REMOTE SENSING APPLICATONS FOR THE MARTIAN FRETTED TERRAIN. B.C.Harrold[1], D.T. King Jr.[1], and L.J. Marzen[1], Department of Geology and Geography, Auburn University, Auburn, AL, 36849 (bch0007@auburn.edu).

Introduction: Remote sensing is presently the only way to gather data on a planetary scale in our solar system. The use of many artificial satellites with their multiple sensors provides an outlet for information acquisition of other celestrial bodies. The main objective of this study is to look at the fretted terrain located in the Martian northern hemisphere using ArcGIS to access possible evolutionary processes .

Study Area Background: The fretted terrain is one of several transitional terrains that can be identified on the Martian surface and is located between the southern highlands and the northern lowlands. The fretted terrain is thought to have a nearly uniform height clustered around 0º elevation with respect to the aeriod comprised of polygon- shaped blocks [1]. The fretted terrain is located along the global escarpment +/- 10º from 40º N latitude and confined between 280º to 350º longitude [1]. There are many existing hypotheses as to how these fretted blocks have come to their present orientation/location.

Instruments: This study includes the use of 3 satellites with multiple sensors aboard. They are: (1) Mars Global Surveyor including MOC– Mars Orbital Camera; MOLA–Mars Orbital Laser Altimeter; TES–Thermal Emission Spectrometer; MAG/ER–Magnetometer and Electron Reflectometer; (2) Mars Reconnaissance Orbiter including CRISM - Compact Reconnaissance Imaging Spectrometer for Mars; CTX - Context Imager; (3) Viking imagery.

Methods: Any planetary study must first begin with an accurate base map. The USGS website (fttp://pdsimage2.wr.usgs.gov/pub/pigpen/mars/mola/) offers a wealth of data bases from which files can be downloaded. MOLA data is the most complete LIDAR data set that is currently available of Mars. For this reason, it makes a perfect base map for which all other data can be calibrated. The simple, cylindrical projection of MOLA data was downloaded from the USGS site with the file name mola128_88N to 88S_Simp_clon0)zip. Extraction of the zip file can then proceed. The MOLA data set is a digital elevation model raster data set which contains information in x, y, and z coordinates for each pixel providing a 3-dimensional map. After the file has been extracted, it can then be imported into ArcGIS 9.x for additional and more detailed analysis.

First and foremost, since we are dealing with a celestial body other than Earth, we must set the parameters internally to retrieve accurate results. After insertion, rectification can proceed with the following application: View>>Data Frame Properties>>Coordinate System>>New>>Projected Coordinate System. This allows the user to set the geoid/aeroid that is most applicable to the data set. For this project, the linear unit was set to kilometers due to the large scale of the fretted terrain blocks. Finally, a geographic coordinate system can be used through: Select>>Solar System>>Mars 2000.prj. This sets the aeroid to the base coordinates of the MOLA data (semimajor axis- 3396.19 km, semiminor axis- 3376.20). After the DEM has been rectified to MOLA data set processing can continue. This is the most important attribute due to the nature of the imported data; a rectified base map must be produced (Figure 1).

Next a slope map was produced using the spatial analyst feature: Spatial Analyst>>Surface Analysis>>Slope. Using the base map, slopes are calculated to a particular degree with a z factor = 1 and a cell size of 463.0836 meters. This will provide a ratio for inclination and slope stability. A contour line and aspect (orientation as defined by north) can be extracted by the same process.

Georeferencing which allows for overlay of other maps, compared to the base map can then be processed to have the same coordinate system as the existing data set. Mars Global Data Sets from The Arizona State University website can be incorporated using this application. From the georeferencing tool located in the top tool bar of ArcMap, control points can be added to the new map and then interpolated to the original base map(Click on new layer>> zoom to layer. By zooming in to the corners of the new layer and right-clicking, x and y values can be entered to maintain accuracy (Georeferencing>> add control points>> enter control points). The coordinates for the control points can be accessed from right-clicking the layers and viewing the image extent. Because both maps are in simple, cylindrical projections, the four corner controls points are all that is need for reference. Images from multiple satellites can be induced to the map by the same process.

Personal Geodatabases are a way to amass and organize large datasets. Created in ArcCatalog, they can be imported into ArcMap for further analysis. (Open ArcCatalog>>right click contents>>new>>personal geodatabase). This allows the user to create multiple data sets and feature classes. A polygon shape was selected to access these fretted blocks. These polygons were traced along the the steepest path using the slope map that was already created earlier. The distinction between a block/mesa and a knob/mound used two parameters: (1) the top of the polygon must have a mean slope < 2º and (2) an encompassing slope of > 20° for more than 50% of the blocks perimeter. All blocks fitting this criteria were traced between 280º to 350º longitude on the Martian surface.

ArcGIS has the ability for insertion of outside script and tools for more advanced applications. One such tool is Easy Calculator 5.0 (http://www.ian-ko.com/) which provides a variety of features for data extraction/organization for points, lines, and polygons. After importation of this tool, a center of mass for each polygon can be extracted. Navigate to the file: polygon_Get_X_MiddlePoint.cal and import the script into the field calculator of the selected feature in ArcMap. Once the calculation has run, repeat the process for the y coordinate: polygon_Get_Y_MiddlePoint.cal. With these two coordinates a new shapefile can be produced and the center of mass provided as a point. The same tool can then be used to draw long and short axes lines through the center of mass to access length vs. width ratios of these blocks. These shape files can be produced as a new feature class in the already existing geodatabases. Axes were digitized perpendicular in this process. Another tool can be incorporated with the axes to obtain compass bearing. Load the script for polyline_GetAzimuth.cal in the same manner to obtain the azimuth of the long axis.

Figure 1. Section of fretted terrain with geoprocessing in ArcMap 9.2.

Preliminary Results: The elevations of these fretted blocks change gradually from east to west lowering by almost 1000 meters. Traveling away from the escarpment, the elevations are quite similar with only slight drops of a few 100 meters over distances of 100's of kilometers with no noticeable tilting or rotation. Long axis orientations are similar to the corresponding placement along the escarpment and lengths are more than twice that of the short axis.

Conclusion: Remote sensing and digitization of recent planetary features provide insight into future land based exploration of Mars. These missions will further the knowledge already discovered by their orbiting predecessors. ArcGis gives us a unique opportunity accrete and process existing and futurely acquired data sets.

References: [1] Sharp, R.P. (1973). "Mars: fretted and chaotic terrains." Journal of Geophysical Research 78: 4073–4083.