PROBING THE ISMENIUS REGION OF THE MARTIAN DICHOTOMY BOUNDARY WITH SHARAD.

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Introduction: One of the main features that characterize Mars is the dichotomy boundary between the southern thick crust and the northern thin crust [e.g., 1]. Aside from longitudes encompassed by the Tharsis volcanic province, Arabia Terra, and Isidis Basin, this boundary tends to be relatively sharp and under a state of isostatic compensation [e.g., 2,3]. The dichotomy boundary formed relatively early, sometime during the Noachian, although it is hard constrain to the early or late phases of that period. The formation mechanism is still debated; some models propose endogenic processes (e.g., degree-1 convection, plate-tectonics) while others involve exogenic forces (e.g., large impacts). Further, it is not clear to what extent modification followed formation. Hence, understanding how the dichotomy formed and evolved will help congeal the early history of Mars into a clearer picture and place important constraints on a series of parameters, including convective vehemence and heat flux during the Noachian.

Region of Interest: The Ismenius Region section of the dichotomy boundary is well defined and contains a steep scarp (~2.5 km high, 20° slope), as shown in Fig.1 [e.g., 4]. Topographically, the transition from southern highland to northern plains consists of three blocks [4]: *i*) the highland proper, bound to the northeast by the steep scarp; ii) a lower bench, abundant in topographic knobs ("fretted") that abruptly terminate farther to the northeast to give way to *iii*) smooth northern plains. Analysis of the topography suggests that this latter transition marks roughly the location of a buried fault [5]. Because the cratering-derived age of the bench is similar to highland ages, the bench is interpreted to be a section of the highlands down-faulted to the north. A lower-bound estimate of strain across the region is set at 3.5% by [4], who proposed viscous relaxation of the boundary as the driving mechanism for the extension. [6] explored this hypothesis via thermo-mechanical numerical models and found the amount of plastic extension consistent with flow of the Martian crust at 4 Ga, while adopting wet-basal rheology and thermal states compatible with stagnant-lid convection. [6] concluded that the sharpness of the dichotomy boundary derives from a modification process, namely the faulting associated with viscous relaxation of an initially gradual (2° slope) boundary.

Here we intend to use sounding data from the Shallow Radar (SHARAD) instrument aboard the Mars Reconnaissance Orbiter (MRO) to positively identify

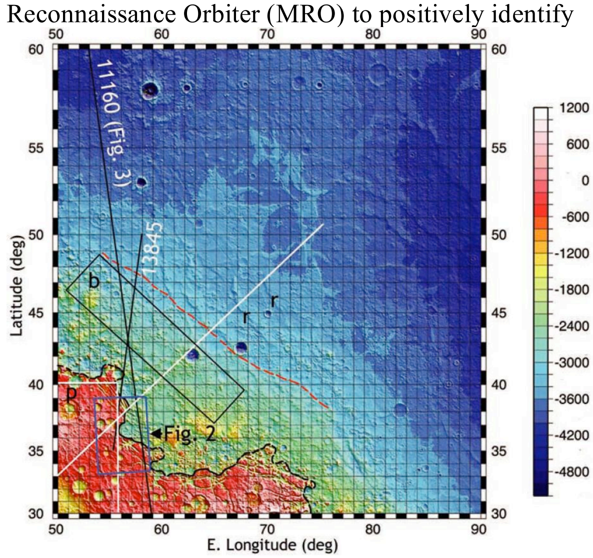

Fig. 1 – MOLA topography (meters) of the section of the dichotomy boundary at Ismenius Region, from Smrekar et al. [2004]. Of concern is the dashed magenta line oriented from NW to SE, which marks the location of a buried cryptic fault.

the buried fault of [5] and thus test the relaxation modification hypothesis of [4] and [6].

SHARAD Data: The SHARAD system consists of a 10 W chirped radar with a bandwidth of 10 MHz and a 20 MHz center frequency [7]. Free space vertical resolution is therefore ~15 m. Part of the energy from radar waves reflect from the surface and part penetrate the subsurface. Waves propagating through the subsurface are henceforth reflected by dielectric interfaces. Because cross-track resolution is 3-6 km, radar energy is reflected from elevated topography off-nadir and ambiguously interpreted as subsurface reflectors – this is known as side clutter. Synthetic aperture processing yields along-track resolutions of 0.5 to 1 km, and the relative motion of the along-track topography with respect to the radar creates artifacts respect to the radar creates artifacts known as range-hyperbolas.

