EVIDENCE FOR A SURGING ICE-SHEET IN ELYSIUM PLANITIA, MARS. J. Nussbaumer[1], R. Jaumann[1], and E. Hauber[1], [1]DLR Institute for Space Sensor Technology and Planetary Exploration, Rutherfordstr. 2, D-12489 Berlin, Germany; juergen.nussbaumer@dlr.de.

Introduction: High resolution Viking images (orbit 724A, 14m/pixel) show evidence for ancient glaciation in parts of southeastern Elysium Planitia. While previous authors have mapped the materials as thin lacustrine and fluvial deposits [1], we present evidence for erosional and depositional processes associated with glacial environments. The previous ice sheet formed hummocky goundmoraines, eskers, and possibly pingos.

Geomorphology: Detailed geomorphological mapping of high resolution Viking Orbiter images reveals several features which can be attributed to glacial and periglacial processes in the southeastern part of Elysium Planitia (Fig. 1).

Ground moraines. The presence of a former ice sheet is indicated by hummocky terrain resembling terrestrial ground moraines. A sharp contact marks the boundary between the ice sheet and an adjacent yardang field.

Eskers. The ground moraine is locally overlain by mostly curvilinear features. They are interpreted as eskers, sinuous ridges of glacifluvial sand or gravel

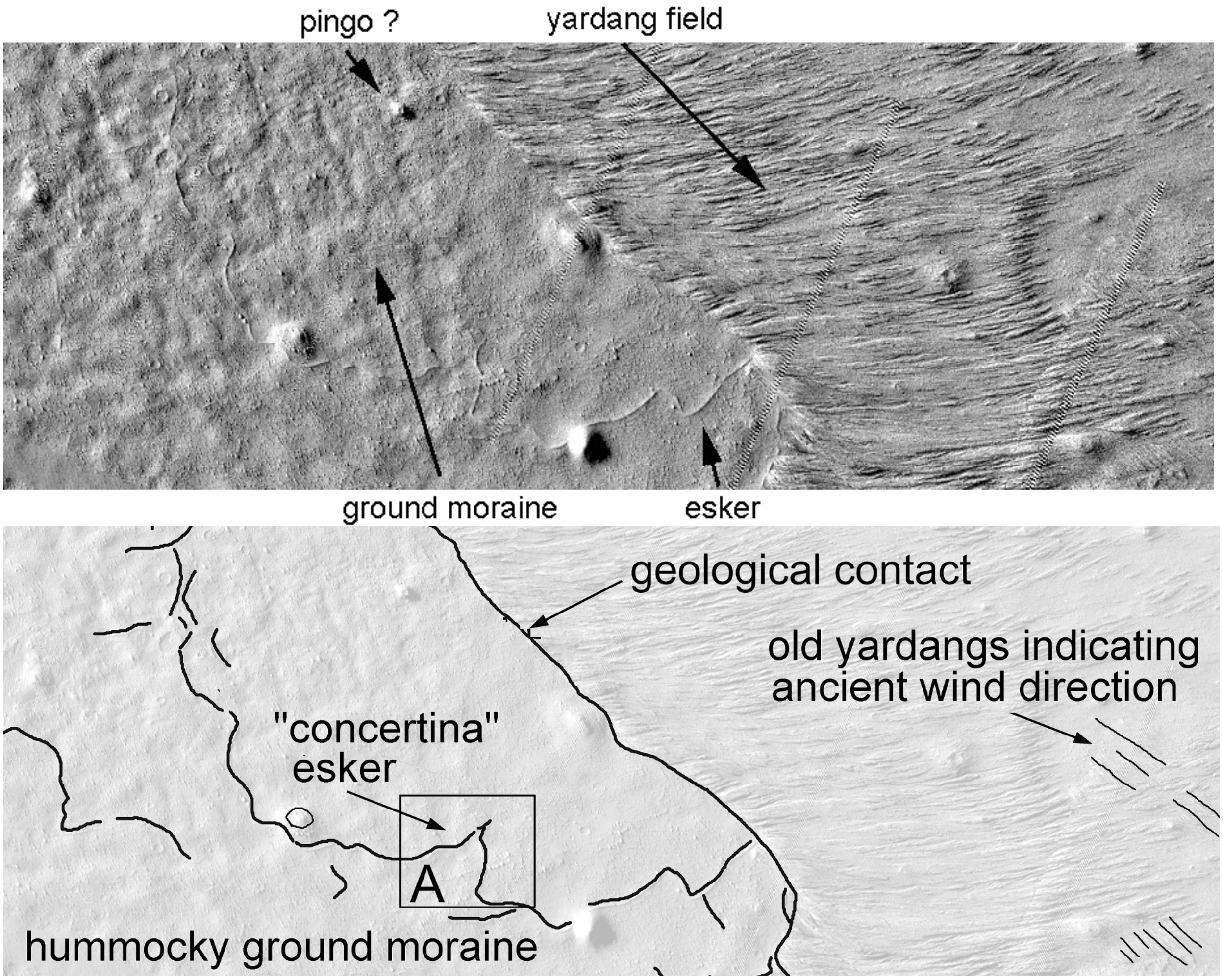

Figure 1: Image mosaic of Viking orbit 724A (14m/pixel; image width 60km, North is up, center at 207°W, -3°S) and geomorphological sketch map. Hummocky groundmoraines, eskers, and possibly pingos are evidence for former glaciation. The outlined box A marks the location of eskers deformed into a zigzag pattern typical for terrestrial *concertina eskers* (compare with box A' in Fig. 2).

formed as infillings of ice-walled rivers [2,3]. Locally, the sinuous pattern of the eskers (as seen in plan view) is changed into a jagged or zig-zag path. On Iceland, previously sinuous eskers have been shortened and crumpled into such a zigzag pattern by the advancing glacier snout (Fig. 2) [4,5]. These so-called *concertina eskers* are associated with *surging glaciers*, characterized by periodic changes in flow velocities over various timescales [6]. It is important to note that the surges are NOT triggered by climatic oscillations, but by oscillations in the internal workings of the glacier [7]. Therefore, although it is tempting to ascribe the former existence of a possible surging glacier on Mars to previous climatic changes, this assumption is not supported by terrestrial analogy.

