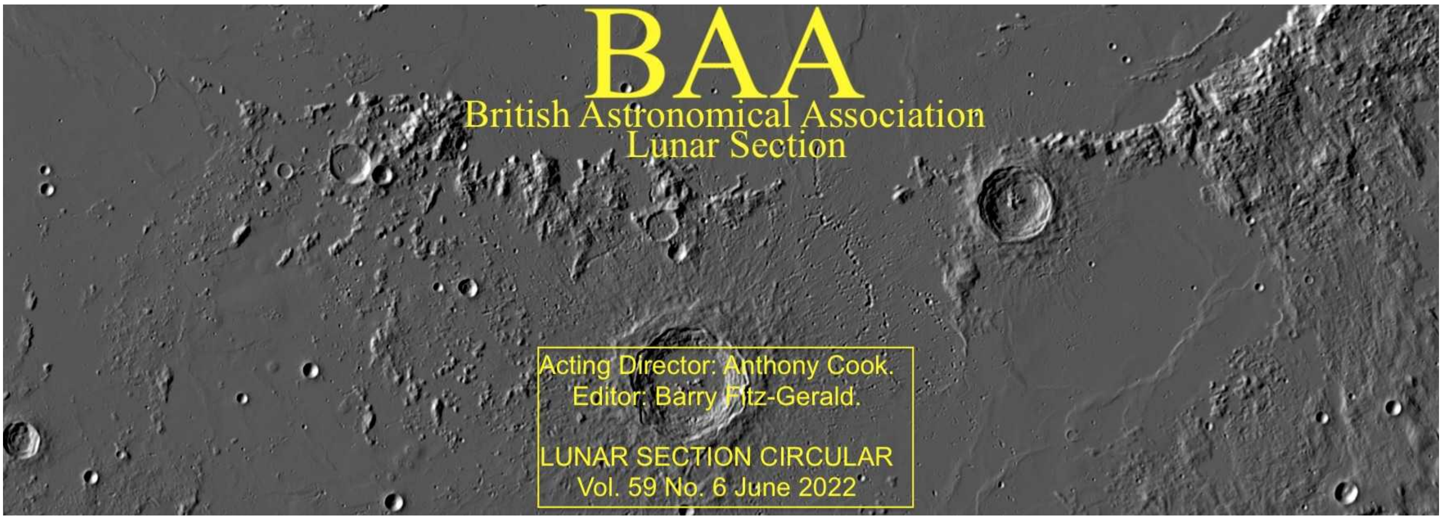

Editorial:

When browsing on the Internet for a specific topic, one can easily be thrown an alternate golden nugget of knowledge that one previously was not aware of. A couple of recent examples I came across were: "Significance of Lunar Impact on Noctilucent Clouds", published in the September 2006 issue of the Journal of Atmospheric and Solar-Terrestrial Physics 68(14):1653-1663, where authors: P. Darlin, N. Pertsev and V. Romejko claim to had found that monthly and half monthly lunar cycles cause respectively 20% and 10% modulation in NLC activity, furthermore the probability of observing NLC's was found to be greater at lunar perigee than at apogee, i.e. when the Moon is closer to the Earth. Rather than taking a single old paper at face value it is always worth following up who has cited it, and what the more modern view is. As far as I can see, more recent publications using satellite data show that at least the semidiurnal effects of lunar tides in the Earth's mesosphere can be detected. The second surprise paper discovery I came across was concerning the demise of the Soviet Luna 5 robotic lander mission that crashed into the Moon on 1965 May 12 UT 19:10. The paper *by K*sanfomality, L. V. (July 2018). "Luna-5 (1965): Some Results of a Failed Mission to the Moon". Cosmic Research. Pleiades Publishing. 56 (4): 276–282, says that it came down near Lansberg (25.48°W, 1.35°S and not as had previously been stated in Mare Nubium (8°W, 21°S). The evidence of the Mare Nubium impact site has always puzzled me as the so-called ejecta cloud, imaged from Rhodwitsch Observatory in East Germany, was supposedly 230 x 80 km in size and lasted 9 minutes – something that no other observed impacts, satellite or meteoroidal, have been seen to have done. The "near Lansberg" impact cloud is smaller at around 20 km in diameter and lasted at least 40 seconds – though again was still untypical of the duration of observed impact events. Curiously the UTs of the impact clouds differ too, the Ksanfomality report gives 22:13 and the Rhodwitsch Observatory report 19:10UT? Maybe the Ksanfomality time was the time from the observatory in Georgia. Both sets of observations were made under non-ideal weather conditions i.e. cloud or gaps in clouds. Anyway, I have included the above in the lunar schedule web site so that we may compare more modern imagery with the 1960's era claimed photographs of the ejecta cloud., and perhaps even subtract one from the other and see if they were due to cloud structure in our own atmosphere rather than on the Moon?

Tony Cook.

Lunar Section Meeting at the BAA's Winchester Weekend April 2022.

By Tony Cook.

The Acting Director, Tony Cook, kicked off the meeting with an introduction to the Lunar Section, its past activities, current and future projects. The Section has for many years been running active programmes in lunar geology, occultations, and Transient Lunar Phenomena, but would like to introduce new projects on impact basins & buried craters, impact flash observing, and encouraging our lunar imagers to support the geological studies more.

Figure 1. The speakers, from left to right: Nick James, Tim Haymes, Tony Cook and Barry Fitz-Gerald.

This was followed by a talk by Tony on "Lunar Impact Flash Observing", explaining what an impact flash was, the extremely high kinetic energies involved, and what simple camera equipment could be used to detect these from the Earth. This is not as difficult as you might think, as you just need a camera with frames rates of say 15 frames per sec or faster, and capable of videoing earthshine and stars down to mag 10, with these you could make some major scientific contributions. Watec or ASI type cameras are quite capable of doing this. Used examples of the former can be bought on eBay for around £50, though you would need a USB video capture card to record to a lap top.

Fig.2 Impact flash as recorded by Tony Cook.

The best times to look for impact flashes can be found on the lunar schedule web site at: https://users.aber.ac.uk/atc/lunar_schedule.htm. The analysis of the video recorded can be done by using software such as Lunarscan or ALFI. – this avoids the boring task of manually watching earthshine video in slow motion. Additional science that could be achieved was also discussed, namely:

1. Locating the longitude and latitude of the impact site so that we can utilize past and present NASA LROC images to find the new crater.
2. Combining light curves of impact flashes from several observers in order to eliminate atmospheric seeing effects.
3. Dual waveband measurement to determine temperature.
4. Using a low resolution diffraction grating in the hope of catching bright but rare, flashes in order to see if we can detect any spectral emission.
5. Looking for elongation in the flashes (related to shallow angle impacts and ejecta clouds).
6. And finally using Long Wave IR and Short Wave IR to detect the heat decay following an impact.

Barry Fitzgerald then gave a talk “Lunar Geology – Old Questions Revisted” with some examples of lunar formations that had a volcanic origin and glancing blow impact craters. The examples discussed were too numerous to list here, but some illustrative cases are given. A tribute was paid to Keith Abineri, who was both an excellent lunar sketcher and also undertook geological interpretation based upon Lunar Orbiter imagery e.g., a study of the Herigonius sinuous rille system. Alphonsus was then discussed as an example floor fractured crater and crater density populations were used to illustrate the different ages and nature of the floor on either side of the central ridge.

Barry discussed oblique impacts and how these could distort the outlines of normally circular craters such as Messier and Messier A and then binary impacts such as Heis and Heis A and Thebit A and Thebit L. Then he moved onto craters where the central peak was offset from the centre e.g., Albategnius, and Pitatus, which may not have anything to do with oblique impacts, but instead may be due to tectonic sideways readjustment under the influence of magmas intruded beneath the crater floor.

After the coffee break, Tim Haymes gave a personal reflection on his experience of observing lunar occultations. Things have changed over the years as visual observations have been superseded by CCD and CMOS video cameras. Occultation predictions can be found with the Occult4 program, which lets you know whether stars are suspected double stars or not. Tim then showed an analysis of the occultation of SAO 164809 from 2017 Oct 29 , made by three observers; A. Pratt, T. Haymes and B. Loader. Using the Occult 4 double star solving tool they were able to deduce an angular separation of of 0.222”+/-0.004”.

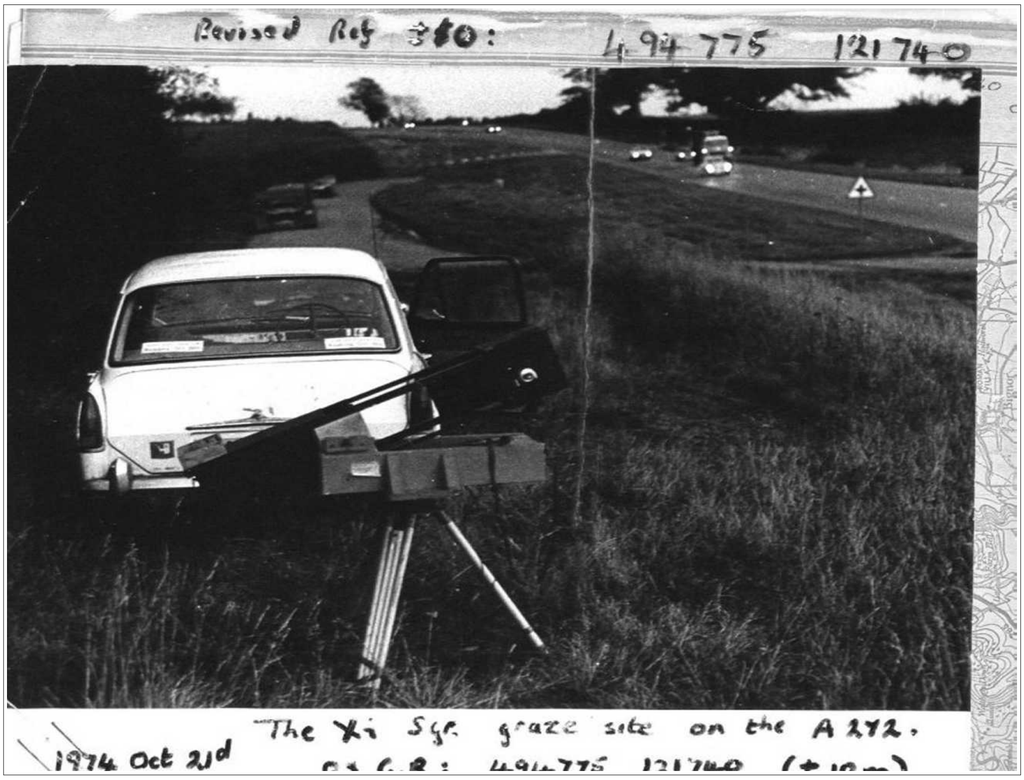

Fig.3 Tim Haymes's preparation for the grazing occulation of Xi Sgr of October 21 1974. Equipment includes an Austin 1100 and home made 6" F/8 on an Alt/Az mount. The road in background is the A272.

What equipment does an occultation observer need – Tim suggests a scope of 4” or larger aperture (a small scope offers portability if attempting graze occultations, though tracking is helpful). For a camera, either analogue video at 25fps (video composite) or USB 3.0 such as an ASI 120 or a QHY174mGPS. For timing accuracy, a GPSBOXSPRITE3 (www.blackboxcamera.com), or TIMEBOX (https://www.shelyak.com/produit/pf0063-timebox/?lang=en) are available. The QHY174mGPS camera comes with GPS timing built in. Some observers have built a RasPi GPS unit which serves the same function as the TIMEBOX. If capturing analog video then you need an analog to digital converter such as a Pinnacle Dazzle USB capture device. For laptop recording from the video capture device Tim uses “IOTA video capture” or SharpCap. Analysis of the photometry of the light curves, can be done with Tangra and/or LiMovie.

Tim then recounted some past graze occultations, one of his first was of ZC 2759 on 1974 Oct 21, just off the A272 near Petworth (Fig.2). In that era timings were made using a tape recorder, two stop watches a 6” reflector and the pips from the BBC at 6PM. Some 34 observers participated in that event. Using modern day spacecraft derived limb topography, the observations were plotted against this and showed remarkable agreement. Perhaps Tim’s most magnificent video of a grazing occultation of delta Geminorum, taken on 2019 Aug 27, where the star was flashing on and off, several times as it passed between mountains and valleys on the lunar polar region – almost as if someone was operating a light house beam there. A future couple of graze occultations were high-lighted: 14 Ceti, to be seen from a line through Coventry on 2022 Jul 19, a grazing occultation of Uranus on 2023 Jan 01, and one of Mars on 2025 Feb 09. Graze observations remain scientifically important as they are an independent check on the limb profile of the Moon. They are also exceptionally effective at detecting/resolving double stars, and the Fresnel diffraction effects visible can give you clues on stellar angular diameters. Additional tips on occultation observing can be found on: p://www.stargazer.me.uk/ and https://groups.io/g/UKoccultations/.

Nick James, had just arrived hot foot back from a visit to the USA, with news about the latest plans for a return to the Moon, by orbiters, robot landers/rovers and eventually manned exploration. He started off with a comparison of launch costs in the past and present. Then discussed NASA’s ARTEMIS 1 plans for an uncrewed flight to the Moon and back, in order to demonstrate the Space Launch System (SLS) hardware. However, he warned of likely delays and has subsequently been proved right. Launches are now no longer confined to the big countries like the USA, Russia and China, but even New Zealand, and hopefully soon the UK, have launch capabilities, at least for smaller CubeSat payloads.

Nick then talked about different orbits for lunar satellites, e.g., at the Lagrange points and halo orbits. He then mentioned the Lunar Gateway space station, the next thing for NASA after the International Space Station, but instead of going around the Earth would be located in cis-lunar space. A precursor satellite, to investigate station keeping for the Lunar Gateway, is the unmanned Capstone mission, due to be launched by Rocket Labs in New Zealand into a rectilinear halo orbit; this will vary considerably in distance from the Moon, but will have continuous communication with the Earth. Another major step in lunar exploration will be the Lunar Pathfinder, in 2024 which will act as a communication relay between surface exploration and the Earth, for about 5 years. Three robotic landers were introduced: Peregine, Nova-C and Z-01, which may reach the Moon by the end of 2022 and a small spider-like rover: “Spacebit”, made with British technology, will be used to explore the area around one or more of these landers.

Finally, we had a short panel meeting that was intended to be a bit like the BBC’s “Question Time” or “Any Questions”, and meant to be about anything anybody wanted to ask about the Moon and lunar observing. However, it was mostly additional questions about topics covered by the previous four lectures.

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Observation Received:

Observations have been received from the following: David Finnigan, Mark Radice, Franco Taccogona, Maurice Collins, Paul Abel, Bill Leatherbarrow, K.C.Pau, Rik Hill, Rod Lyon, Trevor Smith and Bob Stuart.

Klaproth.
By Dave Finnigan

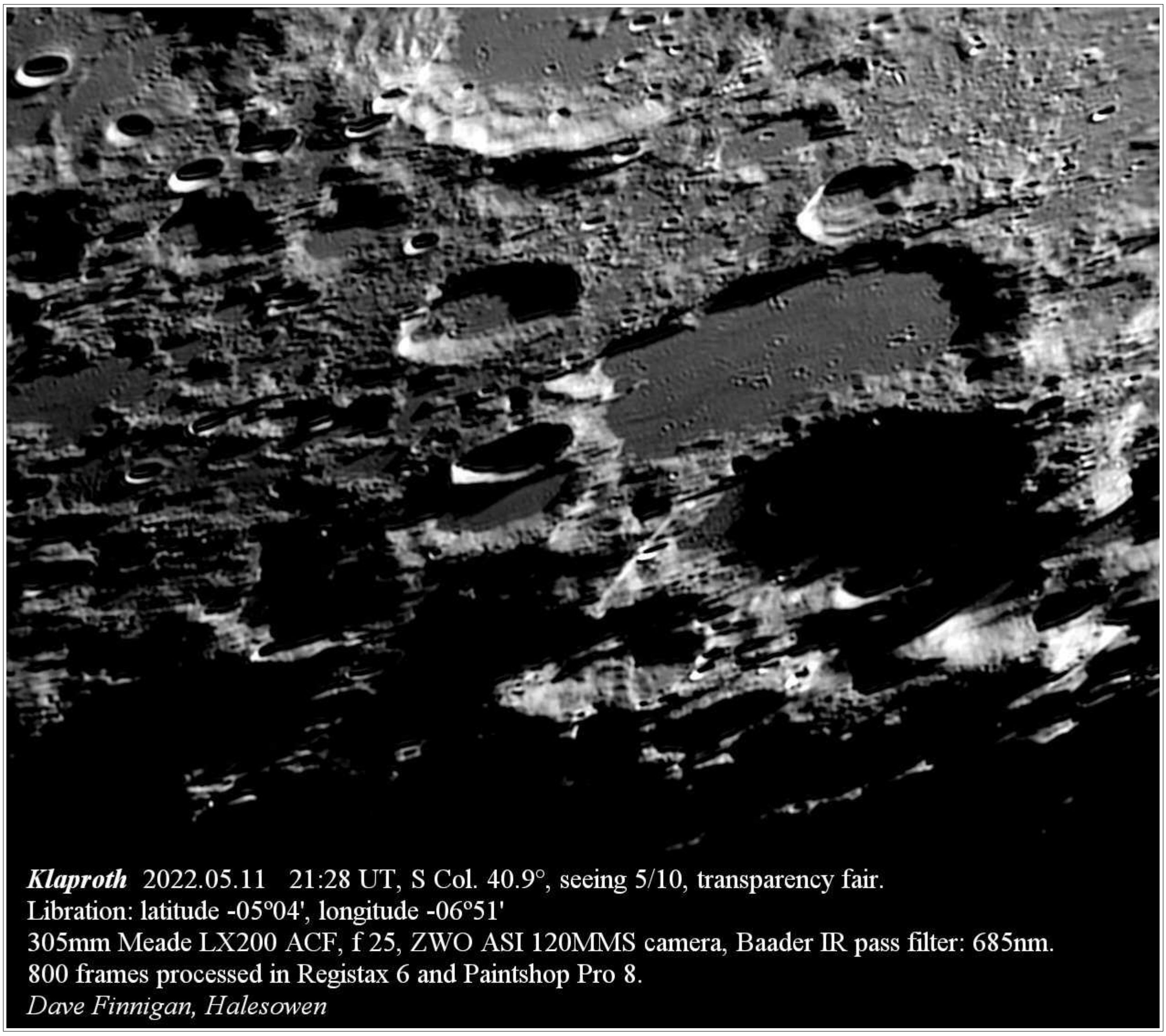


Fig. 1 Klaproth by Dave Finnigan. Details date/equipment as per caption in image.

Editor Comments:Klaproth is an ancient 121km diameter crater situated at the far south latitude of 69.85°S. It is partly overlain to the south by Casatus, which is deep in shadow in Dave's image. Its position this far south results in a fair degree of foreshortening, but its outline is in any event distinctly non-circular due to later impacts on its rim. Its is about 2000m deep and the floor is covered by light plains type deposits which may be basin ejecta, but as with many Nectarian age craters this may be undelain by 'cryptomare' deposits or ancient lava flows of basaltic composition. There is however no evidence for this in spacecraft imagery. Lunar orbiter images (LO IV-152-H2) show some subtle undulations of the crater floor, some of which is evident in Dave's image. The crater just north of the rim (in the 11 o'clock position in this image) is the 44km diameter Blancanus C, something of an oddity as it is a Floor Fracture Crater, examples of which are normally associated with the edges of the mare, not the highlands.

Marius-Reiner-Gamma

By Mark Radice.

