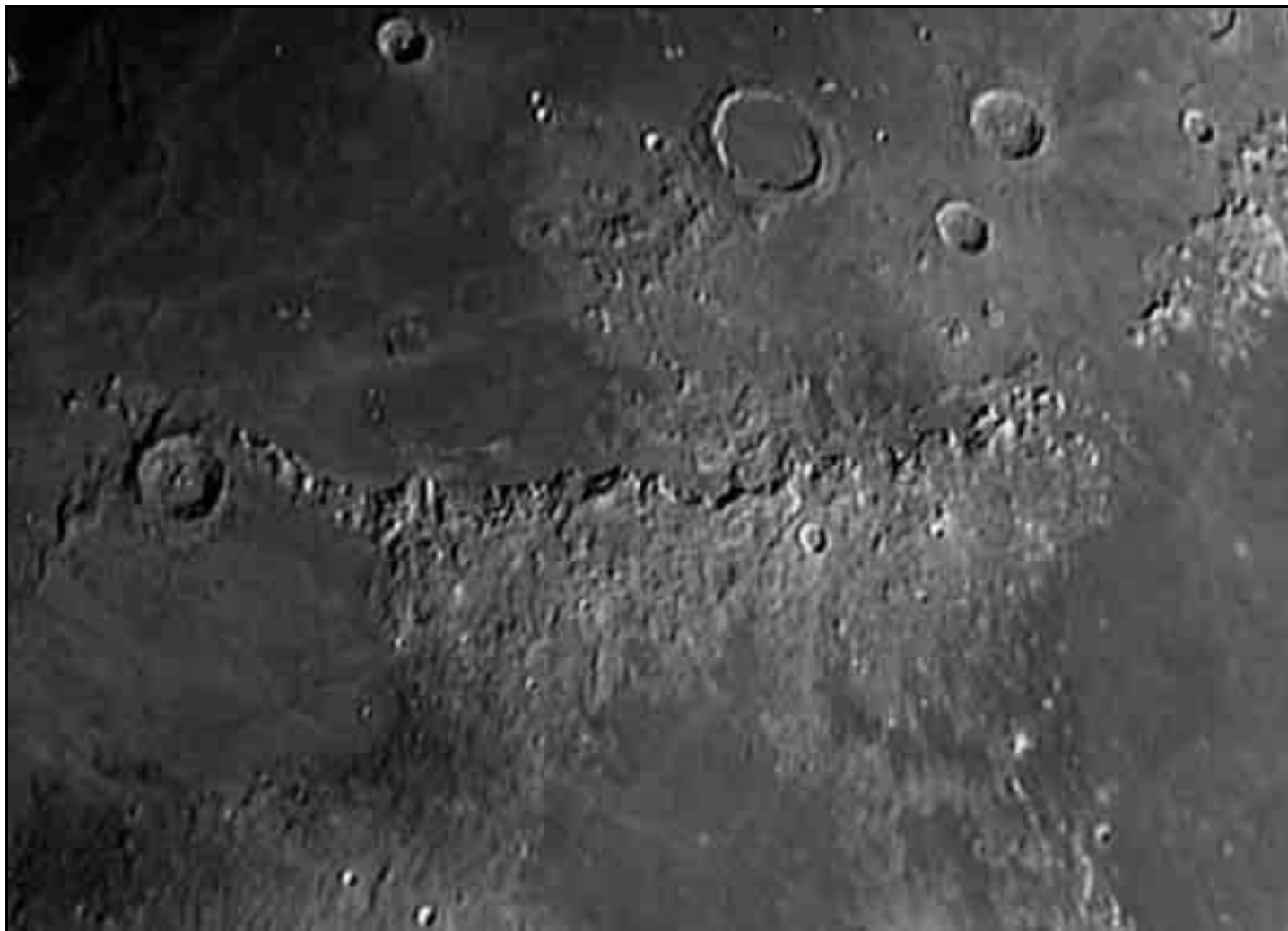


LUNA

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Majestic Apennines



CCD image by Dusko Novakovic Location: Yardley Gobion, UK
30 March 2004 23:43 UT Sun's colong: 27.6°
200mm f/8 Newtonian Philips ToUcam 740

THE Moon's Apennine mountains, Montes Apenninus, sweeps around the southeastern border of Mare Imbrium. 800 km long, it is the Moon's grandest mountain range. The Imbrium basin was blasted out of the Moon's crust 3.8 billion years ago, and the Apennines mark part of the multi-ring impact basin. According to

astrogeologist Paul Spudis, Mare Imbrium has half a dozen rings, the most prominent being concurrent with the border of Mare Imbrium, diameter 1,160 km. Radial to Mare Imbrium, etched into the Apennines, is a striated landscape, some of it resembling a terrestrial landscape that has undergone glacial erosion. Several prominent

headlands within the range are named—Mons Bradley, Huygens, Ampère and Wolf. Peaks on the Apennine front reach heights of 5,000 metres, and the range diminishes in height towards Mare Vaporum. In the image above, Eratosthenes is at left, and the crater trio Archimedes, Autolycus and Aristillus is at upper right.

From the editor



THIS issue features a good selection of news stories, CCD images and observations. These days more people are imaging the Moon, rather than taking a pencil in their hand to draw the Moon's features. The results are certainly superb. But the only way to really get to know the lunar surface is to attend to it, and the best way of doing that is to sketch what you can see through the eyepiece. It doesn't matter that a great piece of art is produced. The observer is experiencing and learning his or her way around the Moon in the process, and that's all that counts.

I won't bore everyone with a long list of excuses why *Luna* hasn't made an appearance in such a long time. I've had plenty of observational material to be getting on with, but hardly enough time to sit down and compile an issue, until now. I am genuinely sorry for the long wait that subscribers have had to endure—it's entirely due to procrastination and time-wasting on my part. Thank you for your understanding and patience!

Peter Grego
Editor, *Luna*

Director, SPA Lunar Section

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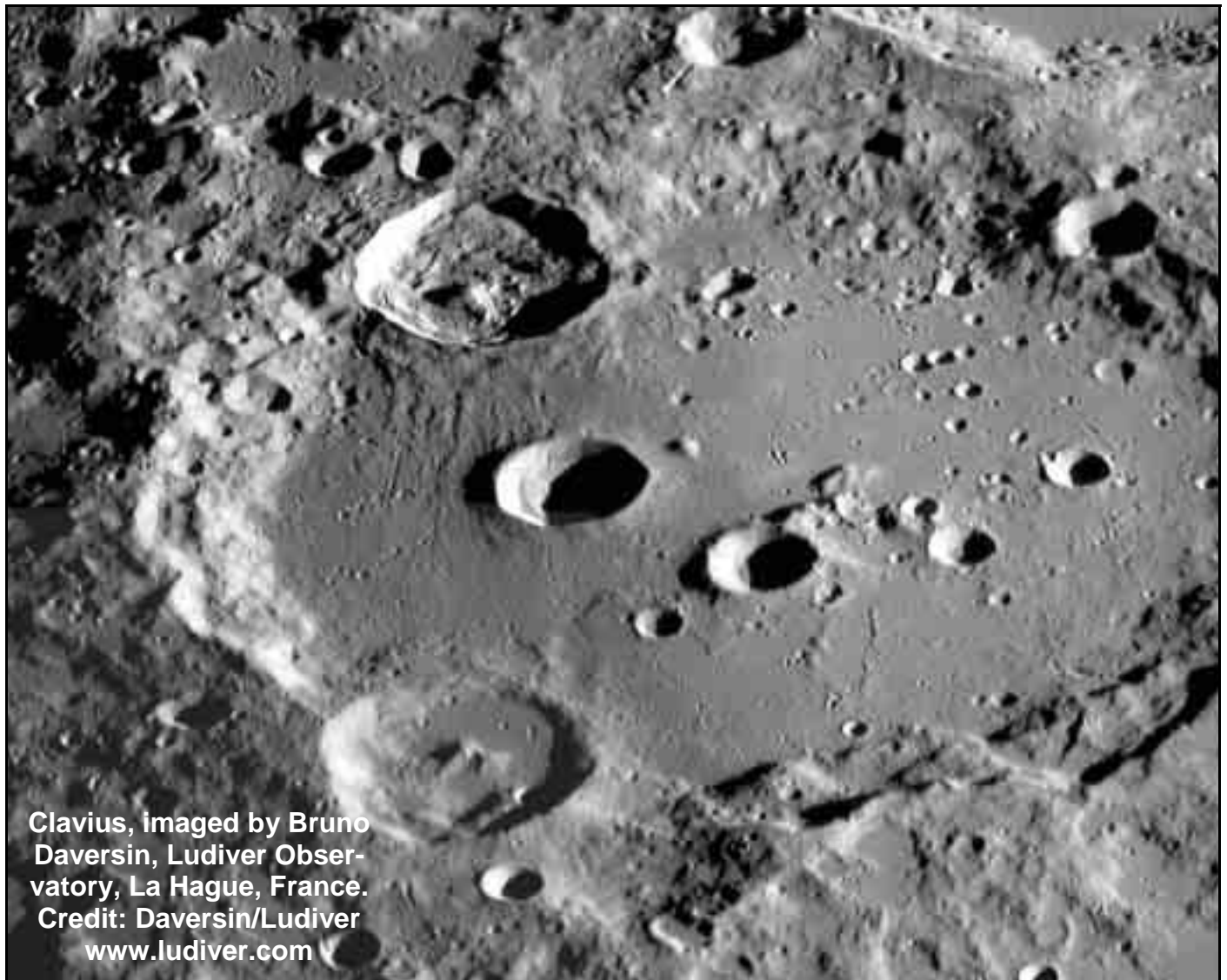