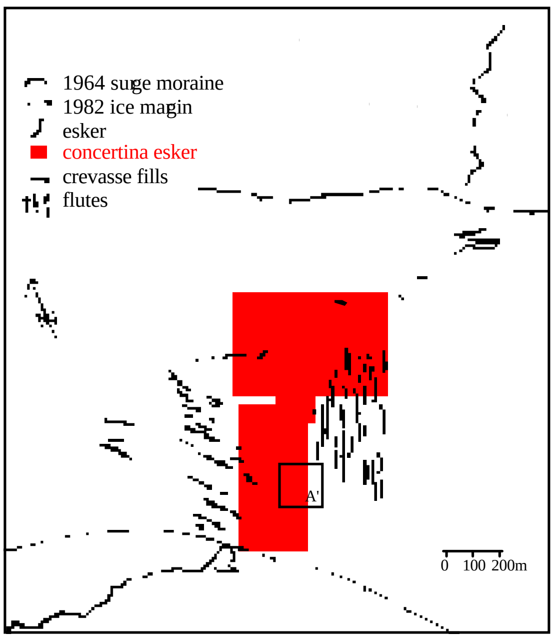

Figure 2: Sketch map of concertina eskers associated with the Bruarjökull glacier in Iceland. Eskers are deformed by the advance of the glacier snout. Note the similarity of the feature in the outlined box A' with the esker in box A of Fig. 1 (modified from [5]).

Pingos. Several circular hills are distributed on the ground moraine, partly characterized by depressions on their top. They are interpreted as pingos, ice-cored hills formed in periglacial environments on Earth by the intrusion and subsequent freezing of pressurized water or by the growth of ice lenses [2,3].

Boulder trains. Boulder trains are widespread on the ground moraine (Fig. 3). While they also occur in the lee of obstacles in large floods or downslope from outcrops on steep slopes, they can also be associated with glacial deposits [8]. There, they indicate the direction of ice movement during the last stage of glaciation [9].

Conclusions: Several landforms in southestaren Elysium Planitia suggest previous local or regional glaciation. The relatively young age (Amazonian, see [1]) and the geographic location near the equator bears important paleoclimatic implications. Further investigations (especially more detailed age determinations by crater counting and high resolution imagery by the *Mars Observer Camera* or future instruments) are required to confirm or reject the possibility of near equator glaciation in the comparably recent past of Mars.

References: [1] Scott, D.H. and Chapman, M.G. (1995) USGS Map I-2397. [2] Washburn, A.L. (1973) *Periglacial Processes and Environments,* Edward Arnold, London. [3] French, H.M. (1976) *The Periglacial Environment,* Longman, London. [4] Sharp, M. J. (1985) *Quaternary Research, 24,* 268-284. [5] Knudsen, O. (1995) *Quaternary Science Reviews, 14,* 487-493. [6] Benn, D.I. and Evans, D.J.A. (1998) *Glaciers and Glaciation,* John Wiley, New York. [7] Meier, M. F. and Post, A. S. (1969) *Canadian Journal of Earth Sciences, 6,* 807-819. [8] Lucchitta, B.K. (1998) *LPS XXIX,* 1287-1288. [9] Sugden, D.E., Glasser, N.F., and Clapperton, C.M. (1992) *Geografiska Annaler, 74A,* 253-264.

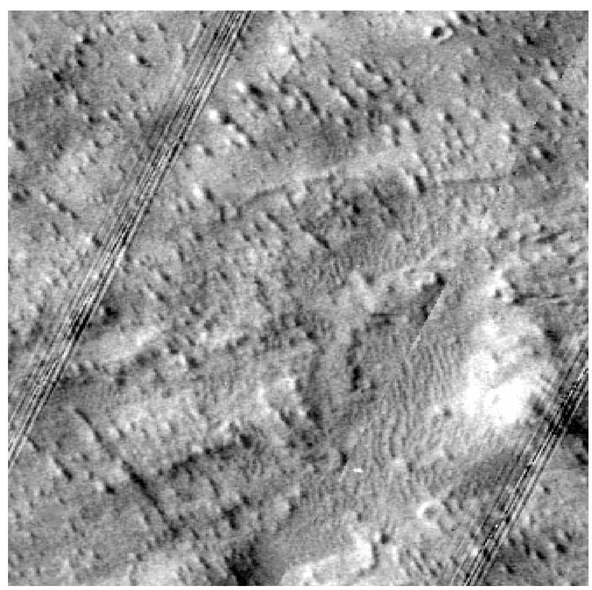

Figure 3: Boulder trains possibly related to a pulse of erosion at the end of the last glacial cycle when the ice was thin [9]. They also indicate ice movement from SE towards NW (topographic data from the *Mars Observer Laser Altimeter* show that topographic gradient is towards NW; Viking orbit 724A, width of image 10 km, North is up).