MAPPING OF THE ZAMAMA-THOR REGION OF IO. D.A. Williams[1], L.P. Keszthelyi[2], P.M. Schenk[3], M.P. Milazzo[4], Julie A. Rathbun[5], and R. Greeley[1], [1]Department of Geological Sciences, Arizona State University, Box 871404, Tempe, Arizona, 85287 (David.Williams@asu.edu); [2]Astrogeology Team, USGS, Flagstaff, Arizona; [3]Lunar and Planetary Institute, Houston, Texas; [4]Lunar and Planetary Laboratory, University of Arizona, Tucson, Arizona; [5]Department of Physics, University of Redlands, Redlands, California.

Introduction: On September 21, 2003, NASA's *Galileo* Mission to Jupiter ended after almost 14 years in space and 35 orbits of Jupiter. As part of the ongoing *Galileo* data analysis, we have produced regional geologic maps of selected areas of Io's antijovian hemisphere, which was poorly-imaged by *Voyager* but well-imaged by *Galileo*. This abstract discusses our mapping of the Zamama-Thor region. Here we identify the primary geologic features, summarize the map units and structures that are present, and discuss the nature of volcanic activity in this region.

Zamama-Thor Region: The Zamama-Thor region (map, **Figure 1**) is located in the leading antijovian quadrant between 15-45°N and 130-180°W. Unlike previously mapped regions, this region contains two sites of large-scale changes that occurred either before or during the *Galileo* mission. The first change is the formation of the Zamama Eruptive Center, which was nonexistent in *Voyager* images and was first seen by *Galileo* as a hotspot and plume site during orbit G1 (June 1996 [1]), with a linear flow field seen during orbit G2 (September 1996 [2]). The Zamama plume undergoes intermittent activity, and produced a bright red diffuse deposit that faded to red-brown over time [2]. It also has ill-defined, white deposits near the contact between the dark flow field and bright plains that are similar to the SO_2-rich flow-front plume deposits seen at Prometheus [3]. The Zamama flow field was observed at high resolution during orbit I24 (Oct. 1999), and is found to emanate from a central vent source. The field contains crenulated flow margins and narrow linear flows thought to be indicative of tube-fed pahoehoe-like flow fields associated with Promethean-style eruptions [4]. Linear bright flows are also visible to the south, suggestive of sulfur-rich lavas [5].

The second site of surface change is the Thor Eruptive Center, source of the largest plume (500 km high, I31, Aug. 2001) seen on Io to date. This plume was part of a Pillanian-style eruption [4] that produced a dark diffuse unit and a ring of white diffuse material.

Map units: From an analysis of the various *Galileo* images of the Zamama-Thor region and a comparison to previously-mapped regions [6], we have identified 11 geomorphologic material units. To summarize, Io can be divided into five types of materials: plains, patera floors, flows, mountains, and diffuse deposits. *Plains*, which cover >70% of Io, are thought to consist of the silicate crust mantled by dark silicate and bright sulfurous explosive and effusive deposits. In this region we can subdivide the Plains into white (SO_2-dominated) and yellow (sulfur-dominated) subunits based on color. *Patera Floors* occur in the caldera-like interiors of volcanic craters and span a wide range of colors, indicative of volcanic centers in various states of exhumation [7] or burial [6], and indicative of the emplacement of a variety of volcanic compositions including silicate, sulfur, and SO_2. In this region we characterize two subunits: Bright (sulfur-dominated) and Dark (silicate-dominated). *Flow* materials are typified by their generally linear morphology (lengths >> widths) and sharp contacts [6]. Like the Patera Floors, Flow materials (the result of one or more effusions of lava) are generally characterized using color and albedo as Bright (sulfur-dominated) or Dark (silicate-dominated). Albedo variations in the dark flows are thought to be indicative of surface exposure: the freshest flows are generally the darkest. Apparently older flows with intermediate albedos and ill-defined contacts make up Undifferentiated Flow Materials. *Mountain* materials are often only visible in low-sun images where shadows highlight scarps, ridges, grooves, and mountain peaks. Previously we characterized three types of mountain materials: Lineated (containing well-defined ridges and grooves, interpreted to be tectonically-uplifted, crustal blocks), Mottled (containing lobes and hills, interpreted to be materials displaced by mass movement), and Tholus (non-tectonically-derived domical edifices, interpreted to be volcanic constructs). We have mapped several tholus structures related to Zamama and Thomagata Patera, as well as an apparently non-volcanic, low-rising mountain north of Reshef Patera. It contains aspects of both Lineated and Mottled materials, but is dominated by neither, justifying a more generic classification, General Mountain Material. *Diffuse deposits* appear to thinly mantle underlying topography, characteristic of relatively fine-grained fragmental material, and typically occur near active volcanoes. On Io diffuse units occur in five distinct colors: yellow, white, black, red, and green. These colors are interpreted to be diagnostic of the dominent chemical constituent: sulfur, sulfur dioxide, silicate, either short-chain sulfur and/or sulfur chlorides, and products of silicate-sulfur alteration, respectively. In this region, only White, Dark, and Red Diffuse Deposits are present.

