Association of Lunar & Planetary Observers

Founded in 1947

Lunar Topographical Studies Section

Coordinator - William M. Dembowski, FRAS

Selected Areas Program

An overview by Dr. Julius L. Benton, Jr.

The missions of Apollo transformed our nearest celestial neighbor from a virtually unknown and inaccessible object into a relatively familiar world. Including the unprecedented historical events of July 20, 1969, twelve astronauts from Earth have set foot upon the Moon's surface, collecting and returning to Earth some 380 kg. of rocks and debris from six Apollo ventures. Of course, in mentioning any lunar explorations from Earth, we cannot omit the small but no less important 130 gm. of rocks gathered during the unmanned Russian Luna-16 and Luna-20 missions.

Apart from the vast collection of photographs, supplementing previous data from missions such as Surveyor and Orbiter, the Apollo program enabled equipment to be set up on the lunar surface to monitor moonquakes, meteoric impacts, thermal characteristics of the lunar surface material, and alleged magnetic phenomena. Adding to the wealth of accumulated data that now exists has been the massive collection of photographs of the entire lunar surface made in unprecedented detail in 1994 by the orbiting Clementine spacecraft. It will be many years, no doubt, before all of this information will be thoroughly assimilated and developed into a realistic account of the Moon and its cosmic history.

For the amateur astronomer, the Moon has always been a favorite subject for his telescopes, and until the first really energetic space efforts, he in large part dominated the field of selenography. Now, with the impact of a great multitude of photographs taken at close-hand, with precise measurements of the Moon's complex chemical composition, radioactivity, and seismic profile, and following sophisticated petrographic investigations of lunar materials, one might quickly assume that the work of the amateur astronomer has been relegated to redundancy or insignificance from our fixed vantage point in space. Too many people have gotten the idea that no awe and mystery remains about our "Queen of the Night."

The activities by Apollo astronauts on the Moon and close-range photographic surveys by lunar orbiting spacecraft are obviously out of the domain of the amateur astronomer. Yet, it must be emphasized that there are areas of lunar observation that still remain the forte of the amateur astronomer, fields that may be pursued without an imminent threat of obsolescence by the onslaught of imposing professional equipment. Unlike the professional specialist, the amateur is often blessed with the freedom to scan a lunar feature of his choice for extended periods of time in hopes of drawing or capturing photographic or CCD images of low-sun shadows of minor relief features, varying tonal patterns exhibited in lunar environments exposed to a high sun, and other possible long-term or transient events.

Any observing program, for its results to be scientifically useful, requires of its participants a suitable blend of preparation, skill, patience, and tenacity. Because of the large image size and brightness of the

Moon, lunar studies are especially suited for amateur astronomers using small to moderate apertures. More importantly, there have been numerous instances when professional astronomers, in trying to resolve some observational query by relying solely on existing spacecraft photographs, have enlisted the services of amateur astronomers. For example, by a fortuitous improper positioning of the spacecraft camera or as a result of unfavorable solar illumination, an optimum view was not afforded of the morphology of a particular lunar crater or other feature.
Fortunately, amateur observers were able to come to the rescue by monitoring the specific region of the Moon under the conditions sought by professional astronomers. In a few cases, needed data already existed in amateur observational archives. Such cooperative efforts clearly demonstrate how meaningful amateur observations of the Moon can be.

Lunar Transient Phenomena (LTP)

There are many areas of lunar research in which the skillful and imaginative amateur astronomer can find worthwhile observational opportunities. One example of a very interesting research program is the monitoring of Lunar Transient Phenomena (LTP). The LTP represent alleged variations at the lunar surface that are typically of ephemeral or instantaneous nature and usually are quite unpredictable. Systematic, simultaneous studies by a team of regular observers using top-quality instrumentation is especially worthwhile, since under optimum conditions LTP events might be glimpsed for only a few seconds to some twenty minutes or so. What is of greatest importance within the scope of such a program is to try to observationally differentiate between LTP "reports" and bona fide LTP events.

