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The StarGazer

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Newark: Where Astronomy and Archaeology Intersect

By Lauren Lennon

***Note from the author**: A little-known tidbit about me: In college, I minored in Anthropology with a focus on Archaeology. Earlier this year, I was finally able to visit Newark, Ohio, to see the earthworks that I had studied years ago but had never seen in person. The scale boggles the mind! When Linda asked me to do a newsletter article (two newsletters ago… and I don't think she was expecting this dissertation!), it sprang to mind, so I thought I would do something a bit different with this topic and approach it more from my Archaeology background. I hope you find the history as interesting as I do! —Lauren Lennon*

Approximately 2,000 years ago, the prehistoric groups of Native Americans that would come to be called "Hopewell" were flourishing across the eastern part of North America. Between 200 BC and AD 400, the Hopewell group's sophisticated approach to architecture and society would lay the groundwork for the 19th century obsession with a lost Moundbuilder race (Silverberg, 1986). Enormous earthworks, unique burial practices, a trade network stretching from the Gulf of Mexico up to Lake Ontario, and an unprecedented volume of and detail in artwork set the Hopewell tradition apart. While groups inhabited areas across the Eastern Woodlands and the Midwest, the Ohio Valley Hopewell stand out as the most eccentric and elaborate of the traditions. (Fagan, 2005)

Model of the original earthworks, animation from the EarthWorks project based at University of Cincinnati. Courtesy: University of Cincinnati, see http://www.earthworks.uc.edu/

One of the Hopewell group's most stunning creations was the great earthworks at Newark, Ohio (Figure 1). Originally covering more than 3,000 acres and consisting of near-perfect geometrical figures, the Newark complex was once the largest set of geometric earthen enclosures in the world (Ohio Historical Society). The sheer size is impressive: "four structures the size of the Colosseum of Rome would fit in the Octagon; and the circle of monoliths at Stonehenge would fit into one of the small auxiliary earthwork circles adjacent to the Octagon" (US Department of Interior). The Great Pyramid at Giza, with sides 230.33 meters in length (Scarre, 1999), covers an area of ~13.1 acres; the 44 acres enclosed by the Newark Octagon could comfortably hold three copies of the Great Pyramid and still have room to spare. When Squier and Davis mapped the complex in 1838 for their *Ancient Monuments of the Mississippi Valley*, they wrote that "These works are so complicated that it is impossible to give anything like a comprehensible description of them," (Squier and Davis, 1848) which is why they are under consideration to become a World Heritage Site, as well as listed as one of the "Seventy Wonders of the Ancient World" (Scarre, 1999). As one of only three in North America, the site is internationally recognized for the impressive monument it is. Not so impressive, however, was its seventh-place finish on the Sacred Sites International Foundation's "Most Endangered Sacred Sites" list in 2005.

The Newark complex is documented to have contained an ellipsoid containing burial mounds (called the Cherry Valley Cluster), a large square, a small square (Salisbury Square), two large circles (the first the Fairgrounds/Great Circle, the second the Observatory Circle), a large octagon, many interior and exterior mounds, an outer polygonal wall, and several sets of parallel ways extending away from ***(Continued on page 3)***

How to Join RAClub

RAClub, located in the Fredericksburg, Virginia, area, is dedicated to the advancement of public interest in, and knowledge of, the science of astronomy. Members share a common interest in astronomy and related fields as well as a love of observing the night sky.

Membership is open to anyone interested in astronomy, regardless of his/her level of knowledge. Owning a telescope is not a requirement. All you need is a desire to expand your knowledge of astronomy. RAClub members are primarily from the Fredericksburg area, including, but not limited to, the City of Fredericksburg and the counties of Stafford, Spotsylvania, King George, and Orange. We also have several members who live outside Virginia and have joined to have the opportunity to use the Mark Slade Remote Observatory (MSRO)—one of the benefits of joining the club.

RAClub annual membership is $20 per family. Student membership is $7.50. Click here for a printable PDF application form.

The RAClub offers you a great opportunity to learn more about the stars, get advice on equipment purchases, and participate in community events. We meet once a month and hold regular **star parties** each month on the Saturday closest to the new Moon. Our website, www.raclub.org is the best source of information on our events.

Yahoo!Groups is the email list that RAC uses to send eMails to its members. Please make sure you are subscribed to the RAC email list so that you receive timely club emails concerning meetings, star parties, newsletters, and other events. Please click this link, then the blue "Join this Group!" button, and follow the instructions to sign up. We also have a Facebook presence.

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Upcoming Events		Recent Outreach Events Completed	
Star Party, Stratford Hall	November 16	RAClub Picnic, Caledon State Park	August 24
Star Party, Caledon State Park	November 23	Star Party, Caledon State Park	August 24
Star Party, Caledon State Park	December 28	Embrey Mill Star Party	September 7
Star Party, Caledon State Park	January 18	Star Party, Caledon State Park	September 21
		Meet the Moon, Porter Library	October 5

President's Corner

RAC began accepting nominations for its four club officer positions during the October meeting. Club membership has grown significantly, and I hope more members will consider serving the club as officers. Please think about running for office or participating at club business meetings. Glenn Holliday is stepping down as Vice President, so we need someone to fill his shoes. Elections for the 2020 officers will be held at the November meeting. RAC will provide pizza, as usual.

Yahoo!Groups is how RAC sends out emails to its members. Please make sure you are subscribed to the RAC email list so that you receive timely club emails concerning meetings, star parties, newsletters, and other events. Subscribe by sending an email to rac_group-subscribe@yahoogroups.com.

Wishing you transparent skies and excellent seeing.

Glenn Faini D. Faini
President

Did You Know? **by Scott Busby**

Nathaniel Bowditch (1773 to 1838) was among those in Massachusetts whose influence was greatest in the development of mathematics and astronomy. He was born in humble circumstances, of New England stock, had few educational advantages in youth, and was almost entirely self-taught. While young, he made five sea voyages, during which he devoted every spare moment to study. His enthusiasm was contagious—on one ship every sailor, and even the cook, learned the art of navigation and could determine the position of the vessel with sufficient precision.

Source: : *History and Work of the Harvard University 1839–1927*, Solon I. Bailey, McGraw-Hill Book Co., 1931

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(Continued from page 1)

and going between parts of the complex (Salisbury 1862, Squier and Davis 1848, Lepper 1998). However, in the 16 to 17 centuries between abandonment of the site and arrival of archaeologists, both manmade and natural processes served to destroy the Hopewell's work. Erosion and weathering would have been noticeable over that time frame, but farming by following groups was the most destructive and continued to erase the complex (Converse, 2003). The lack of written or oral documentation of the site, not unexpected given the length of time involved and the large changes in local Native American populations owing to relocation and outward expansion, means that the full extent of the complex will probably never be known.

It wasn't until the early 1800s that archaeologists became aware of the Newark complex. The city of Newark was officially founded in 1802, and both pioneers and explorers reported "mysterious monumental architecture" (Lepper, 1998) throughout the first decade of the century. Unpublished maps were unearthed in antiquarian archives over a century later, but the first available map of Newark (Figure 2) was not published until 1820, when Caleb Atwater included Alexander Holmes' survey results in his *Description of the Antiquities Discovered in the State of Ohio and Other Western States*. Squier and Davis, whose extensive work was published 1848 and now serves as the only record of many mounds and earthworks across North America, followed with a map (Figure 3) completed by Charles Whittlesey. While their map was more complete then Atwater's, Squier and Davis arrived too late—the City of Newark had been expanding, and the conveniences of civilization spread across Ohio. The Ohio and Erie Canal Project was funded and excavated between 1825 and 1832 to connect the growing settlements in Ohio and Pennsylvania with the established cities on the East Coast and went straight through part of the square and the oval-enclosed burial mounds. It is visible as a black line on the right side of Figure 3.

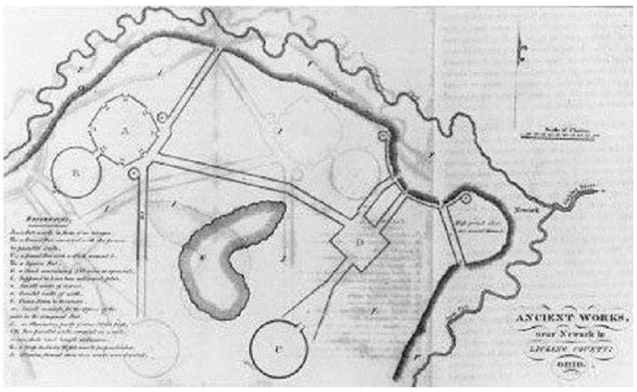


Figure 2: Ancient Works at Newark, published by Atwater in 1820.

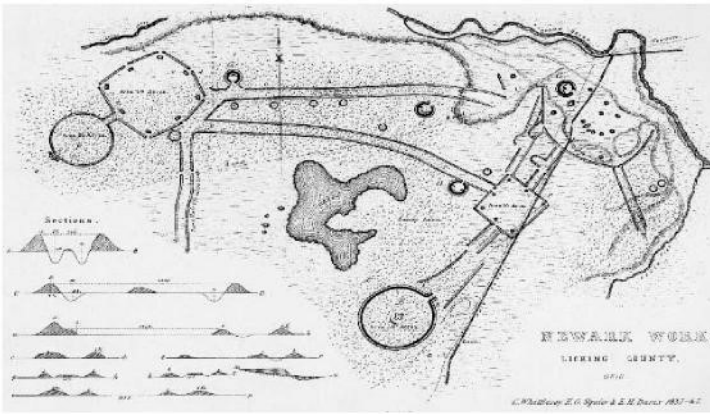


Figure 3: Ancient Works at Newark, as appearing in Squier and Davis' Ancient Monuments.

