COMPUTER ASSISTED TIME SEQUENCE SORTING OF GROOVES IN EASTERN MYSIA SULCI, GANYMEDE. E. S. Martin[1], G. C. Collins[1], Z. A. Crawford[2], and R. T. Pappalardo[2], [1]Physics and Astronomy Dept., Wheaton College, Norton MA 02766 (emartin@wheatonma.edu), [2]Laboratory for Atmospheric and Space Physics, University of Colorado, Boulder CO.

Introduction: Two thirds of the surface of Ganymede is covered by grooved terrain, suggesting an active history of extensional tectonics. One important piece of Ganymede geological history is to determine the order in which groove-forming events happened. Separating grooves into a time sequence will help to constrain the geological events that formed the grooves.

Previous investigations into the time sequence of grooved terrain formation have been made in the Uruk Sulcus and Nippur Sulcus regions [1], the Nun Sulci region [2], and the leading hemisphere and Sippar Sulcus regions [3]. These studies came to the conclusion that the orientation and morphology of the grooves changed over time. Ultimately we hope to link this investigation with previous regional investigations to form a global picture of the sequence of grooved terrain formation.

Target Area: The target area is located in eastern Mysia Sulci, 20°N to 10°S, 305° to 355°W. This area includes both dark and bright terrain, with the central region composed of a complex network of crisscrossing grooves. Most grooves in this area trend in the E-W to NE-SW direction and are interspersed with small polygons of dark terrain (Figure 1). There are few large craters in this region, providing a relatively clear view of the relationships within the grooved terrain. Past analyses of grooved terrain time sequences required sorting by hand, which was time consuming due to the number of grooves, and the difficulty of tracking the relationships between them. These difficulties inspired the development of a computer-assisted technique. This technique has recently been developed and applied to the complex overlapping ridges on the surface of Europa [4]. This is our first attempt to adapt the technique to the grooved terrain of Ganymede.

We began our investigation with the global geological base map being developed by Patterson et al. [5], which separates the grooved terrain into polygons of similar morphology and orientation. We modified the base map to provide finer regional detail by splitting some polygons to accommodate more subtle differences and smaller patches of grooved terrain. The boundaries between each pair of polygons were then examined to determine the relative age relationship. Confidence levels were then assigned on a scale between 0 and 1 (0 being least confident and 1 being most confident) to the age relationship at each boundary. This confidence scale allows the sorter to discriminate between age relationships that are obvious and those that are ambiguous or difficult to determine.

Computer assisted time sequence sorting: Our method of time sequence sorting uses a computer program to convert the map information into a directed graph, where the groove packets are nodes on the graph, and the relationships between adjacent packets are edges linking the nodes [4]. A topologic sort is performed on the graph, to separate the groove packets into time equivalency classes. A time equivalency class represents all the grooves that could be the same age, though it does not necessarily mean that they formed at exactly the same time. For example, two nonadjacent groove packets that are found to be relatively younger than all other packets they touch would be placed in the youngest time class, though they may have formed at different absolute times. To decrease ambiguity, the sort is performed in two directions – one biased to place groove packets in the youngest possible classes, and the other biased to place them in the oldest possible classes. Thus, referring back to the example above, if one of the two groove packets only crosses very old grooves while the other crosses relatively young grooves, then we can differentiate the possible age ranges for these two groove packets.

A topologic sort on the graph only works if there are no loops in the time sequence. If the program finds a loop, it removes edges with low confidence until the loop is broken.

Results: Our target area contained 160 groove polygons and 362 polygon boundaries.

Of these boundaries, 71 were removed during the sorting process, and 72% of those removed were of a low confidence (between 0.1 and 0.4). Boundaries between polygons that are very similar in morphology (and had a low confidence rating) were frequently removed from the sort. Often we found groups of boundaries that were removed, leading to the discovery of a loop, which we removed before resorting our data. One problem we are currently addressing is the removal of some high confidence boundaries on small polygons with few connections, which leads to the complete elimination of a few polygons.

This sorting showed two types of young polygons. One type has prominent, deep grooves oriented in a NE-SW direction, while the other type is generally oriented E-W and forms long, narrow smooth bands. Most of the polygons in the older age categories exhibit a smooth or very subdued groove morphology.

