Emergence of low relief terrain from shadow: an explanation for some TLP

Raffaello Lena & Anthony Cook

We show that two observational transient lunar phenomena (TLP) reports concerning an Alphonsus observation by Poppendiek & Bond on 1958 November 19, and a Ptolemaeus observation by Bartlett on 1973 November 3, are not TLP but are normal appearances for these craters.

Introduction

Amongst the many lunar sites where visual observers claim to have recorded Transient Lunar Phenomena (TLP), Alphonsus is one of the best known with 46 TLP events. An adjacent crater to the north, Ptolemaeus, has also been reported as the site of 7 TLP.[1] In this paper we discuss some past TLP observations concerning these two craters for which we believe we have found a simple explanation, namely the emergence of low relief terrain from shadow.

Table 1. Observers who submitted observations

Observer	*Organisation*	*Telescope*	*Diameter*	*f/no.*	*Method*	*No.of obs.*
A. Bares	GLR	Newtonian	25cm	f/10	CCD	2
S. Basso	GLR	SCT	20cm	f/10	Visual	1
R. Castellano	GLR	SCT	20cm	f/10	Webcam	2
M. Cicognani	GLR	Cassegrain	41cm	f/17	CCD/Visual	3
A. Cook	BAA/ ALPO	Newtonian	20cm	f/5	CCD	1
C. Fattinnanzi	GLR	Newtonian	20cm	f/5	Webcam	1
R. Lena	GLR/ ALPO	Refractor	10cm	f/15	Visual	3
Pg. Salimbeni	GLR	SCT	20cm	f/10	Visual	1
B. Shaw	BAA	Refractor	12.5cm	f/8	Visual	1

The NSSDC (National Space Science Data Center) catalogue includes all reported phenomena regardless of the perceived weight of the observation. Entry no. 705 in the catalogue concerns an event recorded on Alphonsus by Poppendiek & Bond on 1958 November 19 at 04:00–04:30 UTC from San Diego, using a 15cm reflector, ×370 magnification. The observers reported: ‘a diffuse cloud over central mountain, like a plume, very large compared with central peak’. In the same catalogue, entry no. 1380 describes an event recorded in Ptolemaeus by Bartlett on 1973 November 3 at 01:32 UTC from Baltimore using a 10.8cm reflector, ×141 magnification. The event is quoted as a ‘large oval bright area between center and S. wall though floor was in shadow. Looked like a feeble surface glow’. The Alphonsus TLP was assigned a weight of 4 in the NSSDC catalogue, which indicates that the observation had been made by ‘very experienced good single observers’. The Ptolemaeus TLP was assigned a weight of 3 in the NSSDC catalogue, which indicates: a single observation, ‘probably a good observer’.[1] As part of the programmes of the Association of Lunar & Planetary Observers (ALPO)/BAA and Geological Lunar Research (GLR) TLP groups to investigate past TLP reports, we studied these craters using recently obtained international observations made under illumination conditions that matched the above two TLP events.

Figure 1. Image by Cicognani on 2001 August 26 at 20:05 UTC, 41cm Cassegrain + CCD.

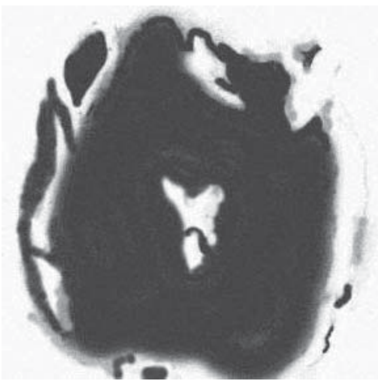

Figure 2. Observation by Salimbeni on 2001 October 24 at 20:50 UTC, 20cm f/10 Schmidt-Cassegrain.

Figure 3. Observation by Lena on 2001 October 24 at 21:20 UTC, 10cm f/15 refractor.

