EVIDENCE FOR A PRE-NECTARIAN IMPACT BASIN IN NORTHWESTERN OCEANUS PROCELLARUM, **Alfred McEwen, Philip Davis, and Annie Howington-Kraus, U.S. Geological Survey, Flagstaff, AZ 86001, and Merton Davies, RAND Corp., Santa Monica, CA 90407.**

SUMMARY: The unified lunar control network [1,2] shows a large topographic low in the region of northwestern Oceanus Procellarum. This basin (here called the NW Procellarum basin) is almost entirely filled by mare lavas, whose surface is about 1734 km from the Moon's center of mass, 4 km below the global average. The basin has a diameter of about 700 km, comparable to that of the Serenitatis basin. Topography and partly flooded craters suggest that the mare lavas are more than 1 km deep. Craters of probable Nectarian age are superposed on the basin rim, suggesting that its age is pre-Nectarian. The Rumker and Mairan volcanic domes may be related to basin structures.

TOPOGRAPHIC DATA: Topographic and crustal-thickness lows in NW Procellarum are present in the maps of Bills and Ferrari [3]. Recently, we compiled a dataset of lunar altimetry in preparation for the Clementine mission. The data consist of Apollo 15-17 laser altimetry [4] and interpolated control points from telescopic observations [5], Mariner 10 [1,2], Apollo 15-17 metric cameras [6], and Zond-8 [7]. The dataset covers about 65% of the lunar surface. Davies et al. [2] recently updated the control net by (1) remeasuring the Mariner 10 points; (2) adding points on the far side from Lunar Orbiter [8], which were also identified in Apollo or Galileo images; and (3) recomputing the coordinates of points north of the Apollo region from Galileo images acquired during the second Earth-Moon flyby. The NW Procellarum basin is the only major topographic low in our altimetry compilation that is not within a previously postulated impact basin other than the Procellarum or Gargantuan basins. Davies et al. [2] measurements near the basin are shown on Figure 1. The basin is also apparent in the 1:2,000,000-scale nearside topographic map prepared by the Army Map Service (AMS) in 1963 [9], although the vertical and planimetric precision is suspect. We are in the process of digitizing the AMS map, so that it can be warped to match the unified control network.

DEPTH OF MARE FILL AND BASIN AGE ASSIGNMENT: Topographic data and geologic relations suggest that the mare fill in NW Procellarum is more than 1 km thick. Where topographic and mare thickness data are available for the Moon, thick lenses of basalt all occur in deep topographic lows [10]. There are no partly flooded craters in the NW Procellarum basin except near the margins. Imbrium basin materials overlie this entire region, so the basin must be pre-Imbrian. Typical Nectarian terrains contain a dozen or more craters larger than 100 km in diameter within an area the size of NW Procellarum basin. Mare lava must be more than 1.2 km thick to cover the rim of a 100-km-diameter crater with pristine depth-to-diameter dimensions [10]. Simulated floodings of impact basins suggest that actual lava thicknesses may be about twice that estimated from partially flooded craters [11]. The 125-km-diameter crater Repsold C, located near the northwest margin of the basin (latitude 48° N, longitude 73.5° W) is completely flooded in its interior, and lavas cover the southeast half of its rim. According to the technique of De Hon [10], this indicates that the southeast half is buried under at least 1.25 km of mare lava. The northwest half is near the mare-highlands boundary, so this crater probably lies on the rim of the topographic basin. Several other large craters in this region (Sinus Roris) have south and/or east rims that are partially buried; all are considered of possible Nectarian age [12], suggesting that the NW Procellarum basin is older Nectarian or pre-Nectarian. If isostatic compensation has not taken place in response to the basalt emplacement, then the original basin must have been at least 1 km deeper than the present one. Its total relief was probably at least 4 km, comparable with the relief of other lunar impact basins. There are only weak positive gravity anomalies over NW Procellarum [13], suggesting that there is either less mare fill or greater isostatic compensation than in the pronounced mascons (Imbrium, Serenitatis, Crisium, and Nectaris).

