LIQUID WATER FORMED SCROLL BARS IN RIVER MEANDERS FOR DECADES IN ELYSIUM PLANITIA, MARS. J. Nußbaumer, Johannes Gutenberg University

Introduction: HiRISE images show evidence for meandering channels with scroll bars in parts of southern Elysium, Mars. This is evidence for fluvial erosion, that carved meandering valleys and scroll bars during impact induced climate change. A meander in general is a bend in a sinuous watercourse. Scroll bars indicate the change of river morphology. The previous river formed meanders during a wetter climate in the past and during long term wet conditions.

Geomorphology: A meander is formed when the moving water in a river erodes the outer banks and widens its valley creating a meander [1]. A stream of any volume forms a meandering course of winding sinuosity, alternatively eroding sediments from the outside of a bend and depositing them on the inside. The distance of one meander along the down-valley axis is the meander length or wavelength. The maximum distance from the down-valley axis to the sinuous axis of a loop is the meander width or amplitude. The course at that point is the apex. The curvature varies from a minimum at the apex to infinity at a crossing point (straight line). The radius of the loop is considered to be the straight line perpendicular to the down-valley axis intersecting the sinuous axis at the apex. Once a sinusoidal channel exists it undergoes a process during which the amplitude and concavity of the loops increase dramatically due to the effect of helicoidal flow in increasing the amount of erosion occurring on the outside of a bend. The helicoidal flow is explained as a transfer of momentum from the inside of the bend to the outside. Most meanders occur in the lower course of the river. Erosion is greater on the outside of the bend where velocity is greatest. Sedimentation occurs on the inner edge of the river, creating a slope called a point bar. The faster moving current on the outside bend has more erosive effect and the meander tends to grow in the direction of the outside bend, forming a small cliff called a cut bank. Scroll-bars are a result of continuous lateral migration of a meander loop. The water carves sediment from the outer curve and deposits sediment in the slower flowing water on the inside of the loop, in a process called lateral accretion.

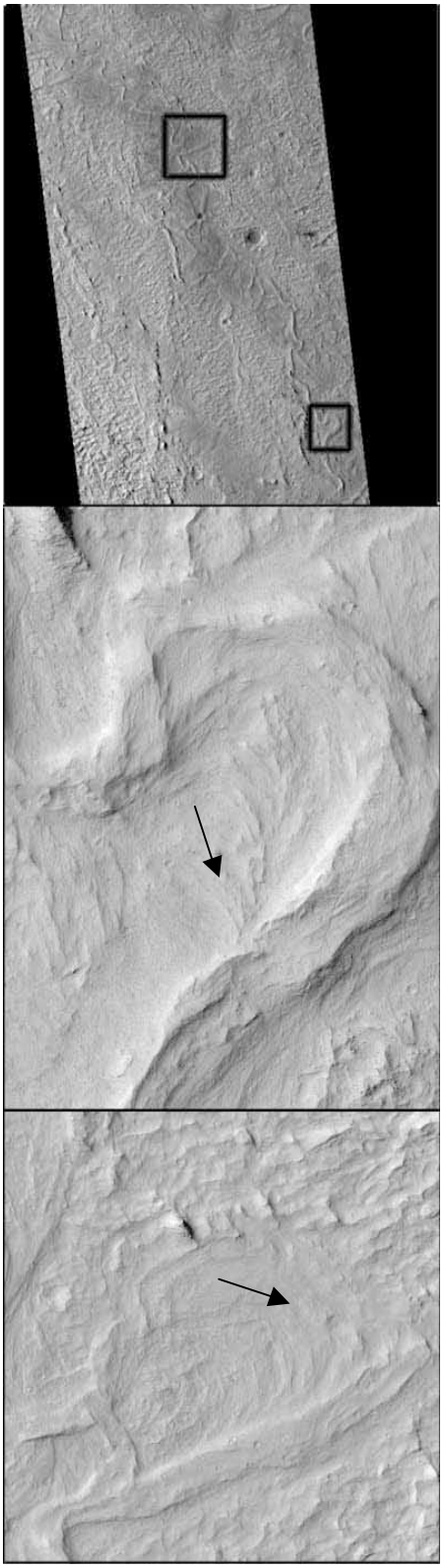

Figure 1: HIRISE Image PSP_006683_1740 of meandering channels (width of meanders is approximately 1km), image resolution is 25 cm/pixel, arrows indicate position of scroll bars, that are evidence for fluvial erosion, that formed meandering valleys during long term climate change. 20 meters of terrestrial meanders are formed within 1 year. Water was flowing from the southeast to the northwest. North is up.

