THE PLAINS AND LINEAMENTS OF DIONE; J. M. Moore, School of Geology and Geophysics, University of Oklahoma, Norman, Okla. 73019

Voyager 1 and 2 images of Dione have provided a semi-global view of this Saturnian satellite at moderate resolution. Lineaments are observed crossing all regions imaged at sufficient resolution. At highest resolution, lineaments are topographically expressed as troughs, chasmata, and catenae. In these same highest resolution images can be seen two terrains of conspicuously contrasting crater densities. Plescia and Boyce (1982) further divide the low crater density region into intermediately cratered and least cratered plains. Thus there are three recognized terrains: cratered, plains, and smooth plains. The stratigraphic relationship of the lineaments (in their various topographic manifestations) to the different terrains and their possible origins are discussed here.

Smith et al. (1981) observed that bright, wispy, linear markings divide the dark trailing hemisphere into polygons. Where the wispy markings can be traced westward into higher resolution images, they can be traced westward into higher resolution images, they are composed of, or may pass into, a large number of narrow, bright lines. Where they can be traced into the highest resolution images, which are in the bright hemisphere, a few of the bright lines appear to be associated with narrow troughs and ridges. The trough and ridge arrangement of the Palatine Chasma in the south polar region strongly resembles grabens and horsts. If grabens and horsts characterize the topography of the wispy, linear markings seen elsewhere, then the network may be a manifestation of a period of global or near-global expansion. The wispy lineaments form broad bands that (assuming they're graben and horst) are vaguely reminiscent of the Ithaca Chasma on Tethys. The formation of Ithaca Chasma could result from either the expansion of Tethys as its H_2O interior solidified (Smith et al., 1982), or by seismic disruption caused by a major impact event (McKinnon, 1982). Moore and Ahern (1982) proposed that the impact event creating the 400 km diameter Odysseus basin formed, or at least controlled, the presence of the Ithaca Chasma, based partly on the geometric relationship of the two features. No significant (greater than 300 km) craters are observed near locations of radii normal to a plain of intersection oriented on the main expression of the wispy lineaments. Smith et al. (1981) observed that near the center of the complex of bright markings there is an elliptical albedo feature (Amata) about 240 km long that may be a large irregular crater or basin. They suggested that the putative basin controls a great regional system of fractures or faults. A similar situation may have occurred where an extensive set of bright lineaments converge on a bright spot (Cassandra) southeast of Amata. It is possible that, in light of the apparently small size of the Cassandra impact structure, these impacts merely established lines of weakness in the lithosphere and are not significantly responsible for expansion along the fractures. It is more likely that, as was suggested by Smith et al. (1981), these fractures were opened or reopened by internally generated stresses such as those associated with extension of the crust during freezing of the interior. Moreover, the distribution of lineaments and bands of lineaments across Dione is more compatible with the freeze-expansion model than the situation on Tethys (Moore and Ahern, 1982).

The troughs and ridges are seen commonly on cratered terrain and less so on the plains, suggesting that the resurfacing material of the plains covered many of the wispy lineament-related fractures or grabens and horsts. It is possible that the resurfacing material travelled to the surface via these fractures. It has been proposed by Smith et al. (1981) and expanded upon by Stevenson (1982) that the wispy nature of the lineaments on the trailing hemisphere may be the result of the deposition of water-ice pyroclasts, probably carried up and explosively discharged by more volatile substances such as methane, nitrogen, and argon. In the southern part of the plains terrain there occurs broad, low northeast-trending ridges first noted by Smith et al. (1981). A possible origin of these ridges is that they are laccolith-like regions of thickened deposits of resurfacing materials over the source fractures. Their orientation, though, seems unrelated to the wispy lineaments. Superimposed on the ridges are fine sets of soalescing pit-lineaments aligned to the northwest and truncated or terminating at the smooth plains boundary.

The smooth plains unit is seen near the terminator in the highest resolution images centered about the intersection of the equator and 65°W, presumably extending some distance to the west of the terminator. It is virtually featureless, except for a few craters, smaller than 20 km. A single lineament, a large trough named Latium Chasma, crosses the smooth plains. Latium Chasma appears to be the distal extension of a large, branching network of troughs, in places forming levees, originating in the north polar region. This network of troughs was probably the source of the resurfacing material deposited in its vicinity (Plescia and Boyce, 1982). This observation is supported by the distributary appearance of the network, with the postulated flow southward, terminating in the smooth plains.

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The orientation of ridges and lineaments in the plains units does not seem related to the control of the wispy lineaments. The ridges in the southern plains are roughly parallel to the smooth plains boundary, while the coalescing-pit lineaments are perpendicular to the boundary. The northern network of branching troughs appear along the contact between plains and cratered terrain. These features are all similar to features observed around the margins of resurfaced areas on the Moon and Mars. The plains and smooth plains units may extend significantly westward beyond the Voyager 1 terminator, an observation that is weakly supported by the apparent absence of large (greater than 40 km in diameter) craters in low resolution views of this region by Voyager 2. If this is so, then the high resolution Voyager 1 images show the eastern border region of the plains units, and the topographic features seen on these plains are oriented to this feature. Possible loading of the pre-existing lithosphere by the resurfacing material may have caused the stresses and thus this orientation.

The endogenic evolution of Dione may have begun with the freeze expansion of its interior, which formed graben out of pre-existing impact-induced lines of weakness along which water-ice pyroclast deposits occurred, forming the wisps in the trailing hemisphere. Apparently superimposed on these lineaments are the plains units whose resurfacing materials may have emerged from these wispy lineaments. The centrally-located, smooth-plains unit, observed by Voyager 1, and the northern portion of the plains unit seem to have been resurfaced by material rising up and travelling south along a large northern network of branching, possibly distributary, troughs. These troughs, as well as ridges and coalescing-pit lineaments in the plains unit, may be oriented around the margin of a major region of plains terrains, which could include a significant area west of the terminator in the highest-resolution Voyager 1 images.

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