HEMISPHERIC-SCALE RIFT ZONES ON RHEA, TETHYS, AND DIONE

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Introduction: Rhea, Tethys, and Dione are among the largest moons of Saturn. Each exhibits substantial extensional tectonic deformation in the form of rift zones ("chasmata"). Numerous mechanisms have been proposed to account for the stresses responsible for the surface deformation of icy satellites, including changes in volume due to phase changes within a satellite and solid-state convection, polar wander, diurnal tides, non-synchronous rotation, and tidal recession [1–8]. We show the map patterns of the chasmata (and impact features) on Rhea, Tethys, and Dione in **Fig. 1**.

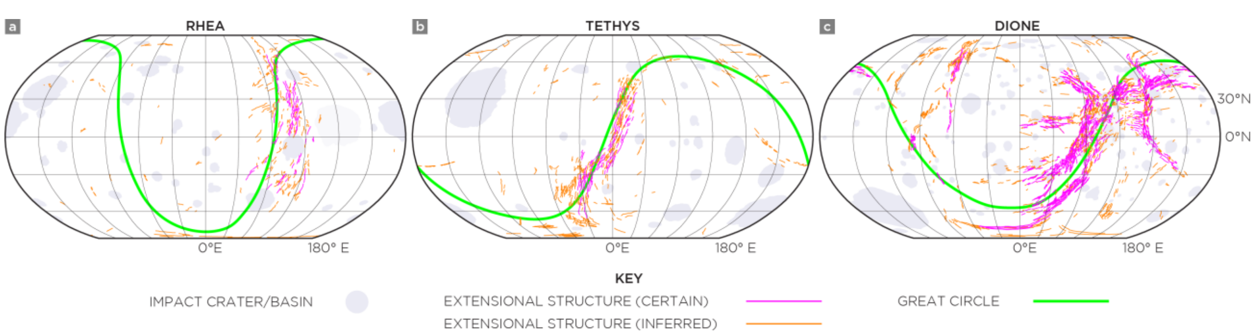
Rhea: Galunlati and Yamsi Chasmata are both located close to the center of Rhea's trailing hemisphere (**Fig. 1a**), and trend approximately north–south. Galunlati is the longer of two, extending for ~1,500 km and subtending 113° of arc. Both systems vary in width along their course, from ~40–90 km, and are characterized by normal fault segments that display minor local variations in strike, relay ramps, and numerous stepover regions tens of kilometers long.

Tethys: Tectonic deformation on this moon is dominated by Ithaca Chasma, which ranges from high northern latitudes in the moon's trailing hemisphere, across the prime meridian, to high southern latitudes at the perimeter of the leading hemisphere (**Fig. 1b**). Although at 1,400 km it is shorter than the chasmata on Rhea, Ithaca Chasma subtends a longer arc (151°), and is between 70 km and 110 km in width. Ithaca Chasma hosts more individual fault segments than either chasma on Rhea, but is similarly oriented ~north–south along much of its course.

Dione: Rifting on this moon displays the greatest structural complexity of the three bodies we survey. Numerous chasmata populate the center of Dione's trailing hemisphere, with several following again ~north–south-oriented trends (notably Palatine, Eurotas, and Padua Chasmata) (**Fig. 1c**). Collectively, these rifts extend ~1,300 km, subtend 133° of arc, and vary 40–130 km in width. The cumulative number of fault segments on Dione is considerably greater than that of Rhea or Tethys.

Discussion: Despite differences in size, density, internal structure, impact cratering history, and dynamical environment, fundamental similarities exist in the style and distribution of large-scale extensional deformation on the icy satellites we investigate. Rifting is concentrated within or at the borders of each moon's trailing hemisphere, shows a preference for ~north–south-oriented strikes, and shows a systematic increase in complexity from Rhea, to Tethys, to Dione.

Sections of each moon's chasma or chasmata appear to lie along substantial portions of great circles (green lines in **Fig. 1a–c**), indicating that the rifting process(es) operated over considerable distances along lines of constant bearing (in spherical geometry). Further, tidally induced stresses alone tend to result in degree-two distributions in strain, in contrast to the hemispherical dichotomy in the localization of strain observed on these three Saturnian icy satellites (and on Rhea and Tethys in particular). Hemispherical differences in ice shell thickness, for example, may account for this "degree-one" dichotomy. Thus these large-scale rifts may have formed under a scenario in which tidal processes contributed at most a secondary component of stress, with Rhea representing the least, and Dione the most advanced stage of deformation.



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