Lunar Section
British Astronomical Association
Director: Bill Leatherbarrow

LUNAR SECTION CIRCULAR

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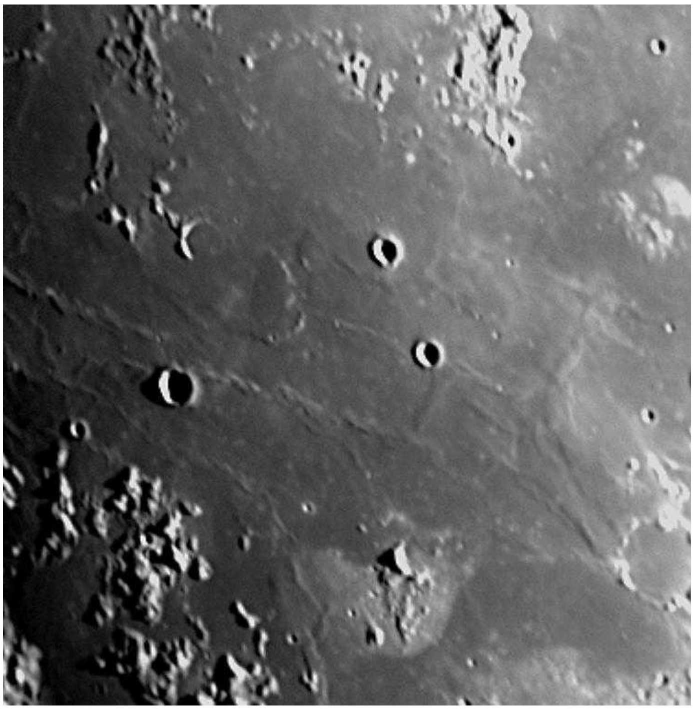
FROM THE DIRECTOR

After months of seemingly interminable cloud and rain over the UK (and much of Europe) February brought some welcome, albeit temporary, relief with a few good clear nights early in the month and the Moon high in the sky. As a result we have received many excellent submissions from observers, so in order to maximise space for these I shall keep my introductory comments to a minimum this month.

Lars Lindhard has written in drawing attention to an interesting cluster of features to the north of the 'Helmet' feature on the Oceanus Procellarum, in the triangle made up by the three small craters Herigonius, Norman and Euclides C (coordinates approximately 32°W, 13°S).



Lars comments on a rectangular set of ridges located between Herigonius and Euclides C, which appears to be part of the Dorsa Ewing system. Euclides C sits at the 'top-right corner' of the rectangle. At the 'top-left corner' there is a strange pancake-like feature that Lars describes as resembling '*a round disc that has a crack in the middle - just in the diameter - so the sides appear to bend slightly up*'.

I am not sure what this feature is, although it could simply be a partial ghost crater or localized upswelling. Or it could also be part of the Dorsa Ewing system. The features described are visible only under low illumination.

I have not yet had time to investigate this further, but I wonder if our Section geologists might care to comment?

Finally, I understand from Bob Garfinkle, our Section Historical Consultant, that his three-volume magnum opus *Luna Cognita* has now been published by Springer Books and should be available for purchase soon. Congratulations, Bob – we look forward to reading it! Further details are available on the Springer website.

Bill Leatherbarrow

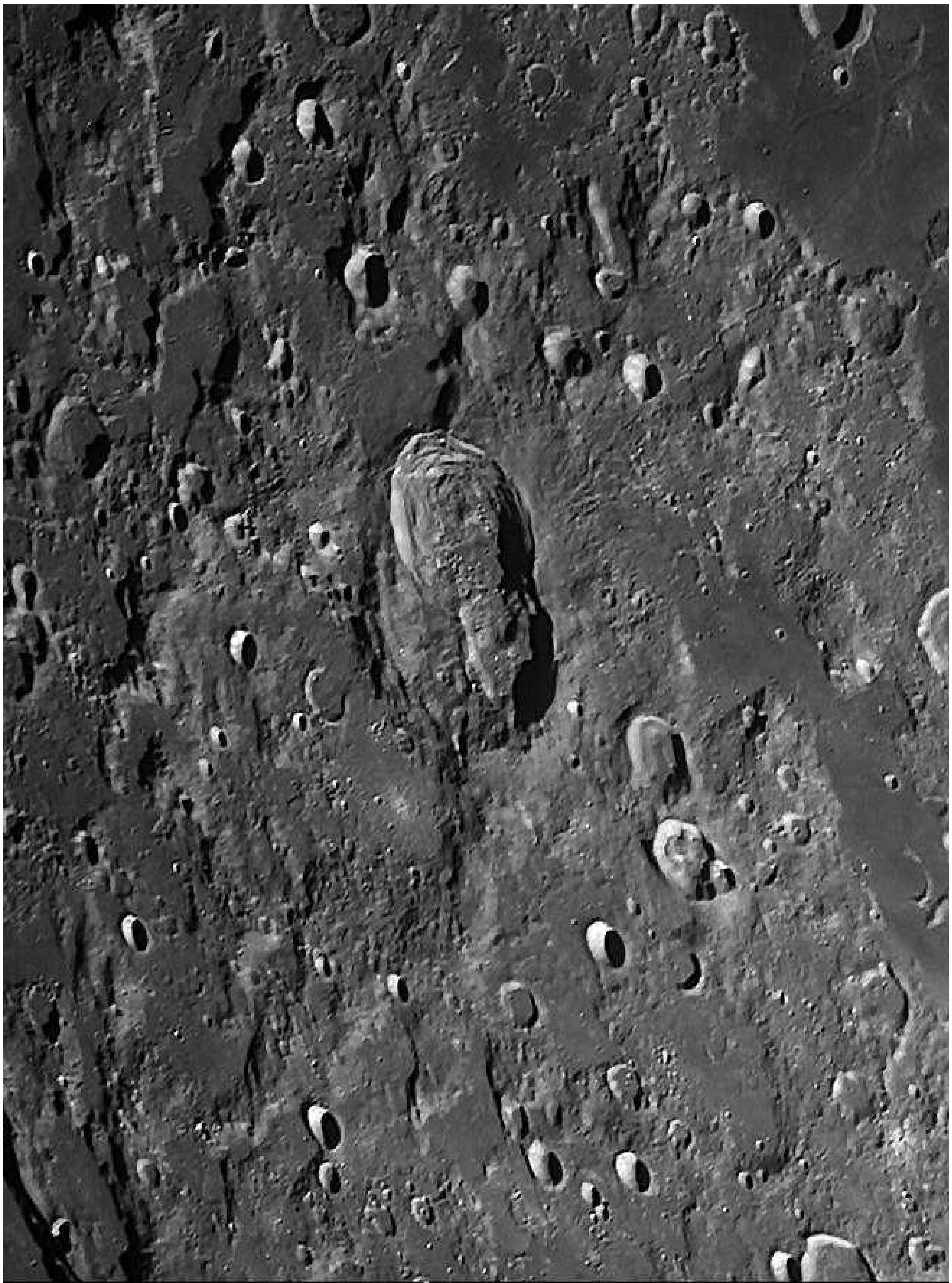
OBSERVATIONS RECEIVED

Images or drawings have been received from the following observers: Leo Aerts (Belgium), Maurice Collins (New Zealand), Dave Finnigan, Clyde Foster (South Africa), Massimo Giuntoli (Italy), Rik Hill (USA), Ken Kennedy, Lars Lindhard, Phil Masding, Bob Stuart, Alexander Vandenbohede (Belgium), and the Director.

It is good to see that UK and European observers have enjoyed some clear nights and reasonable seeing. A selection of images received is offered below.

IMAGES GALLERY

Bob Stuart acquired an excellent series of images during good conditions on the evenings of 5 and 6 February 2020, with the better seeing on the 5th.



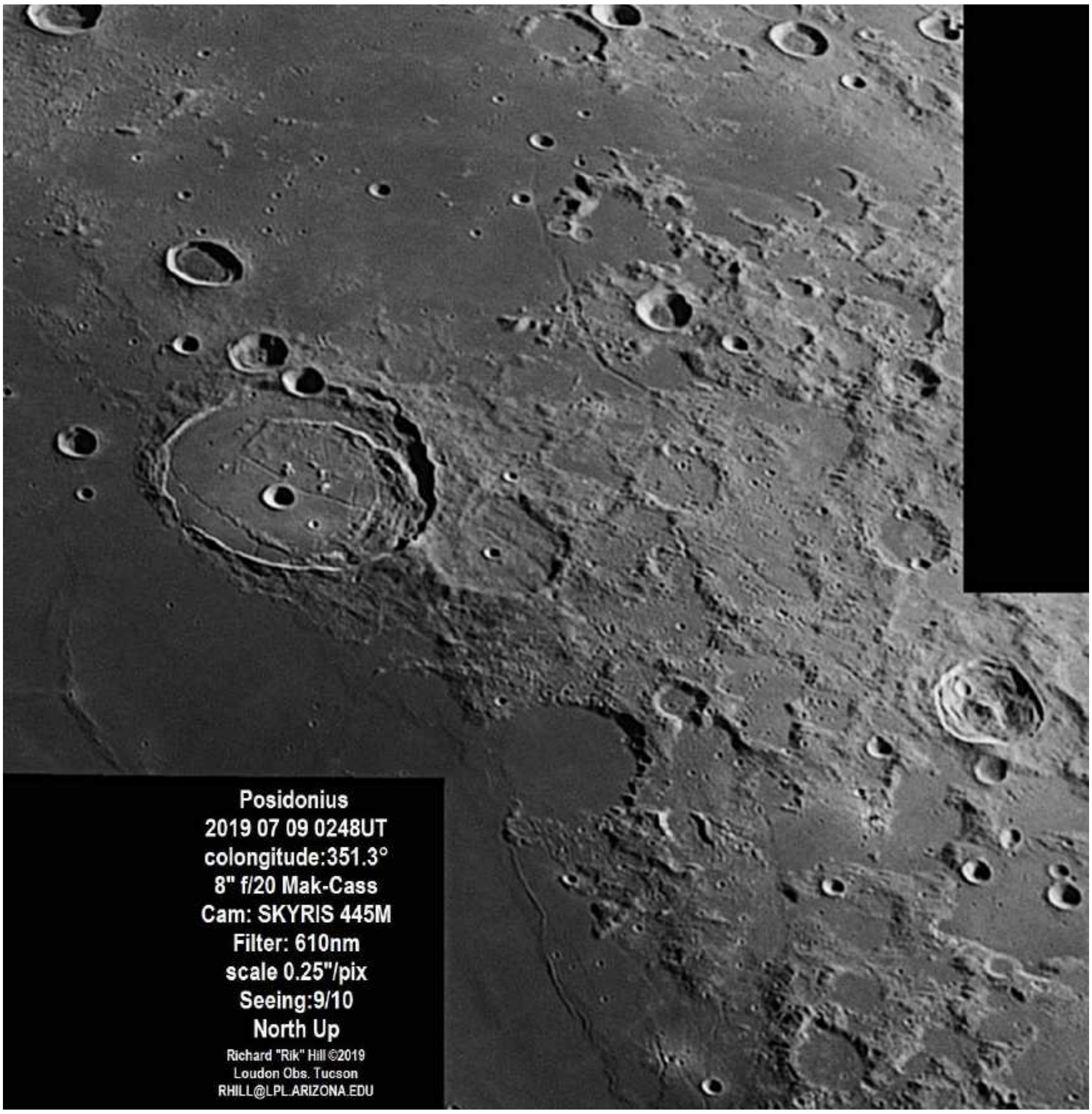
Bob Stuart
Hainzel
05/02/2020 19:43 UT
25cm f6.3 Newtonian
ZWOI 174MM camera
500nmBaader green filter
3xPowerMate

Dave Finnigan also enjoyed good conditions in early February, and we reproduce below two of his images.

Kies, Kies π 2020.02.03 20:47 UT, S Col. 27.3°, seeing 5/10, transparency fair. Libration: latitude +4º09', longitude -07º11'
305mm Meade LX200 ACF, f 25, ZWO ASI 120MMS camera, Baader IR pass filter: 685nm.
640 frames processed in Registax 6 and Paintshop Pro 8.
Dave Finnigan, Halesowen

Letronne 2020.02.05 19:15 UT, S Col. 51.0°, seeing 5/10, transparency fair.
Libration: latitude +1º022', longitude -06º57'
305mm Meade LX200 ACF, f 25, ZWO ASI 120MMS camera, Baader IR pass filter: 685nm.
640 frames processed in Registax 6 and Paintshop Pro 8.
Dave Finnigan, Halesowen

Rik Hill offers an image from last year of the crater Posidonius, along with descriptive notes.



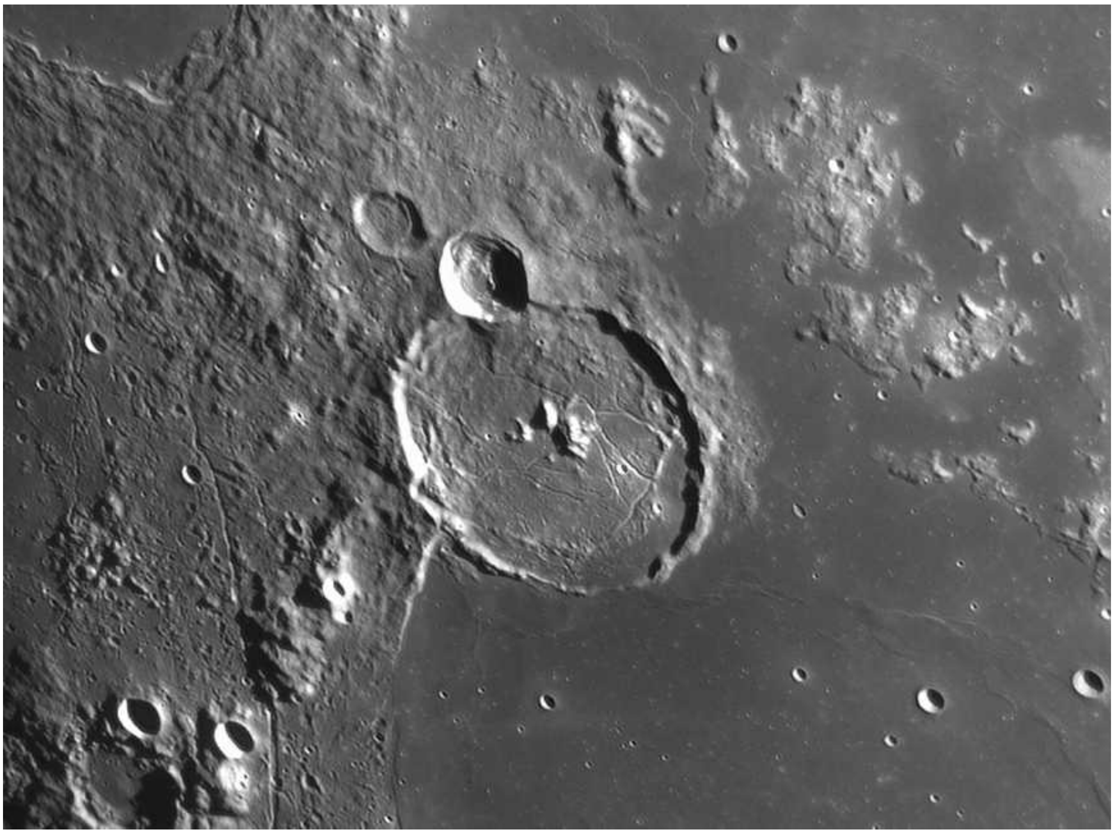
'The great 99km diameter crater Posidonius dominates this image with its system of interior rimae and the curious mountainous ridge on the east side (right side) of the crater floor. There is no central peak but there is an interesting ring of small peaks on the floor near center. The mountains are thought to be a possible wall of a near concentric crater that once existed here. They curve around to the south and then up the other side along the large rima on the east side. This makes that rima easier to spot. Southeast and adjacent to Posidonius is the older and hence more weathered crater Chacornac (53km dia.). It has three rimae running southeast through it and two of them extend beyond the crater down to a crater that has become and bay on the shores of Mare Serenitatis to the west (left). This bay is Le Monnier (63km) and quite an attractive feature for study. Leading south from the lower promontory of this bay is a nice thin delicate wrinkle ridge, Dorsa Aldovandri. There are three craters north of Posidonius the largest of which is Daniell (31km). It lies in Lacus Somnorium.

East of Daniell and Posidonius is a large rima, Rima G. Bond (155km long) and just beyond it is the crater G.Bond (32km). This rima is a graben-type rima where the central portion has dropped below the outer portions as a block, clearly seen here and different than the thin faults in Chacornac. Above G.Bond is a broken ring of mountains that is Hall (41km) the last remnants of an old crater. Way south on the east edge (right) of this image is the very clear oddly shaped crater, Romer (41km) with its very nice system Rimae Romer just to the west of it running 114km almost all the way to Rima G. Bond. Lots of cracks to see in this morning landscape!'

