EVIDENCE FOR POSSIBLE EXPOSED WATER ICE DEPOSITS IN MARTIAN LOW LATITUDE CHASMS AND CHAOS. C. Leovy1, S.E. Wood1, D. Catling1, D.R. Montgomery1, J. Moore2, C. Barnhart1, E. Ginder1, M. Louie1. 1Dept. of Atmospheric Sciences and Astrobiology Program, University of Washington, Box 351640, Seattle WA 98195. 2NASA Ames Research Center, MS 245-3, Space Science Division, Moffett Field CA 94035. (davidec@atmos.washington.edu)

Introduction: A light-toned interior layer deposit (ILD) on the floor of the deep martian depression Juventae Chasma (labeled “B” in Fig. 1) is found to have a relatively high thermal inertia ~500 J m⁻² s⁻¹/² K⁻¹. This could imply rock, but is also similar to the average value of thermal inertia found for north polar layered deposits [1]. Furthermore, ILD-B is found to exhibit a “bluff and terrace structure”. A terrace structure arises naturally in model simulations of the sublimation of large ice deposits (see companion abstract of Wood et al. [2]). Such a staircase terrain, of course, is a further characteristic of north polar layered terrain. Morphological similarity, thermal inertia in the range of thermal inertias of the north polar cap layered terrain, and relatively high albedo lead us to propose that the ILD-B may consist of residual water ice partially covered by, and perhaps mixed with, varying amounts of dust or sand. Other ILDs (A-C) are also found in Juventae Chasma (Fig. 1). While these ILDs lack the close morphological resemblance to the north polar cap, they share many other common features and appear to be part of the same formation. Similar ILDs are found in chaotic terrain elsewhere in the martian tropics. This leads us to propose that water ice may exist in the martian tropics today and may be implicit in the formation of chaotic terrain.

Juventae Chasma ILD “B”: Chapman et al. [3] previously identified three large (>50 km²) ILDs along the base of the western wall of Juventae Chasma. New images from the Mars Orbiter Camera (MOC) and Mars Odyssey Thermal Emission Spectrometer and Imaging System (THEMIS) permit more detailed characterization of these formations and a fourth large ILD, not previously identified in the literature (Fig. 1). ILDs are labeled “A” to “D”, running south to north. Although each ILD shown in Fig. 1 exhibits layered structure, there are significant differences in layer properties between these formations. ILD “B” in Fig. 1 (MOC NA E0202546) is particularly striking because of its large-scale (100m) ‘bluff and terrace’ layer structure that closely resembles the layering at similar scale on portions of the north polar cap (Fig. 2) (E2300860). Another striking similarity between ILD-B and the north polar cap is the decameter scale roughness of the terrace surfaces. While the high resolution of the MOC images (as good as 1.43 m/pixel in M0701527) is not adequate to definitively determine the decameter roughness formation mechanism, it is likely to arise from non-uniform sublimation acting on the north polar cap, and it may also be produced by non-uniform ice sublimation on ILD-B. More support for an icy composition comes from THEMIS thermal infrared images of ILD-B (I01307004 and I01450007) taken at approximately 3 am and 3 pm local solar time. We used a 1-D thermal model of the diurnal temperature wave to match the observed day- and night-time temperatures on the layered NW side of ILD-B, and obtained the best fits for thermal inertias ranging from 430 to 510 J m⁻² s⁻¹/² K⁻¹, depending on the assumed small-scale slope (15°-35°). This is comparable to the average thermal inertia of the north polar layered deposits, 565 J m⁻² s⁻¹/² K⁻¹, derived from Viking IRTM data [1]. These calculations, and other ILD thermal modeling results, are described more fully in the companion abstract of Wood et al. [2].
Other Juventae Chasma ILDs: Other ILDs in Juventae Chasma lack the large-scale ‘bluff and terrace structure’ of ILD-B, but all have fine layer structure (decameter scale), complex erosional styles (including fluting and apparent yardangs), similar relatively high albedos, and (where measured) high thermal inertias (MOC NA M1000466). All lie in the same elevation range close to the foot of the chasm’s western wall in close association with dunes or eolian bed forms (E0301213), and all appear to be undergoing exhumation from beneath dunes, slides, or ridges and plateaus of chaotic terrain (E11002581). Fresh impact craters are notably lacking on all the ILD surfaces, indicating that resurfacing is recent or currently active. Steep bluffs several hundred meters high with fairly regularly spaced gullies that are associated with slides of intermediate tone fine material mark outer edges of several of the ILDs (E1102581). Several are closely associated with features on surrounding terrain resembling glacial or periglacial structures (E1102581, E0200455). These common features lead us to conclude that all of these ILDs are members of the same formation and by inference are likely to be composed of water ice or water ice mixed with dust.

ILDs in the tropics: The ILDs in Juventae Chasma are a subset of a larger class of light-toned layer formations described by Malin and Edgett [4]. ILDs in Aureum Chaos (MOC-NA images E15-00946 and E02-01238), and Iani Chaos (MOC-NA M14-01230) share many particular features with those in Juventae Chasma. These include: fine scale layering, complexly sculptured erosional style, relatively high albedo, bounding cliffs with gullies and relatively dark slides, absence or near absence of craters, partial burial, and close association with active dunes or bed forms. The most prominent ILD in Aureum Chaos exhibits large-scale ‘bluff and terrace’ layer structure similar to ILD-B in Fig. 1, although this structure is degraded by apparent wind erosion. Most of these ILDs are associated with patches or outcrops of exposed bright material in large surrounding areas. We propose that all of these formations may contain water ice and that they may represent the ‘tip of the iceberg’ of much larger volumes of buried ice.

Broader implications: Sharp [5] proposed that chaotic terrain and some of the low latitude chasms of Mars were formed by collapse due to removal of ground ice by melting or sublimation. It is reasonable to expect that this process would leave behind remnants of ice in the chasm and chaos terrains. Although sublimation is relatively rapid in the martian tropics, burial until relatively recent exposure by wind erosion could have provided long-term protection for ice. Our interpretation of the new MOC and THEMIS data supports the Sharp’s early proposal. Intimate association of two other very small ILDs in Juventae Chasma identified by Chapman et al. [3] and ILDs in Aureum and Iani Chaos with apparent collapse structures of chaotic terrain strengthens this case. All of these ILDs lie in apparent source regions of the major outflow channels: Maja, Ares, and Tiu Valles. Occurrences of large residual ice deposits in these settings supports - but does not prove – the hypothesis that floods generated by rapid melting of sub-surface ice shaped these massive outflow channels [1,6,7].