Editorial.

In the northern hemisphere we are now in the middle of Summer with the Sun just past its highest declination. Unfortunately, following the ecliptic across the sky, this implies that for evening apparitions of the Moon, the lunar declination and altitude are dropping fast and observing opportunities during evening social hours are starting to ebb away. Fortunately for our southern hemisphere observers the reverse is true! On the plus side, if you have ever wondered what the lunar surface looks like in the last quarter stage +/- a few days, and do not mind awaking in the early hours in the morning, then mid-Summer onwards until Autumn, provides an excellent opportunity to capture some really spectacular views for us northerners. For others, like me, who do not relish getting up in the early hours, before sunrise, using near-IR filters allows one to do some daytime observing, as the sky is pretty dark at these wavelengths – though I find the seeing is best early on during the day before the Sun has started to warm everything up. BAA members, Rod Lyon and Bill Leatherbarrow have great experience in near-IR daylight imaging with IR-Pass filters. According to the Rayleigh scattering law, if you double your wavelength, the daylight sky is 16x darker – though your optical resolution goes down by a factor of two. Beware though this rule breaks down the closer you are to the horizon, or the Sun in the sky, due to scattered light off aerosols and dust particles. If you do attempt daytime observing, please be very careful not to accidentally point your telescope at the Sun.

Talking about wavelengths, although it is relatively easy to take a colour image of the Moon, normalize the colours, then increase the colour saturation to reveal a colour-enhanced view of the lunar surface, what do those colours actually mean? On Wed 20th July, 7PM BST UK time, we will learn the answer to this as there will be a BAA Webinar: "Backyard Lunar Mineral Prospecting" by Dr Mark Kidger of the European Space Agency European Space Astronomy Centre and Juan José Godoy Carrera. To join the Zoom webinar please click on the link below. This will install the Zoom software if you do not already have it on your computer and then allow you to join the meeting. You may click on the link in advance to install the Zoom software prior to the webinar.

Click to join: https://us02web.zoom.us/j/548739039

Alternatively you can watch the live streaming on our BAA YouTube channel.

The recording will be available to watch later on YouTube, for those who missed the live broadcast.

Tony Cook.

Communications Received.

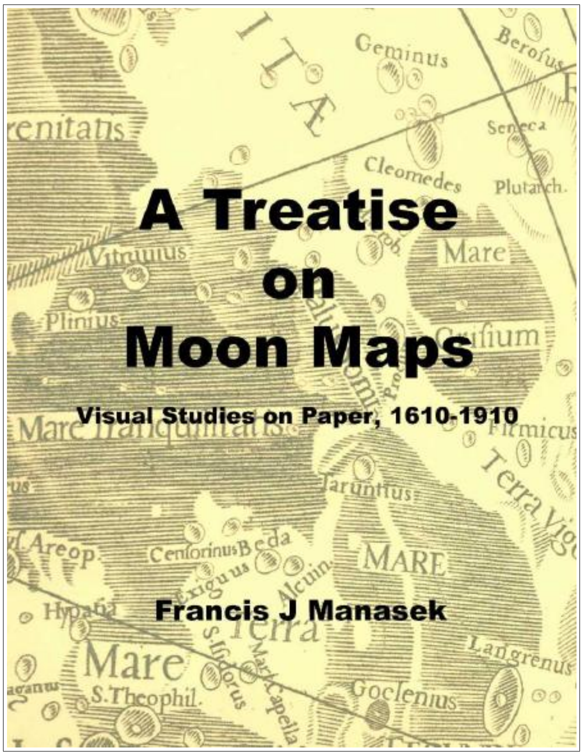
Bibliography of the Moon.
By James Dawson.

"I stumbled on this document on the internet which is fascinating. I thought I'd share with you both in case you'd not seen it before. I started to go through it to see if there were any books I should get, but the file is so long, I got stuck at D!"

Bill Leatherbarrow responds: *"This bibliography is an early effort in the USGS Flagstaff lunar project. Note Dai Arthur's involvement - he went from the BAA to Kuiper's lunar group, eventually fell out with Kuiper and went to the USGS. It is still a useful historical listing even today."*

A Treatise on Moon Maps.
By Bob Garfinkle FRAS.
Union City, CA
Asteroid 31862 Garfinkle
JALPO Book review editor.

"I want to let all of you Moon lovers on Rik Hill's list, and a few others, know about a fantastic new work covering Moon maps from 1610 to 1910. The fantastic work is only available for a free download at: www.fmanasek.com/Intro.pdf . The author is not going to publish the book otherwise. It is a big download, so it may take about 3 minutes to download. I have attached the cover artwork (below). *I am going to write a review of it for a couple of journals"*



Tony – Note that the link given above is just for the Introduction. If you want the whole book by Francis J. Manasek, then click on: https://moon.fmanasek.com/Book.pdf - as Bob says, the book is free !

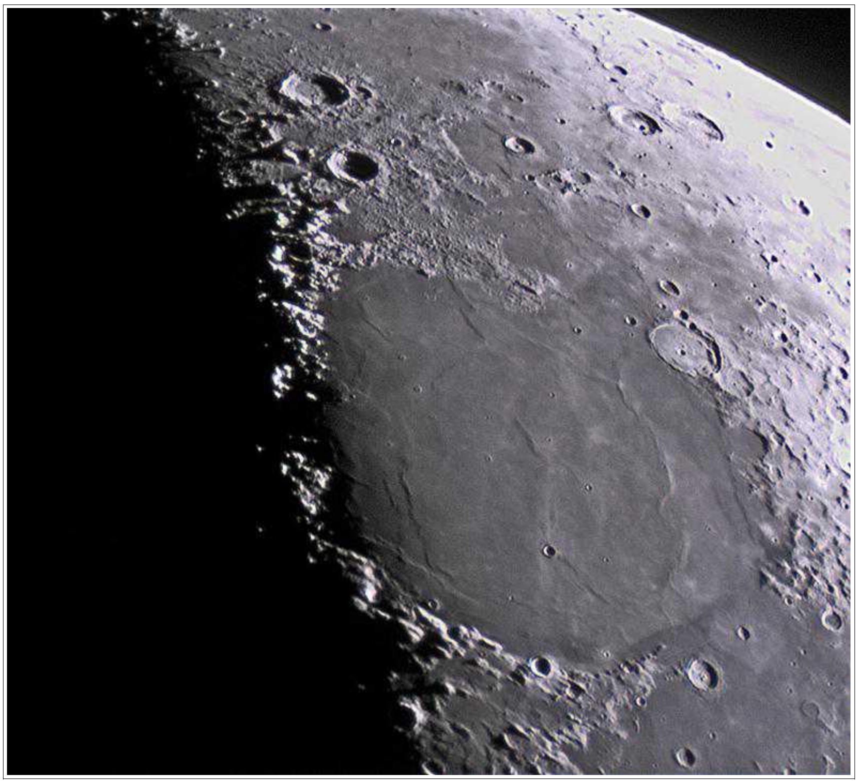
Correction.
In the April section circular, on p7 the observer for Fig 2 (Right) should have been: "Mário Rui Abade" – our apologies over this.

Obituary
Brendan Shaw (1956-2022)
by Tony Cook.

I received an email from Brendan's partner, Mary, that Brendan had quietly passed away in his sleep on the 6th June. Brendan was one of our expert lunar digital photographers, and very active in the BAA Lunar Section from as early as 2002 until 2015. He contributed many images to the repeat illumination programme, and on 2003 May 9 obtained an image of the shadowed floor of Tycho which appeared to show a faint patch where the central peak should have been. Calculations showed that this should not have been illuminated at the time as the Sun was just 1.2° above the horizon, i.e. too low for light to directly reach the floor of the crater or even the top of the peak. Scattered light from the sunlit rim was a possibility, but repeat illumination observations have posed a challenge to replicate this effect.

I am indebted to Mary for providing the following information: *Brendan was born in 1956 and grew up in Anlaby near Hull, UK. His interest in astronomy was sparked when he was very young and read all about comets in his Ladybird book (British children book series akin to the "How & Why Wonder Books" in the US). His dad took him out into the garden to have a look at the night sky and he never looked back. His degrees were in Geology and he and Mary spent many happy hours on beaches looking for rocks and fossils. He was especially interested in astrogeology and managed to acquire a tiny bit of moon rock which was the pride of his collection. He worked in IT all his life but retired about ten years ago and really enjoyed living in Devon where he threw himself into village activities. He was one of the most generous people Mary ever knew and was always happy to share his knowledge. He got very involved with his local U3A and ran some really popular exhibitions at the local library. He was diagnosed with mesothelioma at the end of last year, and it was hoped that he would have more time, but he was able to slip away very peacefully in his own home in the end. He will be very much missed. Mary likes to think of him watching the moon and the stars now but, from closer up.*

A note from Maurice Collins: *"I would like to dedicate this image* (below) *to my long time Moon friend Brendan Shaw of Devon, UK, who has just passed away. I still use the software he developed each time I look up the age of the Moon for my images, and others he developed. I hope he is up there somewhere getting a closer look at the Moon and Universe! Ad Astra and R.I.P. my friend you will be missed."*



Mare Serenitatis as imaged by Maurice Collins on 2022 Jun 06 UT 05:55. North is towards the top. Note several wrinkle ridges present on the impact basin lava flooded floor.

Images and drawings have been received from the following: Phil Masding, Mark Radice, KC Pau, Alexander Vandenbohede, Paul Abel, Rik Hill, Massimo Alessandro Bianchi and Aldo Tonon, Dave Finnegan and Rod Lyon.

Hadley Rille.

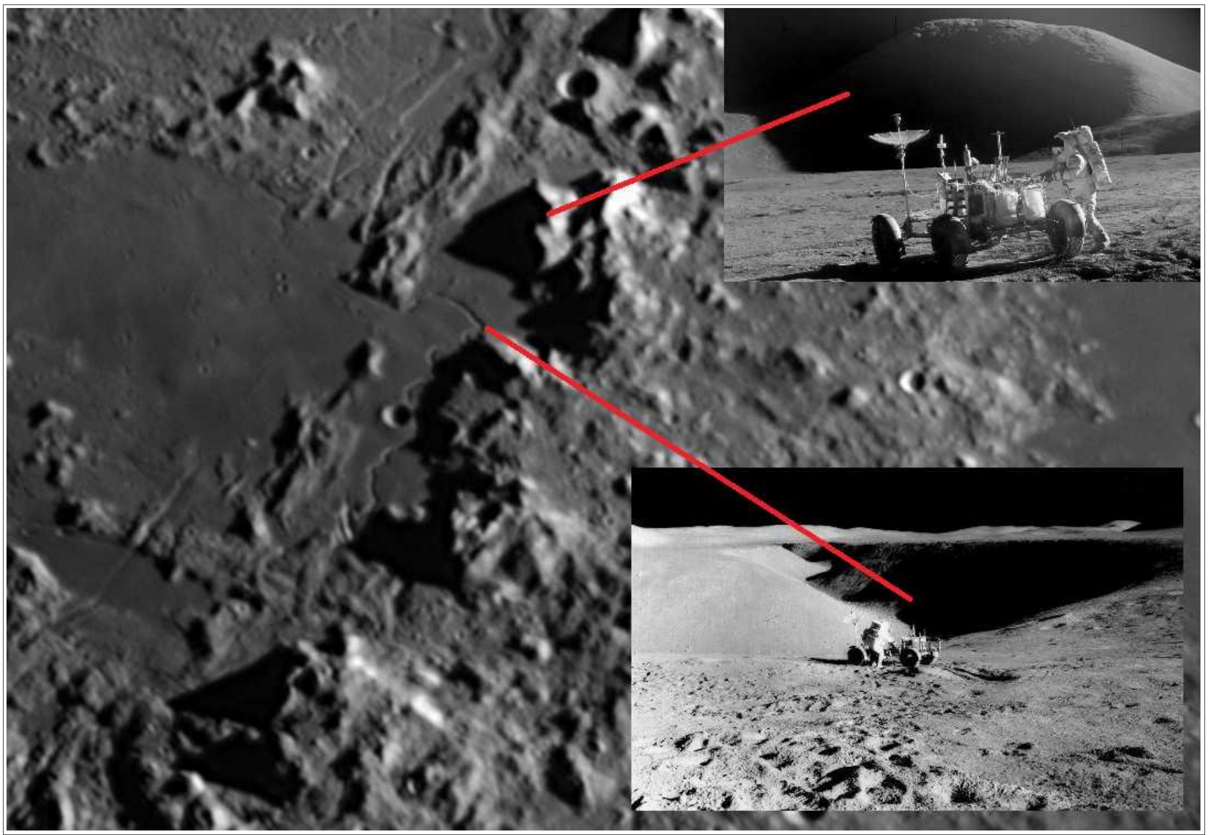


Fig.1 Hadley Rille by imaged by Phil Masding using a 'rather old' 250mm Meade LX200 and a ZWO ASI 290MM, IR pass filer.

Phil comments: *"Resolving the rille along almost its entire length is always a test of the seeing. The top inset show astronaut Dave Irwin with a large mountain in the background. I think this is mount Hadley as indicated but I could be wrong! The other inset shows the rover near the sharp bend in the rille."*

Editor comments: As Phil says, it may be a 'rather old' 250mm Meade LX200, but it has managed to capture an extremely detailed view of the Hadley Rille and the Apollo 15 landing site. The image shows the elongate source vent Béla just emerging from shadow to the south of the crater Hadley C, which itself just nicks the western rim of the rille to the south of the landing site. The 1.5km wide Hadley Rille was one of the main targets of the mission, and photographs taken by the astronauts of the western walls revealed layers of basalt interspersed with thin layers of regolith, showing that the turbulent lavas that carved the rille cut down into the mare surface probably by a combination of thermal and mechanical erosion. In the upper inset image Mt. Hadley looks no more than a vigorous stroll away, it is in fact some 12kms away, and reaches a height of over 4000m above the mare surface. The embayment containing the rille opens out into Palus Putredinis, the surface of which has some subtle features such as dome like structures (visible in this image to the west of Hadley C) and a pair of small (2km diameter) craters formed by the impact of a binary asteroid.

Flamarrion.

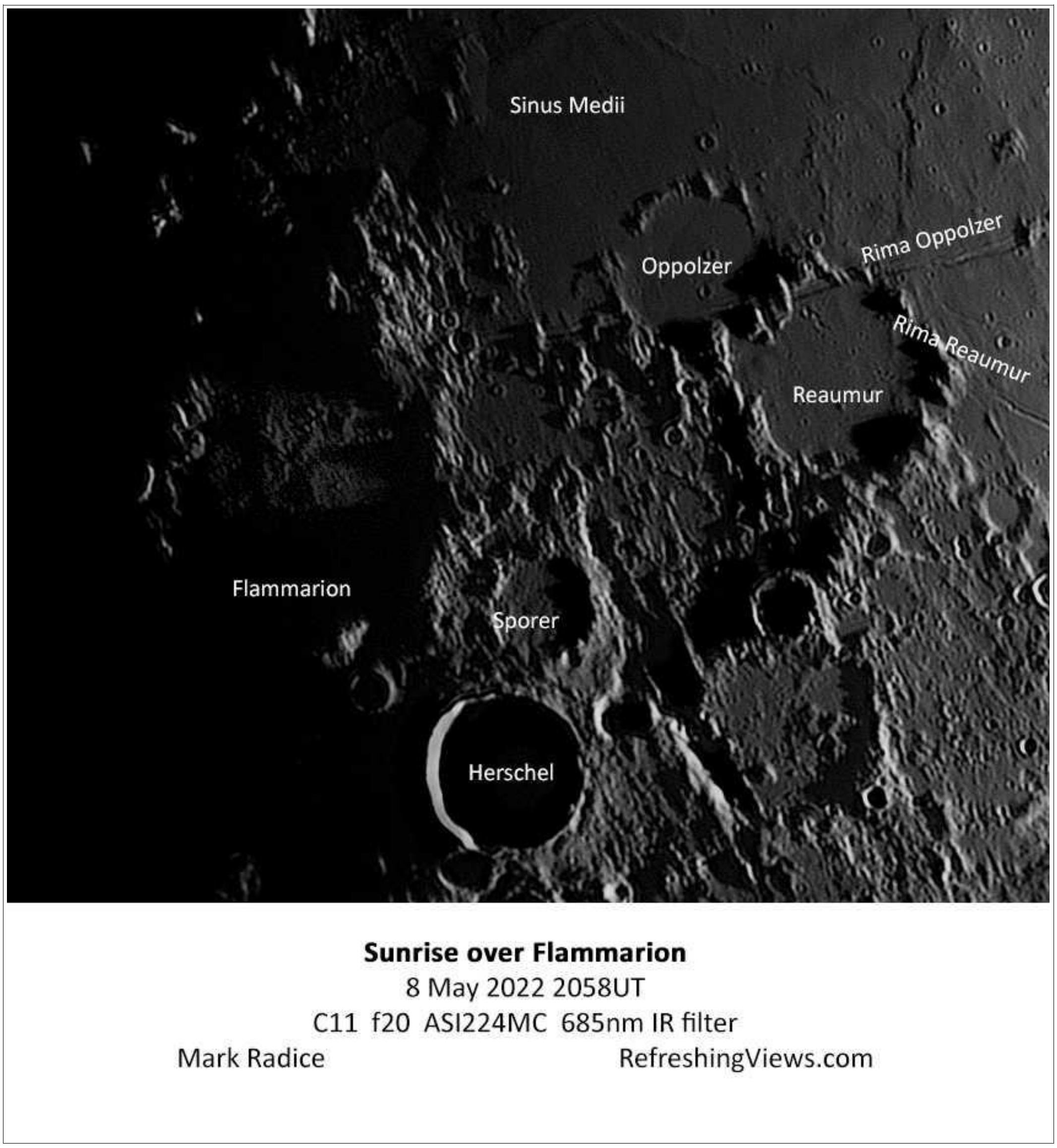


Fig.2 Flamarrion imaged by Mark Radice. Details of time and equipment shown with image.

Editor comments: Mark's image shows this ancient Pre-Nectarian crater as the sun starts to illuminate its floor, which is probably composed of Imbrium ejecta or 'Caley Formation' deposits. The rim exhibits lineations of the Imbrium Sculpture which is believed to have formed as Imbrium basin ejecta scoured the surface, and the rims of Reaumur and Oppolzer also show this modification well. The floor of Flamarrion, under slightly more advanced illumination shows what appears to be a number of domes, orientated almost in lines along a north-south axis. These were drawn by Harold Hill and appear in his Portfolio of Lunar drawings (p.101) though in the accompanying text he points out that there have been doubts as to their existence and the fact that they were not spotted by early lunar observers. Telescopically, these features are quite conspicuous under the correct illumination, but the LRO images of the crater floor reveals no obvious domes, so what is being observed is extremely subtle topography! This is another example of the utility of visual observation, as these features are clearly present but extremely inconspicuous in the spacecraft data. What they are requires further investigation of the available data, could they be domes buried by Caley Formation deposits or are they just random undulations? Answers on a postcard to the Editor please!

The Fra Mauro 'Pearl Necklace'.

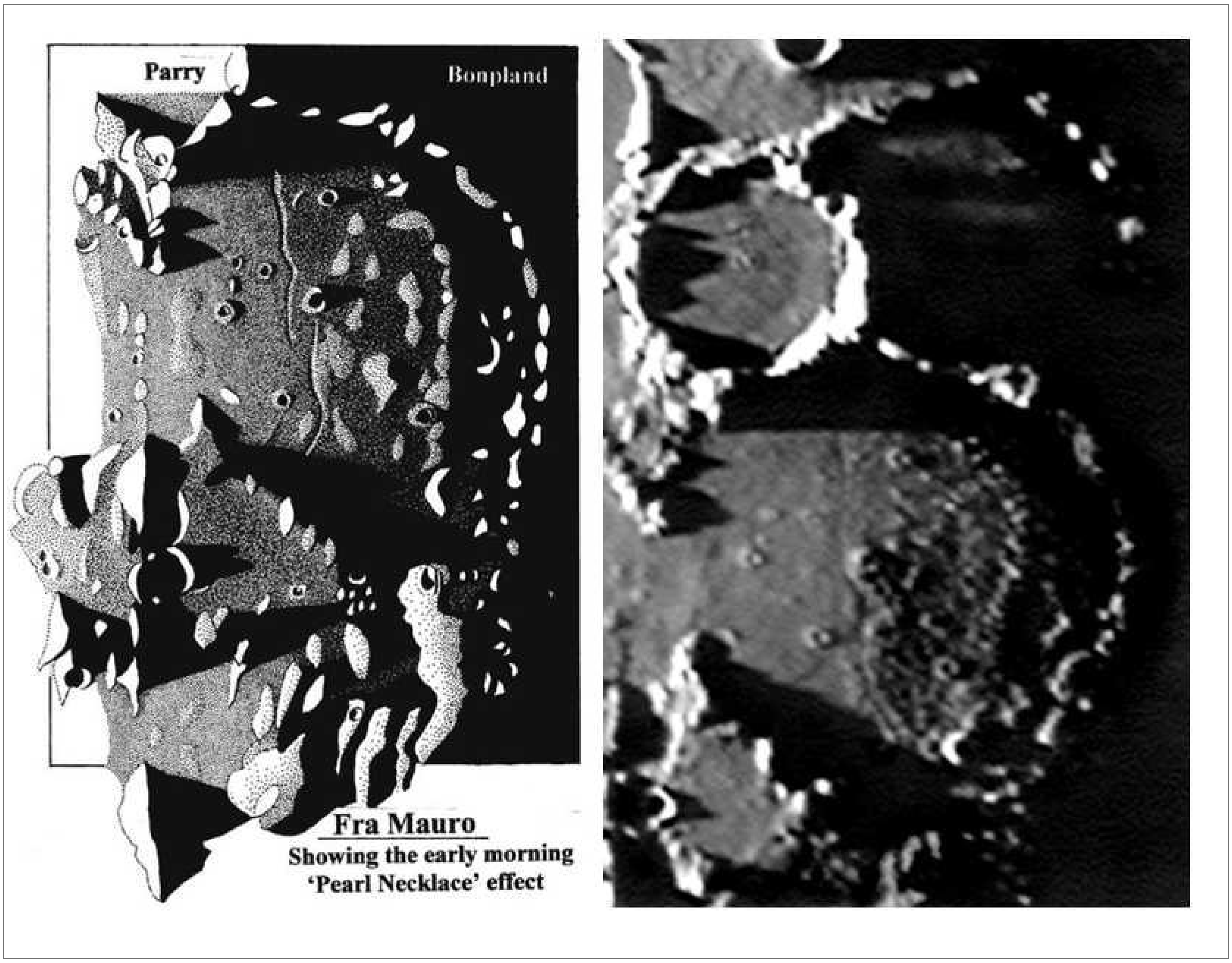


Fig. 3 The Fra Mauro 'Pearl Necklace' by KC Pau.

