PROCELLARUM BASIN: A MAJOR IMPACT OR THE EFFECT OF IMBRIUM? P.H. Schultz, Department of Geological Sciences, Brown University, Providence, R.I. 02912, and P.D. Spudis, U.S. Geological Survey, 2255 W. Gemini Dr., Flagstaff, AZ 86001.

INTRODUCTION: Several studies have suggested that the geochemistry, mare-basalt distribution, and structural patterns of ridges on the lunar nearside reflect the existence of a major impact basin 3200 km in diameter (1,2,3,4,5). Whitaker (3) has argued that the distribution of mare shorelines, mare ridges, and isolated scarps delineate a three-ringed Procellarum mega-basin (centered at 23°N, 15°W) with ring diameters of 1700, 2400, and 3200 km. At one time some of these features were ascribed to outer rings of the Imbrium basin centered at 37°N, 18°W (6). Consequently, we have re-examined the pattern of ridges and grabens on the lunar nearside through global projections centered on the proposed mega-basin and the well-known Imbrium basin. In a separate paper (7), the geochemical evidence for such a basin is reviewed and questioned. The present contribution focuses on the geomorphic evidence and offers an alternative explanation.

LUNAR TECTONIC PATTERNS: The primary data set used for this study is derived from references (8) and (9) augmented by additional structural features in the lunar highlands. Figure 1 permits comparison of features centered on the proposed Procellarum basin and Imbrium. The center of Imbrium was chosen principally on the basis of the inner ridge ring in Mare Imbrium, the Alpes-Apennine-Carpatus mountainous arc, and the Harbinger Mountains. Figures 1a and 1b reveal the difficulty in separating tectonic patterns controlled by the proposed mega-basin from those related to the Imbrium basin. The principal landmark used by Whitaker to identify the inner ring of Procellarum basin is a scarp southeast of Imbrium as indicated in Figure 1a. This arc is at least as well matched with an Imbrium-concentric pattern. The second ring is delineated by the northern Mare Frigoris shoreline and wrinkle ridges in Oceanus Procellarum and Tranquillitatis. Although Figure 1a indicates a possible concentric pattern, an equally valid Imbrium-centered pattern can be identified. It is important to point out that wrinkle ridges typically are deflected by local features. On a small scale, this is illustrated by ridge deflections in and around the Flamsteed Ring, Lamont, and Lambert R. On a broader scale, analogous deflections can account for the broad arcs of ridges ascribed by various workers to a mega-basin, particularly north of the Humorum basin. The outermost ring of the proposed nearside mega-basin corrresponds to the western edge of Oceanus Procellarum. Departures from a simple arc, however, are required to the north and to the southeast; the same point could be made for an Imbrium-centered pattern. Figure 1a also shows ridges uniquely concentric to the proposed Procellarum basin and not Imbrium. These residual patterns can be easily explained by altered stress directions by other basins (e.g., Insularum basin). Figure 1b also shows the nearside pattern of grabens and scarps radial to Imbrium (9) and reveals that certain ridge systems may be controlled by this radial pattern as well.

ANOTHER EXPLANATION: The existence of an Imbrium-centered concentric pattern of ridges outside the major basin rim appears contradictory to the often-quoted sequence of basin-interior compression and basin-exterior extension. Wrinkle ridges reflect not only compression by basin-centered basalt loading but also buried features, localized basalt accumulations, and volcanic vents. A broad-scale Imbrium-centered pattern of ridges beyond the Apennines indicates regions of basin-controlled basalt eruptions not subject to subsequent extension. The ponds of basalts encircling the mountain rings of Humorum and Crisium illustrate this process on a smaller scale. The Imbrium impact did not excavate material to these outer structural rings; nevertheless, the lithosphere responded to this event and subsequent igneous activity. Such an evolution can account for the distribution of basalts and ridges without the need for a mega-basin.

