ALPO Feature: Lunar Changes --
An Old Example in the Crater Herodotus and Some Thoughts on Their Recurrence

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Abstract

The author observed the early morning shadow in the lunar crater Herodotus to be amazingly light on 11 August 1954 near 2:28, (UT) Universal Time. The shadow slowly regained its normal blackness during the next three hours. Subsequent examination of Herodotus under very similar solar illumination on 9 October 1954 showed the expected ordinary aspect. Possible explanations of this apparent change on the Moon are suggested. It is important to relate such reported lunar changes to proper measures of the ever-changing solar lighting and to confirm that they are not just products of that lighting. A short schedule is given for future observations of Herodotus when the lighting will be almost identical to its value during the observed 11 August 1954 oddity.

A Curious Observation

The history of reported lunar CHANGES, as distinct from the considerable variations in aspect of lunar features with changing solar lighting, is full of controversy and contradictions (1). However, in looking over my old observing notebooks for other reasons, I found what appears to be a striking example in the crater Herodotus. The reader may properly wonder why this event was not reported when it occurred, 48 years ago. At the time, I wanted to make other observations under very similar solar lighting in order to confirm that something abnormal had indeed been observed. And after that, the matter just slipped away from memory.

The observation was made on 11 August 1954 at 2:18 - 2:39 UT. A copy of a rather poor drawing is provided as the left image in Figure 1. The following notes were made: "The appearance of the floor is VERY PECULIAR; nowhere is the 'shadow' (necessarily existing with the Sun only a few degrees above the horizon at Herodotus) nearly so dark as in the adjacent crater Aristarchus. The land just north of Herodotus, and perhaps that in the north part of the crater as well, looks AS IF it may be very dark because very slantingly illuminated. The view is often good enough to show the two crater-pits at the foot of the two main dark bands on the east (now IAU west, the hemisphere of Mare Imbrium) inner wall of Aristarchus as two humps on the large interior shadow." At 3:03, UT, the curious appearance was confirmed. At 4:05, it was noted that the "shadow" was much darker than on the earlier drawing, but still less black than the Aristarchus interior shadow. At 5:09-5:28 UT, another drawing was made, here copied as the center image in Figure 1. A note says: "The shadow is of normal blackness now!".

