COMPARATIVE STUDY OF 3-DIMENSIONAL RENDERINGS OF THE VALLES MARINERIS INTERIOR LAYERED DEPOSITS ON MARS AND TERRESTRIAL SUB-ICE VOLCANOES IN ICELAND.

M. G. Chapman[1], B. K. Lucchitta[1], I. P. Skilling[2], J. L. Smellie[3], and T. Thordarson[4]; [1]U.S. Geological Survey, 2255 N. Gemini Drive, Flagstaff, AZ 86001 (mchapman@usgs.gov); [2]Dept. of Geology and Planetary Sciences, 200 SRCC Building University of Pittsburgh, Pittsburgh, PA 15260 ; [3]British Antarctic Survey, High Cross, Madingly Road, Cambridge CB3 OET, U.K.; [4]SOEST, University of Hawaii at Manoa, 1680 East-West Road, POST 802, Honolulu, HI 96822

Introduction. Many Valles Marineris chasmata contain mounds and mesas of interior layered deposits (ILDs). Although the origin of the layered interior deposits remains controversial, mapping indicates that the ILDs formed at different times [1] and adjacent deposits have distinct edifice morphologies and sequences of deposits, suggesting different depositional histories [2]. An origin of the interior deposits as eroded sequences on in-situ wall rock [3] is not considered a viable hypothesis by most investigators because of the vastly different outcrop patterns of wall rock and interior deposits [1, 2, 4, 5]. Some young eolian deposits are present, but great uniformity in thickness and sequence of deposits across several troughs is required if the ILD deposits were largely eolian, because they would have to reflect global events [3] and this uniformity is not observed. The ILDs were suggested to be lacustrine (non-volcanic lake deposits dominated by an external fluvial input of largely fine-grained sediment, with deposition mostly by suspension and inclusion of possible carbonates or evaporites) on the basis of their apparent horizontal continuity, similarity in connected troughs, and local fine layering [3, 4, 5, 6, 7, 8, 9, 10]. The lacustrine hypothesis alone cannot explain (1) the moats that separate the deposits from the trough walls, nor the angled beds on mound flanks observed in MOC images [11]; (2) the absence of large channels that might have supplied the massive amount of sediments that drained into the troughs [12]; and (3) inability of TES to detect typical lacustrine minerals such as carbonates or evaporites in interior deposits [13]. A volcanic origin for the ILDs is supported by the volcano-tectonic setting, layer diversity, low albedo and high competence of some layers, tuff-like weathering, location of dark materials (basaltic ash?), and diversity between adjacent mounds [1, 4, 14, 15]. More recently, workers have suggested that these deposits are locally subaerial tephra [11], but mostly meltwater lake deposits of hyalotuffs, produced by sub-ice volcanism and magma interaction with meltwater. The interpretation that the ILDs may be sub-ice volcanoes is based on erosional resemblance to Icelandic tuyas like Sellandafjall [16], Viking and MOLA topography expression of several flat-topped mesas having resistant caprock as well as ridge forms [11, 17], and morphologic association with putative volcanic vents, catastrophic floods, possible lava flows, and tentative identification of local glacial erosion [11, 17, 18].

We are currently investigating the interpretation that the ILDs are analogous to terrestrial sub-ice volcanic forms, such as tuyas and hyaloclastic ridges. However, as there is a paucity of planetary-applicable research on sub-ice volcanoes and on MOC-related studies of the ILDs, we are mapping the ILDs and constructing models with which to test the sub-ice volcanic hypothesis, and to place limits, if possible, on contributions of multiple processes that may have delivered materials to the ILDs.

Study. Our research project has 2 tasks to better understand sub-ice volcanoes and investigate this origin as it pertains to the interior layered deposits. Task 1: *Investigation of interior deposits of Valles Marineris, Mars* will combine the field relations of task 2 and MGS data to check the validity of the sub-ice volcanic hypothesis for the origin of the ILDs. This task utilizes MOC, MOLA, and Viking data to geologically map certain ILD mounds and mesas (mensae) in order to better discern ages, and possible origins and compositions. Task 2: *Field studies and research of terrestrial sub-ice volcanoes* is underway in order to better understand the evolution and facies of these unique volcanic features in Iceland. Research of terrestrial examples at small scales comparable to MOC resolution is providing a basis to interpret the Martian deposits.