Some good did come of the destruction of the mounds at this phase—observations made of the site as a whole by local antiquarians during the excavations for the canal constitute the only scholarly knowledge of many of its features. Years later, Israel Dille, one of the men involved with documenting the contents of the destroyed mounds, would describe their unexpectedly extraordinary contents to Squier and Davis as follows:

> *In excavating the lock pit, fourteen human skeletons were found about four feet beneath the surface... Over these skeletons, and carefully and regularly disposed, was laid a large quantity of mica in sheets or plates. Some of these were eight and ten inches long by four and five wide, and all from half an inch to an inch thick. It was estimated that fifteen or twenty bushels of this material were thrown out to form the walls or supports of the lock. (Squier and Davis 1848: 72, emphasis added by Lepper 1998)*

The town newspaper also carried the story, wondering "to what race did this people belong. When did they exist? And why were the tenants of this cemetery buried with such marked distinction?" (*The Advocate*, 1827) A pit had also been dug into Eagle Mound at the center of the Great Circle, and Squier and Davis reported that an "altar, but little else, had been found in an excavation into the boxy of the bird" (1848), but more elaboration would describe the altar as "built of stone, upon which were found ashes, charcoal, and calcined bones," and a possible crematory basin (Smucker 1881). The Observatory Mound at the far end of Observatory Circle was the first part of the site to actually undergo official excavations. In 1836, the Calliopean Society studied the site to test an archway theory proposed by Atwater in his 1833 work; however, they thoroughly proved it wrong by reporting that the "mound was composed of earth and rough stones overlying a stone pavement." (Lepper 1991, 1998)

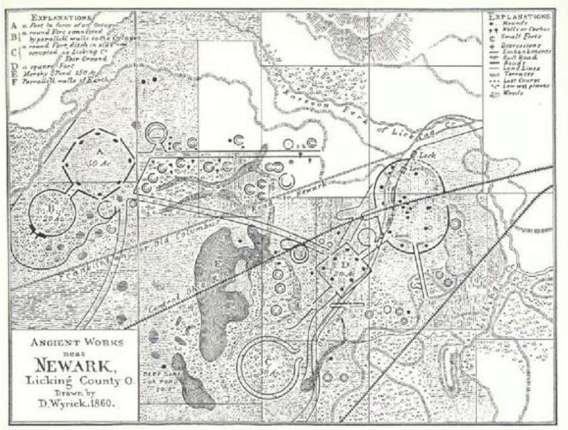


Figure 4: Ancient Works Near Newark, by Wyrick in 1860.

Even after the work and excavations, Newark was still an imposing sight to behold for the exploring Squire and Davis:

> *Twelve feet in perpendicular height by fifty feet base, and have an interior ditch seven feet deep by thirty-five wide. At the gateway or entrance, the walls are much higher than any other point, being not less than sixteen feet in altitude, with a ditch thirteen feet deep, giving an absolute height of about thirty feet from the bottom of the ditch to the top of the embankment. (Squier and Davis, 68)*

Shortly after Squier and Davis's publication, however, the site was further destroyed by the building of the Central Ohio Railroad between 1852 and 1855. Although the Canal had been useful for a short period, the expanding cities of Ohio needed faster and more effective methods for transporting large amounts of material from the east. For reasons unclear, the track was run straight through the Newark complex with complete disregard for the site. David Wyrick's 1860 map published in the *Licking County Atlas* in 1866 (Figure 4) showed the two roads, canal, and railroad all crossing the site. Wyrick's map had been part of a

series investigating the mounds; however, Wyrick believed them to have been created by one of the Lost Tribes of Israel (one of the many groups rumored to be the mythical Moundbuilders) and was embroiled in the "Holy Stones" hoax involving a Hebrew "Keystone" proving his theory (Lepper 2000). When the fraud was revealed, his work was mostly ignored until the mid-1900s when he was proven innocent and recognized as a competent antiquarian surveyor (Applebaum 1996). Between these developments, many of the burial mounds and smaller earthwork remnants were completely destroyed—purposefully, in the case of the Cherry Valley cluster; it was "leveled for use as fill for the railroad embankment or vanishing under equally ignominious circumstances" (Lepper, 1998).

The only artifact in the Ohio Historical Society collections that came from the Cherry Valley mounds is a stone figurine (Figure 5), which was found during the 1881 deconstruction of a mill located on the crest of the largest mound. It was first described as a "remarkable stone image" (Mason 1882) in the *American Naturalist* by O.T. Mason in 1882, and a century later would be the subject of work by archaeologists Dragoo and Wray. It pictures "a Hopewell shaman dressed in a bearskin and holding a decapitated human head" (Romain 2000). Another local antiquarian carried out some small excavations of the mounds in 1868 and described copper and shell artifacts in addition to burials and postholes (J.N. Wilson 1868); however, his collection disappeared upon his death, and no other has ever been found.

Figure 5: Wray figurine of Hopewell Shaman.

The southern circle was preserved because it was purchased by the Licking County Agricultural Society in 1853, before construction began on the railroad; however, from 1854 to about 1933 it was used as the location for both the County Fair and the Ohio State Fair because of its impressive nature.

> *The popularity of this grand fort has been constantly growing...One can scarcely picture a more delightful spot wherein to while away the sultry days of summer. Its superb mounds, its accessibility, its superior conveniences, its inspiring surroundings, and the many facilities afforded for perfect restful contentment and exhilarating diversion, at once commend this favorite retreat as an ideal and unsurpassed pleasure resort. (Lingafelter, 1899)*

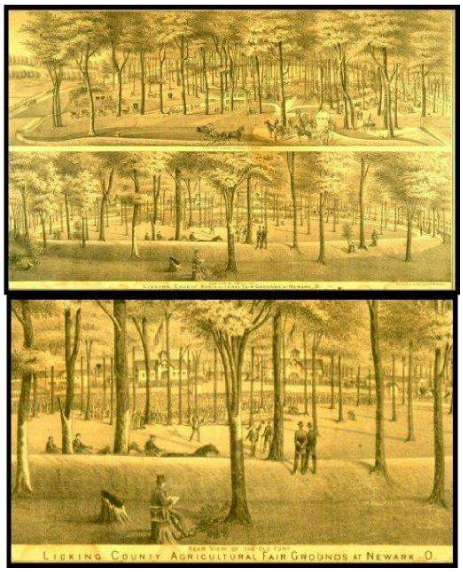


Figure 6: The Great Circle as a fairground and racetrack.

This fed the prevailing misconception that this was a defensive site, resulting in it being called the "Old Fort" or some other defensive term in many manuscripts (Lingafelter 1899, and *General Harrison's Discourse* from 1845, for example) even though Squier and Davis were correct in asserting that "it could not have been designed for defense... the structure which, from the height and solidity of its walls, would seem best adapted for defense, has its ditch *interior* to the embankment—a blunder which no people possessing the skill and judgment displayed in the defensive works of the mound-builders, would be apt to commit" (Squier and Davis, 1848). The use of the central area as a training ground for the 76th Ohio Volunteer Infantry from 1861 to 1862 probably also compounded the misidentification.

Possibly because the Civil War resulted in some manuscripts being overlooked, archeological efforts at Newark, for example, by the Salisbury brothers in 1862, went unnoticed and uninvestigated. Over the next decade, the Great Circle would almost literally be turned into a circus, as the popularity of the area continued to grow and create a yearly tourist event; a racetrack, extensive pathways, fair buildings, grandstands, livestock barns, a hotel, and even a dance pavilion sprang up within its earthen walls (Site Management). Buffalo Bill's Wild West Show even made an appearance in 1884. The great mound at the center, named Eagle Mound, was described as having become "head-quarters for jockeys of the horse ring," with the race track "wearing it away at the base...despoiling it of form and beauty" (Fulton, 1868). Despite urgings to preserve the site and even

an attempt to designate it as the nation's first national park (Haven, 1870), the popularity of the site as a vacation destination (Figure 6) had already been permanently established to the horror of many:

> *They are rapidly passing away by the sacrilegious hands of civilization. This is all wrong. It is a species of vandalism that should not be allowed. They ought to be protected by state authority, as sacredly as the Pyramids of Egypt. But as this will not be done, let us as far as possible preserve them in written records, and faithfully transmit each successive ray of light that may break forth from them. (Park 1870: 56)*

The condition of the earthworks would continue to degrade through the end of the century, as the Great Circle was operated as the Idlewilde Park amusement park from 1896 to 1924. Complete with everything from a casino, to a roller coaster, to a Ferris wheel (Figure 7), Idlewilde accelerated the wear on the earthworks. After the company went under in 1924, and the fair was discontinued in 1933 in the face of the Great Depression, the use of the Circle finally began to move toward a more park-like system.

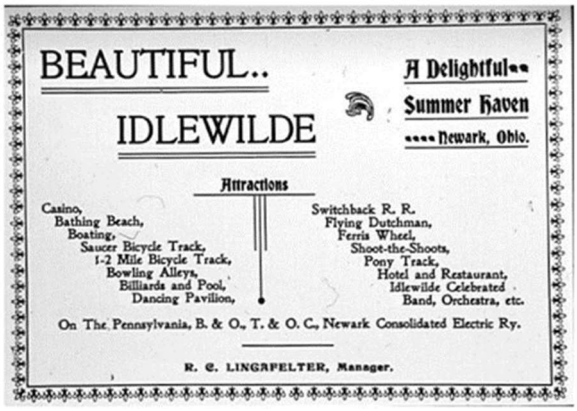


Figure 7: Advertisement for the opening of Idlewilde Park, inside the Great Circle.