NEWS OF THE MOON



La Lune—elle est incroyable!



Clavius, imaged by Bruno Daversin, Ludiver Observatory, La Hague, France.
Credit: Daversin/Ludiver
www.ludiver.com

IN autumn 2003 the lunar observing community on the Internet was buzzing with the news that some astonishingly detailed lunar images—some of the best ever taken from the surface of the Earth—had been posted on the French *astrosurf.com* discussion board. The CCD images, taken by Frederic Mallmann and Bruno Daversin using the 600mm f/16 Cassegrain telescope at Ludiver Observatory at La Hague, France, were so good that their authenticity had been seriously doubted by some, believing they had somehow been faked.

But lunar expert Charles Wood, in a message posted on *observing-*

thesky.org was firmly of the opinion that the images were authentic. Wood wrote: "...it seems to me that their accomplishment is just a logical extrapolation of what others have been doing with 8 to 12" (200-300mm) telescopes. Using the same webcam techniques on a good 24" (600mm) should produce higher resolution images than using a smaller telescope. And seeing is much less of an issue with the stacking of hundreds of images...The main reason I feel the images are authentic is there is nothing they could have copied them from! I know of no other ground based images this good and at such a large image

scale. There are no spacecraft images that could be the sources either. So, if the observers at Ludiver somehow faked them, I hope they do a lot more! I do believe the photographers deserve our rich praise—and that they should tell us more."

Take a look at these incredible lunar images for yourself at www.astrosurf.com/ubb/Forum3/HTML/001915-2.html or the Ludiver site www.ludiver.com/conquerir_espace_scientifique_lune.php.

Both sites are mainly written in French, but the magnificent lunar images certainly have no problem in speaking for themselves!

New lunar mineral discovered

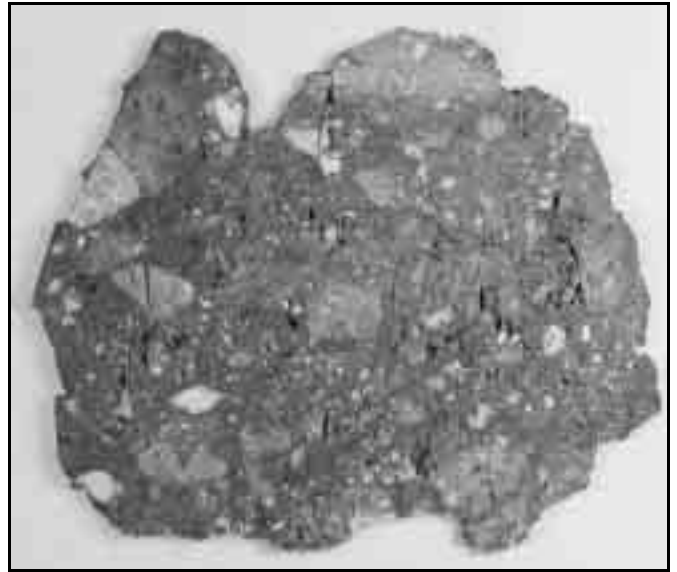
A new lunar mineral has been found in a meteorite from the Moon that landed on the Earth in 2000. The new mineral is called hapkeite after the scientist Bruce Hapke who predicted the existence of the iron and silicon compound on the Moon some 30 years ago. Hapkeite is probably made when tiny particles impact the Moon at very high speeds, say Mahesh Anand and colleagues. Their investigation of the meteorite Dhofar 280 is reported in the *Proceedings of the National Academy of Sciences*.

The formation of rocky debris and soil on the surfaces of airless bodies in space involves processes that are virtually non-existent on Earth.

This 'space weathering' includes the impact of micro-meteorites which crush and pulverize surface rocks on a minute scale.

The micro-meteorites are about 0.1mm or smaller, but because of their velocities, about 100,000km/hour, they carry a great deal of energy that is transferred to very small areas. The impacted surface is 'flash-melted', vaporising metals and causing chemical and structural changes. Hapkeite results from the deposition of iron and silicon in a 2:1 ratio.

Space weathering is a process that has been occurring on the Moon for almost four billion years and has altered the upper few centimetres of its surface. Al-



Slice through lunar meteorite Dhofar 280

though hapkeite was first predicted to exist some 30 years ago, this is the first time it has been seen. Scientists think it could be common in the lunar crust.

Based on the news story at news.bbc.co.uk/2/hi/science/nature/3659551.stm

Mur enigmatique

GENE Cernan, the last man on the Moon, told Singapore's *Straits Times* in March 2004 that he had seen the Great Wall of China from space, stating that "at Earth orbit of 160-320km, the Great Wall is indeed visible to the naked eye." For decades, the Chinese have claimed that the wall was visible, with school textbooks stating that it can be seen with the unaided eye from orbit. But the myth seemed to have been shattered when Chinese astronaut Yang Liwei returned from space last year and said had not seen the Great Wall. Liwei's report led to an official edict that claims of the wall's visibility from space be removed from textbooks!

Earth's new 'moon' may be a chip off the old lunar block

THE Earth has acquired a 'quasi-moon'—an asteroid that will circle our planet for the next couple of years while it orbits the Sun on a convoluted horseshoe-shaped path.

According to *New Scientist* (27 March), the asteroid, designated 2003 YN17, is probably a chunk of debris from an impact between a larger asteroid and the surface of the Moon. How long ago this hypothesised impact took place is currently unknown. The orbital plane of 2003 YN17 is roughly the same as the Earth's, but its unusual path, compounded by a horseshoe-shaped path, means that it is sometimes ahead of us and sometimes behind us.

Since 1996, the asteroid's path has taken it around the Earth, making it a quasi-satellite. This phase will last until 2006," the report says. The finders' team is led by Paul Chodas, an asteroid specialist at NASA's Jet Propulsion Laboratory in California.

Several other small quasi-moons—temporary fellow-travellers in space that loop round the Earth for a while as they orbit the Sun—have been discovered in recent years: asteroids 3753 Cruithne (discovered in 1986), 1998 UP1, 2000 PH5 and 2002 AA29.

Based on the news story at www.newscientist.com/news/news.jsp?id=ns99994814



NEWS OF THE MOON



Stolen, sold—Apollo Moon rocks vanish

A former NASA investigator is trying to track down dozens of small pieces of Moon rock that disappeared after being given away as goodwill gifts. Former US President Richard Nixon gave away 135 lunar rocks in the early 1970s, but only 24 of these gifts can be accounted for, according to Joseph Gutheinz. Of the 135 Moon rocks, about half had either been stolen or lost—or soon would be.