K.C comments: *The Fra Mauro 'Pearl Necklace' was mentioned by Phil Morgan in 2007 November issue of LSC. My photo was taken with 250mm f/6 Newtonian with 2.5X barlow and QHYCCD290M camera on 15July2005 at 12h13m UT. The colongitude is 18.2 degree, which is a bit later than that of Morgan's drawing. I put Morgan's drawing and my photo side by side for comparison. I admit that the photo could not express the spectacular view of the necklace as the drawing did. It seem that the visual impression of the necklace is quite different from that of photographic means. In my photo, the southern neighboring crater Bonpland also shows the small-scale pearl necklace effect.*

Editor Comments: Apart from the rather spectacular 'pearl necklace' effect drawn by Phil and imaged by K.C, both images show the rugged 'Fra Mauro Formation' deposits that occupy the western half of the crater. This is thought to represent Imbrium ejecta, and was the target of the Apollo 14 mission. It is considered one of the only two missions to land in the lunar highlands, though to be fair this is not strictly the 'Lunar Highlands' as it does not represent the primordial anorthositic crust that formed from the original magma ocean. However, despite the pedantry, the breccias collected during the EVA's enabled researchers to pin the age of the Imbrium impact to 3.85 billion years ago, a major event in lunar geological history. I would agree with K.C. that the drawing captures spectacular detail and is a fine example of lunar drawing.

Vallis Inghirami.

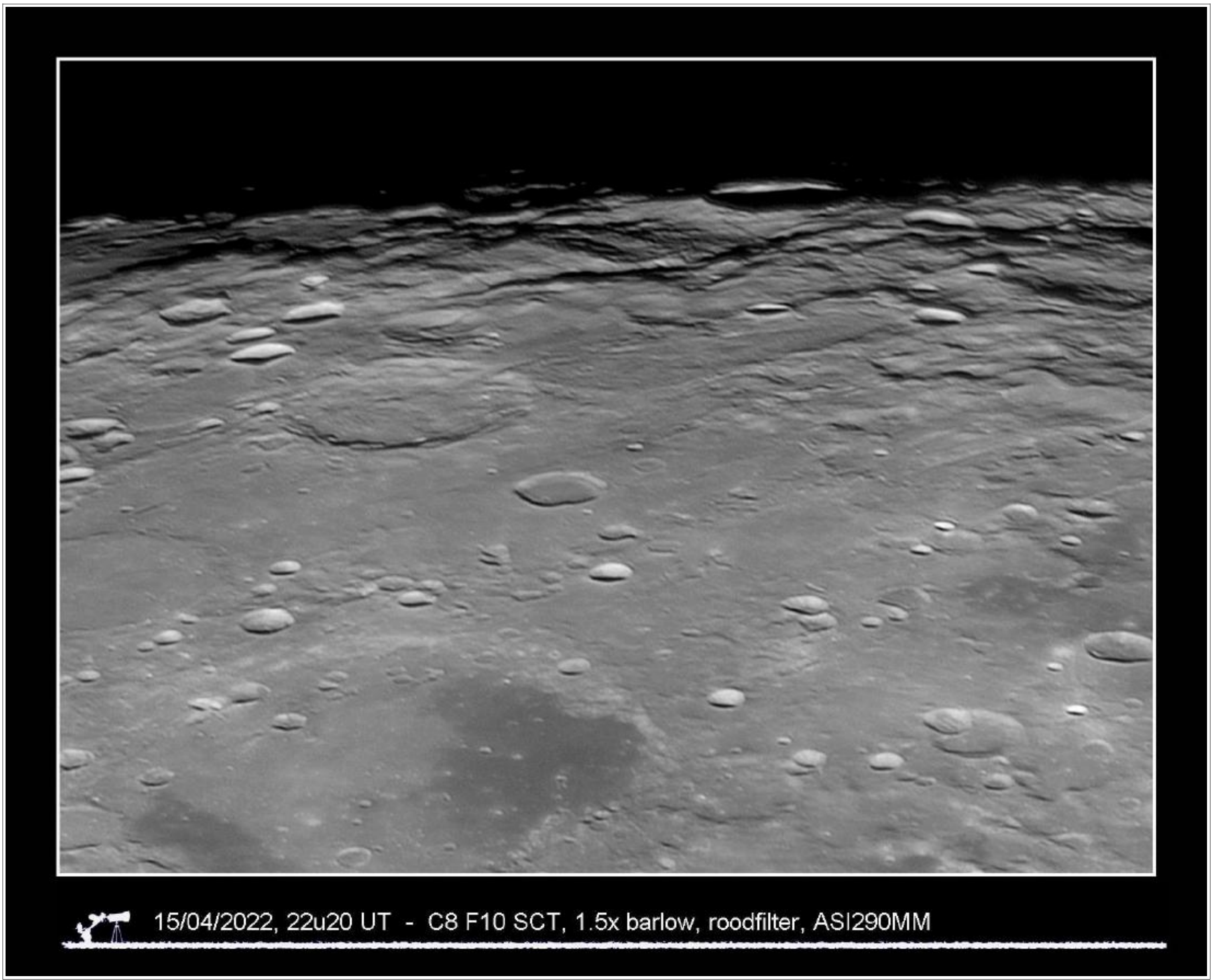


Fig.4 Vallis Inghirami by Alexander Vandenbohede – time and equipment details shown in the image.

Editor comments: Alexander's image captures Vallis Inghirami as it stretches from the top right of the frame, down and into the crater Inghirami, which is just left of centre. This 'valley' is radial to the Orientale Basin and consists of deposits of the Inner Hevelius Formation, which is basin ejecta that appears to have travelled *across* the surface rather than being ejected on a ballistic trajectory from the impact point. This material has a distinctly 'ropy' texture when seen in the spacecraft images, and the floor of Inghirami is covered with deposits bearing a 'flow front' type morphology with concentric ridges and dune like structures. These were once described as 'deceleration dune' (as it was thought they may have been formed as the ejecta encountered obstacles, stalled and was deposited on the surface) but the mechanics of their formation was something of a mystery. Whatever their nature, these deposits appear to have contained abundant impact melt, and their morphology is similar to that of lava flows, whilst their distribution tends to favour topographic lows such as craters and depressions. This image also captures a nice lobe front like feature in Inghirami Q, just beyond Inghirami itself, which is also composed of Hevelius Formation material. Whether there is actually a valley anywhere underneath these deposits is a moot point, and the appearance of a trough may simply be a result of the radial texture of the Hevelius Formation and not a valley in the tectonic sense.

Agatharchides A and Rimae Hippalus.

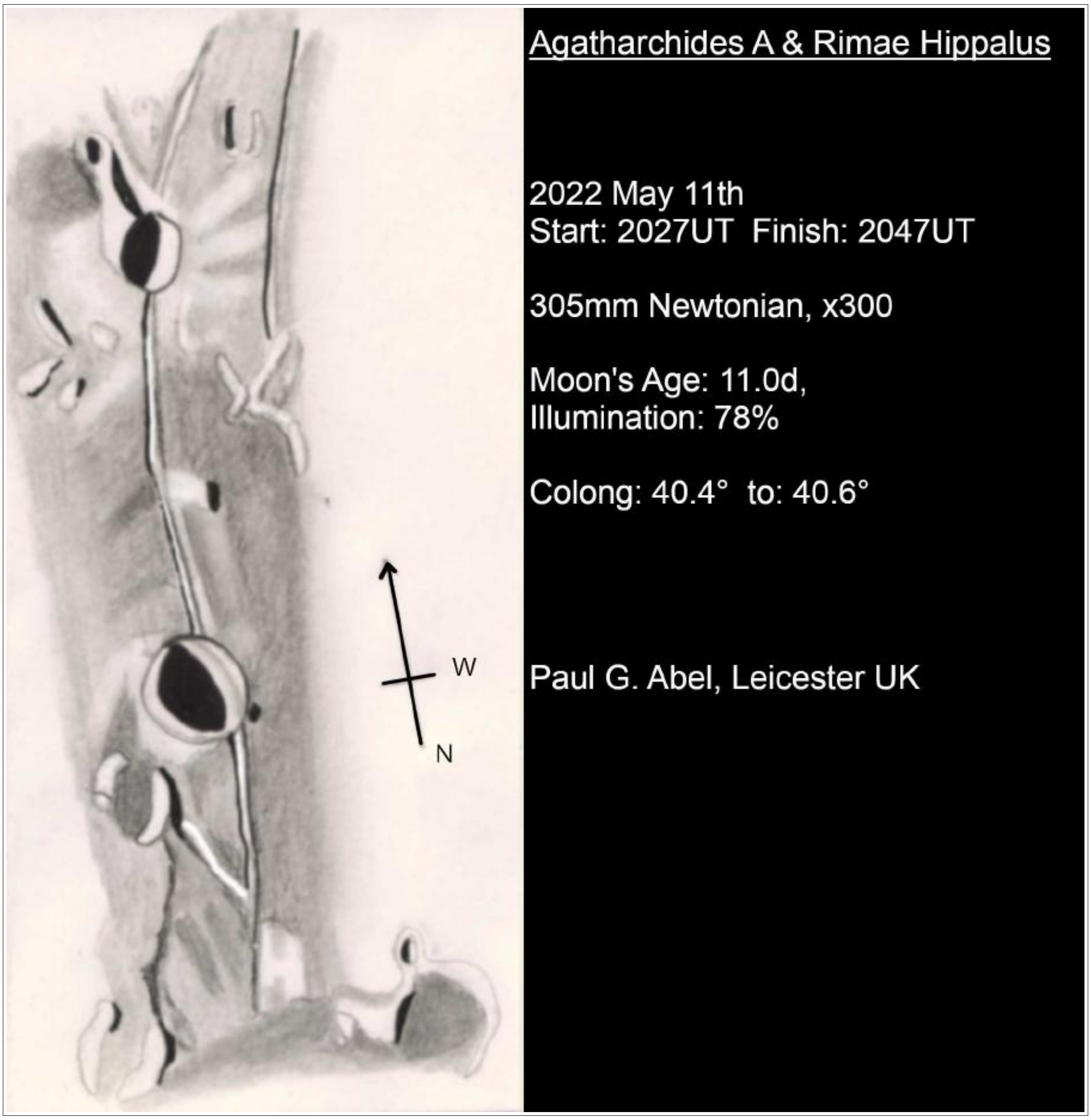


Fig. 5 Agatharchides A and Rimae Hippalus drawn by Paul Abel. Details off date and equipment noted in drawing. Observing conditions described as *clear with seeing around AIII.*

Paul comments: "*Agatharchides A is an interesting satellite crater. The Hippalus Rille system passes by the crater and tonight the region was well presented. I decided to make a strip drawing of the region with the start and end point of the rille system and the craters which it passes by. Unfortunately the seeing conditions were not particularly good and so there isn't a lot of fine detail in the sketch. Still, most of the rille is show*"

Rimae Hippalus is is the name given to the concentric graben that skirt the eastern shore of Mare Humorum, and formed as the central part of the basin subsided due to loading from the basalt lavas that erupted into it. There are three conspicuous concentric graben, and Paul's drawing shows the outermost (furthest east) with the younger craters Agatharchides A and Campanus A superimposed on it. This section of graben is Rimae Hippalus III, the inner ones being being Rimae Hippalus I and II. There is a much fainter graben sharing this concentric trend just to the east of Agatharchides A, but this does not appear to have an IAU designation, whereas another faint graben to the south-east gets the designation Rimae Hippalus IV, despite trending NE-SW and therefore probably being unrelated to the concentric ones. The slightly asymmetric Agatharchides A may have formed by a low angle impact from the west as it has a Zone of Avoidance in its ejecta on this side.

Gassendi.

Fig.6 Gassendi imaged by Maurice Collins on 10th June 2022 at 0855UT using an ETX90 and QHY5III462C.

Editor comments: This image of Gassendi and Mare Humorum by Maurice shows sunrise over crater, illuminating the eastern side of the central peak and east facing slopes of the western rim. It also picks up Rimae Hippalus I,II and III which skirt the eastern edge of Mare Humorum, with Agatharchides A being the prominent crater sitting on top of Rimae Hippalus III as drawn by Paul Abel and shown in Fig.5. Note how the wrinkle ridges within the mare follow the same curvature as Rima Hippalus, as both formed in response to the down warping of the central part of the basin, with compressional forces forming the ridges and tensional forces the graben. Just to the west of Pitatus, on the right edge of the image you can see the Concentric Crater Hesiodus A, and also make out the 'donut' shaped torus located within the rim. The heart shaped crater Wolf can be seen to the north of Pitatus within Mare Nubium, and is located at a low point within the mare. Wolf has an unusually silica rich mineralogy, similar to the Lassell complex to the north-east (out of the frame) and may represent an exotic form of volcanism. It is even possible that Wolf is not an impact crater at all but a volcanic caldera of some form.

Linné.

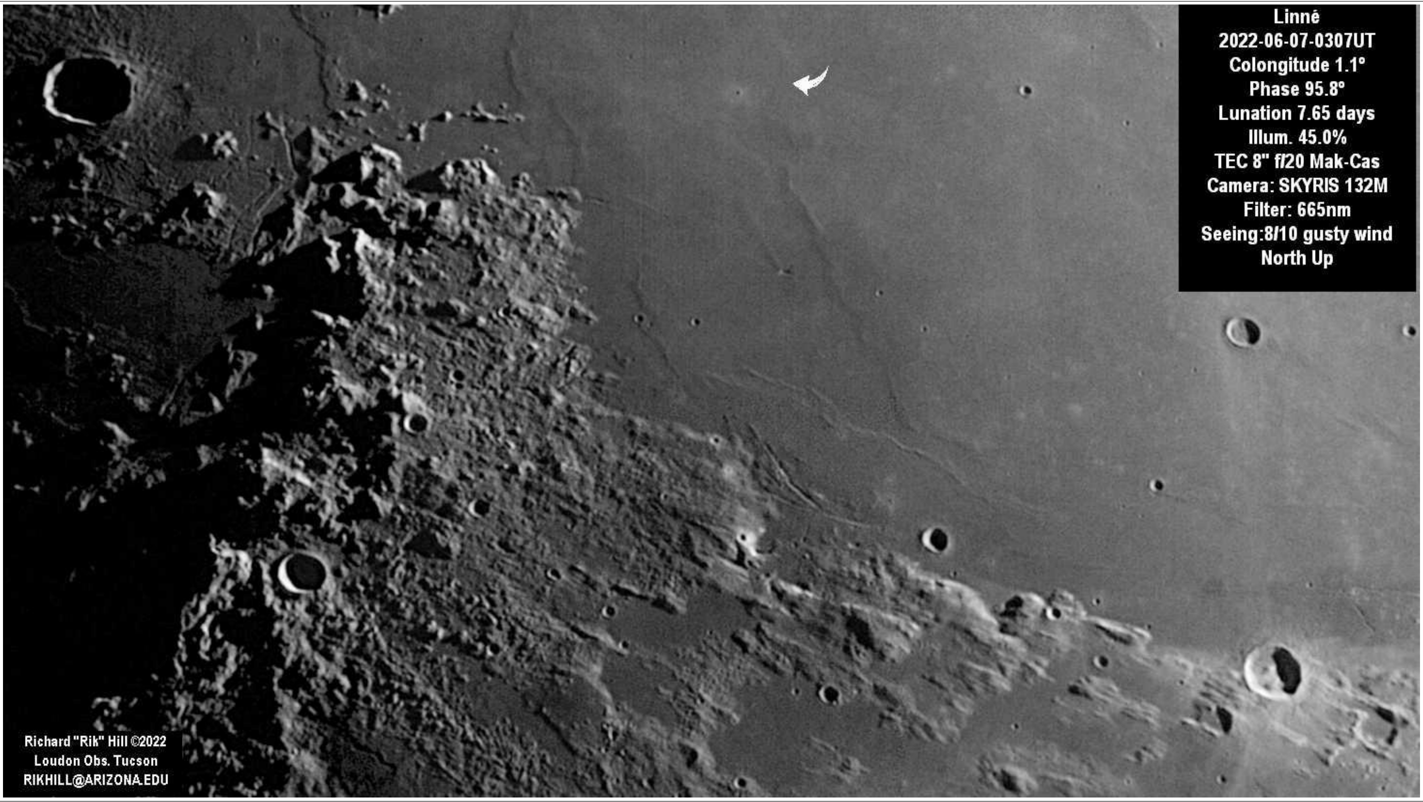


Fig.7 Linné imaged by Richard Hill and made from parts of two 1800 frame AVIs stacked with AVIStack2 (IDL) and combined with Microsoft ICE. Finish processing was done with GIMP and IrfanView.

Rik Comments: "*This is the same region done in an image I posted about a year ago, with some important differences. The extent of this image runs from Autolycus (41km dia.) in the upper left to Menelaus (27km) in the lower right.Note to the right of Menelaus the small Rimae Menelaus with more of them just above almost orthogonal to these making up more of the rimae system. This crater sits on the southern coastline of Mare Serenitatis and the rimae, or most of them, are parallel to this coastline caused by subsidence as the lavas cooled. Just to the left of Menelaus is a smaller crater with a much larger name, Sulpicius Gallus (12km) and above this are another series of rilles, Rimae Sulpicius Gallus alsoparallel to the coastline. The grand mountain range on the left side of this image is the northern portion of the Montes Apenninus with the brightly lighted peaks reaching 4,000-5,000m height.*

But the highlight of this image is the little white blemish in Mare Serenitatis north of the Rimae Sulpicius Gallus just below the upper image edge (see arrow). In the center is a dark spot. This is the shadow filled tiny crater Linné (2.2km) a relatively recently created crater of only a few tens of millions of years in age. Being in a barren expanse of the mare it had been drawn on maps made by lunar astronomers up through the first half of the 19th century and was well known with size estimates ranging from 8-10 km. Then in 1866, Johann Friedrich Schmidt, a well known, respected and very competent lunar astronomer in his own right, reported that the crater was gone and only a white spot remained as seen in his 158mm f/15 refractor at the Athens Observatory within eyesight of the Acropolis! There was a scramble to verify this transient event and reports ranged from confirmation to refutation. This crater was at the very limit of detection for his telescope. Larger apertures in better skies than downtown Athens cleared up the issue. It can be seen here as not just a white spot, but a small discernible shadow filled crater surrounded by a dull white ejecta blanket. LROC QuickMap shows it very nicely and the LROC webpage for this crater shows rocks inside the crater less than a meter across!!"

Campanus and Mercator.

