Acting Director: Anthony Cook.
Editor: Barry Fitz-Gerald.

LUNAR SECTION CIRCULAR

Vol. 58 No. 10 October 2021

From the Director

I would like to welcome our readers back after a two month break. It is not uncommon, if you look at past issues of the Lunar Section Circular, to have the occasional break. For example: changeover of directors, holidays, work pressures, lack of observations in the Summer, and even postal strikes have all delayed publication of the circular. Anyway, I have used this time to think how we can go on after the very successful directorship of Bill Leatherbarrow, whom I'm sure we all wish well in his retirement.

I have made a start by appointing Barry Fitz-Gerald as editor. Secondly, would like to encourage readers to add some text when they forward observations to me. This would take the form of words added to the email giving additional details about the equipment you used and especially what you see in the image/sketch and would like to highlight to the reader. Richard Hill already does this, but if you only wish to add a sentence then that is fine too. Thirdly if you have any old digital images of the Moon at home, which have not been published in the Lunar Section Circular, but you would like to be permanently archived, please get in contact with me and I'll set up an account on the Amateur Astronomy Outreach here at Aberystwyth University to let you upload them. We never know what interesting nuggets of information can be found in digital images of the Moon taken at different selenographic colongitudes, so they are definitely worth keeping for use by Lunar Section researchers.

Lastly, Rik Hill has reminded me that all the images that he has sent into the Lunar Section Circular, and much more, can be found on the Jim Loudon Observatory Lunar Database. This database has been built up over at least ten years and holds more than 560 lunar images, all listed by individual feature. You can peruse the database at:

https://www.lpl.arizona.edu/~rhill/moonobs.html

Hope you enjoy the October edition of the circular.

Tony Cook. (Acting Director)

OBSERVATIONS RECEIVED

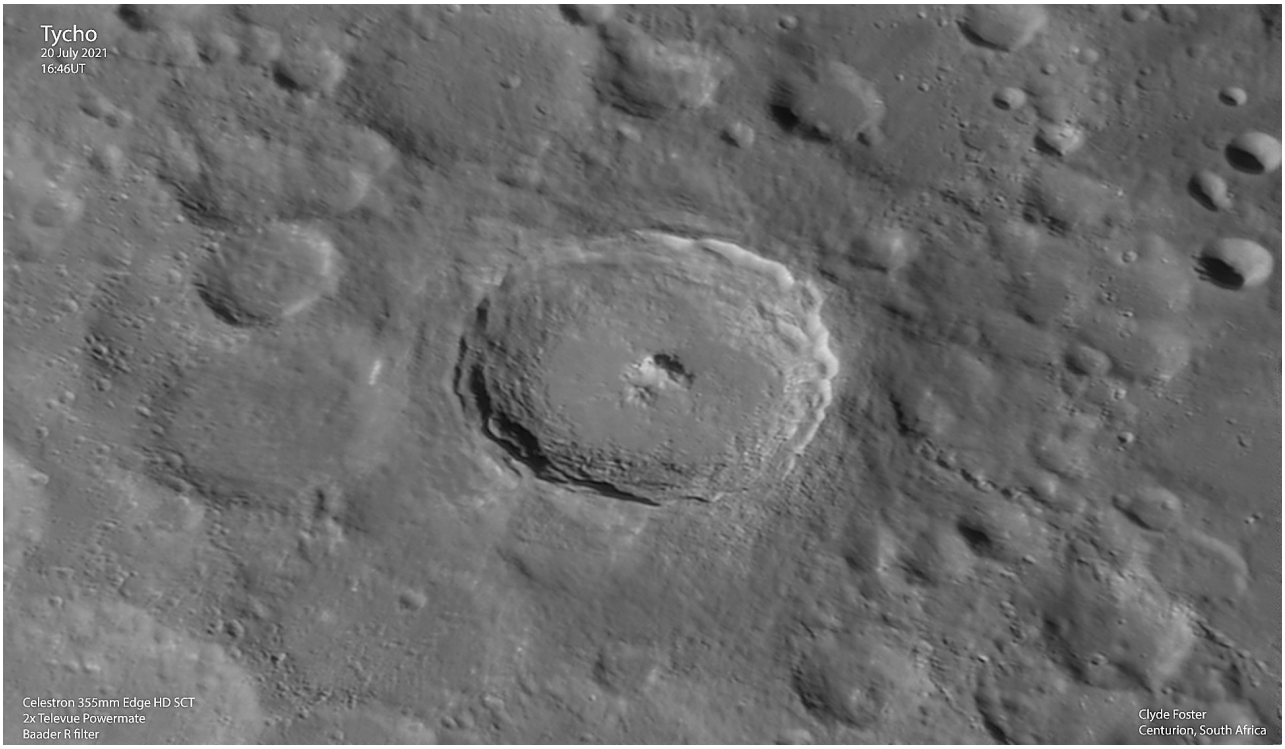
Observations have been received from the following:

Maurice Collins (New Zealand), Clyde Foster (South Africa), Les Fry (UK), Massimo Giuntoli (Italy), Rik Hill (USA), Rod Lyons (UK), Bob Stuart (UK), and Neil Webster (UK)

Note: all other observations are made available to researchers within the Lunar Section upon request and if you wish to contribute images or drawings to forthcoming LSC's please send them in by the 20th of the month for inclusion in the circular.

(Director/Editorial comments in italics)

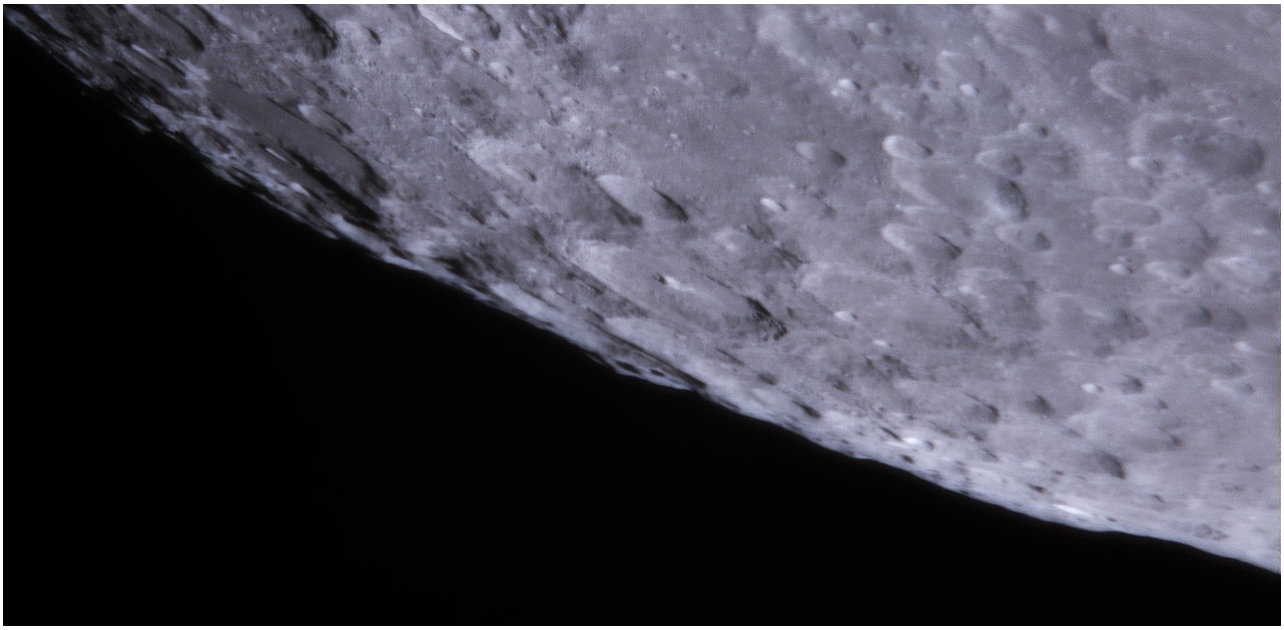
TYCHO by **Clyde Foster**



Tycho imaged by Clyde Foster from Centurion, South Africa using a Celestron 355mm HD Edge SCT. 2X Televue Powermate and Baader R Filter on 2021 Jul 20 UT 16:46 and orientated with north towards the top.

Tycho is one of the youngest, large, craters on the Moon, a mere 108 million years old and 85 km in diameter. The ray system extends across much of the near side of the Moon. It was visited by Surveyor 7 in 1968, albeit just outside the crater and to the north. It was one of the Surveyors that managed to image sunlight scattered off electrostatically charged dust particles suspended above the horizon, when the Sun was below the horizon. Although not visible in Clyde's image, the impact melt on the floor of Tycho has some cracks from the cooling of this former molten material.

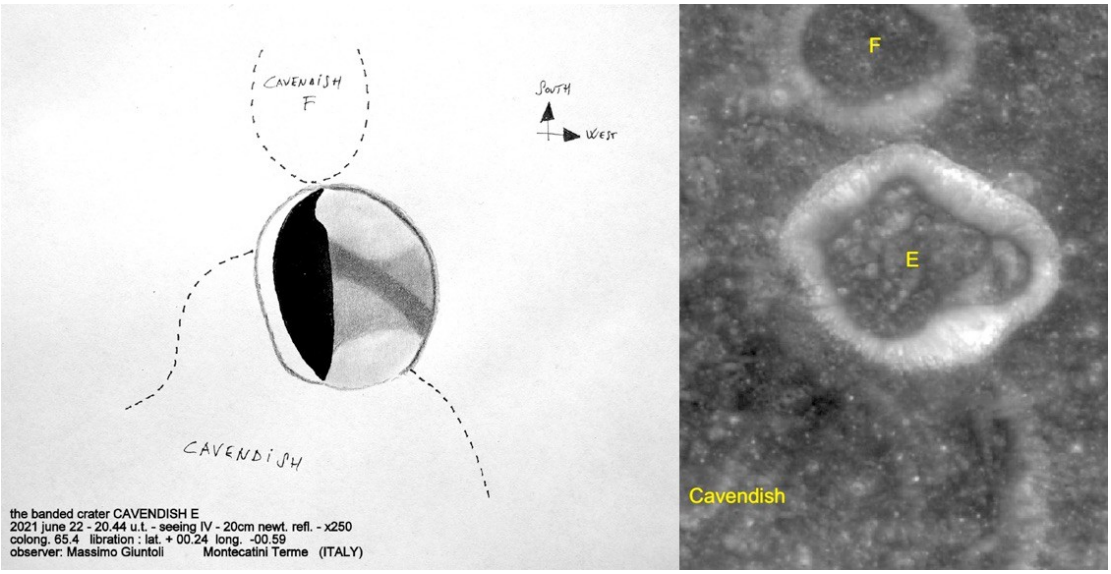
MORETUS by Maurice Collins



Moretus as imaged by Maurice Collins on 2021 Sep 18 UT 04:35 using a C8 scope with a x2 Barlow and a QHY5III462C camera. North is towards the top right.

Moretus is a central peak crater, like Tycho but further south and larger at 114 km across. Unlike Tycho it is not a ray crater, so must be somewhat older perhaps of the Eratosthenian geological era. The libration here has pushed the crater towards the limb. Moretus lies almost 600 km from the south pole.

CAVENDISH E by Massimo Giuntoli



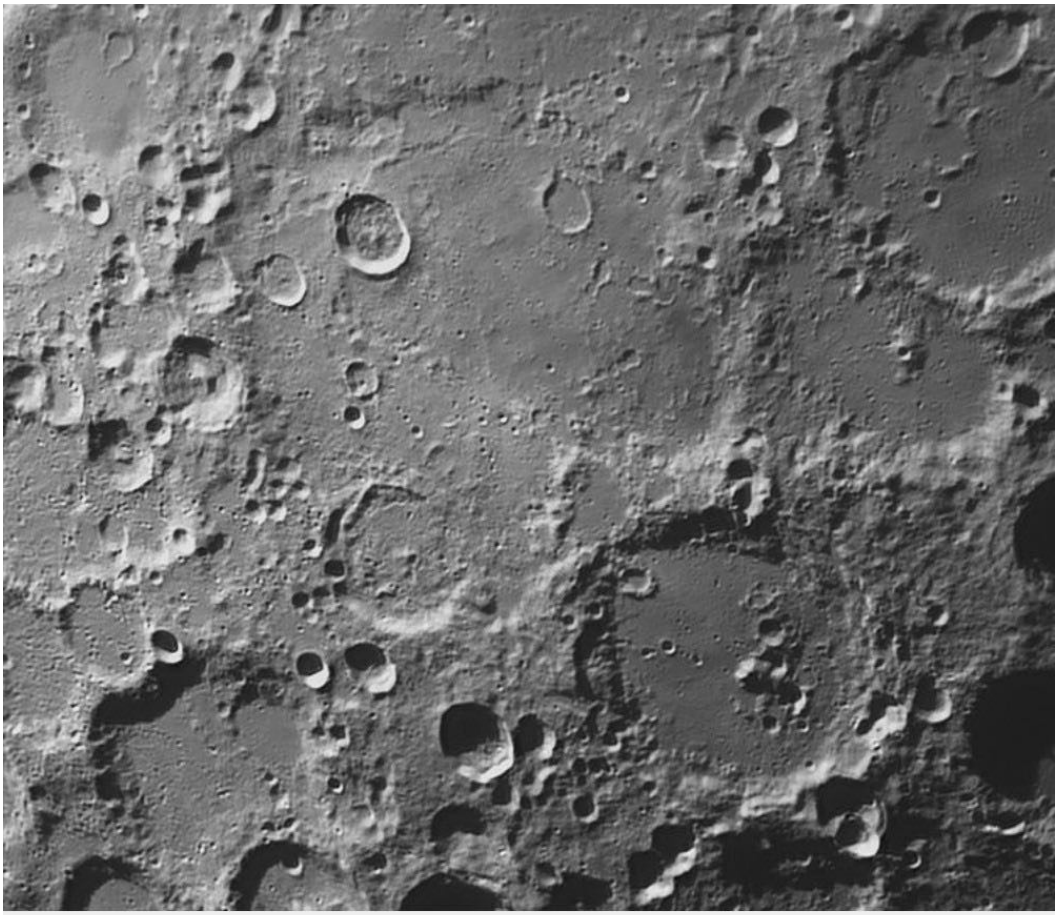
Left: Cavendish E as sketched by Massimo Giuntoli. Dates, UT and direction are given in the figure. Right: WAC Normalized Reflectance (Albedo) Map of the same area.

Cavendish E is a 24 km diameter satellite crater that sits on top of the south west rim of the larger parent 56 km diameter Cavendish. Cavendish E has a smaller crater on its western side, and so could be like Birt, perhaps formed by a shallow incidence angle impact? Alternatively this may represent a slump from the western rim down onto the western crater floor. You can see a nice dark band within the crater, though interestingly it is not radial like most bands are and overlies a broader but less dense radial band on the crater interior.Cavendish E is listed on the Master List of Banded Craters on the ALPO website.

(http://moon.scopesandscapes.com/ALPO_Lunar_Program.htm)

The banding in many craters reflect mineralogical differences in the underlying geology, with darker more mafic material frequently forming radial bands on lighter crater walls. In the case of Cavendish E however we have no such underlying geological diversity and the banding may be produced by a combination of topography, producing the curving shadow and the less than symmetrical darker crater floor material. Cavendish itself may have a light dusting of low albedo pyroclastic material on ts northern floor but this does not appear to extend into Cavendish E. So, another good example of visual observation picking up subtleties not readily seen in the spacecraft imagery.

