Extent and further characteristics of former glaciated terrain in Elysium Planitia, Mars. J. Nussbaumer, Department of Mineralogy, Natural History Museum, London, UK, jurn@nhm.ac.uk.

Introduction: Here is presented the hypothesis that ice sheets from a retreating and sublimating frozen lake changed the planet's surface in southeastern Elysium Planitia, Mars. This hypothesis is based on observed morphologies, that are similar to morphologies in terrestrial formerly glaciated environments. An interesting aspect in this region is the relatively young age of the deposits, derived from the small amount of impact craters [13]. The Elysium region is thought to be an area associated with the youngest volcanic, fluvial and glacial activity seen so far on Mars. The relevant geological units include Aeolis (A), the Cerberus Plains (CP) and the Medusae Fossae Formation (MFF). Parts of the CP are situated at the end of the geological young Athabasca Valles outflow channel [1] and have been previously interpreted as either flood lava [2] or outflow channel deposits [3].

A frozen lake: A retreating and sublimating frozen lake is evident at the lake's receding margins, consisting of ice sheets. Bright platy material in the CP shows features that I interpret to be small scale, polygonal ground (Fig. 2a) and pingo-like cones, both of which are common in terrestrial permafrost. The fill of any basin in Elysium owing to the drainage of Athabasca Valles could result in a lake. However, the water could infiltrate and never form a lake [4]. The water could have infiltrated, then the saturated ground was over run by lava, producing rootless cones. The presence of rootless cones indicating shallow subsurface ice in recent times [4] could be explained by Lava, flowing over marshy or saturated ground. The partial burial of the frozen ice by lava may have conserved water reservoirs, which were freezing to a significant depth, until an equilibrium of salinity, pressure and temperature was reached. The existence of fans on Mars (e.g. Themis VIS V10074013), which resemble terrestrial submarine fans. shows that liquid water under an overlying ice cover could have existed in southern Elysium, too. Meteorite impacts into this overpressured aquifer may have led to outbursts of water, comparable to water outbursts from the Cerberus Fossae. The northward actively retreating ice border, part of the sublimating frozen lake, left structures resembling terrestrial dead-ice holes, flutes and moraines (Fig. 1). Triangular imprints in smooth terrain are interpreted as grounded ice blocks and suggest the former existence of a proglacial lake south of the ice margin. Soft material from the smooth and wet subsurface underneath the ice may have been pressed into crevasses of the surrounding ice [14]. The subsequent sublimation of the ice around the crevasses left behind wall-like structures in a staircase pattern (Fig. 1b), a mechanism well known from similar areas in Iceland [14].

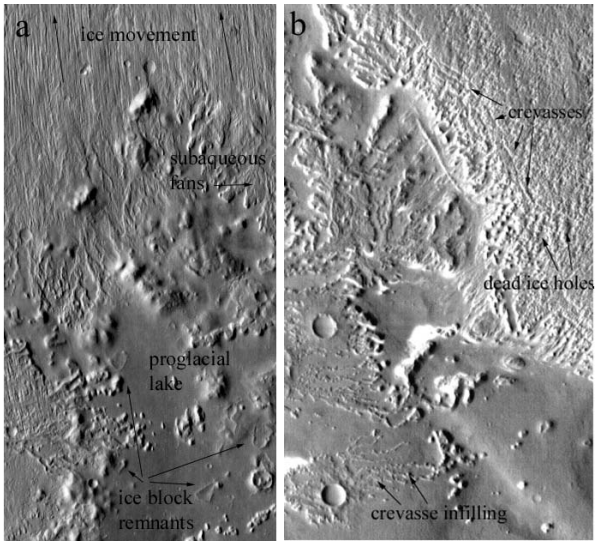

Fig. 1: Themis IR I01842008. ~32 km width (a), Themis IR I09394006, ~32 km width (b)

The Medusae Fossae Formation (MFF): The MFF was proposed to be an volcanic airfall deposit [5], while the relating volcanic vents have not been convincingly [12] identified yet. The formation shows possible signs of sublimation at various places like viscous flow features [15], is superposed on the CP and shows drumlinoid, layered, sometimes triangular blade-like features (Fig. 3c), interpreted as yardangs. Other explanations include penitents or ablation hollows. Terrestrial penitents are triangular blades, common on glaciers in the dry Andes and are formed by strong solar radiation. The similarity of surficial deposits on both MFF and impact crater ejecta (Fig. 3a) suggests a similar formation mechanism. Meteorite impacts into an ice-rich soil would eject vaporized water into the atmosphere, which would condense and precipitate out [6], causing the deposition of dust and ice subsequent to the impact, a possible reason, that parts of the Medusae Fossae Formation have been proposed to be ice-rich [7, 8].

