THE TOPOGRAPHY OF THE LUNAR POLES FROM DIGITAL STEREO ANALYSIS. A. C. Cook[1], P. D. Spudis[2], M. S. Robinson[3], T. R. Watters[1,] and D. B. J. Bussey[3], [1]Center for Earth and Planetary Studies, National Air and Space Museum, Washington D.C., 20560-315; [2]Lunar and Planetary Institute, Houston, TX 77058; [3]Department of Geological Sciences, Northwestern University, Evanston, IL 60208; [3]ESA/ESTEC, Nordwijk, The Netherlands.

Introduction: Digital Elevation Models (DEMs) of the lunar terrain, pole-ward of ±60° in latitude, have been produced using an automated digital stereo matcher. The absolute height topography for these entire areas has not been mapped previously at 1km/pixel. A preliminary summary of some notable topographic features contained here is presented, including the discovery of two previously unknown basins.

Method: The Clementine spacecraft captured approximately one million, mostly nadir pointing, UVVIS images of the lunar surface from a polar orbit [1,2]. The overlap between adjacent along-track images contains sufficient angular parallax to resolve topography [3] using automated digital stereo analysis [4,5]. Each adjacent along track stereo pair was stereo matched and the set of matched points fed through a stereo intersection camera model, using nominal camera position and orientation data. A collection of longitude, latitude, (relative) height points, or a digital terrain model (DTM), was generated for each stereo pair. These were fitted to absolute height Clementine laser altimeter points [6] or iteratively to previously fitted neighboring DTM tiles. Finally the DTM tile points were binned into 1km pixels inside a polar stereographic map projection. The topographic datum used for this work was a 1738km radius sphere.

Results: North Pole: The elevation at 90ºN is –1.4km and the surrounds are relatively flat (–0.7±1.4km elevation out to a radius of 300km), containing many small craterlets. However a topographic high (>+4km) occurs just 180km from the pole on the rim of the crater Plaskett.

A newly discovered impact basin has been found at 45°E, 83°N, and will be referred to as the "Sylvester-Nansen Basin". It is highly eroded and heavily obscured by younger craters, making it invisible on the USGS Clementine image mosaics. The center of the basin is visible in the prospector gravity data [7]. The Sylvester-Nansen basin has an obvious ring of 400km in diameter, a ring width of approximately 80km, and a ring elevation above exterior terrain of approximately 1km. A geological map of the area [8] shows craters (e.g. Peary, Byrd, Hermite, and Nansen) contained within the basin region with pNc (material of highly subdued craters) rims; therefore the basin is Pre-Nectarian.

Other notable topographic features include: a) A graben between Sylvester and Brianchon-Pascal which is 0.5km deep. b) A graben running north-south across the floor of Hayn (83°E, 65°N) – this bisects the 1km high central peaks. c) Craters on the near-side such as, Meton, Barrow, and Goldschmidt, contain rim topography which show clear evidence of lineated troughs which are associated with the Imbrium basin [8]. There are other associated prominent scour marks elsewhere too e.g. 14ºW, 80ºN. e) the northern half of the floor of Nansen is covered with a 1.3km thick deposit which Lucchitta [8] gives as Nectarian age (Nbl) lineated basin material, presumably from the Humboldtianum basin. The boundary of this material appears to lie on a lineament running 300km from just north east of de Sitter to the east edge of Nansen.

Results: South Pole: In contrast to the relatively flat north pole, the terrain near the south is rugged (–4.0±2.5km elevation out to a radius of 300km) out to a radius of 300km) due to the presence of the South Pole-Aitken (SPA) Basin and its associated ring structures [9]. Elevations of +4km elevations are not uncommon here, as are depths of –8km.

A newly discovered impact basin has been found (165°W, 81S°) and is here referred to as the "Schrödinger-Zeeman" basin. It is just visible in the USGS Clementine mosaic [10] and can also be seen in the Prospector gravity data [7]. Wilhelms et al. [11] show this area as being overlayed by Nectarian Nbl basin lineated material, and is interpreted as: a basin deposit corresponding to the Hevelius formation, basin ejecta from the Orientale basin, which is Imbrian in age. Therefore the Schrödinger-Zeeman basin must be Nectarian or older. The basin has a well-preserved double ring structure of diameters: 150km and 250km respectively. The interior floor has an elevation of –7.4km, and the maximum height on the northern part of the inner ring is –3.5km. The width of the inner ring is 30km, the outer ring is less intact and varies from 10-20km in width.

