SPECTACULAR CATARACTS (DRY FALLS) ON THE FLOOR OF KASEI VALLES, MARS.

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Introduction: The floor of Kasei Valles contains an enormous cataract complex, the largest in area of any known on Earth or Mars. Discovered by Baker & Milton [1], these cataracts formed near the confluence of the largest Kasei channels [Fig. 1]. I used THEMIS & MOC images & MOLA data to study the cataracts.

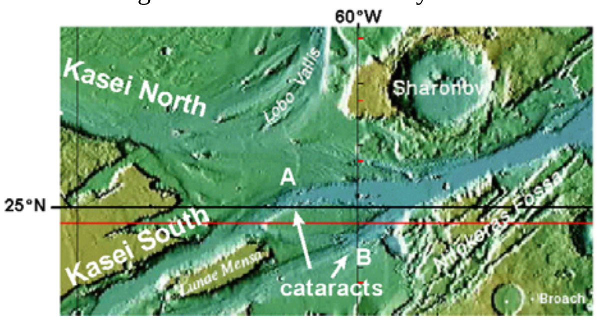

Figure 1. Context image showing location of cataract groups in Kasei Valles. Credit [2].

The cataracts may have begun forming SE of Sharonov Crater, where a venturi-like constriction narrows the channel. Macroturbulence and cavitation would have been enhanced where the flow expanded [3]. Fluid pressures would have increased, collapsing entrained air bubbles and generating intense shock waves that could shatter and undermine bedrock, especially highly jointed flood basalts. The cataracts migrated upstream (westward) along the channel floor, and then branched in the lee of the mid-channel island named Lunae Mensa. Altogether, the cataract complex may have migrated by headward erosion ~125 to 250 km, until Kasei megaflooding ceased.

Fig. 2 shows the latitude and longitude grid and topography for cataract group "A." Total vertical relief is ~500 m. The MOLA profile in Fig. 3 reveals a wide terrace below the headwall, which is visible in Fig. 4.

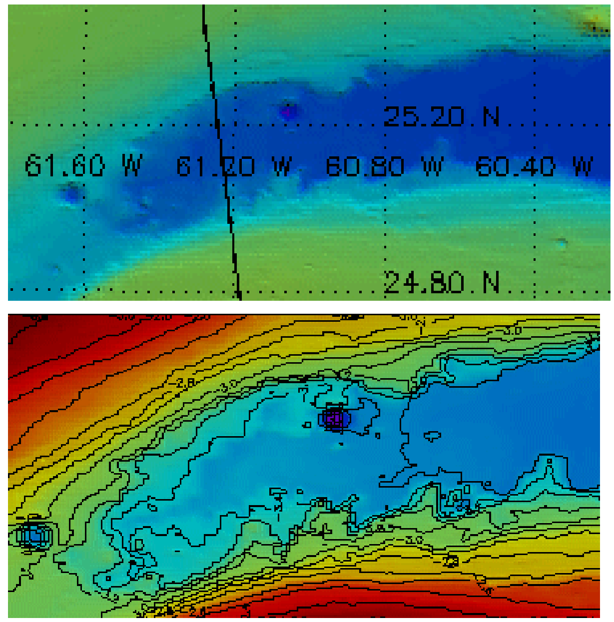

Figure 2. Map coordinates (top) and contour map (bottom) for cataract group "A." C.I. = 100 m. Black line shows the location of the MOLA profile in Fig. 3. Panels created using GRIDVIEW software. Credit: [4].

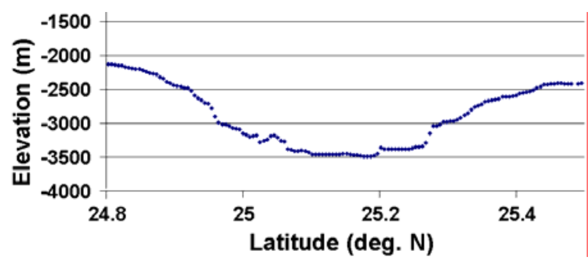

Figure 3. MOLA pass 11944 across cataract group "A" (see white line in Fig. 4). North is to the right. Cross-section made using GRIDVIEW software. Credit: [4].