Structural Features: Through mapping of structural features, and stereo/DEM analyses performed by [8], two mountain-like structures west and southwest of the Zamama flow field were identified as steep-sided shield volcanoes with small summit pits and flattened crests, and a third feature, a small conical mound with a central pit. North and east of Zamama are two paterae on shield-like rises, Thomagata and Reshef Paterae. Because of its location on a structurally distinct rise, [9] defined Thomagata Patera as a mountain of "ambiguous morphology." In contrast, Reshef Patera has an irregular central depression and a deeper southern end relative to its northern end [10]. Reshef sits within an irregular, triangular-shaped mesa. This mesa is undergoing degradation by multiple underground magma sources, as evidenced by a forked canyon whose floor is covered with dark material. A portion of the mesa appears to be separating from the main structure, and because this portion appears to stand higher than the rest of the mesa, we have mapped it as General Mountain Material.

Discussion: Ongoing work involves integrating our mapping analyses with other observations (NIMS, PPR) to better understand the geologic activity in this region. From the correlation of the newly-mapped Thor dark flows in the I32 mosaic to old bright flows in the C21 mosaic, it is possible that Thor was active prior to the *Voyager* flybys, and that it is either a source of renewed silicate volcanism that covered an-cient dark flows that were long ago buried by bright materials, or that Thor is a site where volcanic activity has changed from sulfurous magma that produced bright flows prior to 1999, to silicate magma that produced dark flows and pyroclastics during the 2001 eruption. This latter alternative would be consistent with the new theory by [7], in which new paterae form by exhumation of sulfurous materials in a growing volcanic crater, followed by emplacement by new sulfur flows and later by silicate flows and lava lakes on the floor of the deepening crater. Although the Thor vent appears to be located on a local rise, it is unclear if a larger patera is in the process of forming. There are, however, several small paterae near the main Thor vent, including one with a recently darkened floor.

References: [1]; Davies et al., *GRL 24*, 2447-2450, 1997; [2] McEwen et al., *Icar 135*, 181-219, 1998; [3] Milazzo et al., *JGR 106*, 33,121-33,128, 2001; [4] Keszthelyi et al., *JGR 106*, 33,025-33,052, 2001; [5] Williams et al., *JGR 106*, 33,161-33,174, 2001; [6] Williams et al., *JGR 107*, doi:10.1029/2001JE001821, 2002; Williams et al., *Icar*, in press, 2004; [7] Keszthelyi et al., *Icar*, in press, 2004; [8] Schenk et al., *Icar*, in press, 2004; [9] Jaeger et al., *JGR 108*, doi:10.1029/2002JE001946, 2003; [10] Turtle et al., *Icar*, in press, 2004.

Figure 1. Preliminary geomorphologic map of the Zamama-Thor region of Io's antijovian hemisphere. Basemap is the near-terminator I32TERMIN02 mosaic (360 m/pixel).