No more than a cursory perusal of the available literature will turn up historical accounts of LTP, and while reports of most activity turn out to be dubious, there are growing numbers of undisputedly authentic LTP phenomena from analytical evaluations of available data. Some events have been observed simultaneously by distant and independent observers. As investigative procedures have been refined and improved over the years, it has been possible to confirm some LTP events photographically or with CCD techniques.

Of the more than 1,500 LTP reports and events catalogued since A.D. 557, perhaps the widely publicized Alphonsus spectrograms of Kozyrev in 1958, the observations of Greenacre and Barr of Aristarchus in 1962, and the Moon-Blink reports of the mid-1960's and early 1970's, are the most familiar. Observers are generally more prone to study areas on the lunar surface which are known to have generated LTP reports and events, giving the data sample to date a somewhat lopsided appearance, but it has become evident that LTP events may take place elsewhere on the Moon and not just in the aforementioned "preferential" areas. There are many regions on the lunar surface, indeed, which have been suspected of LTP events, although most of the lesser-known features have never been adequately followed observationally.

Rare and elusive as they may seem, LTP events do appear to fall within roughly defined categories. Small, temporary reddish or pinkish patches, presumably due to fluorescence or incandescent gaseous substances, have been noted shortly after lunar sunrise, while glows lacking any distinct hue have been noticed, sometimes seen on the night hemisphere of the Moon. Emerging quite instantaneously or lasting for several minutes have been bright points of light near the lunar terminator or on the darkened hemisphere of the Moon, while rapid fluctuations in the brilliance of a specific area have been occasionally recorded, again most often in the early lunar morning. Obscurations, visible directly as "fog" or "mist," or indirectly by concealing or obliterating known surface features, are also curiously associated with times of lunar sunrise, but not always so. Any number of variations may sometimes be reported in Earthshine conditions or in conjunction with partial or total lunar eclipses.

From the analytical information to date, it might be concluded that LTP events are probably of random internal origin and are only weakly attributable to external influences. As noted here, the phenomena seem to be of several kinds and involve possible gas or gas/dust mixtures, luminescence of these gaseous substances, and possible luminescence of surface materials.
Perhaps many causative factors operate together to give strong sunrise correlations found in many of the LTP events. Supporting this tentative conclusion of an internal origin of the LTP is the distribution and association of many LTP sites with volcanic maria, dark-haloed craters, sinuous rills, and lunar domes.

The Lunar Selected Areas Program (SAP)

Well over a decade ago, the Lunar Transient Phenomena (LTP) Patrol was introduced as a new program for the A.L.P.O. Lunar Section, and the major thrust of the endeavor was to visually monitor the supposed transient variations at the lunar surface just discussed. In addition to looking for short-lived events, individuals were asked to supplement their observations with a monitoring of certain selected lunar features suspected or historically known to exhibit "seasonal" or long-term phenomena. For example, a variation in the tone or hue of a given area, which cannot be attributed to varying solar illumination and which does not repeat systematically from lunation to lunation, has been seen in certain areas. Principally, these tonal changes occur where dark radial bands or dark haloes are seen within or around some craters, or where darker regions or patches exist on the lunar surface in limited environments. Unusual changes in the apparent morphology, pertaining to overall size and shape, have been detected in conjunction with tonal or color fluctuations in many, but not all, cases. Thus, the intensive studies of specific features such as Alphonsus, Aristarchus, Eratosthenes, Herodotus, Kepler, Messier-Pickering, and Plato, have occurred, and as data were
accumulated and reports on specific regions published, new areas were then added to the list (e.g., Atlas, Ross D, Hell, Pico, Piton, Colombo, etc.).

By 1971, the A.L.P.O. Lunar Recorders decided to segregate the study of LTP from the study of long-term or "seasonal" events, forming the LTP Survey for strictly transient lunar events and the Selected Areas Program (SAP) to deal with long-term variations, each area of concentration headed by a dedicated Recorder. In the years that followed this change, observational data were collected by each program, catalogued, reduced, and published in the Journal of the A.L.P.O., and the results of both programs showed real promise. There were quite a few instances of LTP events and recognized "seasonal" variations apparent in the accumulated data sample.