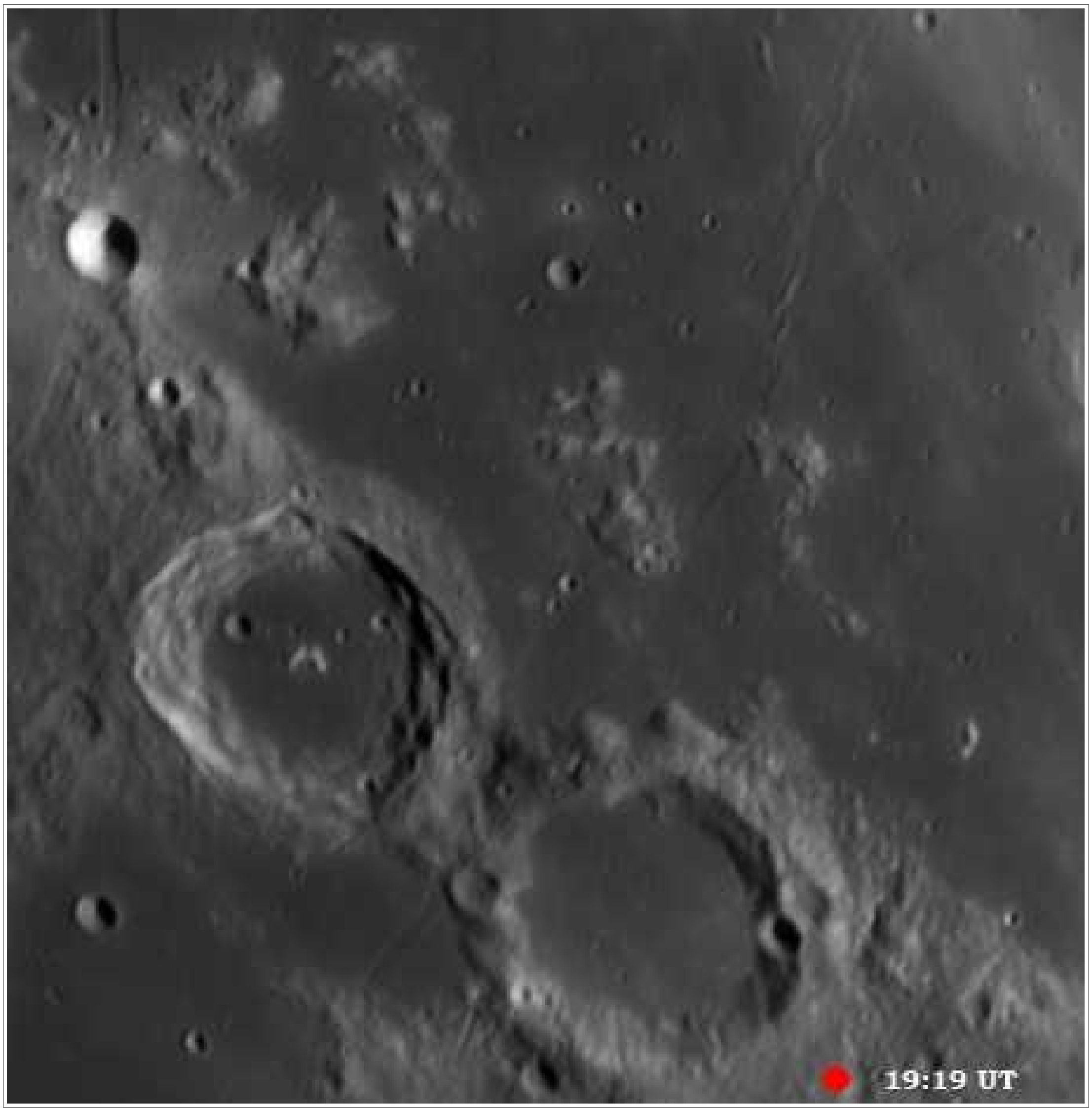


Fig. 8 Campanus and Mercator imaged by Massimo Alessandro Bianchi (UAI), using a ASI 178 MM on a Vixen VMC260L f/11.5, from Milan, Italy. Taken on 2022 May 12 UT 19:19.

Editor comments: Campanus and Mercator are each approximately 46kms in diameter and straddle what appears to be the the south-western rim of Mare Nubium. Both have mare filled floors, and whilst the central peak of Campanus is just visible as a nubbin of rock rising some 500m above the crater floor, any central peak in Mercator is completely submerged. This is explained by the crater depths with Campanus being about 2500, deep, with its floor sloping towards the west and Mercator somewhat less deep at 2000m and a floor sloping towards the east. The tilted floors shows that these craters have been uplifted along an axis which runs through them – which might account for the mare filled graben you can see just to the south-west of Mercator C. This graben might almost be a fit as an outer member of Rimae Hippalus (see Fig's 5 and 6) but its orientation is just slightly off concentric to Mare Humorum, so might not be related to the basin but to some other regional tectonic cause. Campanus is a Floor Fracture Crater, and in all likelihood Mercator is one as well, but the fractures here are concealed beneath basalt lavas. A corner of Palus Epidemiarum can be seen in the lower left of frame, this is a large domed area that has been uplifted by the intrusion of magmas into the crust beneath, these craters are on the side of that dome, which probably goes some way to explaining the tilting and volcanism that has gone on here.

Campanus and Mercator (again!).

Fig. 9 Campanus and Mercator imaged by Aldo Tonon (UAI), using a ASI 290 MM on a 9.25" SCT feq 3400, IR pass (742nm) filter used. Imaged from Torini, Italy.

Editor Comments: Yes, Campanus and Mercator again, but Aldo provides us with a wider image showing this pair as well as the Rimae Hippalus, the buried crater Kies (centre right) Kies A (below) and large swathes of Mare Nubium and Palus Epidemiarum. This image shows what appears to be the rim of Mare Nubium running up from south-east to north-west (bottom right-top left) via Campanus and Mercator, but the choice of *'appears'* is deliberate, because if Nubium is an impact basin, it shows very little in the way of basin like features. Though appearing vaguely circular, there are no other candidate rim (or ring) like structures visible, and the gravity data from missions such as GRAIL show that there is no large central gravity anomaly (the MASCON's discovered during Apollo) a feature common to other, rather more obvious impact basins. Mare Nubium is not the only mare lacking such a gravity anomaly, neither Mare Fecunditatis or Mare Tranquillitatis have one either. This might reflect the ages of these Pre-Nectarian basins, which either never had a significant central gravity anomaly, or the original anomaly became obliterated over time. On the other hand other Pre-Nectarian basins such as the Schiller Zuchis and Mare Smythii basins do have anomalies, so maybe this explanation is not the whole story, and Nubium might not even be a basin at all! The bright rays crossing the mare surface from the lower right are from Tycho which is 500kms away to the south-east.

J. Herschel.

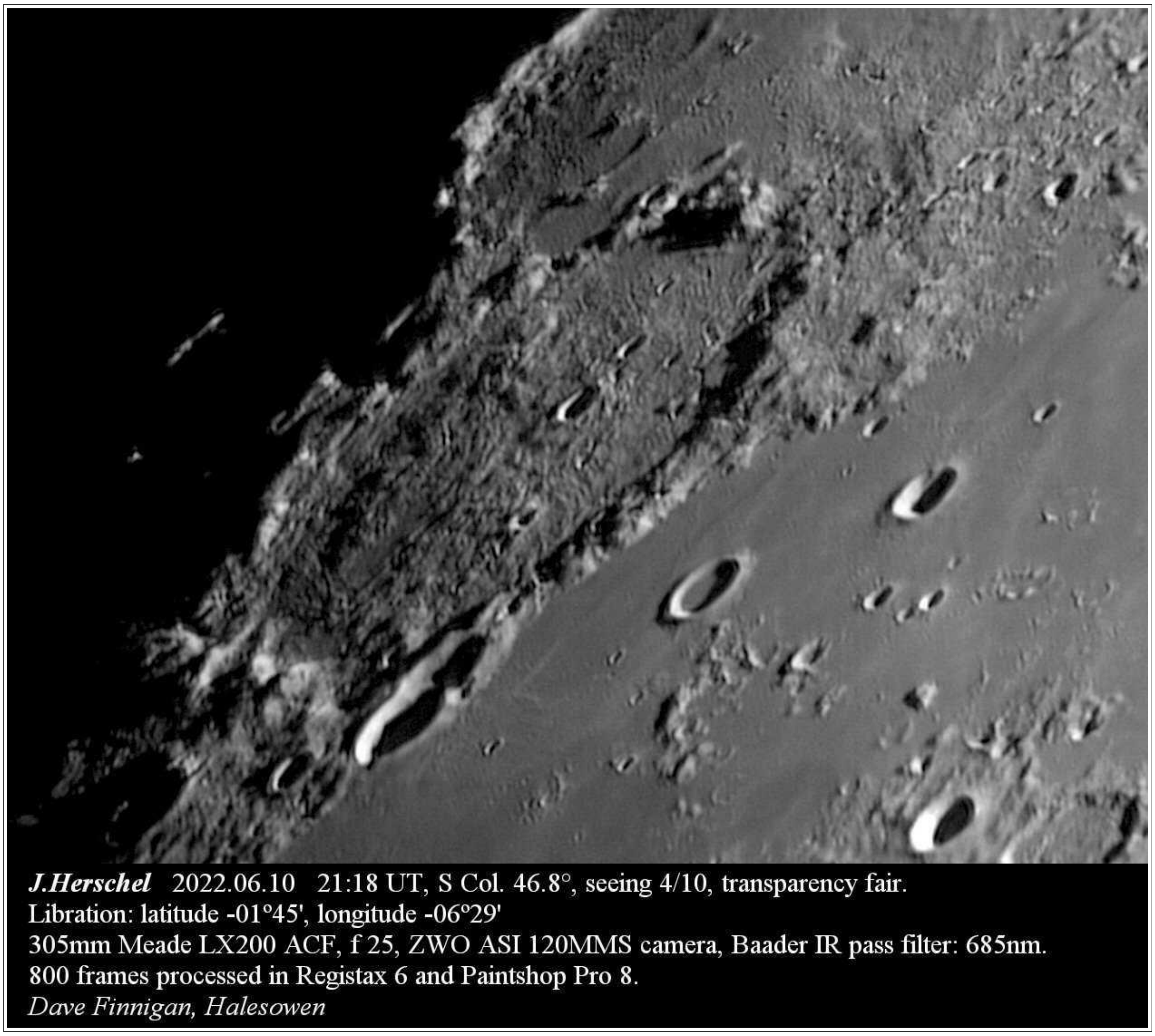


Fig.10. J. Herschel as imaged by Dave Finnegan. Details of equipment and time shown in image.

Editor comments: This 154km diameter pre-Nectarian crater lies to the north Mare Frigoris, and has been battered and modified over the aeons by a variety of processes. A crater of this size should be some 4500m deep so either the crater has been filled with deposits of some form or the floor has been uplifted. Most of the visible crater floor is covered with ejecta from the Imbrium Basin forming event, and this takes the form of uneven hummocky terrain with patches of curving parallel ridges and dune like features, which you might recognise from the description of the Hevelius Formation accompanying Fig.4. This is because the deposits here are analogous to those associated with the Orientale Basin, and probably looked identical when the Imbrium basin was initially formed. These deposits are however probably in the hundreds not thousands of meters in depth, so do not account for all of the shallowing of the floor we see, and indeed a topographic profile shows that the centre of the crater is bulged upwards by about 600m relative to the edges, indicating some form of modification from below, the obvious culprit being volcanic intrusion. So the Imbrium ejecta forms a veneer over an already domed crater floor, but whether the doming came before the ejecta or the other way round is an interesting question. The doming of the floor might be expected to produce surface fractures as are seen in Floor Fracture Craters (FFC's), but none are visible here, maybe fractures exist but are buried by the ejecta that came later. Of course FFC's are often found around the margins of the mare, and J. Herschel is on the margins of the Procellarum Basin, so maybe not such a far fetched idea. Recent (well, in lunar terms) volcanism is visible in the form of a cluster of vents on the south-eastern crater floor, you can make some of these out in Dave's image just to the west of a pool of shadow cast by the south-eastern crater rim. These appear to have mantled the surrounding crater floor with pyroclastic deposits which show up as orange in many 'mineral moon' type images produced by IT savvy imagers.

Langrenus.

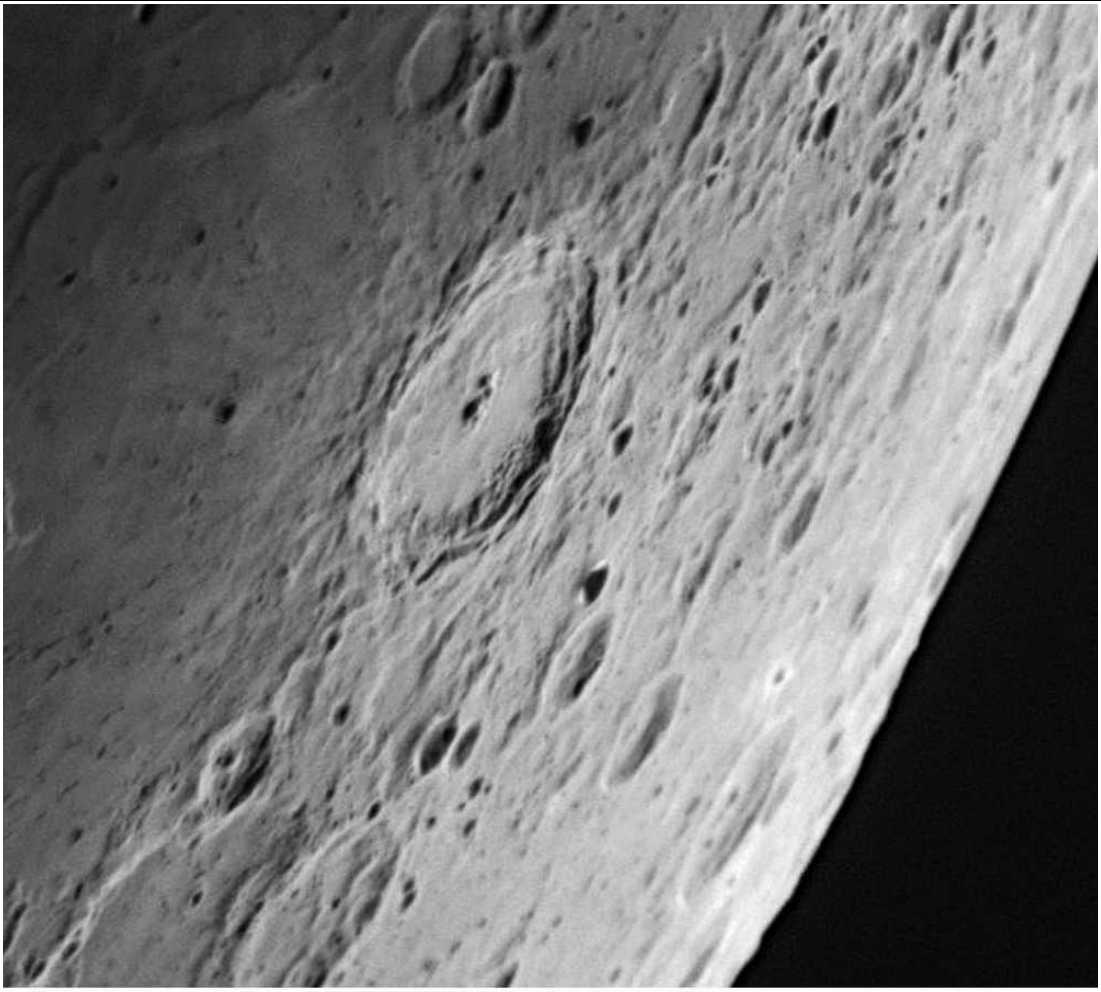


Fig.10. Langrenus as imaged by Rod Lyon. Details of equipment and time shown in image.

Editor comments: The 131km diameter Langrenus is as those of you who follow Tony Cook's Geological Change program one of the few sites where professional observations have potentially recorded a TLP. The observation was made by Audouin Dollfus of the Observatory de Paris using the 100-cm telescope at Meudon Observatory on the 30th December 1992, with the account subsequently published in Icarus*. Rod's image shows the field of hills to the north of the central peak where a "*brightness enhancement associated with an increase of polarization*"was observed and recorded. The 'brightening' persisted for some 3 days, being evident on January 2nd 1993. In his analysis Dollfus eliminated many possible causes of the anomaly and concluded that the observation were "*consistent with clouds of small opaque particles, detached above the lunar surface.*" There is no evidence of volcanic activity within the crater that may be responsible, but an alternative mechanism for mobilising Dollfus's dust particles might be gravity. Lunar apogee (point farthest from Earth) occurred at 17:15hrs UT on 29th December 1992, and recent research based on the Apollo seismic network indicated that shallow moonquakes tended to correlate with this position in the moons orbit, probably as a result of tidally induced crustal stresses**. Could such activity have destabilised regolith on the hills and central peak of Langrenus? It might be worth searching the available imagery to see if there is any evidence for this.

* Dollfus,A. (2000) Langrenus: Transient Illuminations on the Moon, Icarus, Volume 146, Issue 2.
**Watters,T.R., *et al.* (2019) Shallow seismic activity and young thrust faults on the Moon. *Nat. Geosci.* 12, 411–417 https://doi.org/10.1038/s41561-019-0362-2

Gruithuisen's Lunar City re-imagined.
By Nigel Longshaw.

July 2022 marks the 200th anniversary of one of the most remarkable lunar observations ever made. In the early morning light of July 12, 1822, Franz von Paula Gruithusien (1774-1852) turned his small telescope on the central portion of the Moon. There, to his astonishment he gazed upon an arrangement of features, so regular in their form that he could only conclude they were of artificial origin, suggesting some form of intelligent life had been responsible for their construction.

The tale of the discovery, announcement, and eventual debunking of Gruithuisen's 'Lunar City', as it became known, is a cautionary one often repeated in the astronomical literature. Much was made at the time of subsequent observers' difficulties in recovering the features as Gruithuisen described. In the end Gruithuisen's pluralist tendencies overshadowed the accuracy of his depiction, but a few, including S.H.Schwabe (1789-1875) more notable for his solar observations, managed to capture the region under suitable lighting and in general confirmed much of the topography recorded by Gruithuisen. In terms of Gruithuisen's pluralist views we can today perhaps be a little more sympathetic, appreciating his conclusions were drawn at a time when many astronomers and philosophers had similar opinions. However perhaps what's more revealing today is the opportunity to re-evaluate the thought process behind Gruithuisen's interpretations.

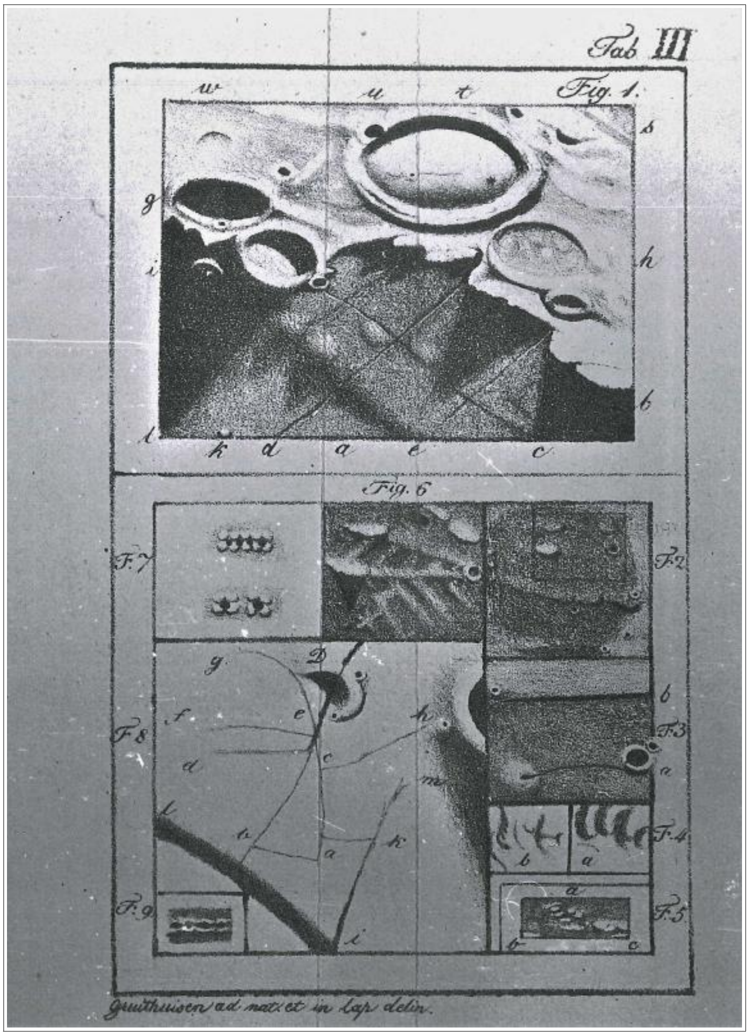


Fig 1- Gruithuisen's original drawings of the 'Lunar City' (fig. 6) and Mersenius from his 1824 publication, *Discovery of many clear traces of the lunar inhabitants, especially a colossal artificial building of the same*.

<u>In the beginning</u>

It was sometime after 3.30 am on July 22nd, 1822, when Gruithuisen was surveying the southern end of the Sinus Aestuum just north of the crater named Schroeter on modern maps. Under less-than-ideal observing conditions, with a power of x90, a pattern of ridges, hills and smaller mountain ranges, suggested an artificial structure in the eyepiece of his small telescope.

History records the purpose of Gruithuisen's lunar investigations was in essence to 'discover' evidence for changes taking place on the lunar surface, and hence evidence for life itself, postulated by his predecessor J.H.Schroeter (1745-1816). Therefore, it was perhaps inventible when presented by such a strange arrangement of features Gruithuisen's thoughts turned to intelligent life.

Gruithuisen argued that particulars of the lunar environment, specifically the cyclic extremes of temperature, would impose a largely troglodytic existence on its inhabitants. By necessity their permanent accommodations would need to be constructed beneath the lunar surface, an idea postulated by J.Kepler (1571-1630) and taken up much later by H.G.Wells (1866-1946) in 'First Men in the Moon'. To Gruithuisen darker areas of the lunar surface indicated a greater moisture content (at the time it was considered the Moon may have a tentative atmosphere) and were therefore more fertile. The location of his 'Lunar City', in one of the darkest areas of the Moon, in close proximity to the equator, was suggestive of a warmer climate, being an ideal location for habitation.

Fig 2- The caves at Maastricht, a contemporary illustration from the authors collection.

200 years in the making.

Interest is again turning towards the Moon as developing nations and private individuals seek to exploit the development of smaller more economical spacecraft. Many robotic explorers and sample return missions are being planned, but for many the ultimate goal is to establish a working community on the lunar surface. Taking material to the Moon to construct the necessary infrastructure to accommodate human beings is a costly business. So, one current suggestion is to use lightweight structures, easily transportable, and utilise the Moon's surface material as a protective layer.

Gruithuisen was a prolific observer and investigated many areas of the lunar surface. In one of his often-reproduced drawings he depicted the crater Mersenius and its immediate surroundings showing the region under sunset conditions with the north-eastern portion of the Mare Humorum disappearing under shadows thrown by the arc of mountains extending south from Gassendi. Here Gruithuisen illustrated several linear features in a somewhat regular pattern which he suggested might represent fields. In addition, several low mounds, reminiscent of lunar domes, are depicted, their appearance probably enhanced by the low light levels.