Sublimating cones: Clusters of cones are present on the CP, whereas many of these cones are near or eroding out from beneath the MFF (Fig. 3b) or impact crater ejecta. Cones in Elysium planitia have been interpreted as rootless cones [4] or pingos [3]. Rootless cones are formed by phreatomagmatic explosions owing to the flow of lava over wet ground [16]. Terrestrial pingos (Fig. 2c) (conical mounds in permafrost areas) are caused by the freezing and growing of water lenses in the ground [17]. Ice lenses form either from former water bodies and lakes. Scars of terrestrial pingos have been found next to former

Pleistocene ice sheets [18]. The proximity of pingo-like cones to the MFF suggest that the cones accumulate subsequent to the erosion and/or sublimation of the MFF. Circular rings at the margin of this formation (Fig. 3b) are possibly the remains of abandoned ice, which was left over after the sublimation and retreat of the Medusae Fossae Formation. Circular features in Athabasca Valles have been interpreted as the remains of melting ice blocks [9] or alternatively, scars of pingos [10, 11]. Similar features have been observed in the Wadden Sea in a smaller scale on Earth in winter. Here, snowpacks were buried with sand owing to tidal action. After the melting of an inner snow core, the small hillock collapses, leaving behind an outer ring structure [12]. Channels, which are running out of such pingo-like hills (Fig. 2b) additionally suggest the melting of a water ice core.

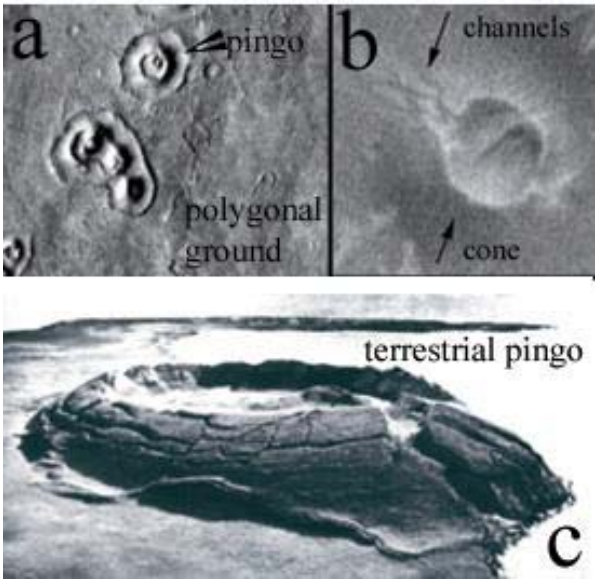

Fig. 2: MOC images r0400778, 1,57 m/pxl, ~500m width (a), cone adjacent to MFF, e1201250 1.63 m/pxl, ~250 m width (b), terrestrial pingo (c).

Conclusions: Water eruption from pressurized aquifers as a result of a growing cryosphere at Mars could form ice sheets [e.g. 9]. Terrestrial analogies are found in permafrost regions, where freezing and pressurization of confined aquifers creates pingos and icing outbursts. Sublimation features on the MFF like cones, possible penitents and moraine-like ridges suggest, that the Medusae Fossae Formation is rich in ice, possibly formed by the drainage of an subsurface aquifer or by the dust and ice deposition subsequent to an impact.

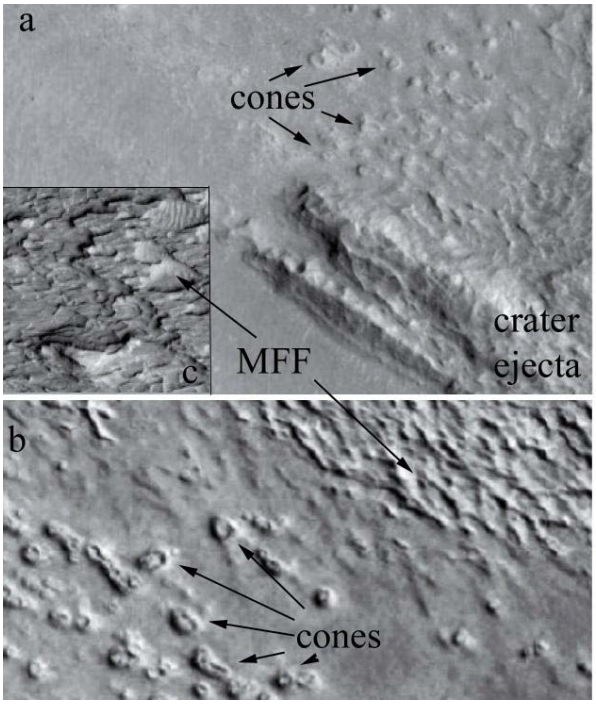

Fig. 3: MOC images e1701551, 6,01 m/pxl, ~2km width (a), m0800090 5,89 m/pxl. ~1,5km width (b) e0400568 3,52 m/pxl, 0,4 km width (c).

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