MARE RIDGES, TOPOGRAPHY, AND STRUCTURE IN SOUTHERN IMBRIUM AND NORTHERN PROCELLARUM, B. K. Lucchitta, U.S. Geological Survey, Flagstaff, Arizona 86001

The relationship of mare ridges to topography along the groundtrack of the Apollo 15 mission was investigated. The study was based on LTO orthophoto maps and Apollo 15 metric photographs. Among the ridges studied were dorsa Burnet and Whiston west of the Aristarchus Plateau; ridges near craters Krieger, Armström, Delisle, and Diophantes, dorsa Heim, Zirkel, Higazi and Grabau near crater Lambert, and ridges west of the Archimedes Plateau.

The following observations were made: Many mare ridges are composed of systems that are parallel, en echelon, offset laterally, or branching, and different segments of the systems may have different characteristics. Typical features of mare ridges are: 1) wrinkle ridges, 2) monoclinal flexures, scarps, or narrow, bulging, linear rises, here called "welts," associated with or underlying the wrinkle ridges, and 3) broad linear upwarps, parallel highs and lows, or other distortions of the mare surface, on which the mare ridges are superposed, commonly near the upper part of the slope.

The wrinkle ridges are up to 1 km wide and 100 m high, the welts are up to 6 km wide and 100 m to 200 m high, the parallel highs and lows have wavelength of 150 to 100 km and have a relief of about 200 m, linear upwarps are up to 25 km wide and may be as much as 500 m high, and other distortions are generally wider than 50 km. Only one ridge was recognized in a trough.

Among about 30 ridge segments studied about two thirds are located along a vertical offset in the level of the mare surface. The elevation differences are up to 400 m, but average around 100 m. The change in elevation occurs along scarps, monoclinal flexures, or welts and flexures combined. The association of many ridges with offsets strongly suggests that the ridges are of structural origin.

The ridges follow distinct trends, influenced by basin structures, buried craters, or the lunar grid (1, 2). Some are parallel to, or continuous with older grabens on the Aristarchus and Archimedes plateaus, and appear to be structures activated along older lines of weakness. Many are concentric to the Imbrium basin, but do not coincide with the basin rings as mapped by Wilhelms and McCauley (3). Most of the ridges trend across the regional slope. This slope has three main directions: 1) northeasterly into the Imbrium basin, 2) northerly from a high area extending from crater Prinz to crater Euler and coinciding with the Imbrium basin rim and three basin rings, and 3) northwesterly near the Aristarchus plateau. Most ridges, however, parallel more local highs and lows superposed on these regional slopes. The association of the ridges with these distortions of the mare surfaces further suggests structural origin.

The wrinkle-ridge part of the mare ridges is composed of steep segments arranged en echelon as overlapping curved or straight pieces. Wrinkle ridges tend to lie along the upper parts of scarps. They commonly occur near the top of monoclinal flexures, but in many places wander across monoclines and welts, and locally extend onto adjacent flat surfaces. In one place a wrinkle ridge continues uninterrupted across a lateral offset in the associated underlying welt, and in another place a wrinkle ridge extends from a monocline draped a buried crater rim across a flat area, to a monocline.
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forming a regional warp of the mare surface. Therefore, it appears that wrinkle ridges locally are only indirectly related to the warps or welts on which they are superposed, and may reflect a different and later stress field.

The ridges pre- and post-date the latest mare flooding in the area, as pointed out previously by Young et al. (4) and Schaber (5). The ridges serve as boundaries to flow units in some places, and buckle lava flows and superposed mare units of different ages in other places. They are both older and younger than rilles, and secondary craters from Aristarchus and Copernicus are superposed on them.

The observations are compatible to some extent with most hypotheses proposed for structural origin of mare ridges. The association of ridges with warps and distortions in the mare surface is compatible with isostatic adjustment as proposed by Bryan (6), Maxwell et al. (7) and Lucchitta (8) and agrees with Muehlberger’s (9) hypothesis of global shrinking. The location of mare ridges on slopes supports the hypothesis of overthrusting as a result of sliding on a decollement surface proposed by Howard and Muehlberger (10), and the en echelon arrangement of the wrinkle-ridges may be the result of shear (11) along rejuvenated older fractures. Mare ridges are common on Moon and Mars, and have counterparts on Mercury. It is possible that they are the result of several different subtle forces that act on planets over long periods of time and that leave a morphologic record only under conditions of billions of years of low internal and external activity.

REFERENCES