GANYMEDE'S SULCI ON GLOBAL AND REGIONAL SCALES. H. Bedle and D. M. Jurdy, Department of Geological Sciences, Northwestern University, 1850 Campus Dr, Evanston, IL 60208. *heather@earth.northwestern.edu, donna@earth.northwestern.edu*.

Introduction: The sinuous, brighter albedo regions on Ganymede, termed sulci, result from episodes of tectonic deformation. Based on topographical terrains, sulci can be subdivided into smooth, grooved, and complex categories. Topographic analyses of the elevations of the different terrain types showed that the complex sulci have the highest relative elevation, and smooth, the lowest. This suggests a variety of processes that create sulci [1].

The stresses that caused the tectonic deformation resulting in sulci are not understood. Several suggested driving mechanisms for sulci formation are 1) coupling of mantle convection stress to the lithosphere, 2) volume changes within the bright terrain, 3) shell deformation caused by tidal and rotation stresses, 4) extension due to Ganymede's volume change caused by the transition of ice to a less dense phase during differentiation [2].

Pure extension cannot adequately account for the formation of sulci. Estimates of Ganymede's volume change have a maximum increase ~7% [3], while another study [4] set the maximum change around 2%. A volume change of 7% would result in 4.6% of added surface area on Ganymede; whereas a volume change of 2%, only 1.3%. These small percentages of expansion do not account for the resurfacing of over half of Ganymede's surface. Yet, if sulci are purely extensional and the surface area of the moon did not increase greatly, this would require convergence. To date, no evidence of convergence has been observed. Perhaps, during the time of active sulcus formation the lithosphere did not act rigidly, allowing relaxation of ridges resulting in thickened lithosphere near the forming sulci. But in several cases [5] the topography surrounding the sulci is not elevated, suggesting the lithosphere is not significantly thicker near the sulci.

Methods: To better understand the formation mechanisms of sulci, average widths were tabulated, along with the location of the end points of the features, and orientations (Figure 1). Initially stratigraphic methods were applied to date age sequences of intersecting sulci on a global scale. Unfortunately, global resolution does not allow for stratigraphic analysis. In an attempt to understand the tectonic processes that create individual sulci, a regional area of interest was chosen, and divided into provinces of similar topographic structure. Located in Nicholson Regio, the north-south trending Tiamat Sulcus intersects the east-west trending Kishar Sulcus near 1ºS, 204ºW (Figure 2). Of particular interest are remnant craters in the northern segment of Tiamat and the interpreted stages of Tiamat's formation.

Global Results: Analysis of sulci length versus width emphasizes similarities between sulci with similar textural topographies. The complex sulci tend to be wider and longer than other sulci (Figure 1), with the grooved sulci trending wider than the smooth. A separation into hemispheres shows that northern sulci of similar terrains are twice as wide the southern. Also observed, grooved sulci are wider than the smooth, but complex sulci average three times wider than both of them. Also, complex sulci have a boxier shape, with comparable lengths and widths, while grooved, and smooth sulci are more elongated.

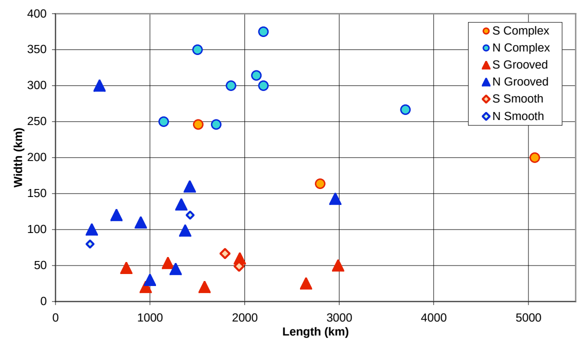

Figure 1: Widths and lengths of sulci, based on terrain and locale

Regional Results: North of its intersection with Kishar Sulcus, Tiamat Sulcus contains remnants of old impact craters. Based on the continuous ridges, craters A and B pre-date Tiamat (Figure 2). Since the crust was not destroyed but displays evidence of pre-existing features, this supports the fault-block extensional origin of sulci [6].

Stages of formation: Relative formation relationships of the intersection of Tiamat Sulcus and Kishar Sulcus are identified (Figure 2). Initially the western (blue) portion of Tiamat formed, extending Ganymede's lithosphere. Next, perpendicularly crosscutting Kishar formed. The 60 km right-lateral strike slip of Tiamat during or after the formation of Kishar (yellow), may have resulted from a block rotation of Nicholson Regio, causing the widening of the southern portion of Tiamat. As the southern portion of Tiamat moved westward, the upwelling of viscous water ice below the mantle, which drove extension, remained stationary. Subsequently, the lithosphere was widened to the east of the pre-existing portion (pink and orange).