It was over this same time that the Octagon, thus far privately owned and extensively farmed, was purchased and given to the state for use as training grounds for the State Militia in 1892. At that same time, the militia also restored part of the Octagon that had been plowed down in such a manner that some began to complain that "the State authorities have a little overdone the matter of restoration" (Fowke 1902:171). When the militia outgrew the site and had to move, leaving the land unoccupied and in need of upkeep, the growing town of Newark engaged in heated debates over the future of the land. For 2 years, the *Newark Advocate*, the town newspaper, was flooded with letters and suggestions to turn the land into a public park or a golf course. Money won out in the end, however, and in 1910, the land was leased to an informal golf country club on the condition that it remained free and open to the public. By 1923, the golf course had expanded to 18 holes and taken the name "Moundbuilders Country Club." (*Newark Advocate*)

In 1928, the Ohio State Museum conducted additional excavation of Eagle Mound to assess the value of the site as well as investigate the claims from Wilson in 1865. Emerson Greenman led the project and documented more than 50 artifacts at the site as well as a rectangular pattern of postholes at the base of the mound from what was once a large structure. A "prepared floor of red clay," mica fragments, charred textiles, bone fragments, and several copper artifacts were found in connection with the structure (Greenman 1928). Interest in the area, particularly some of the parallel walls documented by the Salisbury brothers, was rekindled, and the new resource of flight was used to inspect Newark in 1930 in the hopes of seeing outlines long erased from ground-level view.

> *"The Newark Earthworks were so imposing and elaborate that it is difficult to describe them in terms other than grandiose... In spite of their grandeur, much of this magnificent was destroyed, and, as Squier and Davis (1878:71) predicted, today it is possible to walk through large areas of modern Newark and not know that the monumental Hopwellian geometric earthworks ever existed." (Lepper, 1998)*

Soil discolorations and slight differences in appearance caused by minute differences in height, make even plowed earthworks visible from the air; Warren Weiant observed not only the remnants of the miles-long walls, but also found almost a dozen smaller circles at regular intervals down the roadway (Weiant 1931). These wall remnants extended more than 10 kilometers southwest of Newark, a projected route that would lead directly to Chillicothe—the cultural capital of the extended Hopewell tradition—and so were named the Great Hopewell Road because of their enormous size. To construct "straight, parallel walls nearly 90 kilometers long" would be a monumental engineering feat (Lepper 1998, Byers 1998).

The site was transferred to the Ohio Historical Society by 1933, allowing use of federal Depression Relief funds owing to it now being a historic site. A workforce of more than "220 veteran enrollees and officers" descended on the site; the remaining buildings of the fairgrounds and the destructive racetrack were completely removed, and repairs on the earthworks began based on the maps of a century before (Newark Advocate). The federal funding would run out, however, and work ended so abruptly in 1937 "that crews left the dwelling house [of the

Superintendent] at Octagon unfinished" (Site Management), and the Historical Society had to begin searching for additional funds to sustain the property. Once again, the golf club stepped forward and re-signed the lease on the property within a year—a lease that would be continuously renewed to the present day because the budgetary constrictions of the Historical Society prevented it from personally maintain the property.

Expansion of the Country Club increased through the 1960s, with holes being built within the Octagon itself and the installation of a swimming pool in addition to a new clubhouse. The club, however, prevented further excavations on the property. Discoveries of small caches of artifacts happened intermittently through the 1970s and 1980s, one of which was the only the second time the smaller square enclosure across the Licking River was documented. The Salisbury brothers had documented a brickyard owner's discovery of "a stack of flint spears, numbering 194, about two feet below the surface... leaf-shaped bifaces of Flint Ridge flint... placed points upwards in a conical pile" (1862). Mary Sunkle's 1970 discovery of another cache was the largest collection documented and recovered from Newark, containing "more than 551 artifacts, including 157 Hopewell cores and core fragments, 150 bladelets and bladelet fragments, 22 projectile points, 8 ground stone artifacts, 2 pieces of fossil coral, and other flakes and bifaces... concentrated in a circle 1-2 meters in diameter... layered with cores at the top, bladelets next, and projectile points at the bottom" (Lepper 1998). Aside from individual artifacts occasionally unearthed, there have been no further caches discovered or excavations attempted.

However, there has been continued interest in the possible uses the complex could have had. Such great effort had been put into their construction, over the multigenerational time period required to construct them, that there had to have been some overarching reason for their existence. The geometric shapes required a cleverness previously unattributed to Native American peoples, because field surveys "of the Newark Observatory Circle show that this earthwork, which is more than 1000 feet in diameter, is within four feet of being a perfect circle" (Romain 2000). Romain's *Mysteries of the Hopewell* addresses many mathematical relationships between the parts of the complex, such as that the circumference of the Great Circle is equal, within a 1-percent error, to the perimeter of the square nearby. Even by modern building standards, 1 percent is a perfectly acceptable margin of error in alignments or heights. The great knowledge of math and geometry present at Newark and other Hopewell sites (such as High Banks, also in Ohio and very similar in layout to Newark) suggest a strong grasp of the natural world around them. The mindset that "geometry existed before the Creation. It is co-eternal with the mind of God... Geometry provided God with a model for the Creation... Geometry is God Himself" (Johannes Kepler, Romain 2000) led to prevailing theories that Newark was a religious site and also led to ideas that it served to embody the Hopewell's religion on earth. "We simplify the universe and make things comprehensible by isolating patterns and superimposing simple geometric forms and models on the phenomena around us... Geometry implies that there is order in a universe that might otherwise appear random and chaotic" (Romain 2000). The multitude of sites in Europe that had been shown to have celestial alignments were strong encouragement to look for such works in the New World, and that's what the astrophysicists Hively and Horn set out to do in 1982.

Figure 8. The axial alignment of the moonrise with Newark's Octagon Earthworks. (Photo: Courtesy of The Ancient Ohio Trail)

Their results were astounding: after accounting for the apparent changes in the Sun, Moon, and stars in the 2,000 years since the construction of the site, Hively and Horn found that the Hopewell had designed their grand complex to embody the motion of the Moon (see Figure 8).

Most of the main features related to the orientation, shape, relative size, and asymmetry of the surviving earthworks can be accounted for with the single hypothesis of deliberate lunar alignment. It should also be emphasized that all the alignments we have found correlate with a single object, the Moon. The intellectual power, tenacity of purpose, continuity, and desire for precision that would be implied by conscious lunar alignment is certainly no greater than that required in the construction of the earthworks themselves, a feat which is not in dispute. The geometric regularity of the works shows clearly that the Hopewell had a strong concern for

> *geometrical harmony, and it is not surprising that they might record celestial harmonies (perhaps essential to their calendar) in the same structure. (Hively and Horn 1982)*

Observatory Mound, the walkway, and the Octagon's mutual longitudinal axis was found to be within two-tenths of one degree from the point on the horizon where the moonrise marking the Moon's maximum northern position would occur. The axis of Eagle Mound and the gateway to the Fairground Circle was also found to be an alignment, to within nine-tenths of one degree, with the Moon's minimum northern rising position. If a different horizon elevation is used, as proposed by Romain, then Hively and Horn's results exactly correspond to the lunar positions. These positions only occur every 18.6 years owing to the orbital resonance and locking of the Moon's orbit; that makes the implications of the Hopewell's construction even more awe-inspiring—those corresponding moonrises occurred only once every 18.6 years to allow planning and checking the earthworks!

Any astronomer would thumb his/her nose at proposed alignments—it's possible to create a sighting line wherever it serves one's purpose—so Hively and Horn decided to be thorough. In a 2007 issue of the *Midcontinental Journal of Archaeology*, they published their results regarding a series of simulations. Using a Monte Carlo analysis, which is based on assigning random probabilities to all possible values in a simulation, a computer generated more than "10 billion equilateral octagons, randomly aligned them to a compass bearing and then checked how many astronomically significant alignments resulted. They determined that, even making the most generous plausible combination of assumptions favoring chance alignments, the odds that the alignments at Newark are merely accidental are about one in a thousand. Using more reasonable assumptions, the odds are more like one in 40 million" (Lepper 2007). So even if they allowed up to ~10 percent error in the alignment of the axis, the chance of getting one octagon aligned to that position is one-thousandth; getting to within 1 percent is statistically improbable—around the probability usually associated with winning the lottery.

These grand earthworks, therefore, are the equivalent of the archeological lottery jackpot. A group of people existed prior to any European contact who were advanced astronomers and mathematicians capable of organizing and building such a mammoth work. That so little remains of them now—in the middle of a golf course no less—is a tragedy for future generations of both visitors and archeologists. Preservation of such ancient works, or what remains of them in the wake of civilization, will certainly be one of the greatest challenges as the population of the globe continues to increase. Much can be learned from them, both physically as artifacts and philosophically as ideas of a people long dead because "the question of questions, for all mankind—the problem which underlies all others, and which is more deeply interesting than any other—is the ascertainment of the place which Man occupies in nature and of his relationships to the universe of things" (Thomas Huxley, Romain 2000), and humanity as a species is constantly looking both to the past and the future—and up to the stars—for answers.

References

Advocate [Newark].1827. "Antiquities of Ohio." *The Advocate* [Newark, OH], 29 March 1827.

Converse, R. 2003. *The Archaeology of Ohio*. The Archeological Society of Ohio, Fairborn, OH.

Dragoo, D.W. and C.F. Wray. 1964. "Hopewell Figurine Rediscovered." *American Antiquity* 30:195–199.

Fagan, B.M. 2000. *Ancient North America: The Archaeology of a Continent*, third edition. Thames and Hudson, New York, NY.

Haven, S.F. 1870. "Report of the Librarian." *Proceedings of the American Antiquarian Society*, 27 April 1870, pp. 39–41.

Hively, R. and R. Horn. 1982. "Geometry and Astronomy in Prehistoric Ohio." *Journal for the History of Astronomy. Archaeology Supplement* 13: S1–S20.

Lepper, B.T. 1989. "An Historical Review of Archaeological Research at the Newark Earthworks." *Journal of the Steward Anthropological Society* 18(1&2):118–140.

