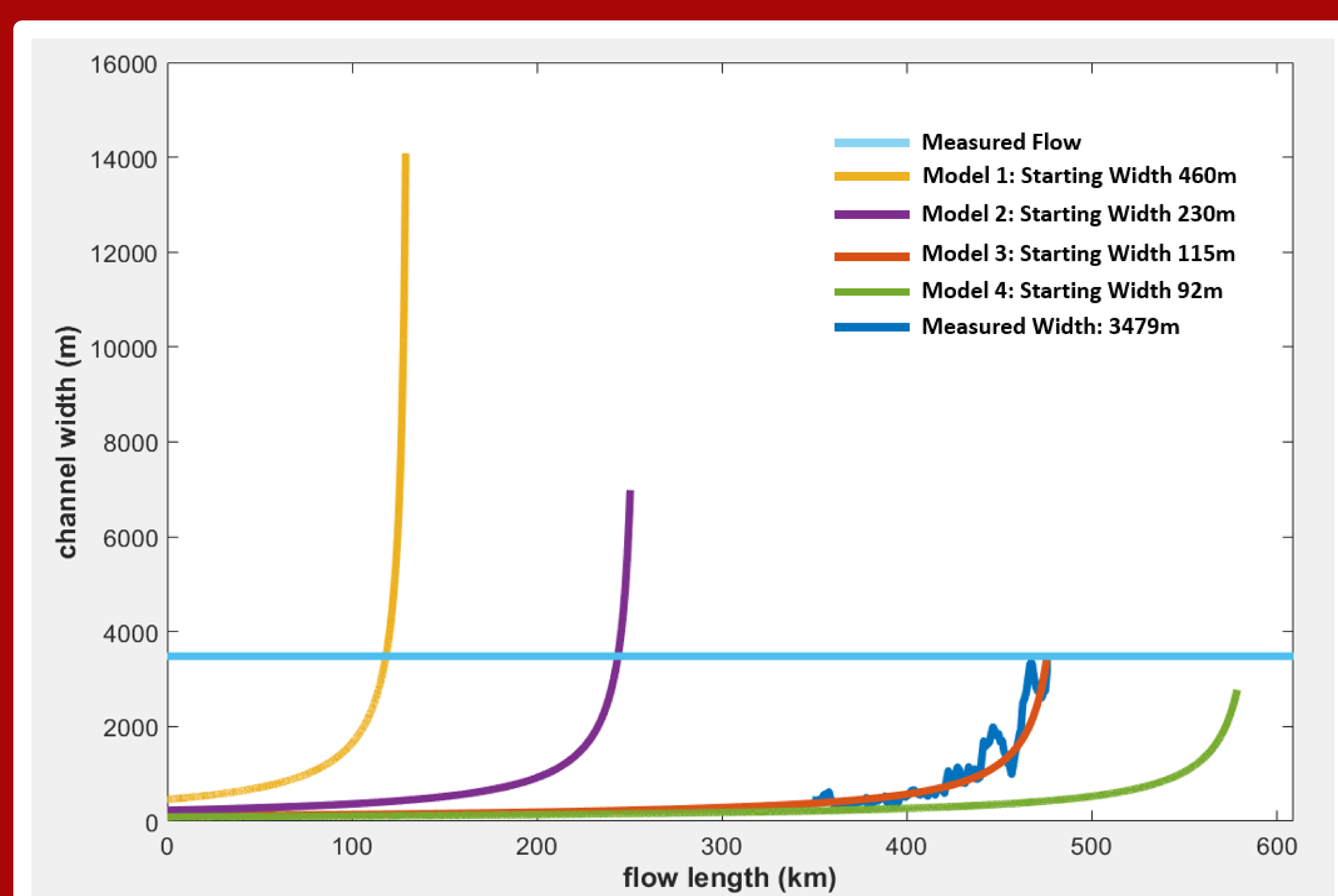

Figure 2: Results of four modeled simulations for the yellow flow in Figure 1a using FLOWGO. These show the flow length (km) versus the channel width (m). The measured flow had a final channel width of 3,479m (indicated by the light blue line) and a flow length of 127km. Model 3 (red line) best matched the measured flow width and length. Typically, the flow length is used to confirm the model fit in FLOWGO for terrestrial lava flows. However, because we do not observe the full length of this flow, the final channel width is used instead.

Results

- Four lava flows have been modeled thus far in the study and the full flow length, potential starting location, and eruptive conditions calculated.
- All modeled flows had < 2% difference between the measured and modeled widths, indicating a good overall fit. Figure 2 is an example of a best-constrained case.
- The results indicate flow origins near possible vent structures identified in the CTX data (Figure 1b).

Conclusions & Future Work

This work is ongoing; however, initial results are promising. Mapping and modeling of more flows will further constrain potential vent locations and the eruptive conditions of these flows, critical information for understanding formation of this flow field. Development of a statistical calculation for the rate of channel width change in relation to flow runout will aid in the mapping effort. Future work will include mapping and modeling of the other candidate flows, as well as CTX derived digital elevation models to use in (and constrain) the modeling.

Acknowledgments

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References

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