Alexander Vandenbohede has again used the LVTV software to create a rectified image of the area around Petavius, made on 12 January 2020 using a Celestron C8 with 1.5x barlow and ASI290MM in prime focus. Seeing was not good but fair. He writes: 'The images shows the area around Petavius. The complete crater is filled with shadow; only parts of the central peak complex sit as an island surrounded with darkness. The highest point is about 3 km above the crater floor. South of Petavius, it is interesting to compare the battered Snellius with the more pristine Stevinus, partly on the image. West of Snellius, there is the inconspicuous Vallis Snellius. West of Petavius B, there is a swelling of the mare floor which looks like a dome. However, it is not in a known domes list such as the Lena book and it is not obvious from the GLD100 elevation model.'

A further selection of members' images follows, starting with **Leo Aerts**' image of Rümker, taken with a 250mm SCT on 6 February 2020.

Phil Masding captured the Gassendi rilles in good seeing on 5 February 2020, at 22.00 UT, using a 250mm SCT.



Ken Kennedy used a 200mm SCT to image the Aristarchus Plateau on the evening of 6 February 2020.

LUNAR DOMES (part XXXV): A putative intrusive dome in Mare Vaporum near crater Marco Polo T Raffaello Lena and KC Pau

To illustrate the mechanism of the intrusion of a magmatic body, Pau has imaged the Mare Vaporum under oblique solar illumination (Fig. 1). Further images of this region display an elongated and large feature near Marco Polo T crater, which is named Marco Polo MD2 (Figs 1- 2). It lies at coordinates of 12.38° N and 0.43° E. As very low solar illumination angles are required to reveal the gentle slopes of lunar domes and raised soil, some of these subtle structures are not prominent in space probe imagery as in the telescopic CCD image shown in Figs 1-2.

The rilles on the summit, detectable in WAC imagery (Fig. 3), are interpreted as fractural features that may occur as a result of the flexural uplift. If an igneous intrusion occurred in this region, related to a magmatic body rising near the surface, an elevated terrain should be visible and the images of Fig. 1 and 2 confirm the presence of a raised soil. Nevertheless it explains what happens when a magmatic intrusion occurs.

The cross-sectional profile based on LOLA DEM dataset confirms the 'visual appearance' of a raised surface (Fig. 4) with an elevation of 95m±10m and a very low slope of 0.5°±0.05° considering the base diameter of ~26km.

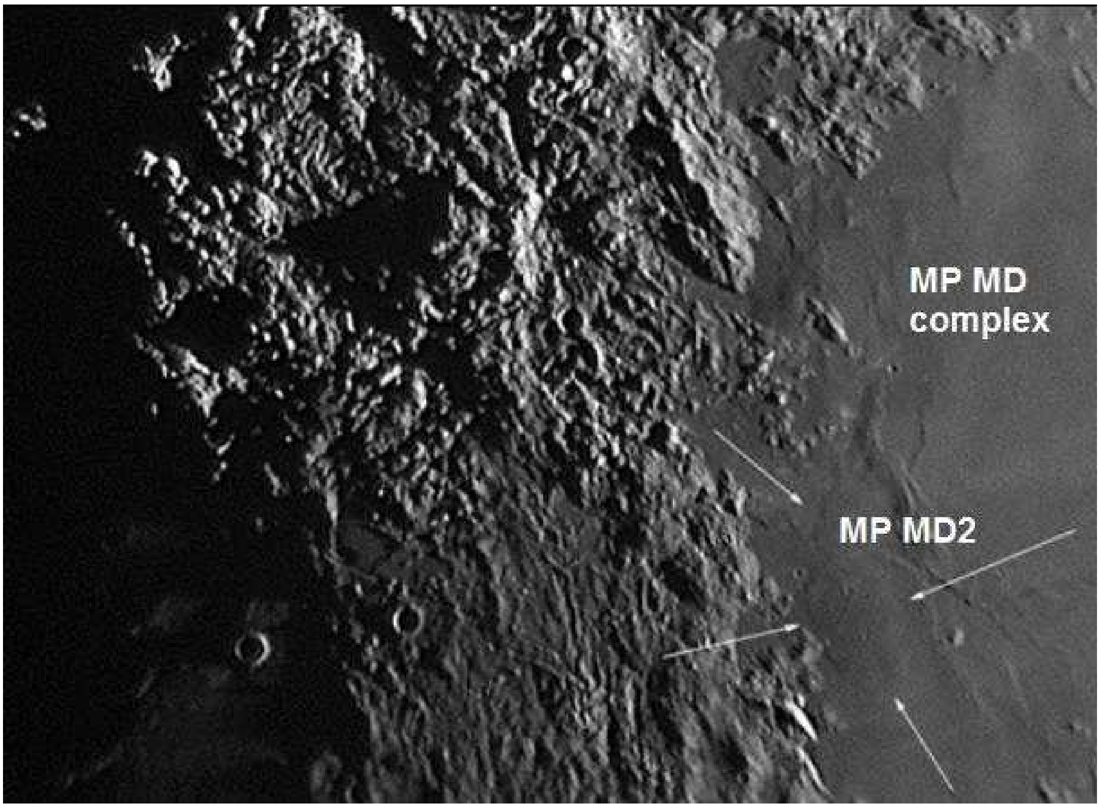


Figure 1: The large dome (MP MD2) examined in the current study imaged by Pau on January 3, 2020 at 12:01 UT using a 250mm f/6 Newtonian, 20mm eyepiece and QHYCCD290M camera. In the image is shown another megadome (MP MD complex) previously examined by Lena and FitzGerald [6-7].

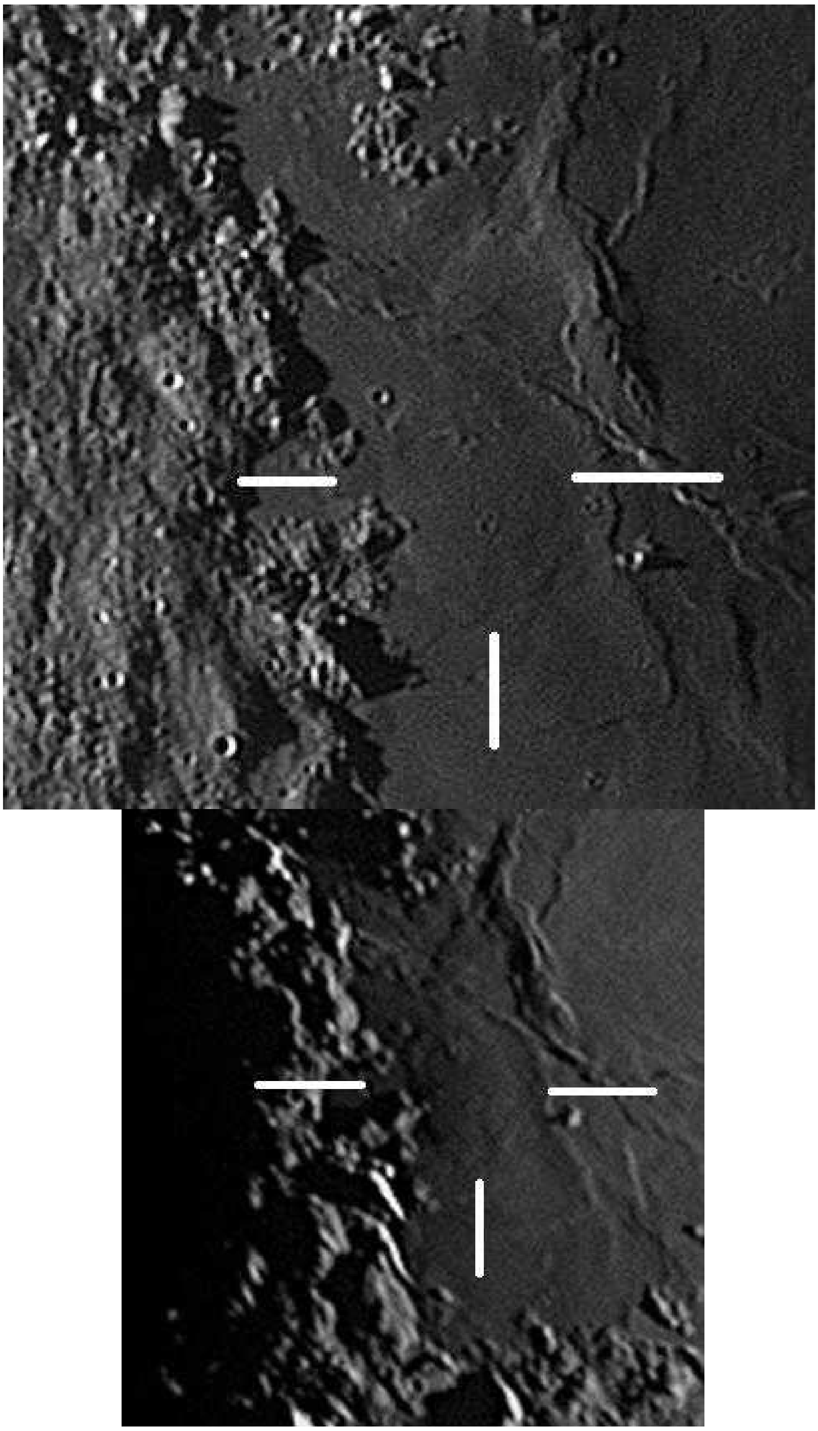


Figure 2: The large dome examined in the current study imaged by Pau. Top image taken on October 1, 2018 at 21:25 UT, using a 250mm f/6 Newtonian, 2.5X barlow. Bottom image taken on December 4, 2019 at 12:05 UT using a 250mm f/6 Newtonian at prime focus.

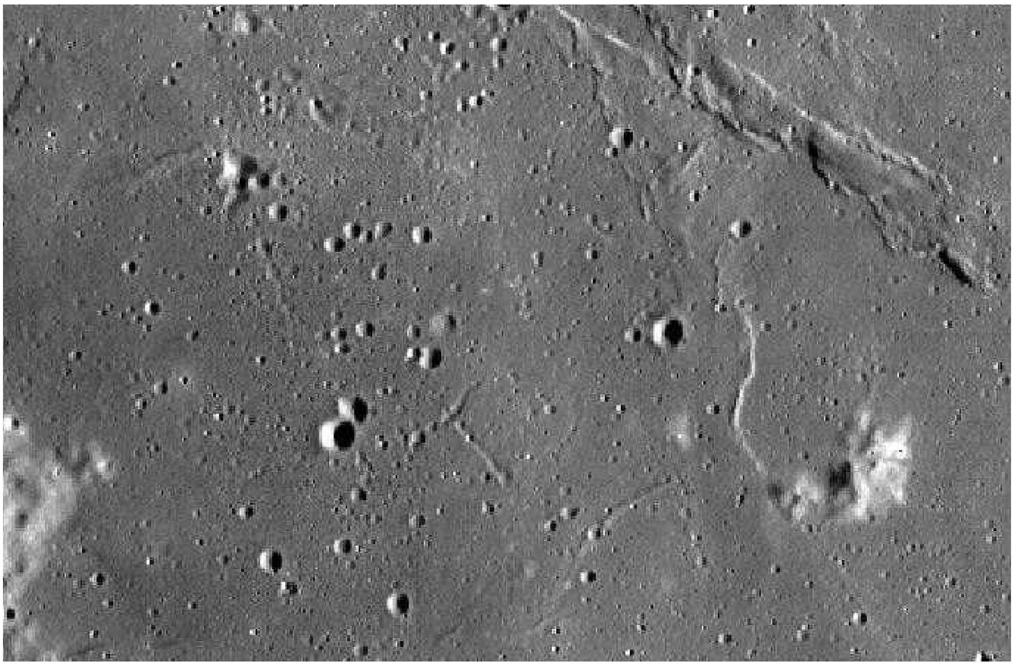


Figure 3: WAC imagery of the examined dome named Marco Polo MD2 extracted from ACT react quick map in cylindrical projection. Some linear rilles are detectable on the summit.

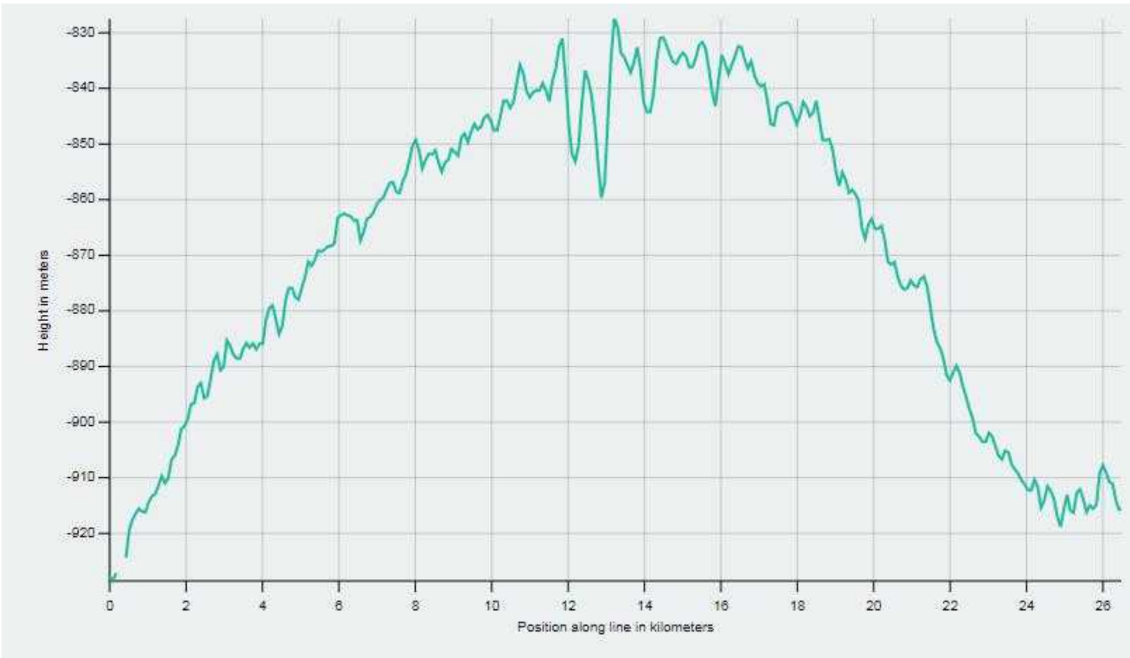


Figure 4: Sectional profile of the dome.

The dome volume V is estimated by assuming a form factor of f = 1/2, which yields an edifice volume of about 27km³. A 3D reconstruction in East-West direction derived by photoclinometry and shape from shading analysis of the examined dome is shown in Fig. 5. The large dome named Marco Polo MD2 belongs to class In1 of putative intrusive domes and this interpretation is supported by its large diameter, very low flank slope, elongated shape and the presence of straight rilles and faults on its surface [1-5].

It is characterised by uppermost basaltic layer thicknesses of 0.3km, intrusion depth of 2.2km and magma pressures of 16.5MPa.

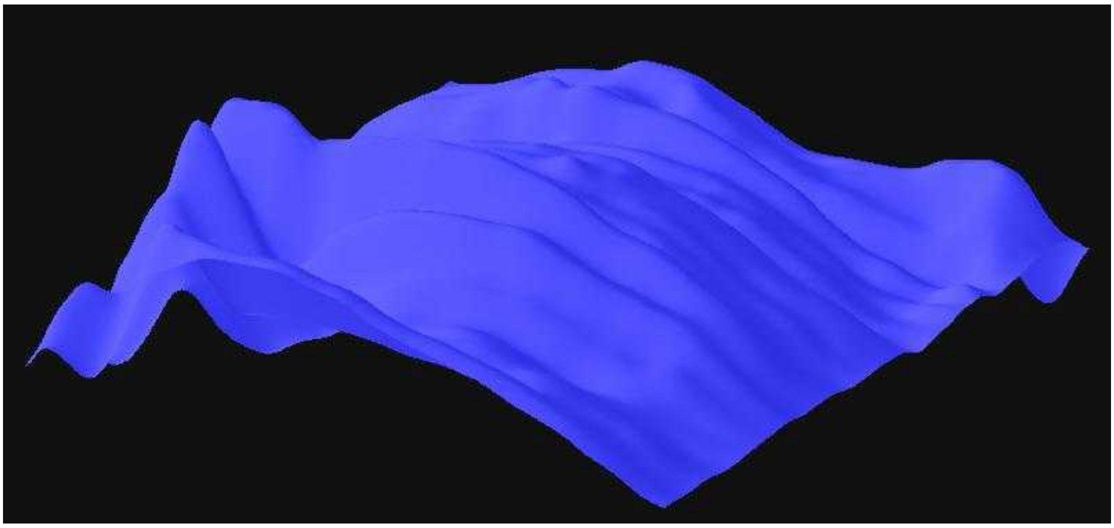


Figure 5: 3D reconstruction in east-west direction derived by photoclinometry and shape from shading analysis of the examined dome.

