VOLCANISM ON IO: INSIGHTS FROM GLOBAL GEOLOGIC MAPPING. D.A. Williams[1], L.P. Keszthelyi[2], D.A. Crown[3], P.E. Geissler[2], P.M. Schenk[4], Jessica Yff[2], W.L. Jaeger[2]. [1]School of Earth & Space Exploration, Arizona State University, Tempe, Arizona 85287 (David.Williams@asu.edu); [2]Astrogeology Team, U.S. Geological Survey, Flagstaff, Arizona; [3]Planetary Science Institute, Tucson, Arizona; [4]Lunar and Planetary Institute, Houston, Texas.

Introduction: We are preparing a new global geologic map of Jupiter's volcanic moon, Io. Here we report the type of data that are now available from our global mapping efforts, and how these data can be used to investigate questions regarding the volcano-tectonic evolution of Io.

Previous Work: During recent years we developed techniques for global mapping using a low-resolution *Galileo* regional mosaic [1], and began mapping on our base, a series of 1 km/pixel mosaics produced by the USGS from the combined *Galileo-Voyager* image data sets [2]. Global mapping was completed in 2008 using ArcGIS™ software. We have also begun production of an Io database [3] that will include most Io data sets to address the surface changes due to Io's active volcanism. Previously [4] we reported the percentage of Io covered by each of 14 geologic material units, such that the whole surface of Io has now been characterized into process-related material units and structures. These data, which include the areal extents and latitude-longitude locations of every resolvable lava flow field, patera floor, mountain, plains unit, and diffuse deposit, as well as the locations of hot spots detected from previous missions, can be used for statistical studies to investigate Io's geologic processes.

Results: We are using the new map to investigate several specific questions about the geologic evolution of Io that previously could not be well addressed, including (for example) a comparison of the areas vs. the heights of Ionian mountains to assess their stability and evolution (**Fig. 1**). The area-height relationships of Io's visible mountains show the low abundance and low relief of volcanic mountains (tholi) relative to tectonic mountains, consistent with formation from low-viscosity lavas less likely to build steep edifices. Mottled mountains are generally less high than lineated mountains, consistent with a degradational formation.

Correlation of Map Units: Fig. 2 shows the stratigraphic relationship of map units. The oldest materials exposed at the surface are crustal materials that have been uplifted to form the various mountain units. Our mapping and other studies support the hypothesis of [5] that the accumulation of volcanic materials on the surface causes compression of the upper crust, eventually leading to tectonic fracturing, faulting, and uplift of crustal blocks forming mountains (our Lineated Mountain material). Over time these materials are mantled and undergo gravitational collapse, forming Mottled Mountain materials that grade into Layered Plains. Surrounding the mountains are the various Plains materials, whose upper surfaces must be very young, based on the lack of impact craters, but whose lower layers are likely the same crustal materials that make up the mountains.

We suggest that volcanism on Io has been happening for at least the last few Ma to create the stress conditions necessary to form the mountains. Volcanism has probably been going on for a much longer period of time, although the rapid reworking of the crust has obliterated any evidence of older activity. The currently visible paterae and lava flow fields (*fluctus*, pl. *fluctūs*) probably formed subsequently (in most cases) to the currently visible mountains. The oldest volcanic surfaces are related to centers that became inactive in the last decades to millennia and are mapped as Undivided Patera Floor materials and Undivided Flow materials. More distinct volcanic constructs, including the Bright Tholus material, probably formed more recently. The visible surfaces of the plains are formed from the coalescence and homogenization of older eruptive products (pyroclastics and lavas).

The time frame of decades to years marks the period of spacecraft observations, from *Voyager* (1979) to *Galileo* (1996-2001) to *New Horizons* (2007). While no new mountains or paterae have formed in this time interval, we have witnessed the formation of the Zamama flow field between *Voyager* and *Galileo*, and ongoing emplacement of new flow fields, patera floors, and diffuse deposits at many volcanoes. These are the source for the other geologic units, including Bright and Dark Patera Floor materials, Bright and Dark Flow materials, and all five types of Diffuse materials. The most recent spacecraft flyby (*New Horizons*, Feb. 28, 2007) recorded evidence of surface changes in both lava flow fields and diffuse deposits at several locations on Io [6].

References: [1] Williams, D.A. et al. (2007), *Icarus*, *186*, 204-217. [2] Becker, T. and P. Geissler (2005), *LPS XXXVI*, Abstract #1862. [3] Rathbun, J.A. and S.E. Barrett (2007), *LPS XXXVIII*, Abstract #2123. [4] Williams, D.A. et al. (2008), *LPS XXXIX*, Abstract #1003. [5] Schenk, P. and Bulmer, M. (1998), *Science, 279*, 1514-1517. [6] Spencer, J. et al. (2007), *Science, 318*, 240-243.

