MAPPING A HIGH-FLUX FLOOD LAVA IN SOUTH KASEI VALLES. G. E. Cushing[1], C. M. Dundas[1] and L. P. Keszthelyi[1], [1]U.S. Geological Survey Astrogeology Science Center, 2255 N. Gemini Dr. Flagstaff, AZ 86001.

Introduction: Although flood lavas comprise a large fraction of Mars' surface area and crustal volume [1], at this time only the Athabasca Valles flow has been thoroughly mapped [2]. The Kasei Valles outflow channel system was initially carved during the Hesperian by catastrophic flood waters from Echus Chasma [3,4], but the valley floors were more recently flooded by lavas during the Amazonian [5]. A lava flow through the extent of south Kasei Valles (SKV) gives a second example of a well-preserved high-flux, turbulent, platy-ridged martian flood lava [5]. Continuing the efforts by [5] to describe the Kasei Valles lavas, we have mapped the margins of a continuous flow more than 2,300 km in length. This mapping will characterize the turbulent, high-flux SKV flow and provide data to compare with the observations made in Athabasca.

Mapping: A high-resolution mosaic of the region [270°-305° E, 10°-30° N] was created from >500 CTX images using USGS ISIS cartography software. The CTX was used as the map base in Esri's ArcGIS® software at a mapping scale of ~1:20,000 to continuously trace fine margins of the SKV flow. Starting at the terminus in SKV, the flow's margins were traced upstream approximately 2,300 km. About 700 km of this length extends southwest, beyond the Kasei Valles portion initially described by [5].

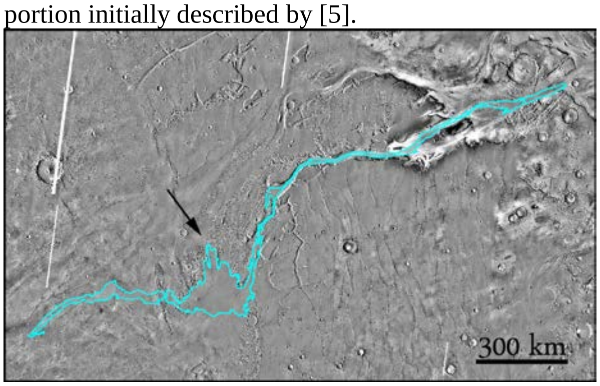

Figure 1. Continuous lava flow emerging from northeast Tharsis, then flowing into and through Kasei Valles. Arrow indicates where lavas may have entered the NKV channel system. Image center is at approximately 289° E, 19° N.

Observations: While flood waters that initially carved Kasei Valles originated from Echus Chasma to the south [3,4], the recent lavas in the valley originated in the eastern Tharsis region (Fig. 1). Emerging from beneath more recent flows approximately 120 km southeast of Tharsis Tholus, the SKV flow is similar in appearance to the hundreds of overlapping flows in the region, however this flow continues uninterrupted for more than 2,300 km, trending generally to the northeast from Tharsis and eventually flowing through SKV proper, where it terminates just west of Rongxar crater (Fig. 1). Due to burial by subsequent Tharsis flows, the vent (and thus the full length) is unknown. The trends of other flows in the region are consistent with a source as distant as Ascraeus Mons, but this cannot be confirmed.

The SKV flow emerges from beneath the termini of subsequent flows in northeastern Tharsis where the terrain is nearly flat (≤ 0.2°), and flow widths vary between ~15 km and ~40 km for the first ~530 km before narrowing and passing over cataracts to enter the northern end of Echus Chasma at ~280.2° E. Here the flow broadens into a vast plain (about 150 × 220 km) before entering the Kasei Valles channel system. Passing through complex topography, the flow's widths and slopes are highly variable, but the final ~950 km is generally 5–20 km wide and flows along a nearly straight valley floor.

The flow surface is well preserved and there is a range of textural types. The most common texture is a platy-ridged texture similar to the Athabasca flow [2], with slab sizes ranging from ~100 m up to several kilometers (Fig. 2a). While the main flow surface appears rough and fractured, lobes of smoother lava resembling pahoehoe are common at the margins. These deposits likely seeped from beneath the margin of advancing platy-ridged material (Fig. 2b). Similar breakouts have been observed at the fringes of rubbly pahoehoe in Iceland [6]. In portions of the flow margin where thin rivulets run through complex terrain, the lava has the appearance of low-viscosity pahoehoe, embaying local relief (Fig. 2c). The presence of these smooth, pahoehoe-type features at the flow margins is consistent with emplacement theories that the broken platy material was floating upon (and insulating) a molten, low-viscosity subsurface [2]. We do not observe clearly defined flow fronts within the SKV lava, and the candidate fronts we see are more consistent with locally inflated lobes or late breakouts rather than with separate flow events. Other possible boundaries appear to be textural differences within a single flow.

Similar to the Athabasca flow, SKV lavas flowed through cataracts and constrictions with areas showing signs of inflation and drainage, e.g., variable surface textures including brecciated crusts that have broken into detached plates. The SKV lava is typically more uniformly rough than the Athabasca flow, and the crust may have been more heavily brecciated. Wake features due to crust translating over obstacles are common. Classic inflation textures like those found in distal Athabasca lava are rare. Unlike the Athabasca flow described by [2], this flow did not form clusters of rootless cones, although there are some marginal candidates. Groups of candidate rootless cones do occur in prior flows immediately adjacent to the SKV lavas, but may instead be structures formed by lava drainage.