In a previous study Lena and Fitz-Gerald have examined another megadome, termed the Marco Polo MD complex [6-7], which is located to the north of the examined dome. The Marco Polo MD complex has a base diameter of 83km. Its height amounts to 500m and the average slope angle corresponds to 0.70° (Fig. 1 and Fig. 6). On its summit some low domes, termed MP1-MP4, are aligned radially with respect to the Imbrium basin. The domes MP1, MP3 and MP4 have moderate slopes of 0.92°- 1.3°, while the large dome MP2 located on the summit of Marco Polo MD complex has a shallow slope of 0.6° [6-7]. The study by Lena and Fitz-Gerald indicates for the large and voluminous Marco Polo MD complex an origin due to a subsurface intrusion of a large magmatic body, where also effusive processes, including dome formation, and pyroclastic activity occurred as well suggesting that intrusive volcanism of laccolith formation was accompanied by related surface activity [6-7].

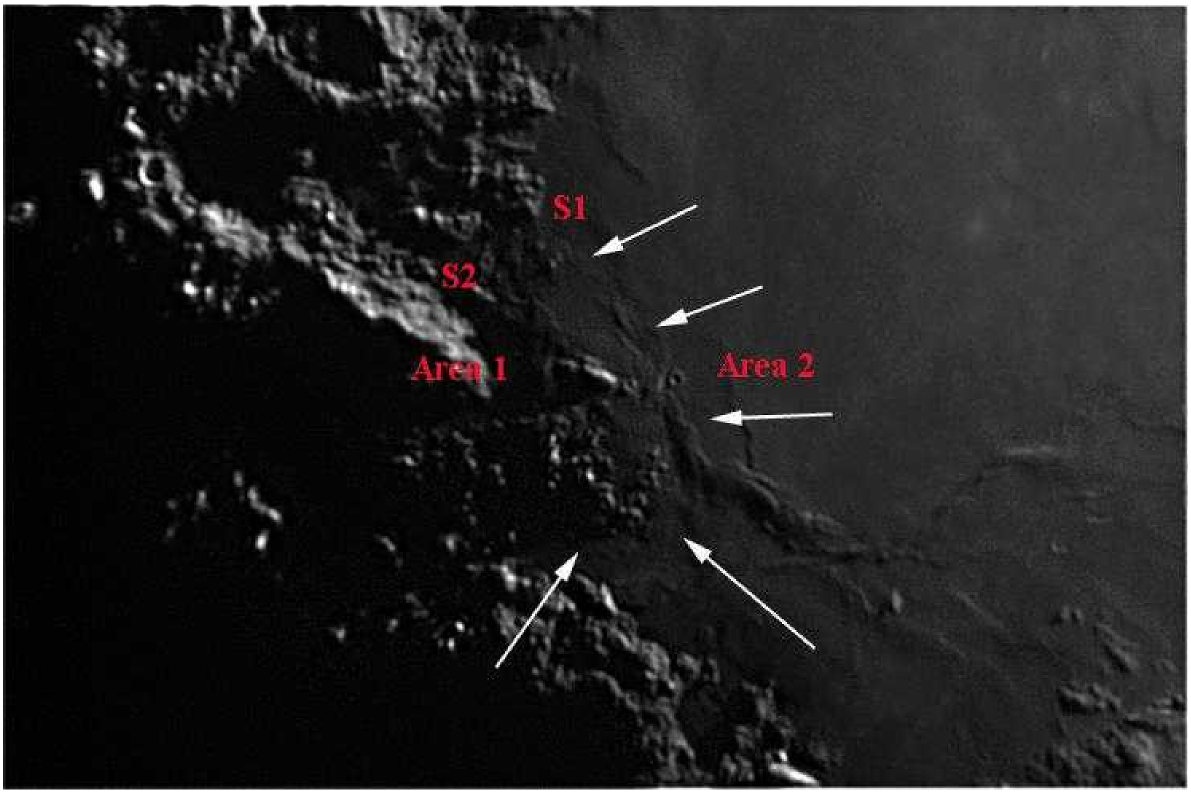


Figure 6: CCD telescopic image of the Marco Polo MD complex made on April 14, 2016 at 21:07 UT by Lena (Mak Cassegrain 180mm). S1 and S2 are the position of the described domes MP1 and MP2 on the summit of Marco Polo MD complex.

These two megadomes, the Marco Polo MD complex, identified in previous works [6-7], and the Marco Polo MD2, described in the current study, provide us with an interesting snapshot of the volcanic geological history of western Mare Vaporum.

An initial phase of uplift seems most likely under the influence of a laccolith-like intrusion in the shallow crust beneath the present location of both two domes. This uplift resulted in surface tensional forces and produced the graben visible on their summits. Only for the MP MD complex, the magma in the laccolith found its way to the surface in a number of vents producing either low-albedo pyroclastic deposits and erupting thin low-viscosity lava flows originating some effusive domes MP1, MP3 and MP4 [6-7]. On the contrary for Marco Polo MD2 only a phase of uplift occurred from the rise of magma that did not erupt onto the surface. These differences deserve attention and other images will be useful to identify further similar structures.

References

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[2] Lena, R., Wöhler, C., Phillips, J., Chiocchetta, M.T., 2013. *Lunar domes: Properties and Formation Processes*, Springer Praxis Books.
[3] Lena, R., 'Lunar domes', chapter in *Encyclopedia of Lunar Science* ed.: Brian Cudnik, 2015, Springer ISBN: 978-3-319-05546-6.
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[6] Lena, R. and Fitz-Gerald, B. ‘The Marco Polo complex. Morphometric analysis and mode of formation of the megadome: another possible lunar volcanic shield’. *The Moon: Occasional Papers of the Lunar Section of the British Astronomical Association,* Volume 3 (September 2013).
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PITISCUS

Barry Fitz-Gerald

An interesting TLP report dates from from September 6th 1981 (01:00 to 01:30 UT)* when a bright glowing cloud was photographed on the floor of the crater Pitiscus by Gary Slayton of Fort Lauderdale, Florida using a 8" reflector. As well as being photographed, the event was observed visually and was described as having a grey colouration with a tinge of red (Cook, 2019). The cloud originated at the central peak and was seen to move, obscuring the surface and a small crater (Cameron, 2006). Pitiscus is 78km in diameter, dates to the Nectarian period (3.9 to 3.8 billion years ago) and is on a relatively uncluttered bit of the southern highlands just to the south-west of Janssen. It has a well defined rim, subdued terraces, small central peak and a battered but discernible proximal ejecta blanket.

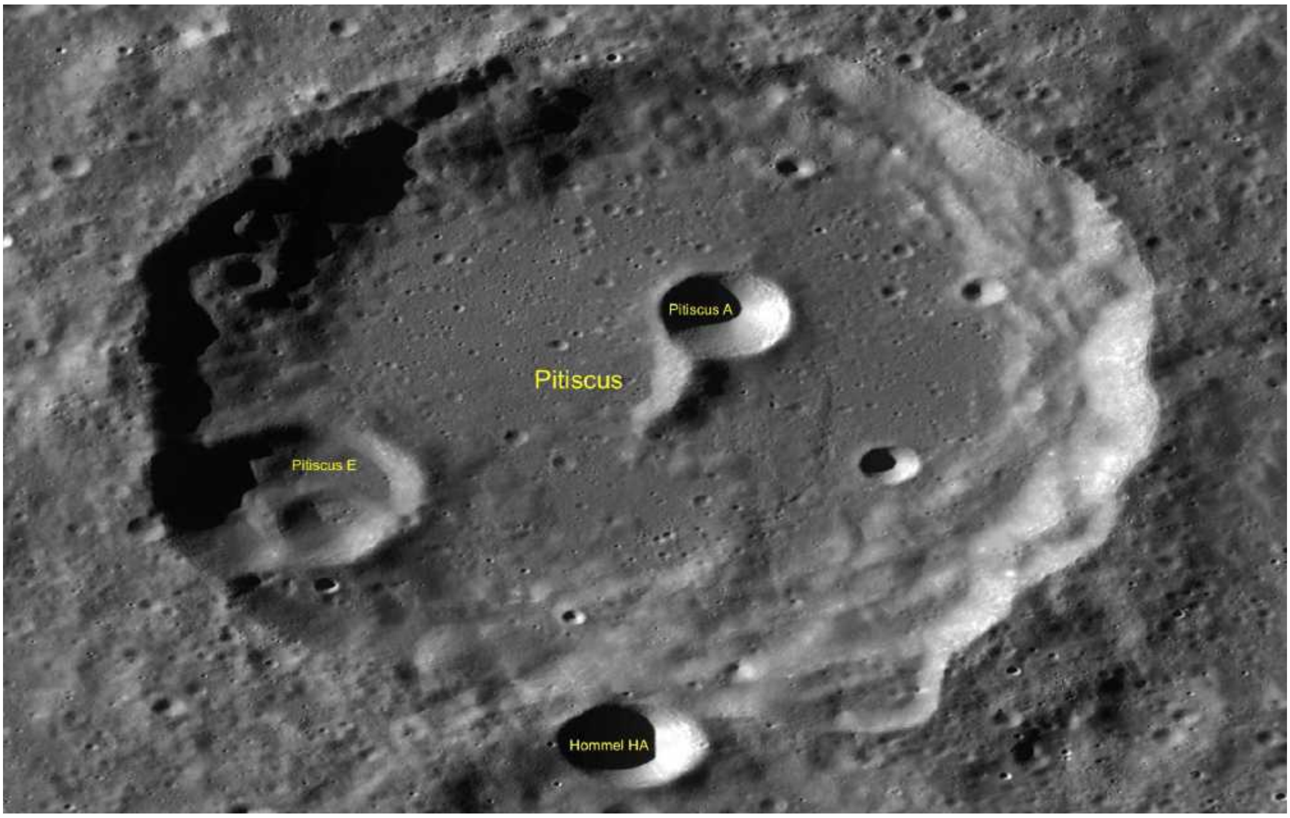

Fig. 1 LROC WAC image of Pitiscus.

The central peak is truncated by the 10km diameter Pitiscus A, whilst another 10km diameter crater, Hommel HA is perched on the southern rim. Pitiscus is 3,500m deep, which is consistent with a crater of this diameter, suggesting that there has been no significant infilling or uplift since its formation (Pike, 1974). The smooth plains visible on the floor are either of volcanic origin or a 'Cayley Plains' type deposit.

At first glance Pitiscus seems relatively unremarkable, with no obvious rocky exposures or interesting albedo features and with no really obvious signs of recent volcanic activity. But a closer look at the crater floor reveals some interesting geological features that hint at a more dynamic history. The eastern and northern parts of the floor are crossed by many lobate scarps, some prominent but some exceedingly subtle in relief. All of these scarps are likely to be the surface manifestation of low angle thrust faults where the rock layers above a fault plane have slid over the rock layers beneath as a result of the crust being compressed horizontally. Even the low resolution WAC image in Fig. 1 is sufficient to show the most prominent scarp which runs from the crater rim near Hommel HA northwards towards the south-eastern rim of Pitiscus A, a distance of some 42kms. The scarp face reaches heights of about 100m in places but generally is much lower. For most of its length the thrust is towards the east with the terrain on the west over-riding the terrain to the east (Fig. 2). This scarp becomes rather complicated near Pitiscus A and looks more like a wrinkle ridge with scarps facing both east and west (Fig. 3).

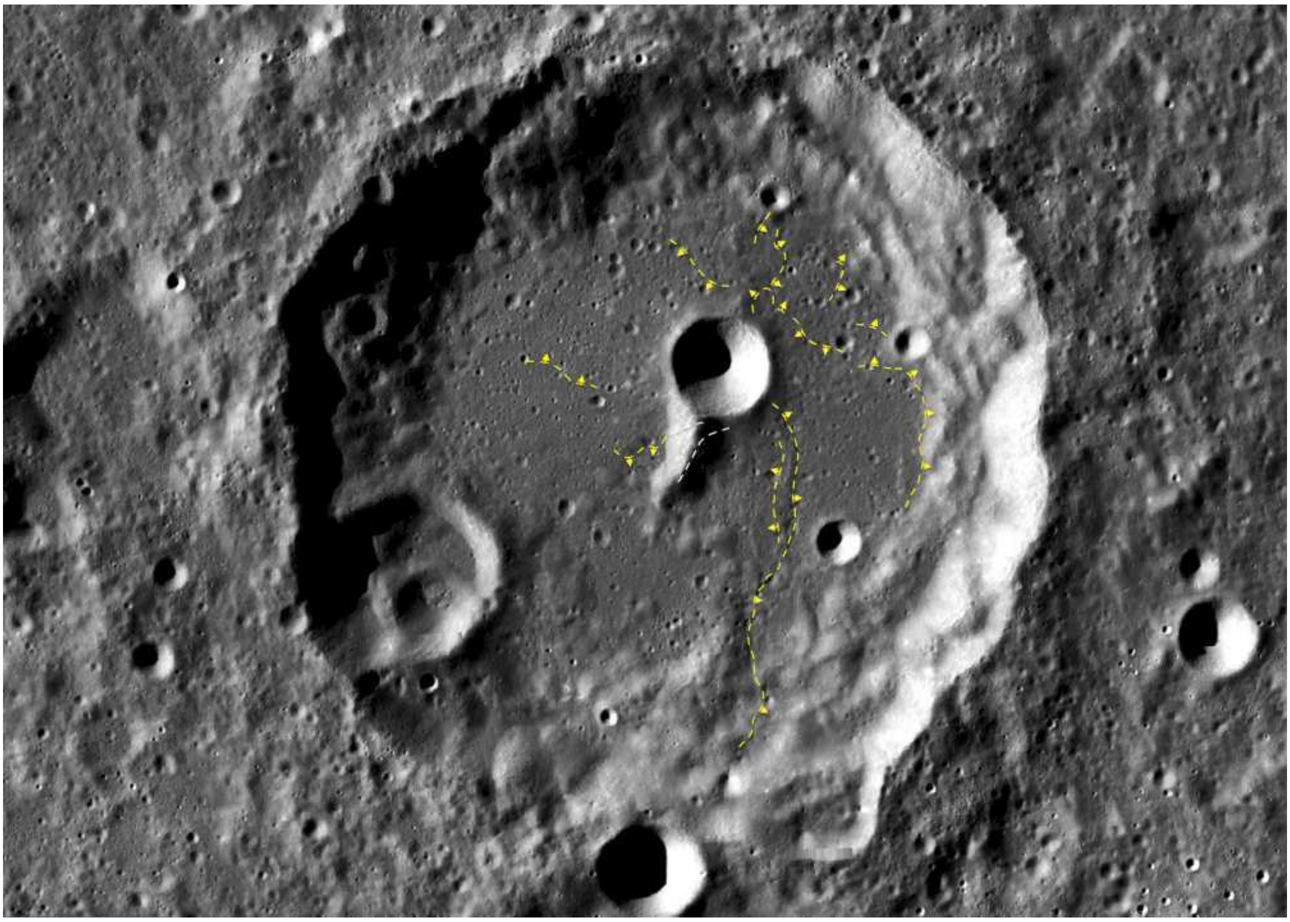

Fig. 2 Pitiscus (South -50.61° East 30.57°) showing a sketch map of the location of lobate scarp fronts (yellow dashed line with arrows to show direction of movement). White dashed lines indicate suspected faults on central peak.

A complex group of scarps can be seen on the northern crater floor, with several of the scarps facing different directions. Scarps can be seen to overlap or interrupt one another indicating that different faults/scarps were active at different times as the compressive forces responsible for them changed direction (Fig. 4).

These compressional forces appear to be related to subsurface geology, as the LROC Quickmap Bouguer Gravity gradient overlay shows that the eastern crater floor has a negative gravity anomaly running approximately north-south beneath it (Fig. 5). The anomaly gives the impression of being part of a 'S'-shaped feature stretching some 300km from Hommel C as far north as the small crater Dove. The overlay shows subsurface rocks of high density in blue and rocks of a lower relative density in red. A higher density signal might indicate the presence igneous intrusions such a basalt dyke swarm or areas of thinner crust where the dense mantle has been uplifted. These anomalies often correspond with areas where the surface is depressed or has subsided, particularly in the mare where they form the MASCONs discovered by the Apollo missions. Subsidence of this type can introduce horizontal compressional forces in the surface layers and produce thrust faults and wrinkle ridge/lobate scarp type landforms.