_____. 1995. "Tracking Ohio's Great Hopewell Road." *Archaeology* 48(6):52–56.

_____. 1996. "The Newark Earthworks and the Geometric Enclosures of the Scioto Valley: Connections and Conjectures," in *A View from the Core: A Synthesis of Ohio Hopewell Archaeology*, edited by P.J. Pacheco, pp. 224–241. Ohio Archaeological Council, Columbus, OH.

_____. 1998. "The Archaeology of the Newark Earthworks," in *Ancient Earthen Enclosures of the Eastern Woodlands*, edited by R.C. Mainfort, Jr. and L.P. Sullivan, pp. 114–134. University Press of Florida, Gainesville, FL.

_____. 1999. *People of the Mounds: Ohio's Hopewell Culture*. Eastern National, Ft. Washington, PA.

Lepper, B.T. and J. Gill. 2000. "The Newark Holy Stones." *Timeline* 17(3):16–25.

Lepper, B.T. and R.W. Yerkes. 1997. “Hopewellian Occupations at the Northern Periphery of the Newark Earthworks,” in *Ohio Hopewell Community Organization*, edited by W.S. Dancey and P.J. Pacheco, pp. 175–205. Kent State University Press, Kent, OH.
Licking County Engineers Office. 1797. *Original Surveys of Licking County, Ohio*. Notebooks on file, Licking County Engineers Office, Newark, OH.
Mason, O.T. 1882. “Stone Image Found in Ohio.” *American Naturalist* 16(2):154.
Mainfort, R.C. and L. Sullivan. 1998. *Ancient Earthen Enclosures of the Eastern Woodlands*. University Press of Florida, Gainesville, FL.
Romain, W.F. 2000. *Mysteries of the Hopewell: Astronomers, Geometers, and Magicians of the Eastern Woodlands*. University of Akron Press, Akron, OH.
Salisbury, J. H. and C.B. Salisbury. 1862. *Accurate Surveys and Descriptions of the Ancient Earthworks at Newark, Ohio*. Manuscript on file, American Antiquarian Society, Worcester, MA.
Scarre, C. 1999. *Seventy Wonders of the Ancient World*. Thames & Hudson, New York., NY.
Silverberg, R. 1986 *The Mound Builders*. Ohio University Press, Columbus, OH.
Smucker, I. 1873. “The Mound-Builders' Works in Licking County, Ohio.” *American Historical Record* 2(23):481–485.
Squier, E.G. and E.H. Davis. 1998 [1848] *Ancient Monuments of the Mississippi Valley*. Edited and with an introduction by D.J. Meltzer, Smithsonian Institution Press, Washington DC.
Wilson, J.N. 1868. “Mounds Near Newark,” in *Isaac Smucker Scrap Book*, pp. 69–71. Manuscript on file, Granville Public Library, Granville, OH.

Sacred Sites: http://www.sacred-sites.org/preservation/endangered_octagon_mound.html
Ohio Historical Society—Site Maintenance Plan: http://ohsweb.ohiohistory.org/places/c08/pdf/Chronology.pdf , http://ohsweb.ohiohistory.org/places/c08/ ,http://ohsweb.ohiohistory.org/places/c08/pdf/Appendix1_History.pdf
EarthWorks Project, University of Cincinnati, http://www.earthworks.uc.edu/
World Heritage List, http://whc.unesco.org/en/tentativelists/5243/

Mark Slade Remote Observatory Now Owned by MSRO Science, Inc.

By Jerry Hubbell

Myron Wasiuta and Jerry Hubbell founded the Mark Slade Remote Observatory (MSRO) in November 2015, and in December of that year, the Mark Slade Remote Observatory Commission was formed to manage the funding, operation, and maintenance of the new facility. As of August 2019, the MSRO had been in continuous operation for 3-1/2 years. On August 23, 2019, the MSRO Commission transferred ownership of the observatory to the newly incorporated non-profit 501(c)(3) MSRO Science, Inc. The MSRO Commission members became members of the Board of Directors of the new company and appointed Myron as the President and Jerry as the Vice-President of the company.

MSRO Science, Inc. Logo

MSRO Science, Inc. Board of Directors and Officers
Member and President—Dr. Myron Wasiuta
Member and Vice-President—Jerry Hubbell
Member and Secretary—Dr. Bart Billard
Member and Treasurer—Shannon Morgan
Member—Lauren Lennon
Member—Linda Billard
Member—Glenn Faini

The company was formed as a non-profit corporation to better bring the work of the observatory to the general public and to take advantage of the various fund-raising opportunities available to non-profits. Donations to the company are tax-deductible, and the company will offer grants to students who want to be trained in the maintenance and operation of the observatory along with options to perform research with the permanent staff astronomers at the observatory. MSRO Science will be announcing its training program soon, along with the cost to the general public for this training. For more information go to www.msroscience.org.

RAClub was an early donor to the observatory and over the years has donated $1,440 to the MSRO to help build the facility and contribute to its operation and maintenance. The club membership currently has $1,440 credit

toward training and observation time on the observatory. At $1.00 per minute for the observatory and instructor, the credit is worth 24 hours of time to be allocated to the club membership on a first-come, first-serve basis as determined by the RAClub officers at the October 16, 2019, RAClub meeting.

The RAClub MSRO credit will become available on January 1, 2020, for RAClub members in good standing since January 1, 2019. These RAClub members are "qualifying" members. Members who have joined since August 2019 will need to be sponsored by a qualifying member and will be allowed to join in that qualifying member's observing session. Additional time can be purchased at the rate of $1.00 per minute with a minimum observing time of 1 hour, including observatory startup and shutdown time of 10 minutes for a total of $60. The purchased time on the observatory includes the equipment rental and a qualified instructor. Observatory time will be allocated to RAClub qualifying members in blocks of 3 hours, with a total of 8 blocks of time currently available. The blocks will be allocated to the qualifying member, and the qualifying member can sponsor another member to attend the 3-hour session to share in the experience and training for free.

If you are a RAClub qualifying member and want to use the MSRO, please contact Dr. Myron Wasiuta at president@msroscience.org or Jerry Hubbell at vicepresident@msroscience.org. to arrange your observation session.

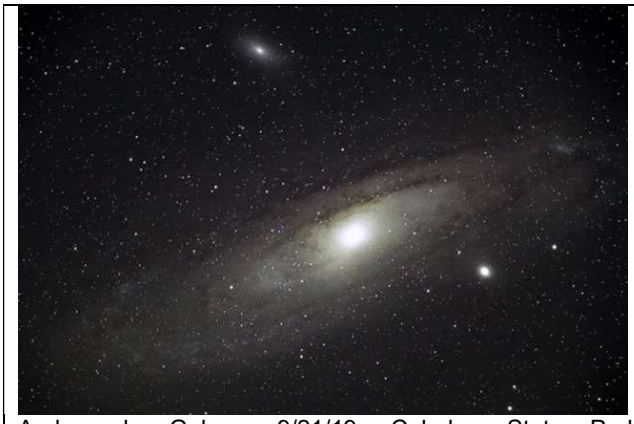
Recent Club Events and Star Parties

By Glenn Faini, David Abbou, and Linda Billard

We had a great picnic and Star Party on August 24 at Caledon. The weather was nearly perfect, and we had a great turnout. Thank you to everyone who participated. Estimated numbers were 21 members and 22 guests. We must have had at least a dozen telescopes.

For the fourth consecutive year, RAClub supported the Embrey Mill star party. David Abbou and Mark Burns hosted the event on September 7, 2019, from 7–9 p.m. About 100 residents stopped by to see great views of the Moon, Jupiter, and Saturn through the two 8-inch telescopes. RAClub applications and NASA outreach materials were provided, and the Embrey Mill Community Manager Lisa George expressed her thanks to RAClub for its continued support.

David Abbou with young participant at Embrey Mill Star Party



Andromeda Galaxy, 9/21/19, Caledon State Park Courtesy Troy Major

On September 21, the Caledon Star Party was, again, very successful, with 6 members, 35 guests, and 9 telescopes. Troy Major, a relatively new member, successfully imaged the Andromeda Galaxy (see photo at left). He used his Williams Optics 98 mm triplet telescope on a Celestron AVX mount. The camera was a Canon EOS M50. The exposure was 30 seconds at ISO 4000. He stacked 45 frames using DeepSkyStacker and processed with PhotoShop Express.

On October 5, David and Mark also participated in the 7th annual Meet the Moon event held at the Porter Library in Stafford. Although the sky was totally cloudy and they couldn't observe the Moon, they and the library staff and

volunteers led several Moon-related activities and provided educational materials for the approximately 100 attendees. In addition, David handed out RAClub applications to several attendees who asked about local astronomy clubs. Here's hoping for clear skies next year!

Pennsylvania Visitor Gets Tour of Belmont Observatory

By Scott Busby and Linda Billard

On August 8, Glenn Faini received an email via his RAClub President's account that Paul Smaglik, the secretary of the Greater Area Hazelton Amateur Astronomical Society would be in our area the following week and asked whether a member of club would be interested in showing him the night sky in Virginia. Scott Busby kindly wrote back agreeing to host Mr. Smaglik for some viewing at his Belmont Observatory.

Here is Scott's report on the visit:

"We had a great visit on Wednesday, 14 August. Paul had come down to Fredericksburg from Pennsylvania on business. On behalf of the RAC and as former RAC President, I invited him out to Belmont Observatory. Paul and I discussed the histories of both our clubs and our general operational methods and our astronomy outreach efforts. Both clubs are roughly the same size with the same number of active members. The biggest difference is they have no annual elections because there are no term limits and the current officers assume their duties for as long as they want. Altogether we spent the better part of 2 hours discussing astronomy, telescopes, and other related topics. I took Paul on a short tour into my observatory and showed him the FRC300. We then went to my workshop to discuss my duties as the RAC equipment manager and looked at a few of the RAC's loaner telescopes. I also showed Paul my Cave 10-inch restoration project. All in all, the visit was productive. Unfortunately, clouds prevailed and a full moon was present, so no observing."

