EVIDENCE OF LATE-STAGE FLUVIAL OUTFLOW IN ECHUS CHASMA, MARS. M. G. Chapman[1], G. Neukum[2], A. Dumke[2], G.Michaels[2], S. van Gasselt[2], T. Kneissl[2], W. Zuschneid[2], E. Hauber[3], and N. Mangold[4], [1]U.S. Geological Survey, 2255 N. Gemini Dr., Flagstaff, Arizona, 86001 (mchapman@usgs.gov); [2]Institute of Geosciences, Freie Universitaet Berlin, Germany; [3]German Aerospace Center (DLR), Berlin, Germany; and [4]LPGN, CNRS, Université Nantes, France.

Introduction: New high-resolution datasets have prompted a mapping-based study of the Echus Chasma and Kasei Valles system. Some of the highlights of our new findings from the Amazonian (<1.8 Ga) period in this area include (1) a new widespread platy-flow surface material (unit *Apf*) that is interpreted to be 2,100-km-runout flood lavas sourced from Echus Chasma; and (2) a fracture in Echus Chasma, identified to have sourced at least one late-stage flood, that may have been the origin for the platy-flow material and young north-trending Kasei floods. This abstract discusses details of the Echus Chasma fracture and putative outflow (Fig. 1).

Supporting Evidence: In north Echus Chasma and also directly northeast of the chasma, there are floor fractures bounding downdropped blocks of plateau that have been subsequently covered by young lava units *Apf* and Tharsis Montes member 5 (*At5*; Fig. 1). One of these features in north Echus Chasma appears to have sourced outflow of water.

Supporting geomorphic relations can be observed within the southernmost young lava lobe of Tharsis Montes Formation member *At5* that flowed into the *Apf*-covered floor of Echus Chasma (Figs. 1 and 2). This lava lobe is eroded and dissected by shallow channels, leaving a ring of rubble marking the former lobate borders of the flow. Similar appearing terrestrial analogs of this eroded morphology can be observed in Iceland, where lava flows have been "washed" by catastrophic flood waters to leave behind blocky terminus areas and piles of internal rubble surrounded by mud-covered terrain (best observed at sites A,B on Fig. 2).

The shallow channeling can be traced back to a fracture (fossa) on the floor of Echus Chasma (Fig. 3). Presumably, water forced upward from a buried aquifer would behave like magma dikes. Dikes utilize preexisting joints and zones of weakness in the crust, enlarging these fractures and also creating adjacent, additional, parallel pathways to the surface [1]. Zones of weakness on the floor of Echus apparently included the floor fracture that cut relatively thick deposits of lava unit *Apf* (Fig. 1) and a wallrock spur on the floor of Echus Chasma (D on Fig. 2). Flood water being emitted from a crack or fossa is a fairly common scenario on Mars, with prime examples being Athabasca and Mangala Valles outflow channels [2,3].

We interpret this late-stage outflow to have been formed by water based on several lines of evidence, the first being the "washed" appearance of the *At5* lava lobe. Where the mouth of the lava-lobe-confined south shallow channel debouches into Echus Chasma, the floor of the chasma is marked by a very straight, likely fault controlled/confined, north boundary of dark albedo material (white arrows on Fig. 2). This boundary correlates with the bottom edge of an uplifted plate (insert Fig. 1). The albedo boundary is edged by a low terrace on either side of the shallow channel mouth (A on Fig. 2). Within the dark albedo area are local areas of sinuous ridges that surround pea-shaped and polygonal areas (Fig. 2 inset), visually similar to wind-eroded permafrost features. This scenario is similar to terrestrial high-latitude lakes bound by terraced material with interbasinal wind-modified ice-wedge polygons derived from frozen lake-fed material (like Tangle Lake, Alaska [4]). Adjacent to the source fracture the channel displays internal, streamlined erosional or depositional bars (marked 'b' on Fig. 3). Finally, where the putative floods exited north of the fracture, there are layered steps or possible lacustrine terraces around a small island and wallrock spur (D on Fig. 2). As no lava flow textures have been identified in association with the shallow channel, we suggest that floodwater was ponded within Echus Chasma and designate the resulting lacustrine material (now highly modified by wind) to be Amazonian Echus Chasma plains material or unit *Apec*. This material is so thin that it is only observed locally, and *Apf* platy-flow materials of the putative lava lake [5], which cover most of the Echus Chasma floor, are either unmantled or observed to peak-out from underneath its eroded margins. Perhaps the fracture flows were sediment poor. At the outer edges of the Echus Chasma floor, there is a series of nested linear ridges setback from the contact with the chasma wall material (best observed on MOC R0900520). These ridges may have formed by cooling and subsidence of the unit *Apf* or they may be wave terraces formed at the lake shoreline of unit *Apec*. Our youngest crater counts on the floor of Echus Chasma range from 54 to 98 Ma, averaging 70 Ma, therefore this flooding and the resulting ponded lacustrine deposit may be very young. This flood and the subsequent pond mark the last fluvial episode in the Echus-Kasei system.