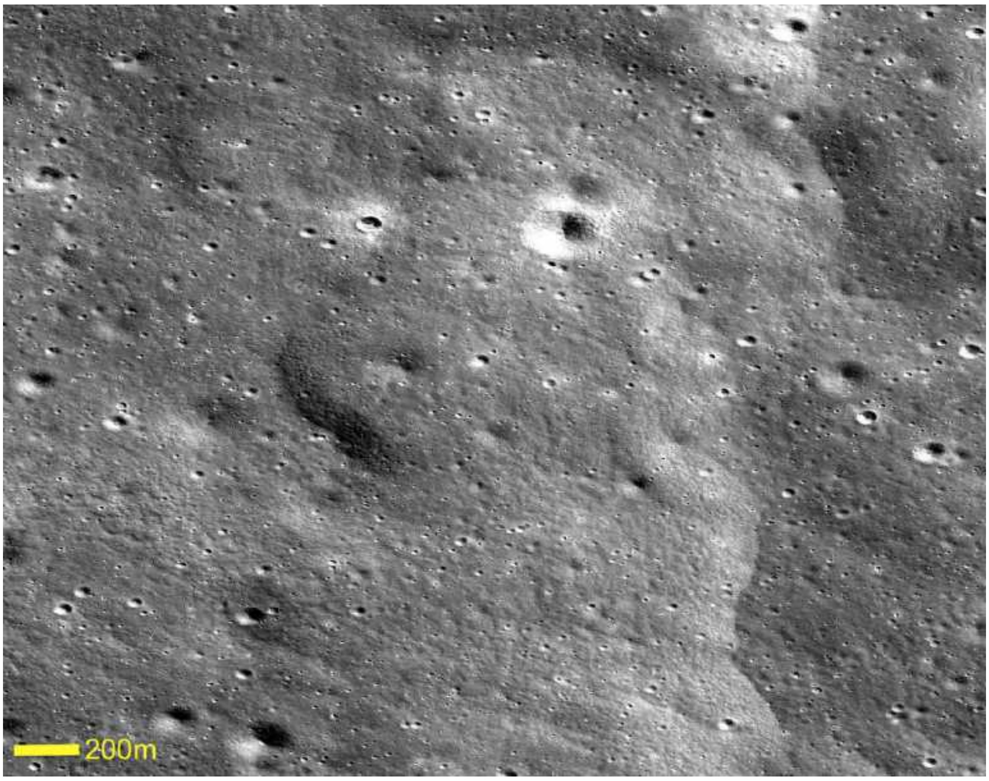

Fig. 3 LROC-NAC image of the northern part of the lobate scarp on the crater floor showing scarp faces both to the east and west.

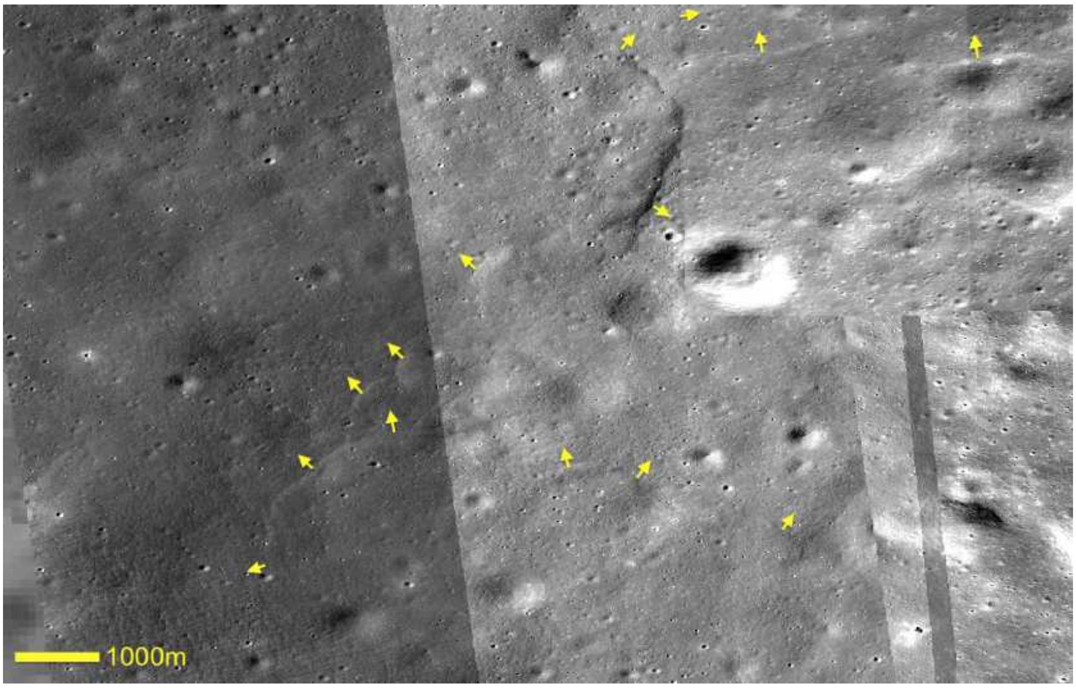

Fig. 4 A LROC-NAC image of part of the north eastern crater floor showing many lobate scarps with varying orientations within a relatively small area. Yellow arrows show the movement associated with the scarp faces.

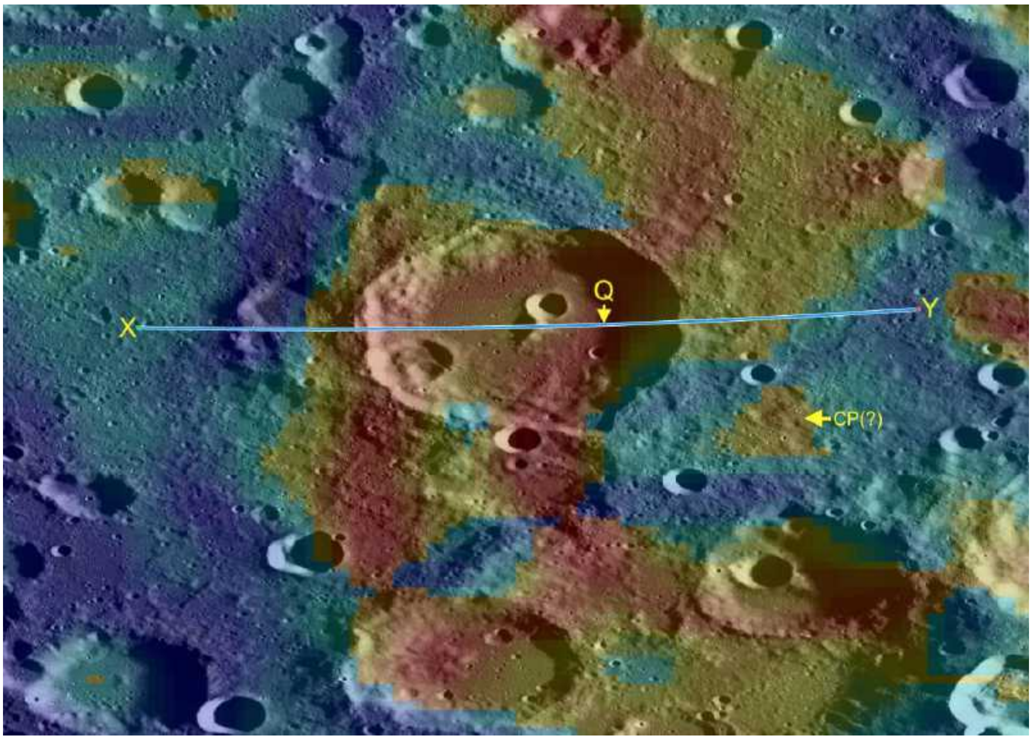

Fig. 5 LROC Quickmap Bouguer Gravity gradient overlay showing a (negative) gravity anomaly (in red) running beneath Pitiscus. Topographic section along line X-Y is shown in Fig.6. CP(?) indicates possible buried central peak of a 140km diameter crater which may be responsible for the anomaly.

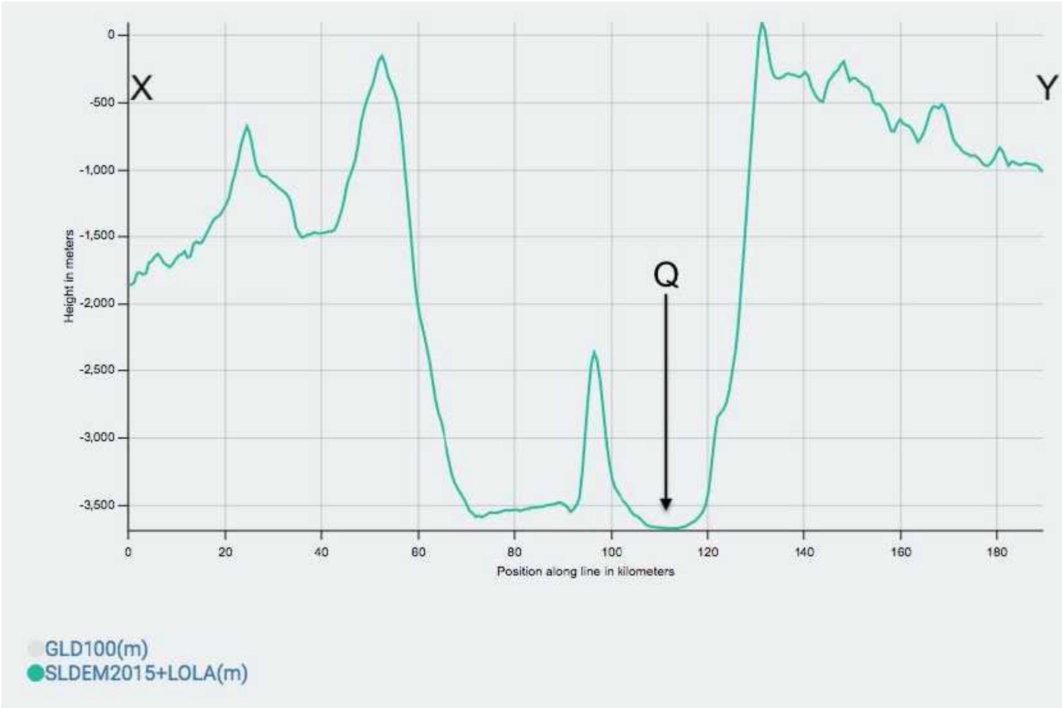

Fig. 6 Topographic section using the Quickmap SLDEM2015+LOLA(m) data along line X-Y in Fig.5. Note that the point Q which marks a trough on the eastern floor corresponds to the gravity anomaly in the GRAIL data.

The anomaly beneath Pitiscus however indicates a rock body of lower relative density, a feature associated with the heavily brecciated zones beneath crater and basin rims. The curving nature of the anomaly might even suggest that it is in fact part of an ancient crater, with the curved section beneath Pitiscus representing the western rim of a now completely buried crater approximately 140kms diameter. Why the surface has subsided in response to the presence of this lower density anomaly is a question that requires more analysis. An east-west cross section of the crater shows that the anomaly corresponds to a north-south orientated trough on the surface which is some 150 to 200m deep and approximately 10kms wide (Fig. 6). This suggests some form of subsidence has taken place along this north-south axis, which is the probable origin of the horizontal compressional forces that produced the thrust faults and their scarps. This interpretation is supported by the observation that when measured east-west, from rim to rim, the central peak is displaced some 2kms towards the east, indicating a degree of localised crustal shortening in this direction.

A link between sudden movement along low angle thrust faults and their associated lobate scarps and shallow moonquakes has been demonstrated using Apollo seismometer data (Watters et.al., 2019). A link has also been proposed between these movements and boulder falls triggered by seismic shaking (Kumar et.al., 2018). A link between boulder falls or other avalanche type events and TLPs is somewhat speculative, but evidence for a such link is not completely non-existent (Fitz-Gerald, 2020) . In the present case the lobate scarps do show evidence of sporadic movement at various points along their length, in the form of high-albedo patches where fresher material has been exposed following localised mass wastage events. This suggests that only short segments of the thrust faults have been active at any one time and that movement may not necessarily involve the whole length of the scarp. An example of this is illustrated in Fig. 7 which shows an roughly 1.25km section of scarp to the south-east of Pitiscus A, where the front is about 100m high and slopes down at approximately 8° to the east.

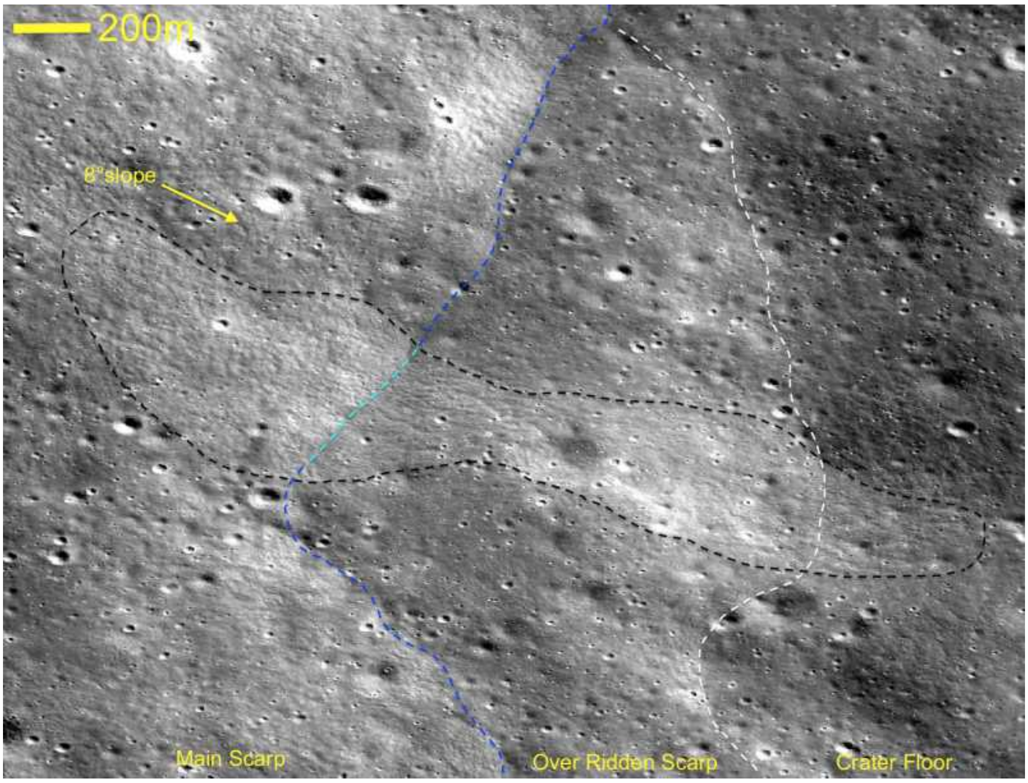

Fig. 7 LROC NAC image of a section of the lobate scarp to the south east of Pitiscus A. The main scarp front is shown with a dark blue dashed line. An over ridden, older scarp front is shown with a white dashed line. A high albedo debris slide (black dashed line) has slumped off the main scarp obscuring its front along a section shown in light blue. This debris slide has travelled over the upper surface of the over ridden scarp and on to the crater floor to the east. The main scarp is some 100m here and slopes to the east at 8°.

The main scarp here has over ridden a smaller older scarp to the east, so within the frame two scarp fronts are visible. The base of the main scarp is partially obscured at one point by a high-albedo debris slide that has slumped onto the upper surface of the over-ridden scarp. This slump can be distinguished by its bright 'tree bark' texture, which is believed to be caused by surface regolith moving down-slope. The high albedo as noted indicates the presence of freshly (in lunar terms) exposed unweathered regolith. This particular slump has then travelled further downhill on to the crater floor to the east. The presence of this type of feature at many points along the scarp front indicates several localised slope failures, probably triggered by separate movements along the fault beneath.

A number of boulders and boulder trails can be seen on the inner walls and floor of Pitiscus A. The boulder trails indicate relatively recent falls (within the last few million years) as these features are relatively ephemeral features with a finite lifespan (Kumar, 2019). These boulders originate from exposures of bedrock along the crater rim. Boulder trails vary in length, some stretch for over 2.5kms and down 1200m from the rim to the crater floor. Other trails are no more than a few tens of meters long indicating only a small amount of movement (Fig. 8). This shows that many boulders travelled down from the rim in stages, the first stage being from their parent exposures, coming to rest on the lower slopes when they ran out of downwards momentum and the slope gradient decreased. This movement produced long boulder trails often broken up in to segments as the boulders bounced and left the surface as they rolled downwards. These trails would over time have eroded away, leaving an isolated boulder on the lower slopes of the crater floor. Some boulders were then dislodged again by a force sufficient to get them moving down the relatively shallow lower slope they sat on, but this time only rolling a short distance and producing a stub of a trail (Fig. 9). This shows that boulder falls, whether caused by seismic shaking as a result of tectonic movement or nearby impacts, are on-going and not one-off events.