(1) Cadogan, P.H. (1974) Nature 250, 315-316; (2) Cadogan, P.H. (1975) in Lunar Science VI, 123-124; (3) Whitaker, E.A. (1981) in Multi-ring Basins, 105-111; (4) Wilhelms, D.E. (1982) NASA TM 85127, 111-113; (5) Wilhelms, D.E. (1983) Lunar and Planetary Science XIV, 845-846; (6) Wilhelms, D.E. and McCauley, J.F. (1971) U.S. Geol. Survey Misc. Geol. Inv. Map I-703; (7) Spudis, P.D. and Schultz, P.H. (1985) Lunar and Planetary Science XVI (this volume); (8) Guest, J.E. and Murray J. (1976) J. Geol. Soc. Lond. 132, 251-258; (9) Mason, J. et al.(1976) Proc. Geol. Assn London 87, 161-168; (10) Schultz, P.H. (1976) Moon Morphology, U. Texas Press, 621 p.; (11) Schultz, P.H. (1984) Lunar and Planetary Science XV, 728-729.

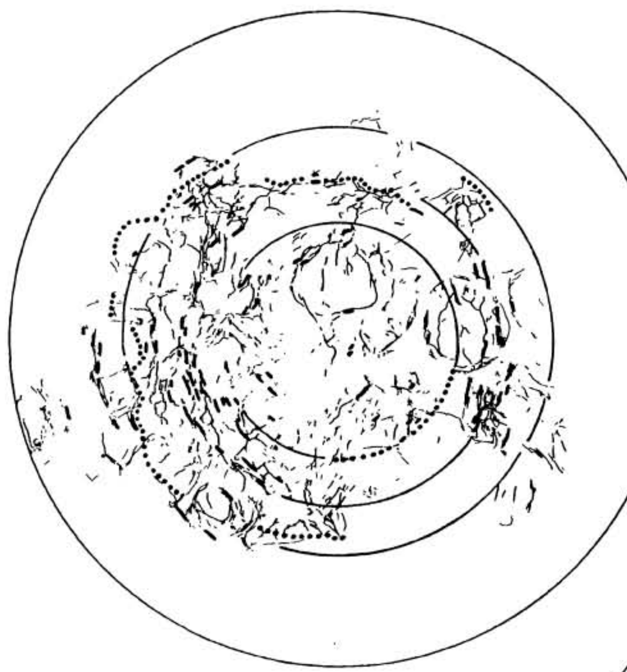

Figure 1a. Tectonic patterns (grabens and ridges) on the lunar nearside centered on the proposed Procellarum basin (23°N, 15°W). Dotted lines indicate major features used by Whitaker (3) to delineate the basin rings. Emphasized patterns indicate features concentric within ± 15° of this basin and not Imbrium.

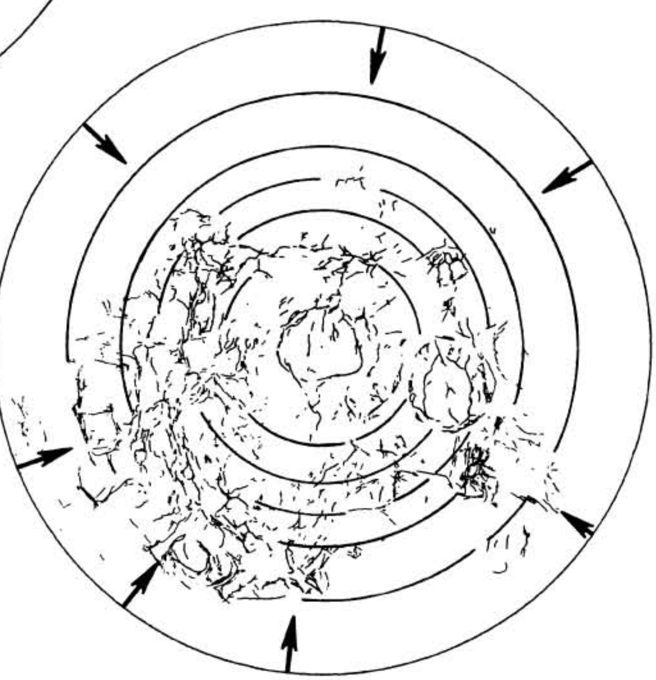

Figure 1b. Tectonic patterns centered on the Imbrium basin (37°N, 18°W). Radial and concentric trends centered on Imbrium provide an equally plausible control over nearside trends. Arrows identify major radial systems of grabens and ridges.