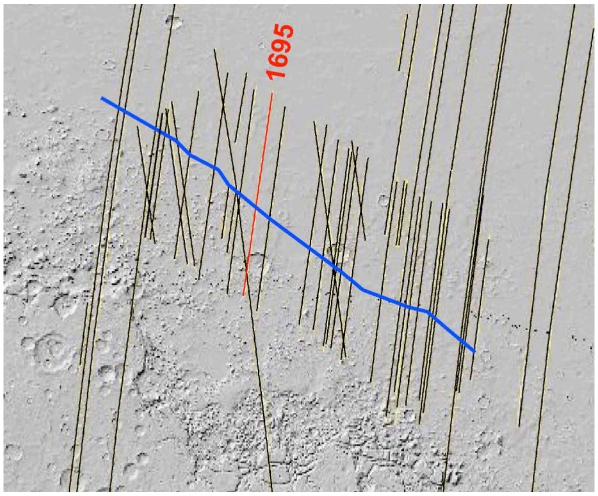

Fig. 2 – Coverage of SHARAD in the Ismenius Region. The orbital pass highlighted in red is the one for which radargrams are shown in Fig. 3. The blue line marks roughly the position of the buried fault shown in Fig. 1.

SHARAD coverage in the Ismenius Region includes numerous orbital passes with different orientations and encompassing highland, fretted bench, and smooth plains (Fig. 2). An initial assessment of several orbital passes reveals substantial contribution from the rough "fretted" topography to the radar returns as side-clutter and range hyperbolas. Fig. 3 shows a portion of the radargram acquired during MRO orbit 1695. A radargram consists of returned power (brightness) over time (vertical dimension) and along track (horizontal dimension). The radargram in the top panel contains apparently dipping structure occurring after the surface reflection. The center panel is derived from a focusing processing of the initial radargram. Focusing is done to mitigate movement-derived data artifacts in synthetic-aperture radars [e.g., 8], such as SHARAD. The dipping reflections remain visible in the focused radargram and, along with their asymmetric shape, it is plausible that the reflections could represent fault planes. The location of this putative fault reflector lies in the general area where [5] stipulated the presence of a buried fault; the bottom panel of Fig. 3 shows a shaded-relief topography of the area about the ground track.

We will continue to assess data from all of the orbital passes in this region and model synthetic radargrams based on MOLA topographic digital elevation model. Our goal is to isolate true subsurface reflectors from radar artifacts and investigate the presence of the possible buried faults, which, if confirmed, would add credence to the hypothesis of modification via viscous relaxation of the dichotomy boundary.

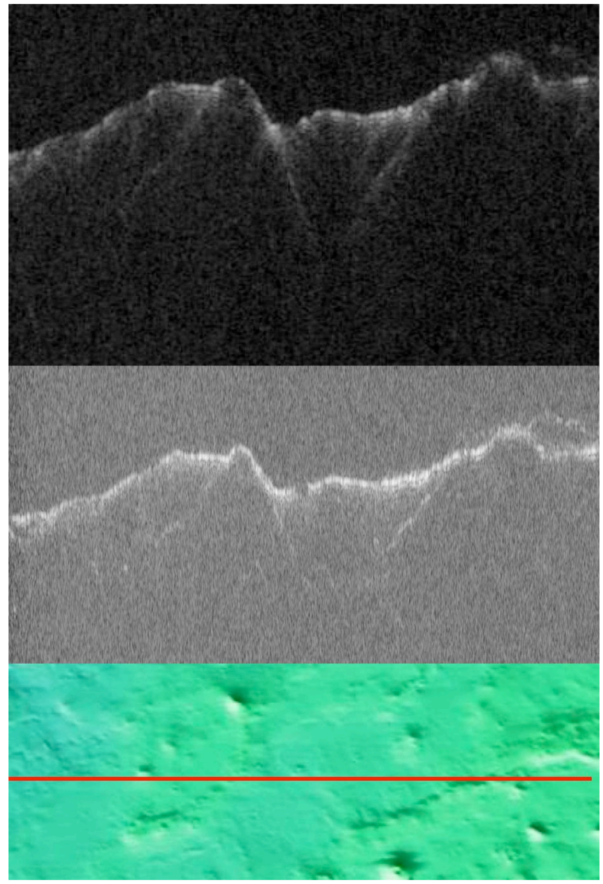

Fig. 3 – Radargram for the section of orbital pass 1695 across the area containing the putative buried fault of [4,5,6]. A fault is possibly identified in center of the radargram. The lower panel depicts orbital pass superposed onto shaded relief.

References: **[1]** Frey et al. (1998), *GRL*, 25, 4409–4412. **[2]** McGovern et al. (2002), *JGR*, 107, 5136, doi:10.1029/2002JE001854. **[3]** Nimmo and Stevenson (2001), *JGR*, 106, 5085–5098. **[4]** Smrekar et al. (2004), *JGR,* 109, E11002, doi:11010.11029/12004JE002260. **[5]** Dimitriou (1990), *PhD Thesis*, U. of Mass. Amherst. **[6]** Guest and Smrekar (2005), *JGR*, 110, E12S25, doi:10.1029/2005JE002504. **[7]** Seu et al. (2004), *Planet. Space Sci.*, 52, 157-166. **[8]** S. Perna (2005), PhD Thesis, Universita' Degli Studi di Napoli.