MORPHOLOGICAL CHARACTERIZATION OF MICROCHAOS ON EUROPA: SHORT-LIVED VS. LONG-LIVED POPULATIONS. K. A. Núñez[1] and L. G. J. Montési[1], [1]University of Maryland- College Park, College

Introduction: The Galileo space probe revealed that the "mottled plain" units of Europa consist of scattered depressions, domes, spots, and small patches of chaotic terrain [1]. Together, these features have been described as lenticulae or microchaos, in contrast to "regular" chaos, which is defined as a distinctive region of broken terrain and typically features a lumpy matrix between blocks [2]. Spots are enclosed features with a consistent dark albedo [3]. Domes and pits can both disrupt terrain like chaos or preserve it. Previous efforts have been made to map and characterize these features [1-7]. We focus here on the distribution of microchaos orientation, aspect ratio, and size to determine if these features formed continuously throughout Europa's history or correspond to distinct events.

Methods: This study uses the features mapped by Noviello et al. [3]. Their map identified domes, pits, spots, and microchaos in the trailing and leading hemispheres. The ArcGIS shapefiles found in [3] were imported onto the Europa Galileo SSI Global Mosaic 500m v2 [8]. We used this lower resolution mosaic compared to higher resolution images since no additional mapping would be done in this study. The area, central latitude, and longitude for each feature were taken from [3]. Although microchaos are widely distributed on Europa [9] we focus here on the trailing and leading hemisphere regions mapped in detail by [3].

Calculating Orientation. Although each microchaos has some level of irregularity, we measure an overall elongation and size. To do so, we randomly generated 10,000 points within the boundaries of each feature. These points are then used as inputs for the directional derivative distribution function that fits an ellipse to all the points within each microchaos boundary. The result is a new shapefile where each feature mapped by [3] is represented by an ellipse characterized by the orientation and length of its semi-major and semi-minor axes. The Directional Derivative distribution function measures orientation as zero starting at the north. The aspect ratio of the features is defined as the quotient of the semi-minor and major axis. The size of each feature in the areas mapped by [3] and the orientation of their semi-major axes are shown in Figure 1.

Results: The distribution of areas includes several large values that make the definition of a mean area meaningless. However, the distribution is approximately log-normal. The average log(area) of microchaos features is 3.84 ± 1 log(km^2) in the trailing hemisphere and 3.98 ± 1 log(km^2) in the leading hemisphere. The mean orientation of the semi-major axis in the

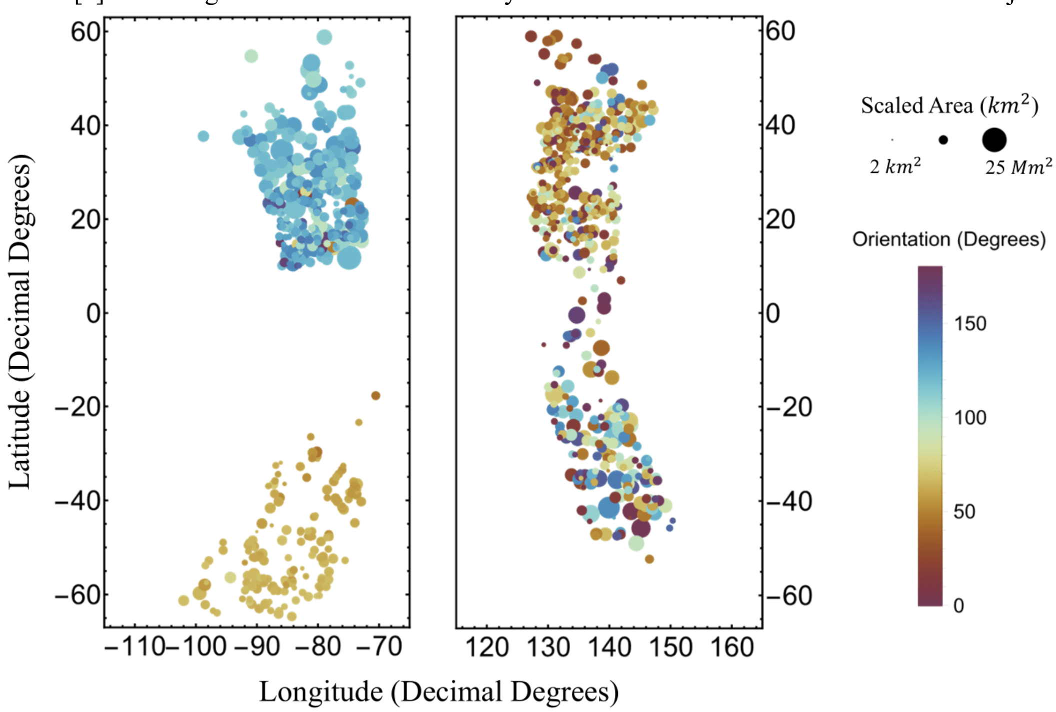

Figure 1 Bubble diagram of microchaos features on Europa. The size of each point is scaled to the area of the feature. The color of each point corresponds to the orientation of the feature. The leading hemisphere is on the left while the leading hemisphere is on the right.