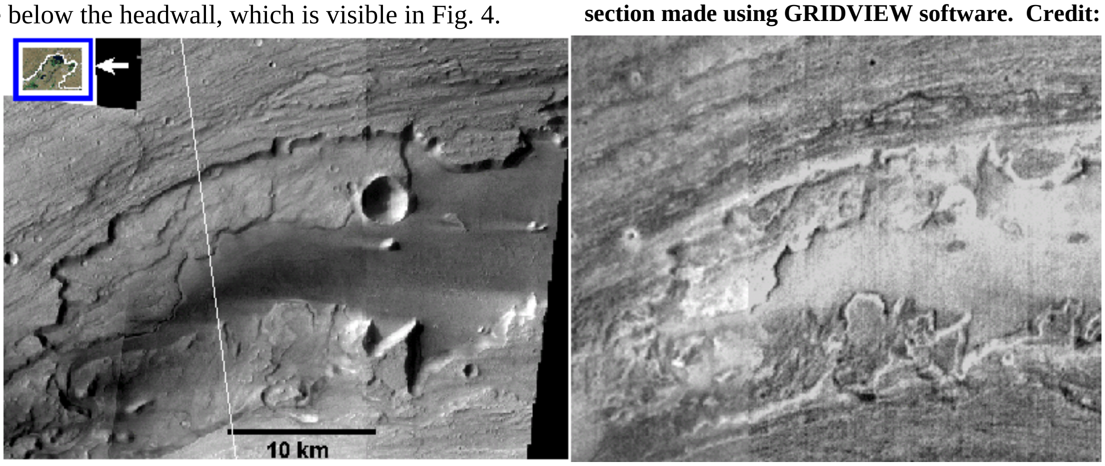

Figure 4. Cataract group "A." Left panel: composite of THEMIS [5] visible light images V02611007, V18412016, and V20883003. Right panel: composite of THEMIS nighttime IR images I05264011 & I04877002. For comparison, at upper left (white arrow) at same scale is the terrestrial cataract *Dry Falls*, eroded 15 kyr ago by Missoula megaflooding.

Interpretation of IR Images: The thermally brightest areas on Mars are rock outcroppings on the sides of canyons, cavi, crater rims, and rocky terrain associated with paleoflood processes. The thermal properties of the uppermost Martian surface are strongly controlled by the thickness of dust layers and the relative abundance of rocks and outcrops. Dust has low thermal inertia compared to rock because the dust heats up and cools quickly, while rocks slowly gain and lose heat. Flat-lying areas will often retain more dust, especially in the lee of hills and crater rims, whereas dust will accumulate less on slopes and rocky, angular surfaces. As seen in the right panel of Fig. 4, the cliff faces, floor, and terraces of the cataract are relatively bright in nighttime IR, which shows these areas consist of relatively dust free outcrops or rock-rich terrain.

A thermal inertia [6] profile across cataract "A" along longitude 61.25°W reveals that the floor, terraces, and headwalls have very high thermal inertias of 325–400 J m^{-2} K^{-1} $s^{-0.5}$, whereas the channel flanks have lower (but still high) values of 275–325 J m^{-2} K^{-1} $s^{-0.5}$. These ranges indicate a strong prevalence of rocks or bedrock, with a greater percentage of rocky surfaces in the lowest parts of the channel.

Cataract Group "B:" The northern flank of cataract group "B" is shown in Figs. 5 & 6. These cataracts formed on the margin of a mid-channel "island" (see Fig. 1), confirming that the island consists of eroded bedrock and is not a depositional feature formed in the low-energy lee of the island. The cataracts also confirm that the eastern half of the island was overtopped by megaflooding. Multiple terraces are apparent in Fig. 5. The headwalls are several hundred meters high.