Because we have found direct evidence that this floor fossa emitted a young flood, it is also possible that this fracture system was responsible for emitting other flood materials including the *Apf* lava flows and some Echus-sourced floods. Although other fractures of this type lie northwest of Echus Chasma and could have emitted water and lava, none have been positively identified to have done so other than the Echus Chasma fossa**.**

Discussion and Conclusion: We suggest that the cooled lava-pond material *Apf* on the floor of Echus Chasma was subsequently inundated by flood water that temporarily ponded within Echus Chasma, and we designate the resulting thin material to be Amazonian Echus Chasma plains material or unit *Apec* and interpret it to be possible lacustrine deposits (now highly modified by wind). The source fossa or fracture in Echus Chasma (and others like it to the north) may have been the vents for the platy-flow material and young north-trending Kasei floods. Perhaps uplift of the large coherent blocks in north Echus Chasma (and directly outside of and northwest of Echus) formed in response to rapidly upwelling sub-surface surges of molten lava and floodwaters.

References: [1] Delaney, P.T. et al. (1986) JGR, 91, 4920-4938. [2] Burr D.M. et al. (2002) Geophys. Res. Lett. 29, 4 pp. [3] Carr, M.H. (1981) The Surface of Mars, 232 pp. [4] Péwé T.L. and Reger R.D. (1983) 4th International Conference on Permafrost, Univ. of Alaska, 263 pp. [5] Loizeau, D. et al. (2008) AGU 89(53), Abstract #P43C-1412.

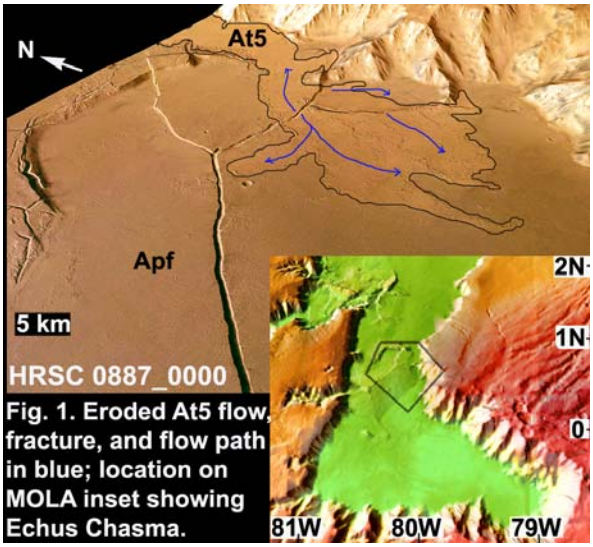

Fig. 1. Eroded At5 flow, fracture, and flow path in blue; location on MOLA inset showing Echus Chasma.

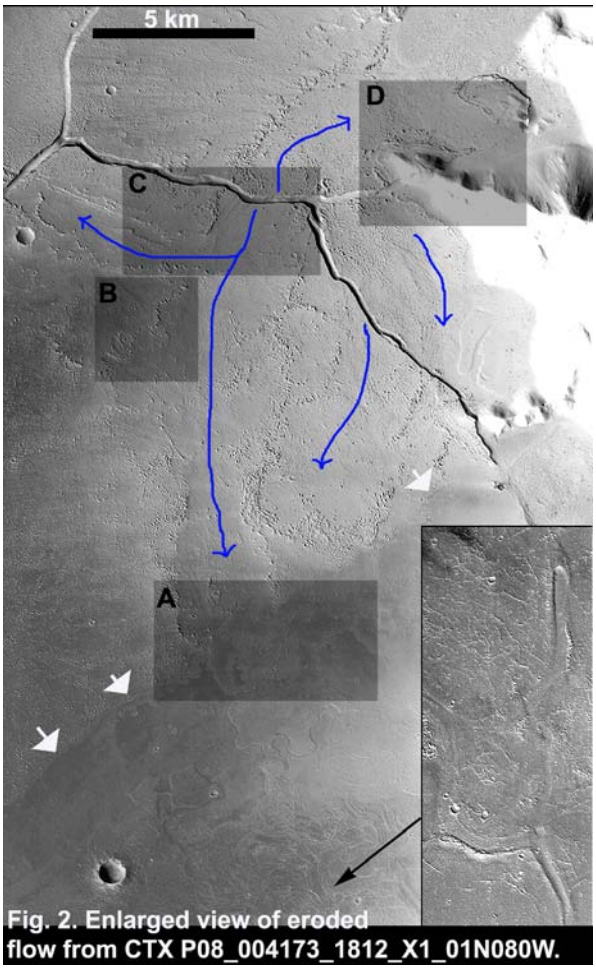

Fig. 2. Enlarged view of eroded flow from CTX P08_004173_1812_X1_01N080W.

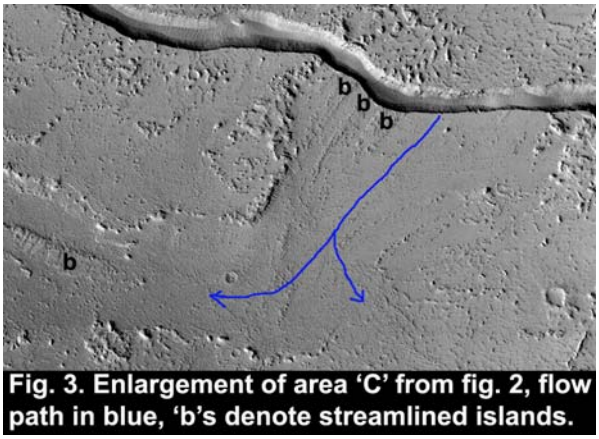

Fig. 3. Enlargement of area 'C' from fig. 2, flow path in blue, 'b's denote streamlined islands.