Indeed, the Selected Areas Program (SAP) and LTP Survey represents meaningful enterprises at the fundamental level of amateur observational astronomy. A major goal of organizations like the A.L.P.O., these are pursuits that are largely concerned with long-term visual monitoring of variable phenomena at the surface of the Moon. The scope of such work has definitely not been rendered obsolete by spacecraft gathering such a great wealth of information about our satellite. Persistent, patient observers, participating in the A.L.P.O. LTP Survey and Selected Areas Program (SAP) can successfully and vitally supplement the findings of space missions and other ongoing professional research, increasing our overall knowledge about the Moon.

Today, the A.L.P.O. Selected Areas Program (SAP) and LTP Survey exist as somewhat separate endeavors, although both programs have achieved greater significance through emerging cooperative ventures of data exchange and comparison. This trend will continue to insure a steady flow of meaningful, scientific data for the future.

The success of the A.L.P.O. Lunar Selected Areas Program (SAP) is dependent upon long-term systematic observations of specific lunar features not only throughout a given lunation, but also from lunation to lunation for many years. Such regular and careful monitoring will familiarize one with the normal, yet often complex, changes in appearance that many features undergo from lunar sunrise to sunset, and it will be possible for the individual to recognize anomalous phenomena more readily from one lunation to the next, should they occur. Special inherent talents for drawing lunar features, although definitely helpful, are not necessary, nor is exceptional visual acuity. The most fundamental and essential prerequisite for participation in the Selected Areas Program is the willingness to follow the Moon and the chosen feature(s) for many consecutive lunations, year after year. Scientific objectivity is mandatory, whereby the observer must develop a constant practice of recording precisely what is seen at the eyepiece, not what one might expect to see (as may be derived from one's previous observations or from studies of published reports from other individuals). Should there be any doubt whatsoever about what is perceived, the observer must routinely note such uncertainties. The resulting data will be far more reliable and of lasting value. While initial efforts to detect rather delicate details on the lunar surface may result in some disappointment, persistent observations will bring about the reward of eventual successful perception (i.e., through training of the eye) of subtle features at the threshold of vision. The joy of recording phenomena or details hitherto unrecognized is reserved largely for the person who has maintained the perseverance to observe the Moon regularly.

Although no inflexible minimum size telescope need be specified for active participation in the A.L.P.O. Selected Areas Program (SAP), most experienced observers are in agreement that the largest aperture available, which can be employed with the existing seeing and transparency conditions, should be used. Even so, a good 10.2cm. (4.0in.) refractor or 20.0cm. (8.0in.) reflector will deliver sufficient resolution of lunar detail for full participation in nearly all aspects of the observing program. No attempt here is made to address the various pros and cons of instrument type or design, and the driving factors in choosing a telescope should be the reliability of the manufacturer, optical and mechanical excellence (giving high-contrast, relatively bright, and crisp images), and reasonable portability.

The percentage of sunlight reflected by the surface of the Moon, as we have seen, varies as the phase angle, g, changes throughout the lunar month. Taken a step further, observers are well aware that one area of the Moon reflects more light (e.g., a crater rim or central peak) than another region (e.g., the maria), regardless of the phase angle, and these areas in turn vary in appearance as the illumination changes. These differences in tone are generally more conspicuous at Full Moon (g = 0o), and the investigation of light and dark areas of the Moon is an interesting observational endeavor.

While there is a definite requirement to know how various lunar features change their normal appearance throughout a lunation in response to variations in phase angle, even more intriguing are those lunar features that behave in an unusual, sometimes unpredictable, and non-repeating manner as solar illumination changes. The A.L.P.O. Lunar Selected Areas Program (SAP) is chiefly concerned with systematically monitoring regular and cyclical long-term variations during many lunations of specifically designated, or "selected," areas on the Moon. The SAP is designed to intensively study and document for each of these features the normal albedo changes in response to conditions of varying solar illumination. The program is equally concerned with the following possible anomalous phenomena:

1. Tonal and/or Color Variations. These are variations in tone or color, or in the size and shape of a region of tone or color, that is not related to changing illumination (i.e., the phenomenon does not exactly repeat from lunation to lunation). Areas in lunar features most subject to such anomalous behavior are radial bands, dark patches, and nimbi or haloes.