trailing hemisphere is 58° while the leading hemisphere has a mean orientation of 104°. The mean circular variance, which measures how concentrated a set of orientations is, ranges from 0 to 1 with smaller values signaling tighter distributions about a mean. The mean circular variance in the trailing hemisphere is 0.63, while the leading hemisphere has a circular variance of 0.057. The mean aspect ratio in the trailing hemisphere is 0.64 ± 0.2 compared to 0.31 ± 0.2 in the leading hemisphere.

These average values imply that, except for orientation, microchaos in the leading and trailing hemisphere are not too different from each other. The area and aspect ratio have approximately the same ranges for both hemispheres. To investigate further the differences in orientation from one region to another, we separated the data in 10° latitude bins that overlap to not create artificial breaks in the data. Histograms of orientation in each latitude bin are shown in Figure 2.

Figure 2a presents the data from the leading hemisphere. Microchaos in the southern and northern leading hemispheres are consistently oriented around 70° and 130°, respectively, with a very low circular variance of 0.057. The different orientations and their consistency are also visible in Figure 1. In the northern leading hemisphere, the distribution shifts from a peak of ~120° to ~130° as we get closer to the equator. A similar pattern can be seen in the southern leading hemisphere.

Figure 2b shows that the distribution of orientations in the trailing hemisphere is broader than in the leading hemisphere, as confirmed by a high circular variance of 0.63. Efforts were made to analytically cluster the trailing hemisphere data to search for subpopulations but no consistent results could be obtained. The large variance of orientation values in the trailing hemisphere made clustering too complex. Even though the northern trailing hemisphere population is oriented at ~50° on average, all possible orientations at all latitude bins are observed, which is in marked contrast with the leading hemisphere data.

Discussion and Conclusions: The profound difference in the consistency of microchaos orientation in the leading and trailing hemisphere may be related to the duration of microchaos activity. If we hypothesize that the orientation of microchaos is influenced by global or regional stresses field, microchaos that formed under the same stress field would have a consistent orientation, as seen in the leading hemisphere. The progressive changes in orientation with latitude in the leading hemisphere might correspond to global variations in stress orientation. However, the microchaos orientations in the northern and southern hemispheres do not converge at the equator, implying that these populations formed at different times.

Microchaos in the trailing hemisphere exhibit a much broader distribution of angles, and the most common orientation does not vary systematically with latitude (Figure 2b). No populations with distinct orientations could be defined, which implies that these microchaos formed either under essentially isotropic or varying stress. The preferred orientation of the northern microchaos in the trailing hemisphere is difficult to reconcile with an isotropic stress field. Thus, we conclude that microchaos developed in the trailing hemisphere as the stress field rotated.

The orientation of lineae has been used to propose formation under different amounts of non-synchronous rotation [10]. No separate episodes can be identified in the microchaos populations, implying a continuous and long-lived activity as the ice shell rotated, at least in what is now that trailing hemisphere.

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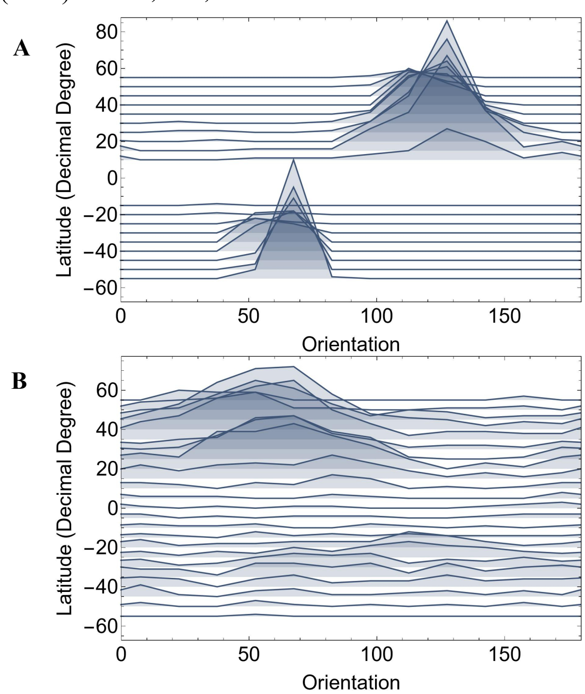

Figure 2 Histogram of orientation by overlapping latitude bins in the leading (a) and trailing (b) hemispheres.