Other notable features include: a) Topographically well defined rilles [10] on the floor of the Schrödinger basin. b) A volcanic vent [10] stands 0.5km above the floor of Schrödinger. c) The interior mountain ring in Schrödinger attains a height of 2.5 km above the floor. d) A 120 km diameter ring structure, located on the south west floor of Schrödinger, is visible in a slope map of the area. e) Nearby Rima Schrödinger and Rima Planck, both appear to have raised rims and to consist of many joined craters. f) Material from pre-Nectarian Drygalski crater appears to have collapsed onto the floor of an older intersecting crater to the west, and formed a deposit at least 1.4km thick. g) Two rings of the SPA basin can be seen. These lie mostly along the dashed lines on the Wilhelms [11] map on the western hemisphere, but in the east the outer ring appears to curve 200km closer to the western edge of Schrödinger than on the map. Also there is a scattering of high terrain in the vicinity of Simpelius that could be associated with the SPA, or the Muttus-Vlacq basin [11] further to the north. h) The height of the rim of the Shackleton crater attains –3.5km in elevation, and so is quite low, but so too is much of the surrounding terrain, apart from a few nearby peaks, hence it can be illuminated for much of the time [12]. i) We see no noticeable evidence in the topography to suggest that a 300km diameter basin [10] is present at the south pole.

Discussion: Our DEMs cover regions that lie beyond the ±75° latitude cut-off of the Clementine laser altimeter. The DEMs are also at a much finer spatial resolution than was obtained by the altimeter, and reveal topography which is not always apparent in spacecraft imagery due to the restrictions of lighting conditions. We have been able to characterize several topographic features in the polar areas, and have discovered two previously unknown basins. At least one of these basins is Pre-nectarian, therefore this increases the number of known pre-Nectarian basins [13,9] by 3% (or 6%). The observation of the raised rimmed craterlets making up Rima Schrödinger and Rima Planck supports the model that their origin is caused by scour marks from secondary ejecta escaping at shallow angles from Schrodinger. However it does not explain why these are non-radial, although there are other examples where this occurs e.g. Rima Stadius near Copernicus.

Experiments are under way to assess the DEMs by: a) modeling limb profiles and comparing with grazing occultation tracks, b) computing shadow lengths and comparing to observational images, c) comparisons to published Earth based radar interferometry results [14].

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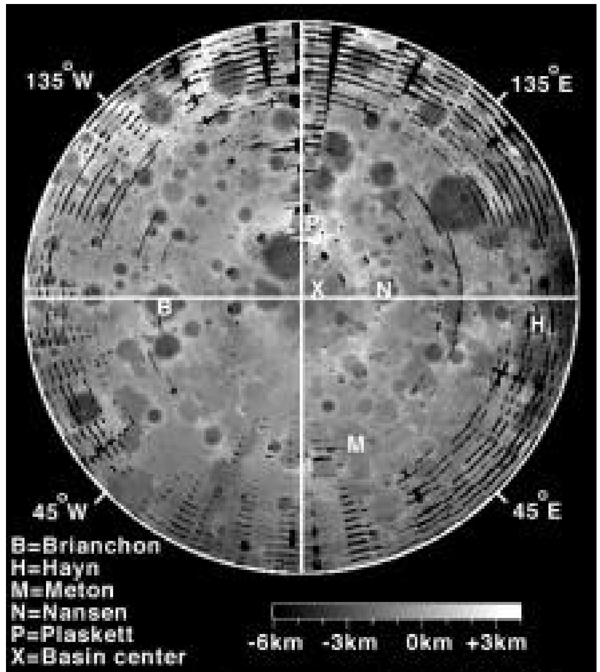

Fig. 1 North pole grey-scale DEM (60°N-90°N)

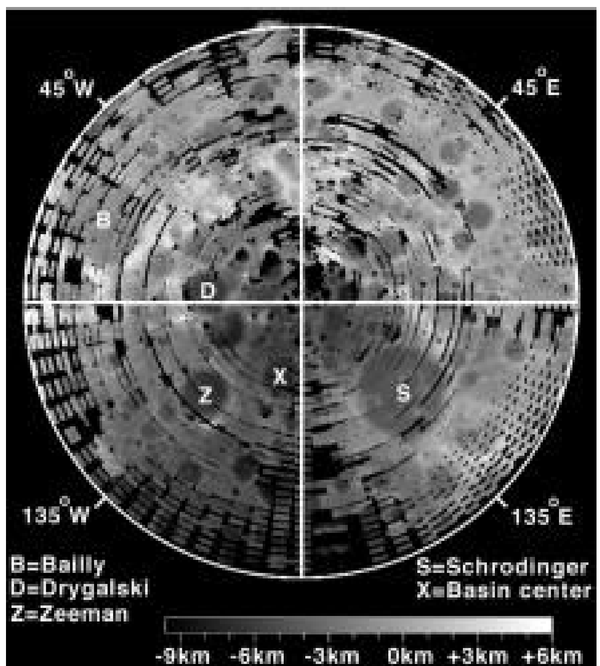

Fig. 2 South pole grey-scale DEM (90°S-60°S)