Future work includes tweaking the program to discard less of the time sequence information and refinement of the polygon boundaries, relationships, and confidence levels. Though we have preliminary evidence that the style of groove formation changed through time in this area, we are working to document this phenomenon more thoroughly.

References: [1] Collins G. C. et al. (1998) *Icarus 135* 345-359; [2] Collins G. C. et al. (1998) *LPSC XXIX* #1319; [3] McBee J. H. and Collins G. C. (2002) *LPSC XXXIII* #1449; [4] Crawford Z. A. and Pappalardo R. T. (2004) *Astrobiology 4*, 2, 232-308; [5] Patterson, G. W. et al. (2005) *LPSC XXXVI* #1068.

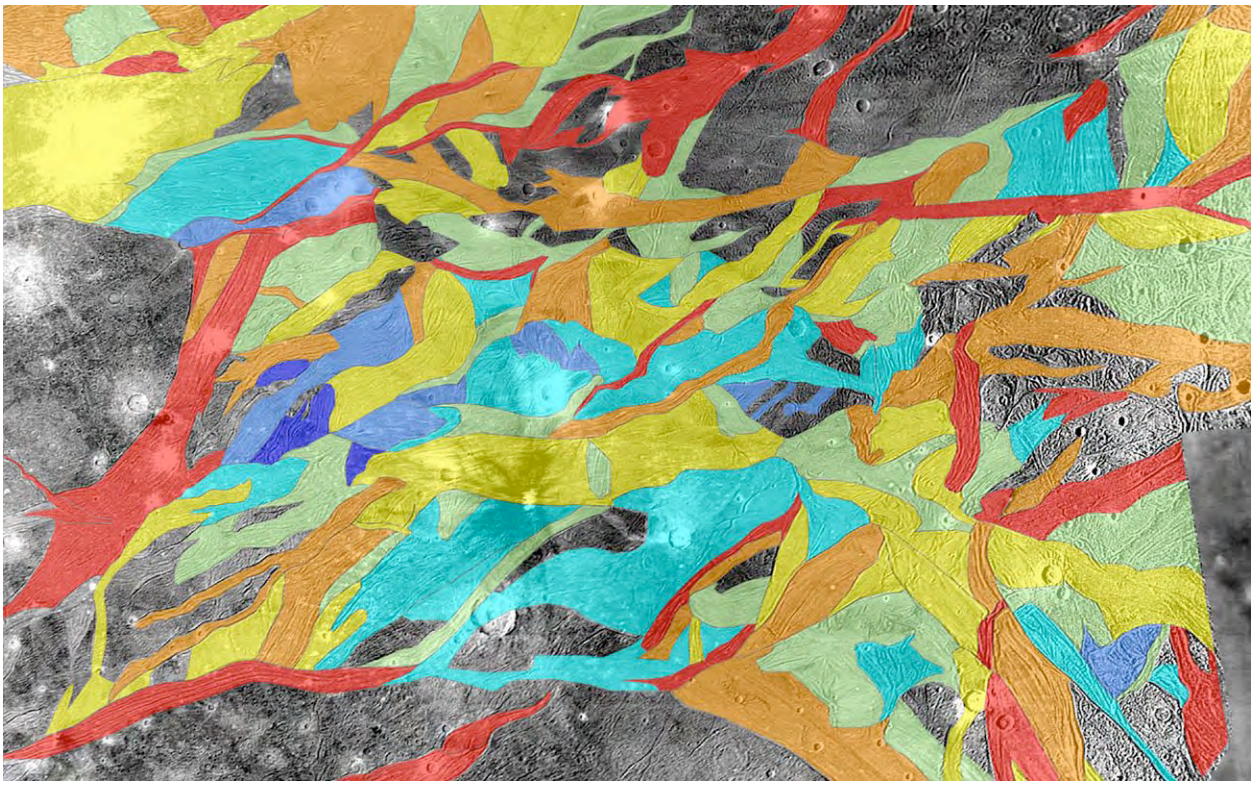

Figure 1: Voyager 1 mosaic of eastern Mysia Sulci target area, overlaid with sorted groove packets. The packets are sorted into seven age categories, symbolized in order from youngest to oldest as red-orange-yellow-green-light blue-medium blue-dark blue. The categories on this map are the youngest age categories to which a groove packet could belong, while the database also contains the oldest possible category for each packet.