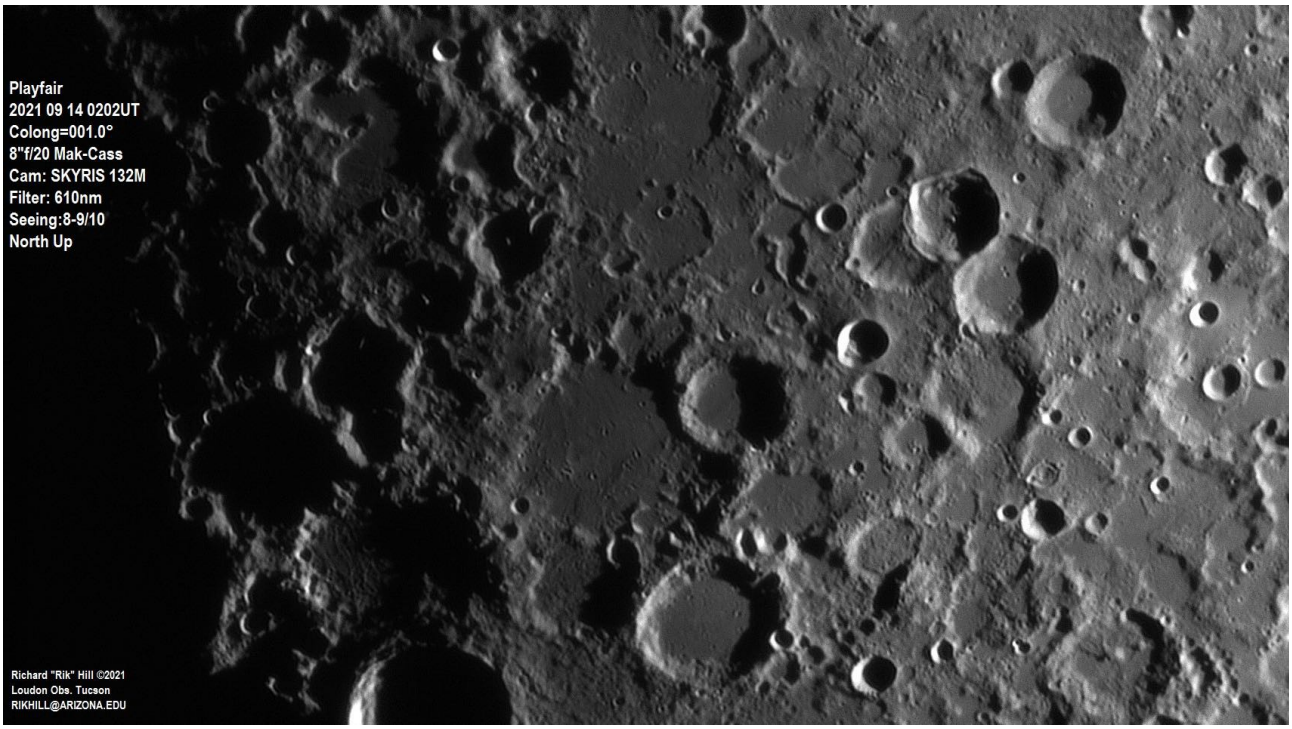
DESLANDRE by Rod Lyon



Deslandres & Walther 2021.08.29 - 07.10 UT
300mm Meade LX90, with ASI 224MC Camera and Pro Planet 742nm I-R Pass Filter.
800/4,000 Frames. Seeing: 8/10, slight turbulence. Rod Lyon

Deslandre is a heavily degraded 227 km diameter flat floored crater. Walther is to the bottom right of this in the figure. The most obvious well defined crater on the floor of Deslandre is the crater Hell, and to the east of this is a Hell Q which becomes a brilliant ray crater under Full Moon conditions.

Playfair and topographic notes by Richard "Rik" Hill.



Playfair captured by Richard "Rik" Hill with north towards the top. Image made from a montage of two, 1800 frame AVIs stacked with AVIStack2 (IDL) knitted together with Microsoft ICE and further processed with GIMP and IrfanView.

There are so many wonderful things to see in the lunar southern highland region around the crater Playfair (49km dia.) seen here in the middle of this image half filled with shadow cast on its flat floor. Below it is a larger crater of similar morphology Apianus (65km). Then to the upper right from Playfair are the twin craters Azophi (49km) south and Abenezera (43km) north. Notice the sharp central peak in the latter crater with sunlight catching the very tip and the straight northern wall. It overlaps an older crater that has some

interesting striations on its floor. To the upper right of these is the crater Geber (46km) with an interesting slump on the interior of its southern wall. South of Azophi on the lower edge of the image is the crater Pontanus (60km) with a central mound rather than a true peak. It's the oldest crater mentioned so far between 3.92 and 4.55 billion years old. Between Pontanus and Azophi is a well-defined young crater Pontanus D (20km). Just above it is an interesting double walled crater Pontanus E (13km) and to the left of that are two parallel old heavily eroded unnamed catenae. Going left from Playfair to the terminator we see half a crater at the lower edge of the image. This is Aliacensis (82km) and above it is Werner (71km) and further up is the flat floored Blanchinus (70km) with nice shadows of the peaks of its crater wall on the floor. Next, you'll notice four shadow filled craters in a diagonal row of descending diameters. The lower, larger one is La Caille (70km), the next one up is Delaunay (48km), then Faye (37km) with a tiny central peak tip catching sunlight and lastly Donati (37km). The interesting thing here is just below La Caille and to the left

of Blanchinus is the well-known fleeting "Lunar X" formed by the walls of these two craters. This is about two hours after it would have been best seen but it still can be made out.

Of course, as usual at this resolution (1 km) there's a lot more to see here. Enjoy the exploration!

Babbage by Les Fry

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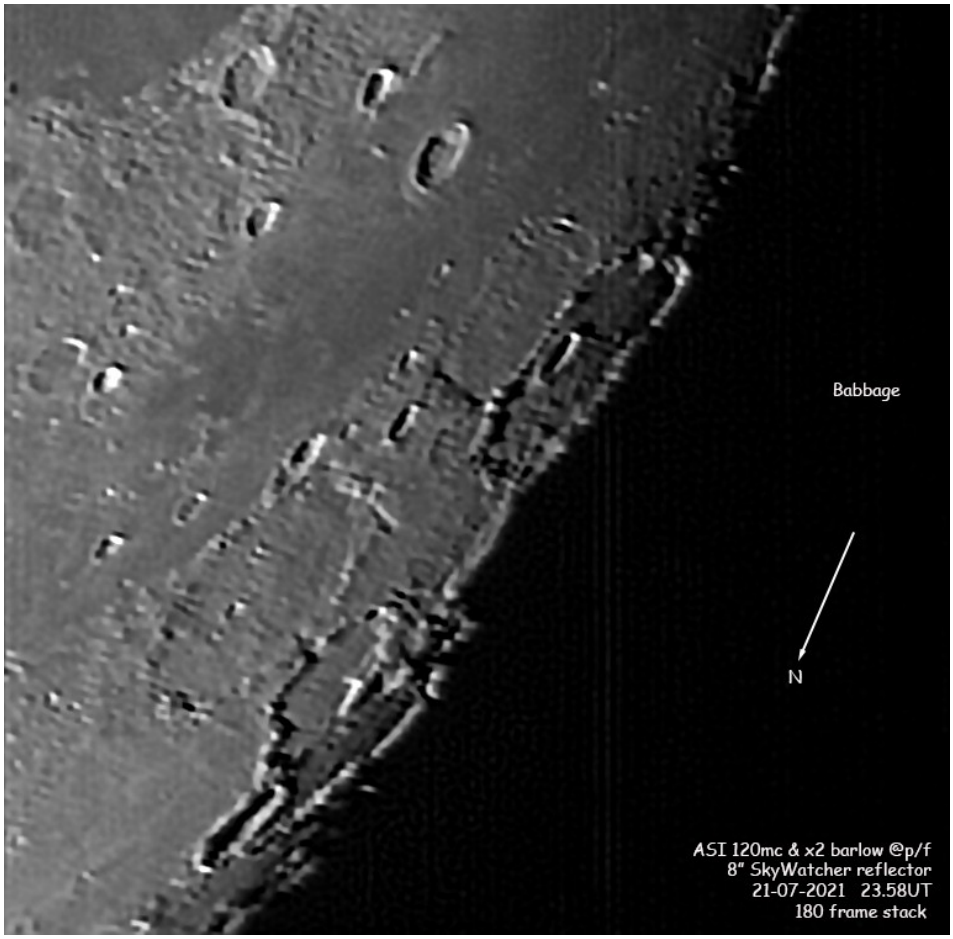
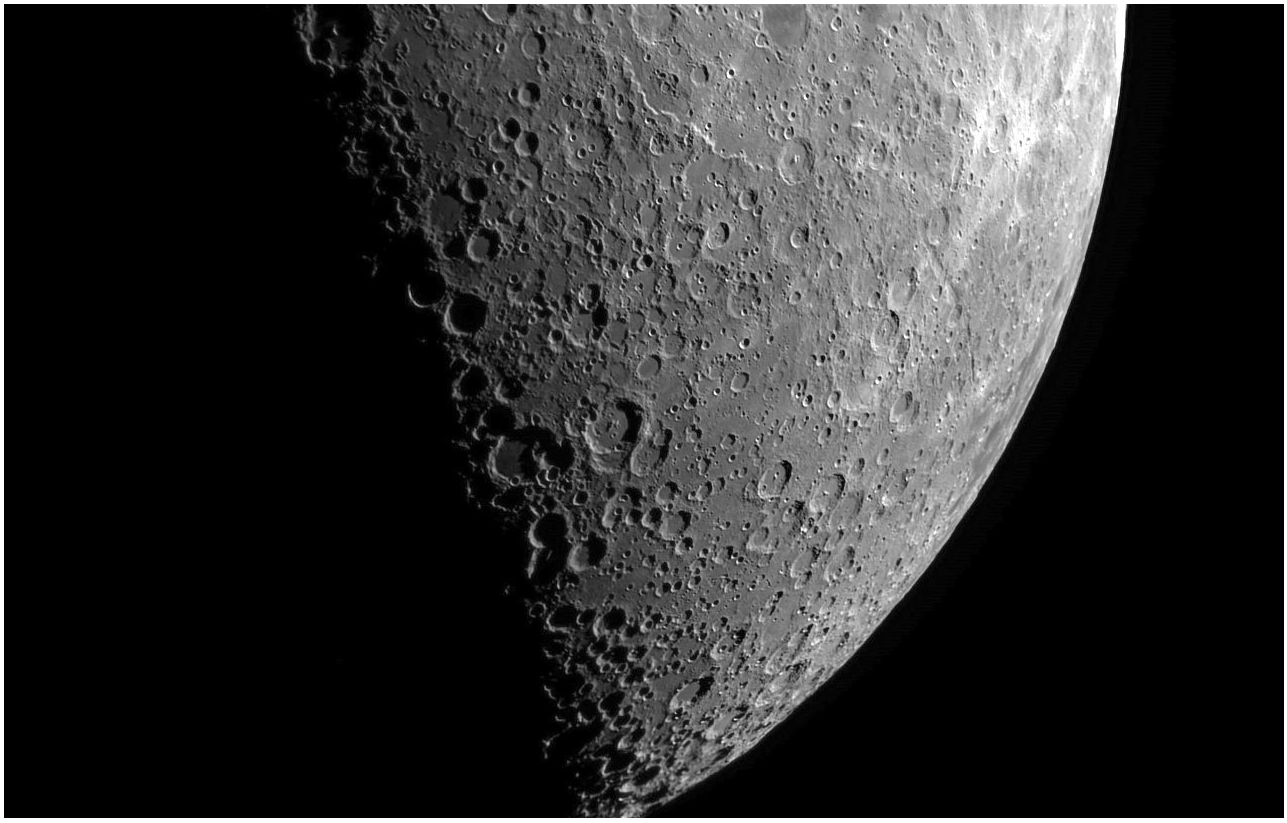


Babbage captured by Les Fry, north has been added as the image

For those of you who do not know, Charles Babbage was a British scientist/engineer from the Victorian era. Apart from inventing the cow catcher for steam engines and engaged in code breaking, he also devised a mechanical calculator: the Difference Engine, and a programmable calculator: the Analytical Engine. Unfortunately, due to falling out with his engineer and a lack of money from the UK government, these were not completed in his lifetime, and the dawn of the computer age had to wait until the 1940's. Anyway, in the image the image that Les took we see that this 143 km diameter crater has a lava flooded floor with approximately straight west and east edges – the eastern edge has the shortest segment of straightness. Cutting through some of the similarly large ringed craters to the north are what appear to be gashes perpendicular to the direction towards the morning terminator. Just to the south of Babbage is an even more degraded impact crater called "South", and to the north east, beyond the terminator, would be the central peak crater Pythagoras – if it were sunlit.

The South East Moon as imaged by Neil Webster

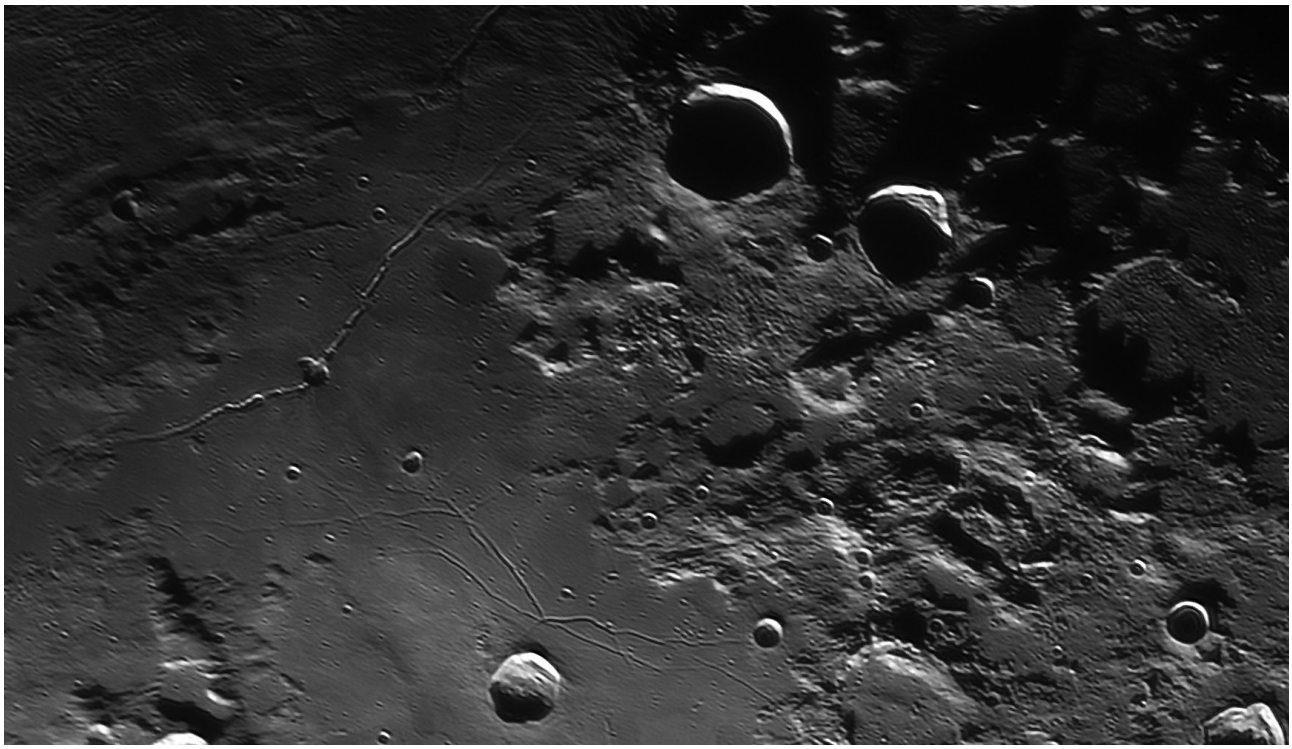


The South East Moon as imaged by Neil Webster on 2021 Jul 16 and orientated with north towards the top left. Taken with a AA115mm APO, EQ6 R, ZWO ASI290MM, Astronomik Filter (642 - 840nm).

