An Early Look At The Tectonic History Of The Claritas Region; Mars

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***Introduction**:* The formation of the Tharsis rise has dominated the geologic and tectonic histories of the western hemisphere of Mars. Claritas rise is a distinct ancient promontory located near the southwestern margin of the Tharsis Rise and contains: a) the greatest percentage of faults preserved in Noachian materials for the western hemisphere (2001), b) an enormous rift system (Fig. 1) and highly deformed mountainous materials interpreted to be ancient basement crust, and c) a center of tectonic activity representing a region of broad magmatic-driven uplift and associated faulting. Because Claritas spatially registers with a magnetic signature, the tectonic activity associated with its formation is interpreted to mark either incipient Tharsis development, or more likely, pre-Tharsis activity, when the Martian dynamo was in operation (>4.0 GA). In order to improve our understanding of the early geologic and tectonic history of Tharsis, a detailed study of the faulting (e.g. type, displacement, etc.), as well interpreting the complex temporal and spatial histories of each major fault system associated with the stratigraphic units exposed within this region has been undertaken. Unraveling and characterizing this complex array of faults associated with Claritas provides a vital key to understanding the early history of the Martian crust.

In this preliminary study, we have examined the spatial and temporal histories of the major fault systems within and surrounding the Claritas Rise in order to better constrain its timing with respect to pre- and incipient-Tharsis tectonism. To accomplish this goal, we used a new, preliminary geologic map quadrangle for the Claritas region (Claritas Fossae: Longitude 248° – 263° east; latitude 12° to 34° south) at 1:1,000,000-scale (Fig. 2a). Using high-resolution orbital imagery we are working towards improving and refining the relative ages and timing of the stratigraphic units for these two regions.

***Methodology*:** In addition to unit contacts and polygons, graben in the mapping area were demarcated in ArcMap at a 1:1M scale using Thermal Emission Imaging System (THEMIS) Daytime IR basemap, supplemented by hi-resolution images taken by the Mars Reconnaissance Orbiter (MRO)'s Context Camera (CTX) and the Mars Express' High/Super Resolution Stereo Colour Imager (HRSC). The graben were then spatially joined to their underlying geologic unit polygons and separated at their vertices into 197,197 straight segments. Using the Field Calculator function of ArcMap and a short Python script, the angles of each segment – calculated counterclockwise from due east – were established using basic trigonometry and then placed into rose diagrams to determine trends in orientation.

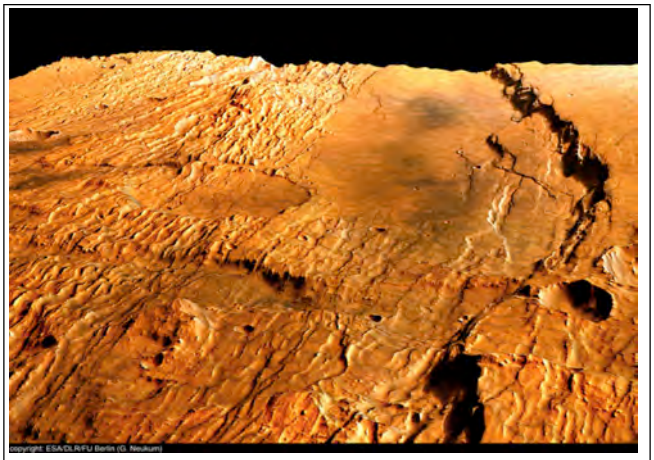

Fig. 1 ESA High Resolution Stereo Camera (HRSC) shows Claritas Fossae, a complex series of linear tectonic faults located in the Tharsis region of Mars. The primary rift basin in the right-central part of the image is about 100 km across. This complex region may hold the key to understanding the tectonic history of Tharsis.

For the purposes of submission, the graben segments in seven geologic units were calculated. The units – as indicated in Figure 2b – includes five volcanic plains units in the Syria Planum region (denoted in Figure 2b in shades of red); one densely-dissected segment of highland terrain that

Tanaka (2014) designed as "eNh" in the southeastern portion of the map (denoted in Figure 2b in purple); and a highland unit that Tanaka (2014) labeled "mNh", denoted in Figure 2b by shades of green. This particular highland unit was further subdivided into five subregions to better-elucidate regional trends in extension within the unit.

***Preliminary Results*:** At the time of this abstract submission, not all the data has been compiled. Preliminary results show that ~95% of the faults are more complex than previously mapped by Anderson et al., (2001). A majority of the faults identified were located within two major units, the middle Noachian Highland unit (mNh-pink in Figure 2a; green in Figure 2b) and the early Noachian Highland unit (eNh-light purple in Figure 2a; blue in Figure 2b) of Tanaka (2014). Although the fault data is still preliminary, three major fault trends have been tentatively identified: 1) a NE trends (~10° NNE-TBD), which projects to the Pavonis center of Plecia and Saunders, (1982), and the Stage 3 center of Anderson et al., 2001; 2) a NW trend (~15° NW-TBD) which projects to the Stage 1 center identified by Anderson et al., (2001); and 3) a minor EW trend, perpendicular to the NE trend identified, that appears radial to the Terra Sireum mapped region. In addition, there are also several lava plains that have been identified and these units correspond to lava flows identified by Richardson et al., (2013). Stratigraphic and cross cutting relationships of the major trends will be provided for this presentation.