PROBABLE IMPACT ORIGIN OF NW PROCELLARUM BASIN: The NW Procellarum basin is probably of impact origin, even though rings around or within the basin are not obvious in the best available images (Lunar Orbiter IV low-sun images at 50-100 m/pixel resolution). However, impact is the only process known to create large topographic depressions on the Moon. Also, the basin is roughly circular (irregularities are probably due to Imbrium ejecta). If the basin is older Nectarian or pre-Nectarian, then many large impact craters such as those apparent on the western and northern margins would have largely obliterated the ring structure on the surface. Other pre-Nectarian basins, such as Mare Australe, also have very poorly defined

rings, and even the Imbrium rings are poorly defined or absent over large sections due to burial by thick mare flows. Furthermore, some ring structures of NW Procellarum may be tentatively identified. An outer ring (Figure 1) may be marked by asymmetrical crater walls near the western margin (cf. LO IV-175-M), mare ridges and a massif west of crater Lichtenberg to the southwest, and the Mairan domes and three source craters for sinuous rilles to the east [14]. A buried inner ring may be marked by a 200-km-diameter circular pattern of wrinkle ridges and the Rumker hills (cf. LO IV-170-H2).

RUMKER HILLS AND MAIRAN DOMES: The Rumker hills and Mairan domes occur within the NW Procellarum basin (Fig. 1); they were perhaps localized by the basin structure. The Mairan domes, which may consist of more viscous lavas than typical mare basalts [15], lie near the basin's margin. The Rumker hills complex, which consists of a polygonal plateau covered by low domes [15], lies along mare ridges that form a circular pattern, perhaps over a buried inner ring. Wilhelms [12] showed an irregular (noncircular) outer Imbrium ring passing through the Rumker hills, but the ring is poorly defined over this region. The intersection of Imbrium and NW Procellarum rings could be related to the uplifted block of the Rumker hills, similar to the uplifted block at the Imbrium-Serenitatis ring intersection [16].

RELATION TO POSTULATED PROCELLARUM BASIN: The NW Procellarum basin (and indeed nearly all nearside maria) is within the hypothetical Procellarum basin [17], and several features ascribed here to the NW Procellarum basin have been attributed to the big Procellarum basin [12]. However, the big Procellarum basin is thought to have experienced significant viscous relaxation, which would account for the lack of topographic expression over most of its postulated extent. Topographic relief of up to 4 km in NW Procellarum is not consistent with significant viscous relaxation. Therefore, the identification of the NW Procellarum basin diminishes some of the evidence for the Procellarum basin.

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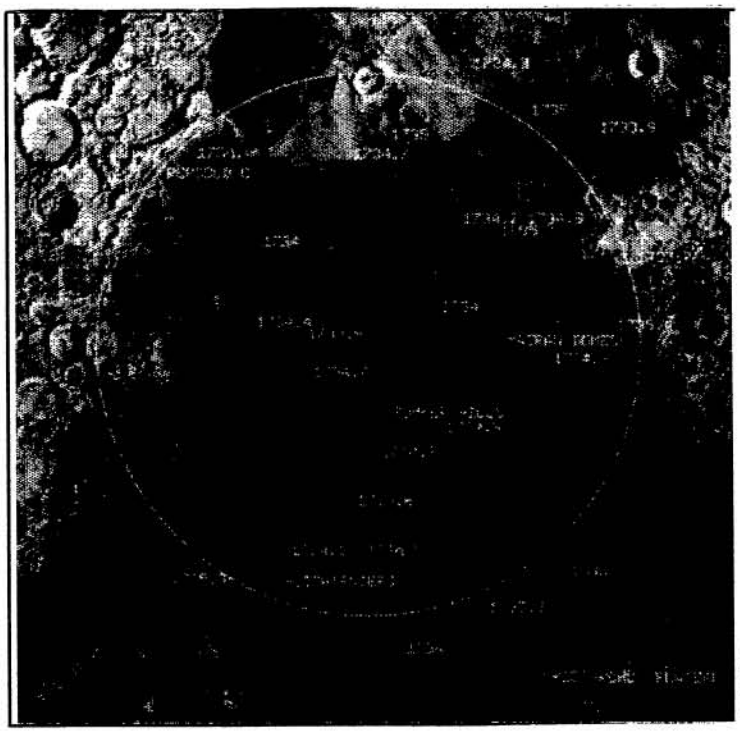

Figure 1. Lunar airbrush map reprojected to Orthographic projection, centered on latitude +42 degrees, longitude 62.5 degrees west, the approximate center of the NW Procellarum basin. Circle of 700 km diameter shows possible basin ring. Lunar radii [2] in kilometers are shown.