Focus On: Alphonsus, Aristarchus, and Herodotus

Jerry Hubbell

(Note from the author: A version of this article was published in the September 2019 ALPO The Lunar Observer *as the Focus On bi-monthly article. Part of my role as the Assistant Coordinator (Lunar Topographical Studies) is to write articles periodically on research done by ALPO contributors. To see full-size versions of the photos in this article, go to http://moon.scopesandscapes.com/tlo_back.html To see the latest issue of* The Lunar Observer, go to *http://moon.scopesandscapes.com/tlo.pdf)*

This month starts a new series of articles based on the craters in the Lunar Topographical Studies Selected Areas Program (SAP). This is a visual observing program that most beginners can easily start using a small refractor or Newtonian reflector. The program is designed to focus attention on areas of the Moon that have shown unusual albedo changes during the lunation period. As stated on the main SAP webpage:

> *"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. In general, 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."*

SAP is a great way to get familiar with some of the main features of the Moon and enjoy visually roaming over the landscape to see every tiny detail. You will find all the information needed to start this observing program here.

This series of articles will cover the areas defined in the program and discuss an additional way you can observe and monitor these areas using your own high-resolution lunar images or other images you may find online. Using the Lunar Terminator Visualization Tool (LTVT), you can do various measurements of these craters and perhaps gain more insight into the "regular and cyclical long-term variations" that may occur in these areas. The LTVT allows you not only to measure the size of features but also systematically measure the height of the various peaks and hills on the Moon using shadow measurements. Some of the changes in these areas involve the

shifting shadows; by measuring specific locations over the long term, the apparent shift in the measured heights over time might give additional data. Using the SAP crater drawing templates and the Lunar Aeronautical Charts (LACs) for each crater, I will identify specific shadows to measure. I welcome any suggestions you may have in this regard.

The craters (with their diameters) in the SAP include: Alphonsus (71 miles), Aristarchus (24 miles), Atlas (53 miles), Copernicus (56 miles), Herodotus (21 miles), Plato (61 miles), Theophilus (61 miles), and Tycho (52 miles). In this article, we start with the craters Alphonsus, Aristarchus, and Herodotus. Figures 1 and 2 show the crater drawing outlines used in SAP for Alphonsus, Aristarchus, and Herodotus, and Figures 3 and 4 show the LAC view of these craters. Note that to more easily compare to the LACs, the SAP drawings are depicted rotated 180° (north up, east right) rather than the crater drawing outline chart (SAP form) available on the website.

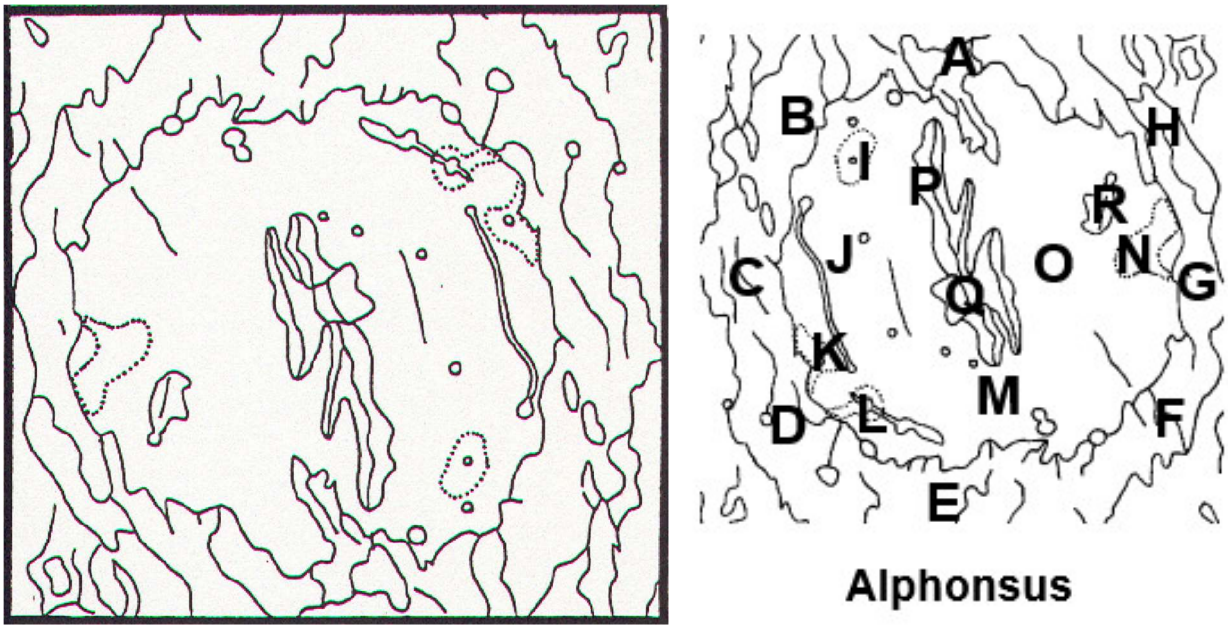


Figure 1. a) Outline drawing of Alphonsus (north-up, east-right). b) Albedo Points for Alphonsus (north-down, east-left)

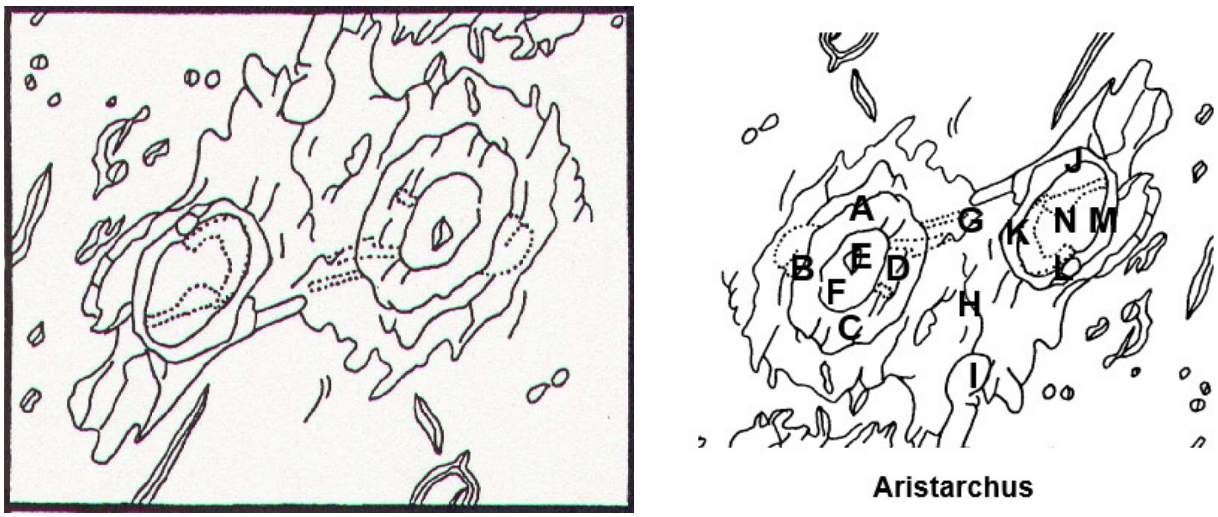


Figure 2. a) Outline drawing of Aristarchus and Herodotus (north-up, east-right). b) Albedo points for Aristarchus and Herodotus (north-down, east-left).

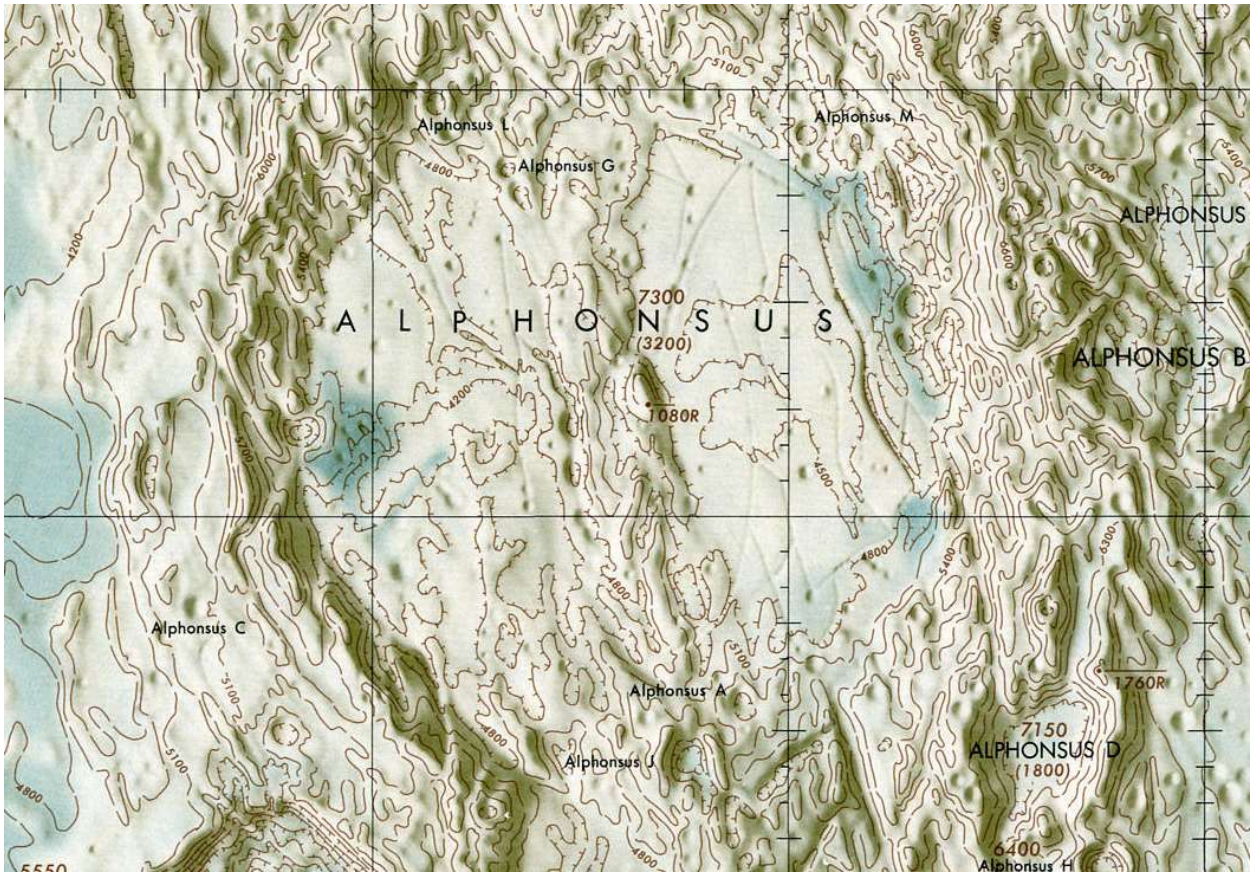


Figure 3. LAC77 chart of Alphonsus. (north-up, east-right)

