Evidence for Three Basins beneath Oceanus Procellarum C. J. Byrne, Image Again, Middletown, N. J.; charles.byrne@verizon.net

Theories of Formation: Oceanus Procellarum is the largest area of mare surface on the Moon. It is unusual not only because of its size but because of its shape, roughly in the form of an arc. There once was a consensus that Oceanus Procellarum flooded part of the floor of a great basin, first named the Gargantuan basin (Cadogan, 1974; Hawke and Head, 1977; Stuart-Alexander and Howard, 1970) and then the Procellarum basin (Wilhelms et.al., 1987). This theory was called into question with a proposal that flooding of an outer trough of the Imbrium multi-ringed basin formed Oceanus Procellarum (Spudis, 1993; Spudis, et al., 1988; Pike and Spudis, 1987).

Flooding of three basins: This paper suggests a third possible formation process; Oceanus Procellarum may have flooded three underlying basins that happened to form an arc. Examination of Clementine elevation data (USGS PIGWAD map) suggests that three basins underlying Oceanus Procellarum could explain both the flooding by lava and also certain plateaus projecting above the mare surface. Examination of Lunar Orbiter photographs revealed supporting evidence of radial ejecta patterns associated with two of these possible basins.

Clementine topographic data: Figure 1 shows a part of a Clementine topographic map showing Oceanus Procellarum. Note that there are three depressions (deeper blue areas on the map of Fig. 1) in the surface of Oceanus Procellarum, probably formed by the cooling of lava. Deeper lava would contract more in cooling. The characteristics of the proposed basins are summarized in Table 1.

Table 1.

Basin	Latitude	Longitude	Diameter
Lavoissier-Mairan	40 N	63 W	760 km.
Cardanus-	22 N	62 W	610 km.
Hermann-Flamsteed	2 S	50 W	360 km.

Because of the flooding of the proposed basins there is no evidence to indicate whether the circular bounds are major rings or outer rings.

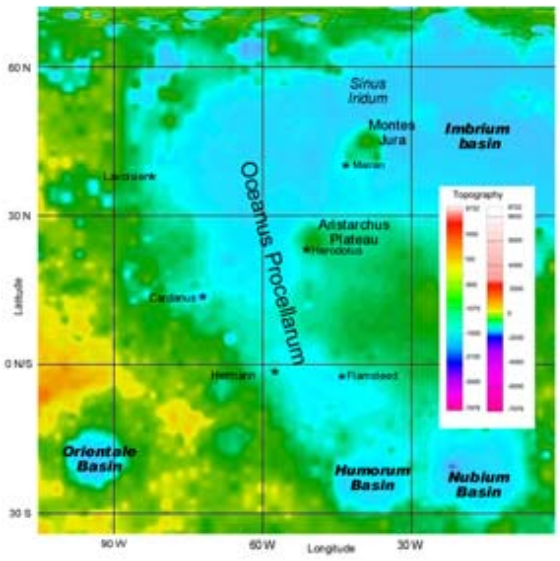

Figure 1: Base: Clementine topographic map (USGS PIGWAD). Within Oceanus Procellarum there are three circular depressions; a northern one between Lavoissier and Mairan, a central one between Cardanus and Herodotus, and a southern one between Hermann and Flamsteed.

Formation of plateaus: There are two plateaus (raised landforms) in or near Oceanus Procellarum:

- Plateau west of and including Montes Jura
- Aristarchus Plateau, west of the crater.

The Montes Jura plateau could result from the intersection of the main ring of the Imbrium basin (1160 km. in diameter), the rim of a crater underlying Sinus Iridum in the northwestern sector of Mare Imbrium, and a ring of the Lavoissier-Mairan basin.

The Aristarchus plateau could result from an intersection of an outer ring of the Imbrium basin (1700 km. in diameter), a ring of the Cardanus-

Herodotus basin, and a ring (same as that mentioned above) of the Lavoissier-Mairan basin.

Radial ejecta from the proposed basins: Much of the ejecta from the proposed basins would have been covered by later ejecta from the more recent Imbrium basin or by mare flooding. However, ejecta could be preserved in the highlands to the west. Figure 2 shows a photo of part of the region west of northern Oceanus Procellarum.