Neil Webster has sent in a wide area context image of the SE quadrant of the Moon. The image is nicely exposed to bring out detail in the terminator, but also does not saturate some of the brighter ray craters closer to the SE limb. Rupes Altai which straddles the SW outer rim of the Nectaris impact basin can be seen close to the top right edge of the image. On the top right you can see a prominent ray crater, Stevinus A.

Sinus Medii area by Bob Stuart.

Two sets of rilles are visible in Bob's image. The left most group, are the Rimae Triesnecker and are possibly tectonic in origin as there are no obvious domes associated with these. On maps the different segments of this Rimae are given roman numerals. In the top right we can see a more segmented sinuous rille: Rima Hyginus, of which Hyginus crater straddles has a great number of pits along its length, which may point to a volcanic origin. Hyginus crater itself, is one of the few craters visible from Earth that is believed to be volcanic in origin. Although not visible in Bob's image, NASA LROC images reveal Ina like features on the floor of Hyginus.



The Sinus Medii area by Bob Stuart, and taken on 2021 Aug 29 and orientated with north towards the top left.

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Rimae Posidonius II by Barry Fitz-Gerald

The sinuous rille Rimae Posidonius II which is located within the 95 km diameter Floor Fracture Crater (FFC) Posidonius, is usually described as originating somewhere along the northern crater wall, then flowing westwards before veering south to re-cross the floor and head north up the western wall to a breach in the crater rim, from which it debouched onto Mare Serenitatis (Fig.1). Sinuous rilles are thought to originate by either constructive or erosional processes, with the erosional ones representing channels created by high temperature flows of lava that cut a channel down into lunar surface by a combination of thermal and mechanical erosion[1]. Some of these rilles formed as open channels whilst others may have originally been roofed over with a crust of solidified lava. Rimae Posidonius II appears to be of the 'open channel' variety of sinuous rille, with no evidence of any roof having existed anywhere along its length. The prevailing view is that sinuous rilles were cut by lava of hight temperature (~ 1440°C) and low viscosity, erupted rapidly and in high volume.

Thermal erosion is believed to have been the dominant process in channel formation as the low lunar surface gravity would limit the kinetic energy of the flow and hence its ability to mechanically erode[ibid]. The low viscosity would allow the development of a somewhat chaotic, turbulent flow which would enhance the erosive potential of the lava. The degree of sinuosity exhibited by sinuous rilles can vary between being very low to very high[2]and Rimae Posidonius II show both extremes*. As already noted, Rimae Posidonius II is usually described as originating somewhere along the northern wall and terminating in the breach in the western rim adjacent to Mare Serenitatis. An argument can be made however for the reverse and that the origin of the rille is near the breach in the western rim and its end is somewhere along the northern wall. Unfortunately the very northern floor of Posidonius is blanketed by ejecta from Posidonius B, obscuring the end (or beginning!) of rille.

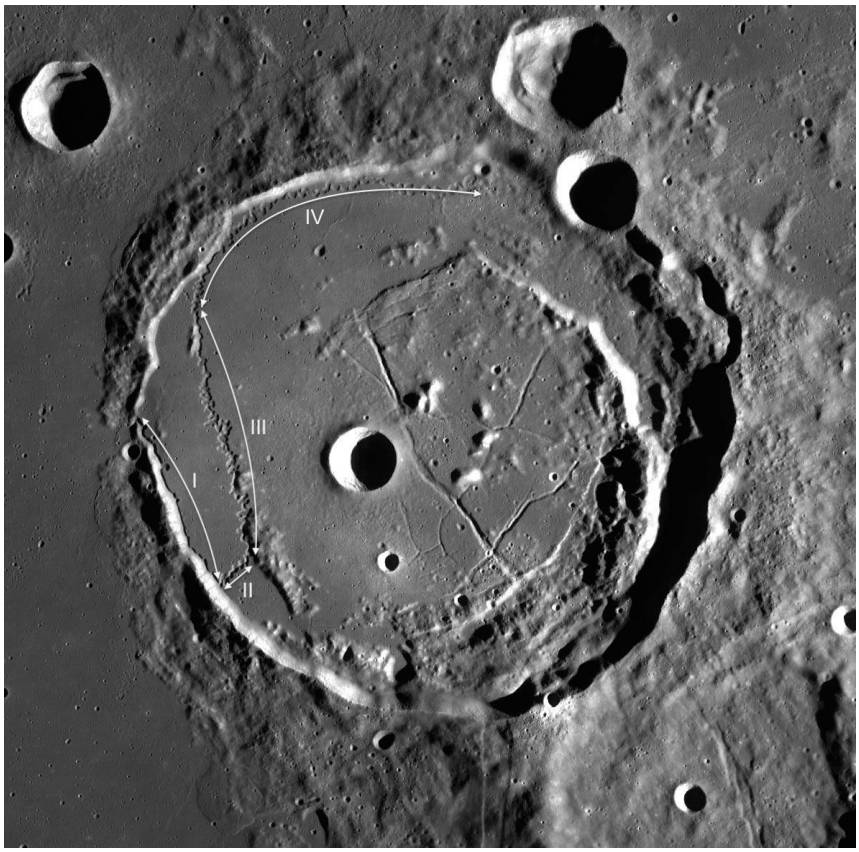

Fig.1 LROC WAC image of Posidonius and the sinuous rille Rimae Posidonius II which is divided for the purposes of this article in to sections I to IV.

In order to evaluate the evidence for this alternative scenario, I will divide the rille into sections (Fig.1) starting with section I at the breach in the western rim and on to to section IV where it follows the northern wall towards Posidonius B .

Section I of the rille begins at the breach in the western rim of Posidonius and travels along the western wall southwards for some 30 kms before it turns abruptly towards the north-east across the crater floor and a massif composed of slumped Posidonius rim material (Fig.2). This is conventionally taken to be the end or distal part of the rille, with the lavas having breached the crater rim before flowing out into Mare Serenitatis. When we look at the detail of this breach (Fig.3) we see can see the rille descends along a curved path, and vertically down some 130 m onto the mare surface, but there is no continuation of the rille beyond the rim to the west.

A glance at Fig.3 shows that the mare surface outside the breach in the rim is deformed by north-south trending lobate scarps and wrinkle ridges, could these have obscured any signs of a westwards continuation of the rille? I think it unlikely, as there are many examples of sinuous rilles that have been deformed by wrinkle ridges and scarps but retain their morphology. Alternatively, if the rille pre-dates the last lavas to erupt into this part of the mare, then any channel may now lay submerged beneath the younger lavas. Whether this is the case or not is open to question, but the LRO and SELENE imagery suggests that the mare surface is more heavily cratered (and therefore older) than the surface within Posidonius, but that is a highly subjective opinion based on appearances and cannot be relied upon.

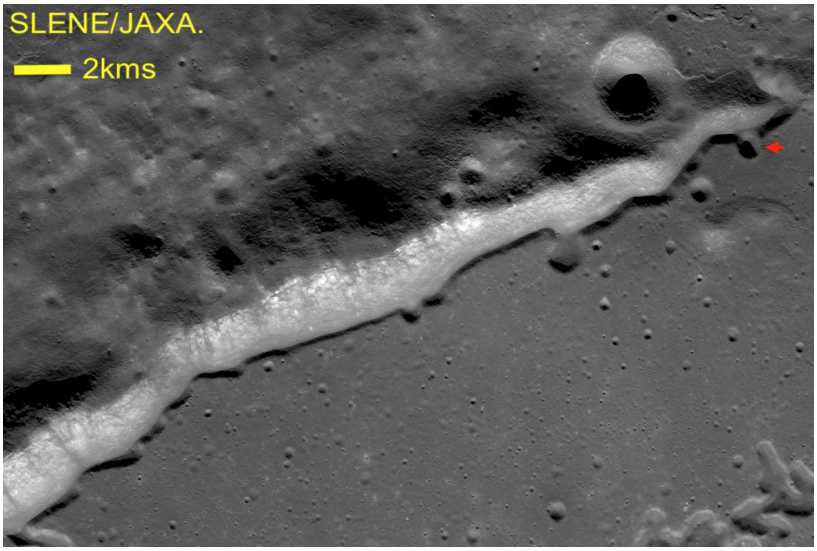

Fig.2 Section I of Rima Posidonius II showing the rille hugging the western crater wall. A dark halo crater near the terminus of the rille is marked with a red arrow. Note, North is towards the right.

A possibly significant structure near this breach is a 1km diameter crater like depression perched on the eastern bank of the rille and opening into it. It has a rather subdued and discontinuous rim and a dark halo surrounding it. One interpretation is that this is simply a small dark halo crater, which is an small ordinary impact crater that has excavated dark mafic material from beneath the surface which forms a low albedo ejecta blanket. In this interpretation the rille, which passed close by, eroded through the western crater wall, opening the crater up into the rille channel.

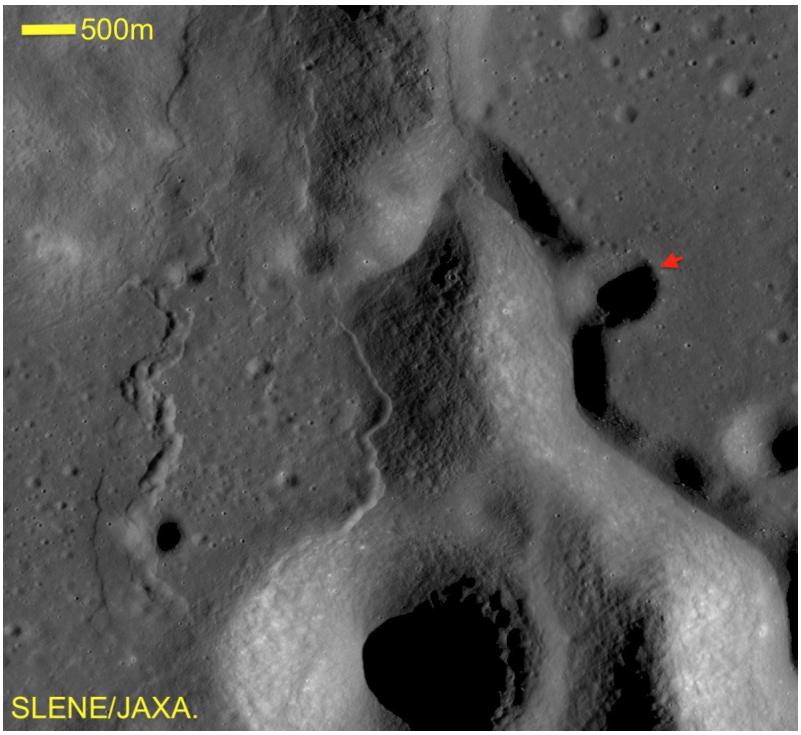

Fig.3. Terminus of the rille at the breach in the western rim. Note the rille descending towards the surface of Mare Serenitatis, and the wrinkle ridge/lobate scarps trending N-S. The red arrow indicates the dark halo crater.

An alternative interpretation is that this is a volcanic vent and the source of the lava that flowed into Rimae Posidonius II. There are a number of lines of evidence supporting this, the first being that floor of the suspected vent is some 40 m lower than the base of the rille, which would be consistent with it being a source vent as opposed to an eroded impact crater. The dark halo contains a high abundance of olivine and pyroxene, the presence of which is evident in in multispectral data (Fig.4) which shows a strong a dip centred around 1µm, a feature characteristic of pyroxenes in pyroclastic volcanic deposits.

Fig.5 shows a LROC-NAC image of the suspected vent with the the solar incidence angle ranged between 0 and 40°. This lighting reveals the low albedo halo surrounding the crater, but also shows that this material is present on the floor of the suspected vent, the rille floor either side and draping rille wall opposite.

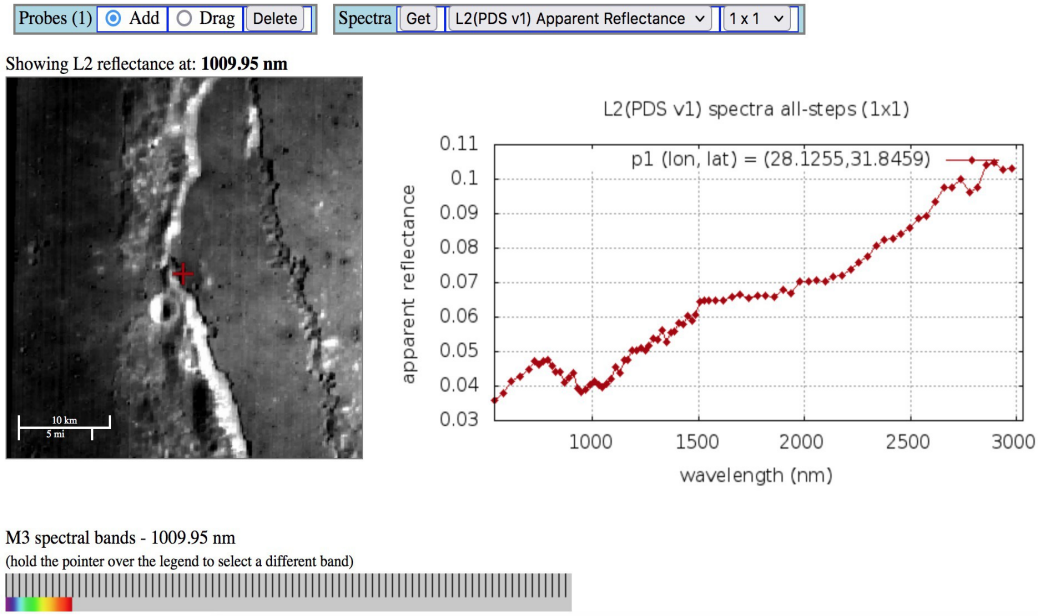

Fig.4 Reflectance spectrum of the pit/crater shown in 'Fig.3'. The dip in the spectrum in the 1µm region is suggestive of the presence of the mineral pyroxene.

This is consistent with the dark material being the result of effusive volcanic activity that accompanied the eruption of lava, but is not consistent with being simply low albedo ejecta surrounding a small impact crater, as this would be restricted to the pre-rille surface immediately surrounding the crater. The presence of the material (which is likely to be pyroclastic deposits) on the floor of the vent and rille would also suggest that its eruption continued after the lava ceased flowing and carving the rille. The walls and rim of the suspected vent are strewn with bright boulders, with some visible almost up to 1km beyond the rim and lying on the dark deposits. The presence of this rocky component is unusual and might be more in keeping with the impact crater origin for this feature, but they may also represent rock torn from the volcanic conduit during particularly explosive episodes. Clearly there is good evidence to support the volcanic origin, but an impact origin cannot be ruled out.

South of this possible vent, the rille hugs the western crater wall, and has a very low sinuosity of between 1.0 and 1.1. This low sinuosity may be the result of a high flow velocity, which would be consistent with this part being a proximal section of the rille, close to the source. Another factor might be a 'channeling' effect produced by the crater wall, suppressing the tendency of the flow to deviate from a straight course. Depth measurements are problematic here as there appears to have been mass wastage off the western wall into the rille, but despite this, depth measurements in places

where the floor is visible, suggest a depth approaching 140 m (see Fig.14). This is also consistent with this being a proximal part of the rille, as the rest of the rille is generally shallower with the exception of the next section (section II).

