COMPARISON OF STRUCTURAL STYLE BETWEEN NORTHERN MARE TRANQUILLITATIS AND SOUTHERN MARE SERENITATIS. W.R. Muehlberger, Dept. of Geological Sciences, The University of Texas at Austin, Austin, TX 78712.

The sharp contrast in structural style between the older basalt of Mare Tranquillitatis and the younger basalt of Mare Serenitatis can now be quantified using the new 1:250,000 scale topographic map series. This analysis uses the assumption that the upper surface of the basalts was essentially horizontal when formed and that slopes now discernible are the results of later tectonic displacements. That this assumption is reasonable is shown by the general absence of flow margins (except for the Eratosthenian-age flows of the Imbrium basin; [1]) and the extremely low viscosity of lunar basalt [2]. These facts suggest flow thicknesses under 10 m and that each flow may be extremely widespread. Further, the 100 m contour interval of the topographic maps eliminates low-relief features associated with individual flow units so that average dips only can be determined. Initial dip direction but not amount can be determined where sinuous rilles are found.

Northern Mare Tranquillitatis has a thin cover of basalt, (most less than 500 m, [3]) that apparently acted as a passive, brittle cap to major block movements. These blocks have margins that trend generally northwest and northeast and whose lengths may be 100 kms or more and with the longer side trending northwest. These blocks have uniform slopes across the block and are tilted or offset relative to its neighbors. Thus the boundaries can be easily identified because all linear rilles occur on anticlinal bends between blocks, wrinkle ridges along synclinal bend boundaries and steep scarps along the offset boundaries.

Most of the tilting and relative displacements occurred before the eruption of the main surface basalts of Mare Serenitatis (pre - 3.2 b.y.) as shown by the remarkably flat surface of that unit which buried tilted and fractured Mare Tranquillitatis basalt. The bulk of this deformation must have occurred prior to the basalt that fills the gap between the mare basins (basalt near Dawes [4]; of Tranquillitatis-type). Fossa Cauchy, the major rille system, separates blocks whose surfaces dip 15 m/km north and 4 m/km south, for a total angular change in slope across the rille of 19 m/km (1°). The synclinal bends are similarly small angles, which probably accounts for the small size of the wrinkle ridges (anticlinal buckles) generated along them. Total structural relief across an individual block may be as much as 500 m, rare instances more.

The surface of Mare Serenitatis averages over 1.5 km below the level of the surrounding older Tranquillitatis Mare basalts. Further, if 1.5 km is a reasonable estimate of the thickness of the younger Serenitatis basalt, then the floor of Serenitatis
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(the upper surface of the older Tranquillitatis basalts) has subsided over 3.0 km below the present Tranquillitatis surface.

Deformation of Mare Serenitatis since the last basalt outpourings has been minimal (especially when compared to the earlier stages) and is restricted to minor faulting (along Dorsum Aldrovandi) and the formation of major wrinkle ridge - mare arch systems. The mare surface is remarkably planar. It is nearly level in the western part, but it has a slight southeastward tilt in the eastern part (1:10000). Superimposed on this plain are major, broad, high-relief wrinkle-ridge (mare ridge) systems that stand above the level of the plain. Linear rilles are absent except for those associated with the anticlinal bend of the monocline (buried fault?) underlying Dorsa Aldrovandi along the eastern margin of the basin and a small north-trending rille that lies farther south along the southern extension of this same structure. This small rille is the result of a slope change of only 7 m/km (0.40°), a remarkably small strain.

The wrinkle ridges in the younger mare fill of the southern Serenitatis basin are large by lunar standards, but are still small structures in comparison with terrestrial fold systems. They are as much as 10-15 km across, 350 m high and in 20-50 km long segments that, as nearly continuous or en echelon chains, extend for many hundreds of kilometers. These wrinkle ridges occupy a basin that has subsided relative to its rim by 3 km or more. This subsidence produces a maximum horizontal shortening of less than 0.2%, if we assume that all subsidence is post-extrusion of Serenitatis basalts. This assumption is clearly wrong as shown by the basalt stratigraphy of the region [5] and the deformational history relative to that stratigraphy [4]. Thus, subsidence can produce only a fraction of the shortening that is calculated from estimated shapes of wrinkle ridges (0.5%, [4]) or derived from more detailed shapes derived from Lunar Sounder Radar data (0.8%, [6]. The planar surface of Mare Serenitatis also prevents assuming any further horizontal shortening by allowing the center to sag relative to the margins. Thus, rationalizing the measured shortening that is a factor of from 5 to 8 greater than the calculated shortening by subsidence alone is the problem to be resolved. The only methods are by global cooling and/or a progressive slowing of rotation rates to produce the observed equatorial (latitudinal) compression [4].

The large size of the Serenitatis structures relative to those in Tranquillitatis must be a combination of a thicker foldable sequence in the Serenitatis basin, plus the addition of subsidence-related shortening to that generated by global cooling and/or decrease in rotation rate. Differential subsidence of the Serenitatis basin is shown by the nearly 0.5 km high scarp of Dorsum Aldrovandi, the topographic low area of the basin being at the southeast margin (opposite the Apollo 17 site) and the Dorsum Buckland-West Serenitatis scarp [7]. Dorsum Buckland,
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with its en echelon offsets, shows a differential horizontal component of slip as well as basin subsidence.