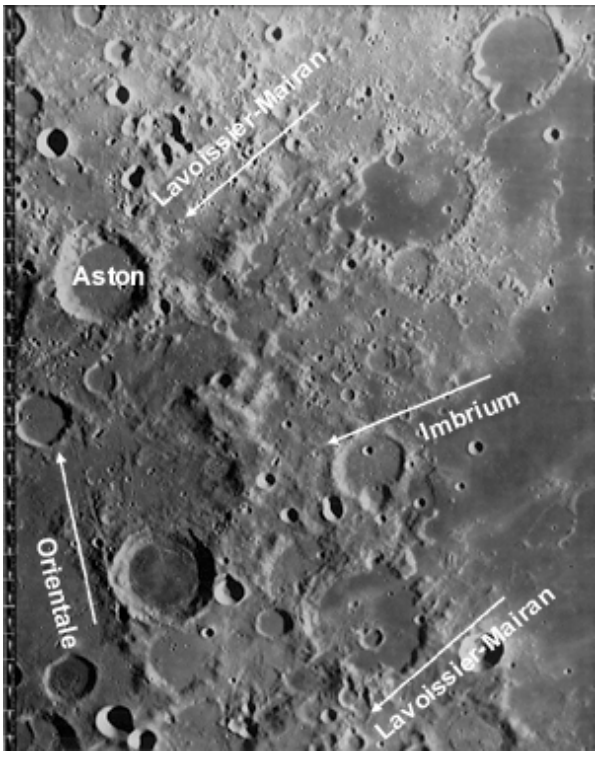

Figure 2: Base: LO4-189H1 (NASA; LPI; Byrne, 2002), showing ejecta striations associated with the proposed Lavoissier-Mairan basin.

Heavy, degraded ridges and troughs can be seen that align more closely with the center of the proposed Lavoissier-Mairan basin than with the center of the Imbrium basin. Striations that align well with the center of the proposed Hermann-Flamsteed basin can be seen in LO4-156H2.

Ejecta from the proposed Cardanus-Herodotus basin has not been identified. Perhaps it was the earliest basin and its ejecta has been degraded and obscured.

Sources of lava in Oceanus Procellarum: Gravity data from Clementine shows no significant anomalies (mascons) in the vicinity of Oceanus Procellarum. This indicates that there are no heavy plumes of mare-forming material that mark sources of lava flowing from beneath the proposed basins. Lava may have flowed into Oceanus Procellarum from mare in nearby basins that do exhibit gravitational anomalies. Specifically, Lavoissier-Mairan may have been flooded from Mare Imbrium and Cardonus-Herodotos from Lavoissier-Mairan in turn. Hermann-Flamsteed may have been flooded from Mare Humorum.

Discussion: Oceanus Procellarum could have been the result of lava flooding depressions of three pre-Imbrium basins within its bounds. The basin floors may have been depressed further by the second outer trough of the Imbrium basin as previously suggested, which would have facilitated flooding by lava from Imbrium.

References: Byrne, C.J., 2002, Automated Cosmetic Improvement of Mosaics from the Lunar Orbiter Atlas, LPSC 33, Abstract #1099, Lunar and Planetary Institute, Houston, Texas (CDROM); Cadogan, P.H., 1974, Oldest and Largest Lunar Basin? Nature, v. 250, no. 5464, p. 315-316; Hawke, B.R. and Head, J.W., 1977, Pre-Imbrian History of the Fra Mauro Region and Apollo 14 Sample Provenance, LPSC 8, v. 3, p. 2741-2761; Pike, R.J., and Spudis, P.D., 1987, Basin-ring Spacing on the Moon, Mercury, and Mars, Earth Moon and Planets 39, p. 129-194; Spudis, P.D., 1993, The Geology of Multi-Ring Impact Basins: The Moon and Other Planets, Cambridge University Press; Spudis, P.D., Hawke, B.R., and Lucey, P.G., 1988, Materials and formation of the Imbrium Basin, LPSC 18, Lunar Planetary Institute and Cambridge University Press, p. 155-168; Stuart-Alexander, D.E., and Howard, K.E., 1970, Lunar Maria and Circular Basins – a Review, Icarus, v. 12, no. 3, p. 440-456; USGS. Planetary GIS Web Server – PIGWAD 2003; Wilhelms, D.E., McCauley, J.F., and Trask, N.J., 1987, The Geologic History of the Moon, USGS Professional Paper 1348, US Government Printing Office, Washington.