Editor Comments: Mark's image shows the Marius Hills volcanic complex which consists of large numbers of domes, cones, sinuous rilles and other volcanic structures concentrated on top of a major volcanic plateu and underlain by a gravity anomaly which indicates the former presence of a large magma body which probably powered the surface activity we see. There is evidence in the form of breached cones and blocky deposits as well as pyroclastic material that the volcanism was not gentle but involved a fair amount of explosive activity. Having said that remote sensing data indictes that the domes are not particularly rich in silica, which would produce more violent volcanic eruptions, but are geochemically similar to the surrounding mare basalts. Mark's image also picks up some of the sinuous rilles that originate amongst the hills and channeled lavas outwards onto the surrounding mare.

The lunar swirl feature Renier Gamma is associated with one of the strongest crustal magnetic anomalies on the moon. The leading hypothesis for its formation is by a 'stand off' effect produced by this magnetism which deflects solar wind particles from the parts of the surface, effectively preventing radiation darkening of the regolith. The source of the magnetic anomaly is open to debate, one theory is that they form above linear igneous intrusions, another is that they are the result of cometary impacts but the most often cited mechanism is that they are produced at the antipodes of major basin forming impacts. Swirls are found both in the maria and highlands (such as near Airy) but are rare in areas of very low iron abundance.

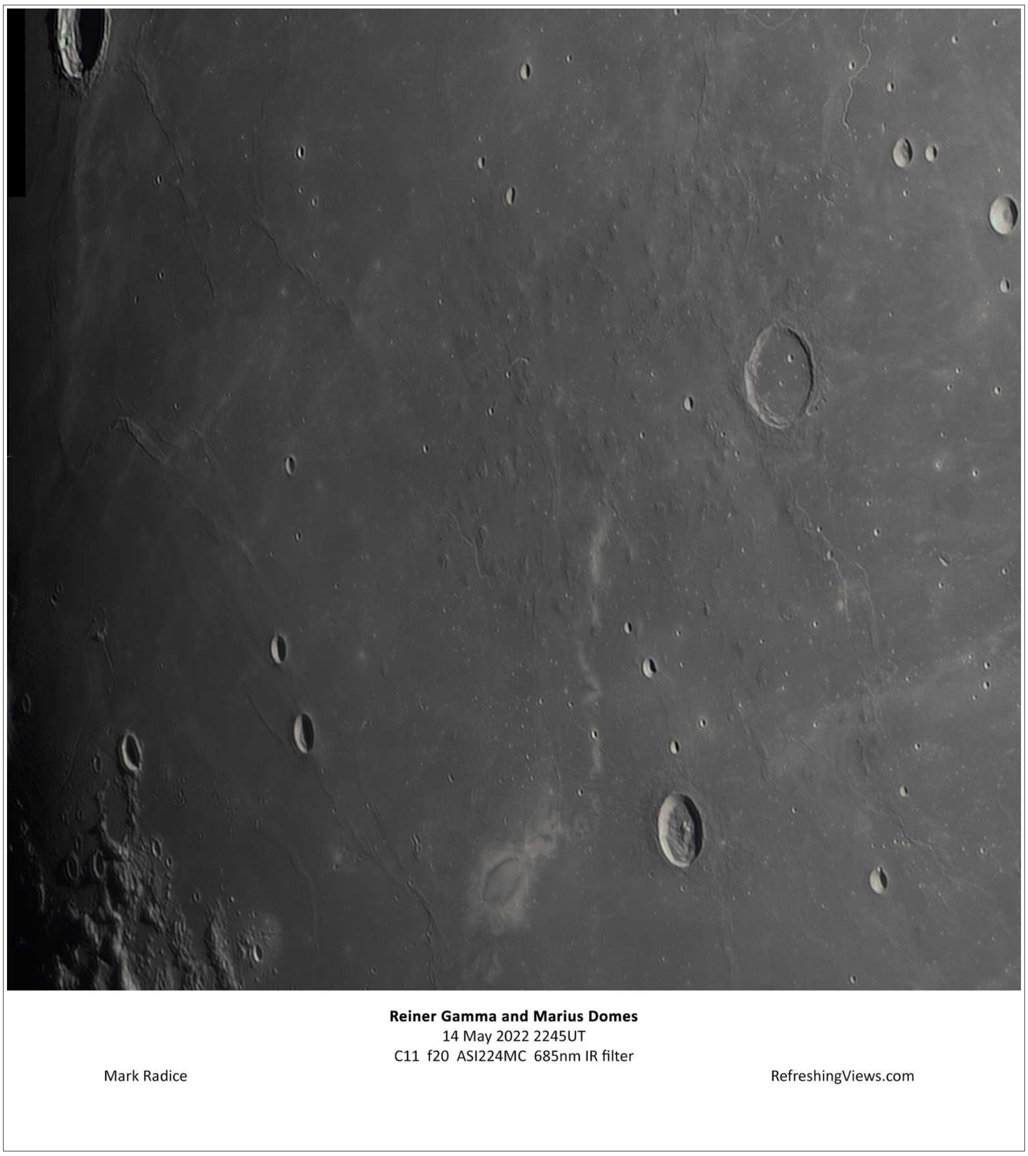


Fig.2 Marius-Reiner Gamma by Mark Radice. Details date/equipment as per caption in image.

Copernicus.
By Maurice Collins.

Maurice writes: Here is the Moon from last night, May 10. I managed to get the telescope out and take these before the clouds rolled in preventing any visual observing afterwards. But least I was able to get some images. It was windy and cold out anyway so I was glad to get back inside quickly!

Copernicus was on the terminator and just the rim lit by the sunlight and the interior still in shadow, I like that view of the crater, makes it look deeper than it is.

It has been a month since my last session, the clouds and seeing have not been cooperative so I haven't tried to do any more than just binocular viewing in the gaps in the cloud cover. It usually clouds over within 5 mins of the sky being clearest autumn we have had, and apparently we have high aerosols from the Tonga volcanic eruption covering our skies with haze too.

Fig.3 Copernicus by Maurice Collins. (North is up).

Damoiseau.
By Paul Abel.

Paul's observing notes are: We had a late clearing here, and the Moon was already quite low in the sky- in spite of the sight, the seeing wasn't too bad. I had intended on drawing the Sirsalis rille but Damoiseau crater caught my eye straight away. I have not observed this formation before and I had the impression it was a concentric crater. I did a bit of research the following morning and discovered that Damoiseau is indeed concentric with the Damoiseau M.

Interestingly, the formation looked subtly different from how it appeared on NASA's dial-a-Moon, and my chart. The shadows around and inside the crater were slightly different from those dipicted on the NASA software. This may well be due to the fact the Moon was at a low altitude. I would have spent more time on it, but by 2358UT the Moon was too low for the telescope. I will return to this feature again when the sun is further west of it.

Editor Comments: Damoiseau is a ~36km diameter Floor Fracture Crater (FFC) on the western shore of Mare Procellarum. Due to its size and location the fracture sysytem is not as obvious as in some of the larger FFC's such as Posidonius or Hevelius or the smaller but more favourably placed Vitello as shown in Fig.6 by Bob Stuart.

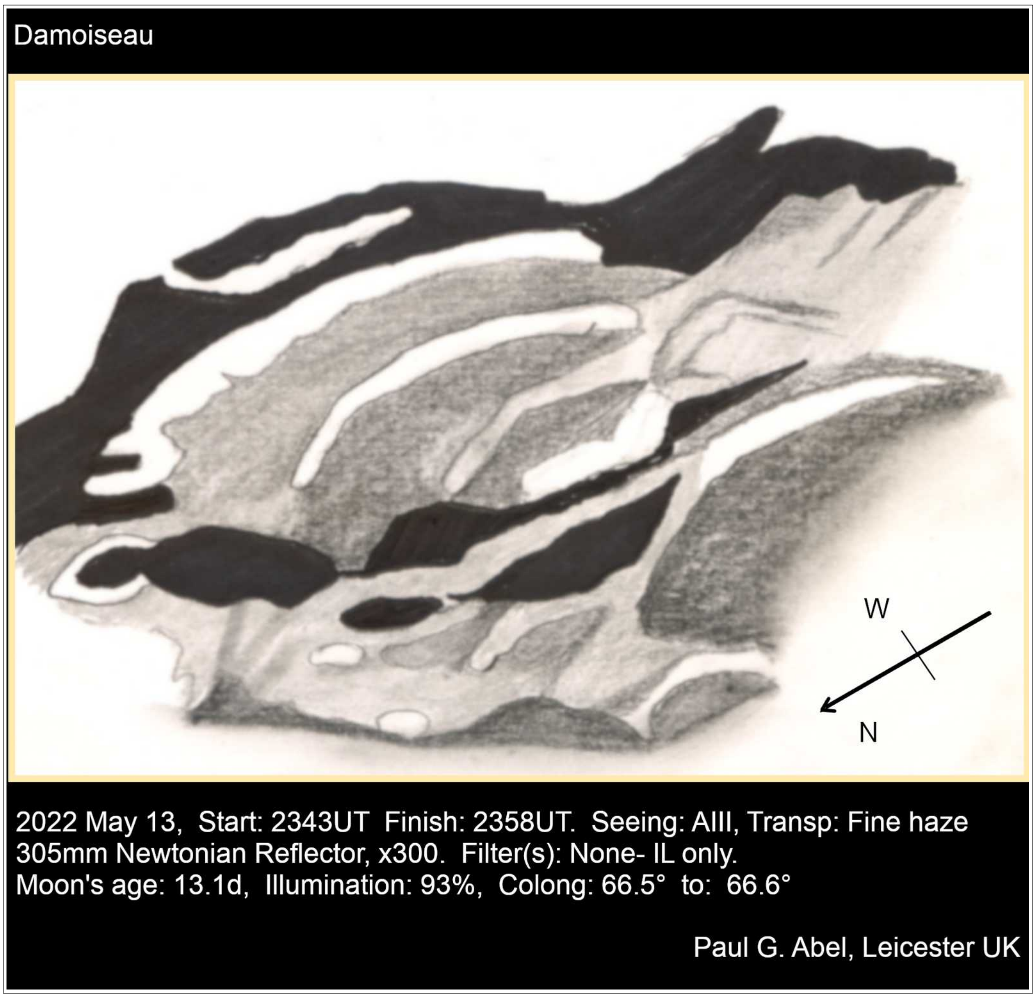


Fig.4 This drawing of Damoiseau was submitted by Paul Abel. Details of date/equipment shown in the drawing.

Rima Hyginus and Hyginus crater.
By Bill Leatherbarrow.

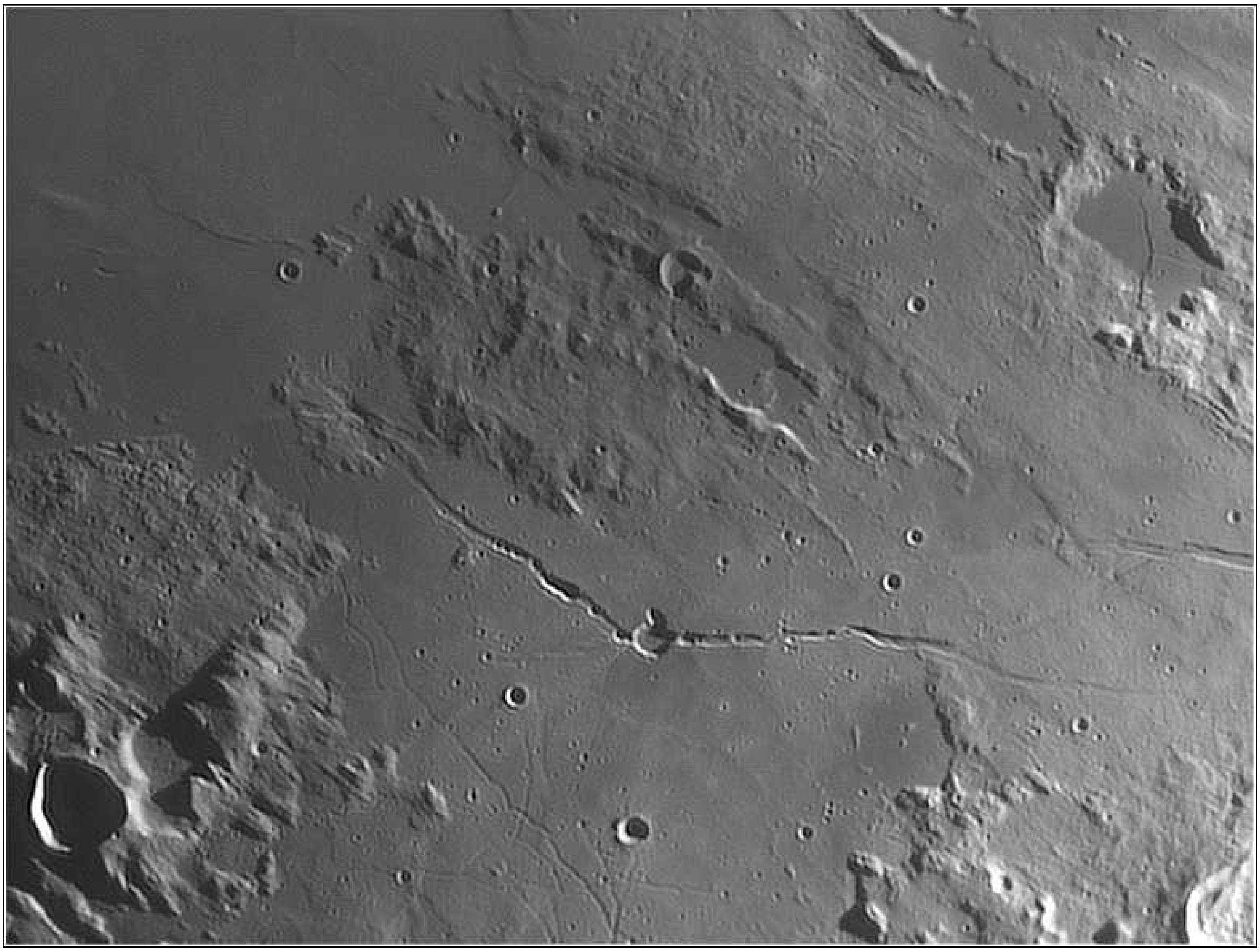


Fig. 5 Hyginus as imaged by Bill Leatherbarrow under good seeing conditions on the evening of 8 May 2022 with his OMC300 and ASI290MM camera.

Editor Comments: This is what might be termed a 'tectono-volcanic' feature, that involves both faulting and volcanic activity. The main culprit is volcanism in the form of sub-surface dikes who's ascent fractured the overlying crust and produced the prominent graben we see. These were late modified by collapse pits which formed along the floor of the graben, possibly as the gas contained within the dike lavas escaped. The main crater Hyginus is another collapse feature or 'caldera' which formed possibly as a result of sub surface migration of magma. The area is blanketed in pyroclastic deposits which is evidence of explosive volcanism, whilst the floor of Hyginus has a field of Irregular Mare Patches or IMP's which are most probably the result of regolith erosion caused by gas escaping from beneath the surface. Bill's image captures the very faint and somewhat segmented western graben which reaches out from Hyginus in the 9 o'clock position, and is presumably older that the two prominent graben.

Ramsden and Vitello.
By Bob Stuart.

Bob comments that the observing conditions were “*not too brilliant, Pickering 3-5, started alright then bombed!*”.

Editor Comments: The image however nicely captures some of the prominent fractures on the floor of Vitello which is a 44km diameter Class 2 Floor Fracture Crater (FFC). Members of this class of FFC have shallow hummocky floors surrounded by abrupt walls. The floors of this class are made up partly of old wall slumps, with the polygonal fracture system visible towards the crater interior. Bob's image also captures the graben that traverse the walls of the flooded Ramsden (with the bright crater on the western rim) and the adjacent mare surface. The small mare flooded Concentric Crater Marth is also visible towards the top right of the frame.

Fig.6 Ramsden and Vitello as imaged by Bob Stuart on the 14th March 2022 using a 25cm f6.3 Newtonian ZWOI 174MM 5x PowerMate and yellow filter.

Apollo 17 Landing Site.
By Franco Taccogona.

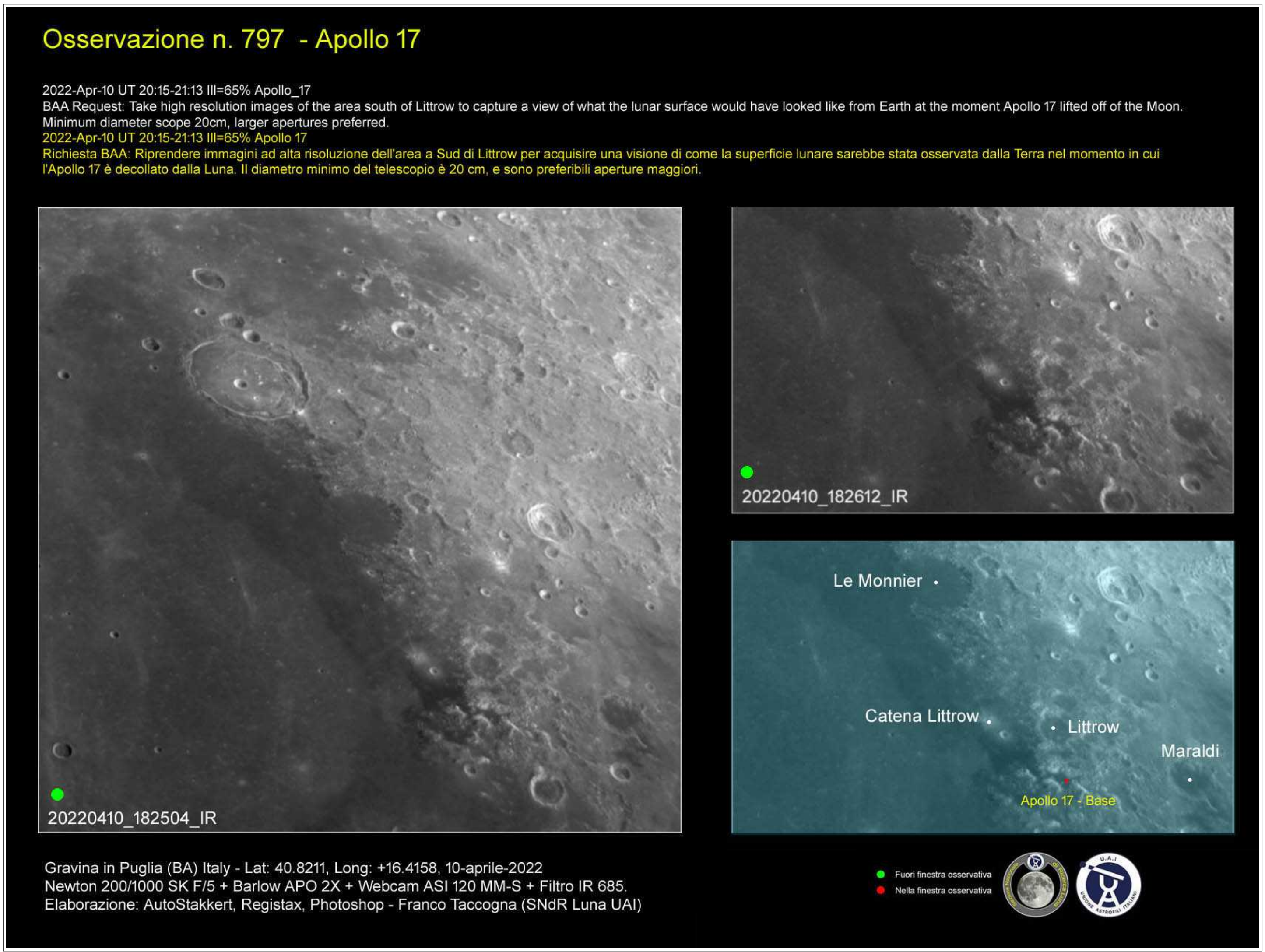


Fig.7 Apollo 17 Landing Site by Franco Taccogona.