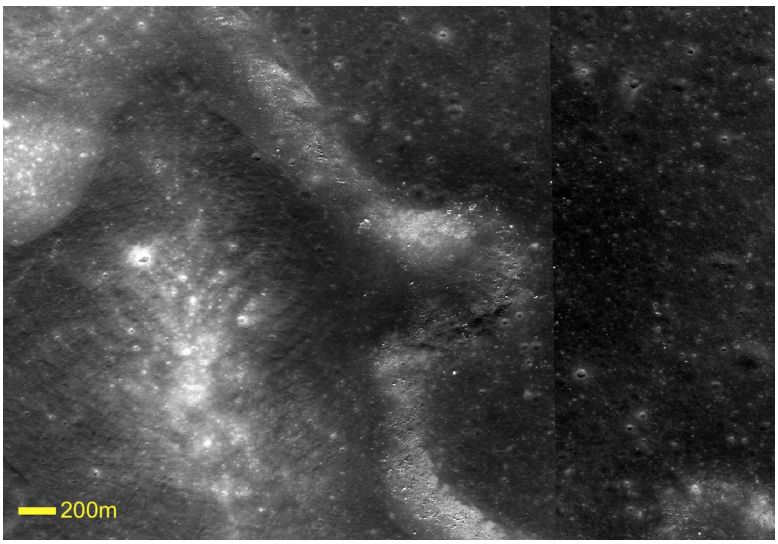

Fig.5 LROC WAC image of the suspected source vent indicated by the red arrow in Fig.3. Note the dark halo surrounding the crater *but* also present on the rille floor and the inner crater wall opposite.

Section II is the short section (~ 7 kms as the lunar crow flies) where the rille crosses from the south-western crater wall, to a massif of a slumped rim material south-west of Posidonius A (Fig.6). It has depth measurements reaching up to 150 m in the westernmost part just as it departs from the western rim, suggesting vigorous erosion which would be consistent with a location nearer to, rather than further from the source. LRO Diviner data also shows that the walls along this part of the rille are very 'rocky', which is again consistent with a very erosive, high turbulent flow. It is interesting that as soon as the rille departs from the western wall and heads north-east onto the crater floor the sinuosity increases to 1.4. This might be explicable in that the 'channeling' effect produced by the crater wall no longer constrained the channel, and the lavas could now deviate from a linear flow and begin to meander, eroding the banks as it did. Why the rille changed course here is not obvious, though it may be connected to an increase in slope towards the south-east which is now no longer apparent. The crater floor here does slope from west to east at a rather modest 1/2°, which is consistent with proposed flow direction, but the present slopes within Posidonius probably bear little relationship to those that existed when the rille was active.

Posidonius is a Floor Fracture Crater, and the floor has experienced significant uplift which was probably followed by uneven floor subsidence, and the only slope measurements that may be of value in this discussion is the regional slope from the south to north as can be seen in Fig.7, with the northern crater rim being between 1000 and 1200 m lower than the southern rim. The cross section shows that the crater floor now slopes generally from south to north, and whilst consistent with the general hypothesis of this article it is of course no indication of the direction of slope when the rille was active.

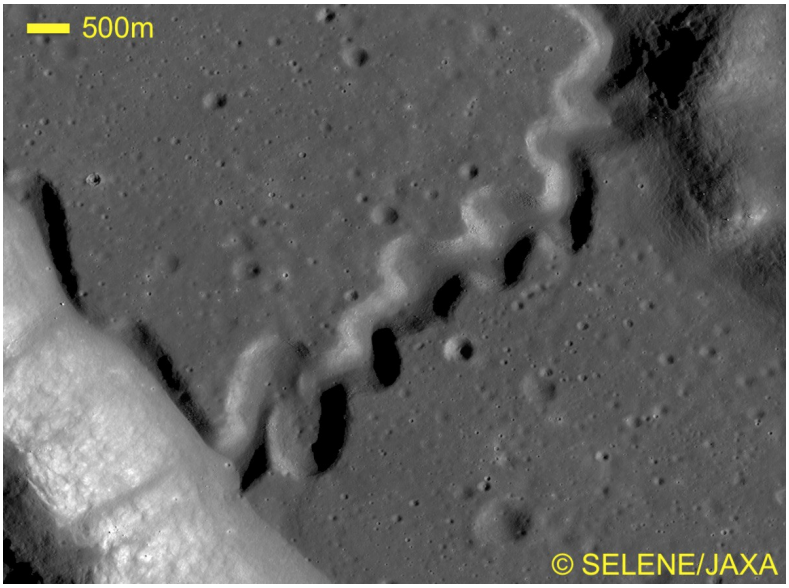

Fig.6 **Section II of the rille showing the deep very sinuous nature at this location. The crater wall is lower left and the slumped massif top right.**

Section III is approximately 30 kms long, crosses the crater floor from south to north, and is the part of the rille frequently captured by imagers. The sinuosity of this section of the rille is high, being in the region of 2.0, which place it amongst the most sinuous of sinuous rilles on the moon (Fig.8). The sinuosity is quite evident when you look at the banks of the rille, but the actual channel itself has broadened out to be replaced by a series of wide, interconnected scalloped depressions. In Section II the rille is some 700 – 1000 m wide, whilst in this section some of the depressions are almost twice as wide.

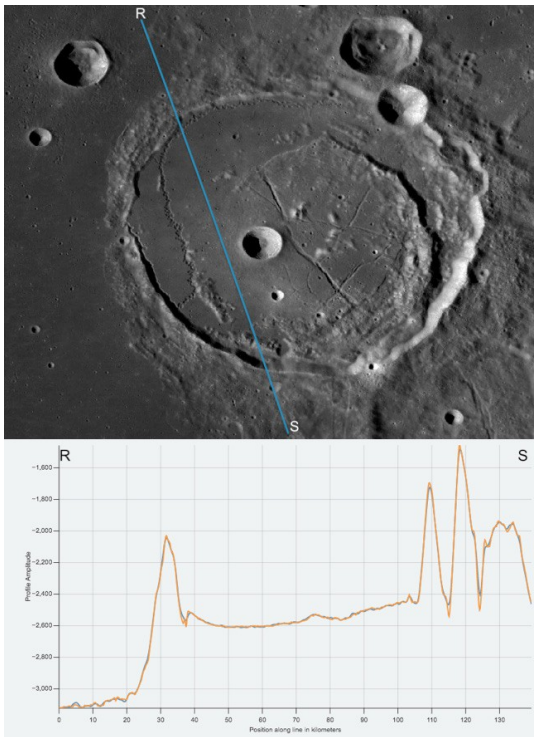

Fig.7 LRO Line Tool profile across Posidonius showing the general subsidence of the northern part of the crater and the general slope of the crater floor from the south towards the north.

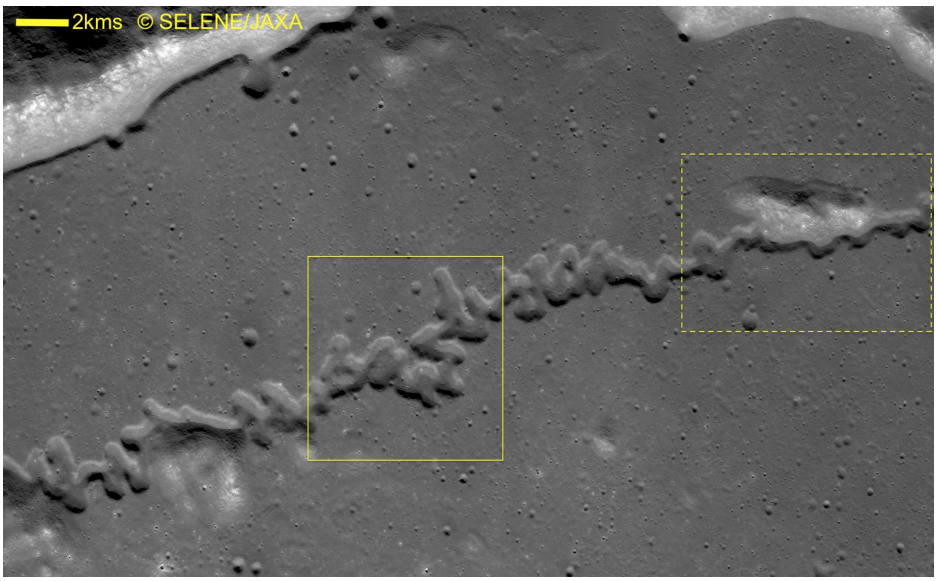

Fig.8 Section III of the rille showing the odd scalloped depressions which replace the meandering sinuous channel. The terrain between the rille and the western rim is occupied by a localised uplift that probably post dates the rille. Area within solid yellow box shown in detail in Fig.9 and area within dashed yellow box shown in detail in Fig.10 Note: North is to the right.

One explanation forwarded for this odd morphology is that the mare across the western crater floor was originally a large stagnant lava pool that occupied a shallow depression, with the rille being a more active channel within it. The lava flowing in the rille however underwent successive periods of flow and stagnation as a result of the very low slope angles prevailing within the shallow basin setting. As a consequence of the lava flow rate being weak the channel became prone to meandering and develop a high sinuosity[3]. The detailed LROC-NAC view shown in Fig.9 illustrates this morphology, with the depressions clearly made up of wide meanders, which in places have isolated former sections of the bank as islands within wider 'pools'. This image of the rille also shows one of a number of odd finger like bays which extend away from the main rille, and which may represent erosion along lines of weakness in the underlying geology, by stagnant but still hot lavas.

An alternative explanation for this unusual terrain may be connected with the presence of a small north-south orientated ridge of highland material, jutting up from beneath the crater floor (Fig.8 dashed yellow box and Fig.10). This 6 km long feature represents a section of rim that has slumped off the western crater wall, and probably represents the tip of a much larger submerged block of highland material. Of particular note is the reduced sinuosity of the rille as it passes along the eastern side of this ridge, and a 2 km long straight section of the western bank as the rille clears the ridge to the north (Fig.10 yellow arrows).

To the south of this ridge, the lavas flowing in the rille would have been contained in a channel where the banks were identical in structure and composition, consisting of a surface regolith layer, with basalt lava flows alternating with regolith layers beneath. As a consequence erosion would likely be symmetrical either side of the channel.

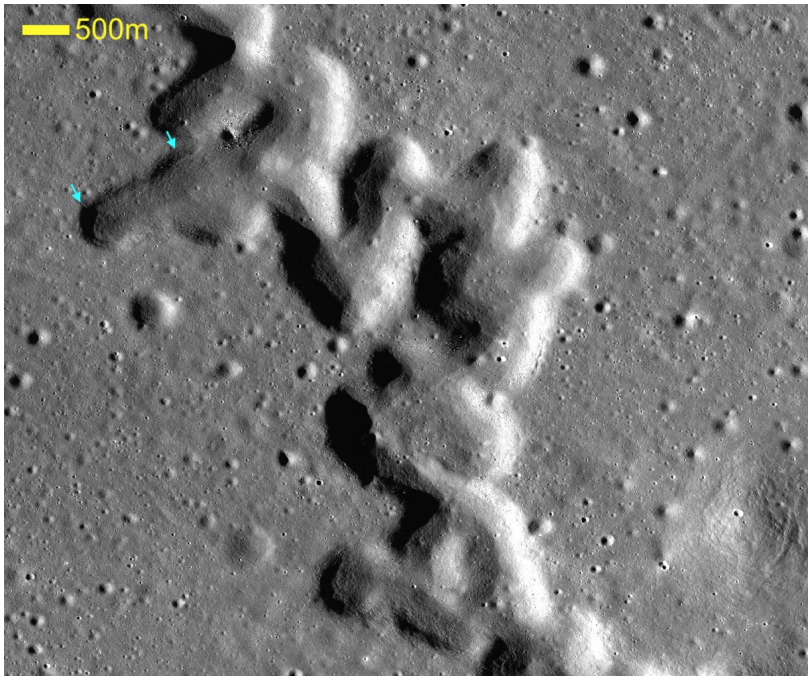

Fig.9 Detail of rille showing wide scalloped depressions formed by channel enlargement and flow reduction. Note the 'finger' like extension of the rille (blue arrows) to the west possibly caused by thermal erosion of a line of geological weakness. Note: North is up.

On encountering the ridge, the flow would now be contained in a channel with banks of a differing structure and composition on either side, a block of highland rim material to the west and layered regolith and basalt to the east. If the ridge material was more resistant to erosion, the channel may have reduced in width, causing the lava flow to increase in velocity, and reducing the degree of sinuosity as a result. The flow might experience a 'channeling' effect against the ridge similar to that seen in Section I, reducing the tendency to meander and producing a more linear flow. Once the flow cleared the northern tip of the ridge, and crossed back onto the regolith/basalt floor, the channel widened, flow velocity reduced and bank erosion became symmetrical once again allowing the sinuosity to resume. Initially however the flow would retain some of its enhanced velocity and more linear flow, resulting in the short straight section of channel immediately north of the ridge. Of course this only works with a south-north flow.

A constriction of the channel in this manner might *increase* the flow velocity through the narrows, but *reduce* the total flow volume passing through. This would cause the lava stream to pond in the 'upstream' reaches to the south, causing a reduction in velocity, increased sinuosity and a tendency to widen the channel – in fact the stagnation proposed previously[ibid]. Unlike a watercourse however, a lava stream would still be able to erode its banks and bed thermally under these conditions, even if its ability to mechanically erode was reduced due to the decrease in stream velocity and turbulence. This would account for the formation of the scalloped depressions as the slow moving lava had time to widen the channel and 'eat' along lines of geological weakness as seen in the 'finger' in Fig.9.

Section IV of the rille is some 55 kms long and skirts the northern wall of Posidonius, becoming obscured at its eastern end by ejecta from Posidonius B, so if there is a source pit here it is invisible (Fig.11). The overall sinuosity is high (1.4) but the westernmost part has an even higher sinuosity (1.5) and morphologically is quite similar to the more sinuous reaches of Section III. This may be a response to another narrowing of the channel as it makes contact with the northern wall and again becomes rather channelized and straight for about 3kms before passing onto the crater floor again

and resuming its sinuosity (Fig.12). Again, this interpretation supports a south-north flow along the rille at this point.

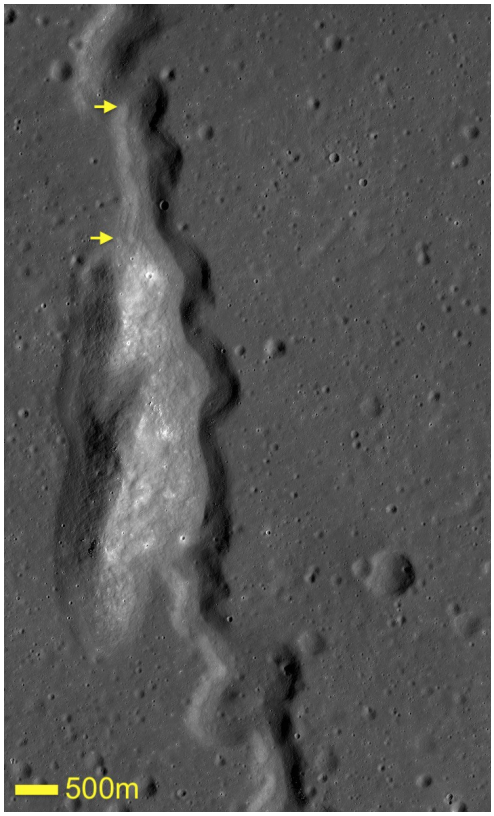

Fig.10 Detailed view of area shown in dashed yellow box in Fig.7. Note the 'straight' section of rille to the north of the ridge of highland material. Note: North is up.

