HYDROGEOLOGY OF THE VALLES MARINERIS-CHAOTIC TERRAIN TRANSITION ZONE, MARS.

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Introduction: The Valles Marineris-chaotic terrain transition zone on Mars is rich in landforms indicative of past water and volcanic activities [1][2][3]. Our preliminary results from the GIS mapping of Gangis Chasma and its surroundings indicate that the region represents one of the best examples of liquid water and ice-related processes as represented by ancient crater lakes, chaotic terrain, an outflow channel system, canyon wasting, moist or wet landslides, ice-related small debris aprons, and a subice volcano. We mapped the Gangis Chasma region over Viking imagery, MOLA (Mars Orbiter Laser Altimeter) topography, THEMIS (Thermal Emission Imaging System) and wide and narrow angle MOC (Mars Orbiter Camera) images.

Elaver Vallis outflow channel and a crater lake: Elaver Vallis is an outflow channel emanating from a degraded impact crater 70-80 km in diameter (Fig. 1). The channel floors are intensely grooved. Patches of chaotic terrain are distributed on the channel floors of the anastomosing middle reach, implying that water was supplied also from these areas. The outflow channel incises uplands and terminates in the Gangis Chasma floor. The lowermost reach of the channel is modified to be a deep V-shaped canyon perhaps of a sapping origin. The transported sediments accumulated at the bottom of Gangis Chasma below the mouth of the sapping canyon (Fig. 1).

The source crater records a series of lacustrine episodes. The terrace morphology observed primarily along the western and southeastern rim is about 200 m above the crater floors and it is interpreted to be the highest shoreline. Besides these terraces, evidence exists for at least two shoreline levels delineated by terminations of networks of shallow channels on the crater floor. Our preliminary work [4] revealed that three altitudinal levels (1320 m, 1213 m, 1120 m) approximately coincide with these shorelines. The floor of the spillover channel is higher than the crater floor and it is about 100 m higher than the terraces. This indicates that the spillover occurred when the lake was above the altitude of the terraces, implying the presence of another lake level not accompanied by a clear shoreline.

Canyon expansion, slope processes and Gangis layered deposit: The region exhibits a number of evidence for processes of ice. Canyons of Valles Marineris have been expanding at least in part through the process of terrain collapsing. The result is the formation of chaotic terrain commonly observed on the floor of Gangis Chasma and other chasmata, in particular Eos-Capri Chasmata.

Landslides in Gangis Chasma are gigantic in their dimensions (Fig. 2). As pointed out by earlier works [e.g., 5], several of the Valles Marineris landslides may have been moist or wet at emplacement. Small debris-aprons around massifs on the Gangis Chasma floor are also possibly indicative of ice-assisted slow deformation process (Fig. 1).

Interior layered deposits (ILDs) overlie the floor of Gangis Chasma. The ILDs in Gangis Chasama and elsewhere in Valles Marineris were recently suggested to have been originated as volcanoes formed in a variety of ice-rich environments (subice, englacial lakes or ice-dammed lakes, for example) [6][7]. Our detailed GIS study on the largest ILD in Gangis Chasma also reveals details of landforms that are best interpreted to volcanic (Fig. 2).

Discussion: Gangis Chasma and its surroundings are characterized by landforms indicative of extensive liquid water and ice activities in the past. Spatial distribution and temporal relationships of such landforms imply a complex history of the region. These processes perhaps accelerate during the periods of elevated magmatic activity or owing to climatic shifts [8]. Endogenic heating appear to have been essential in making ice in the crust to mobilize (melt or creep) in the formation of these features. Climatic shifts including ones caused by the obliquity change could have assisted the mobilization of ice or they may have caused precipitation of snow.

Acknowledgements: This project was supported by the joint ASI/IRSPS MEGIS program.