Editor Comments: This is the view of what the lunar surface should have looked like (illumination-wise) at the moment that Apollo 17, ascent module from the Challenger lunar module, carrying Cernan, and Schmidt, lifted off from the surface on 1971 Dec 14 UT 22:54. UAI observer and instrument details given in the image.

Lacus Mortis.
By Maurice Collins

Fig. 8 Another image by Maurice Collins, this time of Lacus Mortis taken on 8th January 2022 at 0821UT using a Meade ETX-90 and QHY5III462C camera.

Editor Comments: This image captures the northern edge of Mare Serenitatis with the prominent FFC Posidonius as well as Lacus Mortis with its western side still in deep shadow. The low angle of illumination picks out the wrinkle ridges in the eastern extremity of Mare Frigoris particularly well. With a diameter of 160kms Lacus Mortis basin has a somewhat hexagonal outline due to some rim sections being quite straight, particularly to the south west and north where the rim is best preserved. This is probably a reflection of tectonic control due to underlying crustal fractures. Of course the lava filled floor of Lacus Mortis is also influenced by tectonic forces in the form of Rimae Bürg, which can be traced onto the adjecent highlands to the south-west. The rather oddly shaped Römer can be seen towards the right edge of the frame, with its complex arrangement of narrow terraces. Lacus Mortis is probably of Pre-Nectarian age whilst the superimposed crater Bürg has an age somewhere between that of Tycho and Copernicus.

Posidonius, Chacornac and Le Monnier.
By Rod Lyon.

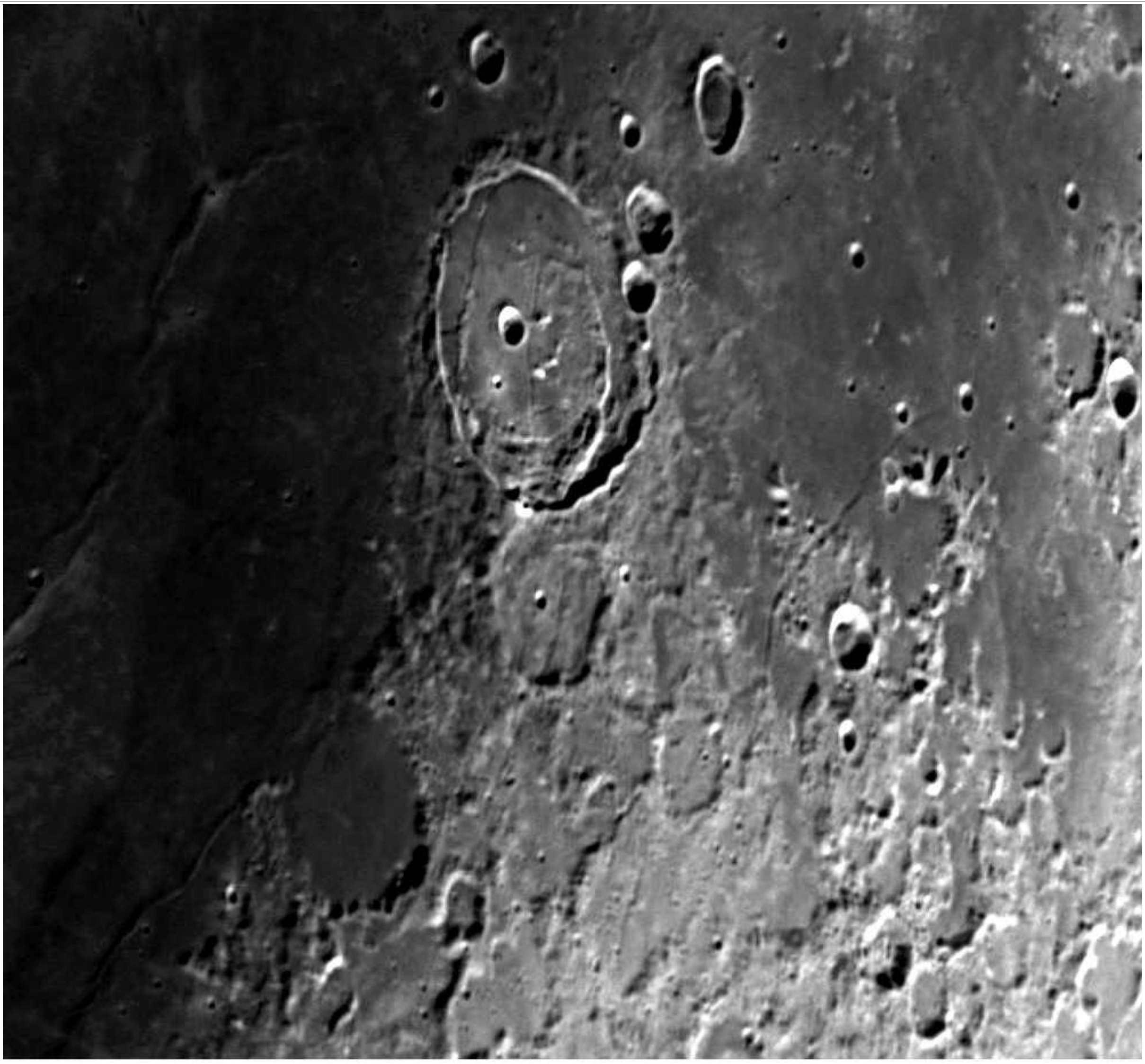


Fig. 9 Posidonius, Chacornac and Le Monnier as imaged by Rod Lyon Details date/equipment as per caption in image.

Editor Comments: Rod has captured some fine detail on the floor of Posidonius, with the sinuous rille crossing the western floor being clearly recorded. Its path along the inside of the northern rim is also visible as a dark line at the edge of the mare filled floor. A peculiar feature that shows up well in this image is a ray like feature that extends away to the north-east from area between Posidonius B and Posidonius J. This may be related to another ray like structure that passes between Posidonius M and Daniell to the north. Both of these rays converge on an area to the north-east of Posidonius B, so they may form the edge of a Zone of Avoidance in the ejecta pattern of Posidonius B which is indicative of a low angle impact. Posidonius B is however rather unhelpfully perched on the rim of Posidonius which makes determining whether this is the case somewhat problematic.

Schickard.
By KC Pau.

Fig.10 Schickard at dawn by KC Pau

KC writes: *Enclosed is the photo of Schickard at dawn. The photo is taken on 13 April 2022 at 12h39m UT with 250mm f/6 Newtonian with 2.5X barlow and QHYCCD290M camera. The eastern rim of the crater cast splendid shadows on the floor. The western rim leaves a big gap under the oblique morning sunlight and the floor shows many details.*

Editor Comments: With a diameter of some 212kms, Schickard is one of the most prominent large impact craters on the moon. It is pre-Nectarian in age and as a result it has been battered and eroded by numerous smaller impacts over the aeons. With a depth of only 2000m, most of its interior is filled with material that completely buries any central uplift (peak or peak-ring). As with Klaproth, the composition of the filling of is open to debate, but again it is likely that the crater interior is occupied by ancient lavas interlaced with highland type materiel derived from the ejecta from more recent crater and basin impacts. There is what looks like a 'wrinkle ridge' on the slightly more elevated central area (which is also of higher albedo) and this shows up well in this image. This is however probably a 'lobate scarp' caused by tectonic forces and not a mare type ridge. There are conspicuous patches of relatively recent (in lunar terms) mare lavas covering the south-eastern and north-western ends of the crater, with the sinuous rille entering Schickard from the crater Lehmann being the source of some of these lavas. This image also shows that the crater floor is slightly domed in the middle.

Struve and Environs.
By Trevor Smith.

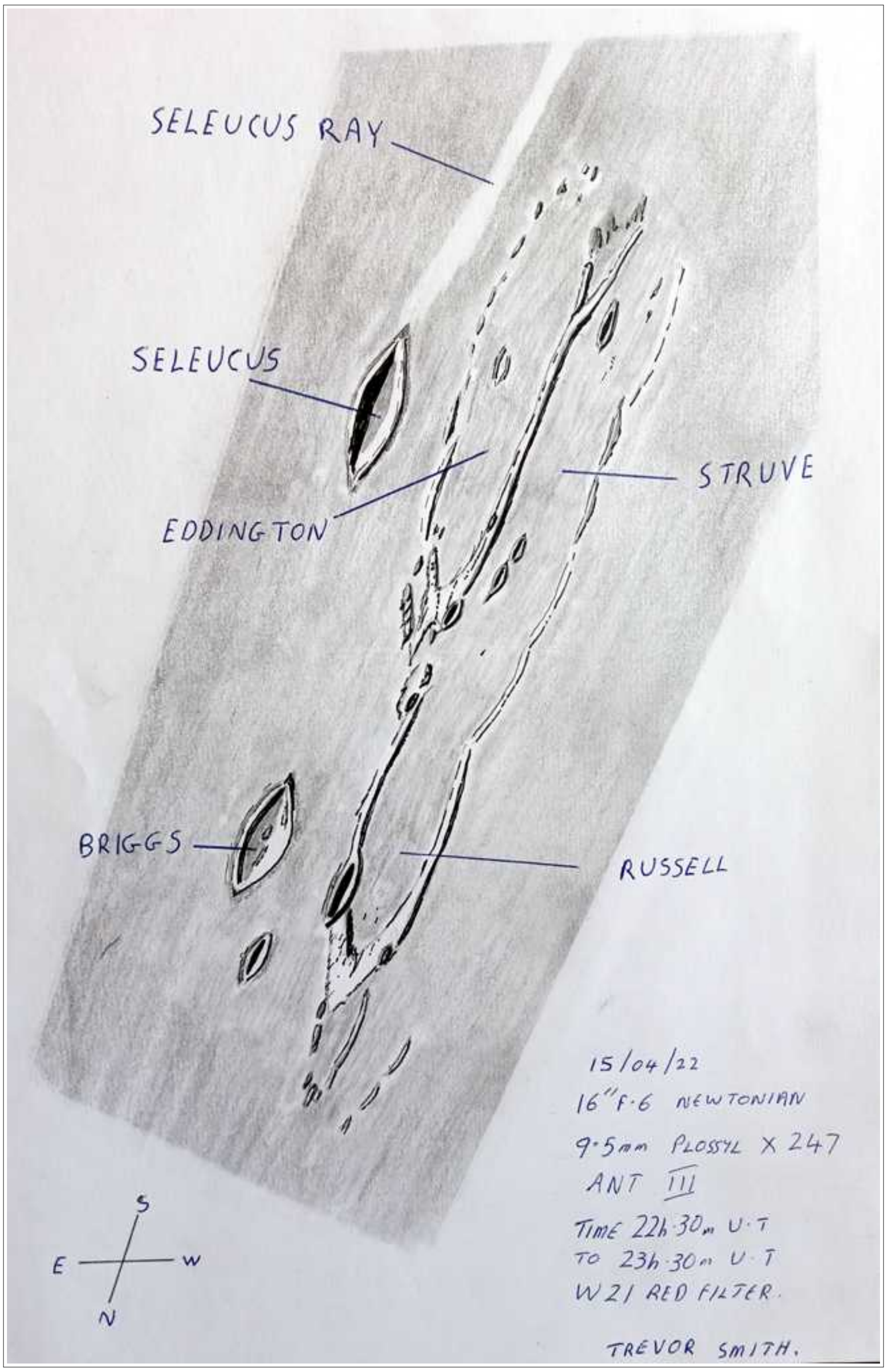
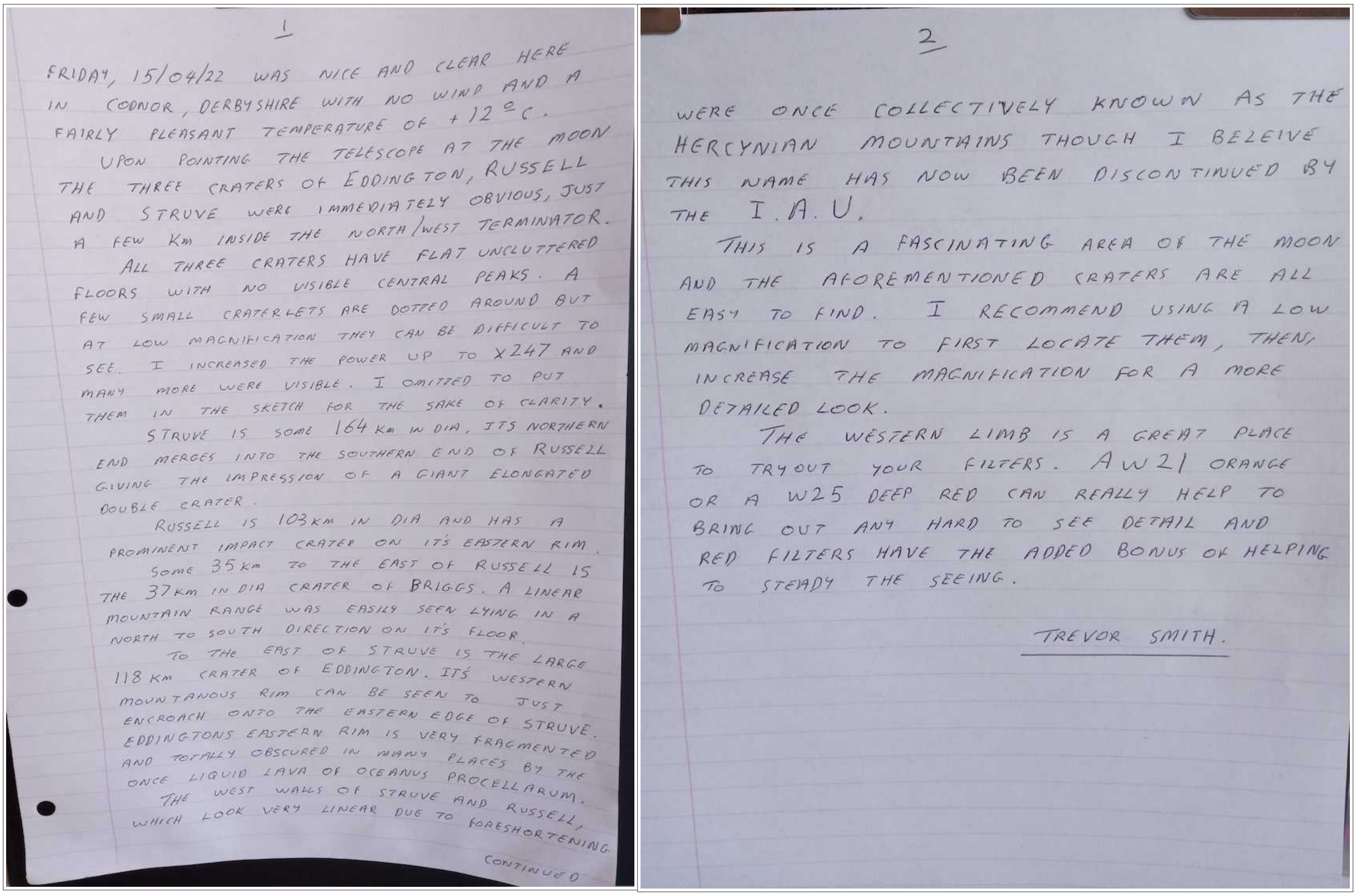


Fig. 11 Struve and its environs as drawn by Trevor Smith. Details of date/equipment shown in the drawing.

Editor Comments: Trevor's drawing covers an area of western Oceanus Procellarum that is quite foreshortened due to its position close to the limb. The drawing covers the mare flooded craters of Eddington, Struve and Russel as well as the floor fracture craters Briggs and Seleucus. The bright ray that skirts Seleucus belongs to the bright crater Glushko, and is notable for the rather odd 'dog leg' in its course between Cardanus and Seleucus.

Trevor was kind enough to supply a copy of his observing notes with some useful advice on filter use for visual observations. Note the telescope used during this observation a 16" f6 Newtonian, the view must have been quite impressive.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FRIDAY, 15/04/22 WAS NICE AND CLEAR HERE IN CODNOR, DERBYSHIRE WITH NO WIND AND A FAIRLY PLEASANT TEMPERATURE OF +12°C.

UPON POINTING THE TELESCOPE AT THE MOON THE THREE CRATERS OF EDDINGTON, RUSSELL AND STRUVE WERE IMMEDIATELY OBVIOUS, JUST A FEW Km INSIDE THE NORTH/WEST TERMINATOR.

ALL THREE CRATERS HAVE FLAT UNCLUTTERED FLOORS WITH NO VISIBLE CENTRAL PEAKS. A FEW SMALL CRATERLETS ARE DOTTED AROUND BUT AT LOW MAGNIFICATION THEY CAN BE DIFFICULT TO SEE. I INCREASED THE POWER UP TO X247 AND MANY MORE WERE VISIBLE. I OMITTED TO PUT THEM IN THE SKETCH FOR THE SAKE OF CLARITY.

STRUVE IS SOME 164 Km IN DIA, ITS NORTHERN END MERGES INTO THE SOUTHERN END OF RUSSELL GIVING THE IMPRESSION OF A GIANT ELONGATED DOUBLE CRATER.

RUSSELL IS 103Km IN DIA AND HAS A PROMINENT IMPACT CRATER ON IT'S EASTERN RIM.

SOME 35Km TO THE EAST OF RUSSELL IS THE 37Km IN DIA CRATER OF BRIGGS. A LINEAR MOUNTAIN RANGE WAS EASILY SEEN LYING IN A NORTH TO SOUTH DIRECTION ON IT'S FLOOR.

TO THE EAST OF STRUVE IS THE LARGE 118 Km CRATER OF EDDINGTON. IT'S WESTERN MOUNTANOUS RIM CAN BE SEEN TO JUST ENCROACH ONTO THE EASTERN EDGE OF STRUVE. EDDINGTONS EASTERN RIM IS VERY FRAGMENTED AND TOTALLY OBSCURED IN MANY PLACES BY THE ONCE LIQUID LAVA OF OCEANUS PROCELLARUM.

THE WEST WALLS OF STRUVE AND RUSSELL, WHICH LOOK VERY LINEAR DUE TO FORESHORTENING

CONTINUED

2

WERE ONCE COLLECTIVELY KNOWN AS THE HERCYNIAN MOUNTAINS THOUGH I BELEIVE THIS NAME HAS NOW BEEN DISCONTINUED BY THE I.A.U.

THIS IS A FASCINATING AREA OF THE MOON AND THE AFOREMENTIONED CRATERS ARE ALL EASY TO FIND. I RECOMMEND USING A LOW MAGNIFICATION TO FIRST LOCATE THEM, THEN, INCREASE THE MAGNIFICATION FOR A MORE DETAILED LOOK.

THE WESTERN LIMB IS A GREAT PLACE TO TRYOUT YOUR FILTERS. A W21 ORANGE OR A W25 DEEP RED CAN REALLY HELP TO BRING OUT ANY HARD TO SEE DETAIL AND RED FILTERS HAVE THE ADDED BONUS OF HELPING TO STEADY THE SEEING.

TREVOR SMITH.

Fig.11a Observing notes by Trevor Smith

Lunar Eclipse as seen from the USA.
By Rik Hill

Fig.12 Composite image of the Lunar Eclipse of the 16th May 2022 taken by Rik Hill in Tuscon Arizona USA.

Editor Comments: And finally - it looks like Rik had excellent conditions for viewing the recent lunar eclipse unlike most of the observers in the UK who had less than ideal conditions.This fine sequence shows us what we missed on this side of the Atlantic. More eclipse images (received after the 20th deadline) will be included next month.
more eclipse

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Communications received.

Atlas-guide photographique de la Lune Georges Viscardy (1917-2008)
By James Dawson.

Like many readers of the Lunar Section Circular, I have a love of books about the Moon. When Alan Dowdell asked me at Winchester if I wanted to buy this second-hand book he'd purchased over 20 years ago in Brittany, there was no hesitation in me reaching into my pocket. This was the first time I had seen this book and I must confess this was the first time I even knew this book existed.