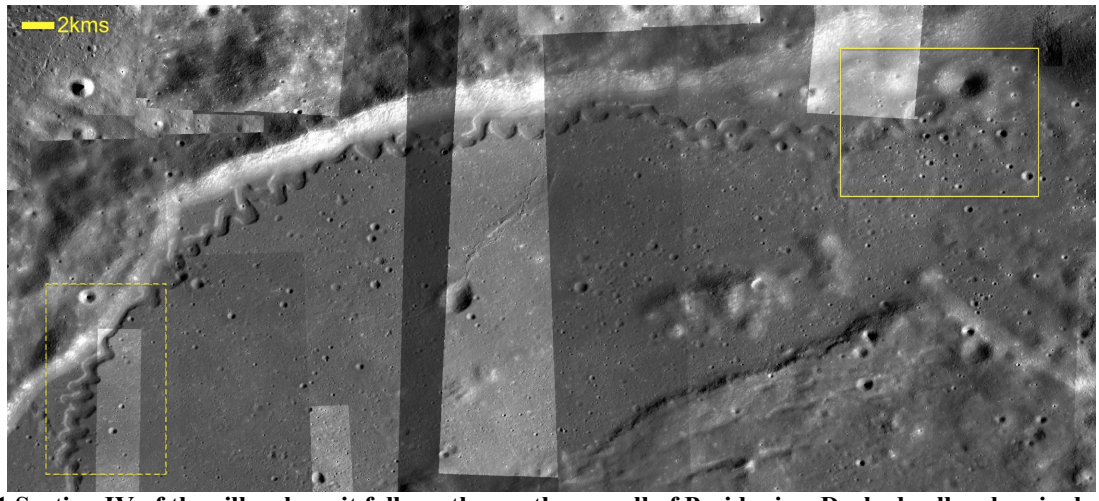

Fig.11 Section IV of the rille where it follows the northern wall of Posidonius. Dashed yellow box is shown in detail in Fig.11 and solid yellow box in Fig.12. Note: North is up.

Over many parts of the remaining course of the rille, the northern bank is obscured by mass wastage off the northern wall, and in one place is crossed by a lobate scarp which appears to follow its course a short distance and actually mimmic its sinuosity. This clearly demonstrates that after the rille formed the floor of Posidonius continued to be deformed, in this case by compressive forces, and making the present slope directions rather irrelevant when trying to work out which way the lava flowed in the rille.

If the rille originated somewhere along the northern wall of Posidonius as is often proposed, the channel here might be expected to be deeply incised and with low sinuosity, indicative of a high volume, high velocity flow. In contrast if we look at Fig.13, which is a detail of the rille close enough to Posidonius B to be partially filled with ejecta, we see a channel form known as an ox-bow cut off. These form in terrestrial water courses where a meander is cut off from the rest of the channel by erosion of the meander 'neck', forming an isolated U shaped lake.

Between the two arms of the 'U' is a preserved section of the former channel bank. Typically these features form in the lower reaches of rivers where the stream velocity is reduced – and not in the high energy upper reaches of the water course. Similar principles may apply here, and for this ox-bow to have formed here suggests that this section of the flow was not a high energy proximal section, but a lower energy distal one, where flow rates were sufficiently low to allow a cut-off to occur. A number of similar features can be seen in other lunar sinuous rilles, with the location invariably being some distance away from the origin of the rille.

Depth along rille.

Fig.14 shows a number of depth profile measurements obtained using Lunar Orbiter Laser Altimeter (LOLA) data from the Quickmap Data Profile tool. As can be seen there is a distinct trend towards a shallower depth as the rille is traced from the breach in the western rim, south and then north towards the northern wall. This observation, if the depth measurements are accurate, supports the current hypothesis that the rille originated along the western and not northern wall. The depth measurements shown were taken where both banks and the original floor of the rille were visible, with sections of the rille where mass wastage has occurred being ignored.

Conclusion.

The evidence outlined above suggests that Rimae Posidonius II originates, possibly in a volcanic pit or vent adjacent to the western crater wall, and near to a low point and apparent breach in the rim of Posidonius. The rille gets progressively shallower along its course, being shallowest where it runs along the northern crater wall, though depth measurements at the very eastern end are complicated by infilling from the ejecta of Posidonius B. The rille varies in sinuosity from extremely low to extremely high, with the highest sinuosity resulting from retarded flow rates and 'ponding' of the lavas within the channel, due to constriction of the channel width up-stream. This allowed the semi-stagnant lavas to thermally erode the floor and banks, producing a series of scalloped depressions along Section III. The ox-bow cut off seen at the eastern end of Section IV is further evidence that this part of the rille represents a distal part, where the flow rate was reduced and the sinuosity sufficient to enable such a structure to form. This proposed flow direction is opposite to that usually stated in descriptions of this rille. Between Sections I and III of the rille the crater surface is domed upwards in an apparent volcanic swelling[4]. This appears to post-date the rille as Section III runs along the sloping flank of the swelling and not at its base as would be the case if the swelling occurred first. But of course if the swelling occurred at the very end of a prolonged volcanic episode that included an early effusive phase involving the rille, then a link between the two might be possible.

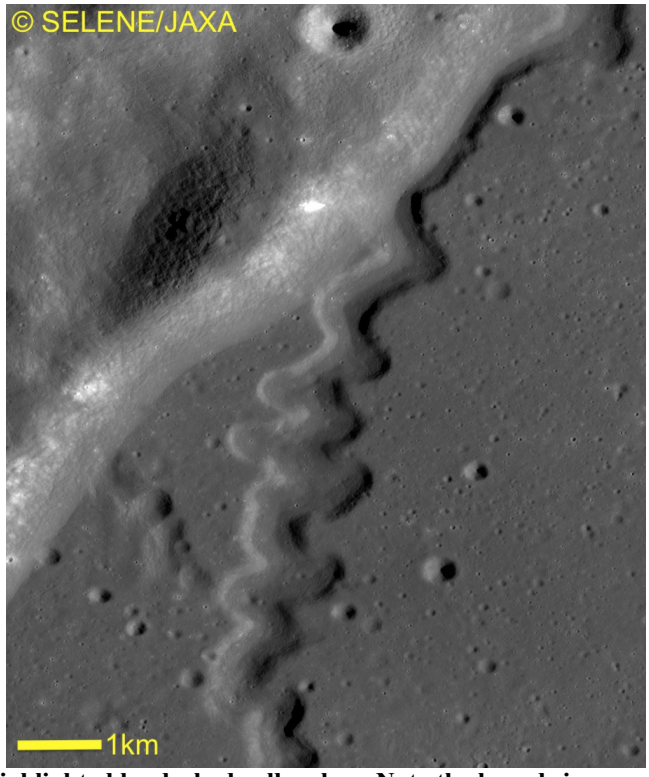

Fig.12 Detail from Fig.10 highlighted by dashed yellow box. Note the broad sinuous nature of the channel to the south of the point where it makes contact with the northern wall. The small line of depressions that appears to head off to the north-west is sometimes described as being a side branch of the rille. It is not and appears instead to be a line of collapse pits.

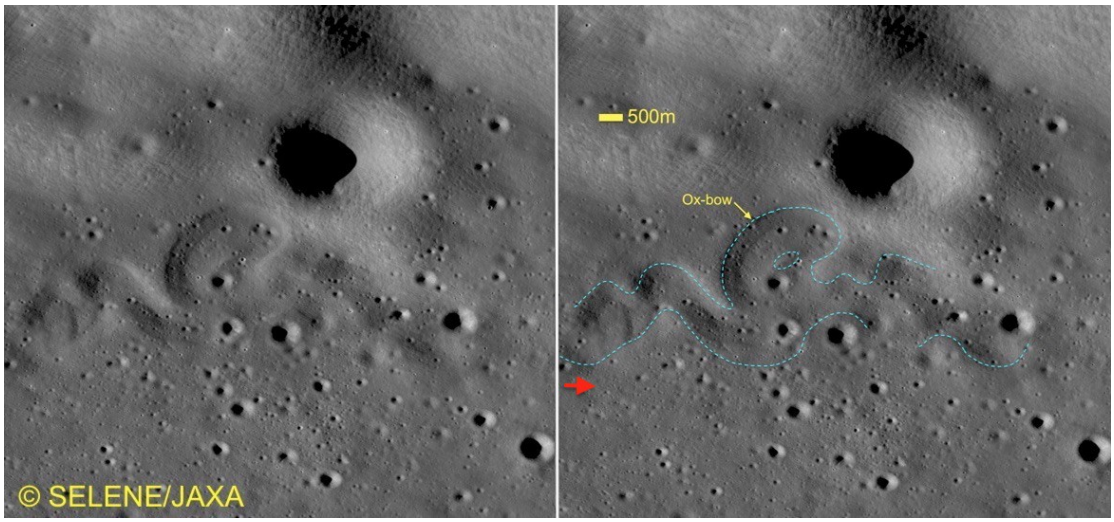

Fig.13 Detail of the northern floor of Posidonius identified solid yellow box in Fig.11. Two identical frames are shown, but with the channel sides outlined with a dashed blue line on the right. Note the cut off ox-bow which has formed to the north of the main channel. Also note the small 'island' of material isolated within the ox-bow. Red arrow indicates the *proposed* flow direction.

As for the branch of the rille that forms the apparent breach in the western rim, it may well have drained lavas onto Mare Serenitatis, but there is no trace of a continuation of this channel out onto the mare surface now.

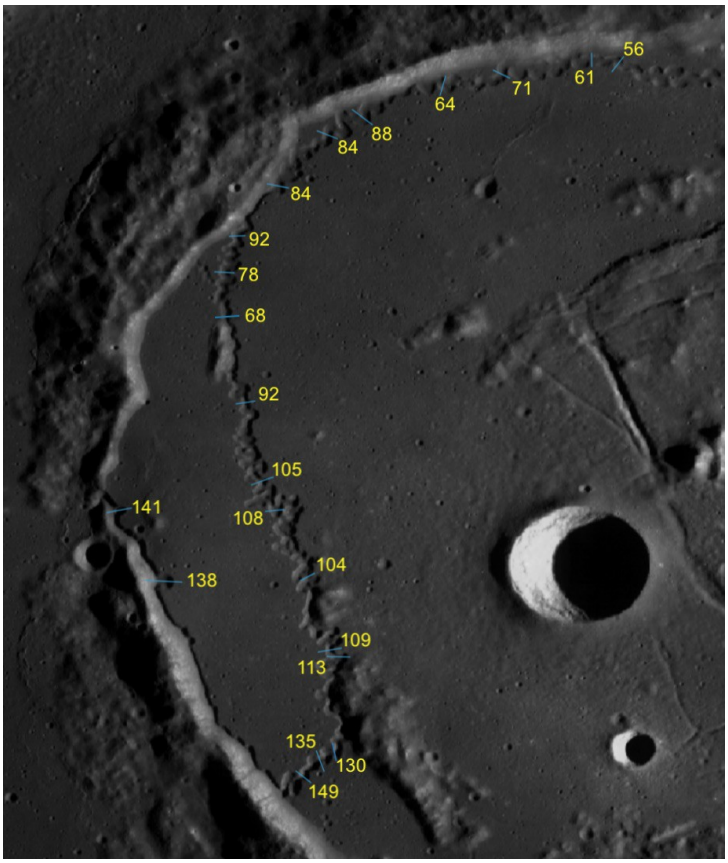

Fig.14. SLDEM2015 (+ LOLA) Depth Profile taken along the course of Rimae Posidonius II. Depth shown in meters. Note that the depths gradually decline as you progress south to north along Section III. The short Section II is very deep considering its location some way from the proposed source, but this may be due to an enhanced level of erosion along this section as shown by its extremely rocky signature in the LRO-Diviner data.

The situation here is complicated by the presence of wrinkle ridges and lobate scarps which show the western rim has suffered from compressive forces, these may have obscured any channels out onto the mare surface, but this seems unlikely as rilles elsewhere have apparently survived similar tectonic forces in a recognisable state. Alternatively, the youngest lavas in Mare Serenitatis may have drowned any rille like structure that may have been present, but as noted above the surface of Mare Serenitatis looks if anything older than the surface within Posidonius which is presumably the same age as the rille. This is something worthy of further investigation by someone who enjoys counting craters.

Acknowledgements.
LROC images reproduced by courtesy of the LROC Website at http://lroc.sese.asu.edu/index.html, School of Earth and Space Exploration, University of Arizona.
Selene images courtesy of Japan Aerospace Exploration Agency (JAXA) at:
http://l2db.selene.darts.isas.jaxa.jp

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[1].Hurwitz, D.M.,Head, J.and Hiesinger, H.(2012) Origin of lunar sinuous rilles: Modeling effects of gravity, surface slope, and lava composition on erosion rates during the formation of Rima Prinz. Journal of Geophysical Research, Vol. 117, pp.1-19
[2].Hurwitz,D.M.,Head, J.and Hiesinger, H.(2013) Lunar sinuous rilles: Distribution, characteristics, and implications for their origin. Planetary and Space Science,Vol.79, pp.1-38.

[3].Schultz,P. H. (1976) Moon morphology: interpretations based on Lunar Orbiter photography. University of Texas Press.
[4].Lena,R and Fitzgerald,B. (2021) LUNAR DOMES (part XLIII). Volcanism in Posidonius: magmatic intrusions and the dome Posidonius 1. British Astronomical Association, Lunar Section CircularVol. 58 No. 1.

* Sinuosity in reference 3 above, is defined as the ratio of the channel length as measured above and the meander belt axis length – which translates to the length along the channel between two points divided by the straight line distance between those two points. Lunar SR's vary in sinuosity from 1.03 to 2.09, with a high sinuosity being > 1.5 and low < 1.1.

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Lunar Occultations October 2021

Tim Haymes

Time capsule: 50 year ago in the October 1971 issue: [With thanks to Stuart Morris for the LSC archives. https://britastro.org/downloads/10167]

- Patrick Moore agrees with L Fitton on the permanent yellow tint in the Aristarchus-Herodotus region.
- J.L Pemberton: Assault on the Moon – 2 passenger and 1 cargo was to be launched from a space station around the Earth in true MGM fashion, to land on the Moon. The base would be under-ground in spent fuel tanks. It's thought to be feasible by 1978, or in the "not-too-distant-future".
- No Lunar occultation section in the 1971 issue.

Re: Spectacular Graze of eta Leonis (v3.5) on October 3rd at 04hr UT\l
Near Keswick

The BAA Handbook page 44 lists grazes. List entry #11 is for the 3rd magnitude star eta Leonis which grazes the northern cusp at crescent phase in the morning sky of October 3rd. Eta is also a close double star which will cause some additional phenomena.

Please refer to the LSC last issue for details and send any reports to the LS.

This Month.

The Moon passes through Taurus and Gemini later in the month – viz Oct 25/26/27. This a good opportunity to observe reappearances at the dark limb. Historically these have always been under-observed due to the difficulty in getting a good time by visual means.

Now that we have video or CMOS cameras, there will be no reaction time (PE) to subtract. I would be pleased to receive observations by eye or planetary video camera.

When the laptop is UT synchronised and the time displayed on the video frames, then a frame by frame re-play will give the time to report.

The recommended software for SER video replay is TANGRA. The frames can be advanced one at a time.

Please get in touch with me by email if any help is needed.

I look forward to some reports, indeed I also hope to observing.