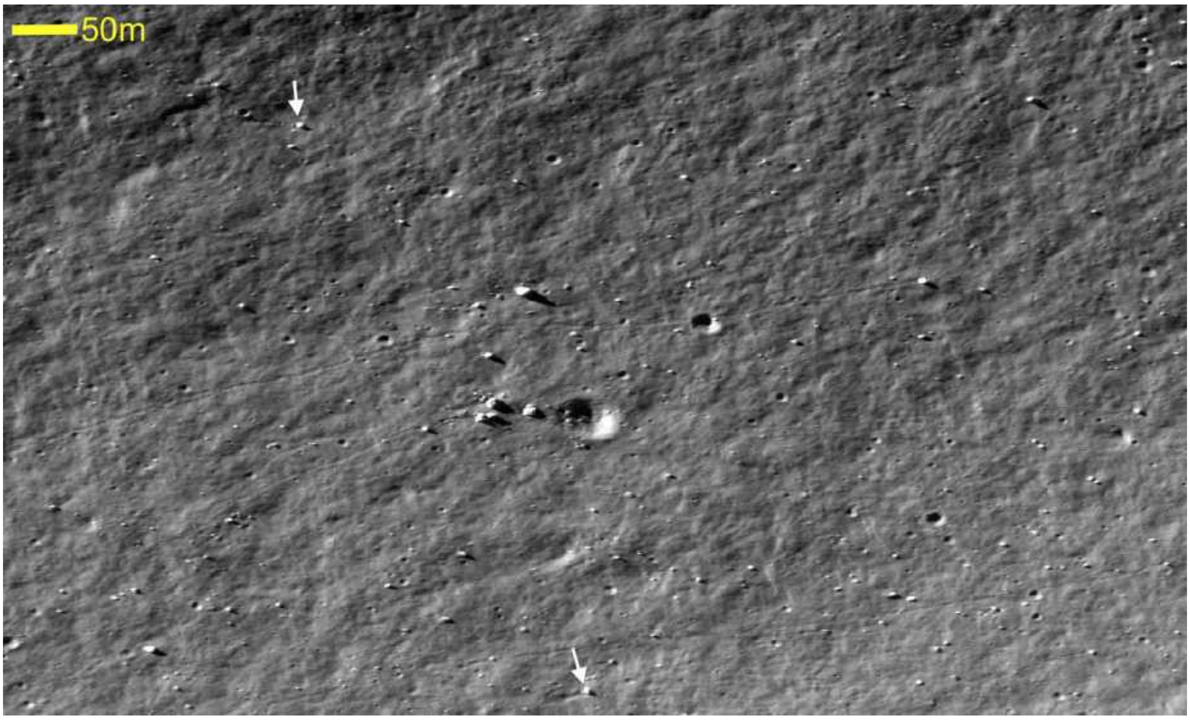

Fig. 8 Boulder trails on the lower slopes and floor of Pitiscus. Older boulder falls (~ several million years) no longer have associated trails as these features gradually become eroded away by infilling, but some of these boulders have received a further nudge downslope and have produced short trails on these gentler slopes (white arrows).

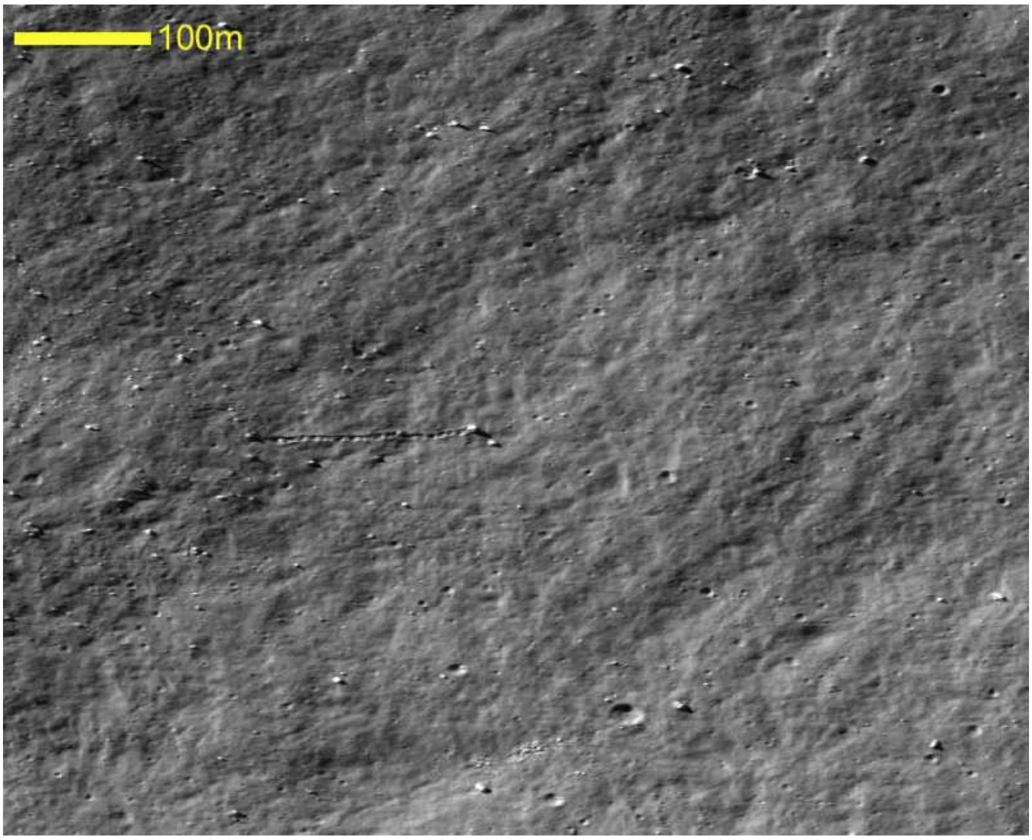

Fig. 9 Boulder trail on the lower slopes of Pitiscus A, where the boulder has rolled a short distance down a shallow slope. The boulder originated higher up on the crater wall some millions of years ago, but the trail it produced on that occasion has eroded to invisibility. This boulder did not have enough momentum during the formation of this trail to bounce and produce a discontinuous trail.

The report from 1981 suggests that the TLP started at the central peak, and the LRO images show that the surface of the western flank is modified and has experienced slope failure. This occurs where deposits at different depths on a slope have different strengths, such as where an unconsolidated surface layer overlies a more compact, competent layer. In this case the surface regolith has separated, in patches, from the underlying deposits and has slid a short distance downslope. These events can build up on steeper slopes and develop into landslides or avalanches involving the displacement of more deeply buried material (such as happens in snow avalanches), but on the 17° slope here the movement seems to have involved only a thin surface layer which traveled a short distance before coming to rest. This produced a texture that is a mosaic of irregular rough patches where the surface layer has been disrupted alternating with smoother areas which represent an undisturbed in-situ surface. The rough patches have a vague pattern of ridges parallel to the slope (rather like terrestrial soil creep) and striations orientated downslope. It also has a higher albedo than the smoother areas due to the presence of freshly exposed unweathered regolith.

A short 4km section of lobate scarp can be seen running across the western crater floor towards the foot of the slope where the failure has occurred (Fig. 10). This scarp face reaches some 10m in height on the crater floor and can then be traced up the western flank, through the zone of slope failure and then over the summit ridge (Fig.

12). The presence of this scarp in the area where the surface is disrupted suggests that the two may be connected, and it is possible that movements along the fault associated with this scarp, though producing no dramatic changes to the scarp face itself, was sufficient to de-stabilise the surface regolith, causing the slope failure that we see.

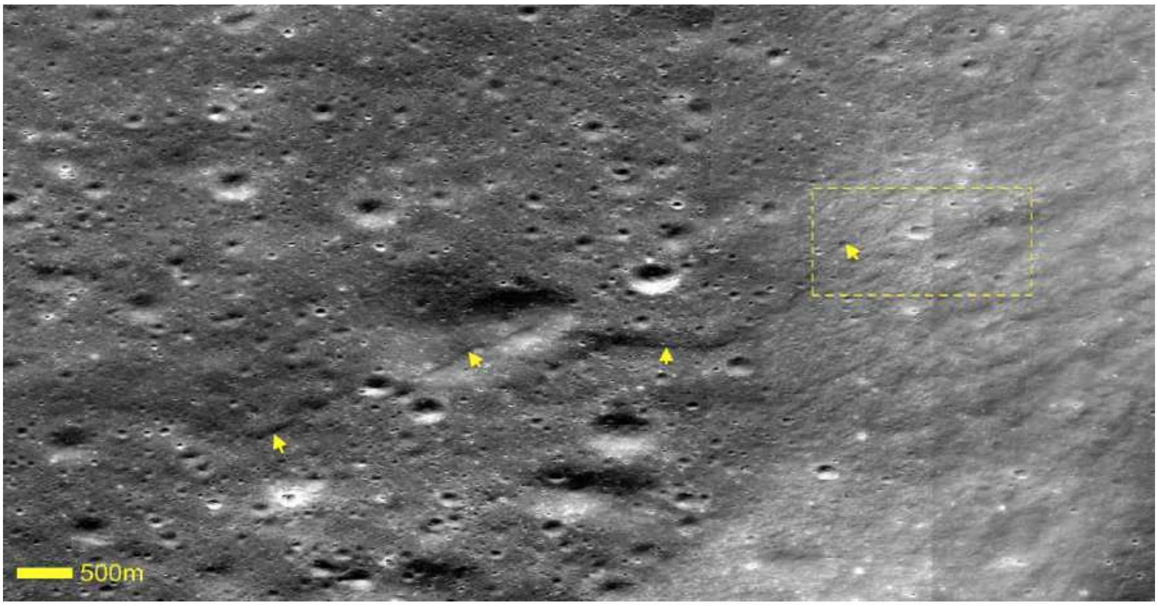

Fig. 10 Western crater floor and flank of the central peak of Pitiscus showing short section of lobate scarp that runs up to and then over the peak. Note its reduced visibility on the slopes due to a mantling of loose slope deposits . Detail of area within the yellow dashed box is shown in Fig. 11.

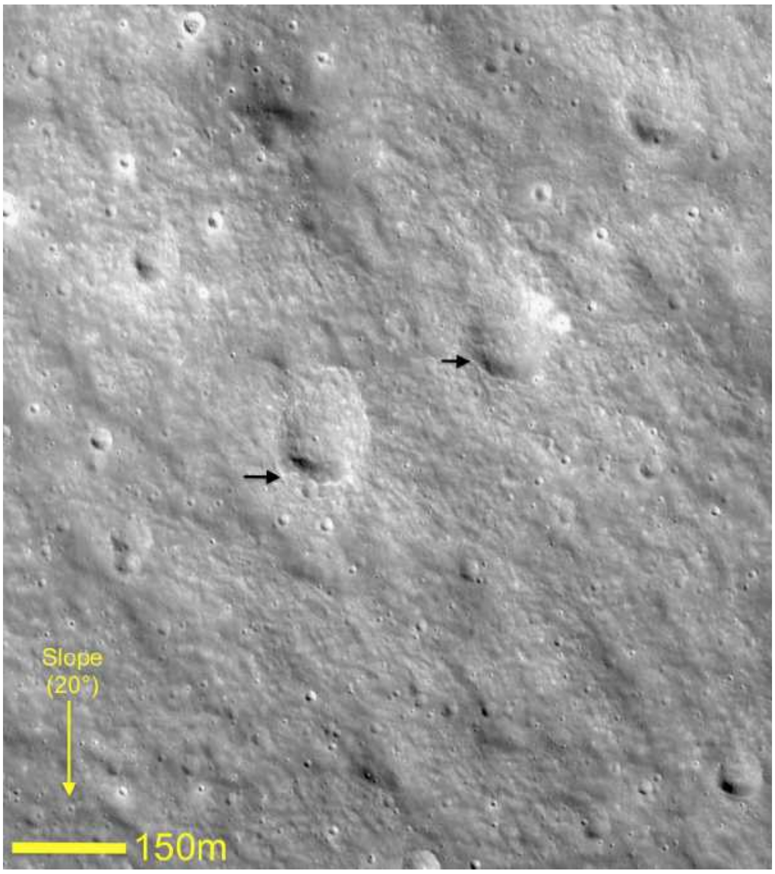

Fig. 11. LROC NAC detail of box shown in Fig. 10. The surface consists of rougher high-albedo patches where slope failure has occurred and smoother lower-albedo ones where the surface remains intact. Note the two ~ 100m diameter craters (black arrows) which share the same rough texture as is visible on the surrounding slope.

There are a number small craters (~100m diameter) on this slope that show the effect of this failure, with the characteristic rough texture extending across them (Fig. 11) and giving them a rather eroded appearance. Smaller craters (<10m) within the rough areas are less numerous and more degraded when compared to the smooth undisturbed areas, they are not completely absent. The depth of the surface layer involved in the failure may therefore not have been sufficient to completely obliterate the small crater population on the slope. This would make the identification of recent activity difficult as the number of craters present due to their survival would suggest a greater age and not reflect more recent surface activity.

Larger slumps have taken place on the central peak, with one large slump mound to the south and another visible on the eastern flank which extends for some 3kms down from the summit ridge on to the crater floor, a drop of 700m (Fig. 12). Subtle linear features are present on the central peak which may represent extensions of the lobate scarp faults from the crater floor. Movement along these faults might also be implicated in triggering seismic shaking and initiating mass wastage off the peak. The slope failure on the western central peak would appear to be a possible candidate for the 1981 event, but as noted above the nature of the failure might not necessarily sweep the slope clean of its small crater population, giving the appearance of a much older surface.

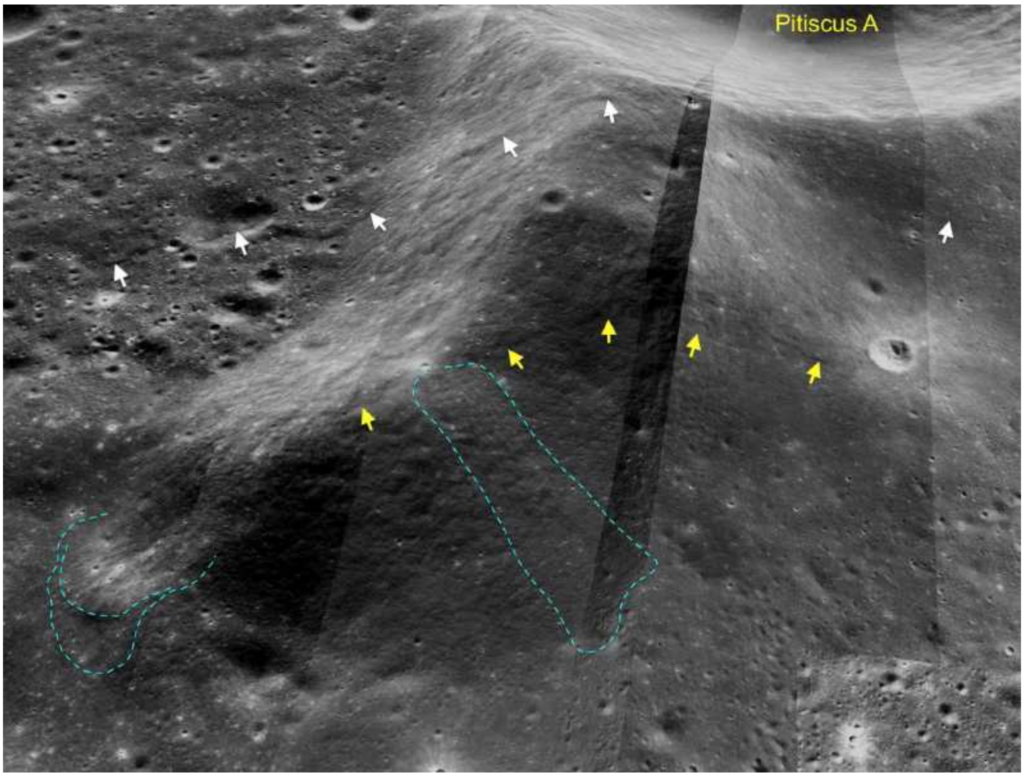

Fig. 12 A 3D generated view of the central peak viewed from the south showing slump/avalanche features (light blue dashed lines) and lobate scarp/fault features extending across the peak. The white arrows indicate the scarp/fault identified in Fig. 10. Note a fault marked with yellow arrows passes above a large avalanche on the eastern side of the peak, and also heads towards the slump off the southern part of the peak.