Moon rocks can fetch up to four times as much as diamonds. The 1.1-g (0.04-oz) fragments presented to foreign governments were mounted in a clear perspex sphere and mounted on a wooden plaque bearing the recipient nation's flag.

The US Apollo missions collected 382kg (842lbs) of rock, which remains the property of the US government.

Mr Gutheinz has contacted a number of foreign embassies, museums and universities in a bid to find the missing material. But poor security and tracking means much of it has vanished without a trace. One rock given to the Honduran government disappeared in the 1990s without anyone realising it. It was finally recovered in a sting operation last year, organised by Mr Gutheinz, after it was offered for sale for \$5m. The dealer involved said that he had bought it from a Honduran general for \$50,000. Another rock given to the people Malta was stolen from a museum. "There was no monitoring, no surveillance and no security," Mr Gutheinz said. He is angry that the US government gave the pieces of Moon rock away without consideration for their safety. "We gave these Moon rocks to some of the big-



NASA Administrator Sean O'Keefe (left) formally returns a plaque containing a Moon rock to Honduran Ambassador Mario M. Canabal (right). Presented by President Nixon in 1971 to the Honduran people, the Moon rock mysteriously disappeared from the Presidential Palace between 1990 and 1994. It was recovered in a sting operation coordinated by NASA's Office of Inspector General and involving several Federal agencies that are now part of Homeland Security. Photo Credit: "NASA/Bill Ingalls"

gest dictators in the world," he said.

Even the Moon walkers weren't presented with a souvenir of the material that they worked so hard to harvest from the lunar surface.

Based on the news story at news.bbc.co.uk/1/hi/world/americas/3912829.stm

Slam dunk your junk on the Moon

A California company is offering to deposit small personal effects on the Moon. TransOrbital hopes to start its lunar delivery service later this year. The company claims to be the only private company allowed by US authorities to operate commercial flights to the Moon. It plans to dump a small cargo of artefacts on the Moon's surface with a robotic probe. "Delivered to the Moon's surface in a special capsule will be your certificates, business cards, cremated remains, jewellery, artwork and many other items of choice," says the company website. "Trailblazer will deliver commercial and scientific projects to lunar orbit, as well as conduct lunar exploration and mapping."

TransOrbital president Dennis Laurie claimed that thousands of people had paid to have their mementos or relatives' ashes deposited on the Moon. Dispatching a business card to the Moon costs \$2,500 (around £1,300, while other items can fly for \$2,500 dollars per gram. A text message sent to the craft costs just \$17 to deliver. TransOrbital's craft will orbit the Moon for about 3 months, sending back images of its surface, including the Apollo landing sites. The craft will then crash on the Moon, and its 10kg cargo capsule will tunnel up to five metres into the surface.

Based on the news story at www.marsdaily.com/2004/040129225859.lean3iwc.html

Moon power

THE United States is planning to use the Moon as a source of fuel that should help it establish ultimate supremacy on the Earth, according to Russian newspaper *Izvestia*. President Bush's ambitious programme to build a Moonbase by 2020 was not a re-election gimmick as much of the media described it, but a strategic economic project, the newspaper said. A lunar base will enable the US to bring back to Earth supplies of Helium-3, a valuable fuel for thermonuclear reactors, which is abundant in the Moon's soil but practically absent on the Earth. Such reactors (yet to be built) could be the key to meeting the world's future energy demands.

Vita Luna

WITHOUT the Moon, there would be no life on Earth, claims a new theory.

Four billion years ago, when life began, the Moon orbited much closer to us than it does now, causing huge tides to ebb and flow every few hours, causing big fluctuations in salinity around coastlines which could have driven the evolution of early DNA-like biomolecules. The theory by Richard Lathe, molecular biologist at Pieta Research, Edinburgh, UK, also suggests that life couldn't have begun on Mars.

According to one theory for life's origin, self-replicating molecules like DNA or RNA emerged when small precursor molecules in the primordial soup polymerised into long strands. These strands served as templates for more precursor molecules to attach along the templates, creating double-stranded polymers similar to DNA. But there needs to be a way of breaking apart the double strands to keep the process going. The force that dissociated the strands was provided by tidal power and the regular variation in coastline salinity. When the tides rolled in, salt concentration was low. Double-stranded DNA breaks apart under such conditions. But when the tides went out, precursor molecules and precipitated salt would have been present in high concentrations, encouraging double-stranded molecules to form, allowing strands to stick together.

Based on the news story at www.newscientist.com/news/news.jsp?id=ns99994786

Marathon Moon

AFTER detective work that involved the Moon and the Spartan calendar, astronomers have pinpointed the date of first marathon. Historians originally misinterpreted the date of the run, says a team from Texas State University in San Marcos. The researchers believe their new analysis may explain the runner's untimely death. The discovery came a month before modern athletes retraced the celebrated run from Marathon to Athens during the 2004 Olympic games in Greece.

According to legend, the first run saw a lone Athenian race to Athens, 42 km away, to warn of an imminent attack by Persian

soldiers. Historians previously thought the run took place on 12 September, based on references to the Moon in ancient texts. But they determined the date using the Athenian calendar, which begins on the first New Moon after summer solstice.

But when Donald Olson and Russell Doescher of the Physics Department and Marilyn Olson of the English Department re-computed the date using the Spartans' own calendar, which starts on the first New Moon after the autumnal equinox, they arrived at a date of 12 August 490 BC.

Based on the news story at www.newscientist.com

Radar evaporates lunar ice

THE thick ice sheets that many astronomers thought were hidden in some of the Moon's polar craters almost certainly do not exist, according to observations from the 300-metre Arecibo dish, Puerto Rico, which bounced radio waves into permanently shadowed craters at the Moon's poles.

In 1994, the US spacecraft Clementine probed the craters in the same way from lunar orbit, and it detected strong echoes that could have been produced by thick ice sheets. Four years later, NASA's Lunar Prospector probed the craters with a neutron spectrometer, leading to a positive detection of hydrogen, and thus water, at the lunar poles. Putting the two observations together, it was concluded that millions of tonnes of water had formed thick ice sheets in the permanently shadowed lunar craters.

But the new Arecibo investigation has come to a different conclusion. Team leader Bruce Campbell, of the Smithsonian Institution, Washington DC, said "There are no thick ice deposits in the areas we observed." The researchers surveyed 20 percent of the Moon's shadowed regions. One crater, called Shackleton, did return a strong echo, but so did another crater that is not permanently shadowed, meaning it could not be caused by ice. "We think that the rough, tilted walls of those craters were producing the strong reflections, not ice," explained Campbell. The new data does not rule out ice altogether. Deposits thinner than a metre, or small ice crystals distributed in the lunar dust, would have remained undetected.

Based on the news story at www.newscientist.com/news/news.jsp?id=ns99994378



NEWS OF THE MOON



SMART-1 reaches the Moon

EUROPE'S first lunar spacecraft, SMART-1, successfully cruised into orbit around the Moon on 15 November, while passing about 5,000 kilometres above the lunar surface.