These mounds, Gruithuisen imagined, were further evidence of lunar habitation, but not on the grand scale of his lunar city, these were smaller structures likened to a cave or grotto formed beneath the lunar surface.

As these structures were formed, Gruithuisen explained, excavated material was piled '…up over the caves made under the ground' thereby creating '…spacious, well-founded places to stay'. 'Imagine the ancient quarry near Mastricht' he wrote. Originally a chalk mine in the Netherlands dating back to the 13th century, workers formed giant caverns, and as excavations progressed stone columns were created to support the rock above. Gruithuisen's selenites would be able take advantage of the reduced gravity on the Moon, creating much larger caverns than possible on Earth. As they did so excavated material would be piled up on the lunar surface, thus creating additional protection from the harsh lunar environment. 'In this way', Gruithuisen wrote, '…the lunar inhabitant will most likely create a whole world beneath the ground …. while we see nothing of it except the rubble rising above it'. Contemporary illustrations of the Mastricht caves (see figure 2) convey some idea of the extent of the subsurface world imagined by Gruithuisen.

Fig. 3- Future lunar accommodation – complete with protective dome constructed of recycled lunar regolith.©ESA-P.Carril.

Any structure on the lunar surface would need to withstand the harsh lunar environment and provide protection from the extremes of temperature and radiation for its occupants. With the advent of 3d printers one idea is to create building materials, in the form of large blocks from the lunar regolith (the lunar surface layer comprising unconsolidated debris). These interlocking blocks could then be constructed around a lightweight structural framework – thereby creating living and working spaces 'beneath' a protective layer of lunar surface material. Additional buildings could be added in a similar manner as the lunar base developed, potentially a regular pattern of individual structures, all interconnected, could emerge.

If we are to utilise the Moon as a base and possible steppingstone to further journeys into space humans are also going to need protection from the harsh lunar environment. What better way to provide that protection than by utilising lunar surface material? Could Gruithuisen, some 200 years ago, ever have guessed that the troglodytic selenites of the future might be human beings!

Despite past conjecture it is always something of a surprise to catch Gruithuisen's 'Lunar City' close to the terminator, when the prominent regular arrangement of ridges presents a compelling spectacle. Around July/August 2022 represents a passage of approximately 11 saros cycles since Gruithuisen made his original observation. So, if observing conditions are favourable during those months, the arrangement of features should present a similar appearance to that which convinced Gruithuisen he had discovered conclusive evidence that the Moon was inhabited - perhaps one day it might be.

Lunar Occultations July 2022.
By Tim Haymes

Time capsule: 50 year ago: in Vol 7 No.7
[With thanks to *Stuart Morris* for the LSC archives]

Mr K. Gayner (Bristol) agrees to become Occultation Co-ordinator (Section newly formed)
*Occultation of Mars on May 15th was observed.
*Miss Botley researches literature on fade occultation.
*J. Hedley-Robinson suggest blue and red filters for occultation observing.
*Could occultation "fade-cum-reddening" be caused by outgassing on the limb ?
*W. Leatherbarrow: Banded crater programme (Aristarchus, Birt, Pytheas etc.)
* Ken Gayner has 13 timings in the Occult database for the period 1971 to 1973.

Some Historical snippets

From JBAA V56 No 8 p147 (Oct 1946)
Frank Robins FRAS (1861-1945) joined the Association in 1926 and was Treasurer from 1927-1931. After retirement at the age of 70, he became an honorary staff member at Mill Hill Observatory and made some *lunar occultation observations* with the 8" refractor with the aid of a recently installed quartz clock. He reduced the observations himself and reported them the RAS. Among his many interest, his membership of the Mathematical Association indicates he was a highly competent computer.

From JBAA V57 No 1 p31 (Oct 1947)
Occultation reductions for 1943: These are now undertaken by the NAO, and a list of timings is published. Historical details of the observing procedure are in the 1943 Handbook.

From JBAA V90 No 6 p572 (Oct 1980)
G.M.Appleby (RGO), investigated 423 lunar occultations from 1943-1977 in a study of **Fading Occultations of the Stars by the Moon.** The majority were known double stars while the remainder are conjectured to be previously unrecognised doubles. These are currently (2022) still being investigated by video timing.

Observations Planned
Graze occultation of 14 Ceti (ZC 76) on 2022 July 19 @ 0159UT (HBAA #7)

The 5.8m star grazes the northern cusp at CA 11, with the Moon 65% sunlit (Last Quarter). The limb is quite rugged and a good number of contacts should be observable between 2.5 and 5km inside the mean limb. Tim Haymes plans to observe the graze from a field in Gloucestershire near the village of Cutsdean about 50min drive from home. The position has a flat entry (not rutted) with a view over a low hedge toward the SE, 4.5km inside the Northern limit corrected for height above sea level. Graze events should be seen one minute before central graze, and one minute after. We hope the weather cooperates.

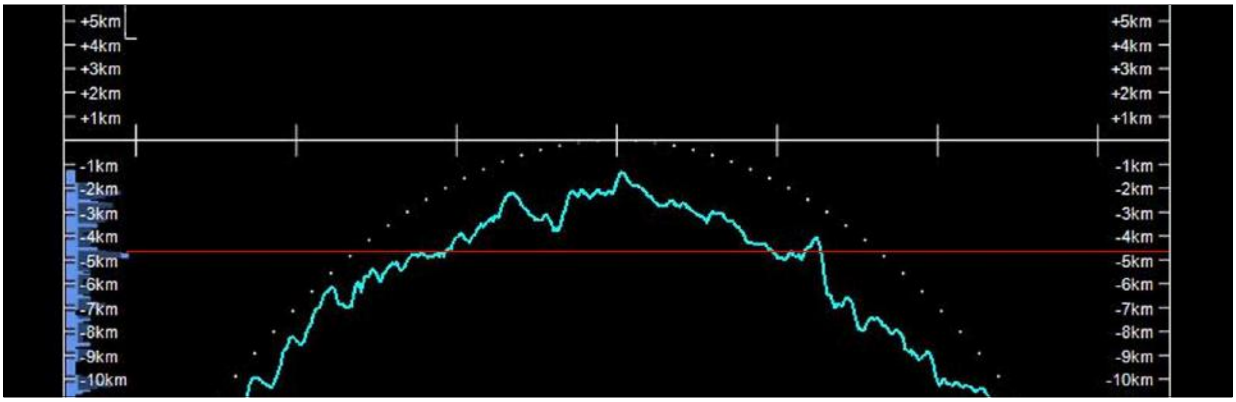


Figure above: Lunar limb profile for 14 Ceti. The red line is expected for the graze attempt.

Occultation prospects July

Gamma Virginis (Porrima) is occulted by the Moon in daylight on July 6th . It should be visible in a telescope if the sky is clear.

Lambda Virginis also occurs in daylight on Friday 8th and at mag 4.5 will be a challenge. Its spectra type is A1 will reduce the contrast with the sky. I've found spectral type F/G/M type stars easier to pick up in daylight. This suggest a yellow or orange filter should improve visibility. I have used an orange filter on a mono video cameras in daylight, and im sure this helped.

Asteroid (289) Justitia is predicted to occult a 12th magnitude star in Sagittarius on July 28 at 2250BST

The magnitude of the target (Asteroid+star) is 11.6 and the drop during occultation is 0.7 magnitude. We mention this prediction because the total brightness and duration is suitable for smaller instruments and possible visual detection. There are currently no multi-chord observations of this asteroid profile.

https://www.asteroidoccultation.com/2022_07/0728_269_76686.htm

https://cloud.occultwatcher.net/event/573-269-262465-646999-U134098#

Please report observations or timings of any of these phenomena to Tim Haymes.

Occultation predictions for 2022 July (Times as other locations will +/- a few minutes)

E. Longitude - 1 18 47.1, Latitude 51 55 40.3. To magnitude 9.0

Moon altitude >5 degrees.

yy	mmm	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
22	Jul	6	16	33	14.6	DD	1821	F0	2.8		46+	86	32	34	157	83N	Porrima
22	Jul	6	17	43	16.9	RB	1821	F0	2.8		47+	86	22	37	178	-56N	Porrima
22	Jul	8	16	26	15.4	DD	2053	A1	4.5	4.5	68+	111	33	15	136	59S	lambda Vir
22	Jul	8	17	30	48.5	RD	2053	A1	4.5	4.5	68+	111	23	21	152	-87S	lambda Vir
22	Jul	8	21	48	14.5	D	158581	F7	9.0	8.7	69+	113	-10	17	216	59N	
22	Jul	9	21	47	29.3	D	159213	K0	8.5	7.8	79+	126	-10	16	202	90N	
22	Jul	9	22	33	10.3	D	159237	K4	8.0	7.2	80+	126		13	212	81S	
22	Jul	10	20	47	37.0	DD	2347	A4	4.6	4.2	88+	139	-4	14	174	17S	19 Sco
22	Jul	10	21	23	28.2	RD	2347	A4	4.6	4.2	88+	139	-8	14	183	-43S	19 Sco
22	Jul	10	23	5	33.8	D	2356	B2	7.9	7.5	88+	140		10	205	34S	
2356 is double: ** 8.8 8.8 0.050" 350.0, dT = -0.15sec																	
22	Jul	11	22	3	34.4	D	185438	G1	8.6	8.3	95+	153	-11	11	177	43N	
22	Jul	11	22	50	27.5	D	185463	F5	8.7	8.5	95+	154		11	187	41S	
22	Jul	12	21	50	15.8	D	187047	G0	8.9	8.6	99+	167	-10	8	160	72N	
22	Jul	12	22	1	8.2	D	187063	B2	8.9	8.9	99+	167	-11	8	162	53S	
22	Jul	12	23	44	54.3	D	2712	K2	8.4	7.6	99+	168		10	185	58S	
22	Jul	12	23	44	59.5	D	187131	K2	8.8	7.8	99+	168		10	185	76S	
22	Jul	13	0	47	55.0	D	187170	B9	8.5	8.5	99+	168		9	198	51N	
22	Jul	13	22	56	57	m	2887	K2	7.7	7.0	100-	174		9	160	62N	
22	Jul	14	0	23	54	m	188607	K2	8.3	7.6	100-	174		12	179	60N	
22	Jul	14	23	28	2.4	R	X176927		8.5	8.2	98-	162		10	152	60S	Dbl*
X176927 is double: BA 8.6 6.6 1.3" 17.3, dT = +2sec																	
22	Jul	14	23	28	4.4	R	3052	K0	6.4		98-	162		10	152	61S	Dbl*
3052 is double: AB 6.57 8.57 1.34" 197.3, dT = -2sec																	
22	Jul	15	1	11	16.7	R	189862	G0	9.0	8.7	97-	161		15	175	20S	
22	Jul	16	1	8	57.6	R	164764	F0	8.9	8.7	92-	148		17	160	71S	
22	Jul	16	1	52	2.1	R	164777	G0	9.0	8.7	92-	147		19	171	68N	
22	Jul	16	23	10	41.0	R	3349	K5	4.1	3.2	85-	135		6	121	74N	tau Aqu
22	Jul	17	0	54	18.8	R	165354	K2	8.1	7.4	85-	134		18	142	48N	
22	Jul	17	23	58	53.7	R	146857	MA	8.9	8.1	76-	122		11	117	81S	
22	Jul	18	0	24	45.5	R	146869	G5	8.8	8.4	76-	121		14	122	84N	
22	Jul	19	1	55	33	D	76	F5	5.9	5.7	66-	108		26	129	3N	14 Ceti
22	Jul	19	2	5	11	R	76	F5	5.9	5.7	65-	108		27	131	20N	
22	Jul	19	2	11	6.3	R	128849	K2	8.4	7.8	65-	108		27	133	55S	
22	Jul	20	2	7	49.1	R	109832	F0	7.5	7.3	55-	96		27	118	70N	
22	Jul	20	2	57	3.7	R	109858	A2	8.6	8.5	55-	95	-9	33	130	76S	
22	Jul	21	0	47	38.6	R	310	F8	7.7	7.5	45-	85		13	89	64N	
22	Jul	22	0	59	48.7	R	93168	A0	8.6	8.6	35-	73		12	80	73N	

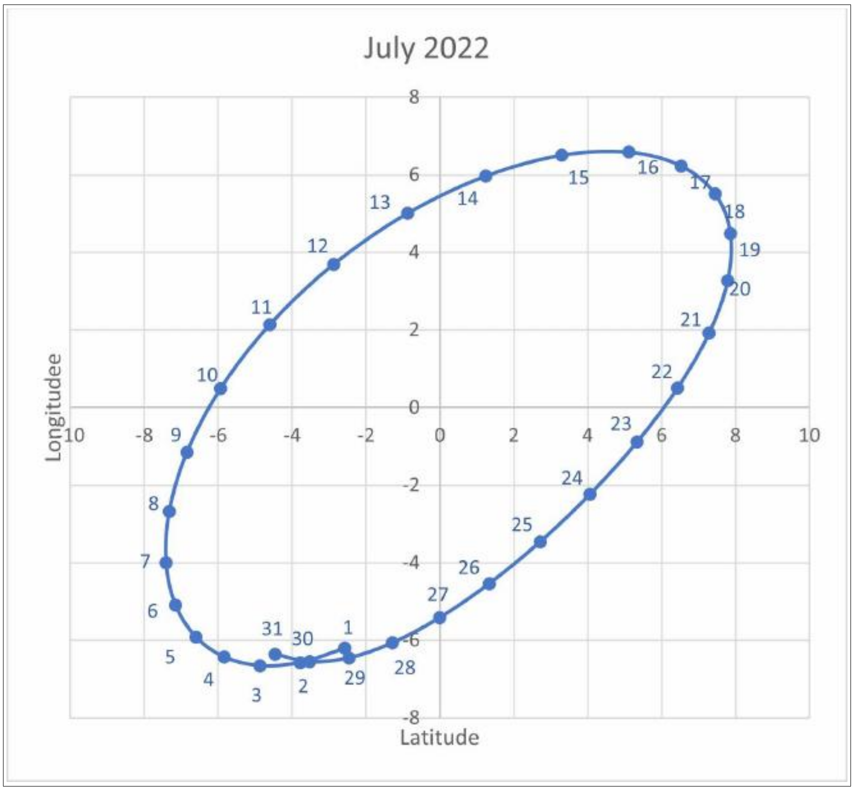
22 Jul 22	1 11 11.4	R	93173	F0	8.6	8.4	35-	73		14	82	67N	
22 Jul 22	3 24 5.0	R	93210	K2	8.5	7.9	35-	72	-7	34	108	69N	
22 Jul 23	0 40 46.2	R	93552	A0	8.1	8.0	27-	62		6	66	69S	
22 Jul 23	1 8 24.0	R	531	B9	5.7	5.7	26-	62		10	70	58N	13 Tau
	531 is double: ** 6.3 6.3 0.050" 350.0, dT = -0.06sec												
22 Jul 23	1 42 38.5	R	93567		8.8	8.5	26-	62		15	77	85S	
22 Jul 23	1 50 2.9	R	533	G8	6.1	5.6	26-	61		16	78	80S	14 Tau
	533 is double: ** 7.1 7.1 0.050" 350.0, dT = +0.02sec												
22 Jul 23	2 24 59.2	R	93579	F2	8.5	8.2	26-	61		21	84	89N	
22 Jul 24	2 39 49.4	R	76664	K1	8.9	8.5	18-	50	-11	19	76	79S	
22 Jul 24	3 12 4.7	R	693	F5	6.0	5.8	18-	50	-8	24	82	52N	
22 Jul 25	2 28 41.1	R	77173	A5	8.4	8.2	11-	39		12	64	34S	
22 Jul 25	2 55 5.0	DB	822	B9	5.8	5.9	11-	39	-10	15	68	-59S	118 Tauri
22 Jul 25	3 36 33.2	RD	822	B9	5.8	5.9	11-	39	-6	21	76	32S	118 Tauri

Key:
P = Phase (R or D), **R** = reappearance **D** = disappearance
m = Miss at this station, Gr = graze near this station (possible miss)
CA = Cusp angle measured from the North or South Cusp.
PA = Position Angle measured from the North though East for a Lunar Eclipse.

Mag(v)* = asterisk indicates a light curve is available in Occult-4

Star No:
1/2/3/4 digits = Robertson Zodiacal catalogue (ZC)
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. Please report timings to Tim Haymes in the Occult4 data format.

Detailed predictions at your location for 1 year are available upon request. Ask the **Occultation Subsection Coordinator**: tvh dot observatory at btinternet dot com
Those interested in Grazes (only) – please indicate your travel radius in Km, and your home post code.
An aperture of 20cm will be used unless advised to the contrary.



Lunar Libration diagram for July 2022.

Basin and Buried Crater Project.
By Tony Cook.

News: Daryl Dobbs has emailed me the following:

"Very interesting project the lunar basins and buried craters, this may not be of much use but this paper from 2016 uses the GRAIL data to come up with two lists of buried features: Identification of buried lunar impact craters from GRAIL data and implications for the nearside maria". There are a couple of interesting tables in the supporting information section, S1 gives the latitude and longitude plus diameter of 103 quasi-circular mass anomalies, table S2 lists 50 partially filled craters with their lunar co-ordinates and diameters. Alas it doesn't give any names only where they are which might suggest they are largely unnamed, perhaps the data in the tables might be a good starting point for further investigation to confirm if they are visible. Since they set an upper limit of 300km, it's no use for the lunar basin list but might be useful for the buried craters.

Regarding a buried crater proposed in 2015 using the GRAIL data the authors proposed the name Earhart, at a 2015 LPSC conference in abstract #1883. The crater in question is centred 41.2N 21.8E and 120km in diameter in the Lacus Sominorum, I'm not entirely convinced they were the first to find it, looking at Section III:III in The Map of the Moon by H P Wilkins published by the RGO seems to indicate something there but it does require a bit of imagination. Also some of the plates (2b and 2d) in section 2 in the Hatfield Photographic Lunar Atlas seems to indicate a feature there too."

I have taken note of this information and updated the tables.

Vaporum Impact Basin.

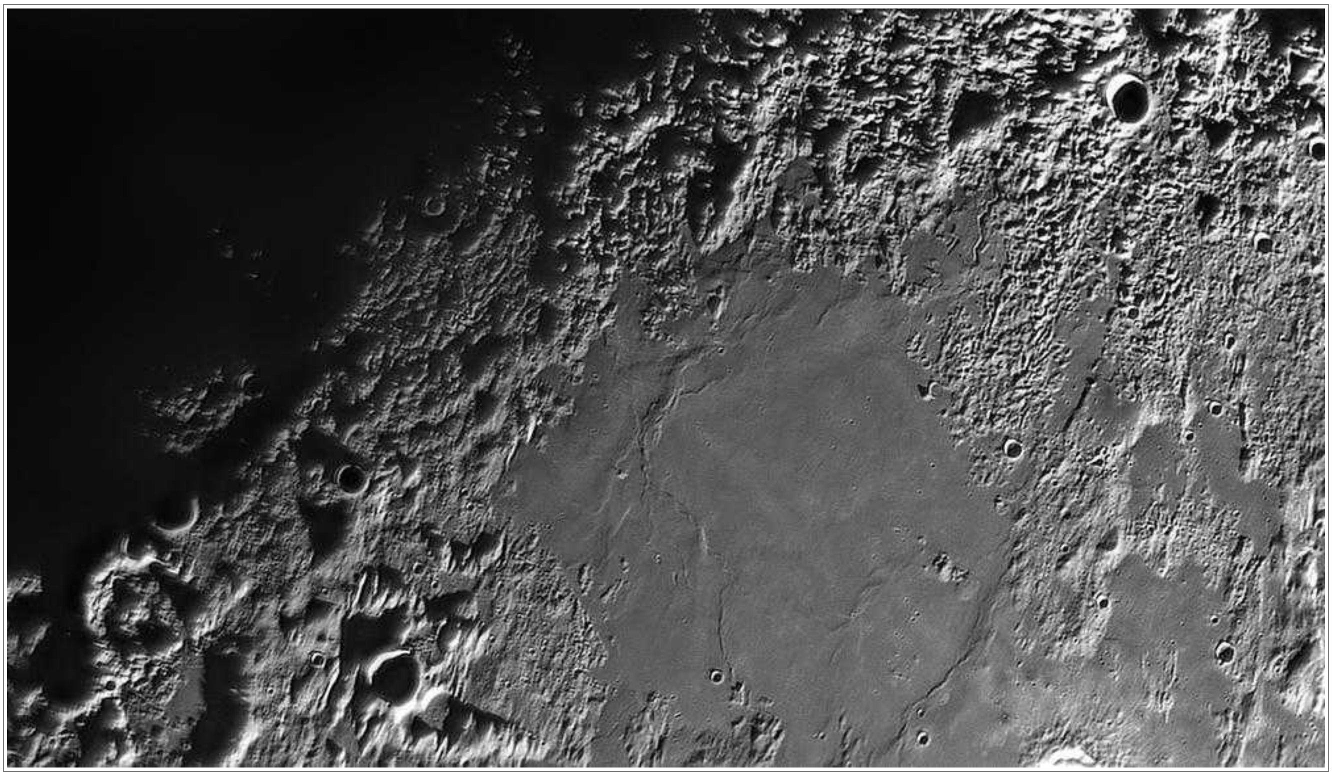


Fig. 1. Mare Vaporum as imaged by Leo Aerts on 2022 May 08, taken with a 25 cm f/15 Opticron Schmidt Cassegrain, red filter and webcam ASI 290MM. North is towards the top right.