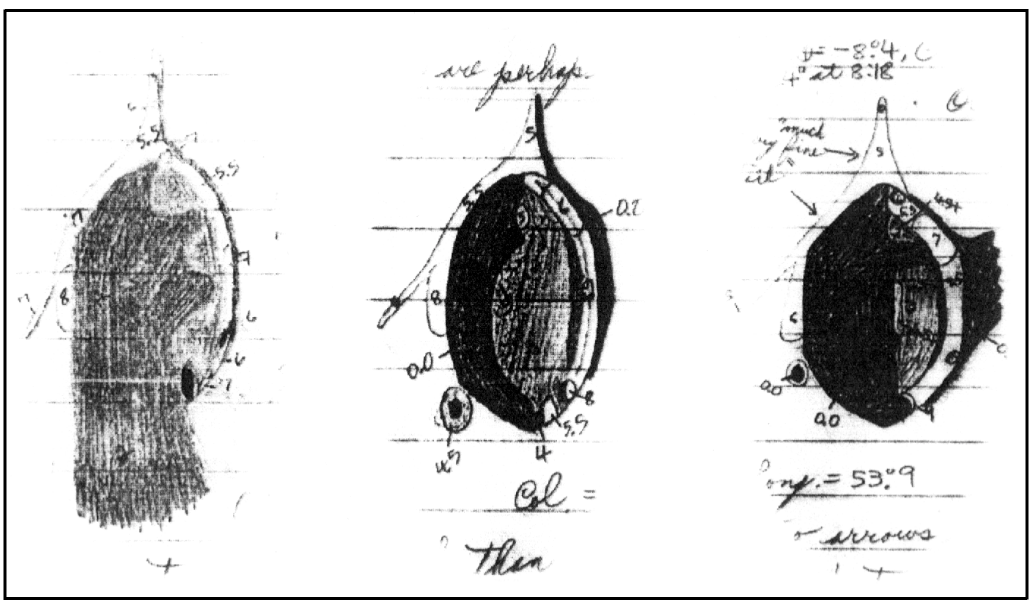


Figure 1: Drawings of lunar crater Herodotus made by Walter H. Haas as viewed through 12.5-inch (32-cm) reflector. Simply inverted images with lunar south at top. Left drawing: 11 August 1954; 2:18-2:39 UT; 303x, seeing poor, transparency variable. Center drawing: 11 August 1954; 5:09-5:28 UT; 303x, seeing bad-to-fair, sky clear. Right drawing: 09 October 1954; 2:21-2:51 UT; 367x, seeing fair-to-good, sky clear, solar lighting for left and right drawings almost the same. Numbers for features on all three drawings are estimated intensities on a scale of 0 (normal shadows) to 10 (most brilliant features).

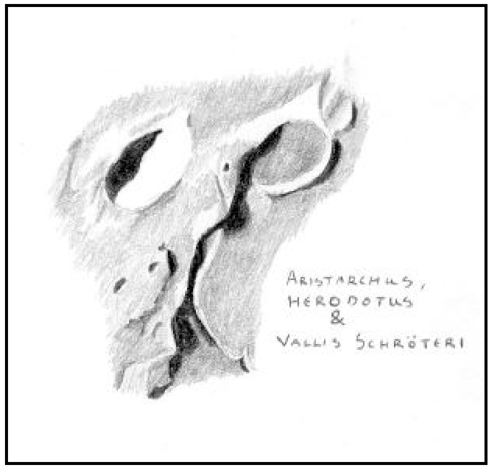
Since the synodic month is about 29.5 days, lighting conditions for a particular lunar feature return approximately after 59 days. Thus, I drew Herodotus again on 09 October 1954 at 2:21-2:51 UT, the right image in Figure l. It was remarked: "The peculiar lightness of the shadow on 11 August 1954, whatever its nature, is certainly not present tonight. In fact, the Herodotus shadow was of normal blackness at 1:45 UT". The observations are summarized in Table l.

It is difficult to explain this observation. Lunar atmospheric obscurations and mists have often been invoked in the past to explain curious appearances, but it is very hard to reconcile them with the known EXTREME tenuity of any lunar atmosphere. Perhaps a meteoritic impact could raise dust from the lunar surface and the suspended particles could obscure underlying shadows, but I have no idea how great an area might be affected, nor for how long. However, I do have great confidence that the appearance remarked on 11 August 1954 was not that normal for the existing lighting. PERHAPS there is even a relationship to some puzzling aspects of Herodotus recorded in the 1950's(2). An APPARENT bright central peak drawn by two regular lunar observers in 1949-50 is missing from a legion of drawings and photographs both before and after those years.

Richard Baum has called my attention to recent evidence for lunar dust veils(9) which may be relevant to the Herodotus oddity. Surveyors 5,6, and 7, and perhaps Clementine as well, detected a patchy glow along the sunset terminator

Crater Herodotus: Little Brother to Aristarchus

(From a writeup at http://users.eggconnect.net/iknight/ob15.htm by Ian Knight)



The extremely bright Aristarchus can be easily picked out within the vast Oceanus Procellarum, contrasting with with its ancient flooded neighbour Herodotus to its right. The brightness of Aristarchus is directly attributable to the ejecta created during its recent formation. Ejecta deposits to the immediate right of this crater also help to pick out the edges of Herodotus to the right.

Under highest magnification (240x) the Vallis Schroteri feature below these two craters becomes easily recognisable. At the head of this impressive valley feature, a crater known as the Cobras Head can be seen. Under this magnification, a rille emerging from the Cobras Head and meandering across the floor of Vallis Schroteri, can also just be made out.