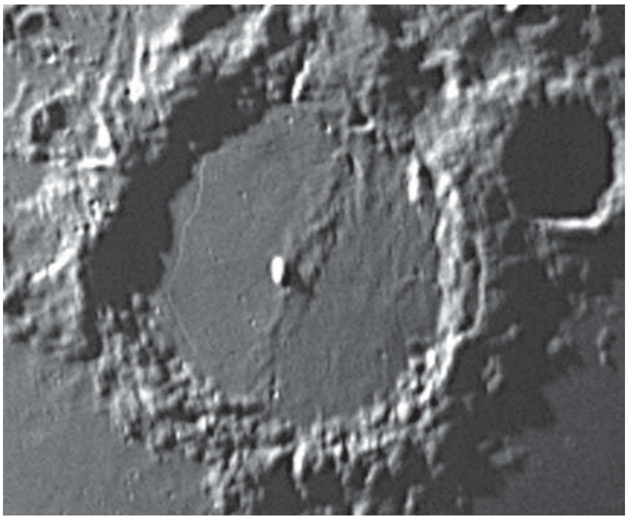

Figure 4. Image by Bares on 2000 March 13 at 21:30 UTC, 25cm f/10 Newtonian + CCD.

Instruments and measurements

Table 1 lists the nine individuals who supplied a total of 15 observations. For each of the observations, the local lunar altitude of the Sun (Alt.), the azimuth of the Sun (Az.), and the Sun's selenographic colongitude (Col.) were calculated using the *Lunar Observer's Toolkit* by H. D. Jamieson (ALPO).[2] The 'Sun's selenographic colongitude' is the longitude of the morning terminator. Using this software we computed dates and times when the lighting conditions closely matched those for the illumination origin of the TLP events reported for the Alphonsus (no. 705) and Ptolemaeus (no. 1380) events; these can be seen in Tables 2 and 3. Observing during such repeat illumination opportunities can help to verify if the reported appearances were normal. The authors encouraged observers to participate in organised simultaneous observations. Such effort significantly reinforced the level of confidence that we have in our data below.

Results

Some of the images submitted to the authors are shown in Figures 1-8; these are all oriented with south at the top, and west (IAU) on the right. Seeing is reported using the Antoniadi scale.

Observing Alphonsus when illumination matches the no. 705 TLP

Figure 1 displays a bright double spot over the Alphonsus central peak. This single image was taken by Cicognani under variable seeing (Antoniadi III–IV) with a CCD fitted to a 4cm Cassegrain telescope (2001 August 26 at 20:05 UTC, Alt=1.4°, Col=4.6°, Az=88.3°). The bright feature was observed again by Lena and Salimbeni on 2001 October 24 at 21:20 and 20:50 UTC respectively. This observation was carried out independently by both observers under Antoniadi III seeing conditions. The telescopes used were a 20cm SCT and a 10cm f/15 refractor. Figure 2 shows the aspect of the region as drawn by Salimbeni. Figure 3 shows Lena's drawing. The unusual spot appeared to fluctuate sometimes due to subtle oscillation of the seeing. Its albedo was estimated at 6.5 on the Elger scale where the peak of Alphonsus was 8.5 on the same scale. [The Elger scale is a commonly used visual method of estimating the relative brightness of surface features and ranges from: 0 (darkest shadow) to 10 (Aristarchus central peak)].[3]

Figure 5. Image by Fattinnanzi, 2002 June 18 at 20:32 UTC, 20cm f/5 Newtonian + Philips Vesta webcam.

Table 2. Observations received which match the lighting conditions to within ±0.1° for the 1958 November Alphonsus event no. 705

Date	*UTC*	*Alt.(°)*	*Col.(°)*	*Az.(°)*	*Librations Lat.*	*Long.*
1958 Nov 19	04:00	1.5	4.6	88.7°	–4.7°	+6.5°
2001 Aug 26	20:20	1.4	4.6	88.3°	–2.1°	+7.5°
2001 Oct 24	21:10	1.5	4.6	88.3°	+4.4°	+3.7°

Three independent observations made over widely separated dates, but at the same colongitude, confirm the presence of a bright feature that matches the no. 705 event. Interestingly Lena identified specific details so that 'the spot showed an interesting interplay of sunlight and shadow. It shows a clear bisected area in the east edge with increasing solar elevation. Examination of several images and drawings revealed the presence of ridges and hills near the Alphonsus peak along the meridian (Figures 4 and 5 by Bares and Fattinnanzi respectively). This slightly raised

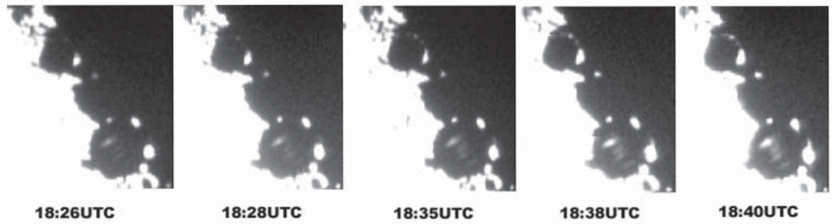

Figure 6. Images by Cook, 2003 January 10 at 18:26–18:40 UTC, 20cm f/5 Newtonian + CCD.