This month we will look at the possible basin in which Mare Vaporum resides. Mare Vaporum is on the near side, close to the centre of the lunar disk, located at 3N 14E, and according to Neumann *et al.* (2015) has two basin rings – one being 220 km in diameter (an inner peak ring?) and a possible outer one at 410 km in diameter. The floor has several wrinkle ridges, and at least one volcanic dome. There are some well-rounded elongated and parallel hillocks near Ukert crater (see below article regarding an unusual suspected volcanic feature in this area). You can see some evidence for this being a basin in the geophysical datasets (Fig.2) from

the NASA/ACT Quickmap website.
Firstly we can see there is clearly a topographic depression here, secondly there is a weak MASCON (concentration of denser material) at the centre, thirdly the crustal thickness is less at the centre, and fourthly the gravity gradient and topographic slope azimuth plots both show a nice ring that matches the visible ring. The ring diameter I measure is about 220 km across (agreeing with Neumann *et al.*), but basins traditionally start at 300 km in diameter, and even if the visible ring it is just an inner peak ring, I can see little evidence for the proposed 440 km diameter ring. I also cannot see any radial ejecta scour marks, as can be found on some other basins, although if the region has been heavily eroded by subsequent large impacts and the surrounds buried by ejecta deposits from elsewhere, then these may no longer be visible. As for the age of the proposed basin, the NASA/ACT Quickmap website gives a Hiesinger crater count age of the Mare Vaporum deposits of 3.45 Ga, or late Imbrium era, so we can therefore say that the depression in which the mare material reside must be older than this.

So is this an ancient impact basin or just a flooded depression/large crater? I do not know, but at least, according to Leo's image we know that for lunar sunrise conditions, it is best seen at a Selenographical Colongitude of between 3° to 6°.

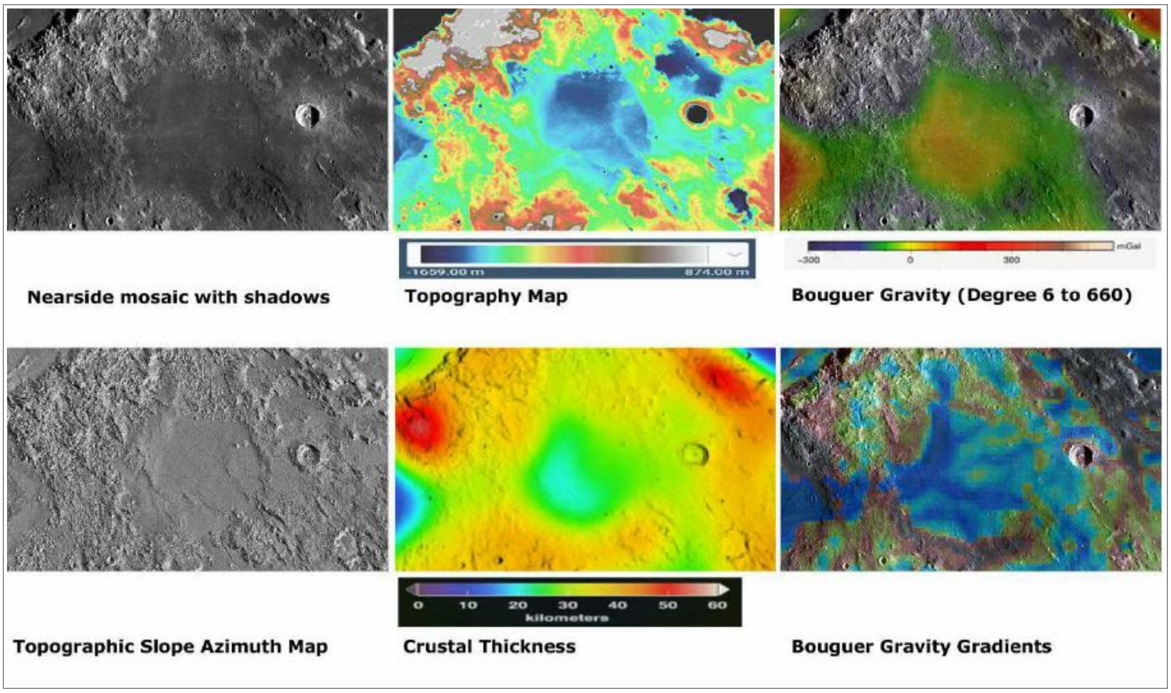


Fig. 2. Geophysical datasets for the Vaporum impact basin.

Please take a look at our website for other lunar impact basins and buried craters that you may want to image: https://users.aber.ac.uk/atc/basin_and_buried_crater_project.htm. I am really keen to gather imagery of the less certain basins, and also for all basins and buried craters in order to find the best selenographic colongitudes to see them at sunrise and sunset.

A suspected volcanic feature in south-western Mare Vaporum.
By Barry Fitz-Gerald and Raffaello Lena.

In last months LSC we described features in Mare Crisium that were a first contribution to the 'Dark Spot' project mentioned by Tony Cook previously. This article is a contribution to the 'Light Spot' side of the project, intended to delve a little further into the nature of one these unusual albedo features. It is hoped that this shows that these spots can turn out to be interesting geological structures, sometimes previously unreported ones, that are well worth identifying and studying in detail. For a telescopic image of this particular feature please refer to the photo by Leo Aerts in Fig.1 of the Basins and Buried Craters section of this LSC. This current article is a condensed version of a longer somewhat more technical version published in the ALPO's issue of the Strolling Astronomer (Vol. 64, No. 3, Summer 2022). Clearly Mare Vaporum is an extremely complicated area with lots for the observer and armchair astro-geologist to explore!

Despite being one of the smaller mare on the moon Mare Vaporum is home to an extremely large and number of volcanic features of quite a diverse nature[1][2][3][4]. Some of these are quite conspicuous, but the example discussed below is inconspicuous to say the least. The suspected volcanic feature in question consists of a roughly lozenge shaped area of terrain on the very edge of the mare and some 25kms to the NE of Ukert J (Fig. 1) and having the appearance of a small piece of partially submerged highland terrain. We will refer to it as Ukert 1 or Uk.1 for brevity in the following discussion.

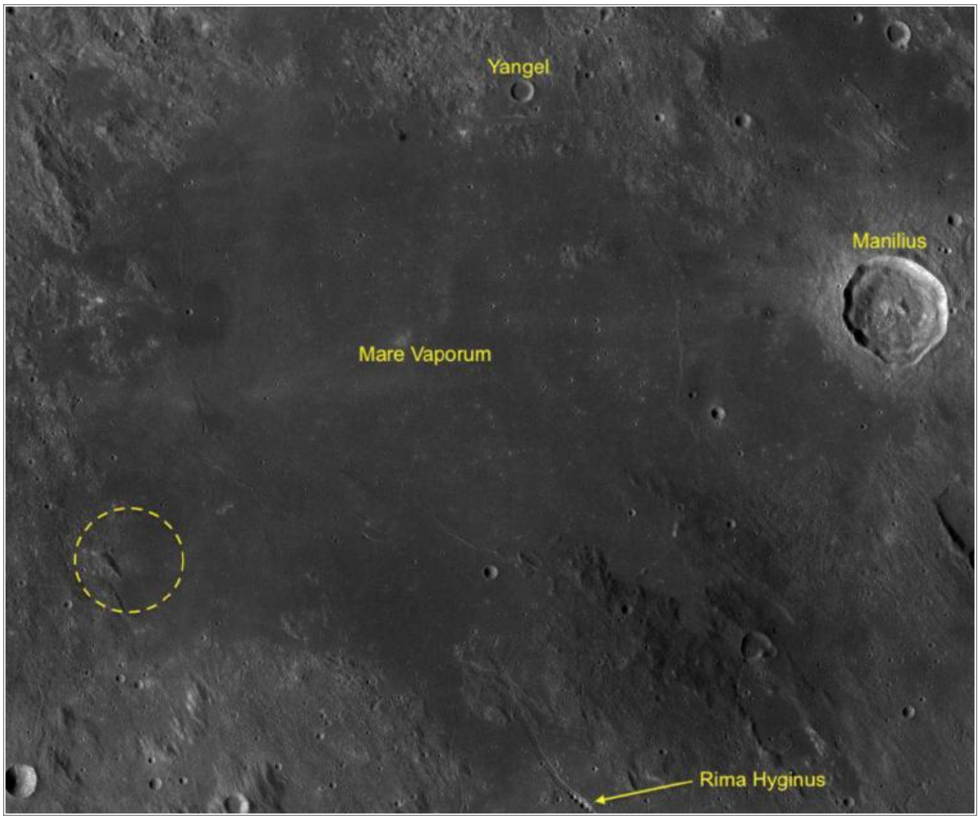


Figure 1: Mare Vaporum showing the position of the suspected volcanic feature UK.1 in the yellow dashed circle.

Measuring some 9kms by 7kms and with a circumference of 29kms, it straddles an E-W trending fault, to the south of which the surface of Mare Vaporum is some 80m lower. As a result Uk.1 is some 120m high as measured from the mare surface to the north, but some 260m high as measured from the mare surface south of the fault. It has very low flank slopes, averaging around 3° making it quite a subtle topographic feature. Uk.1 is shown as being part of the 'Fra Mauro Formation' (composed of Imbrium ejecta) in the USGS Geological map of the area[5] but our analysis suggests it is in fact volcanic in nature and possibly related to the more conspicuous and exotic volcanic features known as 'Red Spots' such as Hansteen α and Gruithuisen δ. These are composed of silicic lavas of high viscosity and distinctive mineralogy – some elements of which are shared with Uk.1.

The mare surface north of Uk.1 is slightly domed upwards forming a sub circular area of high ground approximately 60kms in diameter. However with a summit elevation of only 100m the resulting slopes reach a local maximum of only 0.6°, and are generally much less.

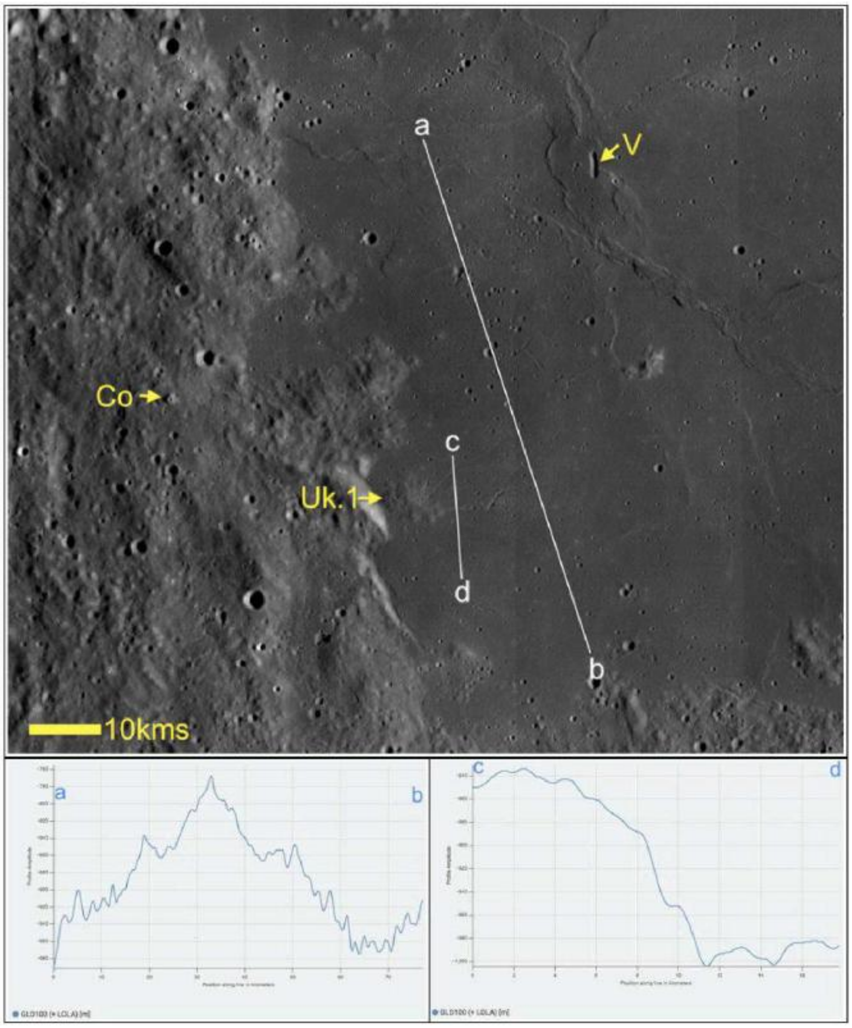


Figure 2: WAC image of the area around Uk1 showing the area of a domed area of high ground to the north which may be the result of a laccolith like intrusion. The topographic profiles along lines a-b and c-d are shown in the lower panels which show the elevation of the 'high' ground and the fault forming its southern boundary which runs beneath UK1. A volcanic vent is shown as V and a suspected volcanic cone as Co.

This may represent an extremely shallow dome caused by the sub-surface intrusion of a laccolith type structure beneath the mare, but alternatively it may represent a tectonically deformed area of mare surface that has buckled upwards under the influence compressional forces (Fig. 2). This domed area is made up of high titanium basalts, whilst the mare to the south of the fault which Uk.1 straddles is of a lower titanium content (Fig. 3). This fault also defines the southern edge of this domed area, and possibly formed as the high TiO_2 mare surface to the north underwent uplift. The lower lying areas to the south were then then inundated with lower TiO_2 basalts at a later stage. UK 1, which has very low titanium content, is superimposed on the fault *and* the terrain to the north and south, consequently it is probably the youngest geological feature in this area.

Fig.4 shows Uk.1 with the the LRO Quickmap Christiansen Feature (CF) overlay enabled, which is related to the level of silicate polymerization. The CF position occurs at shorter wavelengths for felsic and feldspathic compositions and longer wavelengths for mafic compositions. As can be seen Uk1 has CF values ranging from 8.15 to 8.3 µm, potentially indicating the presence of slightly more felsic materials[6] and clearly different to the adjacent highlands and mare. The 'Red Spot' highland domes such as Gruithuisen highland domes and Hansteen α are characterized by much lower CF values than seen here, probably indicating higher amounts of plagioclase content and an elevated SiO_2 content. So whilst Uk.1 has an elevated silicic signature it is not at 'Red Spot' levels.

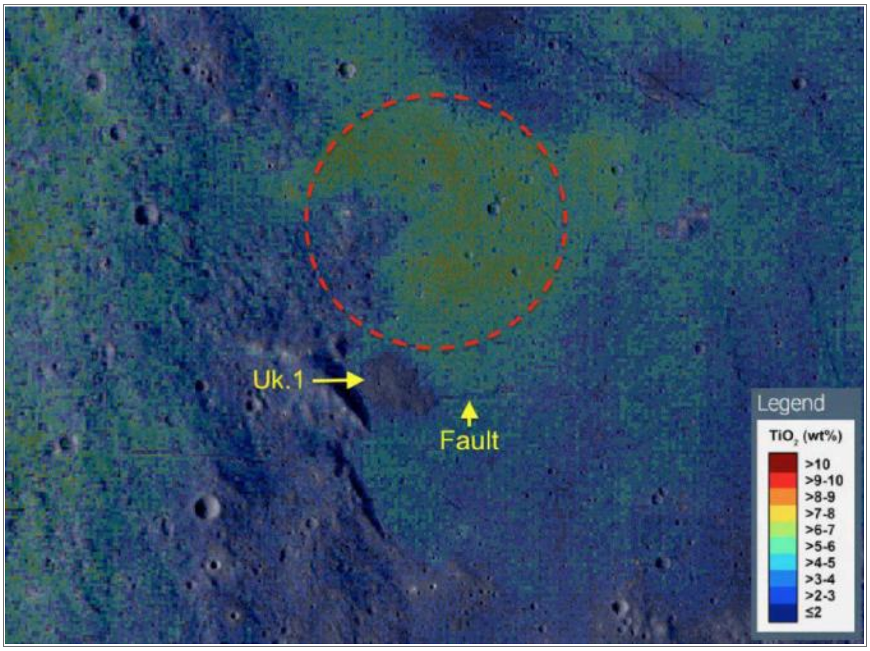


Figure 3: TiO_2 abundance in wt% overlay from Quickmap draped over the area of Uk.1 showing the high TiO_2 content of the high ground to the north, and lower TiO_2 content of the surrounding, younger mare. Note the much lower abundance value on Uk1.

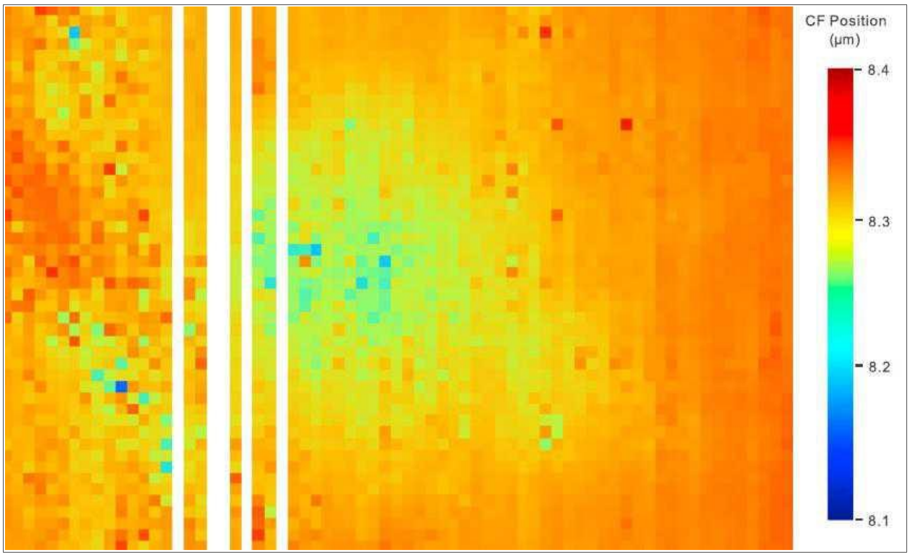
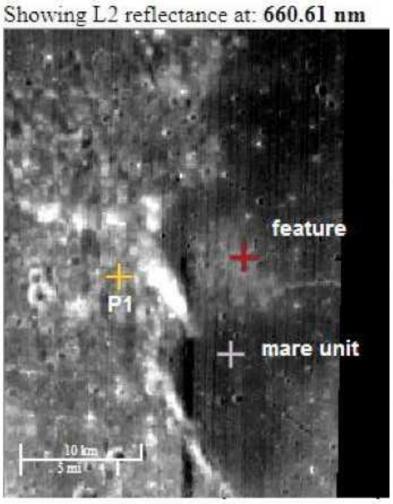


Figure 4: Diviner Christiansen Feature (CF) position map of the examined region.

Uk.1 also exhibits other unusual spectroscopic features, which set it apart from its surroundings and the 'Red Spot' features already mentioned. It shows a higher FeO and lower plagioclase feldspar contents compared with Hansteen α. As highland materials are mainly composed of plagioclase feldspar, with low FeO content, the higher FeO content derived for Uk1 (13.0 -15.0 wt %) could result from the mixing of both a highland and basaltic material. Similarly the CF position of Uk1 is located between the average CF values of lunar highland domes and mare, which also indicate the mixing of basaltic and felsic materials. Uk1 has a TiO_2 content similar to adjacent the highland material, while the adjacent mare unit to the south has a higher TiO_2 content (Fig.5). Uk1 shows weak mafic absorption features compared to the nearby mare units, but higher than the nearby highlands, which might support the mixed highland/mare lithology composition mentioned above.



Wt%	mare unit	feature	P1
Olivine wt%	11.6	4.3	0.0
CPX wt%	11.3	28.8	15.5
OPX wt%	34.7	14.4	23.4
PLAG wt%	42.0	52.0	60.0
FeO wt%	17.1	13.7	11.5
TiO_2 wt%	3.6	<1	1.3

Figure 5: Abundance in wt% of olivine, clinopyroxene (CPX), orthopyroxene (OPX), plagioclase (PLAG), FeO and TiO_2 for three different units located on Uk.1, and the adjacent mare and highlands.

The detailed images of Uk.1 provided by the LRO NAC show an interesting surface that is very different to that of the surrounding mare of adjacent highlands (Fig. 6). As can be seen the surface is of a higher albedo than the surrounding mare and slightly more rugged with crater like depressions and ridge like features. It appears to be composed of two elements, a lower slightly more subdued margin which we will call the lower platform (Lp) and above this is a more rugged upper platform (Up). The slightly steeper (~ 2.8°) upper platform reaches some 100m higher than the more gently inclined (~ 2.2°) lower platform hinting at a compositional difference of some kind, a suggestion that is supported by the slightly higher albedo and rougher surface texture of the more elevated sections of the structure (Fig. 7).

This somewhat 'two-tier' nature is reflected in the spectral data, with a gradient in the amounts of orthopyroxene, iron and feldspar evident as you ascend from the base of the feature towards the summit. Fig. 8 for instance illustrates that point 'A' displays higher mafic content, suggesting the presence of pyroxenes (OPX) and higher iron content compared with the units 'B' and 'C' higher up the flanks, which display weaker or absent mafic absorption features. This distinction between lower and upper elevations is also hinted at in the silicon abundance as shown in Fig. 10, where Lp terrain has a higher iron abundance but lower silicon abundance compared to the Up terrain. Of course this may simply reflect the fact that the Lp terrain has been blanketed in ejecta from nearby craters on the mare surface which elevated the proportion of iron in the soil and blanketed the underlying slightly more silicic surface. This possibility is difficult to discount, but the fact that the iron content declines progressively as you approach the summit of Uk1, some 3kms distant from the mare surface suggests a real compositional gradient and no local masking by locally derived ejecta. It is also unlikely that space weathering leads to these differences, as the surface of Uk.1 is all of the same age. Space weathering would also result in higher CF values which is inconsistent with the slightly lower CF values of the feature if compared with the nearby mare.