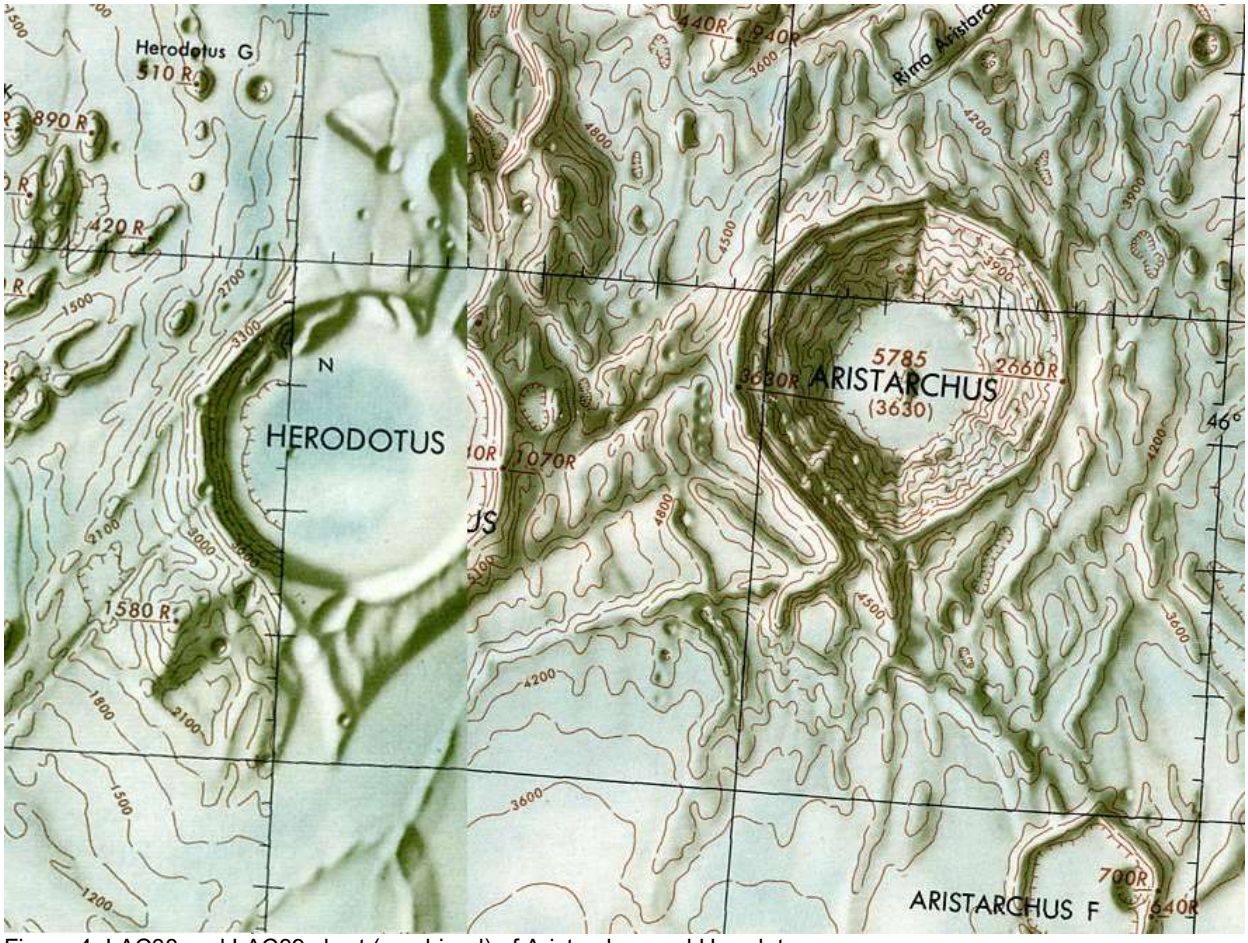


Figure 4. LAC38 and LAC39 chart (combined) of Aristarchus and Herodotus

Rik Hill has provided some great examples of images of these craters, including the image of Alphonsus (Figure 5). I provided one of my early images of Alphonsus taken in 2011 (Figure 6).

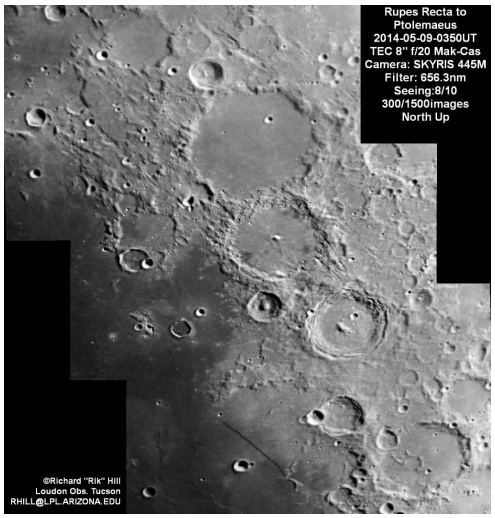


Figure 5. Ptolemaeus, Alphonsus, and Arzachel Region. Rik Hill, Tucson, Arizona, USA, 09 May 2014, 0350 UT. Colongitude, 28.1°, TEC 8-inch f/20 Mak-Cas, SKYRIS 445m CCD Camera + Red filter. Seeing, 4/5.

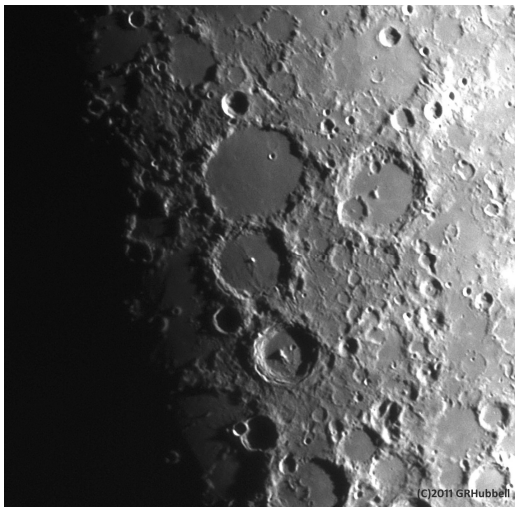


Figure 6. Ptolemaeus, Alphonsus, and Arzachel Region. Jerry Hubbell, Locust Grove, Virginia, 13 March 2011, 0217 UT. Colongitude, 11.4°, SkyWatcher 12-cm f/7.5 APO refractor, ATIK 314e CCD Camera + 2x Barlow. Visibility, 4/5 Transparency, 3/5.

Figures 7 and 8 show the LTVT processed images showing the height measurements of various features of each crater.

