**Dimpled Dione; A look at the cratering distributions and history on Saturn's moon Dione and implications for crater source populations.** S. N. Ferguson[1] and A. R. Rhoden[2], [1]Arizona State University School of Earth and Space Exploration, PO Box 876004 Tempe, AZ 85287-600, sierra.ferguson@asu.edu, [2] Southwest Research Institute, Boulder CO

**Introduction:** Dione, one of the mid-sized icy moons of Saturn (radius = 530 km, density =1.4 g/cm^3) that is thought to have (or have had) an ocean underneath its ice shell [1]. The surface of the moon displays smoother terrain [2] on the leading hemisphere and tectonized "wispy" terrain on the trailing hemisphere [3]. The hemispheres of the moon also vary in color, with a darker trailing hemisphere and brighter leading hemisphere. These color differences have been attributed to bombardment of the surface by E-ring particles, dark material, or high energy particles. [4,5]. Dione is also thought to have been previously cryovolcanically active, resurfacing portions of the leading hemisphere where the smooth terrain is now located [2]. In addition to the tectonics, other surface features on Dione include the Linea Virgae [6] and an assortment of impact craters ranging in sizes from the large, 350 km, Evander basin to the small 1-2 km craters [7,8].

Dione also has two co-orbital satellites (Helene and Polydeuces) that are orbiting in the L4 and L5 Lagrange points. Impacts onto these moons could release debris that goes on to impact Dione, with faster and more oblique impacts on the leading hemisphere [9,10]. Oblique impacts can lead to diagnostic crater shapes. In particular, elliptical craters are those that form when impacting the surface with an impact angle of ≤15° [11,12].

We are investigating the source populations of impact craters on the surface of Dione with a focus on the small craters and elliptical craters. Our goal is to provide constraints on the impactor size frequency distribution and impact parameters (e.g. impact angle) to inform estimates of surface age and models of Saturnian satellite formation and evolution. We also plan to look for signatures of co-orbital debris that may be affecting crater statistics.

We map craters in previously unmapped high-resolution images of Dione, which range in size from 1 km to 100 km. We measure crater diameters and the azimuths of the long axes of elliptical craters to determine whether there is a preferential direction of impact for the source impactors. Additionally, we map pit chains, connected craters, grooves, and other tectonic features that may have been associated with impacts or that can provide regional context for the craters and a more complete understanding of the geology of the study regions. Finally, we compare our results with those obtained for Tethys, another mid-sized icy moon with co-orbital satellites [13].

**Methods:** We utilize image data taken by the Cassini imaging science subsystem (ISS) [14]. The current map comprises two main regions: the smooth terrain and the fractured terrain, as defined by [8]. We are focusing our mapping on individual image sets that have been mosaicked together using the USGS's ISIS3 software [15]. These mosaics have image resolutions of ~200 m/pix. Mosaics are projected into a simple cylindrical projection and georeferenced onto the USGS basemap [16]. The georeferencing to the basemap allows for more reliable location information for each mapped crater.

All mosaics are brought into ArcMap and tied to the basemap. Craters are then mapped, provided that the shadowing of the feature indicates that it would be a depression instead of a topographic high, feature is roughly circular (except in polygonal or elliptical cases), and appears to have a raised rim. Based on our image resolution, we set a limit that a crater must be at least 10 pixels across to count in the final plots. This limit was chosen based on recommendations by [8,17]. This limit is utilized so that we are not counting craters that are too close to the resolution limit and might not actually be impact craters.

To measure the craters, we utilize the Crater-Helper tool extension for ArcMap [18]. This tool will measure the diameter, location, and major/minor axis in regards to elliptical craters, all regardless of map projection. To compute the azimuth (0° is north, increasing clockwise) we utilize a combination of the bearing tool built into ArcMap and the Graphics and Shapes extension [19]. These methods produce measurements for bearing that are independent of map projection. We will take the average of the two measurements for a more accurate value.

**Preliminary Results:** We have currently mapped a region in the fractured terrain on the trailing hemisphere and a region in the smooth terrain (Figure 1). These regions are unique on the surface in that the smooth terrain is less tectonized and appears to have been resurfaced, thus potentially erasing some of the smaller craters. The fractured terrain is heavily tectonized which contrasts the appearance of the smooth terrain. Between the two regions, we've currently mapped 1,152 craters. Of which, 1,010 are classified as a bowl shaped, 108 are classified as elliptical, and

34 are classified as polygonal. Table 1 shows the number of craters in 1 km diameter bins per mapped region. Figure 1 shows the current map of craters on the USGS basemap of Dione.

We will be comparing the size frequency distributions to predicted impactor populations as described in [20]. Additionally, we will be comparing the Dione dataset to the dataset we gathered for Tethys [13]. We will also present an analysis of the azimuths and ellipticities of the elliptical craters.

| Diameter (km) | Leading Hemisphere | Trailing Hemisphere |
|---|---|---|
| 1-2 | 129 | 117 |
| 2-3 | 136 | 173 |
| 3-4 | 103 | 61 |
| 4-5 | 85 | 30 |
| 5-6 | 37 | 23 |
| 6-7 | 29 | 15 |
| 7-8 | 22 | 13 |
| 8-9 | 18 | 15 |
| 9-10 | 11 | 5 |
| 10-11 | 7 | 7 |
| 11-12 | 4 | 5 |
| 12-13 | 2 | 14 |
| 13-14 | 7 | 5 |
| 14-15 | 3 | 6 |
| 15-50 | 17 | 28 |
| 50-100 | 2 | 1 |
| 100+ | 0 | 2 |
| **Total** | **612** | **520** |

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**Table 1.** Number of craters per 1 km bins, until larger diameters where bin sizes are increased. Between the 1-2 km bin and 2-3 km bin, the trailing hemisphere has a higher number of small craters, which might have implications for the source population of these craters. **Figure 1 (below).** Current crater map for the leading and trailing hemisphere mosaics. Colored points mark the location of a mapped crater.