Occultation predictions for North Oxfordshire for 2021 October

Longitude 1 18 46 W , Latitude 51 55 41 N, Alt. 119m; Moon Alt>5 degrees

Some fainter predictions are omitted near Full Moon.

y	m	day d	Time h	m	s	P	Star No	Sp	Mag v	Mag r	% ill	Elon	Sun Alt	Moon Alt	Moon Az	CA	Notes
21	Oct	1	0	7	45.5	R	80002	A0	8.6	8.6	31-	68		5	58	14S	
21	Oct	1	3	57	0.4	R	80105	A0	7.9	7.9	30-	66		38	100	36N	
21	Oct	2	1	25	3.7	R	80648	K0	8.7	8.2	22-	55		7	65	76N	
21	Oct	2	3	45	31.6	R	80693	G0	8.4	8.1	21-	54		27	90	74S	
21	Oct	3	4	15	47.1	R	1484	A0	3.5	3.5	13-	42		21	89	41N	eta Leo
21	Oct	3	4	44	2.2	R	98961	F8	8.6	8.3	13-	42		25	95	25S	
21	Oct	4	4	18	44.1	R	1598	F5	6.5	6.3	6-	30		10	84	23N	
21	Oct	4	4	31	24.7	R	99389	F8	8.8	8.6	6-	29		12	86	60N	
21	Oct	10	19	17	22.7	D	2443	F3	5.7	5.5	24+	59		1	226	79S	26 Oph
21	Oct	11	18	19	36.2	D	186112	G5	8.9	8.5	34+	72	-10	9	201	55S	
21	Oct	11	19	14	59.4	D	X 43245		8.4	8.1	35+	72		5	213	23S	
21	Oct	11	19	18	13.8	D	186181	K0	9.0	8.4	35+	72		5	213	58S	
21	Oct	11	19	20	12.8	D	186189	B5	8.0	8.0	35+	72		5	214	82S	
21	Oct	11	19	43	32.8	D	186222	F5	7.5	7.2	35+	72		3	218	86S	
21	Oct	12	19	57	29.6	D	187716	G6	7.2	6.6	46+	86		6	209	63N	
21	Oct	12	19	58	13.2	D	X 45455	A3	8.6	8.4	46+	86		6	209	65N	
21	Oct	12	20	49	36.0	D	2796	K0	6.9	6.3	46+	86		2	219	36S	
21	Oct	13	18	14	9.7	D	188916	K5	8.7	7.8	57+	98	-10	12	173	85N	
21	Oct	13	20	16	23.0	D	2939	A9	7.5*	7.2	57+	99		11	201	65N	
21	Oct	14	20	9	10.7	D	3087	A9	7.8	7.6	68+	111		16	187	61N	
21	Oct	14	21	23	0.1	D	190080	G0	8.3	8.0	68+	112		13	204	21S	
21	Oct	14	21	42	14.8	D	190087	G6	7.4	6.9	68+	112		11	208	19S	
21	Oct	15	23	41	4.3	D	3242	G1	7.8	7.6	79+	125		10	224	47S	
21	Oct	16	18	4	56.8	D	165327	F0	7.8	7.6	85+	135	-9	13	133	58S	
21	Oct	16	18	53	34.8	D	165339	F8	8.3	8.0	85+	135		18	144	68S	
21	Oct	17	18	0	48.1	D	3484	G5	6.9	6.4	92+	147	-9	11	120	89S	
21	Oct	18	23	25	24.2	D	66	A0	7.1	7.0	97+	160		36	192	78N	
21	Oct	19	18	44	26.2	D	170	K4	6.0*	5.2	99+	170		14	105	34S	33 Ceti
21	Oct	19	23	57	8.6	D	192	A3	5.1	5.1	99+	172		42	189	22S	89 Psc
21	Oct	22	20	0	40.9	R	93443	F2	8.3	8.1	95-	155		18	85	43S	
21	Oct	22	21	58	59.2	R	510	K2	6.8	6.0	95-	154		37	109	40N	
21	Oct	22	22	9	39.0	R	93474	K2	8.2	7.5	95-	154		38	111	80N	
21	Oct	22	22	19	59.5	R	93480c		8.6*	8.1	95-	154		39	114	27S	
21	Oct	22	23	27	50.6	R	517	K1	6.1*	5.7	95-	154		48	132	28S	
21	Oct	22	23	38	59.7	R	93491	K0	8.0	7.4	95-	154		50	135	49N	
21	Oct	23	1	32	49.6	R	93508	K0	8.7	8.2	95-	153		57	179	85S	
21	Oct	23	1	39	41.7	R	93522		8.7	7.9	95-	153		57	181	21S	
21	Oct	23	1	56	10.8	R	93517	A2	8.5	8.3	95-	153		56	188	70S	
21	Oct	23	2	16	48.2	R	93521	F8	8.7	8.5	95-	153		56	197	67N	
21	Oct	23	19	50	39.4	R	76525	G4	7.8	7.5	91-	144		13	73	79S	
21	Oct	23	21	30	47.5	R	76546	F5	8.2*	8.0	90-	144		28	91	59N	
21	Oct	23	21	40	43.3	R	76550	F5	8.7		90-	144		29	93	55S	
21	Oct	23	21	43	24.3	R	633	B9	5.5	5.5	90-	144		30	93	74S	53 Tau
21	Oct	23	22	39	49.9	R	76565	F8	7.1	6.8	90-	143		38	105	36S	
21	Oct	23	23	47	8.2	R	76580	G9	8.8	8.4	90-	143		48	121	39S	
21	Oct	24	0	24	26.8	R	76592	A0	8.8	8.7	90-	143		52	132	62S	
21	Oct	24	0	42	21.2	R	76593	F8	7.1	6.9	90-	142		55	138	81N	
21	Oct	24	3	41	59.0	R	76626	K7	8.3	7.6	89-	141		57	214	51S	
21	Oct	25	22	52	20.2	R	77925	F8	8.5	8.2	76-	121		28	85	25S	
21	Oct	25	22	56	26.8	R	918	K0	7.0	6.5	76-	121		29	85	82N	
21	Oct	26	0	37	42.2	R	77982	K2	8.6	7.9	75-	121		44	106	80S	
21	Oct	26	0	53	0.8	R	78002	B9	8.8*	8.7	75-	120		47	109	60S	
21	Oct	26	1	21	10.R	R	78025	B9	9.0*	9.0	75-	120		51	117	80N	
21	Oct	26	1	26	14.7	R	78029	M0	7.6*	6.8	75-	120		51	118	85N	
21	Oct	26	1	30	35.7	R	78035	A0	8.6	8.5	75-	120		52	119	63S	
21	Oct	26	2	18	28	m	78071	A3	8.9	8.7	75-	120		58	134	9N	
21	Oct	26	2	40	28	m	78088	K2	8.9	8.2	75-	120		60	142	8N	
21	Oct	26	3	51	41.6	R	78101	A2	8.9	8.8	75-	120		64	176	78S	
21	Oct	26	20	38	24.8	R	1049	A2	6.8	6.7	68-	111		4	52	63N	
21	Oct	26	21	50	28.5	R	1055	G0	5.7	5.4	68-	111		12	65	25S	37 Gem
21	Oct	26	22	40	15.8	R	78893	K0	8.9	8.4	67-	110		20	73	60S	
21	Oct	26	23	38	25.5	R	1062	B8	6.4*	6.5	67-	110		28	83	24N	40 Gem

Graze over Birmingham

y	m	day d	Time h	m	s	P	Star No	Sp	Mag v	Mag r	% ill	Elon	Sun Alt	Moon Alt	Moon Az	CA	Notes
21	Oct	27	1	1	0.8	R	78984	A0	8.5	8.4	67-	109		40	100	43S	
21	Oct	27	1	29	51.0	R	78998	G5	8.0	7.7	66-	109		45	106	72N	
21	Oct	27	2	7	13.5	R	79026	G0	8.5	8.2	66-	109		50	115	26S	
21	Oct	27	3	43	4.6	R	1079	K2	8.6	7.9	66-	109		61	148	85N	
21	Oct	27	5	56	29.9	R	1085	G8	7.1	6.7	65-	108	-9	61	211	87S	
21	Oct	27	6	1	56.9	R	79124	F0	7.8	7.6	65-	108	-8	61	213	89S	
21	Oct	27	6	3	14.1	R	79125	K2	8.4	7.7	65-	108	-8	61	214	69S	
21	Oct	27	22	20	31.6	R	1180	F5	7.1	6.8	58-	99		9	62	39S	
21	Oct	27	23	23	29.8	R	79753	K1	7.8*	7.2	58-	99		18	73	56N	
21	Oct	28	1	35	1.8	R	1194	K0	7.8*	7.2	57-	98		37	97	90S	
21	Oct	28	2	23	7.3	R	79821	A0	9.0*	9.0	57-	98		44	108	59S	
21	Oct	29	0	23	2.7	R	1317	A2	8.2	8.1	48-	87		17	76	76S	
21	Oct	29	4	1	32.3	R	80494	G5	8.8	8.5	46-	86		49	122	42N	
21	Oct	29	4	22	16.1	R	80499	K0	8.2	7.6	46-	86		51	128	14S	
21	Oct	29	4	23	10.1	R	1330	G5	7.8	7.5	46-	86		52	128	64N	
21	Oct	29	6	19	6.0	R	1334	G5	7.0	6.6	46-	85	-6	60	174	82S	
21	Oct	30	2	55	11.3	R	1435	K0	6.5	5.9	37-	74		30	97	31N	
21	Oct	30	3	55	58.4	R	1436	K0	6.8	6.1	36-	74		39	111	58N	
21	Oct	30	6	8	12.3	R	1444	K0	7.8	7.1	36-	73	-8	53	150	47S	
21	Oct	31	1	39	24.7	R	1544	M2	5.4	4.5	27-	63		8	77	38S	46 Leo
21	Oct	31	3	41	35.3	R	99202	A2	7.8	7.7	27-	62		26	101	45S	
21	Oct	31	3	52	48.7	R	99207	F8	8.2	7.9	27-	62		28	103	74N	
21	Oct	31	4	31	40.5	R	99225	K0	8.1	7.6	26-	62		33	111	25N	
21	Oct	31	4	41	9.0	R	99223	F5	8.3	8.0	26-	62		34	114	56N	
21	Nov	1	2	46	5.5	R	118843	G0	8.5	8.2	18-	50		6	84	46N	
21	Nov	1	3	20	49.9	R	118854	K0	8.9	8.4	18-	50		11	91	84S	
21	Nov	1	3	26	29.7	R	1659	K0	6.7	6.0	18-	50		12	92	87N	
21	Nov	1	4	22	21.1	R	118880	K2	8.3	7.6	17-	49		20	103	60N	
21	Nov	3	5	5	46.9	R	139213	K0	8.8	8.4	4-	22		3	100	72N	
21	Nov	3	5	55	40.9	R	1898	G5	8.7	8.3	4-	22	-11	10	110	82N	

Prediction up to Nov 3rd

Key: P = Phase (R or D), R = reappearance D = disappearance M = Miss at this station, Gr = graze nearby (possible miss) CA = Cusp angle measured from the North or South Cusp. (-ve indicates bright limb) Mag(v)* = asterisk indicates a light curve is available in Occult-4

Star No: 1/2/3/4 digits = Zodiacal catalogue (ZC) referred to as the Robertson catalogue (R) 5/6 digits = Smithsonian Astrophysical Observatory catalogue (SAO) X denotes a star in the eXtended ZC/XC catalogue. H denotes the HIPparchus catalogue

The ZC/XC/SAO nomenclature is used for Lunar work. The positions and proper motions of the stars in these catalogues are updated by Gaia. Detailed predictions at your location for 1 year are available upon request. Ask the Occultation Subsection Coordinator: tvh dot observatory at btinternet dot com

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Lunar Domes (part LI): Searching domes in Mare Spumans by Raffaello Lena

In this contribution, my fifty-first note written for the lunar domes program, I examine Mare Spumans. The search for lunar domes in the easternmost regions of the Moon can be a goal for amateur astrophotographers and astronomers. The domes in Mare Undarum are an example of the volcanic activity that occurred in these regions. The domes in Mare Undarum have been studied for some years ago and reported in the article published in Planetary and Space Science (Lena et al., 2008; Lena et al., 2013) and also described in the Lunar Section circular in May 2021 issue.

All five domes near Condorcet (see also the image reported in our lunar domes atlas: https://undarumdomes.blogspot.com/) have moderate diameters of between 10 and 12 kms. Condorcet 1–3 are similar to effusive domes with intermediate flank slope of between 1° and 2° comparable those situated in the Hortensius/Milichius/T. Mayer region, whilst Condorcet 4 has steeper flank slope of 2.8° and a larger volume. Dubiago 3 displays an average slope of 0.9° (Lena et al., 2008). Mare Undarum is situated in a major trough concentric to the Crisium basin. The domes Condorcet 1–3 are aligned radially with respect to the Crisium basin. Similar dome configurations aligned radial to major impact basins are known from other lunar mare dome fields (Lena et al., 2013).

Thus it is interesting to monitor neighboring regions such as Mare Spumans, searching lunar domes. During a survey, I have identified a dome, circular in shape, located at 66.2°E and 0.08° S, with a base diameter of 8.5 km (Fig.1).

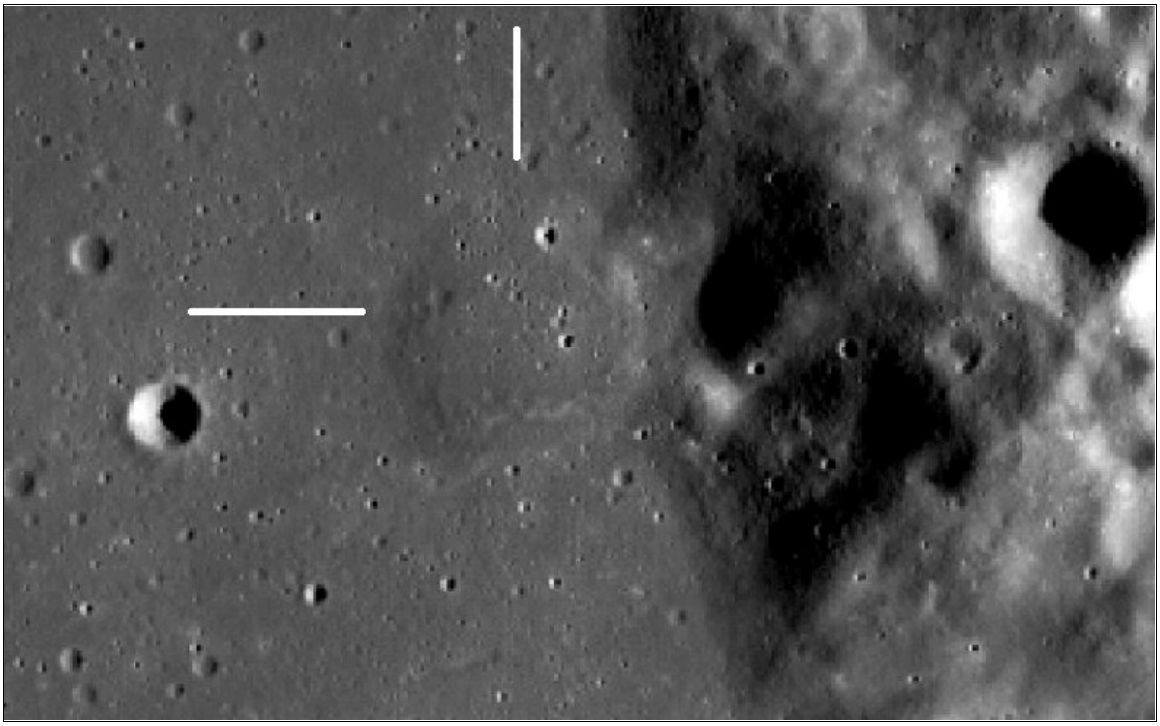

Figure 1: The dome described in the current study, termed as Spumans 1.