Preliminary Results. This is the first year of a three-year study; the project is ongoing and our future work will contain the final results. Using MOLA and Viking data and GIS, new volume estimates of the ILD mounds have been derived [19]. Using GIS and a 3D visualization program, we have constructed detailed models of ILD mounds in central and west Candor Chasma and Melas Chasma and are working together to map the mounds in detail and present the work in peer reviewed articles. From this data set and MOC images, we note possible debris avalanches of newly discover blocky flows that emanate from ILD mounds in western Melas and Candor Chasmata [20].

In FY02, we conducted analog studies of the fine-grained slopes and fluted flank deposits of Sellandafjall, and investigated possible hydrothermal pits on nearby Dyngjufjöll Ytri. Like the ILDs, Sellandafjall has fine-grained slopes with angled bedding, that have been eroded into flutes. Our studies of this terrestrial feature indicate that rather than a tuya, the mound is a hyaloclastite deposit capped by layered lavas showing tiered colonnade and entablature jointing. The fine-grained, angled sloped and fluted deposits of Sellandafjall consist of eroded glacial outwash that is draped over the flanks and that was lithified and later gullied. Like some ILD caps, Dyngjufjöll Ytri has pits that may have formed when later eruption intruded an older hyaloclastic flow containing water or ice [21].

Also in FY02, we had a geologic overflight of some tuyas and tindar ridges and began preliminary mapping of Naefurholtsfjöll tindar, west of Hekla. Our 3D views of Candor Mensa show steep cliffs with horizontal to angled beds similar to fine-grained hyaloclastic material that cap and drape Skrida tindar. In addition these computer-generated views also show Candor Mensa to be capped by a bright material eroded into unusual folds and drapes (Fig. 1). Naefurholtsfjöll tindar is capped by Recent deposits of white pumice erupted from Hekla volcano. Similar to caprock of Candor Mensa, these pumice deposits also show unusual folds and drapes (Fig. 2) that are erosional features induced by annual melt of snow and eolian processes acting on the light-weight pumice clasts.

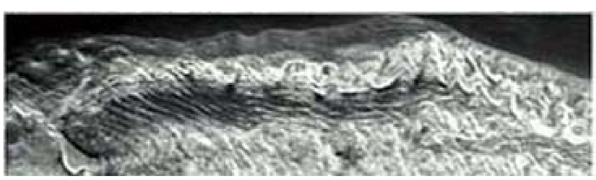

Figure 1. Candor Mensa Caprock.

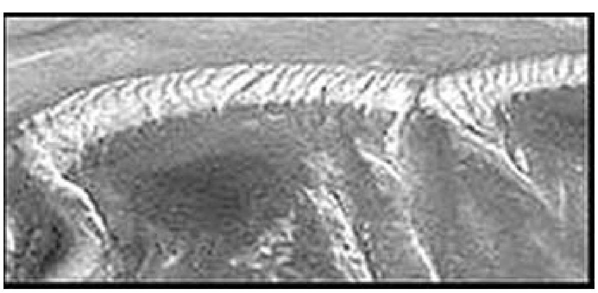

Figure 2. Naefurholtsfjöll tinder Caprock.

References: [1] Lucchitta, 1990, Icarus, 86, 476-509; [2] Komatsu et al., 1993, JGR 98, 11,105-11,121; [3] Malin and Edgett, 2000, Science, 290, 1927-1937; [4] Peterson, 1981, Proc. 12th LPSC, 1459-1471; [5] Nedell et al., 1987, Icarus, 70, 409-441; [6] McCauley, 1978, USGS. Map I-897, scale 1:5,000,000; [7] Carr, 1981, The surface of Mars. Yale Univ. Press, New Haven, 232 pp; [8] Lucchitta, 1982, NASA TM 85127, 233-234; [9] McKay and Nedell, 1988, Icarus, 73, 142-148; [10] Weitz and Parker, 2000, 31th LPSC CD, # 1693; [11] Chapman and Tanaka, 2001, JGR-Planets, v 106, E5, 10,087-10,000; [12] Lucchitta et al., 1992, Mars, Univ. Ariz. Press, Tucson, 453-492; [13] Christensen et al., 1998, Science 279, 1692-1698; [14] Witbeck et al., 1991, USGS Map I-2010, scale 1:2,000,000; [15] Weitz, 1999, 30th LPSC CD, # 1279; [16] Croft, 1990; [17] Lucchitta et al., 1994, JGR 99, 3783-3798; [18] Chapman and Lucchitta, 2000, GSA Abs. w/ Prog. 32, no 7, A304; [19] Noreen and Hare, 2002, LPSC 33rd CD, #1919; [20] Skilling et al., 2002, LPSC 33rd CD, #1361; [21] Sigvaldason, G. E. 1992. J. Vol. & Geotherm. Res. 54, 53-63.