TECTONICS AND WATER-RELATED EPISODES ON CLARITAS FOSSAE, MARS.

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Background: Changes in the direction of the Martian rotation axis resulted in climate changes [1]. The highly inclined rotation axis increased seasonal polar cap insolation and mobilized water from the summer pole into the atmosphere and transported and accumulated it as precipitation, snow and ice to the winter pole and elevated mid-latitude areas [2-4]. Decrease in the rotation axis inclination reversed the climate and moved water from mid-latitudes back to the poles.

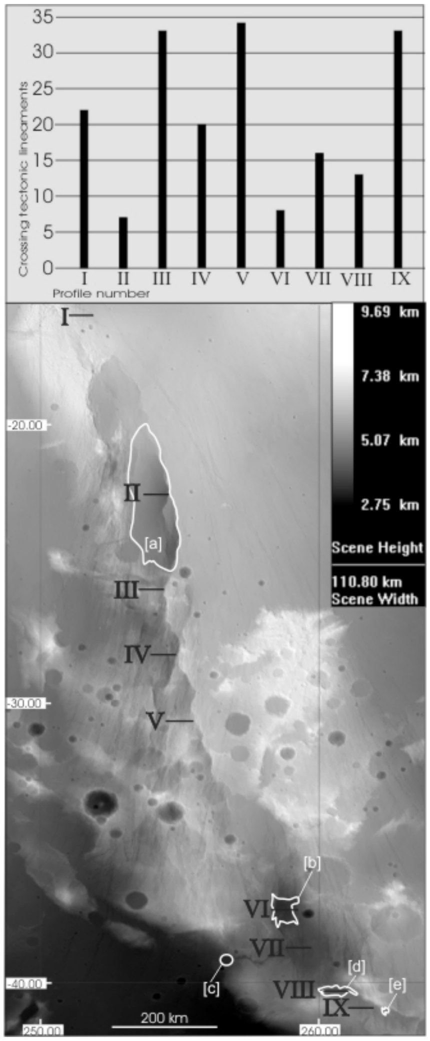

Fig. 1. MOLA topography of the CF area. The resurfacing rate was estimated by counting the number of faults crossing 50-km long profiles (I to IX). Basins have less faults than the elevated areas (III,V,IX). There is a difference between more (II,VI) and less (IV,VII,VIII) re-surfaced basins.

Study area: The Claritas Fossae (CF) area (Fig. 1) is covered by the maps MC-17 and MC-25. The HRSC [5], THEMIS [6], MOC [7], HiRISE [8] images and MOLA topography [9] were used to study geology of the CF zone where tectonic and hydrology events are found in the lava-surrounded environment on the SSE slope of the Tharsis bulge. The concept of tectonics that coexisted with climate-related events provides the study framework. Traces of old morphology let us to identify some of the interplay between tectonics, and valley formation, re-surfacing and hydrology due to changes in the environment and climate [10,11].

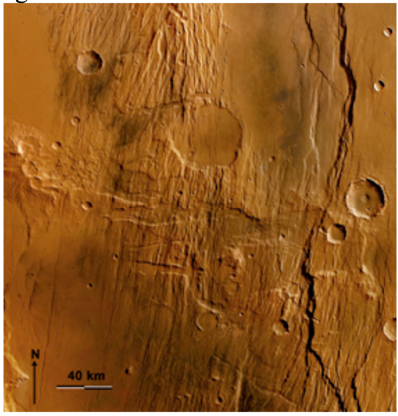

Fig. 2. The HRSC 563 image shows old E-W valleys and channels on the antiform (profile III, Fig. 1).

Re-surfacing: The CF rift zone is cut by sets of long NNE-SSW to NNW-SSE faults. We calculated the number of faults crossing the E-W profiles (Fig. 1) to the west of the Claritas Rupes (CR) fault. The basins have a lower number of faults and thus a younger surface than the higher areas that have more faults and a smaller amount of re-surfacing, There is also a difference between the less (= more faults) and more (= less faults) re-surfaced basins. The faults were thus formed in several events with an amount of re-surfacing activities between the events. In some basins, the main resurfacing was due to hydrology (10,11) while others have also lava flows. The multi-temporal tectonics is evident when some channels precede faults (Fig. 2) while some others were controlled or changed by tectonics (Fig. 3). Some channels may pre- and others post-date the faults of the very same fault set.

Oldest hydrology: The E-W valleys (Fig. 2) show the oldest hydrologic structures of the CF area. Wide valleys were preserved on the elongated first-order NWW-SEE antiforms on the western side of the central CR fault as well as on the highland to the east of it (Fig. 1). Younger channels run in the wide E-W valleys. These both were not influenced by the N-S faults and were thus identified as the results of 2nd and 1st hydrology phase, respectively.

