EXTENSIVE SECONDARY CHAOS FORMATION ALONG SIMUD VALLIS, MARS. J. A. P. Rodriguez[1], J. Kargel[2], D. A. Crown[1], and K. L. Tanaka[3], [1]Planetary Science Institute, 1700 E. Ft. Lowell Rd., Suite 106, Tucson, AZ, 85719, [2]Department of Hydrology and Water Resources, University of Arizona, Tucson, AZ 85721, [3]U.S. Geological Survey, Flagstaff, AZ 86001, alexis@psi.edu.

Introduction: The region of southern circum-Chryse on Mars contains large plateau zones that have undergone collapse, forming low-lying depressions floored by broken-up and morphologically diverse blocks. These collapsed terrains, traditionally referred to as chaotic terrains, commonly occur in close spatial association with Martian outflow channels. Martian chaotic terrains and outflow channels have been intensively studied since the 1970's [e.g., 1-5]. The consensus is that chaotic terrains represent zones where aquifer destabilization led to ground collapse and to the release of vast amounts of fluids at the surface, which subsequently carved the higher and lower outflow channels. Whereas the higher outflow channels consist of ~20- to 50 km-wide canyons, the floors of which are marked by dense erosional morphologies, the lower outflow channels consist of even broader valleys (a few 100 km-wide), the floors of which appear to largely consist of debris flows [e.g., 6].

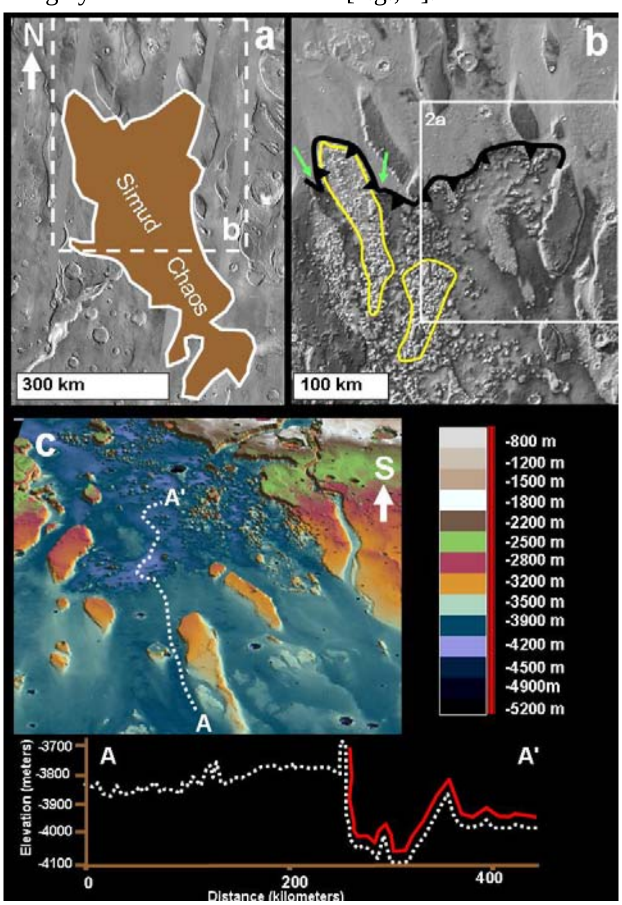

Fig. 1. (a) View of Simud chaos (part of THEMIS IR mosaic centered at -10.06 ° N; 322,31 ° E). (b) View of northern margin of Simud Chaos. Shown is the location of Fig. 2a (gray-scale MOLA-based shaded DEM (128 pixels/degree) centered at 13.81 ° N; 321,15 ° E). (c) Perspective view of MOLA-based shaded DEM (128 pixels/degree) and related elevation profile (A-A').

An obvious implication of this hypothesis is that the formation of chaotic terrains necessarily pre-dated the excavation of their associated outflow channels. Yet, some chaotic terrains formed within the floors of outflow channels, and thus must post-date the excavation of the channel floors they modify. These chaotic terrains, known as *secondary chaotic terrains*, have been previously described in the higher outflow channel floors [5,7]. In this work, we present a synthesis of the morphologic attributes of a secondary chaotic terrain located along the lower outflow channel of Simud Vallis (hereafter refered to as Simud chaos) (Fig. 1).

