REMANENT MAGNETIZATION SIGNATURES IN TERRA CIMMERIA AND TERRA SIRENUM, MARS, AS A RESULT OF FAR-FIELD TECTONIC AND HYDROLOGICAL EFFECTS OF THE EARLY UPLIFT OF THE THARSIS RISE. A. G. Siwabessy[1,2], C. M. Rodrigue[1], and R. C. Anderson[2], [1]Department of Geography, California State University-Long Beach, 1250 Bellflower Boulevard, Long Beach, California 90840 (Andrew.siwabessy@student.csulb.edu), [2]Geophysics and Planetary Geosciences Group, Jet Propulsion Laboratory, California Institute of Technology, 4800 Oak Grove Boulevard, Pasadena, CA 91109

The Illinois, Michigan, and Williston basins constitute possibly viable terrestrial analogues for understanding the tectonic and hydrogeological context of the Eridania Basin in Terra Cimmeria and Terra Sirenum, Mars. Although diagnostic tectonic geomorphologies are often not well-expressed at the surface in intracratonic basins themselves [1], orogenesis along the eastern plate margin of the North American craton has been successively tied both to coeval stratigraphic changes within each basin [2] and to the forcing of metamorphic fluids from compressed aquifers perpendicularly towards régimes of lower topography [3,4,5]. The precipitation of Fe-spherules from these fluids into metamorphosed carbonate country rock also reset magnetic crustal signatures for the Illinois basin in particular [5].

On Mars, Anderson et al. [6] recentered and rotated the stress model of [7] on Tharsis' earliest center of tectonic activity at the Claritas Rise as proposed by [8]. This rotation explains the alignment of nearly all tectonic features surficially expressed across the pre-Tharsis terrains of Terra Sirenum [6,9], suggesting that Tharsis' uplift likely began in earnest at the Claritas center. Interestingly, [6]'s adjusted stress model [7] also predicts compression perpendicular to the direction of outflow observed in the northwestern slope valleys [10], which are thought to be sourced from the putative Tharsis drainage basin [11]. Although no obvious tectonic signatures are surficially expressed to the southwest of Tharsis, the same compressional trend is predicted in this region in the direction of the low-lying eastern terminus of the Eridania basin. It is possible that compression tied to Tharsis' incipient uplift could have overpressured Tharsis aquifers, driving subsurface flow perpendicular to compression downslope off the southwestern margin of the Tharsis Rise and into the Eridania basin subsurface (see Figure 1). Andrews-Hanna and Lewis [12] model a longstanding transition towards shallow water table depths from Tharsis to Eridania along this same span, supporting this inference of regional-scale directional fluid flux downslope from the uplifting Rise. In Terra Sirenum and Terra Cimmeria, fracturing from extensive impact gardening ([13,14]) is inferred to have facilitated the existence of an expansive aquifer robust enough to feed even long-standing groundwater-fed paleolakes in the region (e.g. [15]). The MGS MAG/ER radial magnetic dataset [16] which is published by Connerney et al. [17] additionally appears to correlate with the general form of the Eridania basin [18] (see Figure 2), potentially demarcating the spatial extent of magnetization associated with far-ranging metasomatic effects of this proposed aquifer outflow from the Tharsis Basin [after 4,5] in addition to valley networks sourced by this groundwater [19]. The precipitation of single-phase magnetites into carbonates has been observed in the meteorite ALH84001 and has been hypothesized to form a considerable fraction of subsurface stratigraphy in this region as a result of subsurface fluid fluxes, offering a mechanism to explain the unusual intensity of remanent magnetization in Terra Cimmeria and Terra Sirenum [20]. This is directly analogous to aforementioned petrological mechanism of hydrothermal remagnetization invoked in the Illinois basin [4]. This may have occurred in conjunction with the propagation of Tharsis-radial graben sets in the region [e.g. 21, 22] which may be intermittent surface manifestations of an extensive subsurface swarm of dikes [21,23] that would significantly facilitate further nucleation of magnetic minerals upon interaction with the subsurface hydrology [24]. This possibly suggests that the compression of Tharsis aquifers during the earliest stages of its uplift may have controlled the subsurface hydrogeology of Terra Sirenum and Terra Cimmeria prior to the shutdown of the core dynamo. Furthermore, this tectonic effect may have directly sourced the water budget not only for the northwestern slope valleys but also for hydrologically-linked morphologies as far as 100° to the west of the Tharsis Rise's margin.