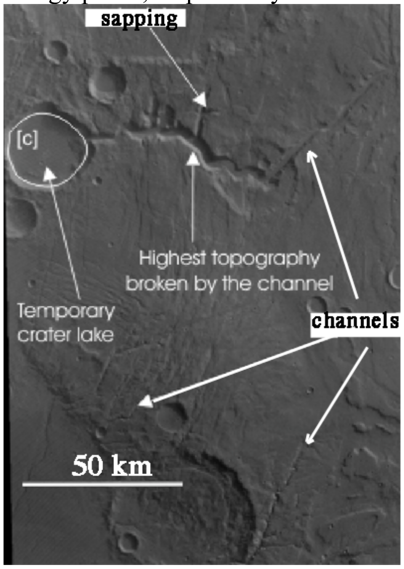

Fig. 3. Highland slopes display various on-surface flows and sapping events (part of HRSC 508).

Paleolakes: In late Noachian, the amount of available water was relatively large as seen from the basins that were flooded by water (c in Figs. 1, 3) or were temporary lakes (b in Fig. 1 [10,11]). This 3rd main hydrology phase was especially effective within the southern CF area. The main channel of this phase (3A, cf. the upper part of Fig. 3) was controlled by a fault as seen from the straight part of the channel. Tectonics of the area still continued as the floor of the channel does not have a continuous westward down-slope trend but an elevated central section.

Groundwater: The intense CF faulting allowed the groundwater formation that led to sub-surface conduits along faults and to sapping events (phase 3B; Fig. 3 [10,11]). A number of channels have sapping characteristics, and even the main southern channel begins with a sapping-type structure. The groundwater formation was probably repeated along the hydrology cycle (cf. the next phases) and resulted in further sapping events controlled by tectonic structures.

Less water: The amount of water in the hydrologic cycle diminished along the time. The 4th hydrologic phase consisted of snow and ice accumulation on hilltops and slopes followed by formation of additional hillside channels (Fig. 3) and alcoves (Fig. 4). Glacial-type valleys were eroded down from the amphitheatres and resulted in a characteristic pattern of ridges and channels that led water down from the deposition areas to re-charge the groundwater reservoirs.

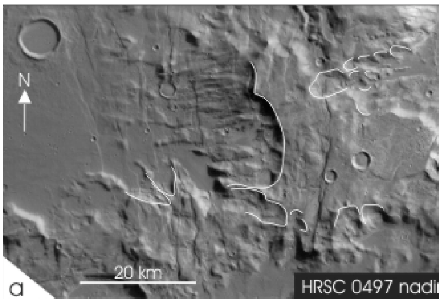

Fig. 4. The local highlands and slopes display glacial amphitheatres eroded by ice and water.

Springs: A more recent, or 5th hydrology phase was identified from the HiRISE image just beside the CR fault (Fig. 5) where sets of braided channels originate from two spring-like areas. The CR fault is relatively young and the image allows the identification of hydrology events active after the fault formation.

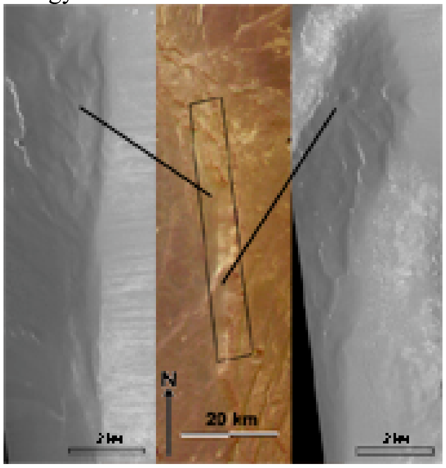

Fig. 5. The HRSC image 68 (centre) shows spring-like deposits connected to the base of the CR fault (cf. the HiRISE image PSP_3251_1475_RED: left and right).

Conclusion: The hydrology development of CF resulted in sets of valley, channel, sapping, alcove and spring structures. The fault and fold tectonics allows us to approach local hydrology event history in relation to episodic tectonics and water re-distribution on Mars.

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References: [1] Laskar and Robutel (1993) Nature 361, 608-612. [2] Head et al. (2003) Nature 426, 797-802. [3] Raitala et al. (2005) LPSC XXXVI, Abstr. #1307. [4] Head et al. (2005) Nature 434, 346-351. [5] Jaumann et al. (2007) PSS 55, 928-952. [6] Christensen et al. (2004) Space Sci. Rev. 110, 85-130. [7] Malin and Edgett (2001) JGR 106, 23429-23570. [8] McEwen et al. (2007) JGR in press. [9] Zuber et al. (1992) JGR 97, 7781-7797. [10] Raitala et al. (2004) Vernadsky-Brown Microsymposium 40, Abstr. #51. [11] Mangold and Ansan (2005) Icarus 180, 75-87.