As noted above, Uk.1 straddles the prominent fault (F.1 in Fig.6) that forms the southern edge of the elevated domed terrain to the north. A second less prominent fault (F.2 Fig.6) approaches Uk1from the ESE where it is visible as a fault scarp on the mare surface, with the downthrow side to the south. It can be traced across part of Uk1 in subdued form, but cannot be seen to emerge onto the mare surface to the west. A third set of faults (collectively labelled F.3 and shown in blue in Fig.6) approach from the NE where they consist of number of parallel to sub parallel fractures which appear as short graben like structures which widen out in places to give the impression of a short crater chain. That these faults are less conspicuous over the upper platform indicates a greater depth of burial as compared to the lower platform, possibly suggesting that the former is younger and mantles older terrain lower down. The close association between Uk1 and these faults might suggest a causal relationship – a possibility that will be explored below.

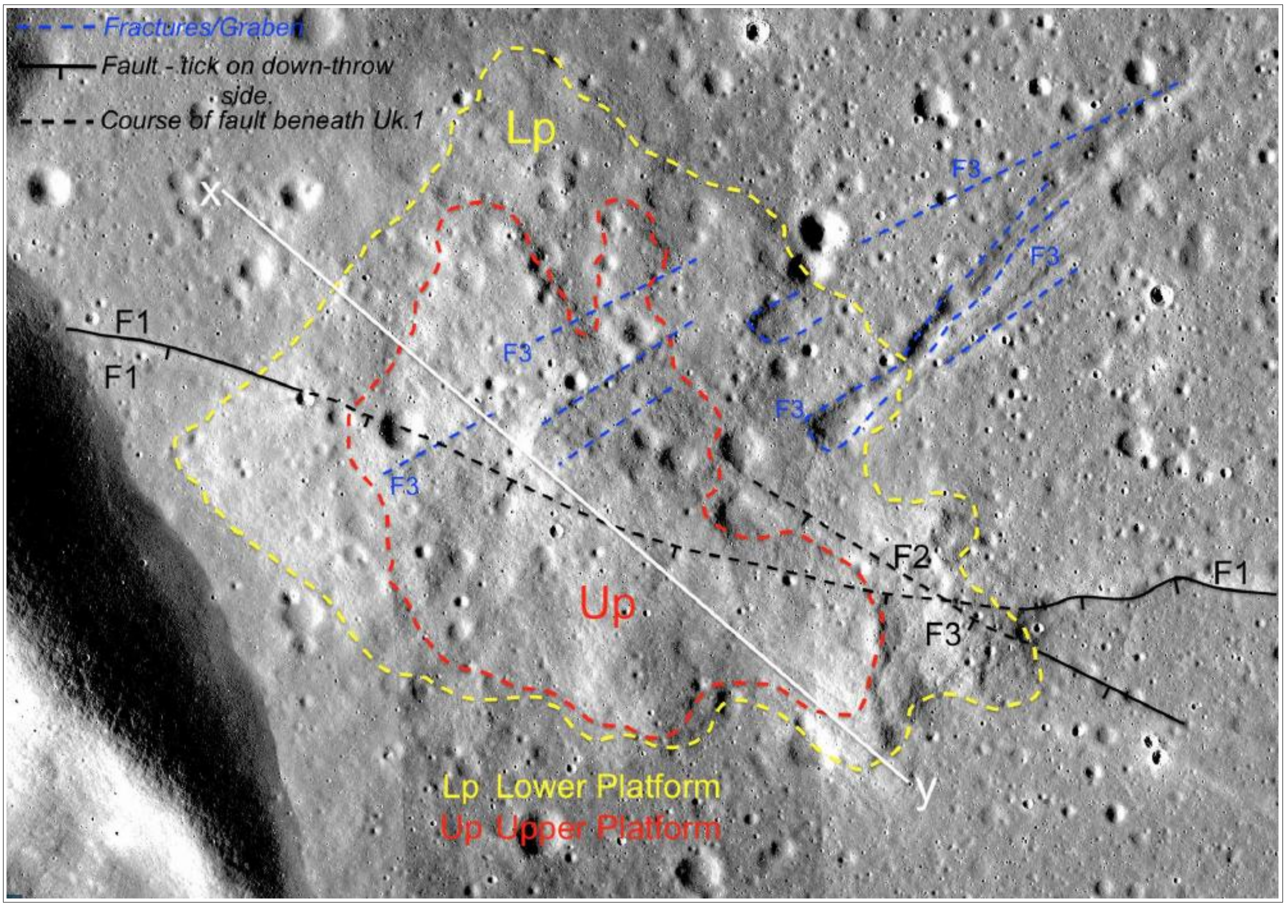


Figure 6: LROC NAC image of Uk1 annotated as a basic geological sketch map. Note the slightly higher albedo over Uk.1and the approximate division of the edifice into a Lower Platform (Lp) and an Upper Platform (Up). Topographic profile along line x-y are shown in Fig. 7. Various faults/fractures are identified as F.1-3.

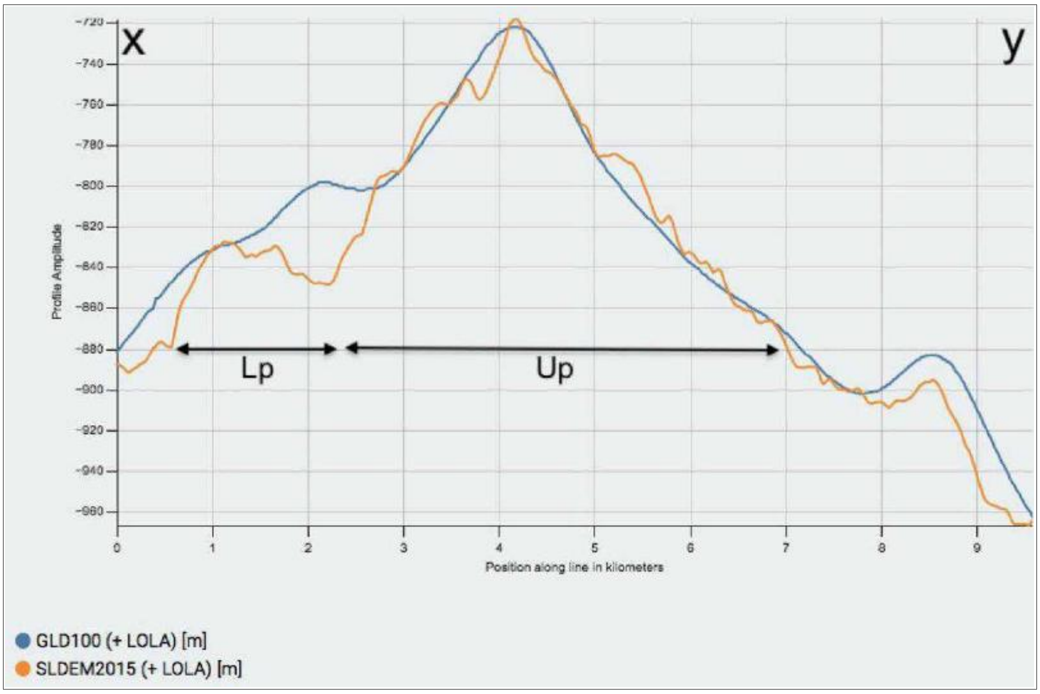


Figure 7: Topographic profile along line x-y in Fig.4 showing the distinction between the Lower platform (Lp) and Upper platform (Up).

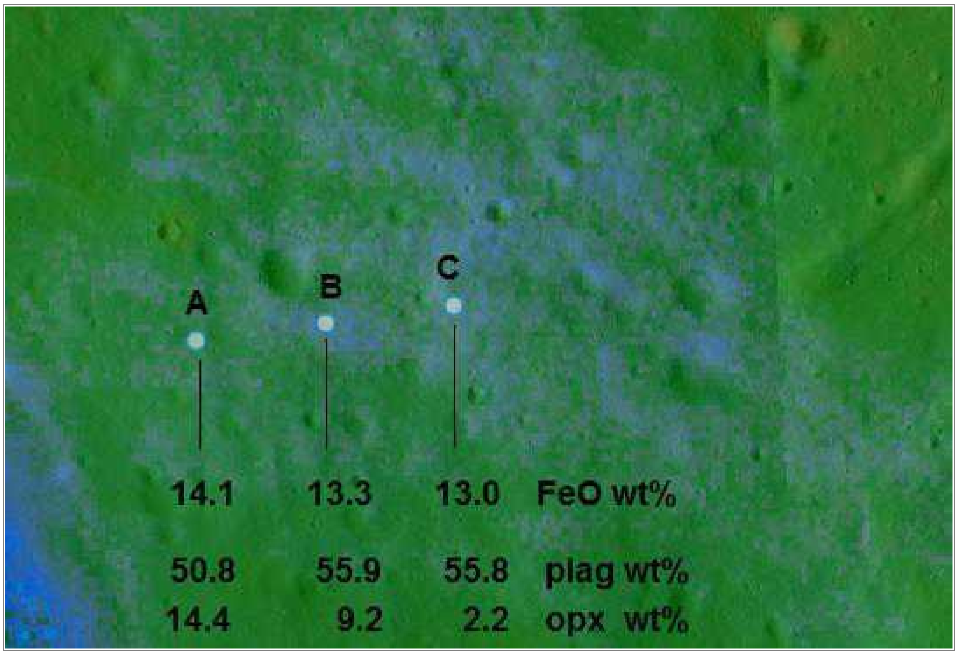


Fig.8: WAC image of Uk.1 superimposed over the plagioclase and FeO map derived from the Multiband Imager (MI) data. Green indicates higher iron content and the azure colour indicates higher plagioclase content.

There is a lack of any clear volcanic structures within Uk1 with nothing resembling a lava flow, vent or area of dark pyroclastic deposits. The surface especially the Up terrain has a number of rounded crater like pits which lack rims and might be interpreted as potential vents, but equally, and in the absence of any supporting evidence they could simply be eroded impact craters. There are no conspicuous bouldery patches that might indicate explosive volcanic activity, but many clearly explosive volcanic deposits on the moon are also remarkably boulder-less so this might not be a significant observation. Slightly more supportive of a volcanic origin for Uk.1 are a number of lobate margin type features along the northern edge of the feature and on the mare surface to the north.

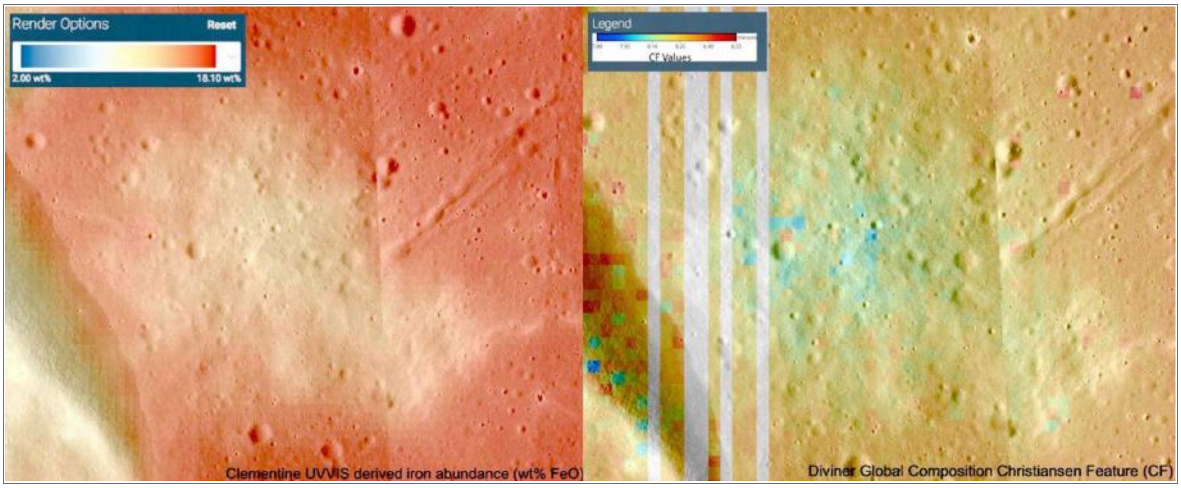


Figure 9: Uk1 with Clementine (left) and Diviner (right) overlays showing the slight compositional differences between the Lp and Up terrains.

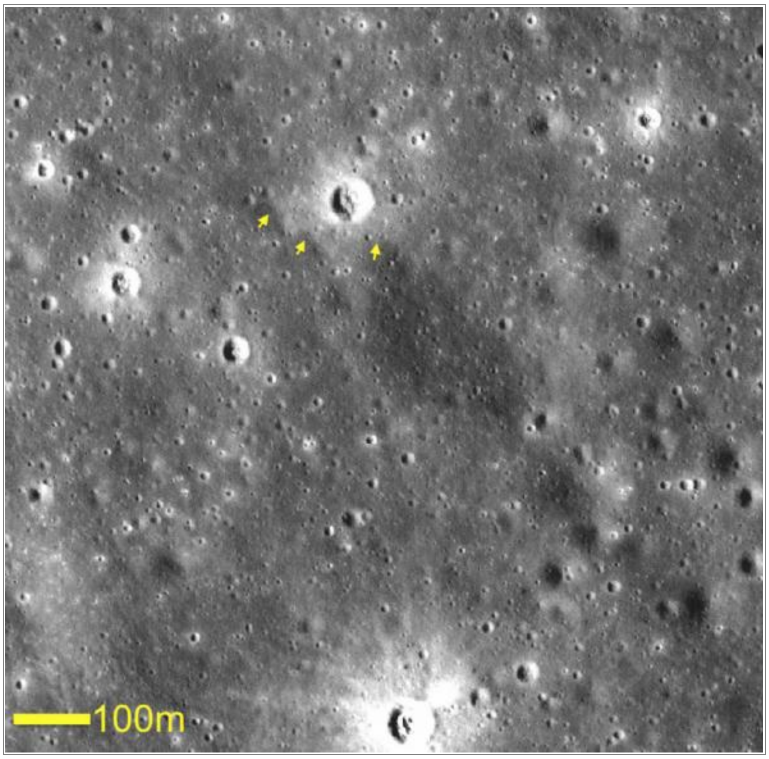


Figure 10: Lobate feature to the north of Uk.1 showing dark lobes apparently obscuring the bright ejecta blanket of a small crater.

Fig. 10 shows one such example, located about 3kms to the north of the northern edge of Uk1. Though quite subtle, a low albedo area with lobate margins can be seen extending from the bottom of the frame towards a moderately fresh crater at upper centre. Note that the bright ejecta from this crater appears to be partially obscured by the darker deposits. One possibility is that this represents a volcanic flow – possibly lava – that originated from Uk.1 and spread out onto the mare surface to the north. This suggestion is probably open to debate, but a number of other similar features are present to the north of Uk.1 adding some weight to the hypothesis.

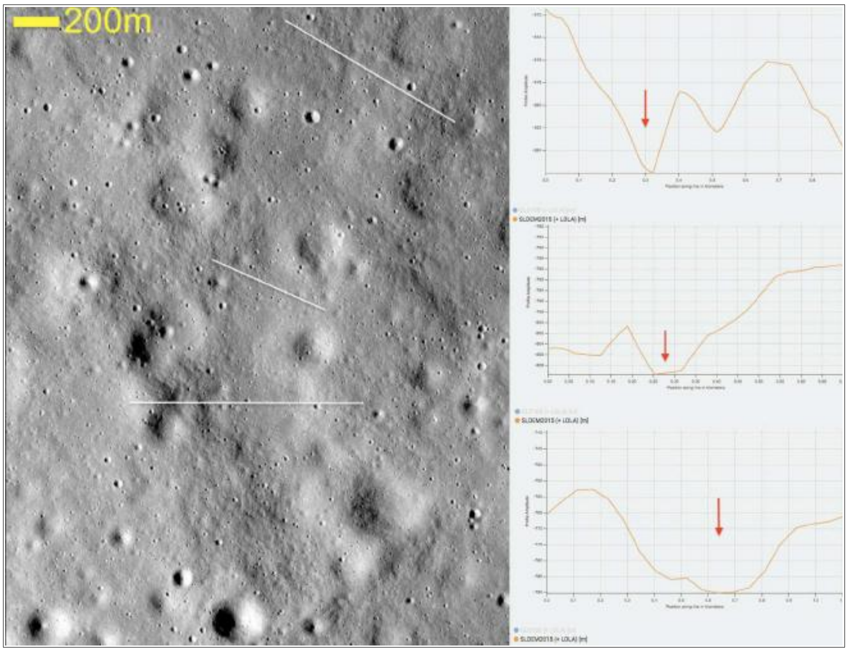


Figure 11: Possible lava channel on the northern flank of Uk.1. Panels to the right show the topographic profiles over the lines indicated in the image on the left

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An additional observation that may be relevant is the presence of a deep embayment in the Up terrain along its northern margin, marking a possible channel leading from the summit area down onto the mare to the north (Fig. 11). With a maximum depth of approximately 30m, this channel has an irregular outline as opposed to the smooth curves usually associated with lava channels, but it is worth considering as a potential source of lavas flowing off Uk.1.A possible relationship between the numerous faults in this area and the origin of Uk.1 has been alluded to above, with evidence for this potential link being visible in the form of a small volcanic cone (Figs. 2 and 12) located some 35kms to the WNW and along the continuation of fault F.1 beneath the highlands. This small feature is 2kms in diameter and 150m high.

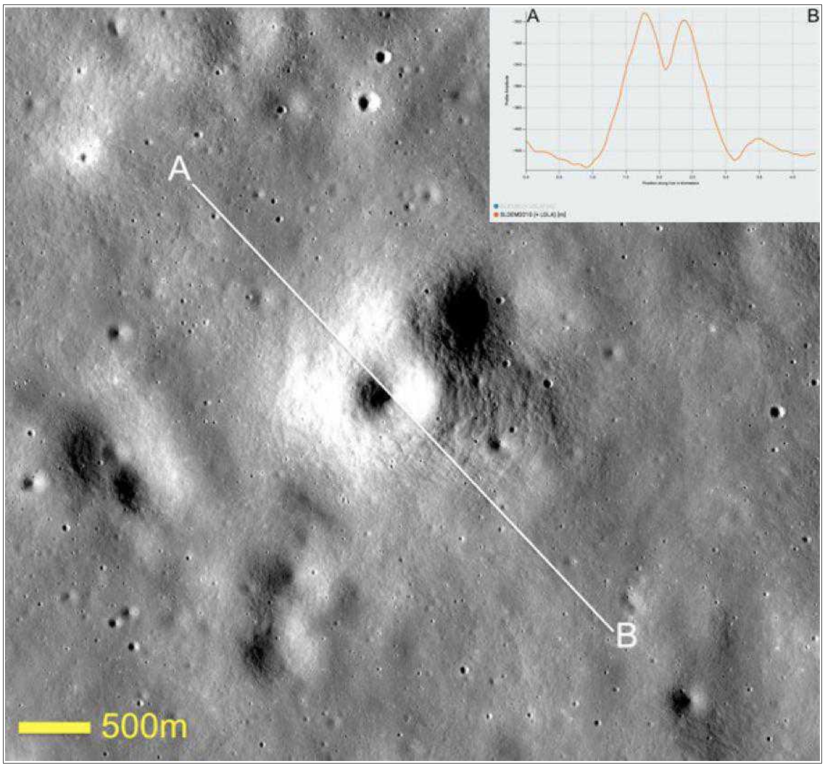

Figure 12: LROC NAC image of a small cone like feature to the WNW of UK.1. The inset shows the topographic profile along line A-B revealing a deep summit crater.

This small cone has a similar mineral abundances to Uk.1, in possessing a low abundance of orthopyroxene, iron and titanium in contrast to its surroundings (Fig. 13). Also in common with Uk.1 it has an enhanced abundance of clinopyroxene which appears for some reason to occupy different areas to those where the olivine abundance is high, possibly suggesting volcanic products of differing composition. Both olivine and plagioclase show an increased abundance on this cone as compared to Uk.1. One significant difference between this cone and Uk.1 however is the absence of an elevated silicon abundance.

Whilst there are mineralogical similarities as well as differences between Uk.1 and this small cone, the important point is that this cone appears to sit along the course of fault F.1, possibly indicating that the fault might have provided the channel along which the lava responsible ascended. This could, if true, indicate a similar process occurred beneath Uk.1, whilst the compositional similarities might suggest a common source of lava within the crust. This is speculative however and the absence of an enhanced level of silicon associated with the cone as compared to Uk.1 may be a flaw in this line of reasoning.

Uk1 is irregular in outline and elevation, and is therefore probably not the result of a gently effusive eruption of low viscosity mare lavas. Explosive volcanic activity may have been involved in its formation but the absence of any spectral data suggesting the presence of volcanic glasses might argue against this. It has some features in common with some of the more unusual lunar 'Red Spots' such as Hansteen α, such as a raised albedo compared to the surrounding terrain, enhanced level of silicon, low levels of iron and orthopyroxene. The levels of silicon in Mons Hansteen is however much higher, indicating a more silicic lava of high viscosity, which probably accounts for its steeper slopes (~4.9°) as compared to the extremely shallow flanks (~ 2.4°) of Uk1. Despite this much shallower profile, Uk1 appears to be composed of two components as far as elevation is concerned, the lower and upper platforms, and in this respect it is similar to the two tier configuration seen in Mons Hansteen[7]. In this case an initial phase of relatively high silica low iron effusive volcanism was followed by a later stage involving even higher silica but lower iron content lavas, with the former composition corresponding to the lower part of the edifice and the latter composition to the more elevated summit area. In broad terms this compares to the situation seen in Uk1, but clearly the viscosity of the lavas involved here was extremely low in comparison. A lower viscosity is also suggested by the possible lava channel provisionally identified on the northern flank of Uk1 and the suspected lobate margins to lava flows on the mare to the north. A lower viscosity for any lavas involved in the formation of Uk1 is also suggested by the lack of any extensive outcrops of rocky terrain, which might be expected in the case of more viscous lavas such as those seen on Mons Hansteen or activity involving explosive eruptions. If it is of volcanic origin as suggested, it is neither a classic monogenetic dome resulting from a single eruption (such as classic rounded mare domes) nor is it a classic highland dome ('Red Spot') as it has a lower plagioclase content. In this respect it may represent a novel form of volcanism, possibly more widespread but unrecognized due to the inconspicuous nature of the structure, both spectrally and topographically.