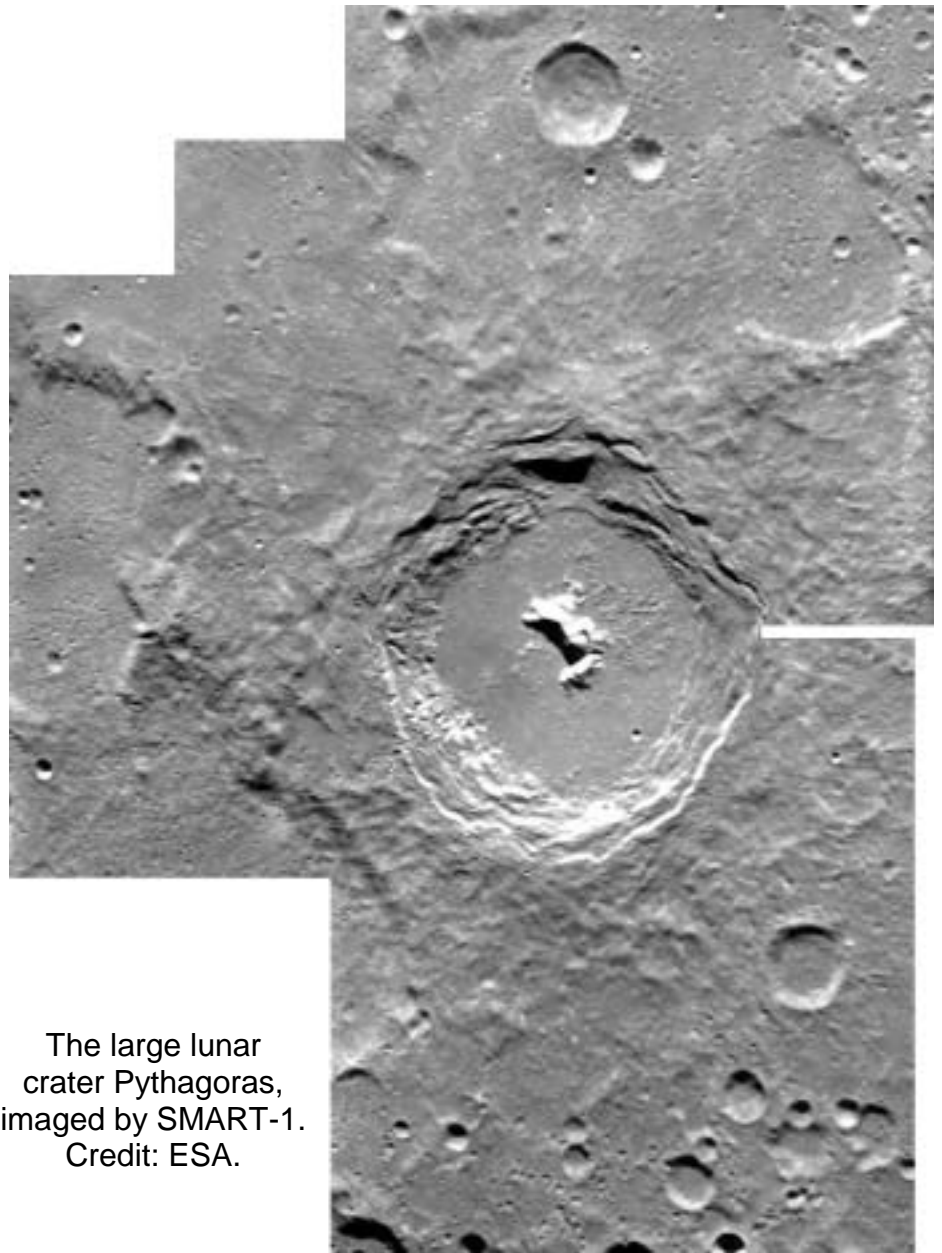
SMART-1's engine spiraled the spacecraft into its final orbit with a series of shorter burns. Scientific observations have been underway since mid-January.

One goal of SMART-1 is to survey a mountaintop at the lunar south pole that is permanently bathed in sunlight. These are often referred to by the rather quaint name of as the 'Mountains of Eternal Light'. Here, the temperature remains pretty stable, making it a desirable location for a future manned lunar base. The bright permanent sunshine could also provide astronauts with on-tap solar power, and there may even be quantities of highly useful water ice in craters nearby.

SMART-1 was launched in September 2003 and is the first of a series of low-budget European Space Agency projects—called Small Missions for Advanced Research in Technology (SMART)—which will test new technologies for bigger projects.

SMART-1 uses a highly efficient ion drive. Solar panels generate electricity, which heats and ionises xenon, which is ejected to propel the craft. The drive is ten times more efficient than a traditional rocket.

The efficiency of the ion engine has allowed the spacecraft to reach the Moon two months earlier than expected. Leftover fuel will allow mission controllers to take the spacecraft into a closer orbit of the Moon than originally planned, giving the instruments a better view of the lunar surface.



The large lunar crater Pythagoras, imaged by SMART-1.
Credit: ESA.

SMART-1 is now sweeping around the Moon in a polar orbit, approaching the south pole to within just 300 kilometres on each orbit. It will study the Moon's topography, its surface contours, map the distribution of a host of different minerals, and hopefully provide new clues about the formation of the Moon and the processes that shaped its surface. Scientists think that the most likely origin of the Moon is a scenario that saw a Mars-sized body smash into the proto-Earth around the birth of the Solar Sys-

tem 4.5 billion years ago. A key region targeted by the probe is the South Pole-Aitken (SPA) basin. Measuring some 2,500 kilometres in diameter and averaging 13 km below the mean lunar surface level, the SPA basin is largest known impact feature in the Solar System. "It's deep enough to have punched through the lower crust down into the Moon's mantle," said Manuel Grande, lead scientist for the SMART-1's X-ray spectrometer. "We're looking into the Moon's interior and into its past."

NEWS OF THE MOON

Moon hero John Young retires from NASA

AFTER four decades and half a dozen space flights—including a flight around the Moon, a walk and a grand prix ride on the Moon and a trip on the first Shuttle mission—legendary NASA astronaut John Young is hanging up his flight suit. How did his amazing career get off the ground?

Forty-three years ago, Young—then a Navy test pilot—tuned in on a small, black-and-white television at the Naval Air Test Center in Florida as President John Kennedy addressed the USA. After hearing the president's bold proposal to land a man on the Moon and return him safely to Earth, Young knew what he had to do.

"I thought returning safely to Earth sounded like a good idea," quips Young, who has stood on the Moon, driven 25 km in a lunar rover and spent three nights on the lunar surface. He is the only person to go into space as part of the Gemini, Apollo and Space Shuttle programs and was the first to fly into space six times—seven times counting his liftoff from the Moon in the lunar module.

Young was born in San Fran-

cisco in 1930. As a boy, Young's favorite pastimes were building model airplanes and reading. He graduated from Orlando High School in Florida and went on to earn a degree in aeronautical engineering from Georgia Tech, where he graduated with highest honors in 1952. Following graduation, he joined the Navy and after flying fighter planes for four years, completed test pilot training and served three years at the Navy's Air Test Center.

Young's career at NASA began in 1962 when he was selected from among hundreds of young pilots to join NASA's second astronaut class. In March 1965, Young made his first flight as an astronaut, with Gus Grissom on Gemini 3, the first manned Gemini flight. He commanded Gemini 10 in July 1966 with pilot Mike Collins.

In May 1969 he served as command module pilot on Apollo 10, and flew to the Moon with Tom Stafford and Gene Cernan. The

crew scouted landing sites from lunar orbit and rendezvoused the lunar module and command module in a full dress rehearsal for the Apollo 11 landing two months later. Young made a return trip to the Moon as commander of Apollo 16 in April 1972. With Ken



Mattingly orbiting in the Command Module, Young and Lunar Module pilot Charlie Duke landed in the Descartes highlands.

"The Moon is a very nice place," Young said. "When we landed, we were 20 minutes behind. Because time on the Moon was so precious, what I remember most is trying to catch up."

Young and Duke set up scientific equipment and explored the rugged lunar highlands in the rover. The mission returned around 100kg of rocks gathered during three geological outings.

In April 1981, Young commanded Shuttle Columbia on its maiden flight, STS-1. In 1983 he commanded STS-9, the first Spacelab mission, a 10-day flight.

Young was chief of the Astronaut Office until May 1987. He later became Associate Director (technical) of the Center in February 1996, overseeing technical, operational and safety of NASA programs assigned to JSC.

"I've been very lucky," Young says. Which moment was most memorable? "I liked them all."



Young gives a leaping salute on the plains near Descartes.



NEWS OF THE MOON

Pluto's moon Charon—a chip off the old block, like Earth's Moon?

PLUTO'S moon Charon could be a chunk blasted off Pluto when it collided with another large planet-sized body early in the life of the Solar System. A similar process is thought to have formed Earth's own Moon.

"An impact is the simplest way to form the Pluto-Charon pair, which makes it appealing," says Robin Canup, at Southwest Research Institute in Boulder, Colorado. Using Charon's present orbit and Pluto's spin, Canup estimated that the planet

once sped through a full rotation every 2 to 4 hours. Today, Pluto takes 6.4 days to rotate, and the most likely cause of the slowdown was a large object smashing into the planet.

