

ANCIENT ICE-COVERED LAKES IN THE ECHUS / KASEI VALLEY SYSTEM, MARS.

Christopher Woodworth-Lynas and Jacques Yves Guigné, Guigné International Ltd. 685 St. Thomas Line, Paradise, Newfoundland, CANADA A1L 3V2 709 895 3819 chriswl@guigne.com

Introduction: From analyses of Mars Global Surveyor Mars Orbiter Camera (MOC) images of the Echus Chasma/Kasei Valles valley system we present further, new observations of surficial Martian features that are interpreted to be the result of interactions between the keels of flat-bottomed floating ice floes with a submerged sediment surface [1,2] (Figure 1). Curvilinear ice keel scour mark troughs and ice floe grounding pits are proxy indicators of three basic environmental conditions: the former presence of a water body; the water body was seasonally, or perhaps permanently, covered by ice floes; the water area was large enough for winds, currents or both to drive the floes forward during ice/lakebed interaction.

Originally we had expected to find evidence of the former presence of floating ice preserved, at least in some places, on the seafloor of an ancient north polar ocean. It is reasonable to expect that there may have been seasonal or permanent floating sea ice, and possibly icebergs, in such an ocean [e.g. 3,4,5] as is the case for the Arctic and Southern Oceans on Earth. Kreslavsky and Head [6] present a model for catastrophic submergence of the north polar basin and, geologically, rapid freezing of the entire water column to the seabed and eventual sublimation of this thick ice mass. For this scenario the conditions for creating and preserving ice keel scour marks and ice floe grounding pits are absent. To date we have found no evidence for the presence of floating ice in the north polar basin.

Background: Echus Chasma comprises a flat, linear plain approximately 1,500 km long and 200 – 300 km wide. The average slope is on the order of 0.025°. Its southernmost extremity terminates just south of the equator above the Valles Marineris system. Its northern limit passes into two branches of the Kasei Valles system between the latitudes of 20° and 25° N (Figure 2). A central region of rough, upland terrain is centered at about 10° N. The eastern, southern and southwestern margins of Echus Chasma are well defined by a more or less continuous line of cliffs. The central and northern portion of the western margin merges into the sloping terrain east of the Tharsis volcanoes.

Description: Echus Chasma is separated from the southern branch of Kasei Valles by a valley 40 km long and ~10 km wide (cliff-top to cliff-top). The floor of this valley is incised by two narrow gorges, each about 500 m wide and 15 km (southern gorge) and 10 km long (northern gorge) respectively (Figure 2). Possible shorelines associated with the gorges indicate that the flow of liquid (possibly both lava and liquid water and floating ice, at different times) was confined in the gorges to maximum widths of 0.5 km (southern gorge) and 2 km (northern gorge).

The two narrow gorges geographically separate large ice floe pits that formed in a very large, long lake of the upper valley system (Echus Chasma) from much smaller ice floe pits that formed in a narrow river system of the lower valley (Kasei Valles). We interpret this difference to be in part the result of mechanical breakup of the large Echus Chasma ice floes as they entered and passed through the narrow gorges, and in part because the valley floor of Kasei Valles, below the gorges, is relatively narrow (2-5 km wide) thus not affording the same opportunities for the formation of large ice floes.

Floating ice-related features in the lower valley (Kasei Valles) are found only in the southern branch of Kasei Valles and do not extend eastward beyond the vicinity of Sharanov crater near the mouth of the valley system.

We have observed similarities between interpreted ice-grounding features and the “platy” morphologies of possible lava flows that occur in the valley system. We conclude that both ice keel-deformed sediment surfaces and lava flows occur as stratigraphically separate units in the valley system.

In places in the Echus Chasma portion of the valley system there are smooth- and rough-appearing surfaces that blanket an earlier deeply grooved curvilinear terrain. These surfaces are commonly associated and may represent the inundation surfaces of sedimentary (smooth) and lava flow (rough) units, deposited at different times. Draping of smooth units over the grooved terrain may represent deposition of sediment from a standing body of water.

The youngest Valles geological unit is the early-Amazonian aged Kasei unit 2 mapped by Rotto and Tanaka (1995) and Tanaka (1997). It is on the surface of this unit that the Kasei Valles ice keel scour marks all formed. The Echus Chasma features occur on the surface of Member 5 of the middle-Amazonian Tharsis Formation (Rotto and Tanaka *op. cit.*; Tanaka *op. cit.*).

Conclusion: Based on the geographic occurrence of scour marks, grounding pits, shorelines and sedimentary and volcanic units we interpret an ancient valley system that was inundated at least once by ice-covered water, possibly alternating with periods of lava flow activity. When flooded by ice and water the Echus Chasma/Kasei Valles lake and valley system was approximately 1,500 km long and 200 – 300 km wide (Figure 3).

References:

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Figure 1. MOC image from Echus Chasma showing features interpreted as ice floe prints. Arrows show two possible grounding positions of the same floe field. Interpreted ice keel scour marks, made by bottom-dragging keels, are shown as thick lines.

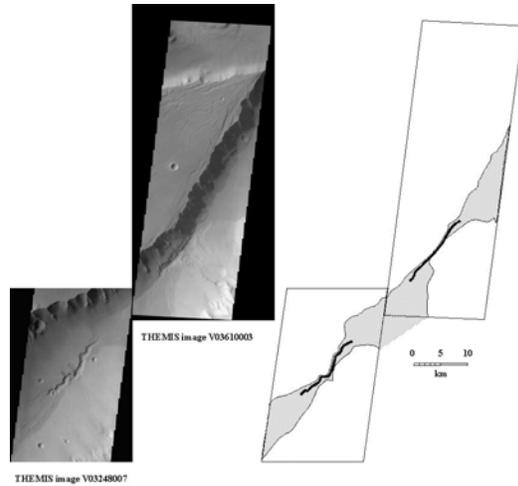


Figure 2. LEFT: image of the two narrow gorges joining Echus Chasma (to the south) to the southern branch of Kasei Valles. The gorges have a total length of about 25 km and are both about 500 m wide. RIGHT: interpretation. The two gorges shown by thick black lines. The grey area represents maximum limit of inundation based on extent of possible shorelines. See Figure 1 for location.

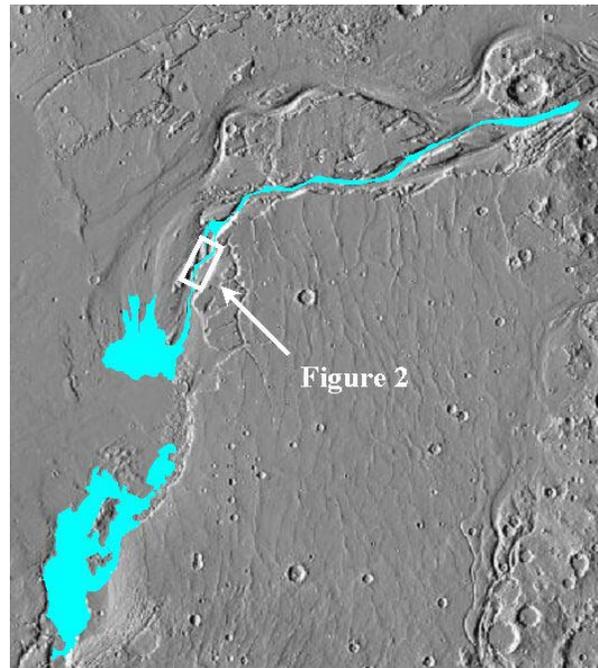


Figure 2. Interpreted extent of ice-covered lakes in the Echus Chasma / Kasei Valles valley system.