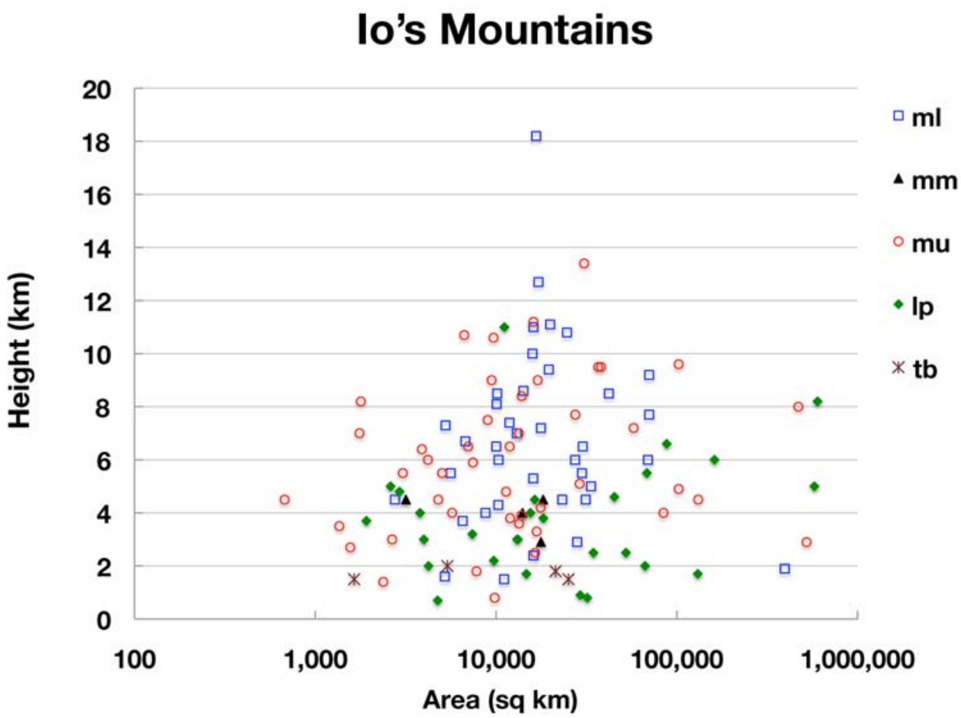

Figure 1. Plot of area-height relationships of Io's mountains. Mottled mountains (mm) are generally less high than lineated mountains (ml), consistent with their degradational formation. Undivided mountains (mu) are widely distributed, as lack of resolution inhibits better characterization. Tholi (volcanic mountains, tb) are of low relief, consistent with formation from low-viscosity lavas. Layered plains (lp) are mostly <6 km high, consistent with highly degraded mountains, grading into eroded plains (i.e., 'resurfacing' by mass wasting, a minor process on Io).

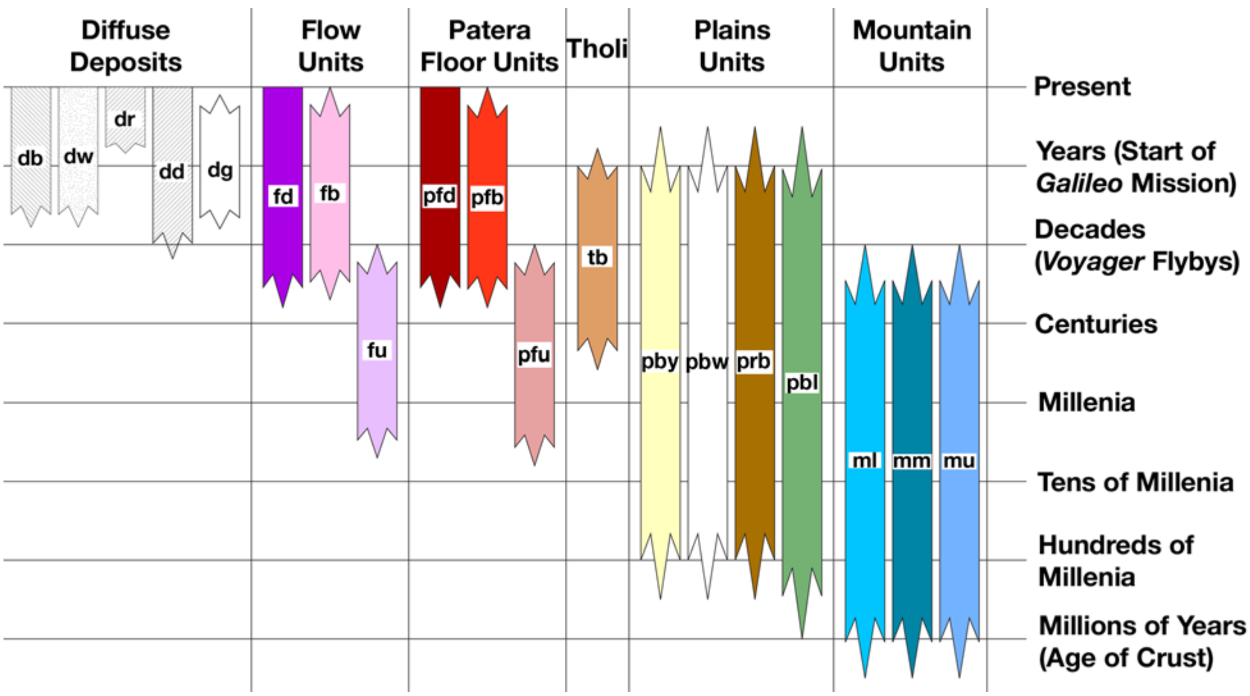

Figure 2. Correlation of exposed map units on Io. Symbols: ml, lineated mountains; mm, mottled mountains; mu, undivided mountains; pby, yellow bright plains; pbw, white bright plains; prb, red-brown plains; pbl, layered plains; tb, bright tholi; pfd, dark patera floors; pfb, bright patera floors; pfu, undivided patera floors; fd, dark flows; fb, bright flows; fu, undivided flows; db, bright diffuse deposits; dw, white diffuse deposits; dr, red diffuse deposits; dd, dark diffuse deposits; dg, green diffuse deposits.