Published in French in 1985, the book is 14" x 12" x 1.5" and is over 450 pages long (Fig's 1 and 2). Harold Hill reviewed the book for the BAA in 1988 (JBAA 1988, 98, 4, p209). Harold said that Viscardy captured the 685 photographs himself over a period of three years using a 310mm Newtonian reflector and a 520mm Newtonian-Cassegrain reflector. Harold goes on to marvel at the dedication Viscardy had put into the project, and in the quality of Viscardy's photographs. Harold also mentions some of the criticisms of the book, including a predominance of images taken under evening illumination only and some technical errata. However, as Bill Leatherbarrow tells us, Harold Hill greatly admired the photographic atlas and made good use of it (JBAA 2010, 120,3, p184). Martin Mobberley visited Viscardy in 1988 and recorded this enchanting trip on video which can be watched online: youtube.com/watch?v=hDYZ66y_t30

By modern standards the clarity of the images reproduced in the book are poor; compare, for example, the images below taken by Viscardy 28 October 1983 (lower left, a 21 day old Moon- Fig.3) with one by Damian Peach (Fig.4), 20 April 2014. But that isn't why we like old books. This work represents an unimaginable amount of work and devotion to the study and photography of the Moon, and it is an absolute joy to study, and I am now very humbled to own a copy.

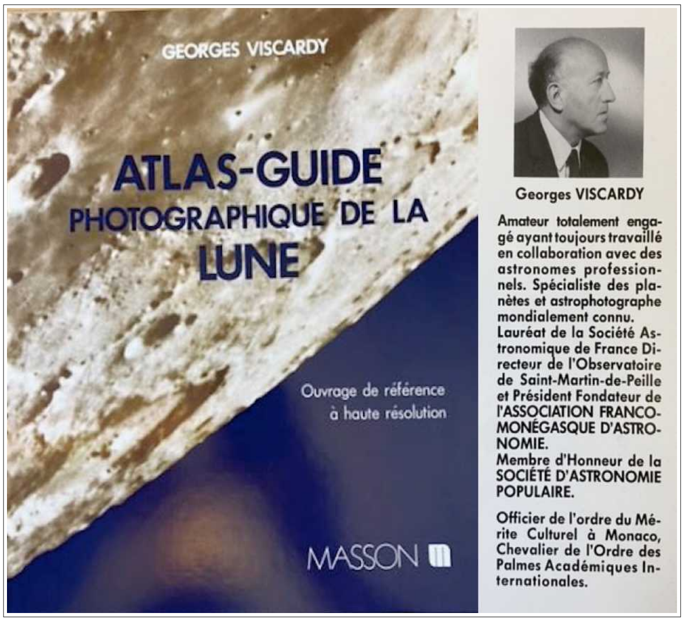


Fig.1

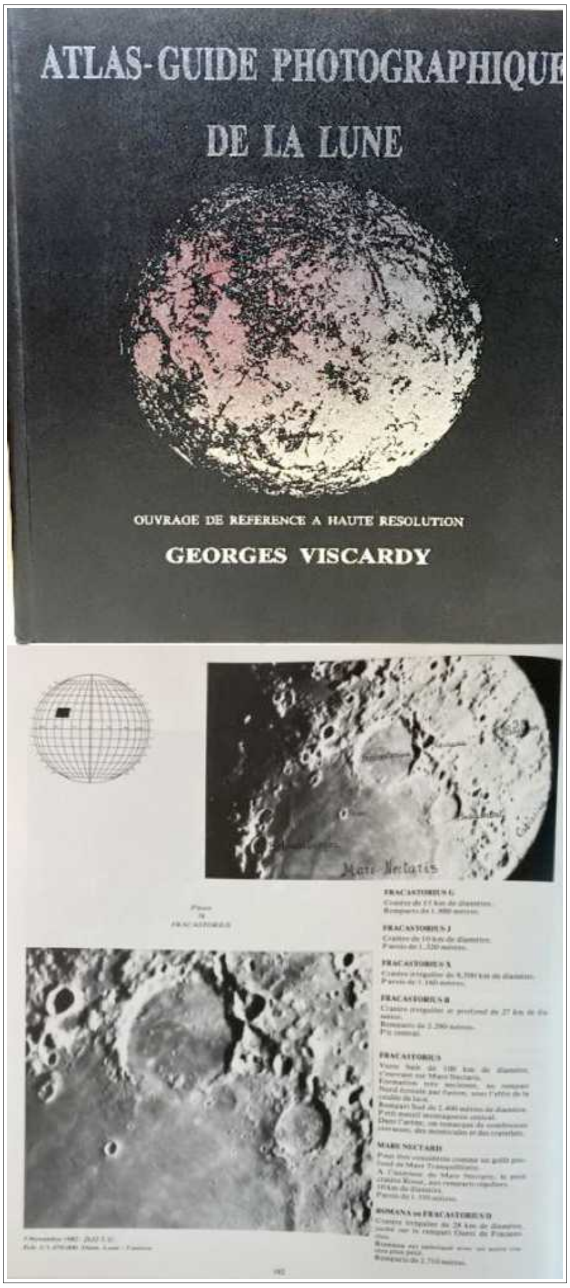


Fig.2

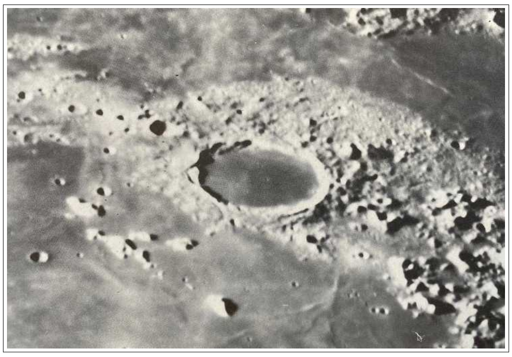


Fig.3

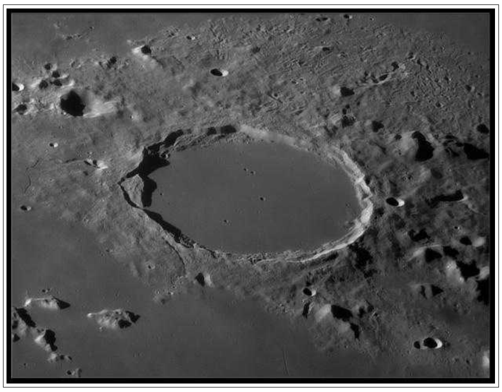
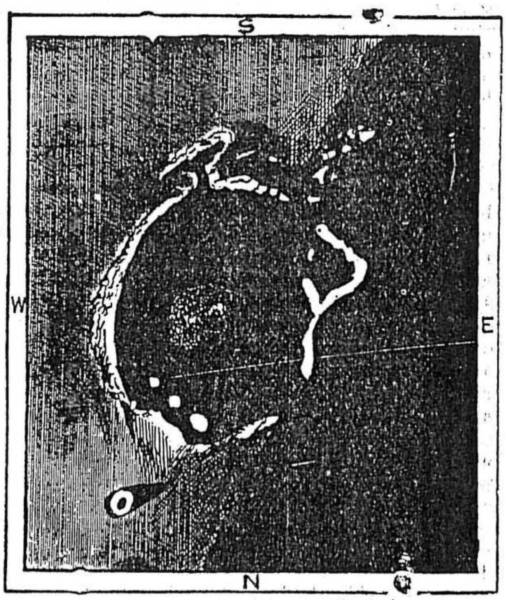


Fig.4

Fracastorius.
By Nigel Longshaw.

SELENOGRAPHICAL—FRACASTORIUS.

[25350.]—THE accompanying sketch was made on the evening of the 8th February, from 6 p.m. to 7 p.m. The definition at the beginning was exquisite; but towards the end it became very poor. Power used was 200, on 12in. Calver mirror. Two wide and obvious depressions, or passes, through



the walls of this interesting formation were observed—one at the N.E., and the other almost due S., and a further break in the continuity of the wall was seen in the S.E.

Clouds coming up prevented further observation, and I was unable to watch long enough to see if the ring became complete, as it has been said to have been seen on rare occasions by several observers.

Three small hills, on a line running N. to W., were seen standing out clearly from the darkness which filled the interior; the central mountain was seen to be of a crescent shape, with the horns turned N. Shortly after this became visible two other fainter points, apparently the summits of two smaller hills towards the N.W., were seen, and a little later the slopes of the central mountain became dimly descried through the gloom. No breaks or passes were to be seen in the W. wall or in the E. wall, so far as it was seen. There appear, however, to be two openings into the peculiar, triangular formation to the E. of Fracastorius.

W. Goodacre.

Forest Gate, February 11th.

MAGNIFICENT DISPLAY OF THE AURORA BOREALIS.

I was interested by the observation of Fracastorius by A. Amorim in the latest LSC as only the day before I had been reading an account of sunrise on the crater by Goodacre from the EM – see attached. It would appear that the central peak/hills become visible while the rest of the crater floor still lies in shadow. Note that Goodacre suggests visibility '…through the gloom' which perhaps indicates a dim illumination and might relate to the coma like appearance reported by Amorim. However, it perhaps does not explain the 'disappearance' of the bright spot noted by Amorim.

Lunar Occultations June 2022
By Tim Haymes.

Time capsule: 50 year ago: in Vol 7 No.6

[With thanks to *Stuart Morris* for the LSC archives]

P Moore (Director) writes comprehensively on FADING OCCULTATIONS, with references.

While the RGO give the cause as double stars, associated visual phenomena remain unexplained.

David Jewitt describes a crater extinction device. https://en.wikipedia.org/wiki/David_C._Jewitt

Miss Jane Biggin (Herstmoceux Castle) – on the timing and reporting of occultations, and a graze of ZC 900* observed by Southampton Society.

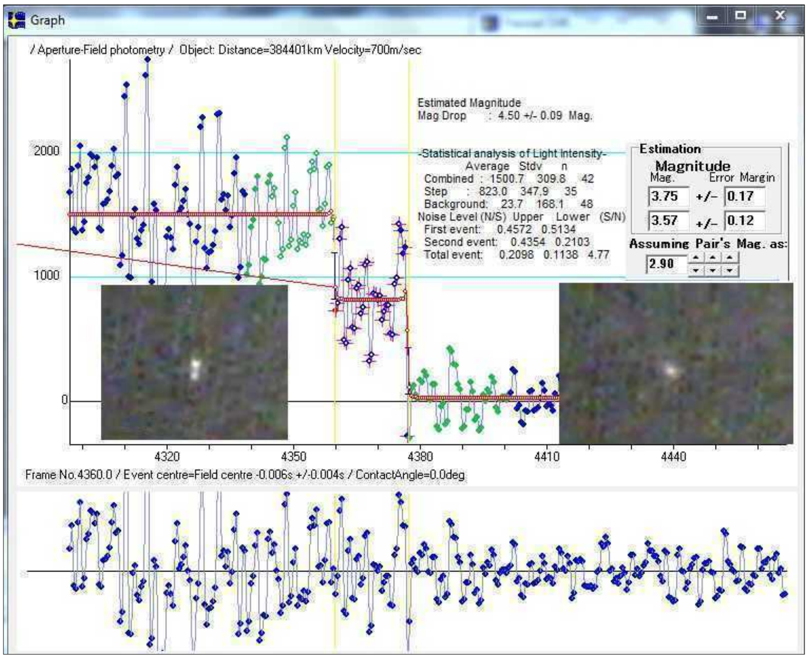
(*) In the Pleiades on March 21st, Occult4 indicates 30 observers took part across southern England.

Observations received.

Porrima (gamma Vir) on May 13th

David Briggs observing at Clanfield with Graham Bryant's 0.3m Newtonian f/5.4, recorded the DD with WAT910HX and SharpCap software. The AVI file was analysed by the Lunar Section using LiMovie, to extract a magnitude difference suggesting the slightly fainter companion was occulted first.The Occult 4 prediction did indicate this.

The data is a bit noisy and there was a technical problem with the frames rate. The step is 0.68s. Congratulations to David at Hampshire Astronomy Group. One of the frames is shown with Porrima resolved – an example of lucky-imaging.



May 16th Lunar Eclipse

No reports of occultation phenomena have been received. The sky was mostly cloudy here in the UK.

David Dunham (IOTA) reports on graze events from Arizona during the eclipse. Predictions and helpful notes were published here: http://iota.jhuapl.edu/AZoccs.htm

Tally for 2022 (March-May)

Tim Haymes reports 32 DD events timed. Those in May were on the 5th, 8th and 11th. Timings were taken from time-stamped SER files, recorded with QHY174mGPS camera and C11.

Occultation Highlights this month

Theta Virginis (v4.4) on the 10th at 02h BST

35 Capricornii (v5.8) on the 18th at 04h BST

Theta Virginis is binary star with fainter companions (not predicted). An opportunity to observer a step event of duration about 1 second. The separation is 0.4 arcsec in PA 359. The Moon is low altitude (5 degress) which will make observing more difficult.

35 Cap occurs in morning twilight.

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 shown in the BAAH. The most phenomena are expected between 4.5 and 5.0 Km. Towns situated in the graze zone follow a line through Uplyme (S Coast), Broadway, Warwick, Coventry, Loughborough, Hull and Skipsea.

Graze occultation of SAO 146191 on 2022 July 18 @ 0308UT (HBAA #6)

The previous night, SAO146191 grazes the Moon over Liverpool at as twilight begins

Details available upon request, or they may be downloaded from the writer's web page.

A report or note on any events attempted would be welcomed, for inclusion in the LSC.

Good luck and clear skies..

Occult4 predictions for 2022 July and August

Download the zip file here:

HBAA#6 2022July18 – SAO146919

HBAA#7 2022July19 – 14 Ceti

HBAA#8 2022Aug18 – omicron Ari

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

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

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	Jun	2	21	17	15.4	D	79351	B9	8.9	8.9	10+	37	-8	15	292	13S	
22	Jun	3	22	58	45.4	D	80105	A0	7.9	7.9	17+	49		7	300	81N	
22	Jun	4	21	11	22.7	D	80626	K0	8.7	8.1	24+	59	-7	27	270	34S	
22	Jun	4	21	53	9.8	D	80648	K0	8.7	8.2	24+	59	-10	20	278	68S	
22	Jun	5	0	6	44.9	D	80693	G0	8.4	8.1	25+	60		2	302	88N	
22	Jun	5	21	29	40.5	D	1456	F2	8.4	8.2	33+	70	-8	28	262	47N	
22	Jun	8	0	44	29.4	D	1682	G0	8.8	8.5	54+	95		4	276	72S	
22	Jun	8	0	50	20.0	D	118938	K0	8.2	7.6	54+	95		3	277	43N	

22	Jun	8	21	30	15.8	D	119305	A2	8.9		63+	105	-8	32	221	61N	
22	Jun	8	22	4	4.0	D	1767	A2	7.6	7.5	63+	105	-11	29	230	60N	
22	Jun	8	22	54	34.6	D	119325	K0	7.6	7.1	64+	106		22	241	73S	
22	Jun	9	22	30	59.1	D	139157	K0	8.3	7.7	74+	118		25	222	72S	
22	Jun	10	0	58	56.5	D	1891	A1	4.4		74+	119		5	254	30S	theta Vir

1891 is quadruple: Aa,Ab 4.49 6.83 0.39" 358.5, dT = -1.3sec

22	Jun	10	22	14	34.4	D	158250	F5	8.9	8.7	83+	131	-11	25	204	74N	
22	Jun	10	22	50	25.8	D	1999	K2	8.7	8.1	83+	131		22	213	76N	
22	Jun	11	21	43	8.1	D	158829	F0	8.7	8.4	91+	144	-9	22	182	59N	
22	Jun	12	21	16	58	m	183793	K0	8.0	7.4	96+	158	-6	15	163	17N	
22	Jun	12	22	36	18	m	2260	K0	7.6	7.0	96+	158		17	181	15N	
22	Jun	12	23	48	4	m	183875	A3	8.3	8.1	97+	159		15	198	13N	
22	Jun	14	23	59	40.2	R	2601	K4	6.8		99-	172		10	172	35S	7 Sag. Dbl*
22	Jun	16	0	38	43.5	R	187844	K4	8.9	8.3	96-	158		10	166	40N	
22	Jun	16	1	1	50.6	R	187861	A0	8.6	8.5	96-	157		10	170	39N	
22	Jun	18	2	4	42.3	R	190335	K4	7.9	7.1	82-	129	-10	13	155	11S	
22	Jun	18	2	20	26.2	R	190325	F2	8.4	8.2	82-	129	-9	14	159	70S	
22	Jun	18	2	36	34.0	D	3141	K3	5.8	5.0	81-	129	-8	15	163	-17N	35 Cap
22	Jun	18	3	8	31.2	R	3141	K3	5.8	5.0	81-	129	-5	17	170	35N	35 Cap
22	Jun	19	0	35	21.0	R	3276	G0	7.3	7.0	72-	116		4	123	32N	
22	Jun	20	2	36	50.2	R	165594	F8	9.0	8.7	61-	103	-8	17	135	62S	
22	Jun	21	1	16	51.4	R	147044	G5	8.5	8.0	51-	91		6	106	66N	
22	Jun	21	1	35	49.8	R	128548	F2	8.5	8.3	51-	91		9	110	76N	
22	Jun	22	2	45	23.5	R	110	G0	8.8	8.5	40-	78	-7	17	111	77S	
22	Jun	23	1	26	25.7	R	109988	A5	8.1	7.9	30-	67		4	84	31N	
22	Jun	23	2	35	32.6	R	237	K0	7.0	6.5	30-	66	-8	14	97	68N	
22	Jun	25	2	31	9	m	93306	F0	8.8	8.6	14-	44	-9	8	73	8N	

Predictions to Jul 5th
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)

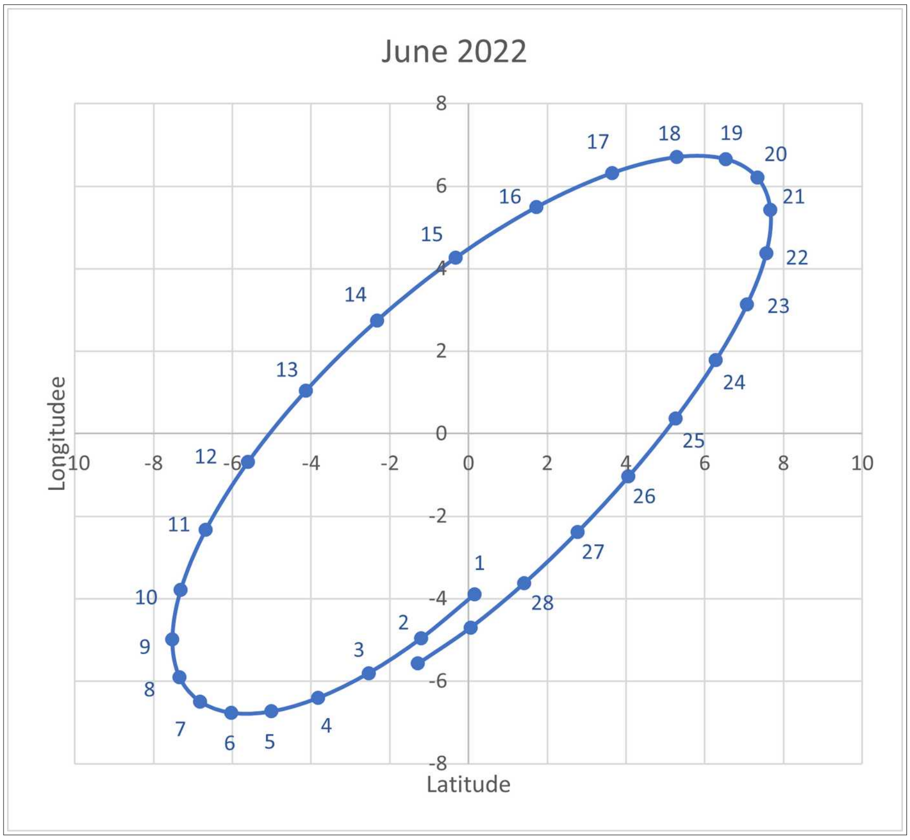
5/6 digits = Smithsonian Astrophysical Observatory catalogue (SAO)

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.