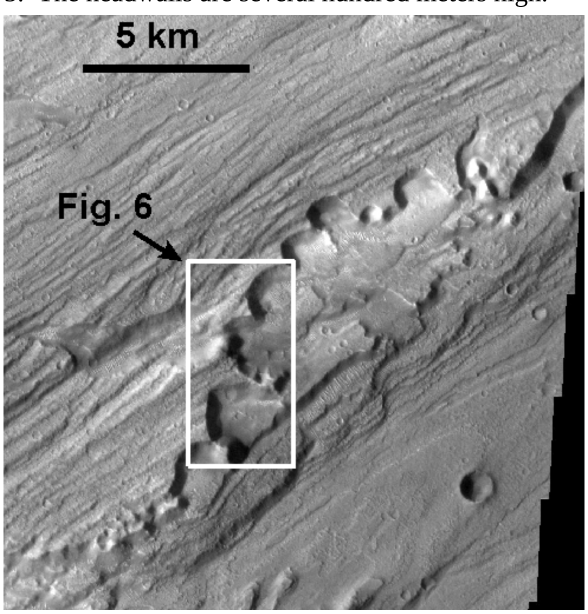

Figure 5. Scalloped headwalls of cataract group "B." THEMIS visible light image V10081003. Credit [5].

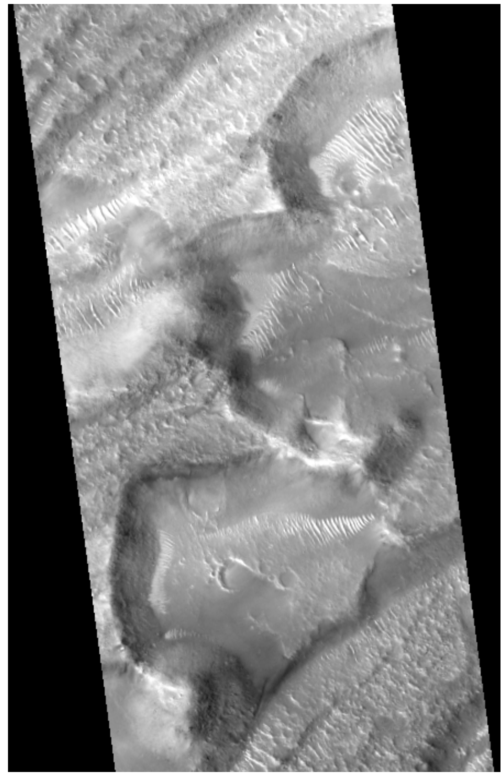

Figure 6. Close-up view of cataract "B" headwalls, near center of Fig. 5 (MOC image E0302147). Credit: [7].

Discussion: These cataracts raise interesting questions about the Martian outflow channels. At this location, the Kasei channels were eroded to depths of 2500–3000 m, and other outflow channels are also deeply eroded in basaltic bedrock. Multiple floods likely formed these channels. Why are more cataracts not preserved on the channel floors? One possibility is that additional cataracts formed but were eroded completely by subsequent megafloods that stripped away hundreds of meters of bedrock. The cataracts we see preserved in the channels would have been formed by the last megafloods. Another question arises: Why are the Kasei cataracts so large? The answer may be that, once they began to grow and migrate upstream, the size of the cataracts was controlled by the great width and depth of the Kasei channels themselves, and the depth and magnitude of the megafloods that carved them.

References: [1] Baker and Milton (1974), *Icarus*, v. 23. [2] USGS Mars 1:5M Map MC-10 online at http://planetarynames.wr.usgs.gov/images/mc10_mola.pdf. [3] Baker (1979), LPSC X, Abs. 1023. [4] GRIDVIEW program available from Goddard, at http://core2.gsfc.nasa.gov/gridview/. [5] Christensen et al., THEMIS public releases, http://themis-data.asu.edu/. [6] Thermal inertia data: Ames Research at http://marsoweb.nas.nasa.gov/dataViz/. [7] Malin Space Sci. Sys. at http://www.msss.com/moc_gallery/.