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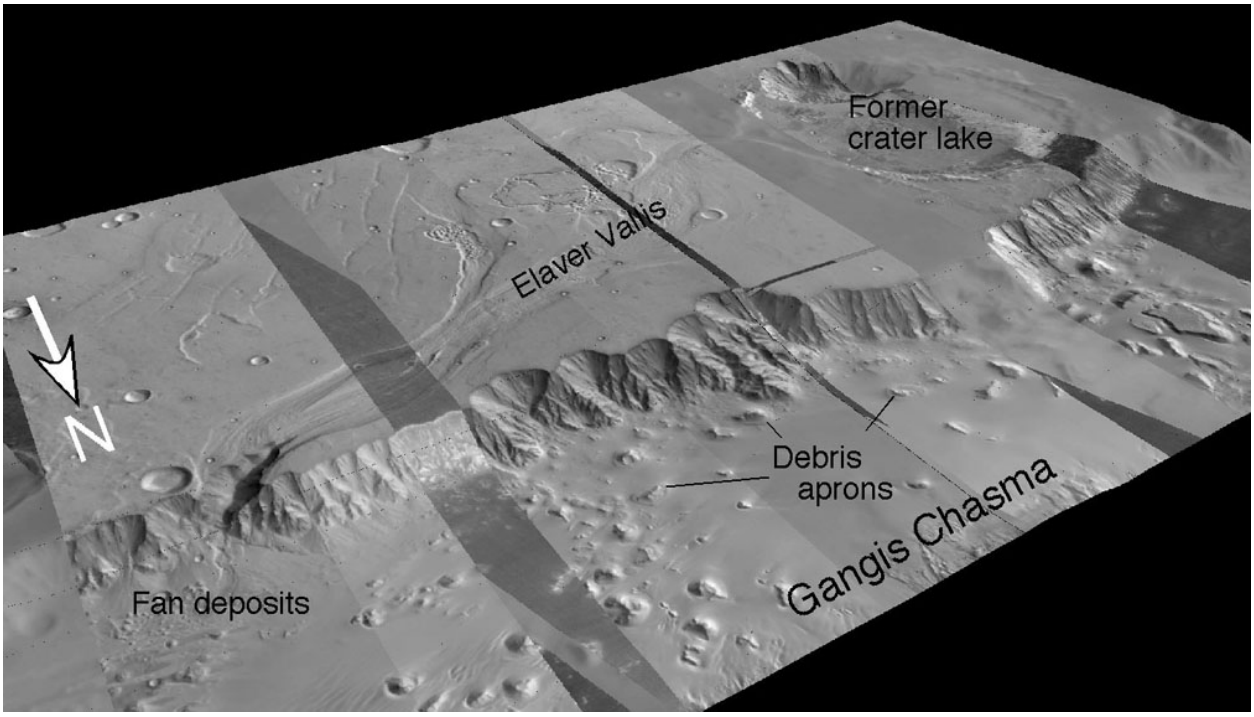

Figure 1. 3-d view of Elaver Vallis on the plateau south of Gangis Chasma. Elaver Vallis is a type of outflow channels that were formed by floods of cataclysmic scales. The primary source for the floods is an impact crater (70-80 km in diameter), but water also appears to have originated from chaotic terrain. Debris aprons around massifs on the floor of Gangis Chasma testify for ice-related processes.

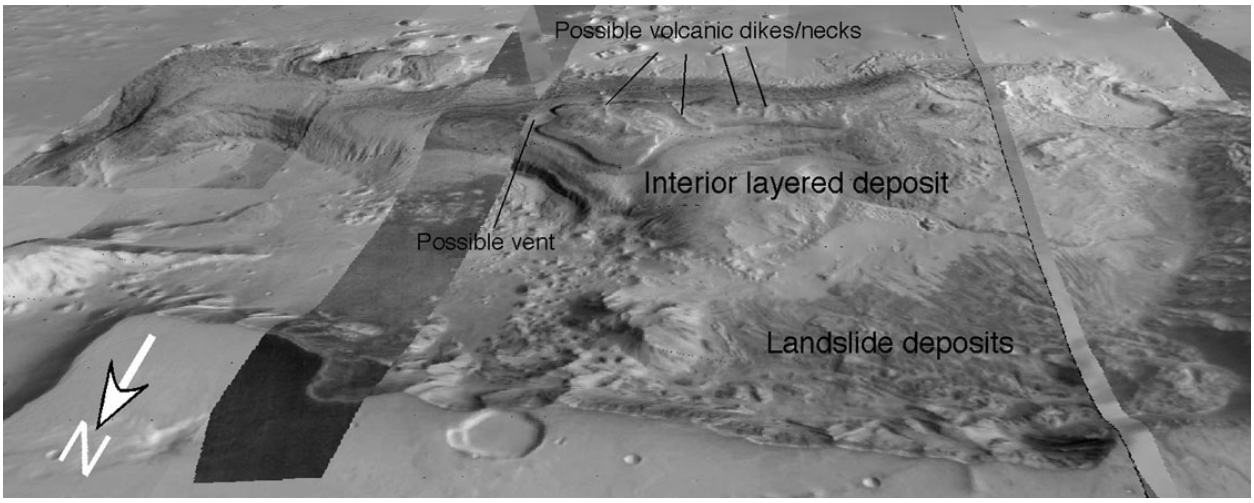

Figure 2. 3-d view of an interior layered deposit (approximately 110-120 km long in the E-W direction) on the Gangis Chasma floor. Widespread morphologies including ridges/domes and depressions are interpreted to be volcanic in origin since they resemble volcanic dikes/necks, and vents respectively. Landslides are an essential component of canyon enlargement processes. Some of these landslides may have been moist or wet at their emplacement.