Morphology and morphometry of Simud chaos: Simud chaos is located along the lower outflow channel floor of Simud Vallis, which consists of vast surfaces marked by longitudinal striations and streamlined, tear-shaped promontories [6]. This chaotic terrain consists of an enormous depression (750 km long) with a base ~200 m below the surrounding channel floors. Its floor contains extensive knobby fields scattered over an undulating surface, and, unlike the adjacent outflow channel floor to the north, it lacks streamlined mesas (Fig. 1b and c). Instead, it exhibits dense clusters of knobs (zones outlined by yellow line in Fig. 1b), one of which has two lateral erosional channels (green arrows in Fig. 1b), suggesting that the formation of Simud chaos involved both the destruction of channel floor materials and streamed lined mesas within. The northern margin of Simud chaos consists of a prominent break in slope (black dented line in Fig. 1b). Our mapping shows that no channels cut and extend north from this break in slope, suggesting that the formation of the chaotic terrain was not associated with generation of catastrophic floods towards the north in the downstream direction. In addition, we have not identified any shorelines along the margins of the chaotic terrain or surrounding high-standing blocks within it, suggesting that bodies of water never ponded within (alternatively shorelines formed and were subsequently resurfaced into chaos). We have identified a bulge located in the northeastern part of Simud Vallis (Fig. 2). The surface of the bulge is in fact at a higher elevation than the floors of outflow channel both in the regional upslope and downslope directions (profile in Fig. 2). Nevertheless, its surface does not display surface flow features; instead it has a hilly texture. Its northern margin is marked by a prominent graben and some fracturing (Fig. 2b). The hills along the southern part of the bulge are more densely clustered, and their lengths are aligned parallel to the bulge's margin. These hills show both peripheral and axial pitting (Fig. 2c, d).

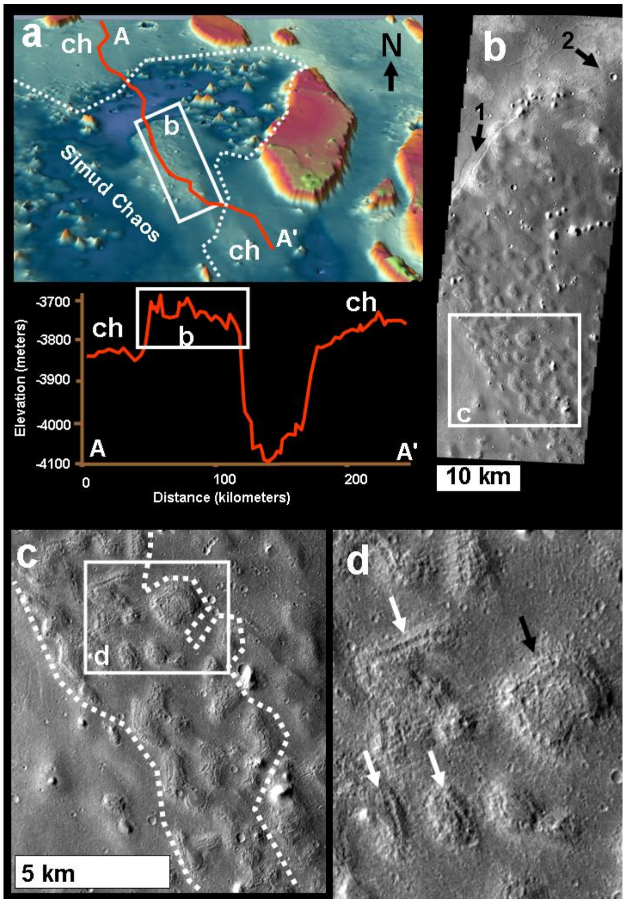

Fig. 2. (a) Perspective view of MOLA-based shaded DEM (128 pixels/degree) of the northeastern part of Simud chaos (margins marked by white dots) and elevation profile (A-A'). The white box (location of panel b) shows a bulge within Simud chaos, the surface of which is at a higher elevation than proximal channel floors (ch). (b). Close-up of bulge within Simud Vallis. Arrow 1 shows a zone where the margin of the bulge consists of a graben which passes into a fractured terrain (arrow 2). The white box shows the location of panel d. (part of THEMIS VIS V19110016 centered at 13.78° N; 322.06° E). (c, d) Close-up views of zone of high density of hills (outline by white dots). Notice the dense pitting located along (white arrows in panel d) and surrounding (black arrow in d) some hills; c is centered at 12.72° N; 322.59° E).

Interpretative synthesis: To the best of our knowledge Simud chaos is the largest secondary chaotic terrain on Mars and unlike most chaotic terrains in southern circum-Chryse, its morphology is not diagnostic of flood release. The morphogenetic association of chaotic terrains and outflow channels forms the foundation for the classic assumption that chaotic terrain development must have been a catastrophic and rapid event. On the other hand, Simud chaos may be the result of a complex and long-lived history of volatile terrain deflation. In fact, the existence of both a low-relief graben with distinct scarp faces as poorly developed fractures (Fig. 2b) suggest that differential vertical displacements (accommodated by extensional stress) have occurred in relatively recent times. Thus, it is possible that chaos-forming resurfacing has operated recently, or may indeed be operating at present, in this particular chaotic terrain.

References: [1] Sharp R.P. (1973) *J. Geophys. Res. 78*, 4073-4083.[2] Baker V.R. and Milton D.J. (1974) *Icarus, 23*, 27-41.[3] Carr M.H. (1979) *J. Geophys. Res. 84*, 2995-3007. [4] Clifford S.M. (1993) *J. Geophys. Res. 98*, 10,973-11,016. [5] Rodriguez J.A.P. et al. (2005) *Icarus, 175*, 36-57. [6] Rodriguez J.A.P. et al. (2006) *Geophys. Res. Lett. 33*, doi:10.1029/2005GL024320. [7] Coleman N.M. (2005) *J. Geophys. Res. 110*.