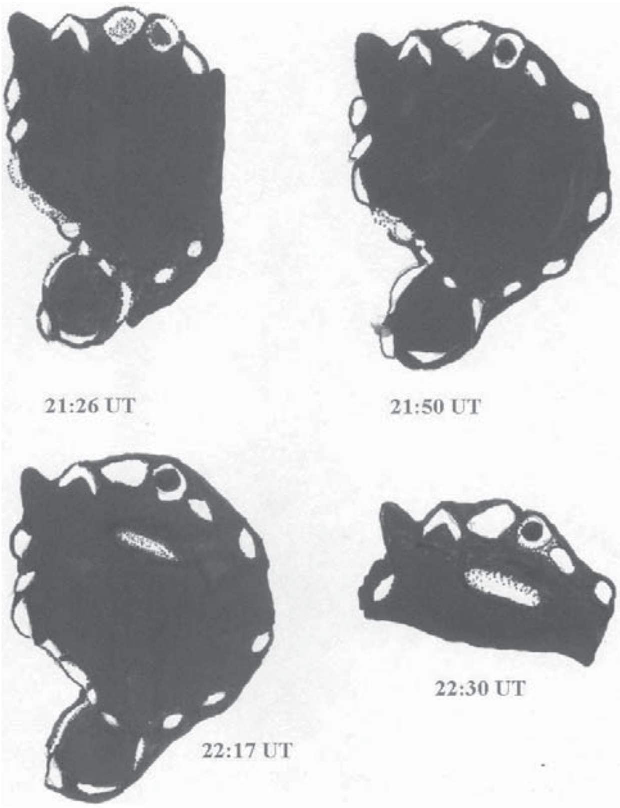

Figure 7. Observation by Lena on 2003 March 10 at 21:26-22:17 UTC, 10cm f/15 refractor.

topography could account for the 'bright effect' under a sunrise illumination.

Observing Ptolemaeus when illumination matches the no. 1380 TLP

On 2003 January 10 at 18:26 UTC Cook detected a large bright oval area that matched Bartlett's description. The CCD sequence, obtained using a Newtonian 20cm f/5, is shown in Figure 6. The first image corresponds to just 10 minutes after the repeat illumination for event no. 1380. Lena detected the same 'bright oval area' in another observation made on 2003 March 10 at 22:17 UTC (Figure 7). He started the observing session at 21:26 UTC when the crater was in total darkness and stopped at 22:30 UTC. At 22:17 UTC a bright oval spot was seen (seeing Antoniadi II). Shaw, during the same night as Lena's observation, reported: 'At 22:40 I saw the faint glow in the south central part of Ptolemaeus. The floor was in shadow and there were four bright spots (one much brighter than the rest, one much fainter than the rest) on the western rim'. Over the next ten minutes Shaw saw three, maybe four, fainter streaks to the north of the main glow, and at about 23:02 UTC they were definite, showing how rapidly the appearance of this area changes with increasing solar elevation. Three independent observations that match the Bartlett's event, on different dates but at the same colongitude, suggest strongly that this phenomenon is also a normal shadow effect.

As reported in Lena *et al.*,[4] several dome-like structures, ridges and a bumpy terrain were found in the southern area of Ptolemaeus. Figure 8 was obtained by Castellano on 2001 April 30 at 20:40 UTC using a 20cm f/10 SCT and a Philips Vesta webcam (Alt=1.6°, Col=3.2°, Az=91.1° over Ptolemaeus). The results presented in reference 4 imply that the interior of the crater Ptolemaeus displays a 'bumpy topography' under low solar altitude (~3°), but a classic 'smooth floor' under a higher solar altitude (>3°). Furthermore on page 69 of the *Times Atlas of the Moon*[5] we see clear evidence in the contours that the southerly part of the floor is in fact high.