Evidence of a right lateral strike-slip occurring in a north/ south manner over 15 km, after the formation of Kishar exists. The eastern segment of Kishar is displaced relatively to the south. This may have caused localized compressional stress on the southern portion of Tiamat, deforming the youngest portion of Tiamat (pink). The older, western portion of Tiamat remains unscathed from this episode since it is older and less ductile than the younger eastern portion. The youngest portion of Tiamat has a smoother topography, with a central ridge (green), agreeing with [2] that the smooth bright terrain is younger than the complex grooved terrains. As noted by [7], the formation of a smooth sulcus, Arbela Sulcus (15ºS, 347ºW), was apparently caused by crustal spreading simultaneously with sinistral shear. This may also be the case in this late-stage Tiamat formation, causing the aforementioned apparent right lateral motion of Kishar.

Discussion: Sulci populations of the northern and southern hemispheres exhibit definite differences. Also, similarly terrained sulci share characteristics on a global scale. This study and others [7] show that the formation of smooth sulci may be the result of complete crustal separation, and due to the smooth topography these may form more quickly than grooved sulci, suggesting a late-stage driving mechanism of high extensional stress. The boxier grooved terrain may be the result of lower extensional stresses that lasted for longer periods of time. The Tiamat and Kishar region demonstrate multiple stages of formation. These stages could be the result of evolving global stress regimes. A global study of other higher resolved regional areas is planned in order to take a more complete look at sulci formation regimes. This should provide additional insight into the driving mechanisms of sulci creation.

References: [1] Schenk, P.M., McKinnon, W.B., Gwynn, D., Moore, J.M., (2001) *Nature*, *410*, 57 – 60. [2] Collins, G. C. et al. (1998) *Icarus*, *135*, 345-359. [3] Squyres, S.W., (1980) *GRL*, 7, 593-596. [4] McKinnon, W.B., and Spencer, J., (1981) *LPSC abstract.* [5] Head, J. et al. (2002) *GRL*, 29, 24, 2151. [6] Parmentier, E. M. et al., (1982), *Nature*, 295, 5847, 290-293. [7] Collins, G. C. et al. (2001), LPSC XXII, Abstract #1498.

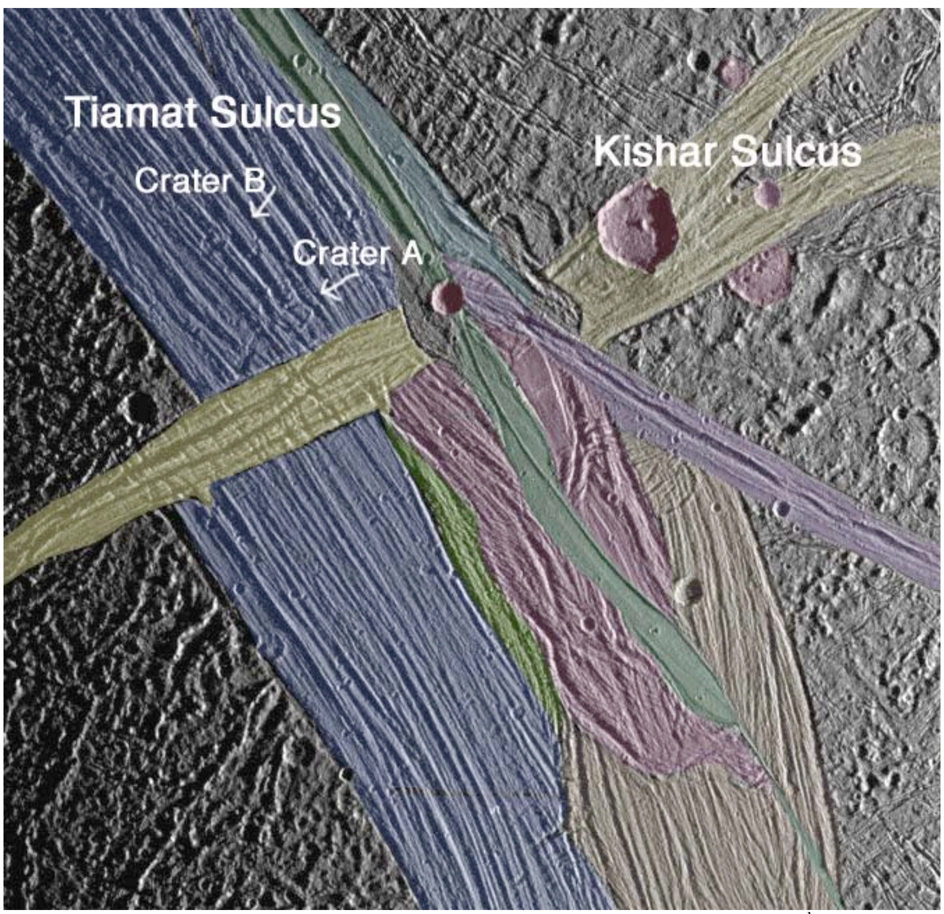

Figure 2: Tiamat and Kishar Sulcus, imaged at 494 meters/pixel during Galileo's 28th orbit. North is up.