***References*:** (1) Anderson, R.C., et al., *J. Geophys. Res.*, vol. 106, E6, 12301-12314, 2001; (2) Plescia, J.B., and R.S. Saunders, *J. Geophys. Res.,* 87, p.9775-9791, 1982; (3) Richardson et al., *J. of Volcanology and Geothermal Res.,* 252, 1-13; 2013.

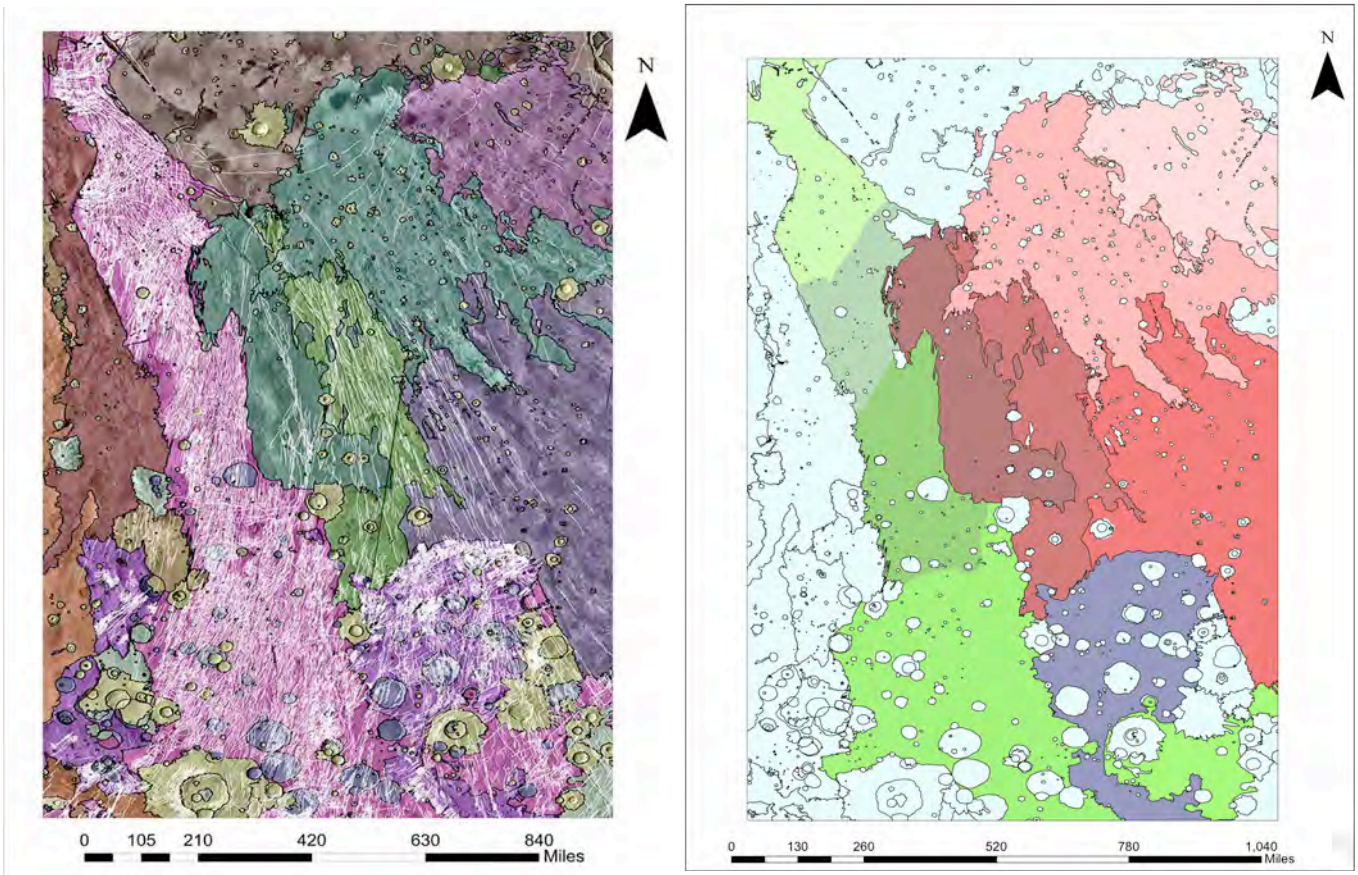

Fig. 2 a) Preliminary 1:1,000,000-scaled quadrangle map of the Claritas Fossae region. Map is based on ASU uncontrolled THEMIS daytime IR mosaic and MOLA Digital Elevation Models (DEMs). Map coordinates are: Claritas Fossae - Longitude 248° – 263° east; latitude 12° to 34° south and the new map will be in Mercator projection. White lines are mapped faults. **b)** Ten subregions iidentified within the Syria Planum region that contain a majority of the faults and were chosen to elucidate regional trends in extension within the unit.