Lunar Libration Diagram for June 2022

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Volcanic features in eastern mare Crisium, physical and spectral properties.

By Barry Fitz-Gerald and Raffaello Lena.

The eastern part of mare Crisium is home to a suite of unusual volcanic structures that are not readily apparent in telescopic views. Raf Lena drew attention to an isolated volcanic cone on the mare surface in a recent LSC article[1], and this is one element of a larger field of volcanic features that are generally far less conspicuous. They are visible in small to moderate aperture instruments, but only as lower albedo marks, in larger instruments some surface textured features are evident. They are not new discoveries, and have been recorded in the USGS Geological Maps of the area and identified as probably volcanic in origin, but their presence is not really cited in the amateur or professional literature. They are however fairly large irregular structures, similar morphologically to many others located on mare surfaces and quite different to the more volcano like and symmetrical lunar domes.

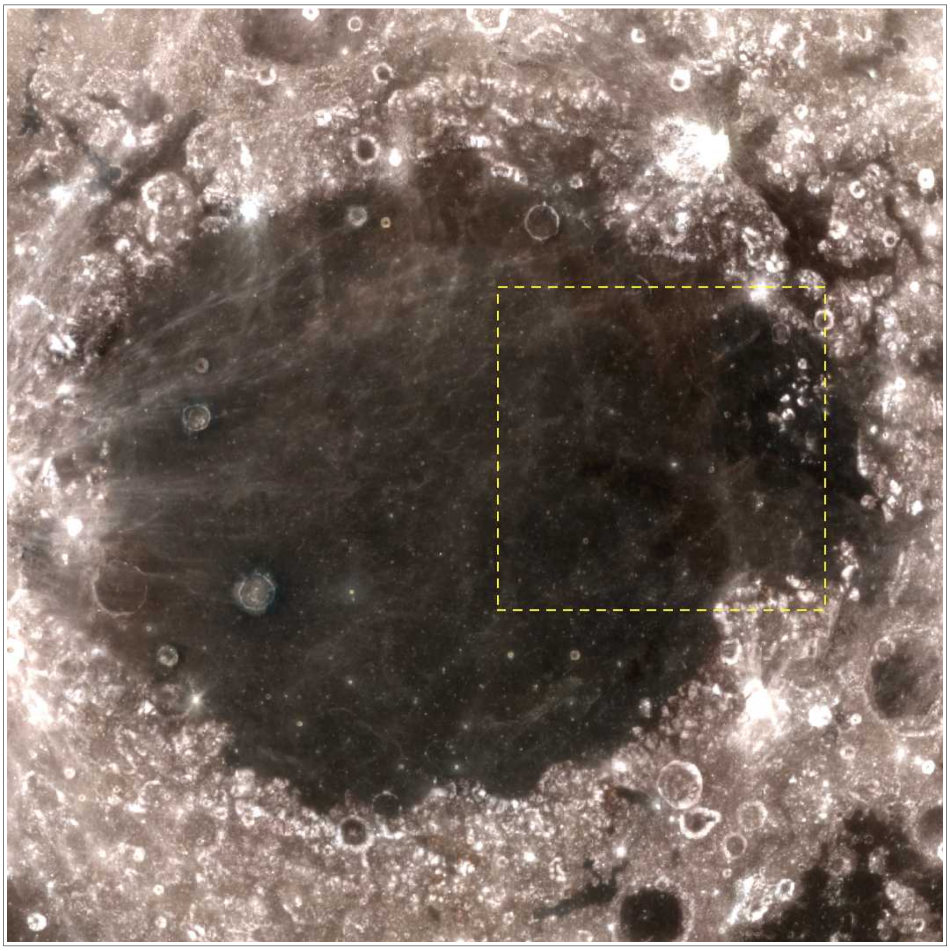

Fig.1 LRO (Colour-Hapke overlay) image of Mare Crisium showing the area within which the volcanic structures described below are located (yellow box). Note their low albedo appearance.

Fig.1 shows an LRO (Colour-Hapke overlay) image of Mare Crisium with the location of these volcanic features identified by the yellow box. As can be seen, they are moderately conspicuous as dark patches and spots, similar in albedo to the extreme eastern part of the mare to the south of Eimmart K. The same area is shown in more detail in the WAC image in Fig.2, with the individual volcanic units being outlined in yellow (Structures I to V). As can be seen there are also a couple of breached cones, including the one described by Raf Lena (feature 'a' in Fig.2) but the structures described below take the form of long, low irregular ridges, reaching lengths of up to 35kms and which *appear* to be composed of chains of confluent individual cones or elongate vents. Fig.3 shows the USGS Geological map of the area with three of these units and the two breached cones clearly marked.

These structures *appear* to be orientated with their long axes radial to the basin centre, which may hint at some form of structural control, and possibly related to fractures within the basin which originated during the basin forming event. The presence of radial fractures is hinted at in the GRAIL data, which reveals that the basin has a number of such features radiating away from the basin margins, particularly to the east.

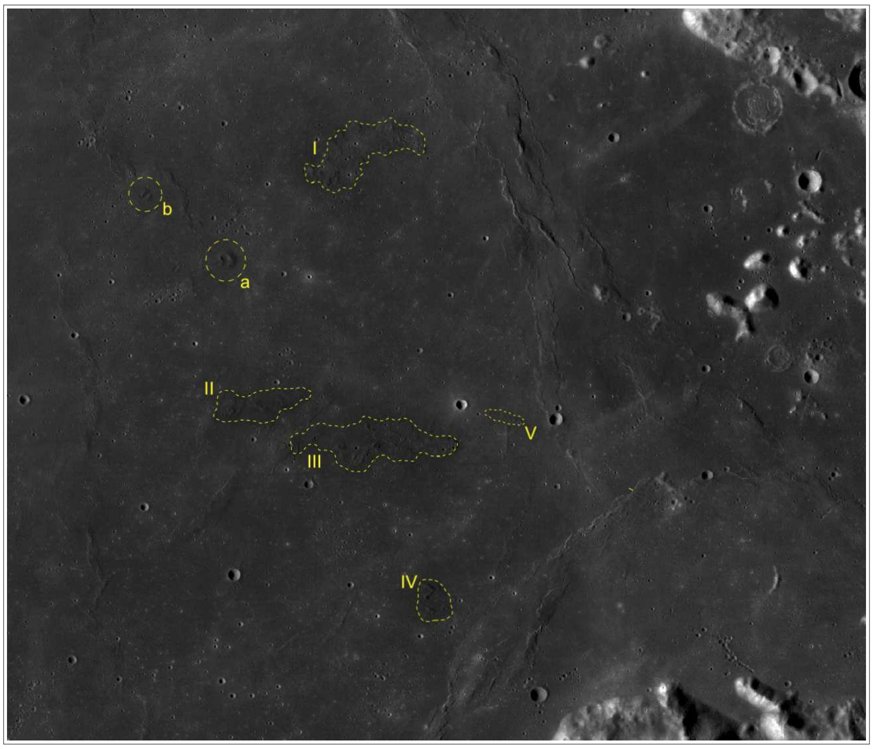

Fig.2 Area shown within yellow box in Fig.1 showing Structures I to V. Isolated volcanic cones are labeled a and b.

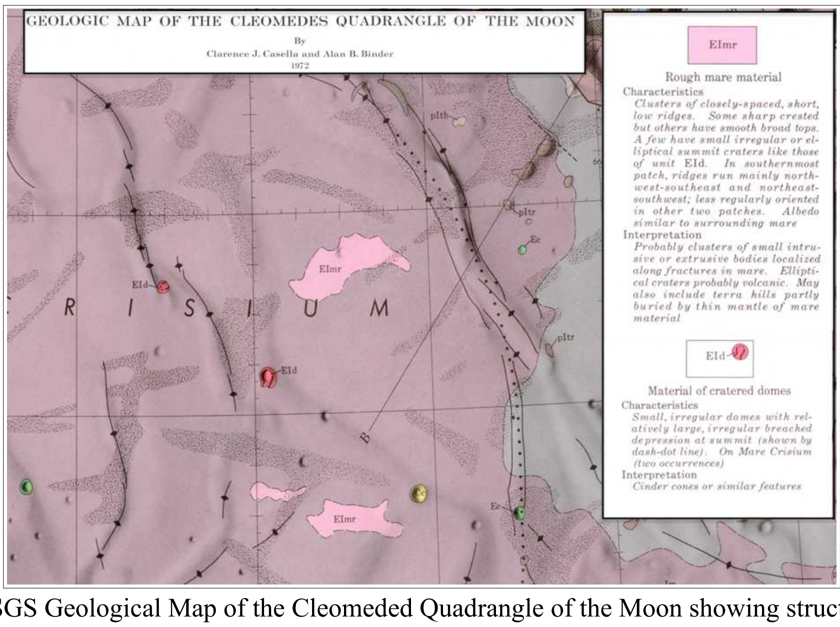

Fig.3 Section of the USGS Geological Map of the Cleomeded Quadrangle of the Moon showing structures I, II and III identified as probable volcanic structures.

The structures described below are generally much less than 100m in height, but appear to be located on the summits of much broader topographic rises suggesting they me be the visible surface expressions of larger subsurface structures. They also appear to have associated dark mantling deposits (DMD's) surrounding them, which may be pyroclastic in composition. This interpretation is not wholly borne out by the spectral analysis carried out, leaving open the possibility that these are thin basaltic lavas of some sort. The ages of the structures appear to cover an extended period, with some appearing older and some younger indicating a relatively protracted period of volcanism and not simultaneous eruptions.

Structure I.

The rather banana shape of the central part of Structure I is 'frilled' to the north and south by irregular bumps and roughly circular features that may represent partial cones or 'break-out' lava flows of limited extent (Fig.4). The surrounding mare surface is covered by low the albedo deposits suspected to be DMD material mentioned above, most obviously to the eastern and western ends of the complex (Fig.5). The elongate nature of the structure suggests eruption of material along a fissure, where individual cones formed, expanded and eventually coalesced to produce the linear feature we see. The mode of formation however appears to involve explosive volcanism which gave rise to the more obvious vents and surrounding DMD material and possibly the effusion of lavas, as a 'breached cone' can be seen along the southern margin, suggesting possible flow activity (Fig.6 Feature 1).

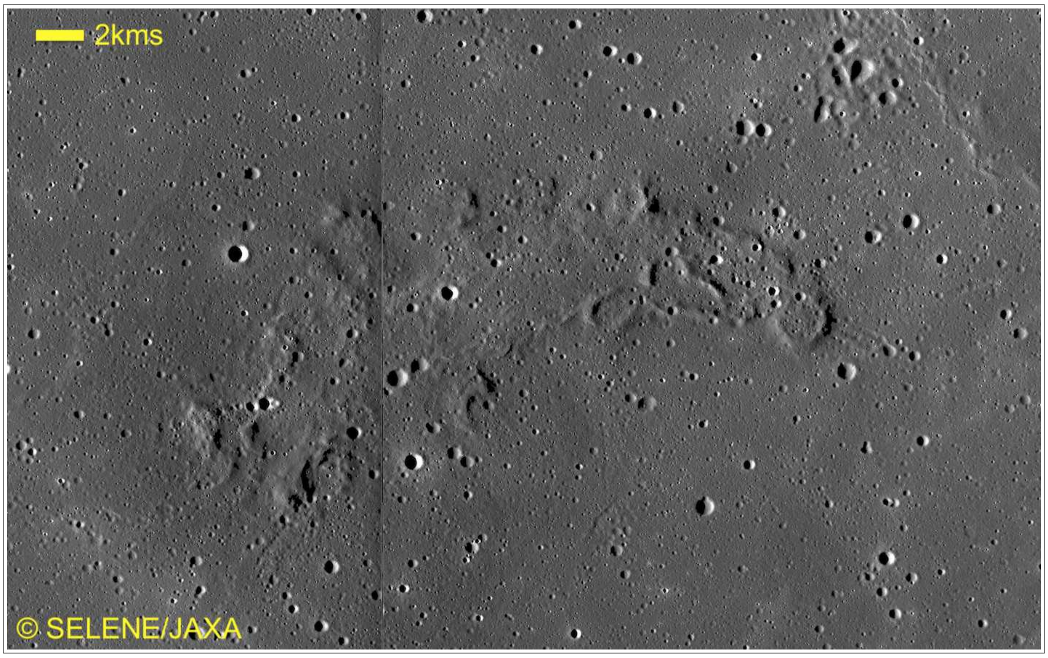

Fig.4 SELENE image of Structure I showing the morphology of central trough bounded by a discontinuous rim possibly made up of a coalesced line volcanic cones arranged along a fissure.

The eastern end of the structure is marked by a circular volcanic cone, some 2.5kms in diameter and 70m in height with a pitted central platform and raised rim (Fig.6 Feature 3). Leading away from this cone and forming the southern margin of the structure are a number of other elongate and interconnected cones. The northern and southern margins of the structure are generally higher than the central zone, though heights above that mare surface are no higher generally than 60-70m. There are no really convincing lava flow type structures, and there is also a lack of boulder rich areas that could signify 'recent' geological activity, suggesting that the structure is not significantly younger than the mare surface which are thought to be mostly Imbrium (~3.74 – 3.5Ga) but possibly as young as Eratosthenian (~2.49Ga) in age

Spectral analysis.

Structure I displays a TiO_2 content < 2.0 wt% and low plagioclase content (<50.0 wt %). The FeO content varies from 16.0 wt % to 19.0 wt % which is similar to nearby mare units. The abundance of orthopyroxene varies from 18 wt % to 31 wt % and clinopyroxene from 20 to 50 wt%. Spectral data using the M^3 dataset, displays an olivine signature throughout the structure with some local variations where the olivine abundance (derived using the Selene Multiband Imager dataset) corresponds to 11-14 wt % (Fig. 6).

The continuum-removed spectra of small fresh craters also exhibit a broad absorption at 1,000 nm, indicating an olivine-rich component. Feature 1 in Fig.6, is a breached cone and is composed of olivine admixed with pyroxene. The absorption bands of volcanic glasses are broader and shallower, and the 1,000 and 2,000 nm band centers are generally shifted to longer and shorter wavelength, respectively bands [2][3]. In the spectral analyses these specific signatures have been not detected, but it is not possible to rule out a pyroclastic composition based only on the absence of a volcanic glass signature in these lunar cones.

Fig.5 LRO (Colour-Hapke overlay) image of Structure I showing the low albedo possible pyroclastic material mantling the surrounding mare surface. Note volcanic cone in the lower left of frame.

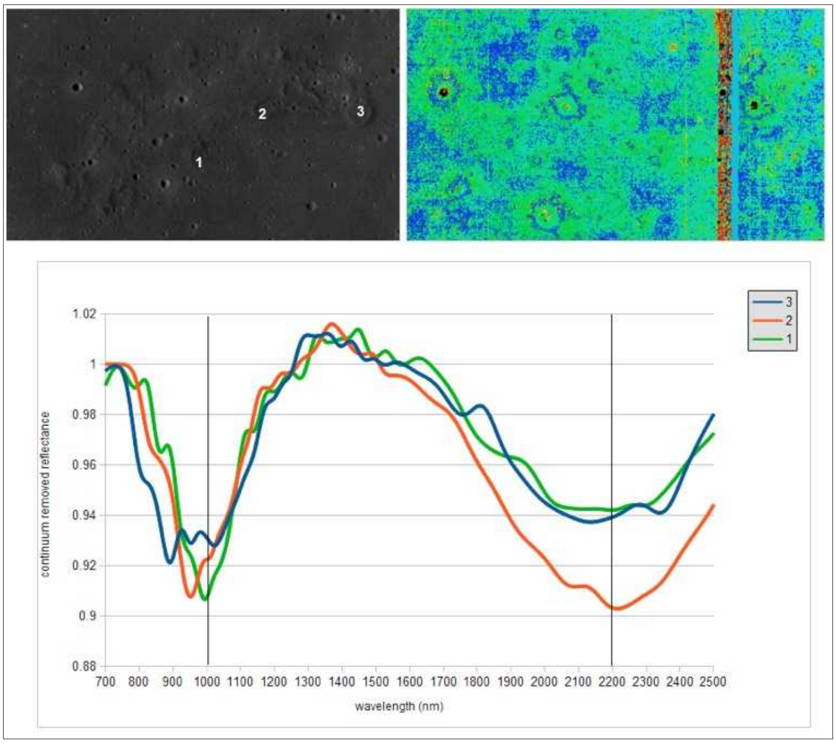

Fig.6:Top left, examined features of the structure I. Top right, abundance map wt % of olivine derived by MI dataset. Bottom, M[3] spectra (OP2C1 orbital period) of three features. The spectra display broad, composite absorption features over 1,000nm having the greatest affinity to typical olivine spectra admixed with pyroxenes. Features 1-3 are discussed in the text. Feature 3 shows high amounts of olivine.

Structure II.

This structure is appears to be a linear cluster of breached cones orientated approximately east-west, with a well preserved example forming the western end (Figs.7-9).

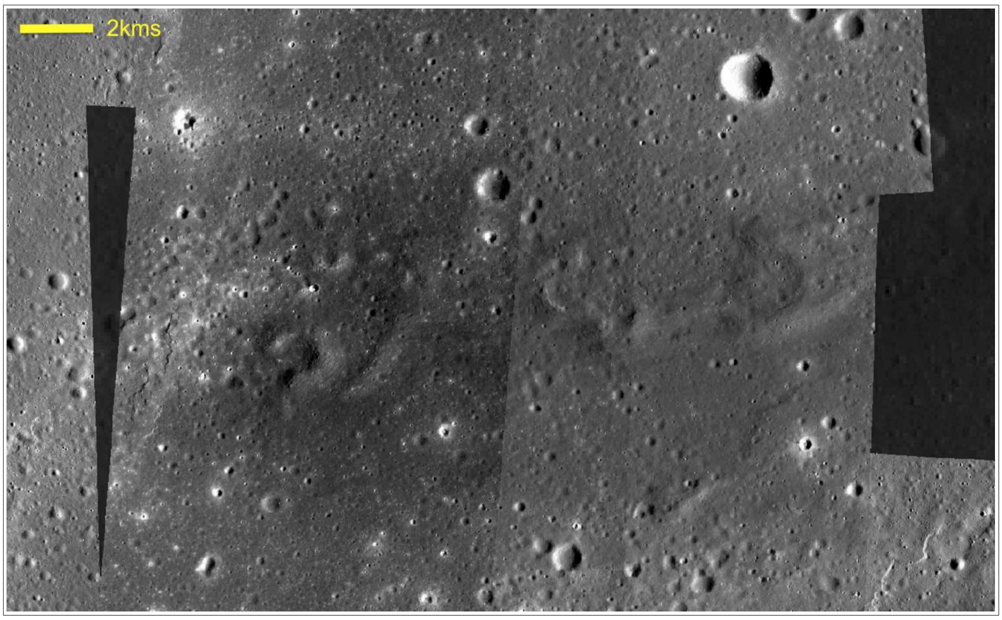

Fig.7 LRO NAC image of Structure II. Note the well preserved cone at the western end and the presence of dark mantling material.

The adjacent mare is also covered in DMD like material, indicating that volcanic activity continued after the youngest mare lavas were in place. In contrast to Structure I however the cones at the western end of this structure have a number of exposed bouldery exposures, possibly indicative of a slightly more youthful age. Immediately to the west of the structure the darker surface deposits are truncated by a series of small en-echelon lobate scarps which themselves have bouldery patches along their length (Fig.8). This suggests that the volcanism responsible for these low albedo deposits (be they pyroclastic or lava in nature) occurred *prior* to the small scale deformation of the mare surface that produced the scarps.