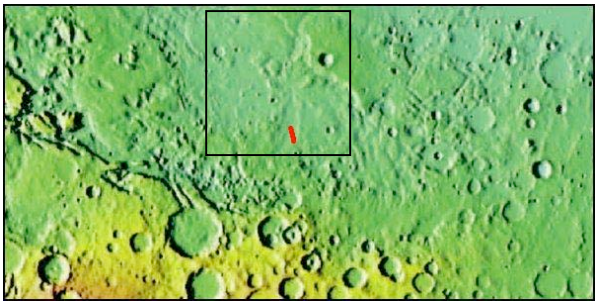

Figure 2: Location of HIRISE image (red footprint) of meandering channel on Mars. Map shows area from 145,6 ° E – 164,3° E and 1,2° S – 10,5 ° S. Box shows location of Figure 4. North is up.

Conclusions: Meandering river sediments in southern Elysium suggest an episode of climate change on Mars, since scroll bars in meanders take several years and decades to form and are a record of the rivers geological history. These meanders are compareable to similar morphologies found near Holden crater on Mars [3-6]. Because the meanders are adjacent to an impact crater (see Fig. 4), it might be suggested, that a meteorite impact in icy soil is responsible for a climate change [7], that rose the temperatures in this region of the planet Mars, so that water could flow on the planets surface. With meander dimensions of approximately 1 km, the meanders would take 20 meters/year to form on Earth [2], therefore terrestrial meanders with the dimensions shown in Fig. 1 would form within 10-100 years. Due to the different gravity on Mars, the meanders would form within a different time frame. Scroll bars represent several episodes of sedimentation showing a fining upward of sediments. The position of meanders can move several times across the same place. A major meteorite impact on Earth would therefore change the climate for a minimum of several decades.

References: [1] Stanley, S (2001) Earth System History, New York: Freeman [2] Press, F. & Siever, R. (1994) Understanding Earth, New York: Freeman. [3] Malin M. C. and Edgett K. S. (2003) *Science, 32*, 1931– 1934. [4] Lewis K. and Aharonson O. (2004), *LPS, XXXV*, Abstract 2083. [5] Jerolmack D. J. et al. (2004) *Geophys. Res. Lett, 31*, L21701, doi:10.1029/2004GL021326. [6] Moore, J. M. et al. (2003) *Geophys. Res. Lett., 30(24),* 2292, doi:10.1029/2003GL019002. [7] Segura T. et al. (2002) *Science, 298*, 1977– 1980.

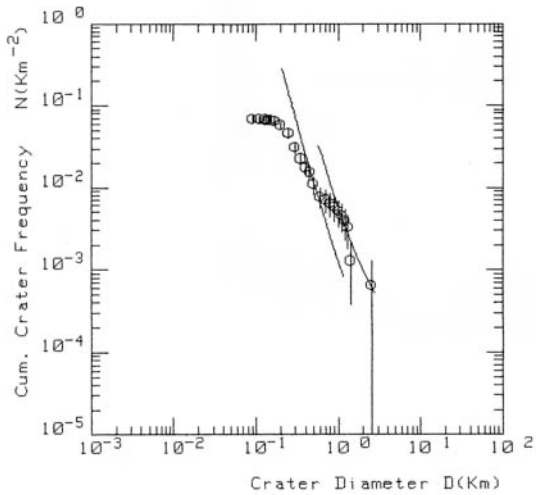

Figure 3: Cumulative Crater Frequency and Crater Diameter of meteorite impact craters around location 1 in figure 4, ages of 2, 58 and 3,78 billion years were calculated.

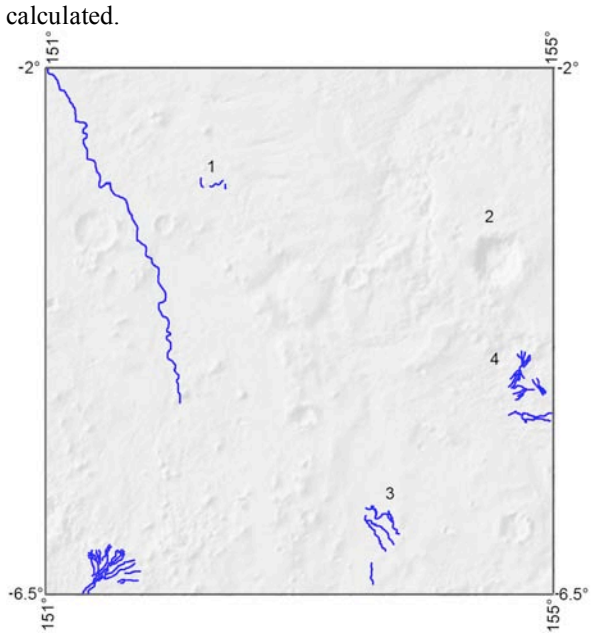

Figure 4: Map of river systems (blue) in the Elysium region. Meandering river is in location 3, age has been calculated in location 1, location 2 shows an impact crater, river sediments adjacent to impact crater are shown in location 4.