This speculation pre-supposes that some mass wastage events can cause a TLP by generating clouds of fine dust which can persist for some time before settling back on to the lunar surface – which whilst a plausible hypothesis is no more than that, and of course many TLP reports relate to areas without any lobate scarps. One problem with the dust as TLP hypothesis is that there is no evidence for the production of dust clouds from mass wastage events and they would in any case leave very little in the way of visible change, producing only a thin virtually undetectable layer once it settles on the surface. The crater Ross D for example has been the subject of many recent TLP reports, but there is little in the crater or its surroundings to indicate any large scale mass wastage events. It has however many boulders and boulder trails its floor, similar to that observed in Pitiscus A, but another unknown is how much of a dust cloud a boulder fall could produce, is a large single boulder capable of producing a dust cloud or would it require many boulders? As for the lobate scarps in Pitiscus, they do not show evidence of widespread recent activity, and have only been active along short localised sections at any one time, leaving most of the scarp front unmodified. Would such localised activity be sufficient to trigger vigorous ground shaking and initiate landslides and slope failure – and potentially generate a TLP?

Seismic activity within the central southern highlands has been demonstrated in research using Apollo seismometer data gathered between 1969 and 1977 (Watters et.al., 2019), but no events within this time period correspond to the location of Pitiscus, the nearest epicentre cluster being some 300kms to the north-west. The same study did however identify a link between the timing of these shallow moonquakes and peak local diurnal compressive stress in the lunar crust. These stresses are generated by tidal forces as the moon orbits the Earth with the peak forces occurring at or near apogee. The Pitiscus event was on the 6th of September 1981 which is very close to the time of apogee which was on September 5th at 6:35UT. This is a further intriguing possible link between tectonic activity in the form of tidally induced moonquakes and the observed TLP.

The TLP seen by Slayton was observed between 01:00 and 01:30UT during which time it seen to move and obscured the surface, a phenomenon often reported in TLP reports. This raises the question as to whether a dust cloud produced in an avalanche or slope failure could account for this type of observation. Rocks, boulders and coarser debris in a lunar avalanche would be expected to follow a ballistic trajectory downslope, but the very fine particulate matter in the regolith might behave differently. Electrostatic effects on dust particles in the ~5 µm size range resulting from exposure to UV radiation has been implicated in the production of the horizon glows photographed by several of the Surveyor landers and the high altitude streamers seen by Apollo astronauts (Grün et.al., 2011). Electric charge is also believed to be capable of building up within the regolith to the extent that dust can spontaneously levitate above the surface as a result of the particle-particle repulsive forces (Wang et.al., 2016). The suggestion of a link between TLPs and dust mobilised by electrical forces is not new, but a self-supporting cloud of dust in which the individual particles are held aloft by electrostatic repulsion could fit at least some of the TLP observations made in the past. This would obviously lead to a segregation of the coarser and finer components of any mass wastage event, the coarse material travelling ballistically whilst the finer fraction separates and remains suspended, at least temporarily above the surface.

In conclusion, what can be said about Pitiscus is that mass wastage events of various magnitudes have occurred in the geological past, but that some of the smaller slope failures might have left only subtle traces on the surface, and not the avalanches and rock slides usually associated with such activity. Research also appears to show that shallow moonquakes have occurred within the central southern highlands very recently, so a mechanism for producing seismic shaking in the area is not unrealistic. The timing of the event close to apogee provides another tentative link as the connection between seismic activity and peak compressional stress appears to be well established. Whether such a combination of events could account for Gary Slayton's 1981 observation is unknown, but it is worth considering as a possible explanation. Of course there is always the possibility that the event reported was the result of spurious instrument or lighting effects, and that nothing whatsoever disturbed the tranquility of Pitiscus in September 1981.

Acknowledgements:

LROC images reproduced by courtesy of the LROC Website at http://lroc.sese.asu.edu/index.html, School of Earth and Space Exploration, University of Arizona.

Selene images courtesy of Japan Aerospace Exploration Agency (JAXA) at:
http://l2db.selene.darts.isas.jaxa.jp

Many thanks to Tony Cook for his extremely valuable comments and advice regarding the above.

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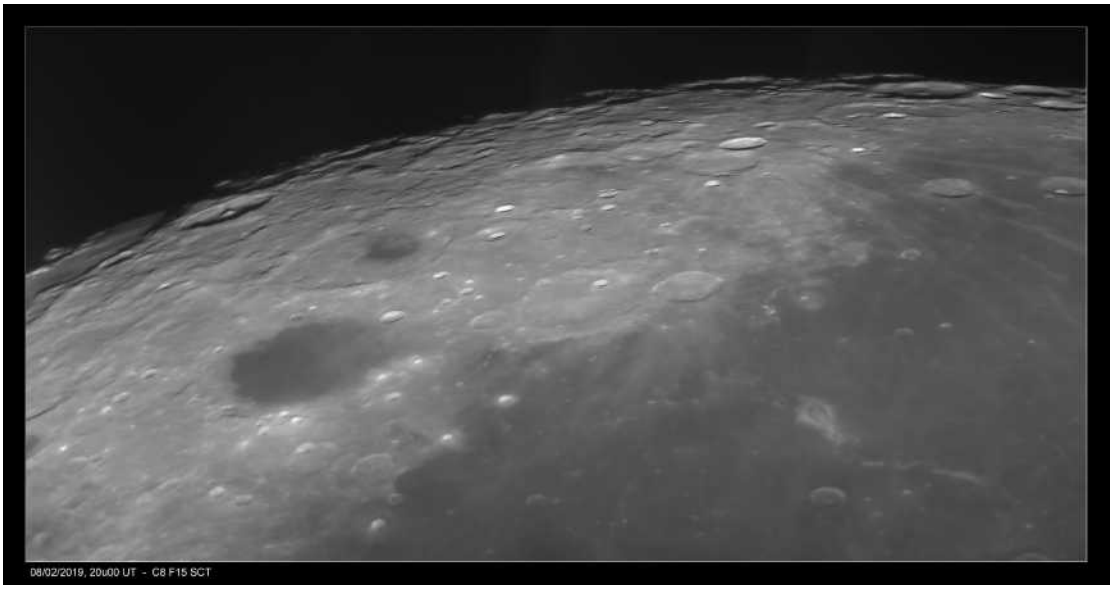
* The date of the event seems to be the early hours of the 6th Sept. 1981 and I am following this date accepted by Cook (Cook, 2019) for this event which is based on entry 152 in Cameron's Lunar Transient Phenomena Catalog Extension (Cameron, 2006).

RECTIFIED IMAGES OF THE ORIENTALE BASIN

Alexander Vandenbohede has submitted some interesting rectified images of the Orientale Basin taken on 8 February 2020 with a 200mm SCT. He writes:

'These show different parts of the Orientale basin and its ejecta deposits. I also rectified the images using the LTVT software. 8 February offered a rare occasion when the terminator was in the Orientale basin, libration conditions were good and there was a spot of clear sky! The different parts of the basin can be distinquished: Montes Cordillera, inner and outer Montes Rook, Lacus Autumni, the different valleys south of the basin and quite some detail in the area between Montes Cordillera and the outer Montes Rook.' [Example images below]

Alexander continues: ‘North of Schlüter, the rectified image shows a structure that looks like a part of a ring. It was the first time that I noticed it. I think this is part of the Rocca ring, one of two outer rings that Hartmann and Kuiper identified in 1962, but seemed to be most probably non-existent in a later stage' [see images below].



LUNAR OCCULTATIONS **March 2020** Tim Haymes

This month…

Special Event DD of ZC1014 March 4th

As I mentioned last month, this is a suspect double star, and observations of the dark limb disappearance would help confirm if a double star exists here. It was reported as possibly double in a video recording made by Bob Sandy (IOTA-US) on April 20, 2010. This is the last opportunity until events resume in 2028 AD. High speed video or visual welcomed.

On the occultation of M1 (Crab)

The Crab nebula is occulted during daylight in the UK, on March 03d 1730 UT.

When X-rays were first observed from the Crab Nebula, a lunar occultation was used to determine the exact location of their source. Before the launch of X-ray-observing satellites, X-ray observations generally had quite low angular resolution, but when the Moon passed in front of the nebula, the X-ray detail become detectable as variations in the nebula's flux were occulted. This was used to create a map of X-ray emission.
– adapted from Wikipedia by the writer.

Prime time for Lunar Occultations

March and April are often the best times of the year to time occultations due to the favourable altitude of the moon in the Northern Hemisphere evenings. I do hope observers can take advantage and time some of these events.

Grazing Occultations

There is one prediction in the BAAH for March: #6 SAO 78561 Mar 04 2049UT – S Limit, IoW, SW counties.
Zipped files may be downloaded from the BAA web site:
https://britastro.org/downloads/17673

The brightest star grazed this year is 33 Psc (v 4.6) on Jul 11th, 0355 UT. The path is over Wales. Anyone planning a holiday in this area should be prepared to take a telescope and be within reach of the graze path!

Graze of SAO 109952 on 27th Feb: The Coordinator reports a successful observation (BAAH2020 #5) with 8 contacts being recorded.

2020 March predictions for Manchester (Occult4 by D.Herald)

W. Long. 002d 15’, N Lat. +53 25’, Alt. 50m
Events excluded: Daytime, Bright-limb

y	m	day d	Time h	m	s	P		Star No	Sp	Mag v	Mag r	% ill	Elon	Sun Alt	Moon Alt	Moon Az	CA o	Notes
20	Mar	1	20	16	37.2	D		93654	K0	8.3	7.7	40+	78		41	240	49N	
20	Mar	1	20	34	49.5	D		581	G0	6.8*	6.4	40+	78		38	244	43S	
20	Mar	1	21	2	8.2	D		93671	K2	9.0	8.5	40+	79		35	251	55N	
20	Mar	1	22	52	52.5	D		93701	F8	8.3*	8.0	41+	79		19	274	74N	
20	Mar	1	23	55	4.4	D		590	A0	6.3	6.3	41+	80		10	285	51N	
20	Mar	2	22	55	31.0	D		94154	K0	8.5	7.9	51+	91		28	267	69S	
20	Mar	3	18	56	36.9	D		77324	B8	8.9	8.8	60+	101	-10	59	179	25N	
20	Mar	3	19	9	30.9	D		77342	M0	8.6	7.8	60+	101		59	184	89S	
20	Mar	3	19	17	15.5	D		77344	A5	9.0	8.8	60+	101		59	188	66N	
20	Mar	3	20	6	22.1	D		851	A1	6.4*	6.4	60+	102		56	208	43S	Dbl*
20	Mar	3	22	19	58.6	D		77460	K7	8.4	7.4	61+	102		42	249	53S	
20	Mar	3	22	24	27.6	D		77469	B8	8.6	8.5	61+	102		41	250	72S	
20	Mar	4	0	7	20.0	D		77553	G0	8.1*	7.8	61+	103		26	272	47S	
20	**Mar**	**4**	**19**	**49**	**27.4**	**D**		**1014**	**A0**	**7.0**	**7.1**	**70+**	**114**		**60**	**178**	**49N**	**Dbl*?**
20	Mar	4	20	31	21.3	D		78561	K2	7.4	6.6	70+	114		59	196	35S	
20	Mar	4	22	1	9.3	D		78627	K2	8.9	8.2	71+	115		52	229	79S	
20	Mar	4	22	26	38.9	D		78628	B9	8.8	8.8	71+	115		49	238	13N	
20	Mar	4	23	35	1.2	D	X	9691	K8	8.6	7.8	71+	115		40	254	62S	
20	Mar	5	0	0	44.5	D		1033	A2	6.8	6.7	72+	115		36	260	88S	
20	Mar	5	0	5	15.9	D		78702	K0	7.8	7.1	72+	116		35	261	79S	
20	Mar	5	20	26	39.0	D		1152	G5	7.0	6.4	80+	127		59	169	49S	Dbl*
								1152 is double: ** 7.7 7.7 0.10" 87.0, dT = +0.19sec										
20	Mar	5	20	56	32.9	D		79573	M0	8.9	8.0	80+	127		59	182	46S	
20	Mar	5	23	0	45.6	D		79628	F5	7.1	6.9	81+	128		51	230	63S	
20	Mar	5	23	13	19.7	D		1167	K0	6.3*	5.8	81+	128		50	233	74N	
20	Mar	5	23	59	15.0	D		79660	K0	7.6	6.8	81+	128		44	246	45N	
20	Mar	6	1	51	26.5	D		79707	A0	8.2	8.2	82+	129		28	270	55S	
20	Mar	6	18	44	52.7	D		80269	F0	8.4	8.3	88+	139	-8	42	116	46S	
20	Mar	6	19	48	29.4	D		80294	F8	8.0	7.7	88+	140		50	134	47S	
20	Mar	6	20	26	31.3	D		80320	G8	8.6	8.1	88+	140		54	146	46N	
20	Mar	6	21	31	24.4	D		1304	A0	6.8		89+	141		57	172	89S	
								1304 is double: AB 7.10 8.08 0.29" 72.2, dT = +0.5sec										
20	Mar	6	21	46	55.6	D		80349	F0	8.5	8.4	89+	141		57	178	29S	
20	Mar	6	23	45	40.5	D		80401	A5	8.5	8.4	89+	141		51	224	48N	
20	Mar	7	0	6	46.6	D		1313	F8	7.6	7.3	89+	142		48	230	57S	
20	Mar	7	0	24	26.3	D		80413	F8	7.6	7.3	89+	142		46	235	18N	
20	Mar	7	0	52	25.9	D		80426	K0	7.7	7.2	89+	142		43	243	62S	
20	Mar	7	19	26	34.2	D		1421	K0	8.0	7.2	95+	153		38	114	90S	
20	Mar	7	21	34	8.0	D		1431	B9	8.3	8.3	95+	154		51	151	83N	
20	Mar	8	2	12	38.6	D		1450	K0	8.0	7.3	96+	156		37	245	63N	
20	Mar	8	19	7	10.4	D		1553	A0	7.8	7.8	99+	167	-11	23	100	79N	78 Leo
20	Mar	11	23	46	7.9	R		1950	G6	5.7	5.2	92-	147		22	136	51N	80 Vir
20	Mar	14	1	33	42.7	R		2213	K0	5.8	5.3	74-	119		12	141	57S	34 Lib
20	Mar	14	2	48	50.0	R		2218	B3	5.5	5.6	74-	118		17	159	59S	zeta Lib
20	Mar	14	3	54	26.2	R		159358	K1	7.2		73-	118		19	174	40S	Dbl*
20	Mar	14	4	53	25.5	R		159379	F3	7.7	7.5	73-	118		19	189	73N	
20	Mar	18	5	9	41.7	R		2835	B7	7.3	7.3	31-	68	-11	5	144	39S	48 Sag
20	Mar	18	5	11	30.4	R		2836	K3	5.5	4.7	31-	68	-10	5	144	17N	49 Sag
20	Mar	28	19	39	27.3	D		93537		8.7	7.9	16+	48	-10	28	259	65S	
20	Mar	28	22	3	14.0	D		93565	B9	7.8	7.8	17+	49		8	287	27N	
20	Mar	28	22	3	48.6	D		93569	F0	8.6	8.4	17+	49		7	287	40S	
20	Mar	28	22	22	15.2	D		93572	F8	8.8	8.5	17+	49		5	291	42N	
20	Mar	29	19	17	38.5	D		668	K0	3.5*	3.0	24+	59	-6	40	246	85S	epsilon Tau
								668 is double: Aa,Ab 3.6 6.0 0.20" 108.0, dT = +0.46sec										
20	Mar	29	21	38	32.5	D		93998	K0	7.4	6.8	25+	60		20	275	83S	
20	Mar	29	23	20	43.0	D		94032	G0	8.9	8.6	26+	61		6	294	89S	
20	Mar	30	21	48	34.2	D		77162	K0	8.7	8.0	34+	71		28	269	76N	
20	Mar	30	22	48	27.4	D		817	B2	4.9	5.0	34+	72		19	281	40N	114 Tauri
								817 is double: **Aa,Ab 5.6 5.6 0.10" 90.0, dT = +0.19sec										
20	Mar	31	20	27	9.0	D		78205	B1	8.6	8.4	44+	83		48	240	88N	
20	Mar	31	20	38	0.6	D		78211	B0	7.9	7.7	44+	83		46	243	90N	
20	Mar	31	20	43	35.7	D		78216	A5	8.4	8.3	44+	83		46	244	83S	
20	Mar	31	21	5	16.8	D		78228	A0	8.3	8.3	44+	83		42	250	50S	

20	Mar	31	21	19	48.2	D	78238	K0	8.9	8.4	44+	83		40	253	58S	
20	Mar	31	21	23	44	M	964	A0	7.0	6.7	44+	83		40	255	0N	12 Geminorum
20	Mar	31	22	5	31.7	D	78273	F5	8.3	8.1	44+	83		34	263	74S	
20	Mar	31	22	56	27.8	D	78315	F0	8.0	7.9	45+	84		27	273	59N	
20	Mar	31	23	44	45.5	D	78345	A5	8.4	8.3	45+	84		20	282	59N	
20	Apr	1	0	14	58.7	D	78367	G5	8.1	7.6	45+	84		15	287	43S	
20	Apr	1	19	41	22.9	D	1100	K	8.2	7.6	54+	95	-9	58	206	87N	
20	Apr	1	19	55	54.7	D	79211	K0	8.7	8.1	54+	95	-11	57	212	56N	
20	Apr	1	23	39	19.9	D	79330	K0	7.8	7.3	55+	96		28	271	42S	
20	Apr	2	0	2	34.2	D	1118	A1	6.2	6.2	56+	96		25	275	56N	58 Geminorum
20	Apr	2	0	28	7.4	D	79364	F5	8.2	8.0	56+	97		22	280	51N	
20	Apr	2	20	59	6.6	D	80053	A0	9.0	8.9	65+	108		55	213	67S	
20	Apr	2	22	26	46.5	D	80087	K0	7.9*	7.2	66+	108		45	241	86S	
20	Apr	2	23	0	26.5	D	80094	K2	8.0	7.4	66+	109		41	249	38S	
20	Apr	3	2	37	25.4	D	1269	G5	6.9	6.3	68+	110		10	292	37N	
20	Apr	3	21	20	39.2	D	98460	A3	8.4*	8.3	76+	121		54	199	72S	
20	Apr	3	21	35	53.1	D	1377	A3	7.0*	6.9	76+	121		54	204	86S	
20	Apr	3	22	32	36.3	D	98481	F0	7.9*	7.7	76+	122		49	224	67N	Dbl*
20	Apr	4	0	57	47.1	D	98534	K0	7.7	7.0	77+	123		30	260	65S	
20	Apr	4	1	36	17.3	D	1392	G0	7.3		77+	123		24	268	82N	
20	Apr	5	3	25	35.3	D	99123	K0	7.3*	6.5	87+	138		13	275	52N	
20	Apr	5	19	50	21.5	D	99474	F8	8.4		92+	148	-9	37	131	50N	
20	Apr	5	21	30	49.5	D	1622	K2	8.2*	7.6	93+	149		45	161	34N	

Predictions to magnitude 9.0 up to April 5th.