It lies at about 26 km south west of the crater Pomortsev. ACT-REACT Quick Map tool was used to access to the LOLA DEM dataset, obtaining the cross-sectional profile (Fig. 2).

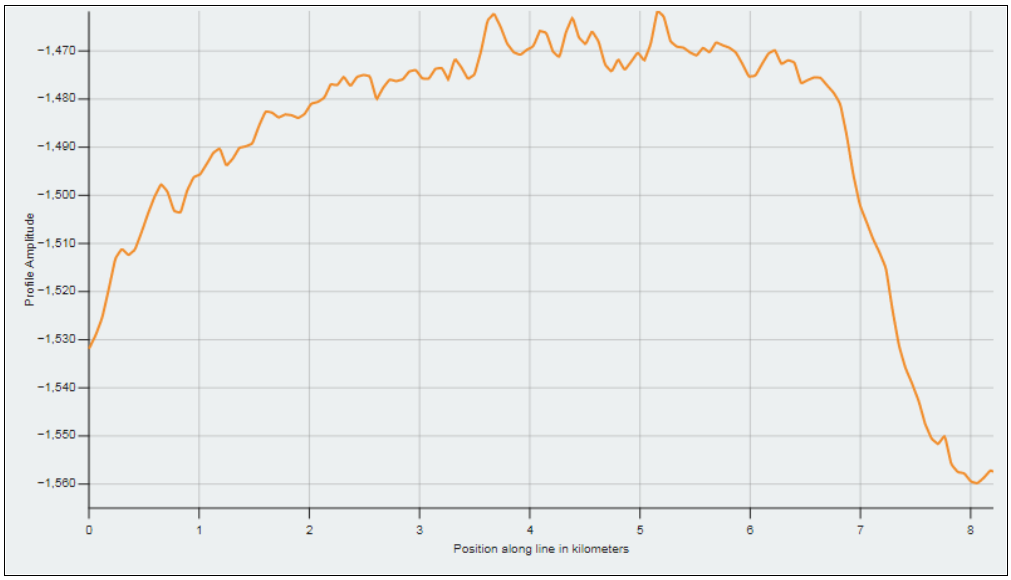

Figure 2: LRO WAC-derived surface elevation plot of Spumans 1 in East-West direction based on LOLA DEM.

The height amounts to 80 ± 10 m, yielding an average flank slope of 1.1° ± 0.1°. The dome edifice volume is determined to about 3 km³ assuming a parabolic shape. A 3D reconstruction is shown in Fig. 3.

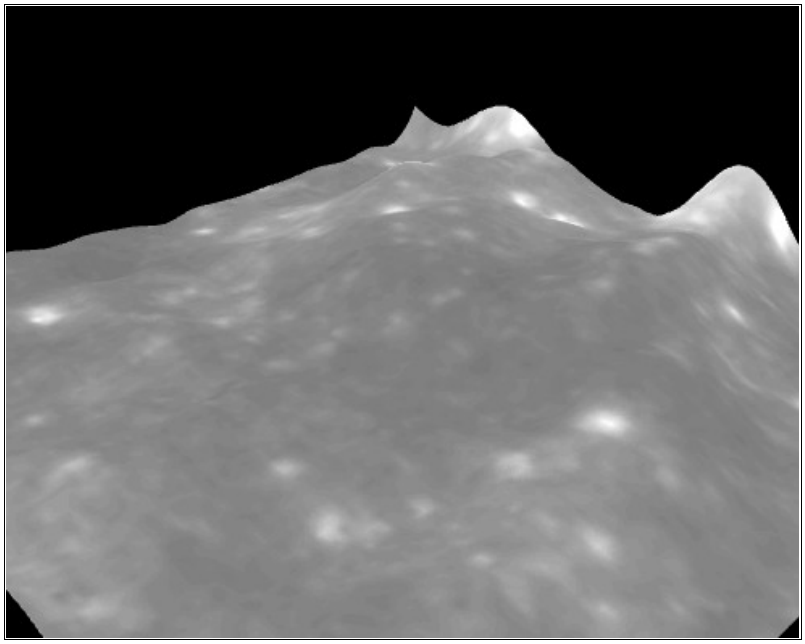

Figure 3: Spumans 1, 3D reconstruction based on GLD100 dataset derived using ACT-REACT Quick Map tool.

The rheologic model (Lena et al., 2013; Wilson & Head, 2003) applied to the examined dome yields an effusion rate of 220 $m^3 s^{-1}$ and a lava viscosity of 6.5 x 10^4Pa s. It formed over a period of 0.4 years. According to the classification scheme for lunar domes (Lena et al., 2013) the dome identified in Mare Spumans belongs to class C_2.

The distribution of olivine is shown in Fig. 5 derived by Mineral Mapper reflectance data acquired by the JAXA SELENE/Kaguya mission (Kodama, S., et al., 2010) ranging from -50° to 50° latitude, and indicating a different composition across the dome summit.

This dome lies in a region mapped as *Im2* unit in the rasterized version of the 2013 renovation of the I-0703 Wilhelms Geologic Map of the near side, mapped at a scale of 1:5,000,000 and ranging from -64 to 64 degrees latitude and -70 to 70 degrees longitude (Fortezzo and Hare, 2013), which denotes *Upper Imbrian* mare material (3.2-3.75 billion years ago). Thus it is of *Imbrian* age.

I encourage high-resolution imagery of this area using telescopic images, which I will correct for the inevitable foreshortening effect, so we can have more data of this dome, under study.
Further investigation is currently ongoing. Please check also your past imagery and send them to me for the ongoing study (mailto:raffaello.lena59@gmail.com).

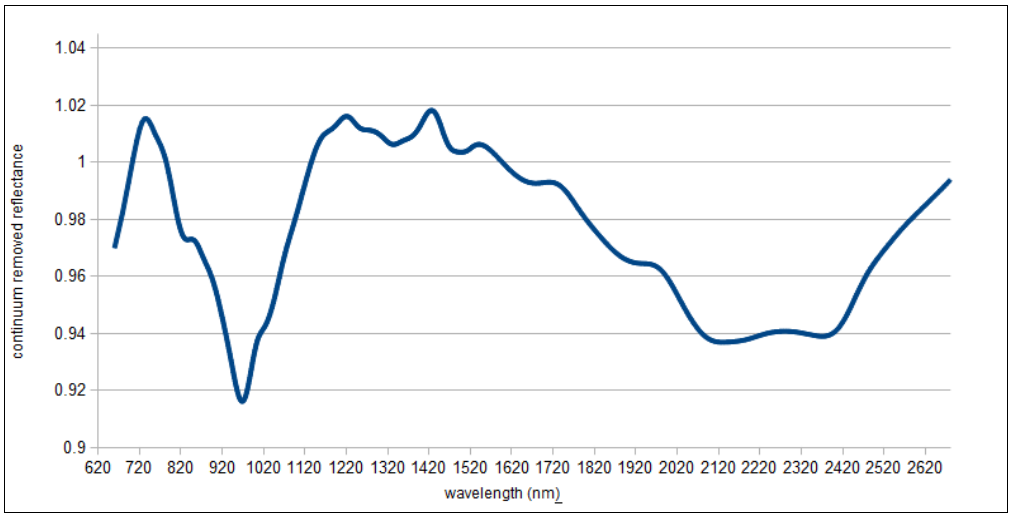

Figure 4: Chandrayaan-1 Moon Mineralogy Mapper, spectral analysis.

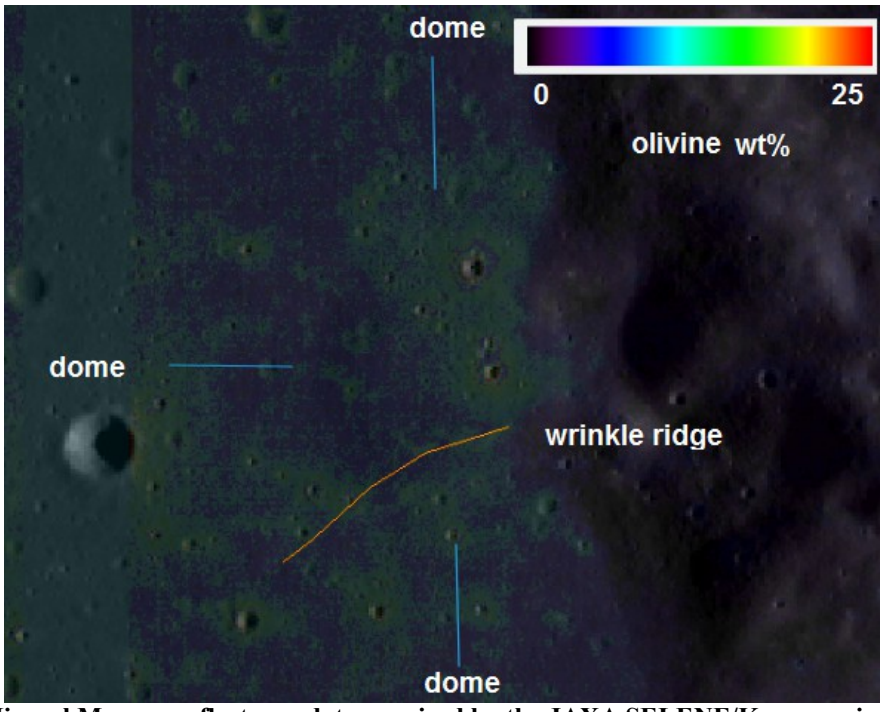

Figure 5: Mineral Mapper reflectance data acquired by the JAXA SELENE/Kaguya mission. Olivine distribution (wt %).

Some possible vents are under investigation. Furthermore a wrinkle ridge is detectable in its summit in south eastern direction.

The spectral signature of the dome, derived from Clementine UVVIS imagery, reveals that it consists of basaltic lava with a low TiO_2content below 2wt% and with a FeO content about 15wt%.

According to the FeO and TiO_2 content we can infer that the main rock type is low-Ti basalt, with some signatures of olivine in some regions on the summit (Fig. 4 and 5).

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LUNAR GEOLOGICAL CHANGE DETECTION PROGRAMME

News: In this newsletter we switch to a different format. Observations listed are those received the past month. These go into an observation database/pool which we shall use at some point in the future. A few of the most important observations received in the past month will undergo a deeper analysis in the current newsletter, which may include some similar illumination observations from the database of observations that people have submitted over the years.

TLP reports: No TLP reports were received in August.

BAA Reports received for July included: Jay Albert (Lake Worth, FL, USA - ALPO) observed: Birt, Copernicus, Hevelius, Plato, Posidonius, and Proclus. Anthony Cook (Newtown, UK – ALPO/BAA) imaged several features in colour, and the lunar surface in thermal IR. Les Fry (West Wales – NAS) imaged: Babbage, Blancanus, Capuanus, Longomontanus, Moretus, Promontorium Kelvin, Schickard, T. Mayer and Vieta. Leandro Sid (Argentina – AEA) imaged: Cassini, Mare Anguis, Plato and several features.

These were covered in the July/September LSC and more fully in the ALPO TLO newsletter for September:

http://www.alpo-astronomy.org/gallery3/var/albums/Lunar/The-Lunar-Observer/2021/tlo202109(7_6MB).pdf?m=1630288824

BAA Reports received for August included: Alberto Anunziato (Argentina - SLA) observed: Alpetragius, Alphonsus, and Eratosthenes. Massimo Alessandro Bianchi (UAI-Italy) imaged: Herodotus and Plato and Sketched: Herodotus. Maurice Collins (New Zealand – ALPO/BAA/RASNZ) imaged: Aristarchus and the whole lunar Moon. Anthony Cook (Newtown, UK – ALPO/BAA): videoed the Moon in the thermal IR. Jesús Piñeiro (Venezuela - SLA) imaged Plato. Leandro Sid (Argentina – AEA) imaged: Arzachel, Herschel, Mons Pico, Montes Apenninus, and Proclus. Bob Stuart (Rhayader, UK) imaged: Albategnius, Alphonsus, Archimedes, Arzachel, Birt, Clavius, Hyginus, Longomontanus, Plato, Rupes Recta, Sasserides, Sinus Medii, Triesnecker, Vallis Alpes and several features. Franco Taccogna (Italy-UAI) imaged: Herodotus and Plato. Aldo Tonon (UAI – Italy) imaged several features.

Mons Pico

Figure 1. Mons Pico and its surrounds as imaged by Leandro Sid (AEA) on 2021 Aug 16 UT 01:53 and orientated with north towards the top.

On 2009 Apr 13 UT 18:55-20:00 J. Adee (UK), and later A. Jarwaski (UK), saw Mons Pico to be incredibly bright. Adee reported "naked eye" visibility, though this does not show up in later CCD images that night. Jarwaski saw another nearby mountain very bright as well. This TLP has been assigned an ALPO/BAA weight of 2. Leandro Sid (AEA) imaged this area under similar illumination recently (Fig 1). The mountain is looking very bright with respect to the dark terminator and nearby mare to the east. However, if we measure the digital number brightness of Mons Pico and compare it with bright craters further to the east, on the more sunlit part of the Moon, it is not the brightest feature in the image in an absolute sense. Many observers in the past simply judged brightness relative to the immediate surrounds of the mountain. It is possible that the 2nd bright mountain that Jarwaski refers too could be just south of Mons Pico or even Mons Piton? I will lower the weight of the 2009 report to 1 as the mountain's sunward facing side is always contrasty, but as yet we cannot yet explain the naked eye visibility that was claimed by Adee.

Alpetragius

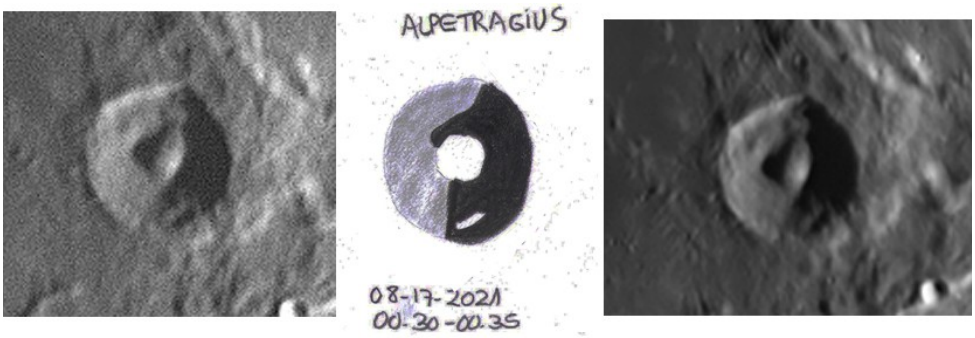

Figure 2. Alpetragius, orientated with north towards the top. (Left) an image by Brendan Shaw (BAA) from 2014 Dec 30 UT 16:16. (Centre) A sketch by Alberto Anunziato (SLA) at the date and UT given in the sketch. (Right) An image by Walter Elias taken on 2018 Nov 17 UT 00:33.

Back in 1889 Sep 4 UT 02:30-03:00 E.E. Barnard, using Lick Observatory's 36" reflector noted that the central peak of this crater was diffuse and pale and the entire inside of the crater seemed to be filled with haze or smoke. This was despite the shadow of the east wall being black and sharp. No other crater showed this effect. On 2021 Aug 17 UT 00:30-00:34 Alberto Anunziatio was able to make a sketch (Fig 2 – Centre) under similar illumination to Barnard's observation, albeit with just a Meade EX 105. Alberto noted that the shadow was nice and dark and everything was normal. There are in fact three candidate dates and UTs for Barnard's observation: 1889 Sep 04 UT 02:30-03:00, 1889 Oct 03 UT 03:00-03:45 and 1889 Oct 04 UT 03:00-03:45 and we have concentrated on the Sep 4th one. For comparison I have found a couple of example images at similar illumination from the ALPO/BAA observation database by: Brendan Shaw (Fig 2 – Left) and Walter Elias (Fig 2 – Right). At the resolutions available it is difficult to tell if there is anything definitely diffuse about the central peak. I think we need higher resolution images and also to check out the other two candidate dates and UTs. We shall keep the weight of the original report at 3 for now, pending future observations.