Canup's team calculated that the body was probably 1,600 to 2,000 km in diameter, slightly smaller than the planet itself. It may have come from the Kuiper Belt—the ring of icy rocks on the edge of the Solar System, where Pluto also resides.

From New Scientist magazine, 5 February 2005.



Pluto and Charon by David A Hardy

Moonbase to run on lunar dust and robots

SIMULATED Moon dust has been used to make a key component of a working solar cell, a vital component of any future Moon base.

"We will need a power source," says David Williams, a planetary and lunar scientist at NASA's National Space Science Data Center in Greenbelt, Maryland. "Bringing stuff up from Earth is really expensive."

Four years ago, Alex Freundlich and his colleagues at the University of Houston in Texas came up with the idea of getting robotic rovers to build solar cells entirely out of lunar dust or 'regolith'. This fine, grey powder is half silicon dioxide, with the remainder made up of a blend of oxides of 12 metals, including aluminium, magnesium and iron. The team reasoned that this mix contains all the elements necessary to build a solar panel, and suggested that robots trundling over the lunar surface could melt regolith, refine it and then lay down a glassy sub-

strate on which solar cells could be deposited. The rover—solar-powered, of course—would leave a trail of solar panels in its wake.

Now Freundlich and his team have shown that a key part of this plan should work. They simulated what the rovers will do inside a vacuum chamber, which they used to get as close as possible to the Moon's near-perfect vacuum. They melted a powder called JSC-1, which has a composition identical to the samples of regolith brought back by the Apollo astronauts, and then let it resolidify as a smooth, glassy sheet. The researchers then showed that a solar cell deposited on the surface of this sheet by thermal evaporation converts light into electricity.

Demonstrating that the base of a solar panel, which makes up the majority of its mass, could be built entirely out of lunar dust is a big step, Freundlich says.

The team's experiment showed, for example, that the glassy re-

formed regolith is smooth enough to serve as a substrate for the micrometre-thick layers of the solar cell, and tough enough not to crack. Such flaws in the base of a solar cell would wreck it by bringing oppositely charged electrodes into contact with each other, causing short circuits. For future tests, the team plans to work out how to make the semiconductor parts of the solar cell using silicon extracted from the regolith.

The researchers were careful to employ only techniques that would be available to them on the Moon. This meant that the solar cells they produced were inefficient. While conventionally produced solar cells convert up to 20% of the energy falling on them, the simulated lunar panels were only 1% efficient. However, this may not matter on the Moon, where real estate is virtually unlimited.

From www.newscientist.com/article.ns?id=dn6892

Lunar reviews, old and new

Photographic Moon Book

By Alun W H Chu

Free downloadable lunar observing guide available from: moonbook.hkas.org.hk

Alan Chu of the Hong Kong Astronomical Society offers a free 94 page book as a lunar observing guide, to download from the Internet and be used without restriction by lunar enthusiasts for personal use, as long as it is not included in any commercial product without the author's consent.

I downloaded the PDF format book and printed out the 94 pages

to enjoy this excellent production, which I highly recommend to all selenophiles. Beginners that wish to be guided in their lunar observing in an easy and thorough way will also enjoy this production.

The Photographic Moon Book offers enjoyable reading, a large amount of data and 150 photographs with excellent detail—over 100 taken by Alan Chu himself. The rest of the photographs include some by local Moon observers and also a number of excellent images from Apollo missions to enhance the detail and to show a different perspective for some of the lunar mountains, craters, rilles, etc.

The largest file covers pages 14 to 76 of the book, and includes Maps 1 to 31. These each cover small sections, with photographs, some annotated and lunar map positions, descriptions and other data, with any relevant comments added. A small lunar globe with the position of the section shown is also included on each page. Among other features covered (too many to mention them all here) are an annotated photograph of the far side of the Moon, and the landing sites of the Luna, Apollo and Surveyor missions.

The complete volume requires a total of eight PDF downloads. Seven of these are downloadable

quite quickly but the main file is over 19 megabytes in size. The total hard disk space required for the complete book is about 29 megabytes. I am not on broadband yet, so this meant a long, patient download. It took over an hour to download the largest PDF file, but for broadband users this should be up to 20 times faster, depending on which service you use.

A full printout of this book is well worth the time and patience, to have the printed photographs and quick readable reference. For your own assessment you can of course read the PDF files online, which I also recommend. For this, you will need an Adobe PDF reader installed on your computer—a free download link is offered on the *Photographic Moon Book* website:

moonbook.hkas.org.hk

John Fifield

Photographic Moon Book

Alan Chu



Lunar reviews, old and new

The Moon

By Richard Anthony Proctor
3rd Ed. Longmans, Green & Co.
Published in 1886

314 pp

Richard A Proctor (1837-88) was born in England, but later in life moved to Missouri, USA, where he remarried. He returned to live in England for a while before going back to America. Plans for another return to England were cut short when he died of malaria.

He was particularly keen on mathematics, and the first edition of *The Moon* was, according to his 1878 preface to the second edition, 'too difficult for the general reader' and subsequent editions were simplified. However the first half of the 3rd edition is still not an easy read, as he does not just describe the Moon's motions, rotation and libration but also explains everything in detail. Considerable attention is required to follow all of this. Although Proctor could be considered the Patrick Moore of the Victorian era, the approach is more mathematical than we would expect today.

Once we reach Chapter IV, the *Study of the Lunar Surface*, we are on simpler ground as this part is just descriptive. It begins with a history of selenography, followed by a discussion of the brightness of the lunar surface, mainly based on the work of Zöllner. This includes a considerable amount of information about the brightness of the various lunar phases. One might imagine that a First Quarter Moon would be half as bright as a Full Moon, but this is far from the case. There is much historical information of the various attempts to measure the heat from the Moon, including the many failures, culminating in the 'recently more conclusive



experiments' by Lord Rosse (made in the 1870s). Apparent lunar surface changes are considered in some detail, especially the, now discredited, Linné affair.

The formation of the craters and other lunar features is considered throughout to be by some form of volcanic action although Proctor later went on to promote the meteoric theory that we accept today.

Illustrations of the lunar surface include photographs of First and Last Quarter Moon (taken in 1870-1871), a map of the crater Bullialdus, by Schmidt of Athens and two illustrations of Nasmyth's models of various craters. The foldout Moon Map at the end is reduced from that of Webb, which was a simplification of the map of Beer and Mädler. Also included are two imaginative paintings, by the author, showing a lunar landscape with first a 'Full Earth' and then a 'New Earth'.

The final two chapters are about the lunar atmosphere, celestial phenomena visible from the Moon and the conditions on the Moon's surface. This is followed by an index to the lunar features on the map (this has 400 entries), and a table of the elements of the

Moon. There is no general index although the 'contents' page is quite detailed.

The final two, unnumbered pages of the book list 26 other books by Proctor, covering a wide range of celestial subjects including astronomical poetry, and also two books on how to play whist!

Proctor was also an expert astrocartographer and he published two star atlases. The smaller was called *A New Star Atlas for the Library, the School and the Observatory*. I have two copies of this in my library. The tooling on the covers exactly match that on the Moon book.

Proctor's daughter, Mary (1862-1957), was also a populariser of astronomy and wrote a number of well-known books on the subject. There is a crater in the southern highlands of the Moon named after her. Proctor's second wife, Sallie Duffield Proctor-Smyth (1856-1941), became a lecturer in astronomy.

Amateur astronomers with an interest in the Moon are recommended to buy a copy of Proctor's *The Moon* if they are lucky enough to find one. My own copy cost only £15.

Mike Feist

Lunar landings

Malcolm Zack describes a sequence of observations of features in eastern Mare Imbrium made in early November 2003.

IN early November I sketched the same area of eastern Mare Imbrium on three nights in a row, noting how the rising Sun affected visibility. All observations were made with a 76mm Irving refractor at $\times 38$, $\times 76$ and $\times 116$.

