THERMOKARSTIC DEPRESSIONS AT THE MOUTH OF ELYSIUM CHANNELS (MARS): NEW EVIDENCE FOR THE PRESENCE OF MASSIVE ICY BEDS.

F.M. COSTARD, Laboratoire de Géographie Physique URA DO141, CNRS, 92195 Meudon Cédex, France.

The analysis of very high resolution Viking pictures (12 m/pixel) in Utopia Planitia indicates a concentration of thousand of depressions at the mouth of Elysium channels. Their spatial distribution concern an area of 220.000 km² between 237°W to 271°W and 41°N to 50°N. These depressions are 130 m to 3 km in length and 20 m to 45 m in depth and occupy a regional depression whose floor altitud is -2 km (fig. 1). The occurrence in the same area of very high density fluidized ejecta craters implies the presence of a continuous and subsurface ground-ice (1) probably in thick sediment deposits (2, 3, 4). The purpose of this study is to compare these depressions with thermokarstic features of Yakutia (Siberia). An eolian origin would produce elongated shapes and not circular depressions as they are actually observed. A kettle hypothesis is also unlikely because of the lack of moraine like ridges in the vicinity.

a) Circular depressions:
These depressions are the most numerous. They are similar in size and form to thermokarstic depressions (alases) of terrestrial Arctic regions (fig. 2). In Yakutia, alases are well developped in presence of massive icy beds which can be as much as 2 km in length and 40 m in thickness (5). On Mars, the occurrence of alases implies a near surface ground-ice which contains massive icy beds (6). A change in the thermal balance of ground-ice, during a warmer climate or a geothermal heating, would produced melting or sublimation of the ice with an extensive alas development.

b) Annular depressions:
In the same area, a few tens of fluidized ejecta craters exhibit an annular moat at the edge of the ejecta blanket. The complete evolution of these annular moats since their formations until their complete developments will be retraced. A thermokarstic origin is also proposed. Just after the formation of the ejecta lobe, a post-deposition fluid flow produced a concentration of volatiles in the edge of the ejecta lobe (fig. 3-B). Such a mechanism is attested by the occurence of channels on some ejecta blankets (fig. 3-A) as advocated by Mouginis-Mark (7). Under the cold climate conditions of planet Mars, freezing of water involved a modification of the porous structure of ground-ice. Its subsequent melting produced individual alases (fig. 3-C) where slope retreats resulted in a progressive widening around the ejecta lobe (fig. 3-D, E). Finally their intersection produces a complete annular moat (fig. 3-F).

c) Stratified deposits.
As advocated by Zimbelman et al. (8), Utopia Planitia seems to be covered by a stratified deposit. The deepest alases reveal an horizontal deposit with three or four layers. In many places, the layers exhibit a trangressive overlap over a distance of 2 km (fig. 4). Such observations involve a stratification of sediments during different episods of channeling and sedimentation with a kind of cross-bedding. Such an apparent stratification on the alas slopes is not consistent with a collapse process. It is supposed that an aeolian erosional process might reveals locally that stratification after the thermokarst episod. The reduced energy regime at the mouth of Elysium channels may have involved a preferential accumulation of fine grained deposit easily removable by an eolian process. Under a cold climate condition, such sediments might have contained considerable amounts of ice (massive icy beds, ice segregations) which favored intense development of thermokarst features.

Conclusion: The occurence of such circular and annular thermokarstic depressions at the mouth of outflow channels supports the presence of a volatile-rich fluvial sediments which contain major amount of massive icy beds.

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References: (1) Costard, F.M. (1989): Earth, Moon and Planets, 45: 265-290. (2) Lucchitta, B.K., Fergusson, H.M. and Summers, C. (1986): Proc. 17th Lunar and Planet. Sci. Conf., J.G.R. pp. E166-E174. (3) Mc Gill, G.E. (1985): Lunar and Planet. Sci. Conf. pp. 534-535. (4) Jons, H.P. (1985): Proc Lunar and Planet Sci. Conf., 414-415. (5) Mackay, J.R. (1973): Permafrost Conf., pp.223-228. (6) Costard, F.M. (1988): Lunar and Planet. Sci. Conf. pp. 211-212. (7) Mouginis-Mark, P.J. (1987): Icarus, 71:268-286. (8) Zimbelman, J.R., S.M. Clifford and S.H. William (1989): Proc. 19th Lunar and Planet. Sci. Conf., J.G.R. pp. 397-407.

THERMOKARSTIC DEPRESSIONS ON MARS: COSTARD F.M.

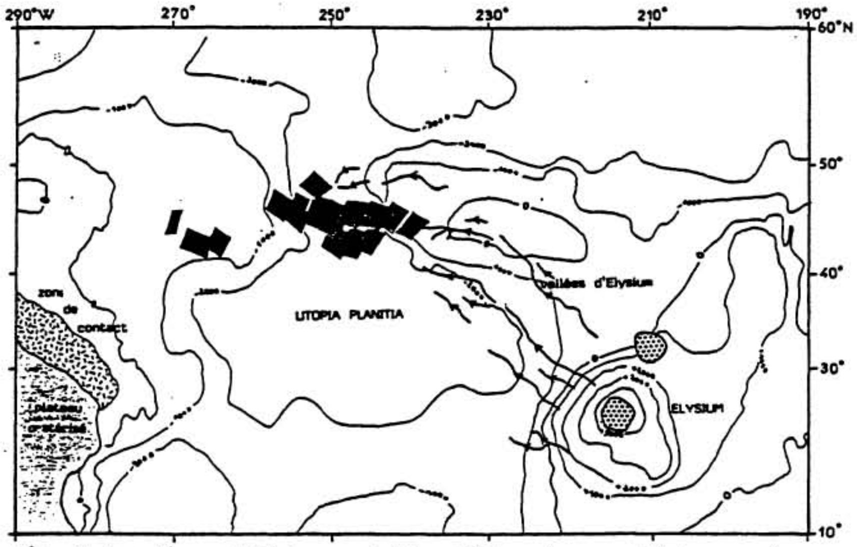


Fig. 1: Location of high resolution Viking images which comprise alas depressions (solid black). Note their association with Elysium channels (solid lines with arrows).

