

tent, timing, and nature of volcanotectonic activity surrounding the Isidis and Hellas basins during Noachian and earliest Hesperian time; then, we explore the possible mechanisms controlling each phase of inferred activity. The location, age and nature of the ridged volcanic plains, volcanic constructs, and major scarp and ridge trends establish the principal observational constraints to be explained. Throughgoing wrinkle ridges of later origin are omitted for this study. Common elements in the histories of these two major basins help to establish a general sequence of basin-controlled stresses over time and permit quantitative tests of alternate models for basin deformation.

TECTONIC AND VOLCANIC SEQUENCE IN THE ISIDIS-HELLAS REGION

Volcanic and tectonic features in the cratered highlands reveal patterns of regional deformation. For this investigation, highland scarps, graben, fractures, and volcanic features are used to infer local deformation in the cratered highland regions around the Hellas and Isidis impact basins. Basin-concentric and basin-radial orientations are presumed to reflect basin control on deformation, and the location of these trends relative to the outer basin scarp (the basin equivalent of the Cordillera scarp around the lunar Orientale basin) is taken as a measure of the lateral extent of basin-controlled deformation. Although wrinkle ridge trends also occur in the region [Chicarro *et al.*, 1985], they cross most features and units and are assumed to reflect later stress regimes outside the time frame of interest.

Tectonic Features

The nature of regional deformation is addressed by grouping individual structural elements of similar trend and nature into broad systems of deformation. These various systems are labeled with the first letter of the associated impact basin and the initials of the named or described features (Figure 1). Three types of tectonic system are identified: sets of fractures and graben, scarp-bounded troughs, and linear scarp systems. The probable basin-controlled tectonic patterns indicated by these systems include (see Figure 1 and Table 1): near-concentric graben formed inside the Cordillera-equivalent basin scarp; distant-concentric "canyons" formed outside the basin scarp; and basin-radial troughs extending through the basin scarp.

The near-concentric graben occur within the massif ring zones of both Isidis and Hellas. The Nili Fossae (I-NF) and Amenthes Fossae (I-AF) fracture massifs northwest and southeast of Isidis, respectively, and are confined to an annulus ranging -200-300 km from the edge of the central basin plains (Figure 1). Typically, these are flat-floored graben between 1 and 5 km in width, although some elements are too narrow to resolve the nature of their floors from available resolution (Figure 2). The

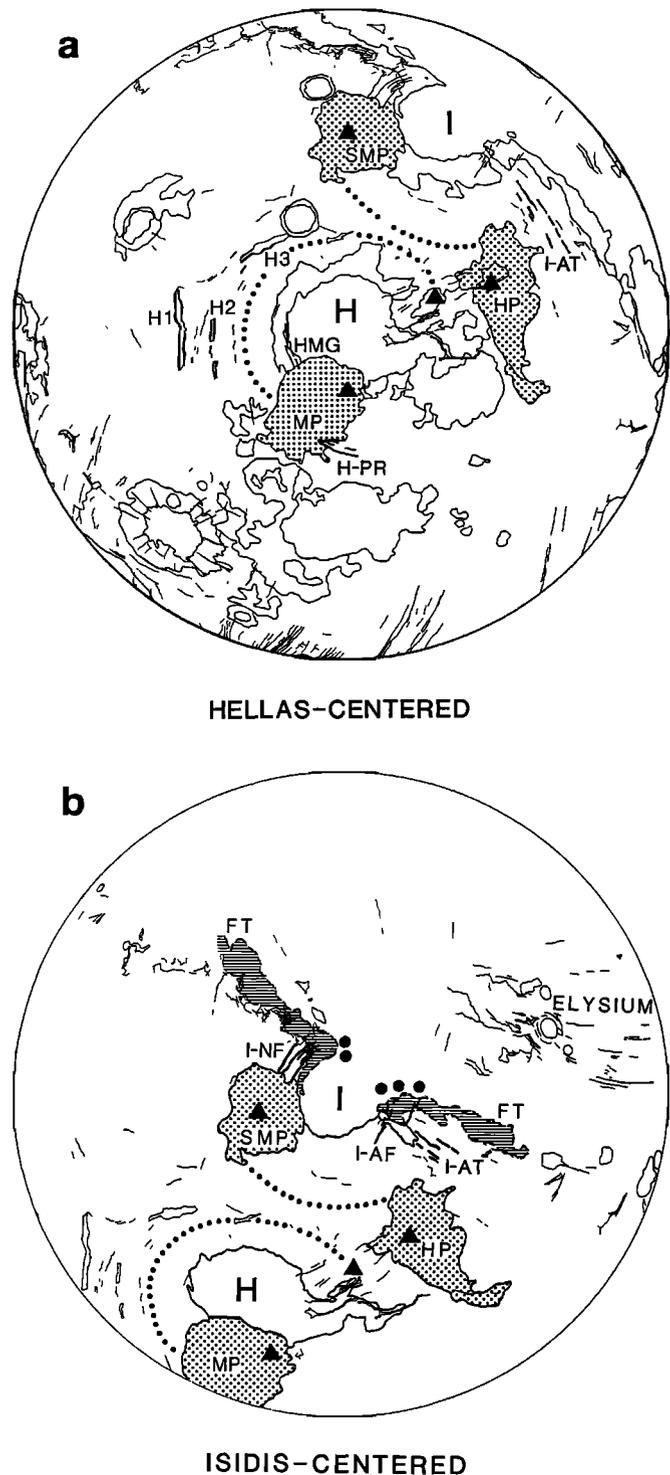


Fig. 1. (a) Hellas-centered and (b) Isidis-centered Lambert projections of tectonic structures and selected geologic features in the Hellas-Isidis region showing dated tectonic structures and volcanic units. H1, H2, H3 are Hellas concentric canyon systems collectively referred to as HC; H-PR, Pityusa Rupes; HMG, graben in the Hesperia Montes; I-NF, Nili Fossae; I-AF, Amenthes Fossae; I-AT, trough near Amenthes Rupes. SMP, Syrtis Major Planum; HP, Hesperia Planum; MP, Malea Planum; FT, fretted terrain along the dichotomy. Dotted lines indicate region of the outer basin scarps. Solid triangles denote volcanic calderae or highland paterae, and solid circles represent locations of volcanic cone fields in the Isidis region.