It is believed by some that this valley feature was formed by an eruption of lava from the Cobras Head crater, an explanation that certainly fires the imagination !

Table 1: Geometric Conditions During Herodotus Shadow Observations (4)

Universal		Sun's*			Earth's		Shadow
Date	**Time**	**C**	**H**	**A**	**Lo**	**La**	
1954 11 August	2:28	53.82	4.11	90.84	-5.18	0.94	Definitely not black
11 August	3:03	54.11	4.11	90.84	-5.18	0.91	Definitely not black
11 August	4:05	54.64	4.94	90.84	-5.20	0.84	Not quite black
11 August	5:20	55.27	5.57	90.84	-5.22	0.76	Black and normal
1954 09 October	1:45	53.47	3.76	91.52	-6.64	-5.14	Black and normal
09 October	2:36	53.90	4.20	91.52	-6.60	-5.17	Black and normal

* All values are in degrees
C = Sun's selenographic colongitude.
H = Sun's height and A = Sun's azimuth above a point in Herodotus at lunar logitude 49.7 degrees west and lunar latitude 23.2 degrees north.
Lo = Earth's selenographic longitude, positive when west.
La = Earth's selenographic latitude, positive when north.

(10,12). The glow advanced westward at the same rate as the sunset terminator and disappeared about 20 miles, or a little more than two hours, into the lunar night. Dr. D. R. Criswell has proposed that the glow is produced by very small dust grains elevated above the lunar surface by electrostatic fields, which had been produced by solar x-rays ionizing atoms on sunlit surfaces and making them positive relative to their shadowed neighbors. The charges become neutral and the dust grains fall 20 miles beyond the terminator. Also, the microparticle detector left on the Moon by the Apollo 17 astronauts found evidence for dust particles moving westward at sunrise and eastward at sunset, especially in the interval from about 40 hours before sunrise until about 30 hours after that event (11). This appears to be a classic example of electrostatic particle levitation.

A Falsely Reported Apparent Lunar Change

A recent example illustrates how easily we can report spurious lunar changes. On 14 June 2000, Mr. Kenneth Fields of the Three Rivers Observatory, photographed the Moon. Later examination of the image showed him a short, bright "plume" extending from the crater Horrebow toward the northwest limb(8). He suggested that we were seeing dust and gas somehow raised from the lunar surface. However, the plume is very distinct on a CCD image taken by Dr. John E. Westfall on 08 August 1995 (5), is less clearly present on an old 1901 photograph (6), and presumably can be found on many other lunar images. The plume is merely the unresolved image of a chain of bright peaks on the west wall of the lunar crater John Herschel. As Dr. Westfall has concluded, the feature is a product of insufficient resolution and can be recorded every lunation over a suitable range of solar lighting (7). Better resolution, he reports, such as a 0.7-km. pixel size on a CCD image, will show the individual peaks.

It should be clear from this incident that we should not report a Lunar Transient Phenomenon, as these events have come to be called, until we have verified that it is not a normal appearance repeated whenever the solar illumination is the same.

Measuring Solar Lighting

We have as an approximate measure of illumination the Sun's selenographic colongitude, defined as the lunar western longitude of the sunrise terminator at the Moon's equator. This colongitude is APPROXIMATELY 0 degrees at First Quarter, 90 degrees at Full Moon, 180 degrees at Last Quarter, and 270 degrees at New Moon.

If an unexpected lunar appearance is due to lighting only, it should repeat for a particular fixed observer on the Earth's surface at intervals of about 59 days. If it fails to repeat, we may need to seek a different explanation. However, the height and azimuth of the Sun at a particular point on the Moon are determined not just by the Sun's selenographic colongitude but also by its selenographic latitude, especially for features well away from the Moon's equator. Though the role of azimuth is probably usually very minor, we should try to repeat the observation at the same value of the Sun's height.

It is true, however, that the needed later observation can hardly ever be at the same values of the Moon's librations in latitude and longitude, which will have greatest effects near the limb of the Moon.