Notes on the Double Star selection.
Doubles are selected from Occult 4, where the magnitudes of the pair are not more than 2 magnitudes different, the fainter companion is brighter than mag 9, and the time difference(dT) is between 0.1 and 5 seconds. **Please report double star phenomena.**

Key:
P = Phase (R or D), **R** = reappearance **D** = disappearance
M = Miss at this station, Gr = graze nearby (possible miss)
CA = Cusp angle measured from the North or South Cusp.
Dbl* = A double star worth monitoring. Details are given for selected stars.
Mag(v)* = asterisk indicates a light curve is available in Occult-4
Star No:
1/2/3/4 digits = Zodiacal catalogue (ZC) referred to as the Robertson catalogue (R)
5/6 digits = Smithsonian Astrophysical Observatory catalogue (SAO)
X denotes a star in the eXtended ZC/XC catalogue.
The ZC/XC/SAO nomenclature is used for Lunar work. The positions and proper motions of the stars in these catalogues are updated by Gaia.

Detailed predictions at your location for 1 year are available upon request.
Occultation Subsection Coordinator: Tim Haymes
tvh.observatory@btinternet.com

LUNAR GEOLOGICAL CHANGE DETECTION PROGRAMME

Tony Cook

Reports have been received from the following observers for Jan: Jay Albert (Lake Worth, FL, USA - ALPO) observed: Aristarchus, Gassendi, Herodotus, Mare Frigoris, Plato, Proclus and Torricelli B. Alberto Anunziato (Argentina, SLA) sketched Macrobius. Maurice Collins (New Zealand - ALPO/BAA/RASNZ) imaged: Atlas, Mare Nectaris, Posidonius, Proclus, and captured some whole Moon images. Anthony Cook (Newtown, UK, ALPO/BAA) imaged the lunar eclipse with a compact camera telephoto and videoed the Moon at low resolution with a thermal imaging camera. Walter Elias (Argentina, AEA) imaged Aristarchus, Atlas, Gassendi, Romer, Ross, Schmidt and Tycho. Johana Gonzalez (Argentina, AEA) imaged: Aristarchus, Censorinus, Mare Crisium, Mare Tranquillitatis, and Plato. Walter Latrónico (Argentina, AEA) imaged Proclus. Lafras Smit (South Africa) imaged earthshine. Trevor Smith (Codnor, UK, BAA) observed Aristarchus, Gassendi, Hyginus, Plato and Proclus. Aldo Tonon (Italy – UAI) imaged Mutus F and Maurolycus. Alan Trumper (Argentina, AEA) imaged Alphonsus, Aristarchus, Le Verrier, Mons Pico, Sinus Iridum, and the Full Moon. Ivan Walton (BAA) imaged several features.

News: readers may be interested in the following Lunar and Planetary Science Conference abstract, for a conference at League City in Texas on 16-20th March - it discusses potential science that a proposed DORN payload could do on upcoming lunar lander missions. I would like to thank Prof Christopher Cokinos for pointing this out to me.

TLP reports: I do not know whether to regard this as a proper TLP or not, but on 2020 Jan 06 UT 22:10 Trevor Smith (BAA) noted, whilst observing Proclus, that Censorinus seemed to had a slight reddish tinge, where as other nearby craters did not. He was using a 16-inch Newtonian reflector and 9.5mm Plossl at x247. However, I think for now I will put this down as a weight 1 report, just to see if we can get visual confirmation when the illumination repeats. Normally Censorinus has a bluish cast, being a relatively young fresh crater.

On 2020 Jan 27 UT 17:58, BAA member Clyde Foster reported that Lafras Smit (28.2E, 27.2S) had taken an image (Fig. 1 – Left) of the earthlit Moon and that it showed a bright point beyond the sunlit south cusp.

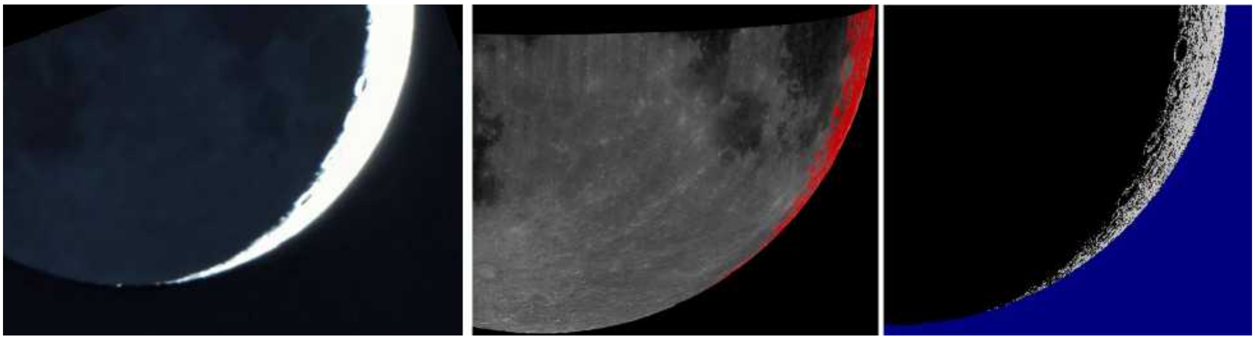


Figure 1 *The southern illuminated part of the lunar crescent for 2020 Jan 27 UT 17:58.* ***(Left)*** *image by Lafras Smit (South Africa).* ***(Centre)*** *A visualization produced by Anthony Cook, using ALVIS – red shows the illuminated limb.* ***(Right)*** *An LTVT visualization produced by Maurice Collins.*

I checked for occultations, using the Occult program, but could not find anything suitably bright. Then I ran my ALVIS simulation software (Fig. 1 - Centre). Although this produced some small illuminated peaks roughly in the right place, these are not especially bright and do not show up well at all in Fig. 1 (Centre). Then I asked Maurice Collins to run LTVT and Fig. 1 (Right) shows the result from this – again sunlit peaks, but not especially bright. Maurice did however remember that he had seen this offset peak before on pervious occasions, so thinks it is normal. The reason why the ALVIS and LTVT programs do not portray the polar areas well is maybe that neither of them is good at modelling simultaneously grazing incidence illumination and grazing incidence viewing angles – and do not take into account the width of the Sun's angular diameter well?

Routine Reports: Below are a selection of reports received for January that can help us to re-assess unusual past lunar observations – if not eliminate some, then at least establish the normal appearance of the surface features in question.

Sinus Iridum: On 2020 Jan 06 UT 04:06 Alan Trumper (AEA) imaged the NW part of the Moon and captured Sinus Iridum under similar illumination and topocentric libration (to within ±1.0º) to the following report:

Sinus Iridum 1996 Apr 28 UT 20:00 Observed by Brook (Plymouth, UK, 60mm refractor, x112, seeing III, slight breeze, twilight) "dark shaded area on floor ~1/4 diameter of Sinus Iridum on western interior by rim" BAA Lunar Section Observation. ALPO/BAA weight=1.

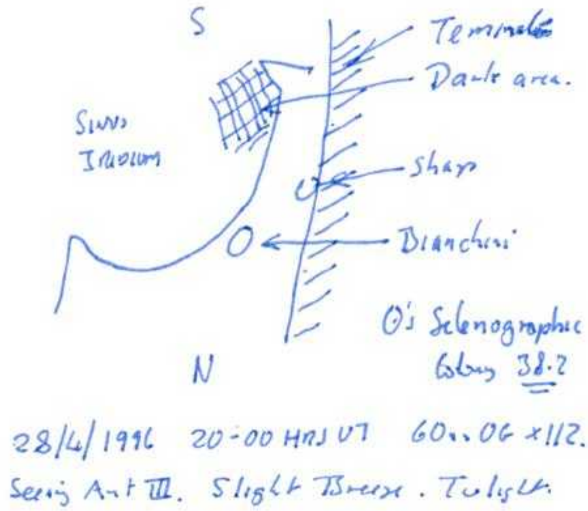


Figure 2. *Sinus Iridum orientated with north towards the bottom.* ***(Left)*** *Colour mage taken by Alan Trumper (AEA) on 2020 Jan 06 UT 04:06.* ***(Right)*** *A sketch made by Clive Brook (BAA) on 1996 Apr 29 UT 20:00.*

As you can see from Fig. 2, the viewing angle in Alan's image is the same as for Clive Brook's TLP report, and illumination is not too dissimilar. However, there is no sign of the shading on the SW floor that Clive Brook saw in Alan's image. However, Alan's image does show a light patch on the east side of the floor which is brighter than the mare to the south. I wonder if Clive was comparing the west side to the east side and not considering brightness relative to the mare? It doesn't quite explain the shape of Clive's dark patch, however as you can see comparing Fig. 2 Right and Left, Clive's sketch has some cartographic issues as the terminator is further to the west than it is in Alan's image. For now, we shall leave the weight at 1. We have studied this region before in past newsletters: 2016 Oct, 2018 May and 2018 Apr.

Gassendi: On 2020 Jan 06 UT 21:13 and 22:05, Trevor Smith (BAA) observed visually Gassendi under both similar illumination and topocentric libration, to within ±1.0º, to the following report:

On 1977 Apr 29 at UT21:40-23:20 an unknown UK observer reported a TLP in Gassendi crater. The following are reports by observers attempting to *confirm activity: J.W. Napper (Didcot, UK, 30cm reflector, x287, Wratten 25 and 44a, conditions clear 5+) received a telephone alert call at 22:00 but the sky was cloudy until 22:30. An initial look revealed nothing unusual, then at 22:54 he observed a colour blink just inside the north wall, appearing bright in red and normal in blue or white light. No loss of detail seen and the effect lasted only 2 minutes. A sketch was made. However, the observer stresses that the very bad seeing casts some doubt on this observation. L. Fitton observed using an 8.5" reflector, with Moon blink device at x200, seeing was I-II. All areas negative, including Gassendi from 21:40-21:55 and again 22;00-22:25 and finally 22:50-23:30 negative. Mike Brown (Huntington, York, UK, 30cm reflector, x220 and x350, seeing 3-4/5, and transparency 5/5) - observed from 22:00-23:25UT no colour seen, nor obscuration, all filters negative, despite seeing a lot of fine detail inside this crater. ALPO/BAA weight=2.*

Trevor, using a 16-inch reflector, noted that everything looked normal with no sign of any clouds or false colour seen. At 22h 05m UT Gassendi still looked perfectly normal. We shall therefore leave the weight at 2.

Gassendi: On 2020 Jan 06 UT 23:08 & 23:09 Walter Elias (AEA) imaged this crater under similar illumination, to within ±0.5º, to the following report:

Gassendi 1966 Apr 30 UT 21:30-23:28 Observed by Sartory, Ringsdore (England, 8.5" reflector, S=E), Moore, Moseley (Armagh, Northern Ireland, 10" refractor, S=VG), Coralitos Observatory (Organ Pass, NM, USA, 24" reflector, Moon Blink) "English moon blink system detected red spots with vis. confirm. Ringsdore says no color but saw obscuration. (LRL 60-in photos showed nothing unusual by my casual inspection). Indep. confirm. (even E. wall was in dark). Corralitos did not confirm by MB." N.B. event had finished by the time Corralitos came on-line. NASA catalog weight=5. NASA catalog ID #931. ALPO/BAA weight=4.

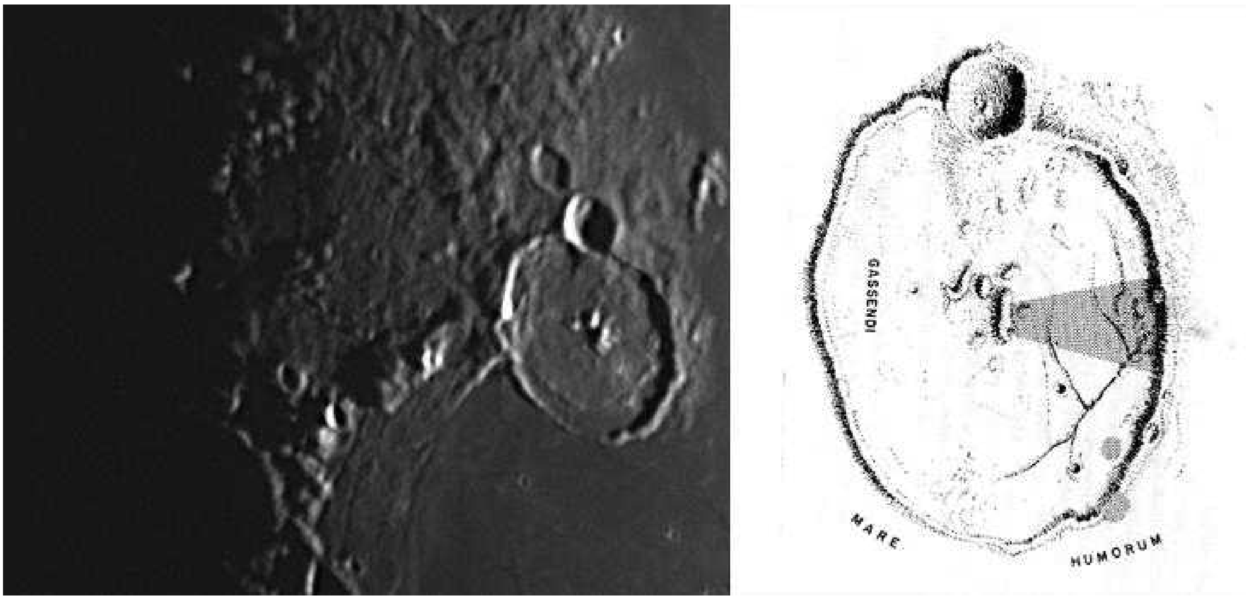


Figure 3. *Gassendi orientated with north towards the top,* ***(Left)*** *as imaged by Walter Elias (AEA) on 2020 Jan 06 UT 23:09 in monochrome and orientated with north towards the top.* ***(Right)*** *a sketch map for the events of 1966 Apr 30 / May 01 from p135 from "The Moon and Planets : A Catalog of Astronomical Anomalies" by William R. Corliss (1985), where shaded areas mark colour phenomena seen.*

Although Walter's image (Fig. 3 – Left) is in monochrome, it can at least address Ringsdore's comments that an obscuration was seen. Quite clearly there is no sign of any abnormal lack of detail, therefore what Ringsdore reported was abnormal. We shall therefore leave the weight at 4.