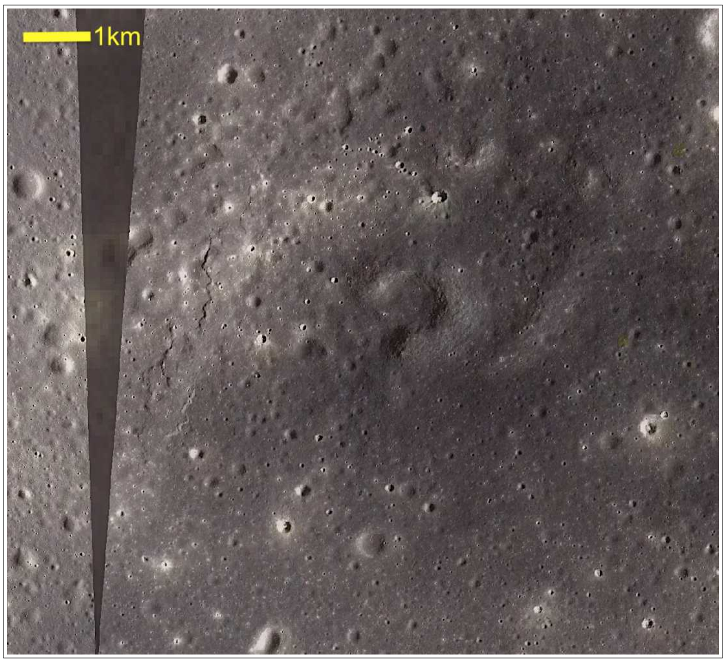

Fig.8 Detail of the western end of Structure II with a Colour-Hapke overlay showing the western cone and the lobate scarps that truncate the dark mantling deposits to the west.

Spectral analysis.

The lunar cone shown in Fig.8 (located at 17.06°N and 61.95°E) has a diameter of 3 km, a height of 90 m and an average flank slope of 3.5° (Fig. 9). The spectrum of this breached cone, derived using M^3 data set, is shown in Fig. 10.

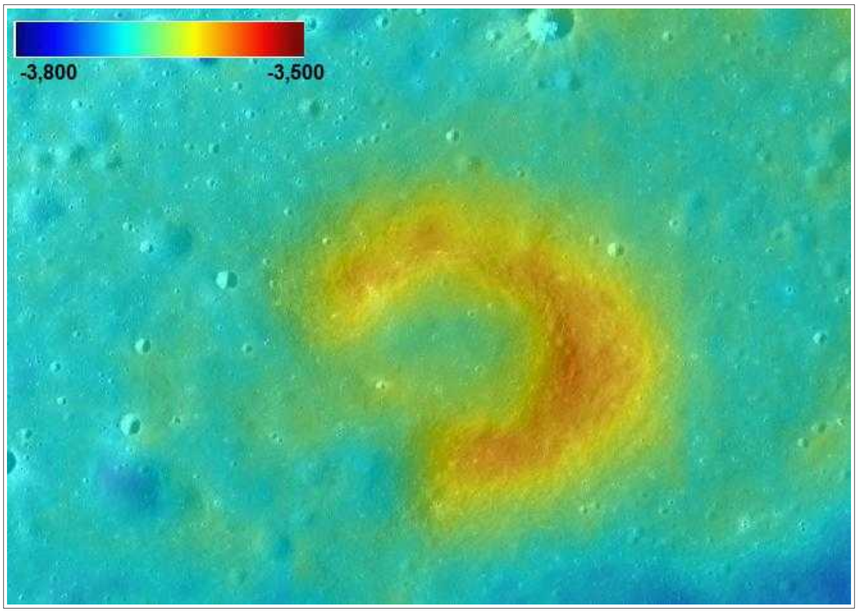

Figure 9: ACT REACT Quick Map tool. Elevation map.

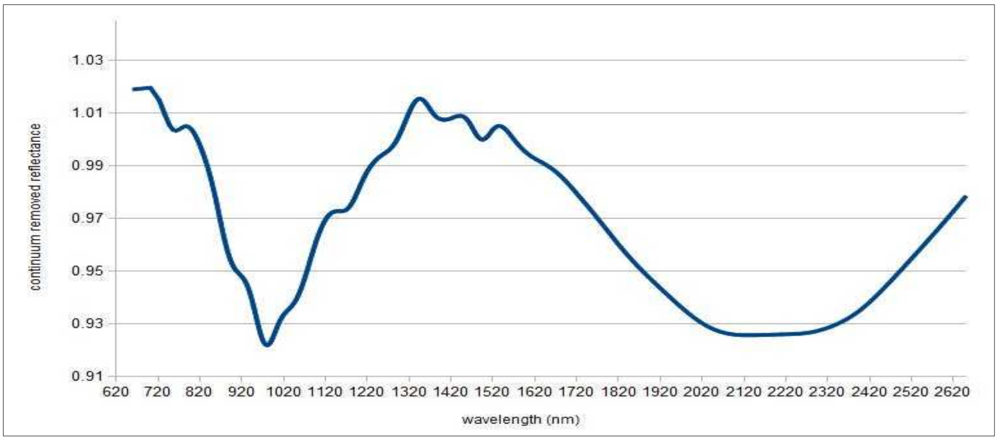

Figure 10: M^3 spectra (OP2C1 orbital period) of the cone. The spectrum displays broad, composite absorption features over 1,000nm having the greatest affinity to a typical olivine spectra admixed with pyroxenes.Absorption centers of olivine, appearing as shoulder, are near 900 nm, 1,050 nm, and 1,200 nm,respectively.

The olivine reflectance spectrum is revealed by a broad and asymmetric 1,000nm absorption feature, but lacks the 2,000nm absorption feature. The broad Band I absorption in olivine is caused by three distinct absorption bands [2][3]. The central absorption, located just beyond 1,000 nm, is caused by iron in the M2 crystallographic site, and the two weaker absorptions near 850 and 1,250 nm are the result of iron in the M1 site. The Band I "secondary" absorption near 1,250nm allows olivine to be detected when admixed with the spectrally "stronger" pyroxene. The band centers are influenced by the amount of Fe2+ and Ca2+. With increasing Fe2+ and Ca2+, the band centers move to slightly longer wavelengths. However, in the case of a olivine-pyroxene mixtures, Band I is dependent on the relative abundances of both olivine and pyroxene.

This cone displays a TiO_2 content of 3.0 wt% and low plagioclase content (<50.0 wt %). The FeO content varies from 18.0 wt % to 19.5 wt % similar to nearby mare units. The abundance of orthopyroxene varies from 25 wt % to 43wt % and clinopyroxene from 18.5 wt% to 37 wt%. Furthermore the lower clinopyroxene of the lunar cone is detected where the olivine abundance is higher (ranging from 6.5 wt % to 13.7 wt %), suggesting the presence of volcanic products of differing composition (Fig. 11).

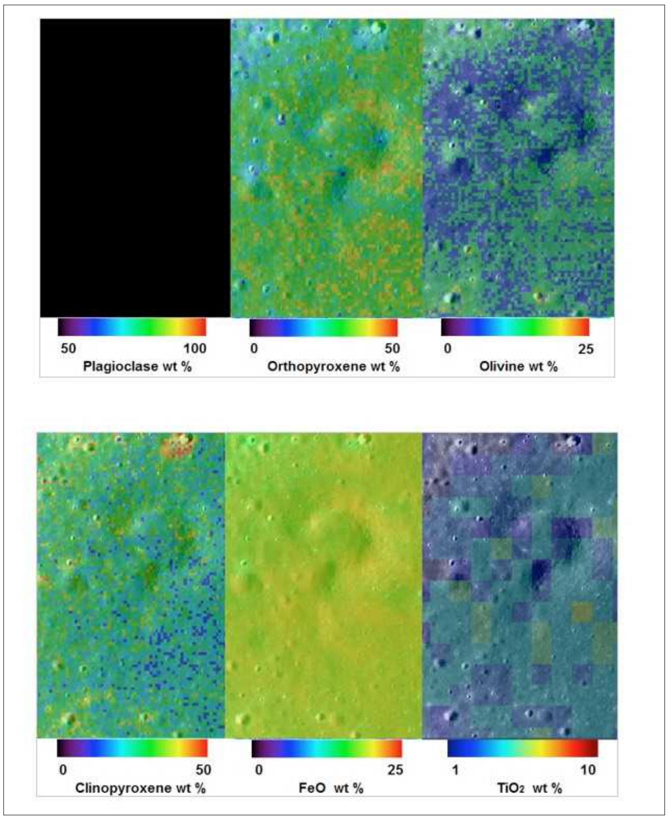

Figure 11: Top (left) plagioclase, (middle) orthopyroxene, (right) olivine. Bottom (left), clinopyroxene, (middle) FeO, (right) TiO_2 content. Derived abundance maps in wt%.

The surrounding mare is also covered in DMD of possible pyroclastic origin, which shows an olivine signature admixed with pyroxenes, with a spectra similar to the lunar cone shown in Fig. 10. A realistic 3D reconstruction view of this cone, based on NAC digital elevation *QuickMap Terrain Shadows* is shown in Fig. 12.

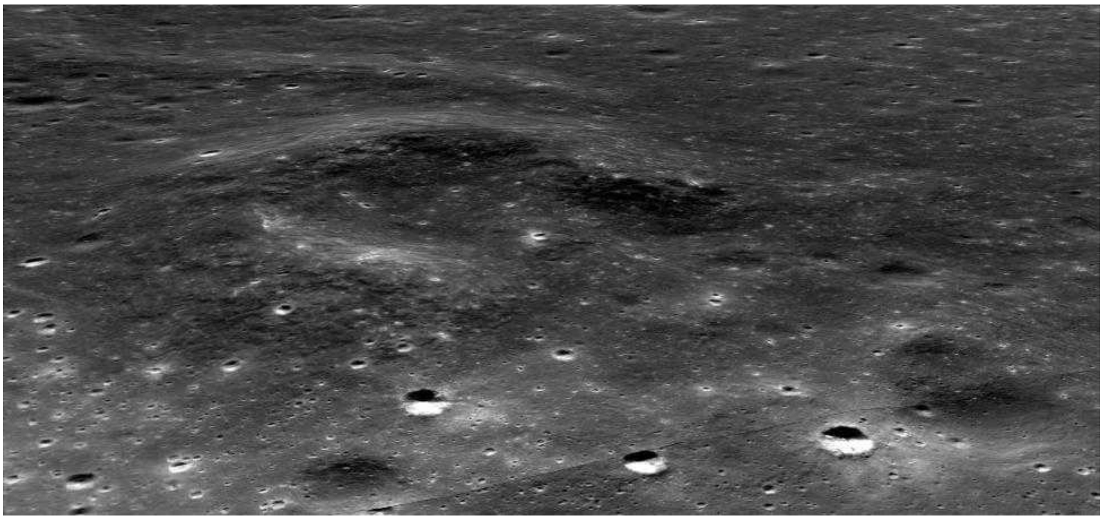
Figure 12: ACT REACT Quick Map tool 3D reconstruction of cone shown in Figs. 8 and 9 based on NAC imagery. Note the breached in the rim.

Structure III.

This structure is located some 14kms to the south-east of Structure II and is also surrounded by a low albedo halo of low albedo material (Fig.13). Structures II and III are separated by a north-east to south-west trending wrinkle ridge, the surface of which is marked by a number of extremely youthful looking lobate scarps, whilst the ridge surface itself exhibits a number of 'mini-grabens' orientated at roughly 90° to the ridge long axis which are an additional indication of relatively recent geological activity.

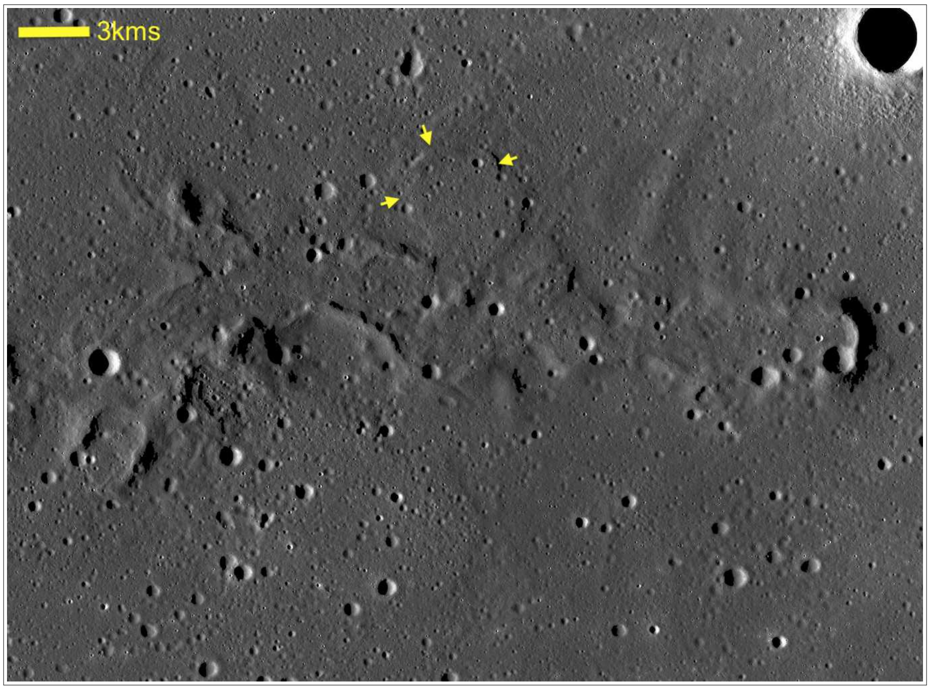

Fig.13 SELENE image of Structure III. The yellow arrows mark the edges of a possible 'break-out' lava flow emerging onto the mare surface to the north. Note the apparent central trough and marginal rim.

As with Structure II, the surrounding low albedo deposits are truncated by this wrinkle ridge, indicating that the volcanism responsible ceased prior to the surface deformation. Structure III is similar morphologically to Structure I, consisting of a meandering central trough with a raised rim to the north and south. It may be that this configuration resulted from the confluence of a number of separate vents which erupted along a fissure as is proposed for Structure I. If this is the case, the fact that all of these structures (I to III) are elongated roughly east-west suggestsome form of regional control possibly along fractures radial to the centre of the Crisium basin. The height of Structure III above the mare surface is generally in the 60-80m range, so quite limited in vertical extent.

An interesting component of this structure is what appears to be a 'break-out' lava flow emerging onto the mare surface through the northern rim (Fig.13 yellow arrows). This low circular feature has height of about 20m above the surrounding mare surface, and this together with its very limited areal extent suggests a lava composition of quite a viscous nature, and certainly not a low viscosity mare basalt lava.

Figure 14: M^3 spectra (OP2C1 orbital period) of the unit located at 16.7° N and 63.6° E. The spectrum displays broad, composite absorption features over 1,000nm indicating olivine admixed with pyroxenes.

Spectral analysis.

Structure III displays a TiO_2 content ranging from 2.3 wt% to 4.7 wt% and low plagioclase content (<50.0 wt %). The FeO content varies from 18 wt % to 20 wt % similar to the nearby mare units. The abundance of orthopyroxene varies from 21 wt % to 41 wt %, and clinopyroxene from 19 wt% to 35 wt%. Spectral data (obtained using the M^3 dataset) display an olivine signature throughout the structure with some local variations where the olivine abundance (derived using Selene Multiband Imager or MI dataset) corresponds to 13-18 wt % (Figs. 14-15).

The 1,000 and 2,000 nm band positions can be used to distinguish between orthopyroxene (OPX; band centers between 900-940 nm and 1,800–1,950 nm), clinopyroxene (CPX; 980–1,040 and 2,050–2,400 nm), and iron-bearing glass (1,060–1,200 and 1,900–2,050 nm). Mixtures of these minerals have band centers that fall in the intermediate regions between the end members[4]. Olivine exhibits a band typically centered near 1,050–1,080 nm and plagioclase feldspars exhibit broad and shallow bands centered between 1,250 and 1,350 nm, but neither exhibits a corresponding 2,000 nm band. Derived spectral analysis indicate a mixture of pyroxenes and olivine.

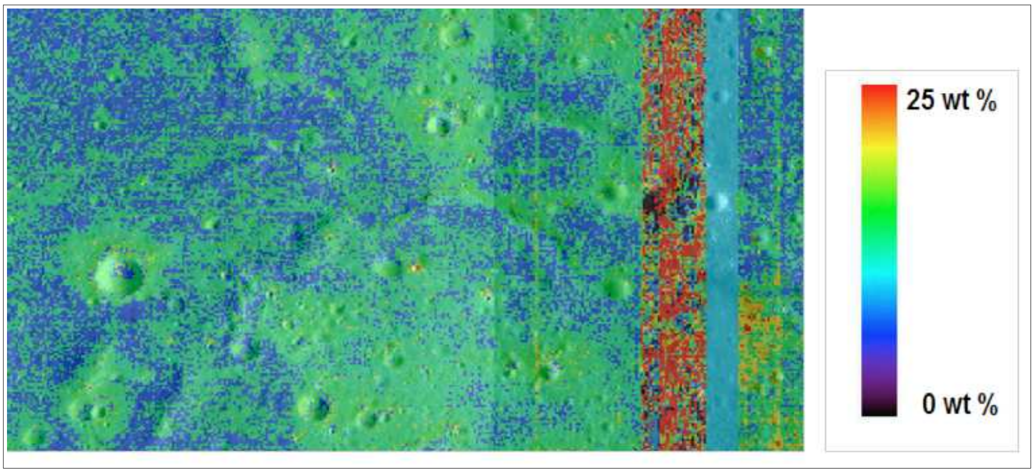

Figure 15: Olivine wt% map of Structure III.

Structure IV.

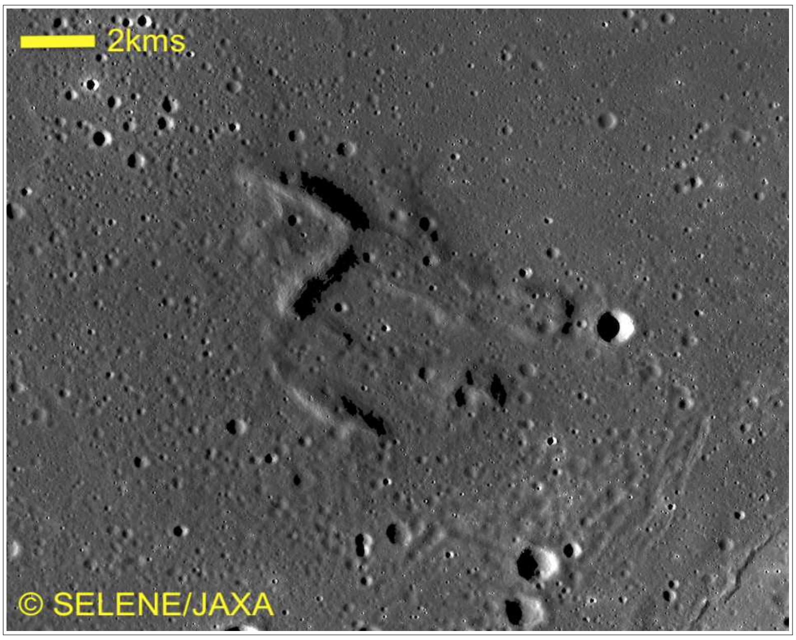

Fig.16 SELENE image of Structure IV.

This most unusual structure (Fig.16) differs in appearance to the previous ones, and takes the form of a sharp (but discontinuous) ridge in the shape of a rather loose 'Z' connected to some short low ridges to the east and not the interconnected vent like appearance seen in Structures I-III. This unusual morphology is however likely to be the result of similar explosive volcanic processes but in this case the vent or vents are not readily apparent. A mantling of dark material surrounds this structure, indicating volcanic activity that post-dates the youngest local mare basalts.