1 Nov 2003, 18:30 to 18:40 UT. Autolycus (22) and Aristillus (17) with Cassini (57) and Mons Piton (q). The 7 day old Moon was low in the south. First view was bright although atmospheric were visible. Lots of detail despite conditions. Spotted the two craters which were very prominent due to their dark floors. The rim of Aristillus was very bright, catching the rays of the rising Sun. North of the crater (bottom of image), was a very bright peak—almost starlike in its intensity right on the terminator. Checking with Rühl's map confirmed this as Mons Piton which is named after a peak in Teneriffe. East of Mons Piton is Cassini, with what appeared to be a double peak on the floor but were later confirmed as Cassini A and B, 56km and 17km wide respectively. The walls of Autolycus and Aristillus are over 3km high. I could not see Aristillus' rays in this observation. South of Autolycus were three small peaks, one on the terminator. Mare Imbrium was prominent and smooth. In 1959, the Russian spacecraft Luna 2 impacted about 50km from Autolycus.

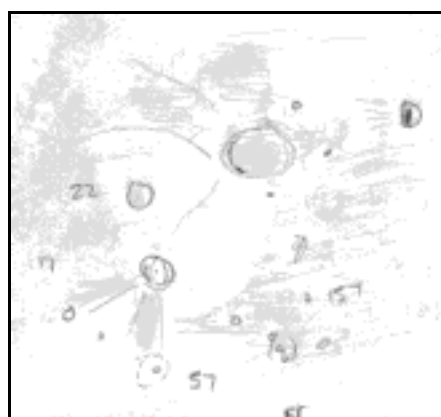
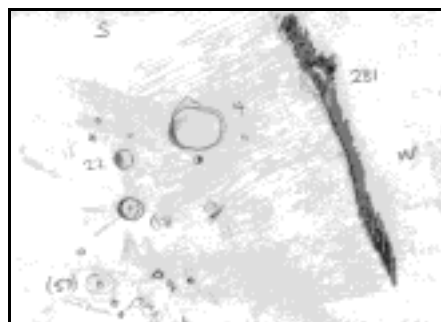
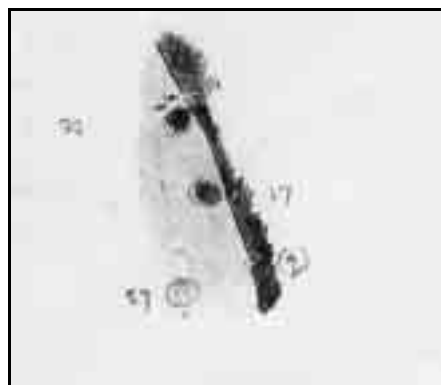
2 Nov 2003, 19:07 to 19:40 UT. Most noticeable is the change in Cassini (57) which is the same colour as its surroundings. Only Cassini A was visible this time and the rim of Cassini looked like a doughnut. To the north several smaller features including the southerly aspects of Montes Alpes

were picked up, and Mons Piton (q) was very bright. There was a faint ridge running from Mons Piton to the west with a feature about a third of the way along it. This was later confirmed as crater Piazzii Smyth, 12.5km wide.

Aristillus (17) still distinct with a little shadow on its eastern side and sharp sunlight on its western rim. Two or three rays could be seen in Mare Imbrium. Autolycus was very clear, but the features to its south were less distinct and hard to draw. West of Aristillus, the Spitzbergen mountain range was noticeable for three tiny triangular shaped shadows and a circular ridge. I did not pick up Kirch (which I noted checking the map when indoors), despite it being the same size as Piazzii Smyth.

The large crater to the west is Archimedes (14), 83km wide and with a dark, smooth floor, the same colour as the mare. I could pick up the highlands to the south and A to the west. On the terminator was Timocharis (281). The eastern rim caught some sunlight and beyond the terminator part of the western ridge was bright so that you could almost see the whole rim of the crater. Further north (not drawn) there was a good view of Plato and Montes Teneriffe. There was great contrast around Mons Pico.

3 Nov 2003, 20:15 to 20:35 UT. Most of this observation was done at $\times 116$. By this time at the lower power, the glare was bright and needed a filter. The drawing did not scan well, but it attempts to capture the different shadings of the area which were now in full morning sunlight. The terminator is off the edge of the page. Rays from Aristillus were very clear, and both this crater and Autolycus



appeared to be on a raised plain which is whiter than the surrounding mare. The boundary of this area is indicated by the curved lines to the south and west of Autolycus. Cassini was almost invisible, although Mons Piton and Montes Spitzbergen were very clear. Archimedes' floor was now greyer than the maria, and there was a distinct darker shadow on its eastern side. I could pick up Kirch (157) this time but the ridge on which Piazzii Smyth sits was washed out.

This was an interesting exercise in observation. When I first pick an area, I sketch it first and then identify the features using maps indoors.

International Bright Lunar Rays Project

Messier A and its rays

By William M Dembowski, FRAS, Project Coordinator

Introduction

The International Bright Lunar Rays Project is a joint effort of the American Lunar Society, the Association of Lunar & Planetary Observers, the British Astronomical Association, the Society for Popular Astronomy and various independent observers. The purpose of the project is to learn everything possible about these fascinating features.

Messier A and its rays

Since this is a long term study, any report of a specific ray system such as that associated with Messier A should not be viewed as a final report. Much has been learned about the Messier A system, but much more work remains to be done. Observations of Messier A will continue to be accepted and incorporated into our knowledge of its ray system.

The picturesque pair of Messier and Messier A (formerly called Pickering) lies in western Mare Fecunditatis. Although intimately linked in time and space, only Messier A is responsible for the unique, comet-like ray system associated with the pair. The odd appearance of the crater pair and double ray contributed to several interesting theories. Walter Goodacre detected five ghost craters lying between the two rays. V A Firsoff explained their presence by theorizing that Messier A was gradually creeping eastward, with the ghost craters marking its previous locations. Franz von Gruithuisen even proposed that the rays were artificial in nature.

We now believe that both craters, and associated rays, were created by a single body (or a very close double body) whose angle of impact was too shallow for the ejecta to disperse radially. Non-radial dispersion occurs when the impact angle is less than 45°. The extreme nature of the Messier A rays suggests that the angle was probably less than 15° and, quite possibly, as little as 1° to 5°.

The odd shape of Messier A, espe-

cially under changing light, prompted Harvey Nininger to suggest that a meteorite had crashed through a ridge leaving a hole on either side connected by a tunnel. K C Pau's image, however, clearly shows that Messier A simply overlaps an older, existing crater (Figure 1).

The rays themselves extend from Messier A to the vicinity of Lubbock H on the edge of the highlands to the west, a distance of about 105 km (65 miles). Rays, particularly at their greatest distance from the parent crater, are notoriously difficult to trace across highland areas and so their total length is probably slightly greater. Of relatively equal size, both rays are approximately 6 km (3.7 miles) across at their widest point.

The northern ray begins to break apart in the last 40 km (25 miles) of its length. This appearance could also be caused by the ray overlapping, or being overlapped by, another ray pattern. If the separation of the northern ray is not the result of an overlap one also has to wonder if it occurred in 'mid-air' or as the ray material struck the lunar surface.

Other rays on the Mare Fecunditatis also enter the picture. A broad fan-shaped ray, narrowest to the south, covers the area from the eastern rim of Messier to the eastern rim of Messier A, a distance of about 16 km (10 miles). It then fans out to several times that width as it travels north as shown in Walter Kupson's image (Figure 2).

In addition, a slender and gently curving ray, originating from the vicinity of Taruntius B, crosses the Messier A ray at its midpoint and proceeds to the area east of Lubbock. It does not intersect the Messier A ray at the point where the previously mentioned separation occurs. See Daniel del Valle's sketch (Figure 3).