Proclus: On 2020 Jan 06 UT 22:10 Trevor Smith (BAA) observed visually and at 23:21 & 23:23 Walter Latrónico (AEA) imaged, this region under similar illumination, to within ±0.5º, to the following report:

On 1987 Oct 04 at UT 02:20 D. Darling (Sun Praire, WI, USA, 12.5" reflector, x170, S=8, VG, T=5) obtained the brightest measurement he had ever recorded on the northern rim of Proclus. Brightness 9 and adjacent plain was of brightness 6.5. The Cameron 2006 catalog ID=308 and the weight=3. The ALPO/BAA weight=3.

Figure 4. *Proclus and its surrounds as imaged by Walter Latrónico (AEA) on 2020 Jan 06 UT 23:23 and orientated with north towards the top.*

Walter's image (Fig. 4), although a little saturated on the rim of Proclus, does show that it is very bright, and brighter than Censorinus. A little earlier that evening, Trevor Smith UK had observed visually and found that: *'Proclus looked very bright but not unusually so. That said, it was much brighter than Censorinus'*. I will lower the weight of David Darling's report from 3 to 2 so that we may re-observe and confirm the very bright appearance of Proclus at this colongitude.

Aristarchus: On 2020 Jan 08 UT 00:55-01:35 Jay Albert (ALPO) observed under similar illumination (±0.5º) to the following 5 reports:

Cobra Head 1966 May 02 UT 20:05 Observed by Sartory (England, 8.5" reflector x400) "Eng. moon blink detected red spots, seen visually also". NASA catalog weight=4. NASA catalog ID #934. ALPO/BAA weight=3.

On 1978 Mar 21 at UT 20:57 an Unknown observer observed a TLP in Aristarchus crater. The details for this report are still being looked up in the archives. In view of the uncertain details this TLP has been given an ALPO/BAA weight of 1.

Aristarchus 1982 Jul 03/04 UT 20:55-01:08 Observed by Foley (Kent, UK, Seeing Antoniadi III) "Brightness variance" - CED 3.6-4.1-4.9. When the crater was dark it had a slate-blue-grey interior. Moore found the crater to be exceptionally bright and this was confirmed by J.D. Cook (CED 3.8-4.1). The Cameron 2006 catalog ID=174 and weight=5. The ALPO/BAA weight=3.

S. of Aristarchus 1951 Sep 13 UT 14:00? Observed by Osawa (Japan, 6" reflector) "Brownish-red color, blue on NW rim of A." NASA catalog weight=3. NASA catalog ID #546. ALPO/BAA weight=3.

On 1965 Jun 12 at UT > 00:00 an unknown observer (Porta?) reported that the area of Herodotus and the Cobra Head expanded and the colour went to rose. The next night the floor was normal. In filters, phenomenon accentuated in orange. The Cameron 1978 catalog ID=880 and weight=3. The ALPO/BAA weight=2.

Figure 5. *Aristarchus as imaged in colour using an iPhone by Jay Albert on 2020 Jan 08 UT 01:31 and orientated with north towards the top.*

Jay noted that Aristarchus was the brightest feature on the Moon. However, none of the reported 'red spots' were seen visually. The central peak was nevertheless very bright, and plenty of detailed terracing was visible on the interior walls as well as the usual dark, vertical bands. He was unable to see any significant brightness difference when viewing Aristarchus with W25 red and W44A blue filters. Jay observed at 290x from 00:55 to 01:35UT and attempted to image Herodotus and Aristarchus with his iPhone during this time. One respectable image was captured (Fig. 5) which confirms much of the visual description that Jay gave. We shall leave the respective weights of these TLP as they are for now.

Mare Crisium: On 2020 Jan 10 UT 01:15 Johana Gonzalez (AEA) imaged the Moon under similar illumination to the following report:

In 1954 Jan 19 at UT 03:00 Porta (Mallorca, Baleares, Spain, 3" refractor, x50) observed the following during a total lunar eclipse: "3 brilliant yellowish-white spots between Picard & Peirce. Phosphor. light distinguished easily against grey-green background of mare. Irreg., intermittent. Did not perceive them all dur. totality. Next day had impression that all of area was less clear & lightly veiled.". The Cameron 1978 catalog ID=561 and weight=3. The ALPO/BAA weight=2.

Figure 6. *Mare Crisium as imaged by Johana Gonzalez (AEA) on 2020 Jan 10 UT 01:15 and orientated with north towards the top.*

Although Johanna's image is clearly not in an eclipse, and is an equivalent Full Moon image, it does not reveal any sign of brilliant points between Picard and Peirce. The Moon during a total lunar eclipse is essentially what the Full Moon looks like, i.e. an albedo map, but illuminated by the weak refracted light around the Earth's atmosphere. As these points are not visible in Fig. 6, they should not have been there back in 1954. We shall therefore leave the weight at 2.

Penumbral Lunar Eclipse: On 2020 Jan 10 UT 19:09 Anthony Cook (ALPO/BAA) imaged the Moon during a penumbral lunar eclipse in both visible and thermal infrared light.

Figure 7. *A colour image of the 2020 Jan 10 penumbral lunar eclipse taken by Anthony Cook with a Lumix DMC-TZ80 compact camera on maximum optical zoom. Colour saturation increased to 75%. To bring out the penumbral shadow.*

There are numerous past TLP during past lunar eclipses: total, partial and penumbral. I used a thermal imaging camera on my telescope and a tripod mounted Lumix compact camera for optical imaging. Alas the thermal IR camera was being used for the first time (so I was not used to using it) and there were plenty of clouds and haze in the way – therefore this was a bit of a failure and no recognizable lunar features could be seen and no obvious sign of the shadow. The optical images though were a bit more successful and I show one of these in Fig. 7, one minute before eclipse maxima. You can just make out the penumbral shadow in the lower part of the Moon.

Macrobius: On 2020 Jan 14 UT 04:00-04:30 Alberto Anunziato (SLA) sketched this crater under similar illumination (±0.5º) to the following report:

On 2005 Oct 21 at UT 13:07-14:27 R. Gray (Winnemucca, NV, USA, 15cm F/9 refractor, x228, seeing 4-5, transparency 5-6) observed a possible TLP in Macrobius. His report is as follows: "Blinked Macrobius with Wratten Filters Blue 38A and Red 29. Macrobius became almost invisible through the Blue 38A and essentially the same as in white light through the Red 29. The interior of the crater was completely in shadow. The only part of the east wall that was visible was an apparent high point still in the sun and seen as a bright point of light. This faded into darkness before 13:56UT. No sign of any illumination of the east wall crater interior or the interior of the west wall was seen during the observation period. The outer west wall was a rough looking, complicated mix of deep shadow and illuminated sunlit terrain." The observer concluded that there was not a TLP - although he did get a filter reaction, this may have been due to the different densities of the filters? ALPO/BAA weight=2.

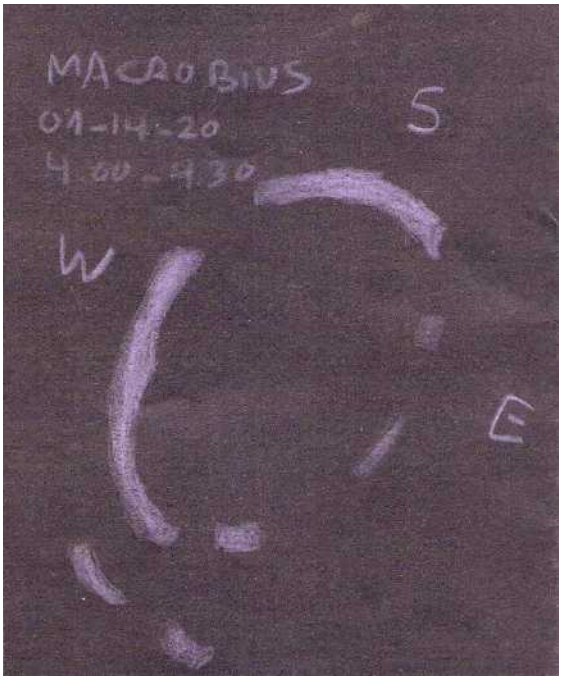


Figure 8. *Macrobius as sketched by Alberto Anunziato (LSA) on 2020 Jan 14 UT 04:00-04:30. Orientated with north towards the bottom left.*

Alberto's sketch (Fig. 8) confirms that the crater is entirely shadow filled at this colongitude, and that the eastern wall has parts of the rim still sunlit, though not a continuous rim. We don't have a sketch from the Robin Gray report, so Alberto's sketch is helpful in our understanding of Robin's description. As Alberto notes no colour, we shall leave the weight of Robin's TLP report at 2.

Copernicus: On 2020 Jan 18 UT 14:46 Ivan Walton (BAA), remotely logged in via the BEN 6-inch telescope in Amado, AZ, USA (part of the Micro-Observatory Robotic Telescope Network, hosted by the Harvard-Smithsonian Center for Astrophysics or OWN – Observing With NASA) to capture an image of the Moon containing Copernicus, close to the following ±0.5° repeat illumination window for the following report:

Copernicus 1996 Sep 06 UT 01:45 Observed by C Brook (Plymouth, UK, 60mm refractor x28, x112, transparency, not good) "Shadows of central mountains could not be seen although the shadows on the crater ramparts were visible" BAA Lunar Section report. ALPO/BAA weight=2.

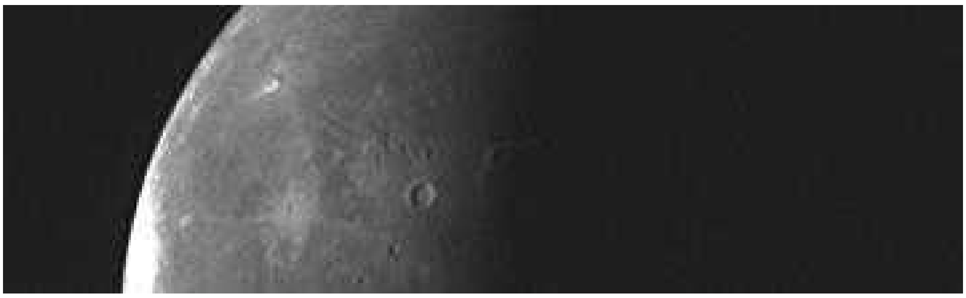


Figure 9. *The Oceanus Procellarum region, containing Copernicus, orientated with north towards the top. Image by Ivan Walton (BAA).*

The great thing about using robotic telescopes is that you can observe from somewhere else in the world even though it might be daylight where you are. It is also a good way of dealing with lunar phases that are best observed during normally anti-social hours. Indeed, we have relatively few images at this particular phase. Although Ivan's image (Fig. 9) is only of relatively moderate resolution, it does at least show Copernicus as it would have been seen through Clive Brook's 2" refractor. We shall leave the weight at 2 for now.

Aristarchus: On 2020 Jan 20 UT 15:45 Maurice Collins (ALPO/BAA/RASNZ) took a low-resolution Canon 1200D 250mm-fl telephoto shot of the Moon at around the same time that similar illumination occurred for the following TLP:

On 1987 Oct 17 at UT17:00-18:00 (in daylight) J. Moeller (Kerkville, NY, USA, 6" reflector, x80-x135) observed that Aristarchus had a long trench-like feature going off to the north west limb. On the 18th this feature was more cloud like, "bright white and opaque. (Trench = Schroter's Valley? Similar to 10/13/67)". The Cameron 2006 catalog ID=311 and the weight=1. The ALPO/BAA weight=1.

Figure 10. *The NW area of the Moon taken on 2020 Jan 20 UT 15:45 by Maurice Collins and orientated with north towards the top.*

Although Maurice's image (Fig. 10) is of low resolution, at this stage in the lunar phase we have very little in the way of observations, so at least it gives us a context view around the crater. There is some wrinkle-ridge like features between Aristarchus and the limb. I wonder if any of those could have been mistaken for a 'trench-like' feature? Curiously, at this resolution, the pair of features: Reiner Gamma and the crater Reiner look like a light cloud and its dark shadow. They obviously are not cloud and shadow, but it illustrates how resolution can play tricks on one's interpretation of the lunar surface. We shall leave the 1987 report at a weight of 1 for now.

Maurolycus: On 2020 Jan 31 UT 18:22-18:32 Aldon Tonon (UAI) imaged this crater for a lunar schedule event for the following past TLP report:

ALPO Request: On 2012 Feb 28 Raffaella Braga noted that only the tip of the central peak was visible. Most of the crater was in darkness - this was normal at this stage in illumination. When viewed through a red filter, the central peak was visible, but however when viewed through a blue filter it was invisible. Please try to observe this crater visually with red and blue filters, to see if you can replicate this effect? If so, then check for similar effects on other craters on the terminator. Otherwise try to obtain some high-resolution colour images. This work is suitable for telescopes of 4" aperture or larger - if you have a choice of a refractor or a reflector, please try the refractor.

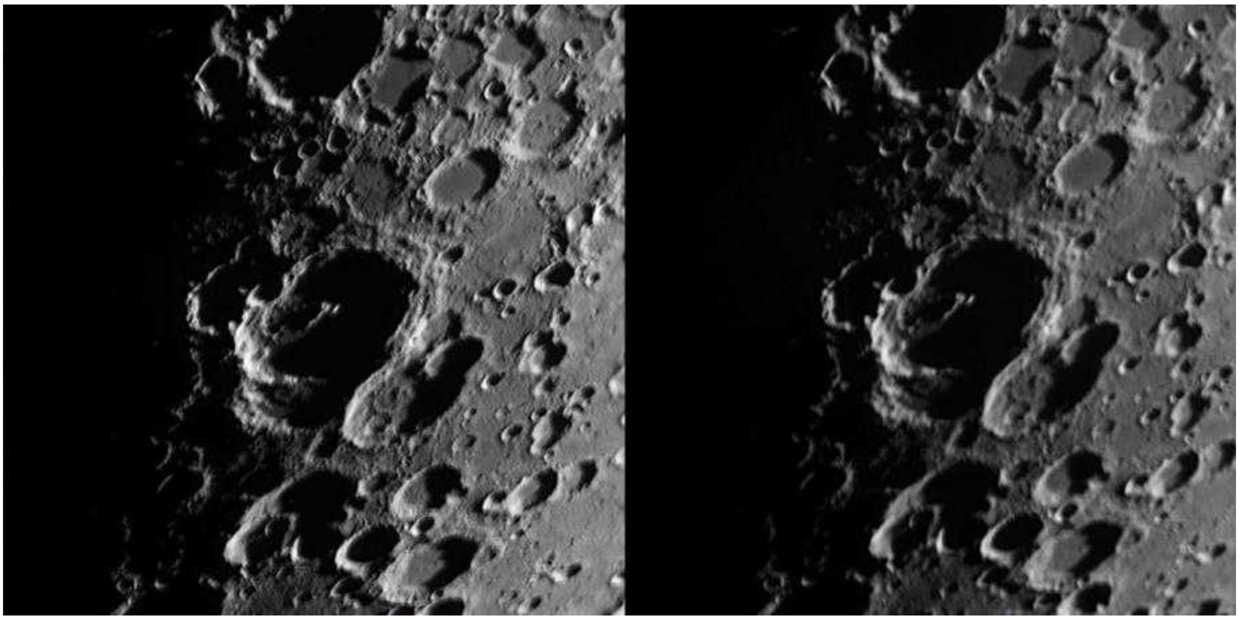


Figure 11. *Maurolycus orientated with north towards the top, as imaged by Aldo Tonon (UAI), on 2020 Jan 31.* ***(Left)*** *18:23 UT – Red filter.* ***(Right)*** *18:26 UT – Blue filter.*

In Fig. 11 we see a couple of Aldo's red and blue filter images. Quite obviously the central peaks area of Maurolycus stand out from a mostly shadowed floor as was stated was normal in the description by Raffaella. However, it is clearly visible in both the red and blue filter images in contrast to what Raffaella describes. We shall keep the Raffaella TLP report at its current weight of 2.

General Information: For repeat illumination (and a few repeat libration) observations for the coming month - these can be found on the following web site: http://users.aber.ac.uk/atc/lunar_schedule.htm . Only by re-observing and submitting your observations in this way can we fully resolve past observational puzzles. To keep yourself busy on cloudy nights, why not try 'Spot the Difference' between spacecraft imagery taken on different dates? This can be found on: http://users.aber.ac.uk/atc/tlp/spot_the_difference.htm . If in the unlikely event you do ever see a TLP, firstly read the TLP checklist on http://users.aber.ac.uk/atc/alpo/ltp.htm , and if this does not explain what you are seeing, please give me a call on my cell phone: +44 (0)798 505 5681 and I will alert other observers. Note when telephoning from outside the UK you must not use the (0). When phoning from within the UK please do not use the +44! Twitter TLP alerts can be accessed on https://twitter.com/lunarnaut .

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