Spectral analysis.

The spectral data for Structure IV displays an olivine signatures, indicating the presence of a mixture of pyroxenes and olivine (Fig. 17). It has a TiO_2 content ranging from 2.3 wt% to 4.0 wt% and a low plagioclase content (<50.0 wt %). The FeO content varies from 19 wt % to 20 wt %, similar to the nearby mare units. The abundance of orthopyroxene varies from 30 wt % to 41 wt %, and clinopyroxene from 22 wt% to 35 wt%. Spectral data (using the M^3 dataset) display an olivine signatures throughout the structure, but with some local variations (Fig. 18) where the olivine abundance (derived using Selene Multiband Imager dataset) corresponds to 13-18 wt %. Highest olivine abundances are localized in the ejecta of small craters (20-21 wt%). The surrounding mare unit displays an olivine abundance of 7-11 wt %. Also in this case relatively Mg-rich basalts have been detected.

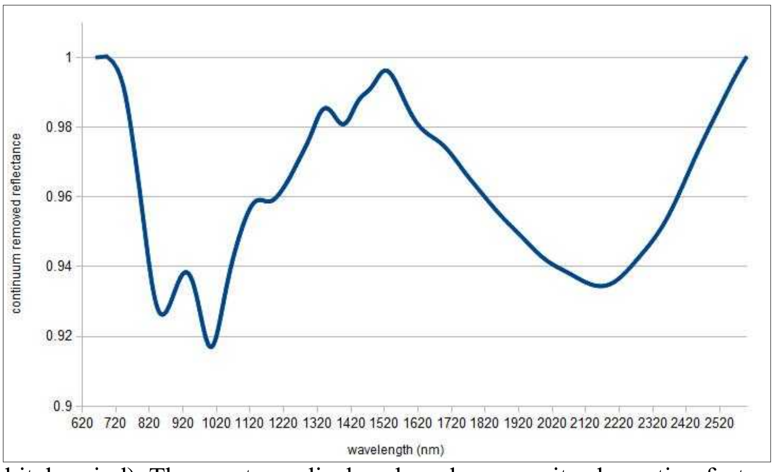

Figure 17: M^3 spectra (OP2C1 orbital period). The spectrum displays broad, composite absorption features over 1,000 nm having the greatest affinity to typical olivine spectra admixed with pyroxenes (OPX and CPX).

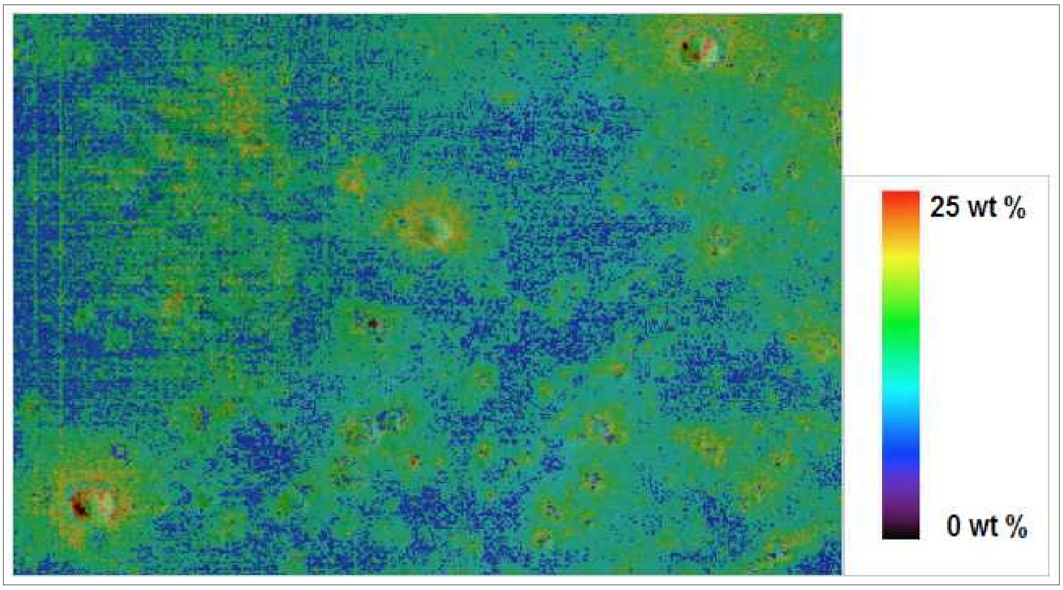

Figure 18: Olivine wt% map of Structure IV.

Structure V.

This structure is a small approximately 6km long cluster of volcanic features slightly to the east of Structure III (Fig.19). It may consist of cone like features, with the easternmost element of the group being a volcanic cone complete with a small summit pit. One notable aspect of this particular feature (Fig.20) is that the flanks are mottled with patches of higher albedo deposits, possibly where fresh material has been exposed by miniature avalanches but also possibly representing some form of more recent volcanic activity. Similar low albedo patches have been recorded elsewhere associated with lunar volcanic vents[5] and are possibly connected to the venting of gasses or other volatiles, and related generically to mare irregular patches (IMP's). This little cluster of features is not surrounded by any conspicuous DMD's and may therefore be a slightly different type of structure to the ones previously described.

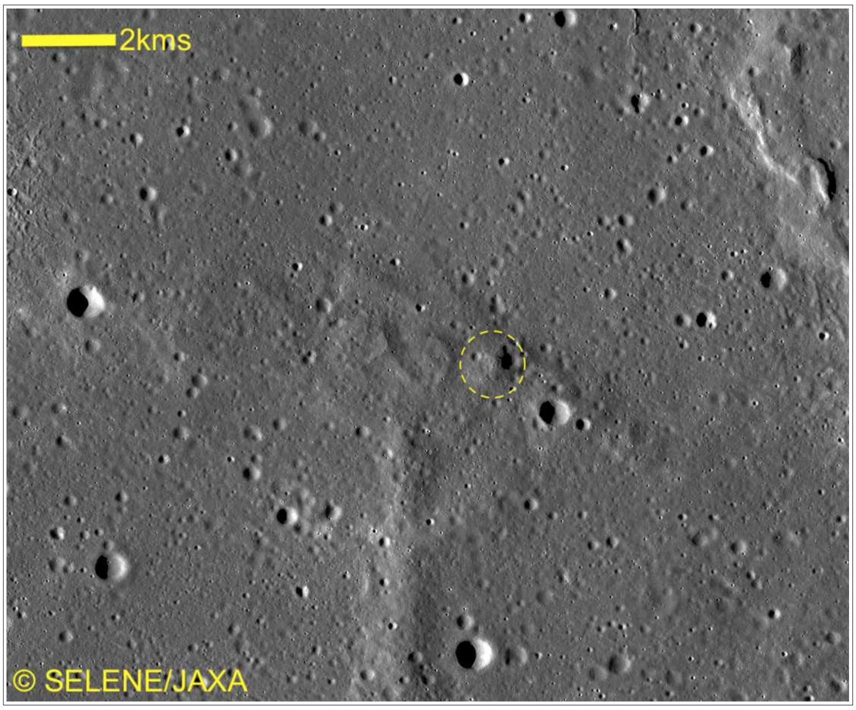

Fig.19 SELENE image of Structure V. A small dome like structure is marled with a yellow circle.

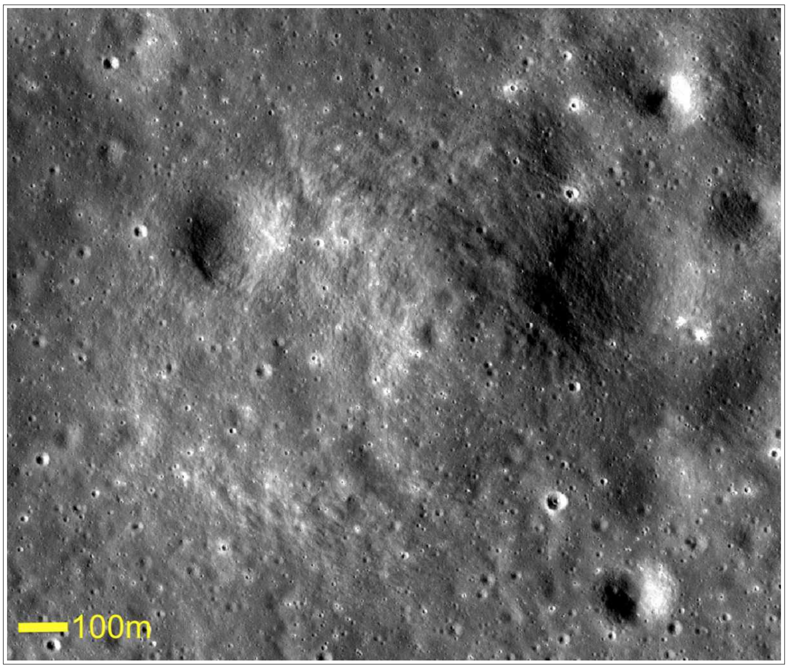

Fig.20 LRO-NAC image of the small cone like feature identified in Fig.19. Note the lighter patches on the western flanks.

Spectral analysis.

The volcanic feature shown in Fig.20 is located at 16.48 °N and 64.57° E, and has a diameter of 1 km, a height of about 50 m and an average flank slope of 5.6° (Fig. 21). Based on morphometric data it is a lunar cone.

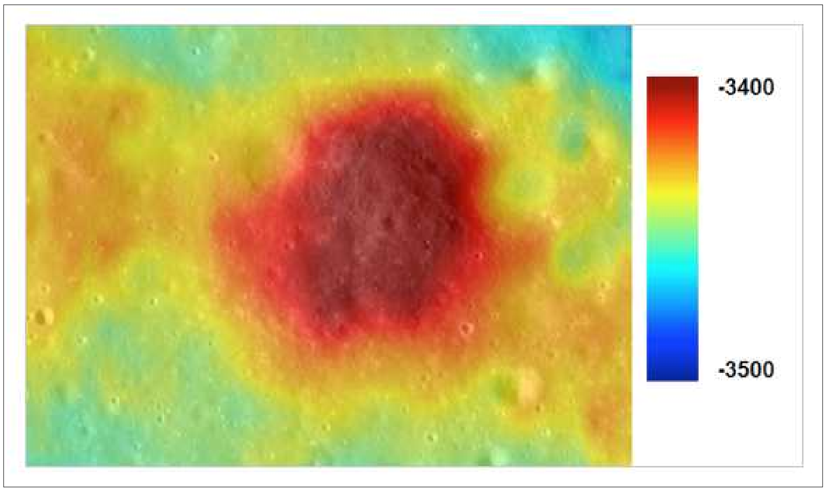

Figure 21: ACT REACT Quick Map tool. Elevation map.

The TiO_2 content of the region including the cone is low (<2 -2.3 wt %) and with a low plagioclase content (<50.0 wt %). The FeO content amounts to 17 wt % similar to the nearby mare units. The abundance of orthopyroxene varies from 18 wt % to 34 wt %, and clinopyroxene from 17 wt% to 35 wt%. The olivine abundance amounts to 11-18 wt % (Fig. 22), whereas on the western flank of the cone olivine amounts to 12 wt %. The continuum-removed spectrum of the lunar cone exhibits a broad absorption at 1,000 nm, which indicates an olivine-rich component (Fig.23).

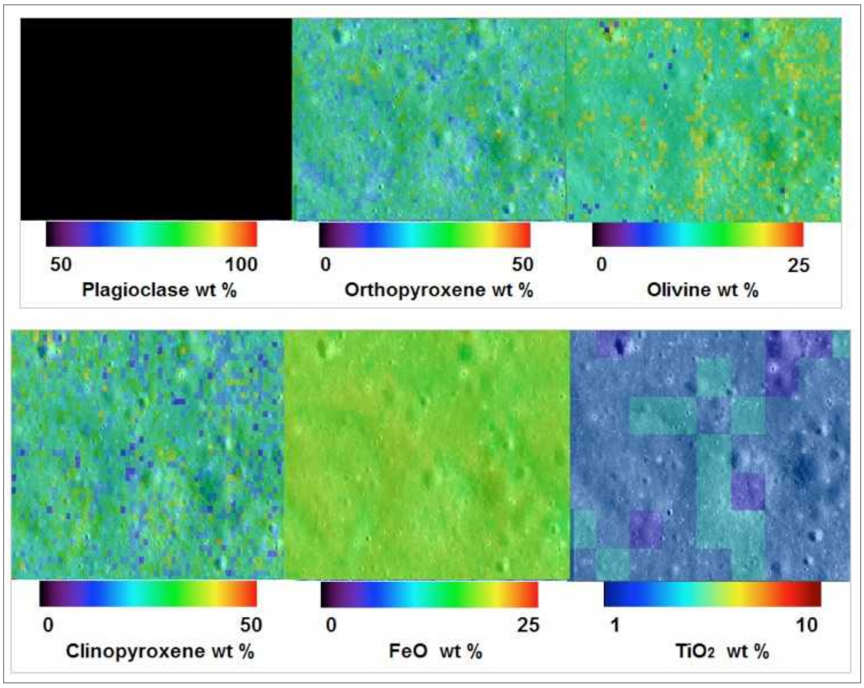

Figure 22: Top (left) plagioclase, (middle) orthopyroxene, (right) olivine. Bottom (left), clinopyroxene, (middle) FeO, (right) TiO_2 content. Derived abundance maps in wt%.

Summary:

These low relief volcanic features may be associated with a number of radial fractures within the Crisium Basin along which eruptions took place, producing volcanic cones along their lengths which merged to produce the ridge like structures we see. All the structures discussed display an olivine component (considered a primary constituent of the lunar mantle and an important product of basaltic magmatism) in the spectral data and are thus characterized as a mixture of pyroxenes and olivine rich basalts. Some local variation in olivine abundance is apparent throughout the structures, this likely to be related to differentiation processes within the basaltic melts derived from a partly melted lunar mantle.

Eruptions of a DMD type material appear to have occurred and these can be seen to mantle the mare surface surrounding some of these structures. However a positive identification of pyroclastic material is not possible as volcanic glass has not been identified in the spectral data. There are four main characteristics of pyroclastic DMDs: morphology, low albedo, position of absorption band centers, and spectral resemblance to laboratory volcanic glass signatures[3], with the last being the most diagnostic. The absence of one of these characteristics, which in the present case is the volcanic glass signature does not preclude a DMD interpretation, but it weakens any possible interpretation of the deposits as being pyroclastic in origin. Consequently characterization of these low albedo deposits as pyroclastic in nature must remain provisional, but this interpretation must remain the most likely.

Conclusion

Some of the suspected DMDs and cones examined in this study show morphological evidence for a pyroclastic origin, but their spectral characteristics do not allow them to be distinguished from the surrounding mare basalts. The ejecta surrounding some small craters also indicate an olivine signature which is more consistent with the presence of an underlying mafic-olivine rich material(basalt lava) that is not of pyroclastic in origin. Therefore the spectral data indicates that the compositions of several of the dark units and deposits noted above is more consistent with mare basalts rather than pyroclastic material containing volcanic glass.

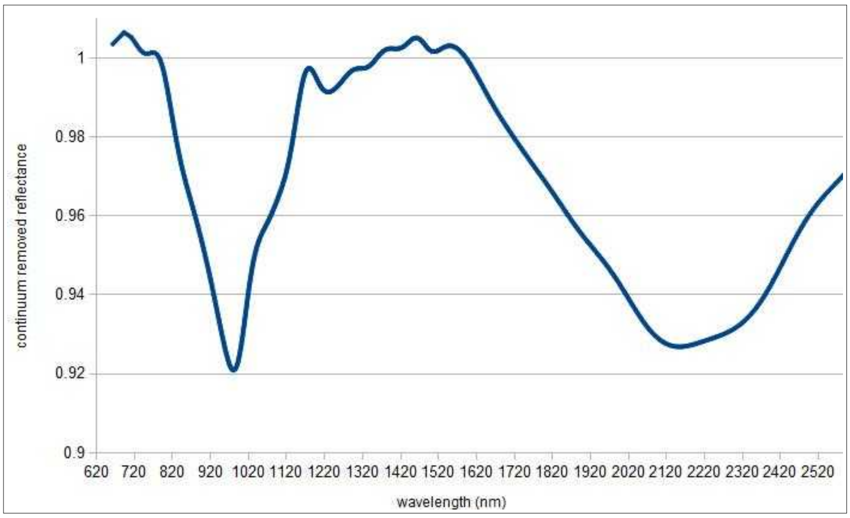

Figure 23: M^3 spectra (OP2C1 orbital period) of the lunar cone. The spectrum displays broad, composite absorption features over 1,000nm having the greatest affinity to typical olivine spectra admixed with pyroxenes.

There is however no obvious evidence for the large scale eruption of low viscosity lavas which may have formed these low albedo areas, with the only evidence for flows being the smaller 'break-out' features noted on the adjacent mare surface such as that shown in Fig.13. This type of flow would be more consistent with the eruption of a differentiated lava at the very end of a volcanic episode, but presence of 'breached cones' such as that shown in Fig.12 imply that low viscosity lavas may also have been erupted, but that the resulting flows remain undetected due to their extremely thin nature.

The features appear to range in age with Structures I and III being the oldest and II, IV and possibly V being the youngest. They are in any case probably some of the youngest structures within Mare Crisium, representing the last gasp of volcanism within the basin.

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3. Besse, S., J. M. Sunshine, and L. R. Gaddis (2014), Volcanic glass signatures in spectroscopic survey of newly proposed lunar pyroclastic deposits, J. Geophys. Res. Planets, 119, doi:10.1002/2013JE004537.

4. Horgan, B., Cloutis, E., Mann, P., & Bell III, J. (2014). Near-infrared spectra of ferrous mineral mixtures and methods for their identification in planetary surface spectra. Icarus. 234. 132–154. 10.1016/j.icarus.2014.02.031.

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Basin and Buried Crater Project
By Tony Cook

This month we have our first image of an impact basin sent in. This one is the obscure Cruger-Sirsalis basin (66W, 15S) and 400 km in diameter. Firstly, we have Alexander Vandenbohede's image at the top of Fig.1 taken on 2022 Apr 15 UT 22:10 and orientated with north to the right. As the basin is pre-Nectarian in age it is one of the earliest basins, and so has subsequently been heavily eroded by overlying, more recent craters. The basin is slightly more obvious in the centre image which is a visualisation from the LROC QuickMap web site with artificial illumination at 6 deg above the horizon and coming in on an azimuth of 77 deg. The lower figure is the definitive proof that this is a basin as there is a clear depression here. I cannot see any obvious signs of outer rings, though there may be an inner rim? The website for our current lunar impact basins and buried craters is: https://users.aber.ac.uk/atc/basin_and_buried_crater_project.htm . Apologies over the web in last month's newsletter, but it contained an unnecessary space which unfortunately broke the link.