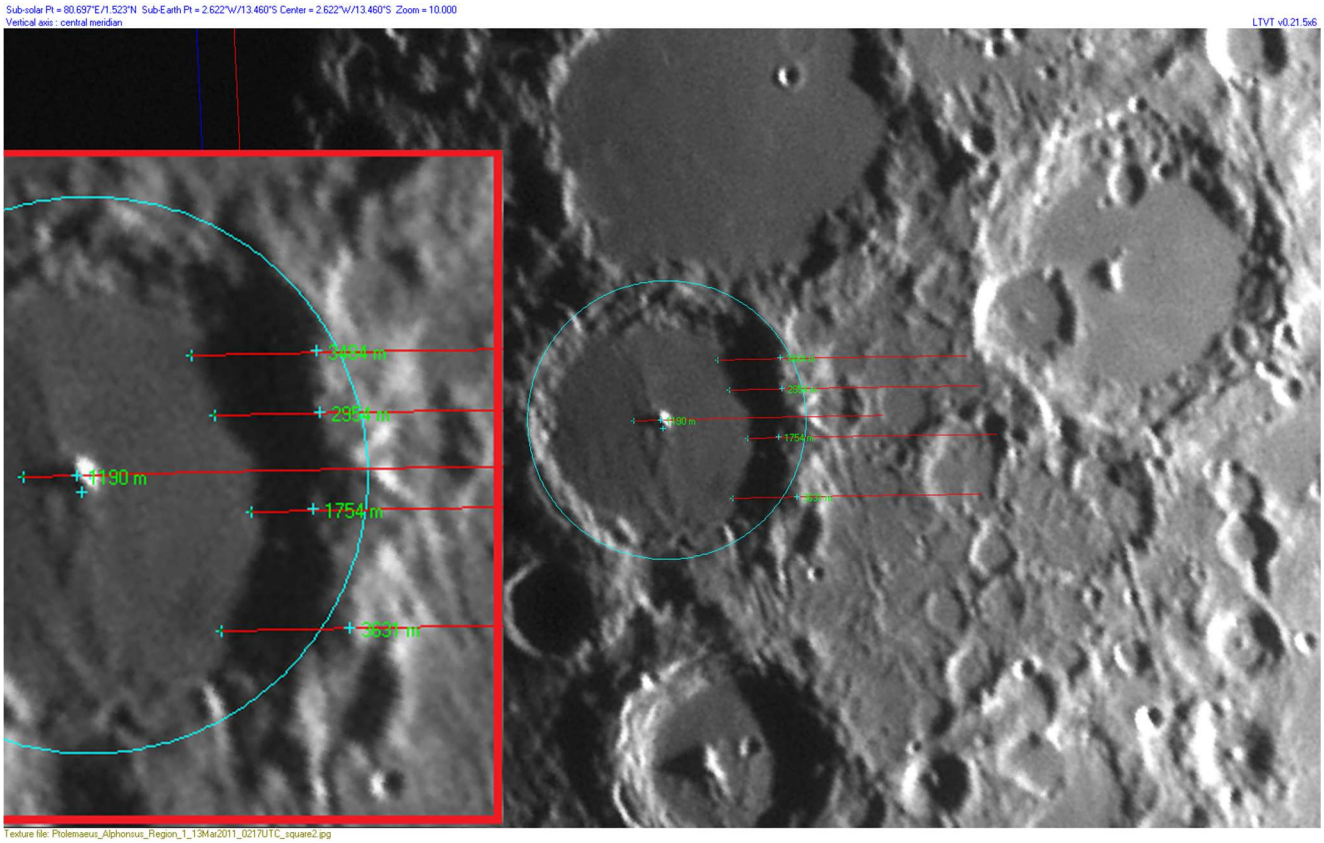


Figure 7. Alphonsus LTVT Measurements. Jerry Hubbell, Locust Grove, Virginia, 13 March 2011, 0217 UT. Colongitude, 11.4°, SkyWatcher 12-cm f/7.5 APO refractor, ATIK 314e CCD Camera + 2x Barlow. Visibility, 4/5 Transparency, 3/5.

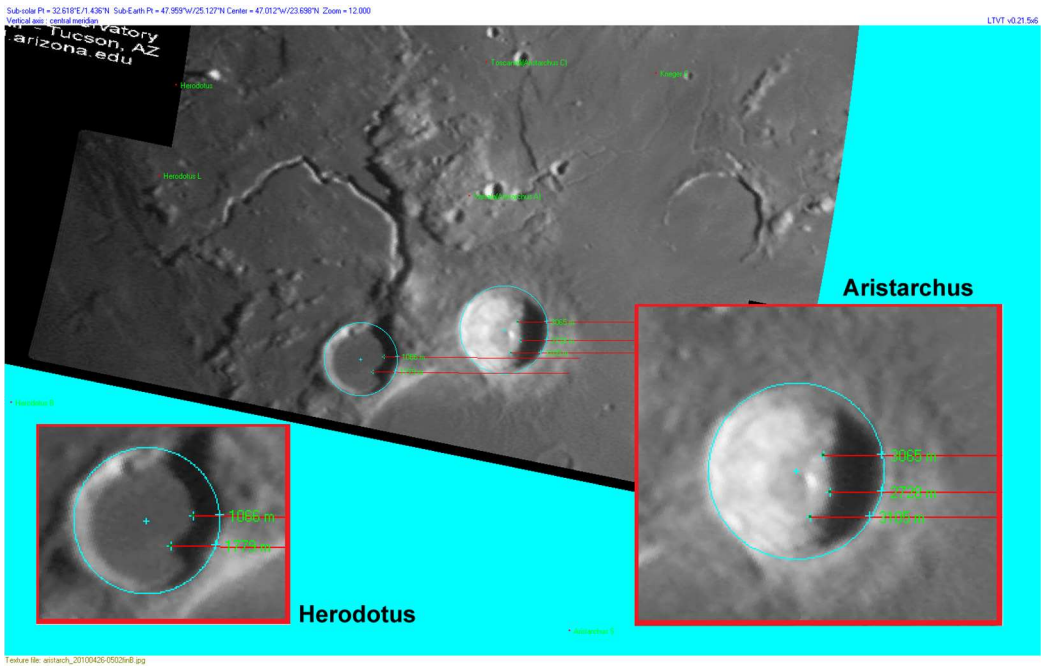


Figure 8. Aristarchus and Herodotus LTVT Measurements. Rik Hill, Tucson, Arizona, USA, 26 April 2010, 0502 UT. Colongitude, 28.1°, north-up, east-right, Celestron C-14 SCT f/22, SKYRIS 445m CCD Camera + 2x Barlow. Seeing, 8/10.

LTVT also measures the diameter, latitude, and longitude of the craters. The reference chart/catalog values shown in Tables 1, 2, and 3 are from the Lunar Aeronautical Charts and the program *Virtual Moon Atlas (VMA)*. (see References) The Alphonsus measurements shown in Table 2 show how the crater rim changes height with a low spot near the center of the rim looking from the east. The crater center Longitude and Latitude and the diameter are in close agreement with the catalog values.

Table 1. Alphonsus Measurements

Parameter	Measured Value	Chart/Catalog Value	Diff
Selenographic Longitude	W02°34'	W02°51'	- 0°17'
Selenographic Latitude	S13°20'	S13°44'	- 0°24'
Crater Diameter	121 km (75.2 miles)	118 km (73.3 miles)	+ 2.5%
Central Peak Shadow	1,190 m (3,904 ft)	*1,080 m (3,543 ft)	+10.2%
Crater Rim Shadow Point 1	3,484 m (11,430 ft)	**2,320 m (7,612 ft)	+17.7%
Crater Rim Shadow Point 2	2,954 m (9,692 ft)		
Crater Rim Shadow Point 3	1,754 m (5,755 ft)		
Crater Rim Shadow Point 4	3,631 m (11,913 ft)		

*Chart value is a single point measurement on opposite crater floor (LAC77)
**Compared with the average of the first 3 rim measurements (2731 m)

Table 2. Aristarchus Measurements

Parameter	Measured Value	Chart/Catalog Value	Diff
Selenographic Longitude	W47°20'	W47°30'	- 0°10'
Selenographic Latitude	N23°51'	N23°44'	+ 0°07'
Crater Diameter	40.5 km (25.2 miles)	40.0 km (24.9 miles)	+ 1.3%
Crater Rim Shadow Point 1	3,065 m (10,055 ft)	*2,660 m (8,727 ft)	+12.7%
Crater Rim Shadow Point 2	2,828 m (9,278 ft)		
Crater Rim Shadow Point 3	3,105 m (10,187 ft)		

*Chart value is a single point measurement (LAC39). Compared with the average of the 3 rim measurements (2,999 m).

Table 3. Herodotus Measurements

Parameter	Measured Value	Chart/Catalog Value	Diff
Selenographic Longitude	W49°42'	W47°50'	- 0° 08'
Selenographic Latitude	N23°25'	N23°15'	+ 0° 10'
Crater Diameter	33.6 km (20.1 miles)	35.0 km (21.7 miles)	- 4.0%
Crater Rim Shadow Point 1	1,066 m (3,497 ft)	*1,440 m (4,724 ft)	- 1.3%
Crater Rim Shadow Point 3	1,779 m (5,837 ft)		

*Chart value is a single point measurement (LAC39). Compared with the average of the 2 rim measurements (1,422 m)

When repeating the shadow measurements at different Colongitude values, it is important to make sure you are measuring from the same point on the rim of the crater. This allows you to trend the measured value for that specific point on the rim over time. Several measurements made at the same Colongitude can be averaged, and the scatter of the data can be used to estimate the precision of the measurement. You can use the program VMA to calculate the time and date at your location for a given Colongitude value so that you can image at those times every month to gather your data. Over time, a record of the measurements will show you how your imaging technique has improved the resolution of your images.

In the next few months, I will be establishing the optimum Colongitude for each of the craters in the SAP and the selenographic longitudes and latitudes of the crater rim locations for shadow measurements. That way we all can make repeatable measurements every month and start to understand if we have any odd occurrences going on in these craters with this additional data.

REFERENCES:

Lunar Reconnaissance Orbiter, *ACT-REACT Quick Map*, http://target.lroc.asu.edu/q3/ (retrieved October 31, 2017)

Chevalley, P. and C. Legrand, *Virtual Moon Atlas*, http://ap-i.net/avl/en/start (retrieved June 30, 2018)

Aeronautical Chart Information Center (ACIC), United States Air Force, *Lunar Chart Series (LAC) LAC-38 Seleucus (March 1965), LAC-39 Aristarchus (March 1963), LAC-77 Ptolemeus (May 1963)*, hosted by the

Lunar and Planetary Institute, https://www.lpi.usra.edu/resources/mapcatalog/LAC/ (retrieved September 1, 2019)
Aeronautical Chart Information Center (ACIC), United States Air Force, *LAC Series Chart Reference*, hosted by the Lunar and Planetary Institute, https://www.lpi.usra.edu/resources/mapcatalog/LAC/lac_reference.pdf (retrieved September 1, 2019)
Lunar and Planetary Institute, *Digital Lunar Orbiter Photographic Atlas of the Moon*, http://www.lpi.usra.edu/resources/lunar_orbiter/ (retrieved September 1, 2017).