2. Shape and Size Changes. These are variations in the appearance and morphology of a feature that cannot be traced to changing solar illumination or libration.

3. Shadow Anomalies. These are deviations of lunar shadows away from the theoretical normal absolute black condition, or a shadow with an anomalous shape or hue, in most cases not attributable to changing phase angle.

4. Appearance or Disappearance of Features. Although exceedingly improbable and controversial, these are features that seem to be present now, but appear to be absent on earlier maps or photographs; or, features that are no longer visible today but which are clearly indicated on earlier maps or photographs.

5. Features Exposed to Earthshine. These are any anomalous tonal or albedo phenomena (any of the categories listed here) that occur under the conditions of Earthshine.

6. Eclipse-Induced Phenomena. These are features that exhibit anomalous characteristics (categories 1 through 4 above) during and after an eclipse, compared with previous eclipses when the same areas were monitored.

Most of the phenomena listed above are related to anomalous variations in morphology, tone (albedo), or color, which cannot be attributed to changing solar angle (phase angle) or libration, and which clearly do not repeat systematically from lunation to lunation. As stated earlier, however, it is essential in our program to establish a record of both the normal and abnormal behavior of suspect lunar areas under all conditions of illumination.

Generally, the SAP has retained some of the methods pioneered years ago by past Lunar Recorders, but a few significant changes have been necessary as the SAP evolved with time. Several areas had been selected in the past for inclusion in the SAP, and while massive files exist on many of these regions, there has been no reason to simply abandon study of these areas. A few published reports appeared in the JOURNAL OF THE A.L.P.O., and some very interesting data resulted, but further investigations are needed to establish a long-term record of normal and any abnormal albedo variances. The lunar features that are currently designated as the official lunar formations that are being monitored as part of the SAP appear below.

SAP Feature	**Selenographic Latitude**	**Selenographic Longitude**
Alphonsus	4°W	13°S
Aristarchus	47 W	23 N
Atlas	43 E	46 N
Copernicus	20 W	9 N
Plato	9 W	51 N
Theophilus	26 E	11 S
Tycho	11 W	42 S

NOTE: The nearby Herodotus, and its evirons, is also considered a part of the program.

All of the areas listed above were chosen because they are relatively easy to find, convenient to observe, and have historically shown numerous instances of suspected anomalies. Complete outline charts and observing forms are available from the A.L.P.O. Lunar Section for each of the features noted.

The standard SAP procedure is to visually monitor as many of the selected lunar features as possible throughout successive lunations, employing established systematic, objective methods of observation. It has already been stressed earlier in our discussions how important the quality of the instrument being used is, and individuals should be familiar with their telescopes and accessories, how to recognize scattered or reflected light, irradiation, as well as aberrations caused by the eye, the instrument, and the atmosphere.

Thus, observations of the Moon that are specific to the Lunar Selected Areas Program may be summarized as:

1. Visual photometry of specific lunar features, defining their normal albedo profiles throughout a lunation as a function of changing solar illumination.

2. Visual photometry of specific lunar features, monitoring variances from their normal albedo that are not simply a result of changing solar illumination.

3. Drawings of specific lunar features throughout a lunation and from lunation-to-lunation in conjunction with visual photometry.

4. Routine photography, CCD imaging, photoelectric photometry, and videography of specific lunar features to supplement visual photometry programs throughout a lunation and from lunation-to-lunation.

5. Comparative analysis of lunar features and albedo profiles.

NOTE: Now included as part of the Selected Areas Program is the Bright and Banded Craters Program and the Dark-Haloed Craters Program. Further information on these programs are available upon request.