Besides these geocentric librations, there is also the *topocentric* libration, which can be as large as about one degree and which varies with time and the position of the observer on the Earth's surface.

Solar eclipse chasers are familiar with the "saros", the interval of time after which the Sun, the Moon, and the Earth return to almost exactly their original positions. A saros is 18 years, 10 or 11 days (depending on how many Leap Years intervene), and about 8 hours. Except for its great length and the resultant frequent difficulty of duplicating the original conditions of observation, here is the ideal interval after which to look for a repetition of a suspected lunar event. Dr. Anthony Cook has pointed out that topocentric libration may cause the best match to be a few months on either side of the moment of the saros (13). Of course, re-observations after two or more saroses are also excellent, though the small differences from the initial alignment must slowly increase with time. Also, it becomes ever-harder to duplicate the conditions of the original observation after 36, 54, or more years.

Table 2: Schedule for Future Observations of Herodotus Shadow (4)

Universal Time		Sun's*		
Date	**Time**	**Colongitude**	**Height**	**Azimuth**
2002 18 October	6:39	53.82	4.12	88.83
16 November	20:13	53.82	4.12	89.55
16 December	10:31	53.82	4.12	90.40
2008 12 September	0:22	53.81	4.121	90.80
* All values are given in degrees.				

A Well-Evidenced Apparent Lunar Change

There has been a recent attempt to recover a well-observed LTP one saros later. On 29 January 1983, a number of British observers found the small crater Torricelli B on the Sinus Asperitatis, not far from Theophilus, to be temporarily the most brilliant feature on the whole Moon and to exhibit color abnormalities generally at the violet end of the spectrum (3). Observations in following years showed curious variations in brightness and color (3). Special efforts to monitor Torricelli B were made one saros after the original report, that is, on 09 February 2001 near 4:53 UT. The Wilhelm Foerster Observatory in Germany supervised an intensive international examination of Torricelli B, but the reported 1983 events in brightness and color were not observed. My own personal observations with 20- and 32-cm, reflectors on 09 February and adjacent dates showed only the most ordinary aspects.

Future Opportunities

Table 2 lists dates in 2002 when the solar lighting of Herodotus will be almost identical to that when the curious 1954 observation of an abnormal shadow was made. For lunar observers in the United States the last best opportunity this year will occur on 18 October 2002. We also supply the date for 2008, which is three saroses after the initial observation. Readers are invited to examine Herodotus at these times, and perhaps they will find some clues to explain the surprising appearance on 11 August 1954. It is a pleasure to acknowledge the assistance of Mr. Julian Baum in Chester, England and Mr. J. O. Hughes in Las Cruces, NM, in the preparation of the illustration Figure 1 for this publication.

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Lunar Transient Phenomena

(From the http://www.lpl.arizona.edu/~rhill/alpo/lunarstuff/ltp.html)

The definition of Lunar Transient Phenomena (LTP) is a short lived phenomenon observed on the Moon. This can consist of red glows, flashes, obscuration, and abnormal albedo and shadow effects.

The purpose of the LTP section is to evaluate observations concerning possible LTP events. This department also establishes programs in which observers can participate. The best example is the recent mission to the Moon by the Clementine spacecraft. The ALPO had the opportunity to participate with this mission by conducting ground based observations on specific lunar formations as the spacecraft passed over them.

The LTP program consists of different levels of participation by the observer. The first level is just general observing of the Moon. If an observer detects anomalous behaviour they would then submit an LTP report. The second level would be to conduct systematic observation of select Lunar features for LTP. The third level consists of a coordinated observing effort of a specific lunar formation on a specific date and time. The fourth level consists of ground based observation in conjunction with a lunar spacecraft mission.

Individuals who which to participate in this program need to have a working knowledge of lunar observing. They should be skilled observers familiar with the Moon and its many aspects of illumination and libration. If you have been an active observer of the Moon and feel this program is for you please contact the LTP coordinator for more information.