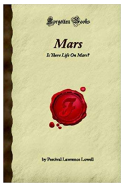
ADDITIONAL READING:

Bussey, B and P. Spudis. 2004. *The Clementine Atlas of the Moon*. Cambridge University Press, New York.
Byrne, C. 2005. *Lunar Orbiter Photographic Atlas of the Near Side of the Moon*. Springer-Verlag, London.
Chong, S.M., A.C.H. Lim, and P.S. Ang. 2002. *Photographic Atlas of the Moon*. Cambridge University Press, New York.
Chu, A., W. Paech, M. Wigand, and S. Dunlop. 2012. *The Cambridge Photographic Moon Atlas.* Cambridge University Press, New York.
Cocks, E.E. and J.C. Cocks. 1995. *Who's Who on the Moon: A Biographical Dictionary of Lunar Nomenclature*. Tudor Publishers, Greensboro.
Gillis, J.J. ed. 2004. *Digital Lunar Orbiter Photographic Atlas of the Moon*. Lunar & Planetary Institute, Houston. Contribution #1205 (DVD). \(http://www.lpi.usra.edu/resources/lunar_orbiter/).
Grego, P. 2005. *The Moon and How to Observe It*. Springer-Verlag, London.
IAU/USGS/NASA. Gazetteer of Planetary Nomenclature. http://planetarynames.wr.usgs.gov/Page/MOON/target.
North, G. 2000. *Observing the Moon*, Cambridge University Press, Cambridge.
Rukl, A. 2004. *Atlas of the Moon*, rev. updated edition, ed. Gary Seronik, Sky Publishing Corp., Cambridge.
Schultz, P. 1972. *Moon Morphology*. University of Texas Press, Austin. The-Moon Wiki. http://the-moon.wikispaces.com/Introduction
Wlasuk, P. 2000. *Observing the Moon*. Springer-Verlag, London.
Wood, C. 2003. *The Moon: A Personal View*. Sky Publishing Corp. Cambridge.
Wood, C. and M. Collins. 2012. *21st Century Atlas of the Moon*. Lunar Publishing, UIAI Inc., Wheeling.

Highlights of Recent RAClub Presentations

Abstracted from Bart Billard's Meeting Minutes
NOTE: There was no presentation at the August meeting, which was the annual RAClub picnic.

September 2019—Vintage Astronomy Book Collecting



Cover, *Mars*. Courtesy Amazon.com

Scott Busby introduced his interactive program by displaying a number of astronomy books he had collected and placed them in two groups. One group contained a facsimile edition of the book *Mars*, by Percival Lowell. Scott said he was leaving that group on the table for people to look at during the meeting. He passed out the second set of books and said he would have each person read the title, author, and publication date, and then read the bookmarked passage (or passages).

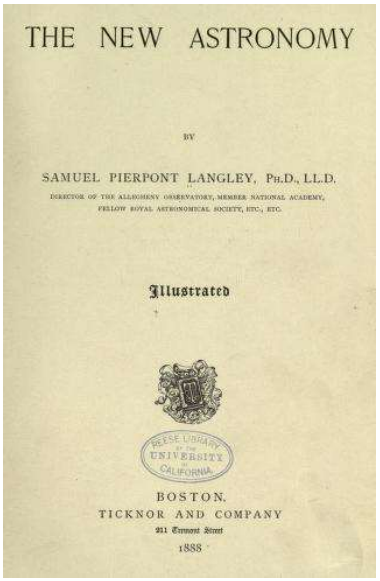
Scott called on Matt Scott first. Matt had *History and Work of Harvard Observatory* by Solon I. Bailey, published in 1931. He read a passage about an 1871 study of the Moon's surface using the large refractor. The observer, studying the lunar surface from the standpoint of a geologist, concluded that the contours resulted from volcanic action and that the radiating bands were crevasses stained by escaping gases. The author concluded that similar views were held by many selenographers, although the origins of the lunar markings were still in doubt. We discussed how puzzling that seems now.

Jean Benson had *First Observations in Astronomy* by Mary E. Byrd (1913). She read a passage about how to see the Milky Way that included advice to write down data to look for changes. It also had the author's notes from an observation from Goshen, Massachusetts. Scott said Mary Byrd established an observatory on Nantucket. Glenn Faini wondered about the darkness of the sky for her observation, and Linda said Goshen was in western Massachusetts, which would have been pretty dark back then.

Rolando Pancotti was next with *Our Sun* by Donald H. Menzel (1949). One passage described prominences. Scott said at the time the book was published, traveling to view total eclipses was almost the only way to view prominences. Another passage discussed ions, including how doubly ionized magnesium was similar to sodium.

Scott said this discussion gets into spectroscopy. Astronomers were unable to find singly ionized helium until they discovered it in the corona, which made them appreciate the high temperature required to get it.

Jerry Hubbell read a passage from *The Adolfo Stahl Lectures in Astronomy* (1919). His passage was a discussion of the lack of the expected number of impact craters that appeared to be the result of glancing blows (i.e., not circular). We discussed the current consensus about an early period of heavy bombardment of all the planets in the solar system, and Scott said he thought of Saturn with its rings as an analog of that early solar system. Jerry said that current science has explained crater shapes—because of the energy released in impacts, even an angle as low as 20 degrees could create a circular crater.


THE NEW ASTRONOMY

BY

SAMUEL PIERPONT LANGLEY, PH.D., LL.D.

DIRECTOR OF THE ALLEGHENY OBSERVATORY, MEMBER NATIONAL ACADEMY, FELLOW ROYAL ASTRONOMICAL SOCIETY, ETC., ETC.

Illustrated

BOSTON.
TICKNOR AND COMPANY
211 Tremont Street
1888

Title page, *The New Astronomy.* Courtesy https://archive.org

Linda Billard was next with *The New Astronomy* by Samuel Pierpont Langley (1888). Her passage concerned comets' appearance and their apparent speed being too high to be explained by the Sun's gravity. It also indicated their inclination to the ecliptic was not well understood. Scott talked about frequently viewing images of comets passing close to the Sun taken by SOHO, including ones that didn't survive their closest approach and one that had its tail blown away by the solar wind.

Tim Plunkett had Fred L. Whipple's *Earth, Moon, and Planets*, published in 1941. One passage he read described the different types of tides and their interaction. Another was a discussion of rays on the Moon. They were still unexplained in 1941, and the passage noted they do not cast shadows, asking whether they could be emissions from cracks. Tim read a third passage on the naming of Pluto. It compared predictions of the orbit and mass made by Lowell and Pickering. We learned that 1919 photoraphic plates caught Pluto without leading to its discovery. In one, Pluto fell on an emulsion defect, and in another, it was too close to a star. Scott pointed out that Whipple does not even mention Clyde Tombaugh.

In closing, Scott said he would often go back to a book covering something he was currently observing to see whether anything had changed. One example of change was evident when he and Myron Wasiuta compared a photo they had made of a galaxy with an old image of the sane galaxy. Blinking the images revealed some stars with detectable proper motion.

October 2019—Prehistoric Astronomy

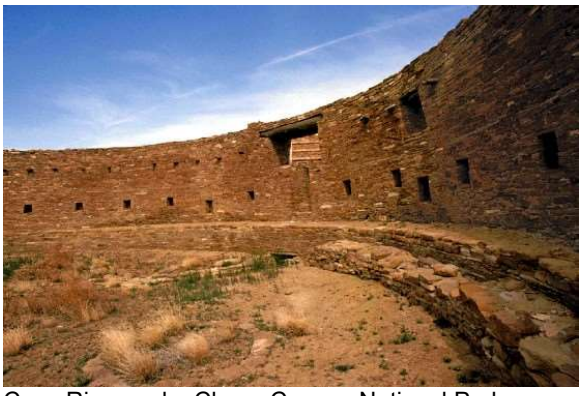
Tom Watson began his program by noting that evidence of early astronomical observations indicates Neolithic farmers studied the sky as early as 7,500 years ago. They needed to find signs indicating the approach of favorable times of year for planting, harvesting, or other activities affected by the weather and seasons. Tom said he would show examples from all the inhabited continents. He started with a photograph of the Kalokol Pillar site near Lake Turkana in Kenya. He noted that weather variation in that region was not so noticeable compared with more temperate zones, so relying on astronomical signs of changing seasons would be more important.

For Asia, Tom chose a Yellow River area in northern China that had an observatory from about 2,300 to 1,900 BC (4,300 years ago). The observatory consists of a circular ditch in the ground and a hole at the center of the circle where an observer could look though slits between stones set in the ditch. (The stones are gone now.) This region was another area where seasons were not so variable.

Tom showed an outline of an emu drawn representing a constellation near the Southern Cross used by ancient people in Australia. He related a story of three brothers who went fishing. One caught a forbidden sawfish and Sun Woman saw this. She made a canoe that took the brothers to the sky, and it was represented by the Milky Way.

Tom said a region of Europe was his preferred area of study of Neolithic culture and illustrated it with an image of the scientific reproduction of a stockade in two concentric circles. It had pairs of openings aligned so that the Sun would shine straight through both circles to the center at certain times of the year (including the equinox). The original was built about 5,900 years ago by a late linear pottery culture.

For North America, Tom showed the ancestral pueblos in Chaco Canyon in Arizona. As with other sites, these were built around astronomy. They dated from the 10th to 11th centuries AD. He also showed a butte that a woman anthropologist decided to climb one day. She found some petroglyphs and happened to be there at the right time to see a Sun dagger fall on one. Tom's picture showed a spiral pattern with a narrow wedge of sunlight across it. It is believed the petroglyphs indicated the solstice or equinox when the Sun dagger fell across the center.



Casa Rinconada, Chaco Canyon National Park. Courtesy, National Park Service

The Mayans of Central America were the closest Tom could get for South America. He mentioned their written language and lamented the many codices burned by Catholic priests traveling with the early European explorers. Tom showed one of the surviving codices, which included astronomical tables.

Image of the Quarter

Silver Sliver Galaxy taken by Scott Busby on October 4 at about 2 a.m. NGC 891 (also known as Caldwell 23 or Silver Sliver Galaxy) is an edge-on unbarred spiral galaxy about 30 million light-years away in the constellation Andromeda. The galaxy is a member of the NGC 1023 group of galaxies in the Local Supercluster. Specs for the photo are as follows:

Scope: FRC300 FL: 4680mm @ f15.6
Camera: ZWO ASI1600MM-C
Frame Exp: 60
Frames: 133
Total integration time: 2hrs 13m, 59s
Capture: SharpCap 3.1
Process: Deep Sky Stacker (DSS) 4.2.1
Finishing: Adobe Photoshop CS6