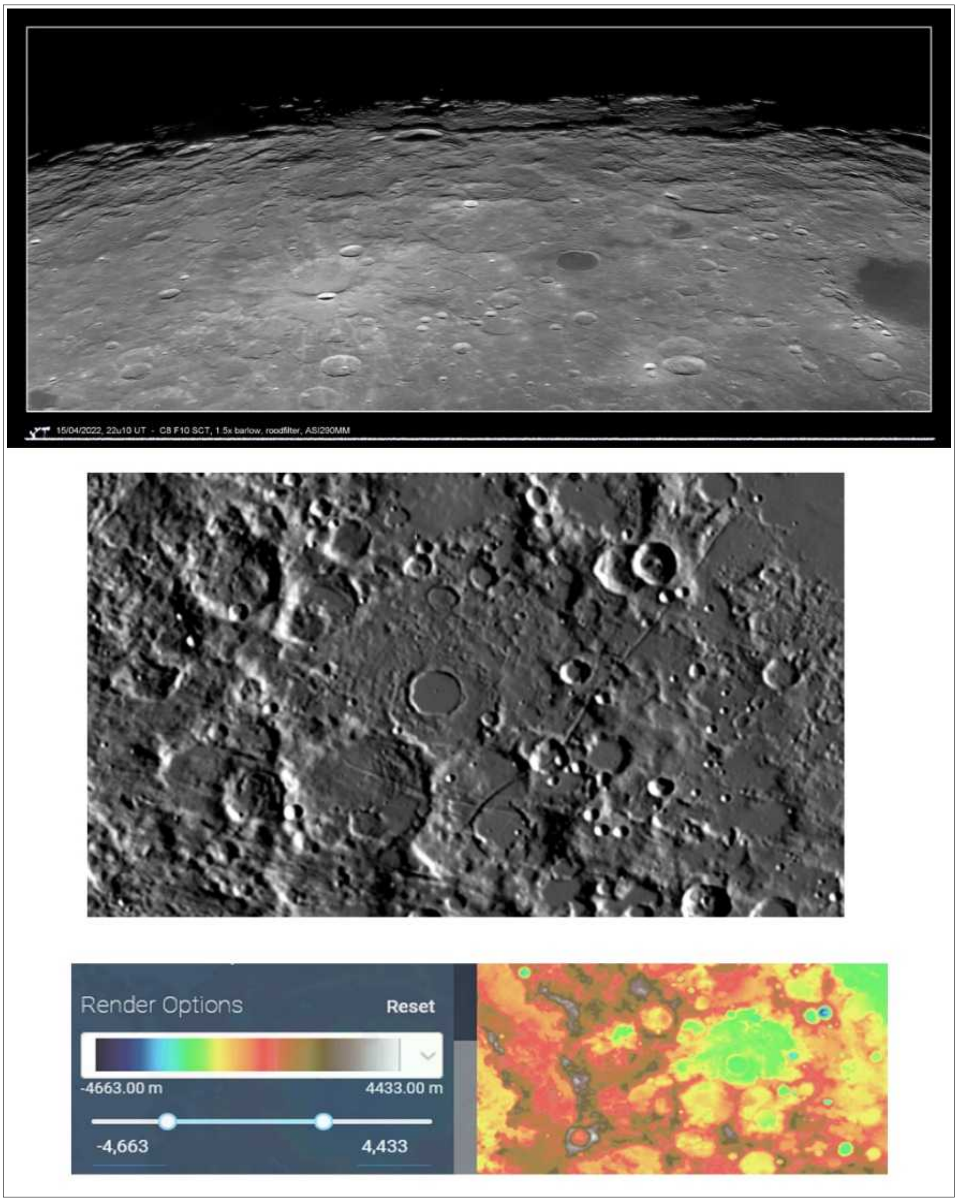

Fig.1.

LUNAR GEOLOGICAL CHANGE DETECTION PROGRAMME
By Tony Cook.]

TLP reports: No reports were received for May.

Routine Reports received for April included: Jay Albert (Lake Worth, FL, USA – ALPO) observed: Censorinus, Eratosthenes, Gassendi and Plato. Alexandre Amorin (Brazil) observed: Fracastorius. Alberto Anunziato (Argentina – SLA) observed: Plato. Anthony Cook (Newtown – ALPO/BAA) videoed earthshine and imaged several features in visible light and the thermal IR. Maurice Collins (New Zealand – ALPO/BAA/RASNZ) imaged: The Moon, Ptolemaeus, and several features. John Duchek (USA – ALPO) imaged: Eudoxus and the Moon. Walter Elias (Argentina – AEA) imaged: Curtis, Gassendi, Hyginus, Lubbock, Mons Piton, Plato, Playfair and Schiaparelli. Les Fry (West Wales, UK – NAS) imaged: Alphonsus, Archimedes, Maginus, Mons Piton, Motes Alpes, Montes Apenninus, Moretus, Rima Flamarion, Rupes Recta, Triesnecker, and Walther. Massimo Giuntoli (Italy – BAA) observed: Cavendish E. Mark Radice (near Salisbury, UK – BAA) imaged: Bulliadus, Montes Recti, and Reiner Gamma. Trevor Smith (Codnor,, UK – BAA) observed: Alphonsus, Aristarchus, Birt, Plato, Proclus, Tycho and Vallis Schroteri. Aldo Tonon (Italy – UAI) imaged: Montes Teneriffe. Fabio Verza O(Italy – UAI) imaged: Montes Teneriff

Routine Reports Received: Note that for this month it was not possible to do much analysis due to time constraints, so readers are invited to read the descriptions and make some interpretations of their own.

Eudoxus: On 2022 Apr 09 UT 01:58-02:01 and 02:14-02:17 John Duchek (ALPO) attempted a Lunar Schedule request for the following:

BAA Request: Eudoxus - please try to image the interior of this crater. We are trying to detect bright spots and a linear features within the shadow of the east wall at sunrise. Nigel Longshaw (BAA) suspects that this might explain Trouvelot's observation in 1877 of a luminous rope-like feature.

Eudoxus BAA Request: Eudoxus - please try to image or sketch the crater. This is to try to explain a line of light effect seen inside this crater by French astronomer Trouvelot back in Victorian times. The BAAs Nigel Longshaw says that this may be seen between colongitudes of 0.3 to 1.2 degrees. Please send any images or sketches to: a t c @ a b e r . a c. u k .

Fig.1. Eudoxus as imaged by John Duchek (ALPO) on 2022 Apr 09 UT 01:58-02:01 and orientated with north towards the top.

Ptolemaeus: On 2022 Apr 09 Maurice Collins imaged this crater under similar illumination to the following TLP report from the Cameron 1978 catalog:

Ptolemaeus 1866 Apr 22 UT 20:00? Observed by Ingalls (Champion Hills, London, UK) Crater seen on terminator - the surface showed a lot of detail. Normally it is very smooth. The Cameron catalog gets this interpretation around the wrong way. NASA catalog weight=3. NASA catalog ID = 142. ALPO/BAA weight=1.

Fig.2. Ptolemaeus as imaged by Maurice Collins on 2022 Apr 19 UT 07:38 and orientated with north towards the top.

Clearly, Ingalls, who was quite an accomplished astronomer, was perhaps not so experienced at lunar observing as Maurice's image infers, if you are prepared to wait for the right narrow range of selenographic colongitudes, near local sunrise/set on the lunar surface, and adequate seeing conditions, then you can capture a wealth of detail on the floor. We shall reassign the weight of this TLP report to 0 and effectively remove it from the ALPO/BAA database.

Montes Teneriffe: On 2022 Apr 9 Aldo Tonan (UAI) at 21:36UT, Les Fry (NAS) at 21:41UT, and Alberto Anunziato (SLA) at UT22:40-22:50 UT, observed this area under similar illumination to the following report:

Montes_Teneriffe observed by Hart_R on 1854-12-27 nr. Plato in Teneriffe Mountains 1854 Dec 27 UT 18:00-23:00 Observed by Hart & others (Glasgow, Scotland, 10" reflector)"2 luminous fiery spots on bright side on either side of a ridge, contrasting colour. Seemed to be 2 active volcanoes. Ridge was normal colour. Spots were yellow or flame colour. Never seen before in 40 yrs. of observing." NASA catalog weight=4. NASA catalog ID #129. ALPO/BAA weight=2.

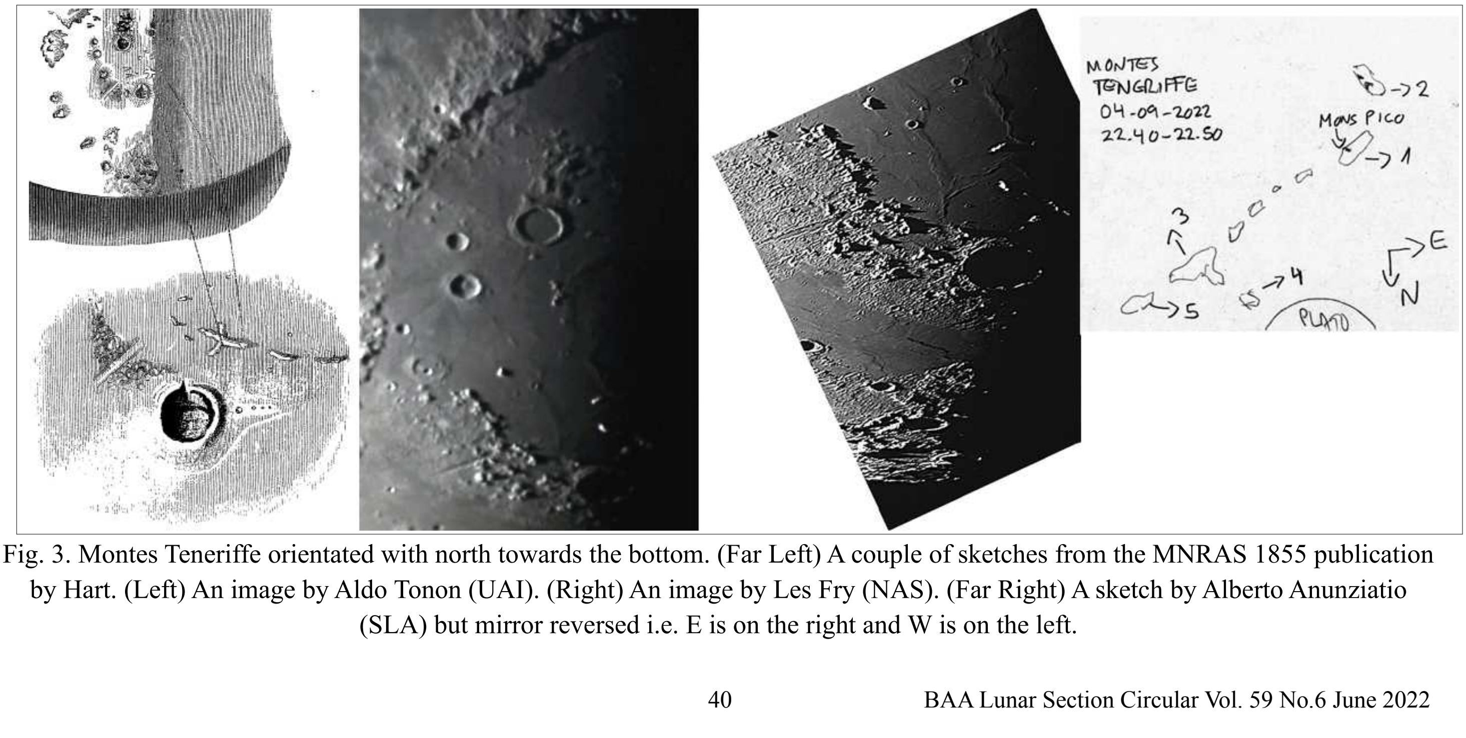

Fig. 3. Montes Teneriffe orientated with north towards the bottom. (Far Left) A couple of sketches from the MNRAS 1855 publication by Hart. (Left) An image by Aldo Tonon (UAI). (Right) An image by Les Fry (NAS). (Far Right) A sketch by Alberto Anunziatio (SLA) but mirror reversed i.e. E is on the right and W is on the left.

We have examined repeat illumination observations of this TLP several times before e.g. in the 2018 Dec, 2019 Feb, 2020 Aug, 2020 Dec and 2021 Jan newsletters. It is becoming clear that the sketches in the MNRAS publication (Fig 3 – Far Left) are at different times, the top far-left one more clearly represents the illumination that Aldo, Les and Alberto depict, and the lower far-left sketch is just a finder chart made on a later night – quite a poor one as they have drawn Plato as circular. If this is the case then the two dashed lines must represent the two "luminous fiery spots" that Hart saw. So, I think we are now a little clearer as understanding the location of the TLP.

Copernicus: On 2022 Apr 10 Franco Taccogna (UAI) imaged this crater under similar illumination to the following three events:

Copernicus 1955 Jul 28 UT 20:20 Observed by Firsoff (Somerset, England, 6.5" reflector x200) "Great brilliance of the terraces in E(IAU?) wall system(?) gets specular refl. (he gave 0820UT, but must have meant 2020" NASA catalog weight=4. NASA catalog No. #600.

On 1990 Aug 30 at UT02:11-02:36 D. Darling (Sun Praire, WI, USA, 3" refractor, x90, seeing conditions: "at,. boiling") noted a coloured area on the west wall of Copernicus that was unusual in appearance - however other craters along the terminator had a similar effect. There was also a "dazzling bright spot on the E. rim and he witnessed 6 flashes from the lighted part of Copernicus over a very short time interval. Cameron comments that the colour may well have been dur to chromatic aberration because a refractor was used. The Cameron 2006 catalog ID=408 and the weight=0. The ALPO/BAA weight=1.

2012 Sep 24 UT 22:00-23:00 Copernicus. E. Horner (Salisbury, UK, 15cm reflector) observed a prominent red arc where the sunlit part of the interior wall met the shadow. Sometimes the arc was 1/4 the way around the interior, and sometimes half of the way around. Telescope moved, but the red arc stayed where it was. Eyepieces change, but the effect remained. Other parts of the Moon checked, but no red seen. There were however splashes of green e.g. Longomontanus on the terminator, elsewhere further inland from the terminator, and little splashes of green on Mare Frigoras - but lasting a brief time. The red colour was as strong as a red LED and the green similar to that of the northern lights. The observer's husband was asked to independently check Copernicus and remarked that he could see a little bit of green at the top and some red near the bottom, along the line of the internal shadow. Although there were checks for red elsewhere on the Moon and none were seen, the Moon was starting to get low and it is typical of spurious colour in a few respects. Therefore the ALPO/BAA weight=1 for safety.

Fig.4. Copernicus as imaged by Franco Taccogna on 2022 Apr 10 UT 20:07 and orientated with north towards the top. The colour saturation has been increased to 20%.

The western terraces appear to be bright, but not exceptionally so – so assuming Firsoff meant Classical East then this is normal. There is a white spot on the east rim, which I guess under exceptional moments of seeing may brighten in appearance. There is a hint of red on the west inner rim, which is due to atmospheric spectral dispersion but can also be seen on other features.

Gassendi: On 2022 Apr 12 UT 01:57-02:06 Jay Albert (ALPO) observed visually this crater under similar illumination to the following report:

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

Jay was using a Celestron NexStar Evolution 8" SCT. The waxing Moon was 75.5% lit and nearly overhead. The sky was partly to mostly cloudy with no haze. Transparency varied from opaque to 4th magnitude depending on the fast-moving clouds. Seeing varied continually from 3 to 6/10. Filters were not used. Jay commented that the crater was right on the terminator. No red spots or other colour was seen. The crater was mostly in deep shadow with only the exterior E walls of Gassendi and Gassendi A sunlit.

Plato: On 2022 Apr 14 UT 22:35 Walter Elias (AEA) imaged this crater under similar illumination to the following report:

Plato 1981 Jun 15 UT 21:30 Observed by Amery (Reading, England, 25cm reflector, seeing Antoniadi IV-V) At the 4 O'Clock position on the North West corner?, there *was a dark smudge which reached from the floor across and over the wall and onto the terrain outside the crater. Foley, alerted by Amery, saw a dark show-like patch in the crater's north west corner, again lying across the rim. 2006 Cameron catalog extension ID=148 and weight=4. Foley used a 12" reflector and seeing was III-V. ALPO/BAA weight=3.*

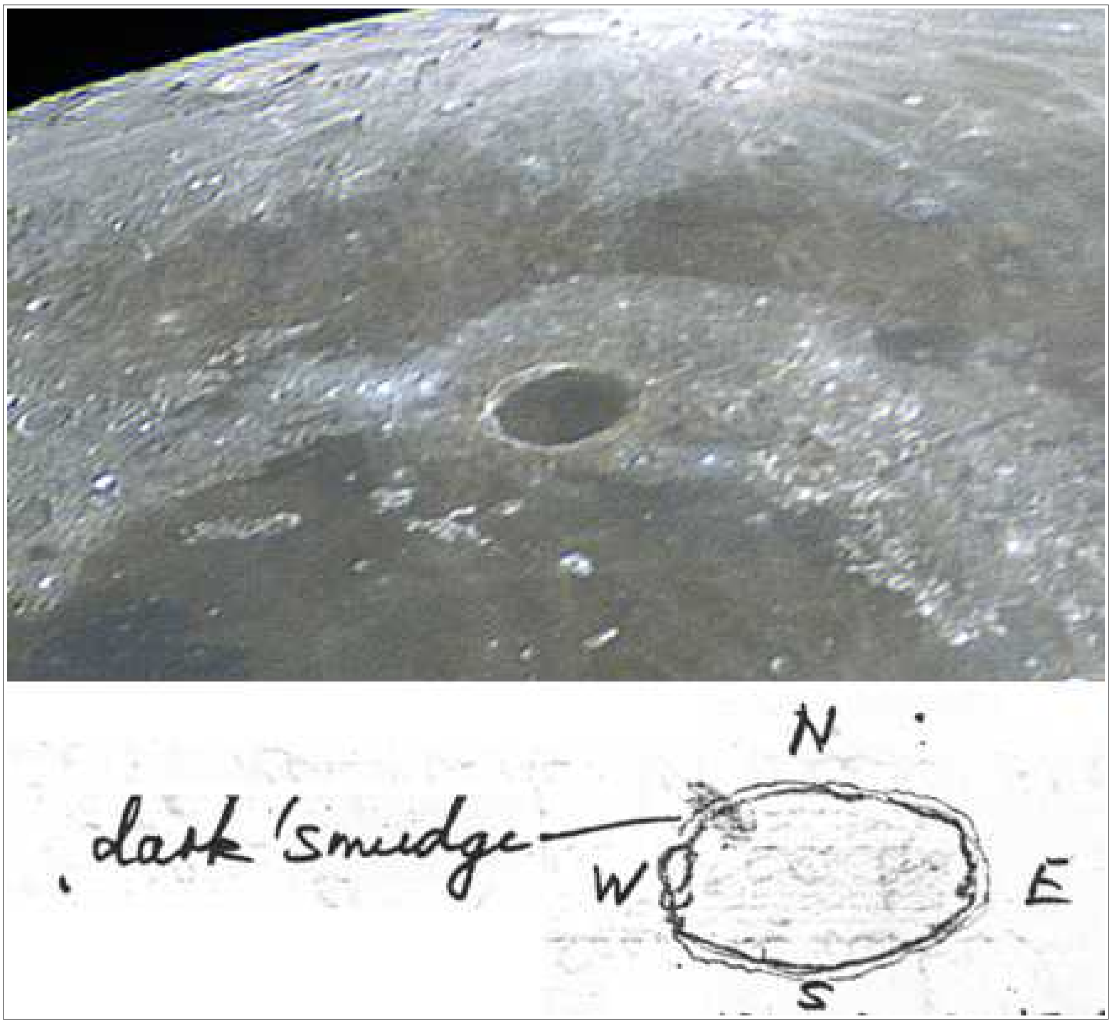

Fig.5. Plato orientated with north towards the top. (Top) An image by Walter Elias (AEA) taken on 2022 Apr 14 UT 22:35 – this has been colour normalized and then had its colour saturation increased to 60%. (Bottom) The original TLP sketch of the dark smudge on the NW rim of Plato by Geoff Amery from 1981 Jun 15 – note that the writing has been rotated through 180 degree to match Walter's image orientation.

No obvious sign of a dark smudge in Fig 5, so we shall leave the weight at 3 for now.

Cavendish E: On 2022 Apr 13 UT 21:10 Massimo Giuntili (BAA) continued to monitor this crater to see if it repeats a flare up in brightness that he saw in the past. On this occasion the northern floor of crater slightly brighter than usual but not brilliant. The seeing was IV-II (var.) / col. 60.1 / sub sol. lat. -0.8 / lat. -5.31 / long. -6.24. A 150mm OG - x240 used.

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