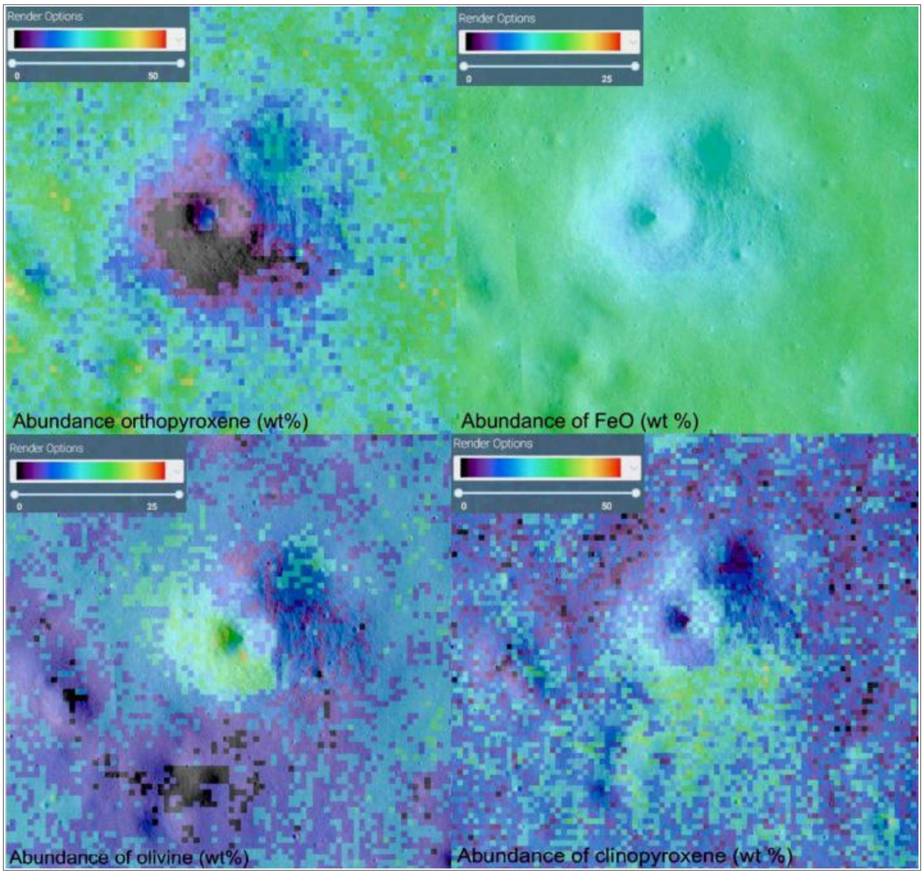

Figure 13: Mineral overlays from Kaguya draped over image of cone shown in Fig.12. Note the low abundance of orthopyroxene and iron (upper panels) and increased abundance clinopyroxene (lower right) which are also exhibited by Uk1. Note the distribution of olivine and clinopyroxene which appear to occupy exclusive areas.

In conclusion it appears that Uk.1 may be a volcanic structure of some form caused by the extrusion of a silicic lava of a *relatively* low viscosity and intermixed with large amounts of basaltic material. It differs from the basaltic mare lavas onto which it erupted by having lower iron, titanium, and orthopyroxene contents, but slightly enriched in silicon possibly in the form of plagioclase feldspar. The presence of clinopyroxene indicates a composition not totally unrelated to mare basalts. The apparent mineralogical gradient as one ascends the slopes from the level of the mare to the summit, as well as the morphological distinction between the lower and upper platforms, suggests a two phased formation, with an initial effusive phase involving relatively low viscosity lavas with a slightly higher iron content, followed by a later eruption of higher viscosity lavas of progressively lower iron but higher silicon content. One possible scenario is the draining of a differentiated magma chamber where an initial eruption of large amounts of basic basaltic magma left behind a residue with a relatively enriched silicon content and higher viscosity. This scenario might be supported by the fact that Mare Vaporum appears to have been the focus of considerable volcanism over a protracted period, as indicated by the numerous surface volcanic features and evidence for subsurface intrusions which have warped the overlying mare surface extensively. The position of Uk.1 superimposed on top of the fractures that cross the mare surface indicate that it is probably one of the youngest geological features in Mare Vaporum, and therefore an origin from a late stage magma chamber may be a plausible if highly speculative hypothesis.

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Acknowledgement:

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LUNAR GEOLOGICAL CHANGE DETECTION PROGRAMME
By Tony Cook.

News: Peter Andersen (Australia – BAA) has forwarded a PowerPoint presentation (Fig.1) as a poignant reminder for observers to be careful when interpreting colour on the lunar surface*: "What this powerpoint demonstrates is the variation in the appearance and in the relative luminosity of brightly illuminated lunar peaks, 'frame by frame', under poor atmospheric conditions. I am struck by TLP reports in some LSC's where it appears that inexperience coupled with such atmospheric effects may combine to cause a spurious TLP report. Perhaps the images in this powerpoint may prove of some use to demonstrate the effect, which is of course well known to experienced observers"*. He also comments that visually *"On this occasion the Moon was low and the central peak of Alphonsus was becoming fully illuminated and twinkling like a bright low altitude star, complete with chromatic effects".* So all observers are reminded that if they suspect a TLP, that they to check adjacent features on a similar longitude to see if the effect is present there too – if so then it is not lunar in origin but related to the Earth's atmosphere – this is especially the case if the Moon is low in altitude. A good set of guides on what to check out if you suspect a TLP is available in the appendix B of "The Hatfield Lunar Atlas: A Digitally Remastered Edition" and the SCT version.

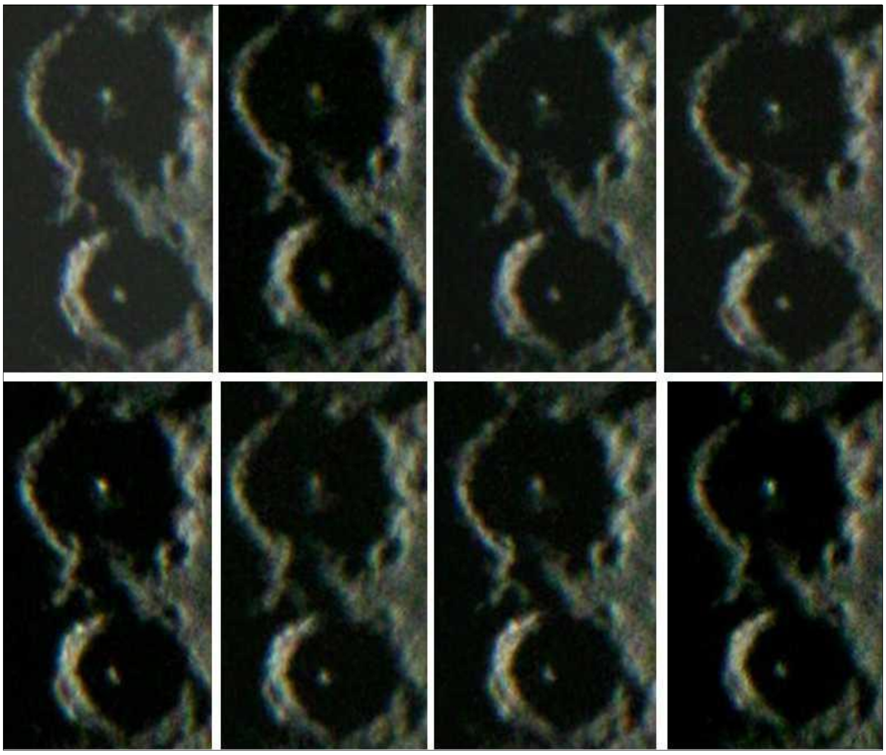

Fig.1. The effects of atmospheric spectral dispersion on the lunar surface as imaged by Peter Anderson (BAA) on 2013 Apr 18. Note how the central peak of Alphonsus changes in brightness and colour and the red fringes on the east on light/dark borders and the blue on the west of dark/light edges.

TLP reports: No reports were received for June.

Routine Reports received for May included: Jay Albert (Lake Worth, FL, USA – ALPO) observed: Alphonsus, Kies, Lambert Gamma, and Sasserides H. Alberto Anunziato (Argentina – SLA) observed: Aristarchus, Atlas, the Lunar Eclipse, the Lunar Poles, Manilius, Menelaus, Mare Serenitatis, Mons Piton, Oceanus Procellarum, Riccioli, and Tycho. Massimo Alessandro Bianchi (Italy – UAI) imaged: Campanus and Plato. Maurice Collins (New Zealand – ALPO/BAA/RASNZ) imaged: Archimedes, Aristarchus, Clavius, Copernicus, Letronne, Mare Humorum, Marius, Schickard, Schiller, Sinus Iridum, Tycho, and several features. Alexandra Cook (Spain) imaged the lunar eclipse. Anthony Cook (Newtown – ALPO/BAA) videoed earthshine in visible light and SWIR (1.1-1.7 microns), and also imaged several features in the visible, SWIR and in the thermal IR. Walter Elias (Argentina – AEA) imaged: Gassendi and Plato. Valerio Fontani (Italy – UAI) imaged: Campanus, Herschel and Plato. Massimo Giuntoli (Italy – BAA) observed: Cavendish E. Rik Hill (Tucson, AZ, USA – ALPO/BAA) imaged: Eratosthenes, Hortensius, the Lunar Eclipse, and Plato. Mark

Radice (near Salisbury, UK – BAA) imaged: Flammarion and Ptolemaeus. Aldo Tonon (Italy – UAI) imaged: Campanus, Herodotus, Heschel, and Lichtenberg. Trevor Smith (Codnor, UK – BAA) observed: Aristarchus, Bullialdus, Cassini, earthshine, Eudoxus, Mare Humorum, the north pole region, Plato, Proclus, Ptolemaeus, Tycho and the west limb. Aldo Tonon (Italy – UAI) imaged: Campanus, Herodotus, Herschel, and Lichtenberg. Fabio Verza (Italy – UAI) imaged: Campanus, Eudoxus, Herodotus and Herschel.

Analysis of Reports Received:

Proclus: On 2022 May 5 UT 20:41-21:05 & 21:57-22:12 Trevor Smith (BAA) observed this crater under similar illumination to the following report:

On 1989 Feb 10 at UT 19:00? Edmonds (England) observed a "bright red coppery" colour in the northwestern part of Proclus crater. He checked and found that there was no colour elsewhere, though he still suspects that the effect was spurious colour. Cameron comments that usually blue is seen in the north and red in the south if due to spurious colour. The Cameron 2006 catalog ID=350 and the weight=3. The ALPO/BAA weight=2.

Trevor was using a 16-inch Newtonian (x247) under Antoniadi III-IV seeing conditions. Immediately upon looking he noticed a slight coppery red colour to the N/W part of the rim. The reddish colour was more concentrated where the bright N/W wall met the dark interior floor shadow. In between clouds he was able to view the crater through orange Wratten 21, blue Wratten 38A, and light blue Wratten 80A filters, but they did not seem to affect the appearance. Cloud then hindered observing at 21:05, but he was able to undertake a second observing session later. There was still a reddish colour on the NW wall, but checks on some other craters also revealed the same effect, though not as strong as in Proclus. The redness seemed to appear and disappear, but this may have been related to the poor seeing conditions. We shall lower the weight from 2 to 1.

Sasserides H: On 2022 May 11 UT 02:55-03:15 Jay Albert (ALPO) examined this area under the same illumination conditions to the following TLP report:

On 1974 Jan 03 at UT 18:30 a Norwegian amateur astronomer, Hoydalsvik(Hakonsgate, in West Norway, 60mm refractor) photographed the Moon using High Speed Ektachrome (400ASA) film with good focus. The TLP was located on the southern slope of Sasserides H and was pink in colour with some bluish in it. The coloured area was circular with a diameter of 0.5 minutes of arc. Only one exposure was taken. The photograph was checked by the Institute of Theoretical Astrophysics, University of Oslo. This report was received by the BAA Lunar Section. ALPO/BAA weight=2.

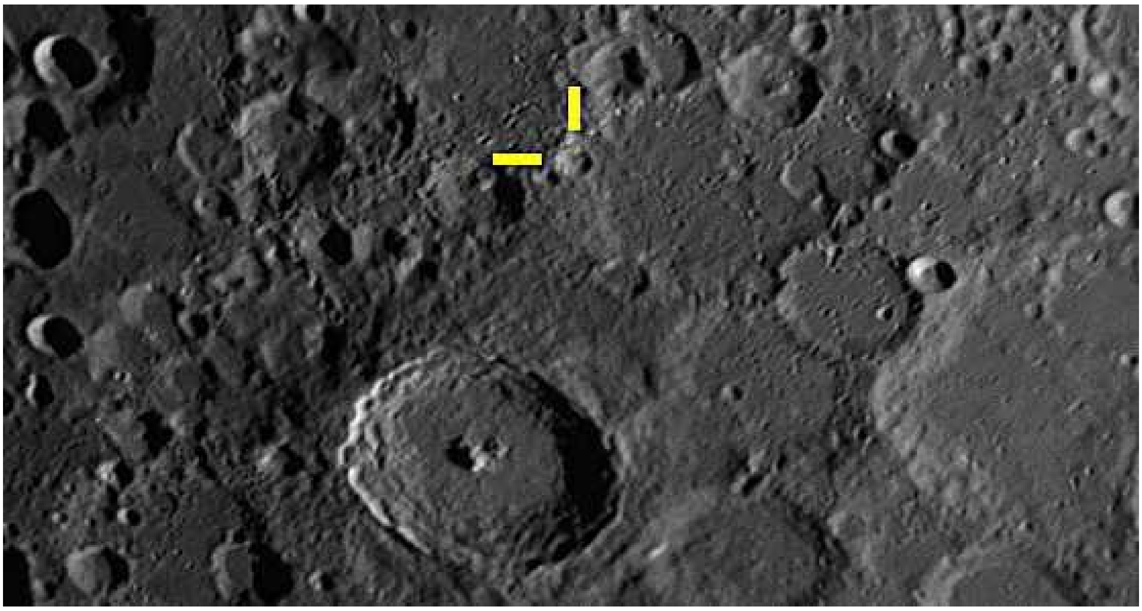

Fig.2. Sasserides H, as captured by Brendan Shaw on 2011 Jan 14 UT 17:43 and orientated with north towards the top. The yellow tick marks indicate the location of the crater.

Jay was using a Celestron NexStar Evolution 8" SCT under 3rd magnitude transparency with 5/10 seeing. He comments that *"Sasserides H was shadow-filled with a bright W rim. The seeing at this time was deteriorating,* *so I dd not attempt a photo. I saw no pink, blue or other color on H's S slope or elsewhere in or around the Sasserides area. I had to reduce the magnification to 226x due to the seeing".* He has previously observed this crater on 2010 Jun 22 and 2014 Apr 10, and on both occasions the crater looked normal. Alas the BAA lunar section does not appear to have the 1974 photograph in its archives, but does at least have the original letter from the Theoretical Physics department, to Patrick Moore, and also a rebuttal letter by Lawrence Fitton who thinks it was an effect of static electricity on the film or a processing artefact. It is not clear from the correspondence, back in 1974, whether the colour film was eventually sent off to Kodak's for checking. This is a pity as although incredibly rare, there is a very slight chance that it was an impact flash. Either way, I thought it would be interesting to show a repeat illumination image (Fig.2) of what the area would look like under normal conditions – as you can imagine a photo through a 2" refractor would have been of much lower resolution, but at least the claimed TLP would have been easily seen at 2/3rd of the diameter of Tycho crater. We shall lower the weight the ALPO/BAA TLP weight to 1 as it is not clear whether a photographic processing lab checked the photo or whether a "Theoretical Astrophysics Institute" had sufficient photographic knowledge to correctly interpret the image.

Herschel: On 2022 May 12 UAI observers: Valerio Fontani and Fabio Verza, imaged this crater under different resolutions, for the following Lunar Schedule request:

BAA Request: Can you see, or image, a very black rectangular feature along the western side of Herschel and slightly to the north? You can use a telescope aperture as small as 3.5-inches(90mm) to make this observational study. All observations should be emailed to: a t c @ a b e r . a c. u k

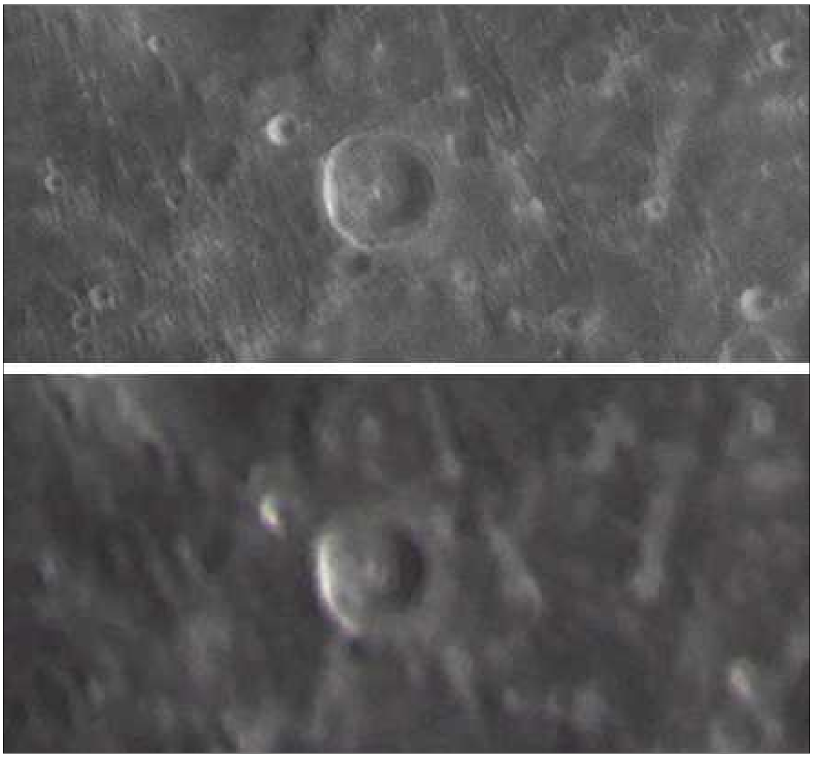

Fig. 3. Herschel oriented with north towards the top, taken on 2022 May 12. (Top) an image by Fabrio Verza (UAI) taken at 21:26 UT. (Bottom) An image by Valerio Fontani (UAI) at 22:21 UT.

The two different resolution images in Fig 3 do not show anything obviously rectangular, or very dark, along the western edge of .Herschel. The original TLP report was: *"On 2015 Sep 25 UT 03:28-03:40 D. Davis (Albany, OR, USA, Questar telescope used, x80 and x120, seeing 6, transparency), saw a very black rectangular feature along the western side of Herschel and slightly to the north. the effect was first noticed at 03:28-03:32 and it was checked again at 03:37-03:40. The length was ~4x the width and it was roughly 80-100 km long by 15-20km wide. Probably not a TLP, but it's worth checking again under similar illumination. ALPO/BAA weight=1".* Fig 3 (bottom) is a closer match to the resolution obtained through a Questar telescope back in 2015. Could it be that they mistook "J. Herschel" for "Herschel"? I used NASA's Dial a Moon website to feed in 2022 May 12 UT 22:00 and came up with this startling finding that neatly explains the Daryl Davies report – see Fig 4. It turns out that J. Herschel does indeed have a nice dark rectangular shadowed area, but some distance west of its western rim. I wonder if this is what Darryl Davis saw back in 2015? Unfortunately his email address from 2015 no longer works, so if anybody knows him, please let me have his contact details so I can ask him what he thinks about this this theory.

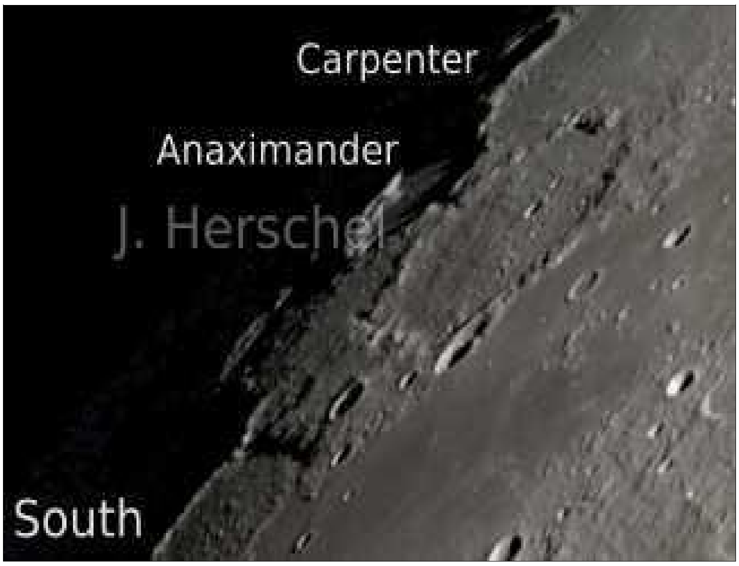

Fig. 4. J. Herschel as visualized by Dial a Moon for 2022 May 12 UT 22:00 and orientated with north towards the top.