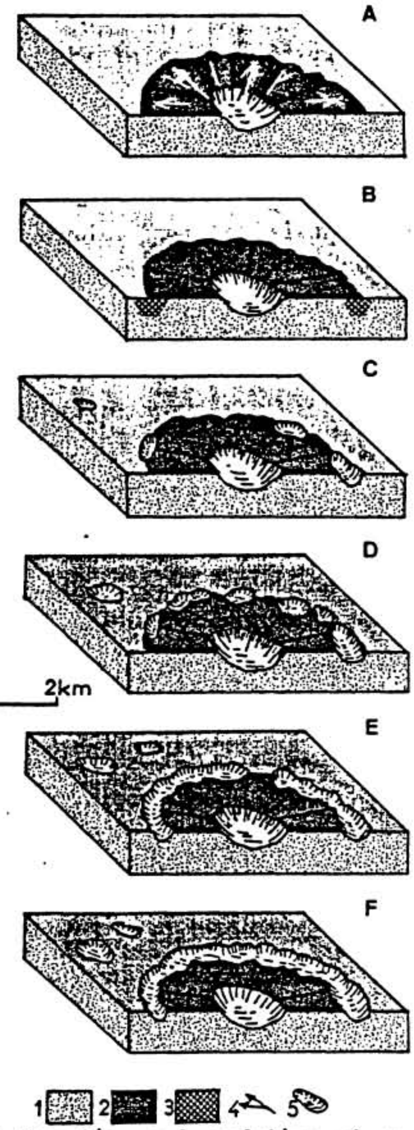


Fig. 3: Formation and evolution of an annular moat around a fluidized ejecta crater. 1: ground-ice; 2: ejecta blanket; 3: volatile concentration; 4: channels; 5: alas.

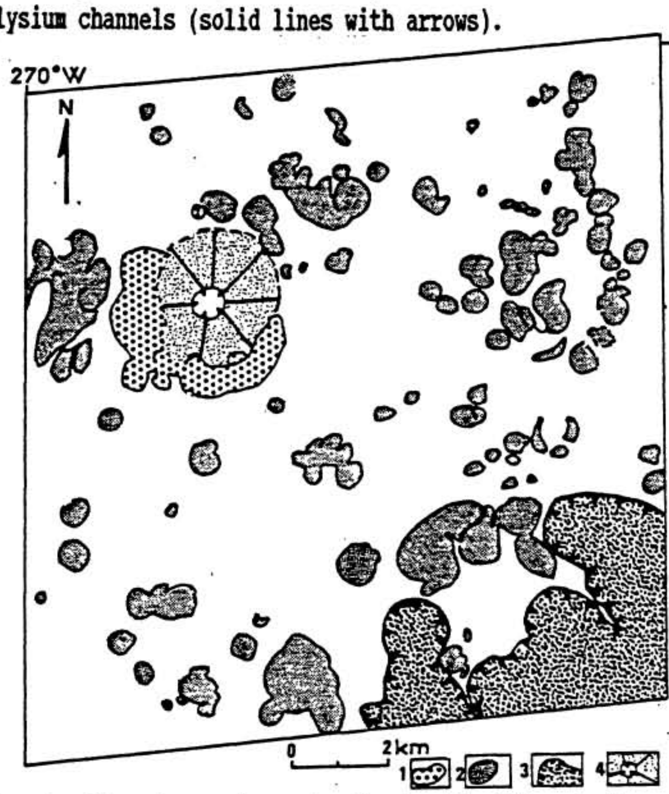
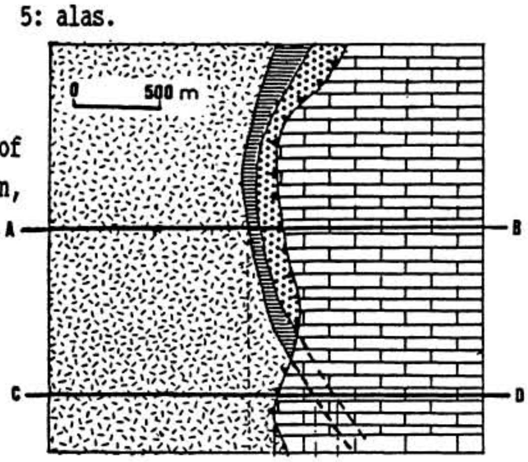


Fig. 2: Alas depressions in Utopia Planitia at the mouth of Elysium channels. (1): annular moat, (2): circular depression, (3): large thermokarst depression, (4): fluidized ejecta crater.



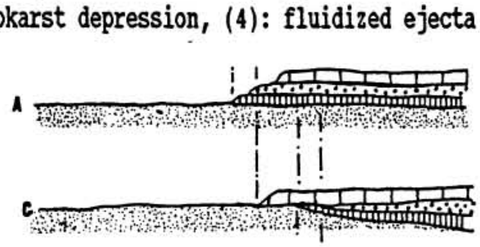


Fig. 4: Map showing a transgressive overlap within stratified deposits of a thermokarst collapse.