Mars Orbiter Laser Altimeter (MOLA) data indicate that the flow is tens of meters thick where it stands above the adjacent surface. With a flow area of ~59,000 km^2, a depth estimate of 30 m yields a volume ~1770 km^3. This estimate is crude (the flow thickness is certainly variable), but likely accurate to within a factor of two. While the SKV flow traveled more than 1.6× the distance, Athabasca produced a flow volume of ~5000 km^3 [2], about 2.8 times larger than the exposed SKV lava.

The northern arm of Kasei Valles (NKV) was also flooded by platy-ridged lava, likely close in time to the SKV flow since the preservation state appears identical. Flux calculations based on digital derrain Models suggest that this lava behaved similarly to that in SKV. Some portion of the SKV lava appears to have spilled into this northern-arm flow (Fig. 1, arrow) raising the possibility that the lava was one eruption; however, the small size of the connections and the occurrence of candidate flow fronts near the interface makes it more likely that the NKV lavas are from one or more separate (but similar) eruptions. Work is ongoing to understand the connections between NKV and SKV, but the bulk of the lava in NKV appears to have descended as one or more flows from the west; the discussion above considers only the well-defined SKV lava.

SKV records one of the largest and perhaps the longest well-preserved effusive lava flows in the Solar System. Reduced dust cover makes it easier to study than most of the large flows high on Tharsis. Although particularly long, this flow is likely similar to other Tharsis lavas and may be representative of their emplacement. Similar large, high-flux flows may have been the main way of constructing the Tharsis rise, and could have had pronounced effects on the climate for years after their eruption.

Acknowledgements: This work was funded by MDAP grant NNH14AY77I. We thank Corey Fortezzo for ArcGIS assistance.

References: [1] Keszthelyi L. P. et al. (2008) *JGR*, 113, E04005. [2] Jaeger W. L. et al. (2010) *Icarus*, 205, 230-243. [3] Baker V. R. and Kochel R. C. (1979) *JGR*, 84, 7961-7983. [4] Harrison K. P. and Grimm R. E. (2008) *JGR*, 113, E02002. [5] Dundas C. M. and Keszthelyi L. P. (2014) *J. Volc. Geotherm. Res*., 282, 92-102. [6] Pedersen G. B. M. et al. (2015) *LPS XLVI*, Abstract #1845.

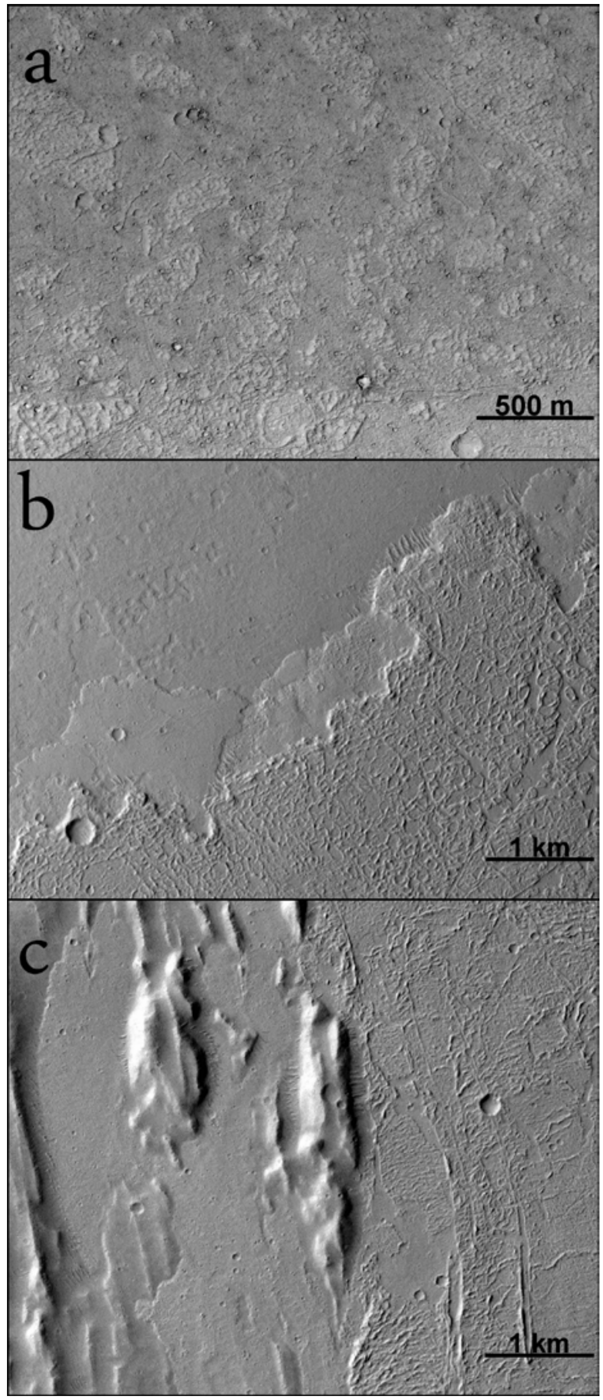

Figure 2. a) Broken, rafted lava slabs, which cover most of the SKV flow (HiRISE: ESP_025481_2025); b) Smooth, lobate deposits, common at flow margins, are likely formed by low-viscosity lava seeping from beneath the primary flow (CTX: G14_023833_1935_XN_13N078W); c) Smooth, pahoehoe-type lavas often embay local terrain at flow margins. (CTX: G01_018453_1984_XN_18N077W).