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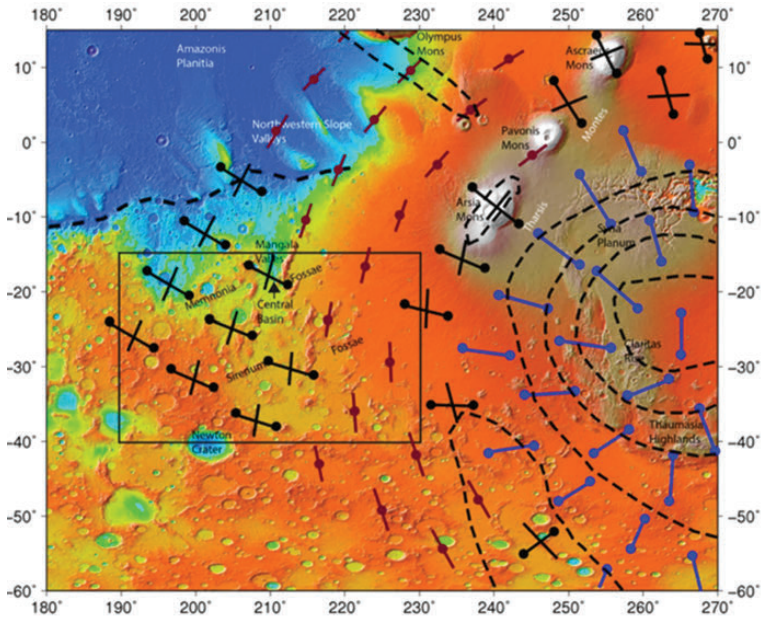

Figure 1. The rotated stress model of Anderson et al. [6], recentered on the Claritas Rise. Figure is borrowed from [6]. Zones of compression are denoted by lines with a ball in the center, and extension is denoted by lines with balls at each end. Note the perpendicular alignment of compression with the northwestern slope valleys of [10] in the northern part of the figure (~0°N, 220°E), and the southward continuum of predicted compression due south of that region. The Eridania 0basin initiates to the southwest perpendicular of the compression mapped around ~-50°S, 230°E.

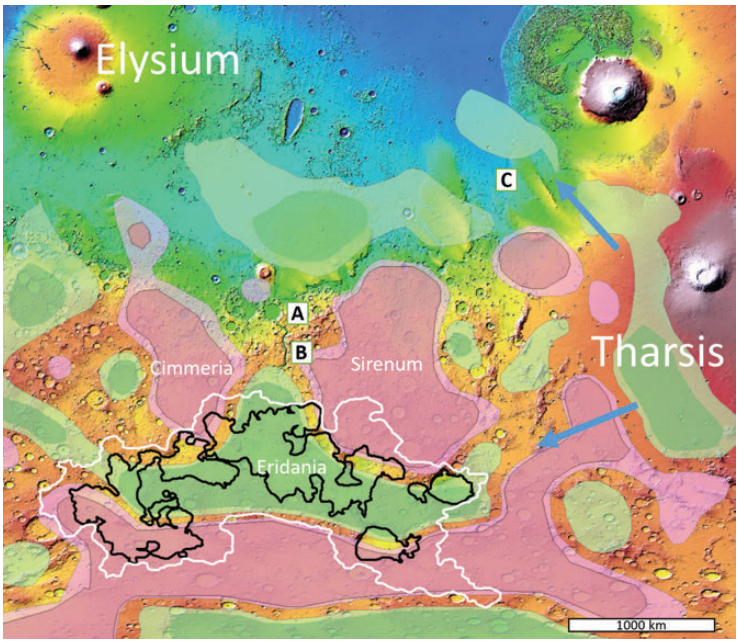

Figure 2. The Eridania basin's basin-filling deposits (in black) and associated watershed (in white) (after Irwin et al. [18]) are superposed on a radial map of magnetic field strength isolines (+/- 10 nT and 20 nT) at 400km altitude (after Connerney et al. [17]). Green indicates a negative polarization and red indicates positive polarization. The direction of predicted flows induced by the modified stress model of Anderson et al. [6] are displayed, including out towards the northwestern slope valleys [C]. Note the agreement of the magnetized lineament with the shape of the Eridania basin, including the southern reach of the Eridania's drainage to the north through Ma'adim Vallis [B] towards Gusev crater [A].