Plato

In ALPO's Strolling Astronomer Vol 6, p86 T.A. Cragg reports that they were amazed to see not even the central craterlet on the floor of Plato on 1952 Apr 04, (before 02:45 UT), despite using a 12" reflector under fairly good seeing and fair transparency. This was assigned and ALP/BAA weight of 3. Fortunately, we now have a nice image taken by Jesús Piñeiro (Fig 3 – Top Left) under similar, illumination which also shows a total lack of detail on the floor of Plato. We can therefore lower the weight of the Cragg TLP report from 3 to 2.

Interestingly there is another account of a lack of detail on the floor of Plato, this time by F.C. Butler of SW London, UK, where he states that on 1980 Oct 30 UT 03:10-05:07 the floor of Plato seemed quite devoid of detail, apart from a vague mottling seen during the best moments of seeing. Only at the start of the observing session could he just glimpse the central craterlet under Antoniadi III (moderate) seeing, that eventually worsened, but never quite reaching IV (poor). Bob Stuart imaged (Fig 3 – Right) the crater under similar illumination and obtained quite a remarkable amount of detail on the floor. I especially find the very faint light bands across the floor of Plato interesting – presumably ray material, although it is curious that they happen to lie in the same direction as E-W shadow bands would at sunrise/set – one assumes a coincidence. Anyway, as Bob's image shows a lot of detail, even after degrading the resolution (Fig 3 – Bottom Right) we shall leave the Butler TLP report at a weight of 1.

I am fairly confident that the visibility of detail on the floor of Plato, that some people claim as obscurations, in the past, can probably be explained by a combination of seeing conditions, image contrast and telescope resolving capability. But we need more observations on a case-by-case basis to eliminate past TLPs where obscurations of floor detail have been observed.

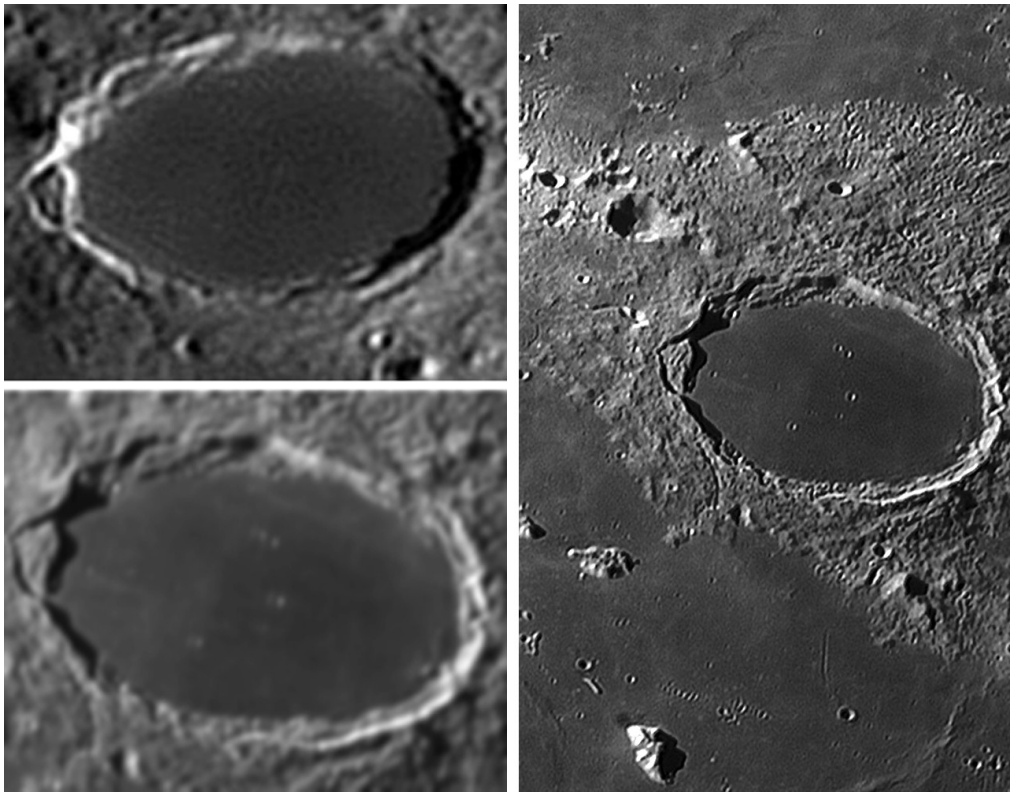

Figure 3. (Top Left) Plato as imaged by Jesús Piñeiro (SLA) on 2021 Aug 17 UT 23:29. Size and type of telescope used: 90 mm. Maksutov-Cassegrain. Filter:IR cut UV-IR (Astronomik L2 UV-IR 2"). Camera: ZWO ASI 533MC. (Right) Plato as imaged by Bob Stuart (BAA) on 2021 Aug 29 UT 04:19. (Bottom Left) Bob's image, but degraded in resolution to match Jesús' image.

Herodotus Pseudo Peak

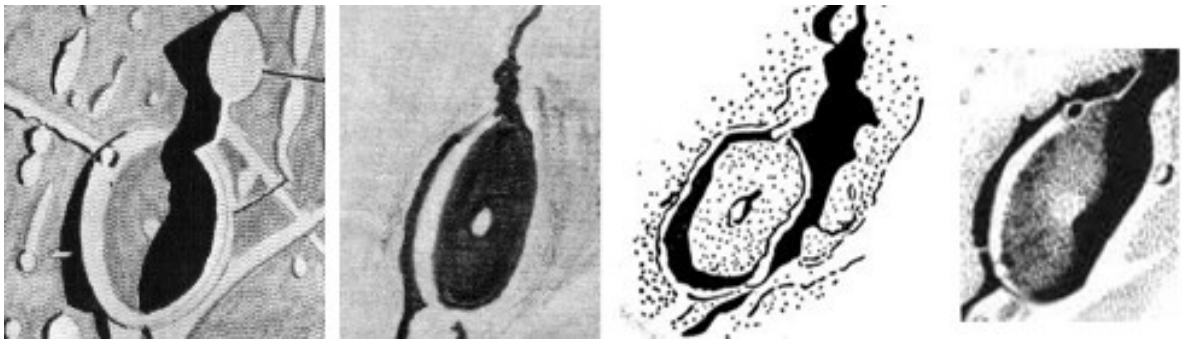

Figure 4. Herodotus observations showing a "Pseudo-Peak" or central light spot. (Far Left) H.P. Wilkin's sketch from 1950 Mar 30 UT 19:00? (Left) Bartlett's sketch from 1950 Jun 27 UT 02:30? (Right) Firsoff's sketch from 1955 Jul 15 UT 03:50 - depicting a shadow from the central peak in this evening illumination configuration. (Far Right) A sketch by Harold Hill from 1966 Nov 24 UT 21:50 of a very faint central white diffuse spot.

Readers are probably aware that from time to time we show observations and images which are under similar illumination to when many observers have seen a pseudo peak on the floor of Herodotus crater (Fig 4). Sometimes in these historical observations the pseudo peak is completely embedded in the shadow of the floor for the crater. At other times there is a light spot on the floor and very occasionally the pseudo peak can exhibit a shadow. Because there is no actual visible peak on the floor of Herodotus, it is not surprising that most modern attempts to observe the crater under similar illumination have nearly always failed. Spacecraft imagery show nothing there either. If readers are interested, a good article about past historic observations of the pseudo peak was written by Tom Dobbins and myself for the BAA Lunar Section's: "The Moon: Occasional Papers of the Lunar Section of the British Astronomical Association Lunar Section, 2 (2012 Dec) p22-35" and four of the observations from this are include in Fig 4. There is a southern white spot that was seen by Peter Grego and Raffaello Lena, but this is a permanent feature and always predictable – possibly due to ray material on the floor?

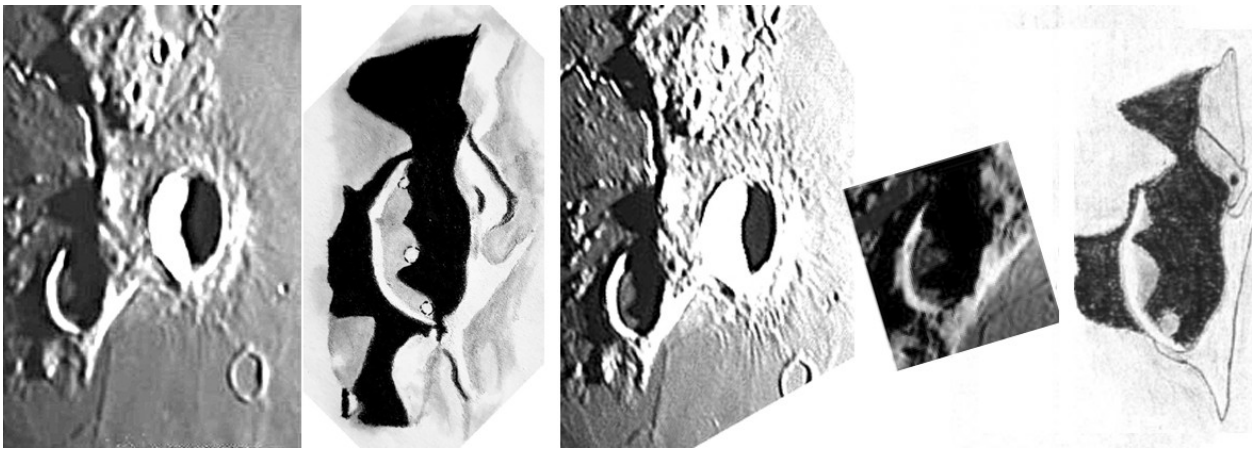

Figure 5. Herodotus orientated with north towards the top. (Far Left) A high pass filtered and contrast stretched image by Massimo Alessandro Bianchi (UAI) taken on 2021 Aug 19 UT 20:53. (Left) A sketch made by Massimo Alessandro Bianchi (UAI) UT 20:55-21:18 showing three spots on the floor of Herodotus. (Centre) A high pass filtered and contrast stretched image by Franco Taccogna (UAI) taken on 2021 Aug 19 UT 21:14. (Right) An ALVIS simulation of the interior of Herodotus based upon ephemeris data for 1966 Jun 30 UT 03:10 corresponding to yet another Bartlett observation of a pseudo peak – but alas we have no sketch for this. (Far Right) A sketch by Robin Gray (ALPO) made on 2002 Oct 18 UT 04:14-04:36 made under similar illumination to Massimo's sketch.

We have a Lunar Schedule request out for people to observe the floor of Herodotus between selenographic colongitudes of 52.6° and 55.8°, and any sub-solar latititude. This encompasses the range of illumination that people have seen a central white spot or pseudo peak. On most occasions nobody see's anything. So, I was especially interested when I heard that on 2021 Aug 19 UT 20:55-21:18 Massimo Alessandro Bianchi (UAI) sketched no less than 3 spots on the floor (Fig 5 - Left). Massimo and other UAI members were imaging that night and by pushing the high pass filtering, some evidence of the spots may be hinted at – see Figs 5 Far Left and Centre. However, it should be said that the filtering is getting close to the point where "ringing" artefacts are starting to show up on contrasty edges, but at least the subtle light patches lie in roughly the right locations. I also found a 2002 sketch by Robin Gray that is very close in illumination to Massimo's sketch (Fig 5 – Far Right), however the libration was different – but at least a southern spot was visible. Finally, I checked through the simulated images of Herodotus in the Dobbins and Cook publication to find the most similar illumination computer visualization which corresponded to a past pseudo peak report (Bartlett 1966 Jun 30) and although this does not show any spots, and again the libration is not the same, it does give some confidence to some of the floor detail being shown in Figs 5 Far Left and Centre.

So, what can we learn? Unfortunately, we have not definitively solved the puzzle as to what the pseudo peak observations from the past were about. It is interesting though that the left of centre and lower spots in Massimo's sketch (Fig 5 – Left) correspond to dimples (depressions) in the shadow. The northern spot may correspond to low level relief on the floor as there are hints of these in the two images and simulation. Another point to take into consideration is that when sketching small features on the Moon, although the sketches are usually topologically accurate, the spatial geometry can become less reliable, meaning the locations of the spots sketched could be slightly offset from where they really are. So, if Bartlett sketched a spot in the centre, it could have been offset slightly which could easily mean that it might be the same as what Massimo drew? Anyway, we need more high-resolution images (ideally time lapse) as well as sketches to get a better understanding of what these old and new reports are about.

A Fuzzy Patch Near Herodotus

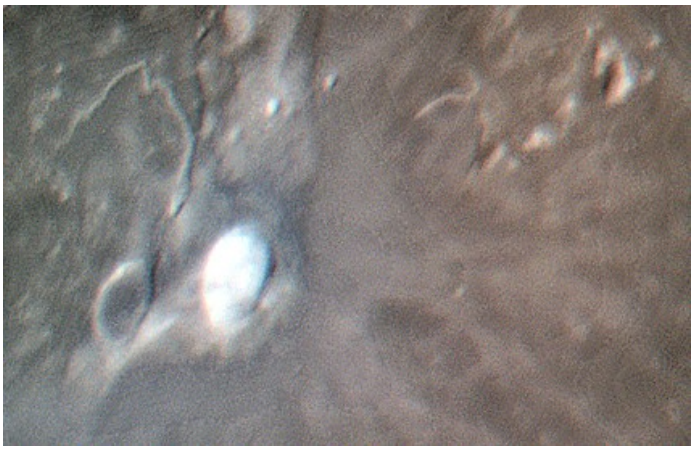

Figure 6. Aristarchus as images by Maurice Collins in colour on 2021 Aug 21 UT07:45. Orientated with north towards the top and colour normalized.

On 1989 Jun 17 at UT 06:33-07:16 R. Manske (Sun Prairie, WI, USA, 1" refractor) sketched a nebulous spot near to Herodotus crater that at 06:49 (when he tried some filters out) was visible through red, blue and yellow filters, though it was slightly fainter through the red filter. The Cameron 2006 catalog ID=366 and the weight=3. The ALPO/BAA weight=2. Maurice Collins (ALPO/BAA/RASBZ) re-observed under similar illumination and obtained the image shown in Fig 6. It is very unclear what the 1989 TLP report refers to as a fuzzy patch – perhaps the SW ray from Aristarchus? Alas I can find no sketch in the archives. Certainly, the instrument that Manske used was a bit on the small side. I think we should lower ALPO/BAA the weight from 2 to 1.

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? If you would like your observations to be considered for mention in the next newsletter, then they should be submitted by 17:00UT on the 24th of July, covering observations for June. Please send observations in, even if older than this as they are still very useful for future repeat illumination studies. This can be found on: http://users.aber.ac.uk/atc/tlp/spot_the_difference.htm . If in the unlikely event you do ever see a TLP, firstly read the TLP checklist on http://users.aber.ac.uk/atc/alpo/ltp.htm , and if this does not explain what you are seeing, please give me a call on my cell phone: +44 (0)798 505 5681 and I will alert other observers. Note when

telephoning from outside the UK you must not use the (0). When phoning from within the UK please do not use the +44! Twitter TLP alerts can be accessed on https://twitter.com/lunarnaut .

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