Table 3. Observations received which match the lighting conditions to within ±0.1° for the 1973 November Ptolemaeus event no. 1380

Date	*UTC*	*Alt.(°)*	*Col.(°)*	*Az.(°)*	*Librations* Lat.	Long.
1973 Nov 03	01:32	0.1	1.7	91.2	-4.1°	-4.0°
2003 Jan 10	18:16	0.0	1.7	91.2	+4.8°	+0.7°
2003 Mar 10	22:30	0.1	1.6	91.5	-1.5°	-5.6°

Conclusion

The results obtained suggest strongly that small elevations seen under shallow illumination can appear as bright spots. Our hypothesis that event nos. 705 and 1380 are not real TLP is further supported by the recurrence of brightness as seen in observations made under the same specific lighting conditions. We suspect that many other TLP reports in the NSSDC catalogue, involving events during local lunar sunrise, are similarly normal appear-

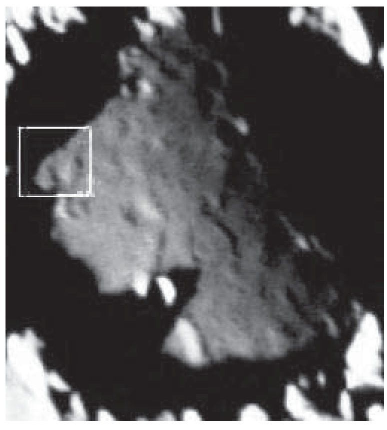

Figure 8. Image by Castellano, 2001 April 30 at 20:40 UTC., 20cm f/10 Schmidt-Cassegrain + webcam. The rectangle indicates the location of two dome-like features.[4]

ances. Future observing schedules are being planned to investigate each of these on a case by case basis (see **http://www.lpl.arizona.edu/~rhill/alpo/lunarstuff/ltp.html** for predictions for the current month and also Appendix 1 for future repeat illumination conditions on Alphonsus and Ptolemaeus that match the TLP report nos. 705 and 1380). It is hoped that by eliminating many of the less reliable reports in the NSSDC catalogue, we will be left with a core set of observations upon which more reliable statistical analysis of the nature of TLP reports can be performed.

Acknowledgment

We wish to thank all the observers for their contributions to this paper.

Addresses: (AC): School of Information Science and Information Technology, University of Nottingham, Jubilee Campus, Wollaton Road, Nottingham NG8 1BB *[acc@cs.nott.ac.uk]*
(RL): GLR TLP coordinator, Via Cartesio 144, 00137 Rome, Italy

References

1 Cameron W., *Lunar Transient Phenomena Catalog*, NSSDC, NASA-TM-79399, July 1978
2 Jamieson H. D., The Lunar Dome Survey – Fall, *Strolling Astronomer*, 1992 Progress Report, **37**(1), pp. 14–17 (1993)
3 Elger T. G., *The Moon: A Full Description of its Principal Physical Features*, George Philip & Sons (London), 1895
4 Lena R. *et al*., *Selenology*, **20**(3), pp. 3–6 (2001)
5 Lewis H. A. G., *Times Atlas of the Moon*, Times Newspapers (London), 1969

Received 2003 June 19; accepted 2003 October 29

Appendix I

Future prediction times in UTC for repeat illumination conditions that will match the NSSDC catalog event nos. 705 in Alphonsus and 1380 in Ptolemaeus. Predictions are only given when the Moon is at least 20° above the local horizon to ensure sufficient altitude to avoid the worst aspects of poor seeing.

Date		*Alphonsus*		*Ptolemaeus*	
		(From UK)	*(From Italy)*	*(From UK)*	*(From Italy)*
2003	Dec 01	16:50	16:50		
2004	Jan 29	21:30	21:30	16:51	16:51
	Mar 28		20:39	20:39	
	May 26		21:08	21:08	
	Jul 24				19:24
	Nov 19			20:15	20:15
2005	Feb 16	20:11	20:11		
	Apr 16	23:17	23:17		18:24
	Dec 08			18:33	18:33
2006	Feb 05		23:49		
	Mar 07	18:49	18:49		
	May 05	20:48	20:48		
	Jul 03		19:27		
	Oct 29		17:40		
	Dec 27	21:56		17:16	17:16
2007	Feb 24			22:32	
2008	Jan 15	20:58	20:58	16:12	16:12
	Mar 14			20:56	20:56
	May 12			22:04	22:04
	Jul 10				20:01
	Nov 05				19:22
2009	Feb 02	20:03	20:03		
	Apr 02	23:58		18:53	18:53
	May 31				18:39
	Nov 24			17:50	17:50
2010	Feb 21	18:58	18:58		
	Apr 21	21:24	21:24		
	Dec 13	21:32	21:32	16:42	16:42
2011	Feb 10			22:16	
	Mar 12		17:22		