Aristarchus: On 2022 May 13 UT 05:47 Maurice Collins (ALPO/BAA/RASNZ) imaged this crater under similar illumination to the following two reports:

On 2004 May 01 at UT 22:20 R. Lena (GLR, Italy) received an image from one of his observers showing possible blue colour in Aristarchus crater and part of the ray towards Herodotus. The ALPO/BAA weight=1.

Aristarchus, Schroter's Valley 1963 Dec 28 UTC 01:15-02:00 Observed by Olivarez, Edinburgh?, TX?, USA, 17" reflector) "In poorer moments of seeing, red on Aris. rim & Sch. Valley. Spurious seeing effects?". NASA catalog weight=1. NASA catalog ID #788. ALPO/BAA weight=1.

Fig.5. Aristarchus as imaged my Maurice Collins on 2022 May 13 UT 05:47, orientated with north towards the top and colour saturation increased to 30%.

Maurice's image does indeed show some red on the rim of Aristarchus and Vallis Schroteri. You can also see some tinge of blue on the illuminated rim of Aristarchus (natural colour). The fact that the 1963 observation refers to red being seen during poorer moments of seeing, is not exactly encouraging over the reliability of the report. For the 2004 report, the fact that blue was seen on the crater is not unexpected, as we can see it in Fig 5. We can therefore remove these two TLP reports from the ALPO/BAA database by assigning weights of 0.

Cavendish E: On 2022 May 13 UT 20:15 Massimo Giuntoli (BAA) observed this crater using a 20cm Newtonian (x200 & x250, seeing IV. He found the northern floor of the crater has its usual appearance - bright but not brilliant. (colong. 65.9° / sub sol. lat. 0.0 / libr. lat. -2°38', libr. Long. -6°11').

Plato: On 2022 May 14 UT 21:00 Massimo Alessandro Bianchi imaged the Moon under similar illumination to the following report below and to a lunar schedule request for the second report:

Mannheim Observers 1788 Dec 11 - Bright point seen on the dark part. Cameron 1978 catalog ID is 38 and the weight assigned is 5. ALPO/BAA weight=1.

Two observers have reported colour on the rim around this colongitude, once in 1938, and again in 2013. Please take a look and report what you see, and where on the rim. Please send any high resolution images, detailed sketches, or visual descriptions to: a t c @ a b e r . a c. u k .

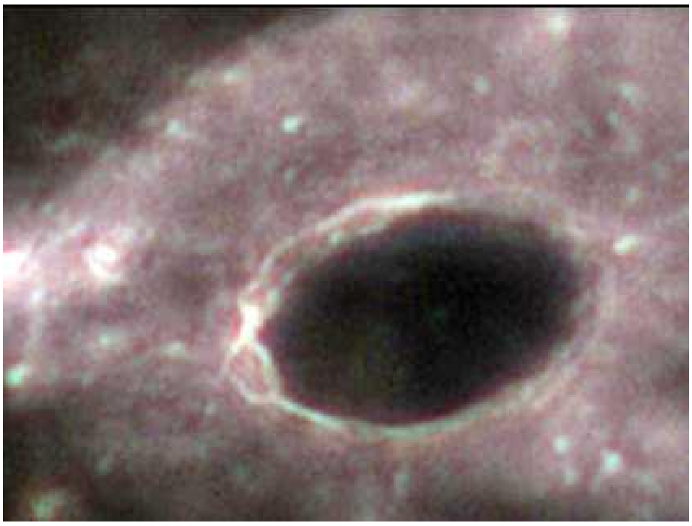

Fig.6. Plato as imaged by Massimo Alessandro Bianchi on 2022 May 14 UT 21:00 and orientated with north towards the top. The image has been colour normalised and had its colour saturation increased to 30%.

I am wondering if, for the 1788 TLP report, they are simply referring to the central craterlet on the dark floor of Plato. If so then visibility is dependent upon seeing and image contrast. It is just about visible in Massimo's image (Fig 6). The lunar schedule request actually refers to two TLP reports: 1938 and 2013, both at similar colongitudes. The 1938 report was for a prominent gold-brown spot on the east wall with a yellow glow but no definite boundary, spreading out over onto the floor of Plato. The 2013 report was for a golden yellow colour being seen on the eastern rim. Although colour normalized and colour saturation enhanced, Massimo's image shows no yellow colour on the eastern rim of Plato. We have covered repeat illumination observations for the 1938 and 2013 TLP, before in the 2015 Feb and 2018 Jan newsletters, and the yellow colour never reappeared in those reports. So what ever happened in 1938 and 2013 was clearly most unusual and so we shall leave the weights of those two TLP unadjusted.

Gassendi: On 2021 May 14 UT 21:13 Walter Elias (AEA) imaged the crater under similar illumination to the following report:

Gassendi 1973 Dec 08 UT 20:20-20:22 observed by J-H Robinson (Devon, UK, seeing fair to poor). Suspected blink detected on crater floor - might have been due to atmospheric conditions?. ALPO/BAA weight=1.

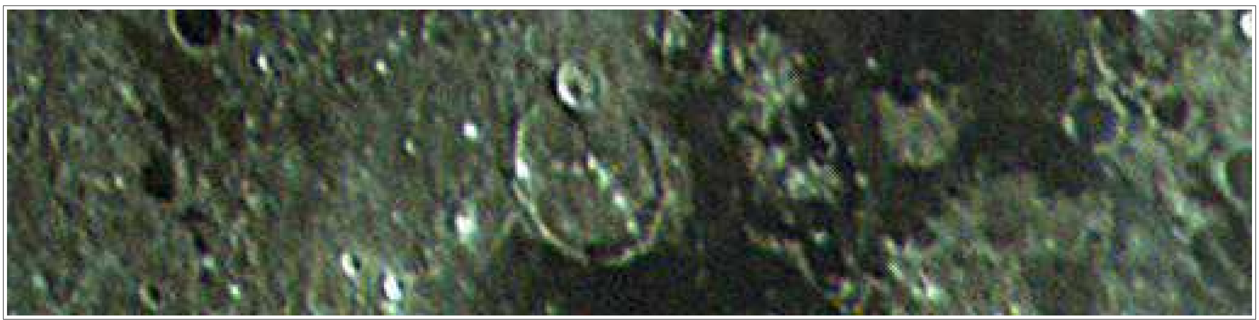

Fig.7. Gassendi as imaged by Walter Elias (AEA) on 2021 May 14 UT 21:13 and orientated with north towards the top. The image has been colour normalised and then had its colour saturation increased to 70%.

Walter's image (Fig 7) shows that there is no natural colour here that could explain the effect seen in 1973. As the original report was already a weight of 1, we cannot go much lower on the weight. Despite the poor seeing mentioned by Hedley Robinson, it is interesting in the original report that the effect lasts about 2 minutes and is then not seen again that night. Also a visual Moon Blink was used, which would rule out atmospheric spectral dispersion or chromatic aberration. For now we shall keep the ALPO/BAA weight at 1.

Lichtenberg: On 2022 May 15 UT 19:58 Aldo Tonon (UAI) imaged the crater in colour for the following repeat illumination request:

BAA Request: An important historical TLP sketch of this crater, and its surrounds, made by Richard Baum back in 1951 seems to have the wrong UT? It is very important that we establish what the UT and date of this observation actually was. In this prediction we are seeing if his date was off by 1 day. Please email any sketches, monochrome, and especially colour images to: a t c @ a b e r . a c. u k

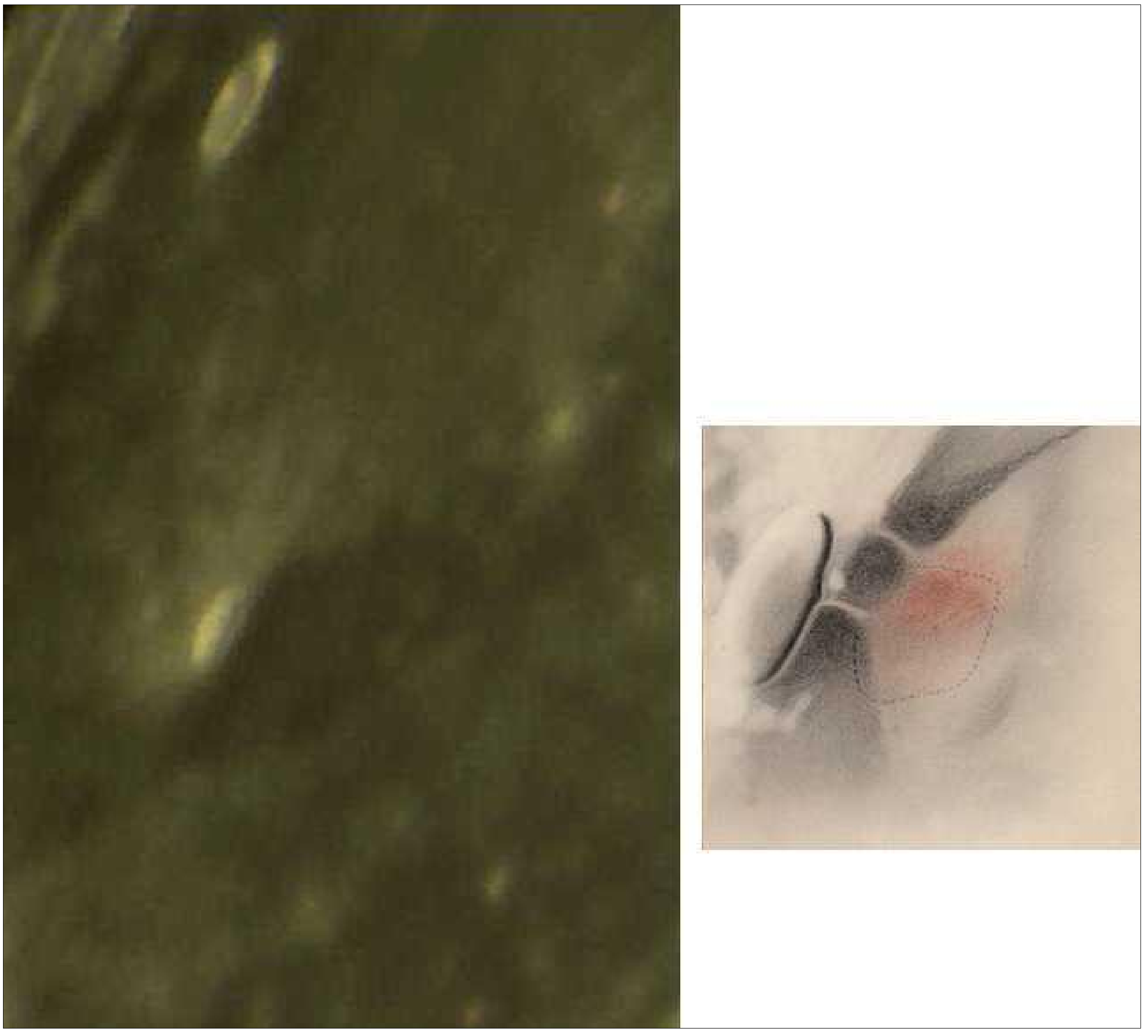

Fig. 8. Lichtenberg, oriented with north towards the top. (Left) A colour image by Aldo Tonon (UAI) taken on 2022 May 15 UT 19:58. (Right) A sketch by Richard Baum – where the date and UT were given as 1951 Jan 21 UT 18:19-18:39.

Aldo's image in Fig 8 shows the dark "bow-tie" appearance SE of Lichtenberg and also has the appropriate amount of shadow inside the crater. This suggests strongly that the date that Richard Baum used for his Lichtenberg sketch was probably off by one day. We have covered this before in the 2020 Jun, 2021 Apr and 2021 Jul newsletter and I think we have enough proof now to adjust the date in the TLP catalog from 1955 Jan 21 to Jan 22 UT 19:19-18:39. What was causing the rose tinge SE of the crater, back in 1951 remains a mystery.

Grimaldi: On 2022 May 16 UT 01:56-02:05 Alberto Anunziato (SLA) observed this crater under similar illumination to the following report:

On 1964 Jun 25 at UT ~01:07 Rubens de Azevedo (Brazil) observed a white streak from Grimaldi on the limb, during an eclipse. The Cameron 1978 catalog ID=822 and weight=4. The ALPO/BAA weight=2.

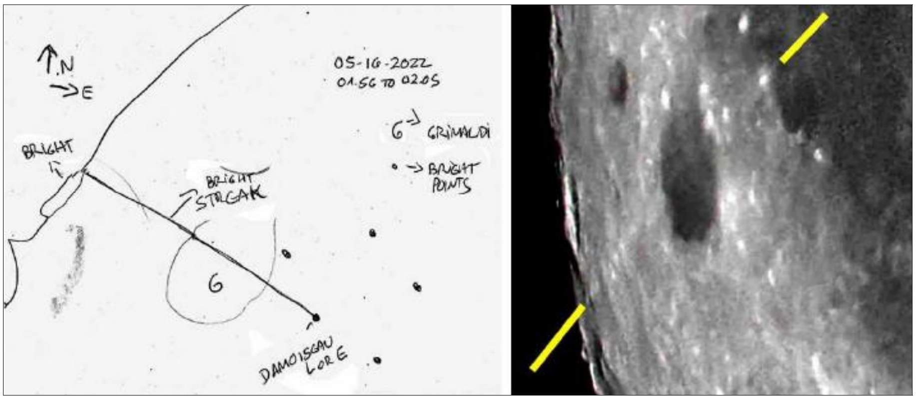

Fig. 9. Grimaldi and the west limb of the Moon. (Left) A sketch of this region during the penumbral stage of the lunar eclipse by Alberto Anunziato (SLA), made on 2022 May 16 UT 01:56-02:05. Image has been mirror reversed, orientated with north towards the top and text has been re-orientated from the original drawing. (Right) A section of the same area from an archive image of the Full Moon, by Valerio Fontani (UAI), taken on 2022 Dec 18 UT 21:32 – the yellow tick marks indicate a possible ray.

Alberto could see a white streak from Damoiseau L (or Damoiseau E) passing through Grimaldi and ending on the West Limb (See Fig 9 - Left). Note that this was seen during the penumbral stage of the eclipse, but the Brazilian report was made between first contact of the umbra and totality. As the Full Moon is a good analog to the phase angle, we see the surface at during a lunar eclipse, an examination of a near-Full Moon image (Fig 9-Right) is a useful reference and shows the alleged ray quite well. Searching through the archives I managed also to find a series of sketches (Fig 10) that seem to match the Grimaldi ray in Fig 10, but appear to be a lot more prominent – they were actually made during the 1968 lunar eclipses, but as you can see the original claimed discovery of the "valley of Grimaldi" was from 1964.

On page 94 of the same Lunar Section Circular it states: *"On receiving a letter from SAVAL (Sociedad Astronomica de Valparaiso, Chile) I was informed by the team of such society, organized to observe the recent and total eclipse of the Moon, that they again observed the "valley" of Grimaldi, which was registered by my friend and colleague, Prof. Rubens de Azevdeo and his team, observed for the first time during the eclipse of June, 1964. This strange formation appears to start from the western (IAU) wall of Grimaldi running to the nearby limb. According to all who have observed it, it is conspicuous and "very bright". One could observe it even without any experience of Moon observing. Another colleague, of ASOA (Salto, Uruguay) saw this strange ray "as a subsequent chain of bright spots" and exactly on the same place. It is to be noted that Prof. Rubens and a group of 20 observers, noticed it again during the recent eclipse. Their instruments were powerful enough to avoid mistakes: 12-inch, F/d:7, Reflector and some less powerful. From my own observation, it was not seen, but this could be attributed to phenomena particularly observed during eclipses only"*. – J. Niccolini (Brazil).

So, to summarize this 1964 TLP report concerns a ray system that is strongest on the western side of Grimaldi, towards the limb, and the observers attributed the bright spots, in the vicinity of Damoiseau, as a continuation of the ray, possibly as far as Kepler. Examination of the Full Moon image and Alberto's sketch (Fig 9), and also an image from a Wikipedia page, about the 2022 May 16 eclipse, looks similar to the sketches in Fig 10. I think the visibility of this supposed alignment, is related to observing conditions. We shall therefore lower the weight from 2 to 0 and effectively remove this report from the ALPO/BAA TLP database.

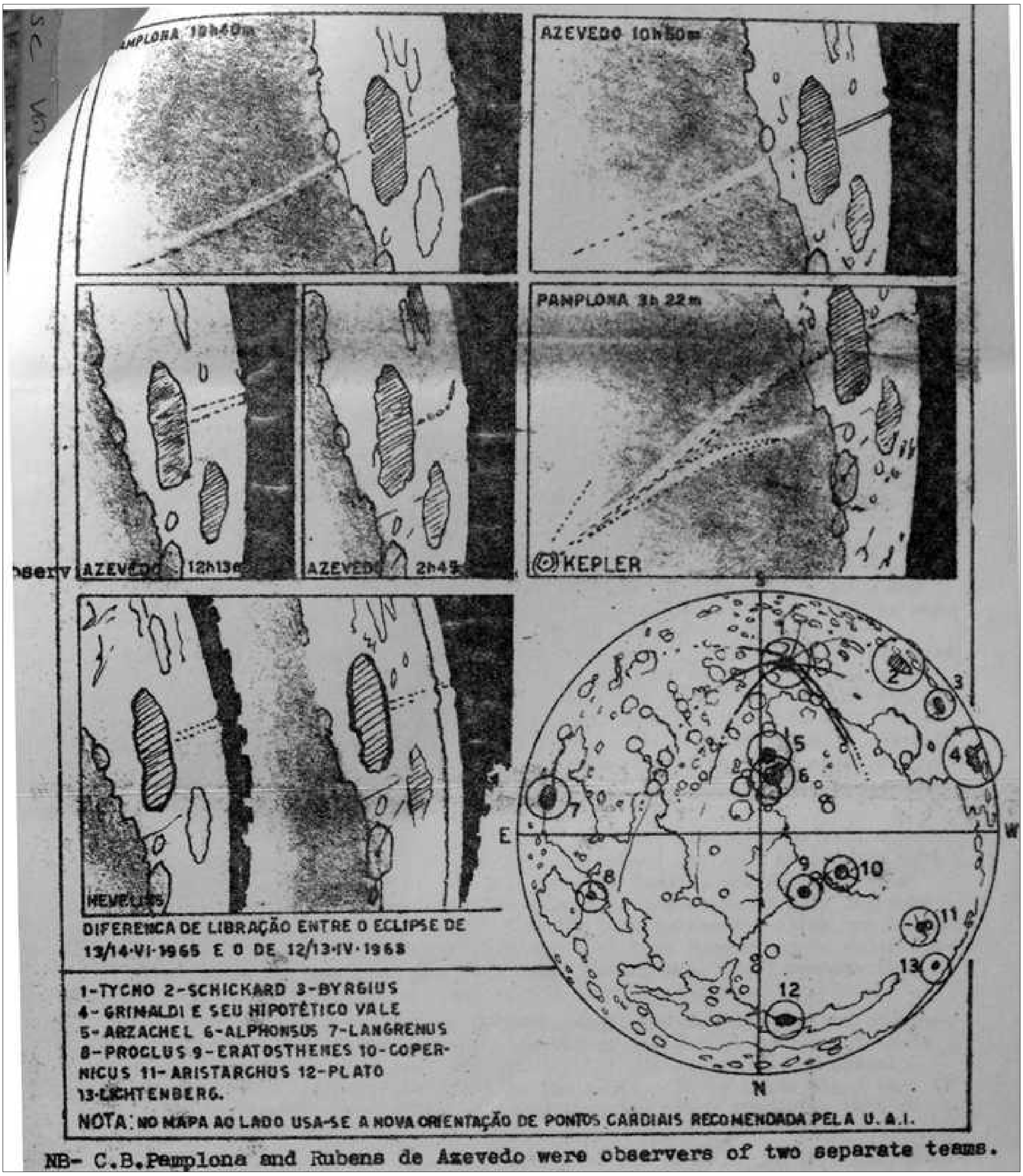

Fig. 10. Sketches of rays in the Grimaldi area of the Moon, made by Pamplona and Azevedo, during the two eclipses of the Moon in 1968. From the BAA Lunar Section Circular p103, No. 10, Vol 3, from 1968. Not these are orientated with north towards the bottom.

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 . By re-observing and submitting your observations, only 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 .

Dr Anthony Cook, Department of Physics, Aberystwyth University, Penglais, Aberystwyth, Ceredigion, SY23 3BZ, WALES, UNITED KINGDOM. Email: atc @ aber.ac.uk

BAA LUNAR SECTION CONTACTS:
Acting Director: Tony Cook (atc @ aber.ac.uk)
Lunar Section Circular Editor: Barry Fitz-Gerald (barryfitzgerald@hotmail.com)
Website Manager: Stuart Morris [contact link via the Section website at https://britastro.org/section_front/16]
Committee members:
Tony Cook (Coordinator, Lunar Change project) (atc @ aber.ac.uk)
Tim Haymes (Coordinator, Lunar Occultations) (occultations @ stargazer.me.uk)
Robert Garfinkle (Historical) (ragarf @ earthlink.net)
Raffaello Lena (Coordinator, Lunar Domes project) (raffaello.lena59 @ gmail.com)
Nigel Longshaw