Observers and instruments

27 observers contributed a total of 195 observations of Messier A and its ray system. Their names, location

and instruments are shown below:

Michael Amato (West Haven, CT, USA)
6" Newtonian

Patrick, Anway (Munising, MI, USA)
11" SCT

Francesco Badalotti (Cremona, Italy)
10" SCT

Paola Battaglia (Milan, Italy)
60mm refractor

Gerard Coute (Chateaugay, France)
7" Dall-Kirkham

Daniel del Valle (Aguadilla, Puerto Rico)
8" Newtonian

William Dembowski (Elton, PA, USA)
5" refractor

Jeffrey Edmons (Boise, ID, USA)
10" SCT

William Elsbury (Mason City, IA, USA)
8" SCT

Rick Gossett (Detroit, MI, USA)
8" SCT

Robin Gray (Winnemucca, NV, USA)
6" refractor

Peter Grego (Rednal, England)
10" Newtonian

Doug Hansen (San Diego, CA, USA)
6" Maksutov

Alan Heath (Long Eaton, England)
10" Newtonian

Jack Kramer (Libertyville, IL, USA)
4" refractor

Walter Kupson (Middlebury, CT, USA)
4.5" Newtonian

David Lehman (Fresno, CA, USA)
10" Newtonian

Gilbert Lubcke (Middleton, WI, USA)
11" SCT

William O'Connell (Whitman, MA, USA)
8" SCT

K C Pau (Hong Kong, China)
10" Newtonian

Harry Pulley (Guelph, Ontario, Canada)
8" SAC

Giuseppe Sorrentino (Rome, Italy)
8" SCT

Alexander Vandenbohede (Gent, Belgium)
8" Refractor

Rodrigo Viegas (Montevideo, Uruguay)
4.5" Newtonian

Grahame Wheatley (Long Eaton, England)
12" Newtonian

Robert Wlodarczyk (Czestochowa, Poland)
7" Newtonian

Davide Zampatori (Anzio, Italy)
8" Newtonian

Instrumentation is summarized as follows: Newtonian—11; SCT—8; refractor—5; other—3.

A total of 195 Messier A observations have been received and are summarized as follows: 117 maps by 5 observers; 34 sketches by 10 observers; 20 video stills by 8 observers; 15 CCD by 8 observers; 9 photographs by 1 observer.

Video stills and CCD images

Electronic imaging, with both still cameras and video, has given lunar observing a tremendous boost in recent years. Not surprisingly, most imagers concentrate on the terminator to take fullest advantage of the electronic camera's ability to record fine detail. Fortunately, electronic cameras also have the ability to record a wide range of tones, which makes them particularly useful in ray research.

Figure 1—Video still



By K C Pau
12 October 2003 17:17 UT
Colongitude: 115°
10-inch Newtonian / x5 Barlow / Philips ToUcam Pro
250 frames stacked

Figure 2—CCD image



By Walter Kupson
9 December 2002 22:01 UT
Colongitude: 334.6°
4.5-inch Newtonian
3.2 Megapixel Canon S30

Sketches

The time-honoured tradition of making lunar sketches is of great value in the study of lunar rays because those who sketch what

they observe also tend to provide valuable descriptive notes with their drawings. These notes can include anything from brightness estimates of the rays to emphasizing some interesting ray properties not immediately apparent.

Figure 3—Sketch



By Daniel del Valle
12 April 2000 23:45 UT
Colongitude: 15.5°
8-inch Newtonian x266
Moon and W80A Filter

Maps

Mapping is sketching rays onto a copy of a lunar map, usually the Lunar Quadrant Maps. This method is relatively quick and requires a minimal amount of drawing skills. Mapping is particularly useful when trying to determine when rays are, and are not, visible.

Although the study of Messier A's ray system is still incomplete, Michael Amato's ray maps span a considerable range. He has documented the rays at local lunar sunrise with a solar altitude of only 0.43° and an altitude of 15.67° at local lunar sunset. These angles are calculated from the centre of the parent crater, Messier A. The solar altitude at sunrise is of particular interest since rays are commonly classified as 'high Sun' features. It would appear that the rays of Messier A are easily visible any time they are struck by sunlight.

Figure 4—Ray map



By Michael Amato
9 September 2003 02:40 UT
Colongitude: 65.79°
6-inch Newtonian x200

Photographs

Only one observer used film-photography to record the Messier A ray system, a further statement on the popularity of the more user-friendly electronic imaging.

Figure 5—Photograph



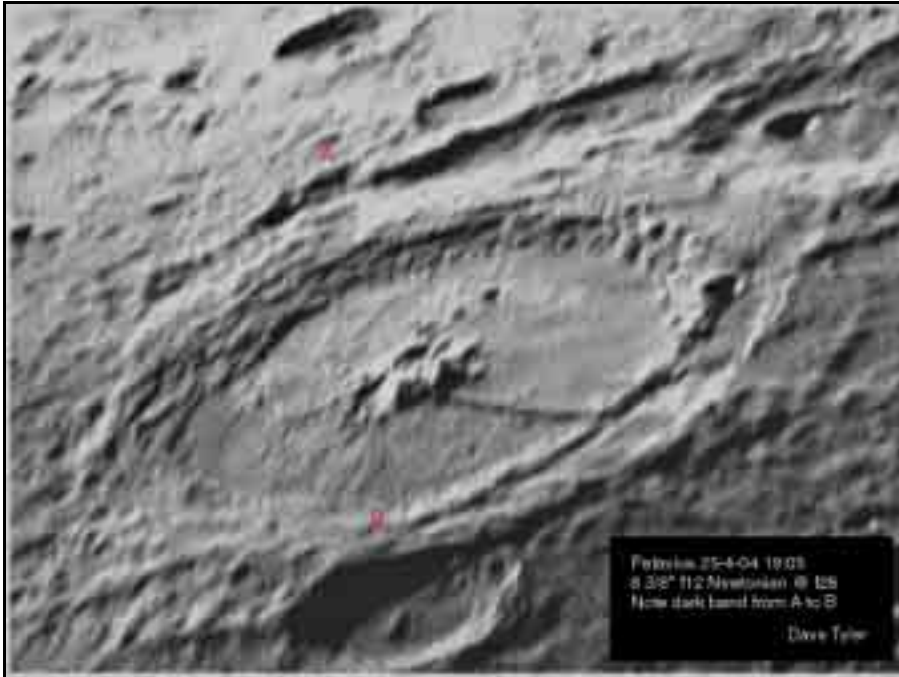
By William Dembowski
13 July 1999 02:05 UT
Colongitude: 266.25°
5-inch refractor Tri-X Film

Conclusion

Anyone wishing to participate in the International Bright Lunar Rays Project should contact the Coordinator, William M. Dembowski, via email at Dembowski@adelphia.net or by postal mail: 219 Old Bedford Pike, Windber PA 15963, USA.

Interested parties are also urged to visit the International Bright Lunar Rays Project website which includes a monthly newsletter, *The Impact Ray Observer*, at: <http://users.adelphia.net/~dembowski/rays.htm>

Mystery in Petavius



CCD images by Dave Tyler (Flackwell Heath, UK)

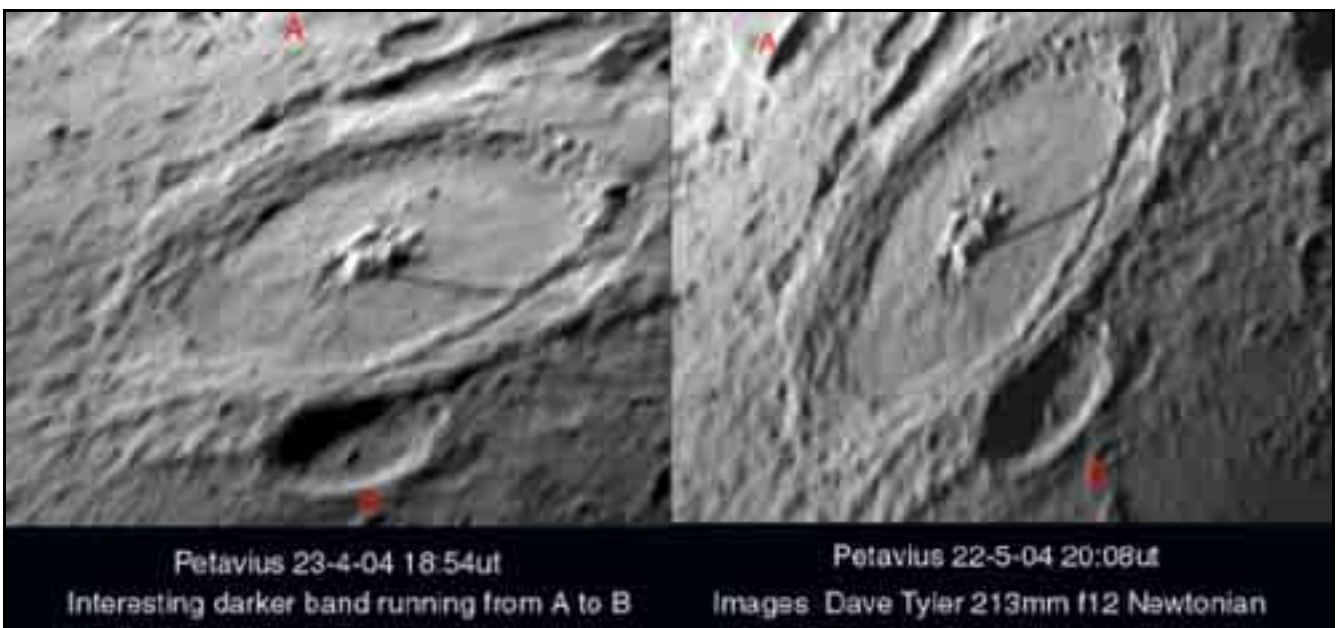
Notes:

I have observed Petavius for many years as it is a great feature on a young Moon, but I have never noticed the dark band running from A to B (marked on the images here). My ToUcam noticed it right away. The feature appears on three different AVI movie clips. You may also note it is accompanied by a brighter band to the right of it which is also highlighted on the central peak. It appears to me to be a shallow groove

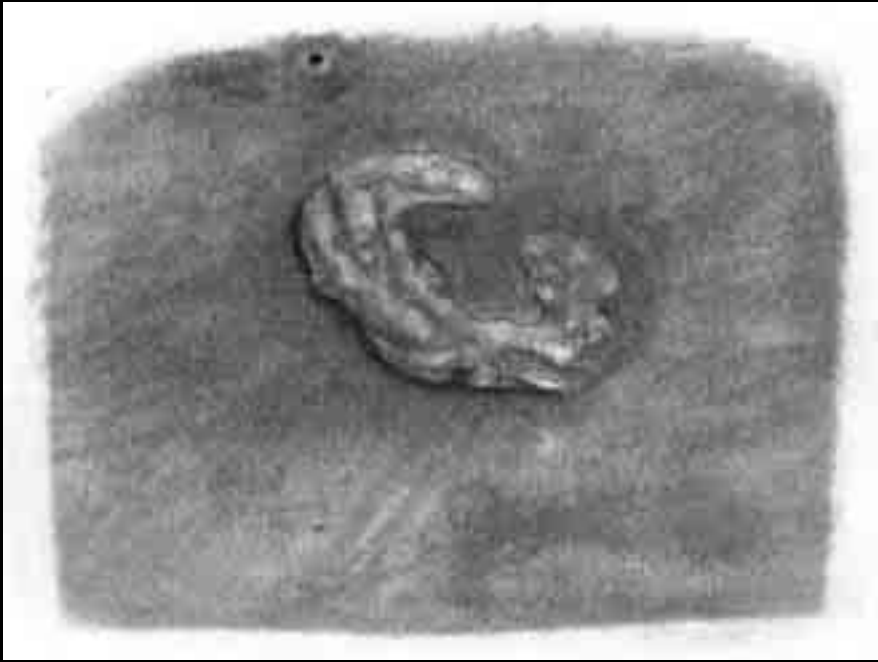
one side of which is highlighted by the Sun. This groove also appears in the crater rim. I don't know if it a recognised feature and has a name.

Peter Grego's reply:

I too have never seen or read about this intriguing feature. I have checked against other images of Petavius in my library, including the *Consolidated Lunar Atlas*, and find that it is not at all clear on these images. You appear to have captured the apparent feature at its best. I believe that the effect is enhanced by the strong fault line cutting across Petavius' outer wall and causing a difference in illumination on either side of it, and this line seems to extend across Petavius' floor in a series of low hills to one side of it. Whether this is all a real fault line, or whether it is an effect caused by a combination of topography, illumination and albedo, I cannot say at present, but it certainly would deserve closer attention to verify it on images and by visual observation. Observations are welcomed by the SPA Lunar Section.



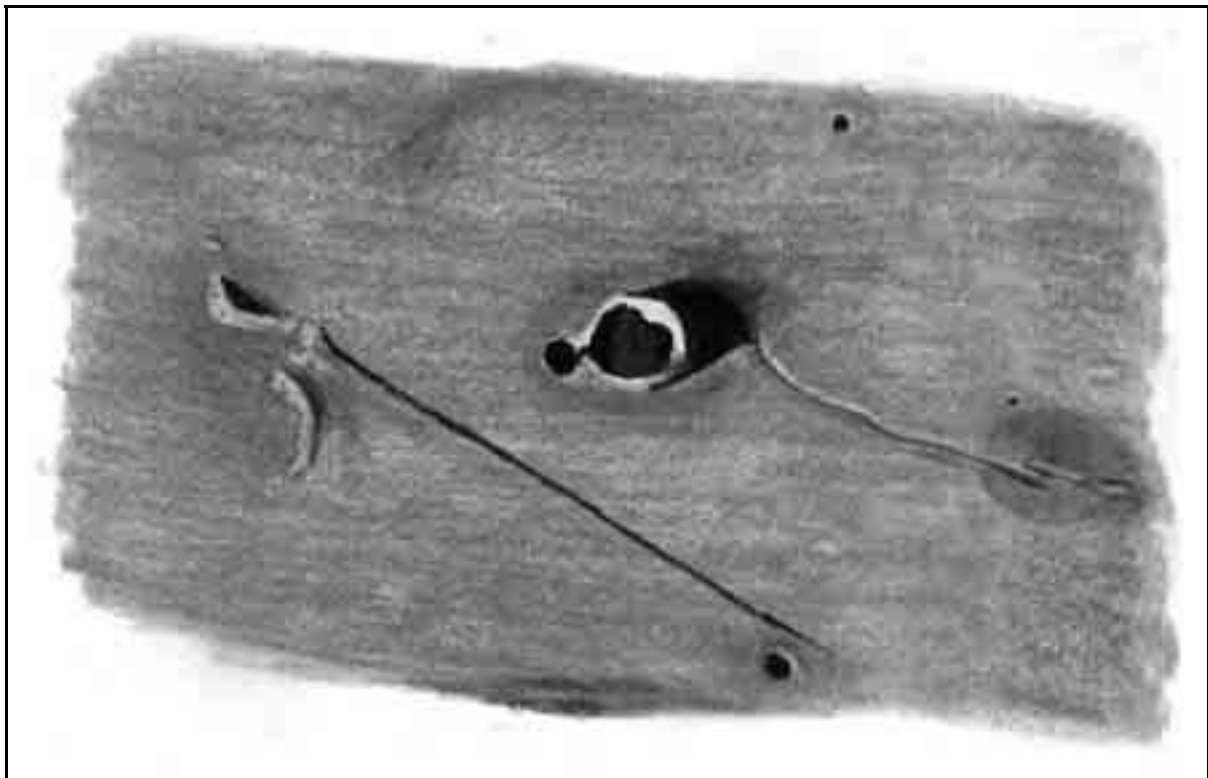
Mons Rümker



Observation by
Daniel del Valle
(Aguadilla, Puerto Rico)
2-3 May 2004
23:48-00:20 UT
120mm refractor x222
Seeing 5-6/10
Col. 70.2-70.5°

Notes: This complex of lunar domes is an exceptional formation, but difficult to observe and see its details clearly. Its surface appears lumpy and complex.

Rupes Recta, Birt and Rima Birt



Observation by Daniel del Valle (Aguadilla, Puerto Rico)
27-28 May 2004 23:00-00:06 UT
203mm Schmidt-Cassegrain x451 (x2 Barlow used)
Seeing 7/10 Col. 14.9-15.4°

Notes: This observation was hampered by weather conditions, but during the better moments I observed that the rille connecting Birt E and F has a twin rille that travels further northwest.

Janssen



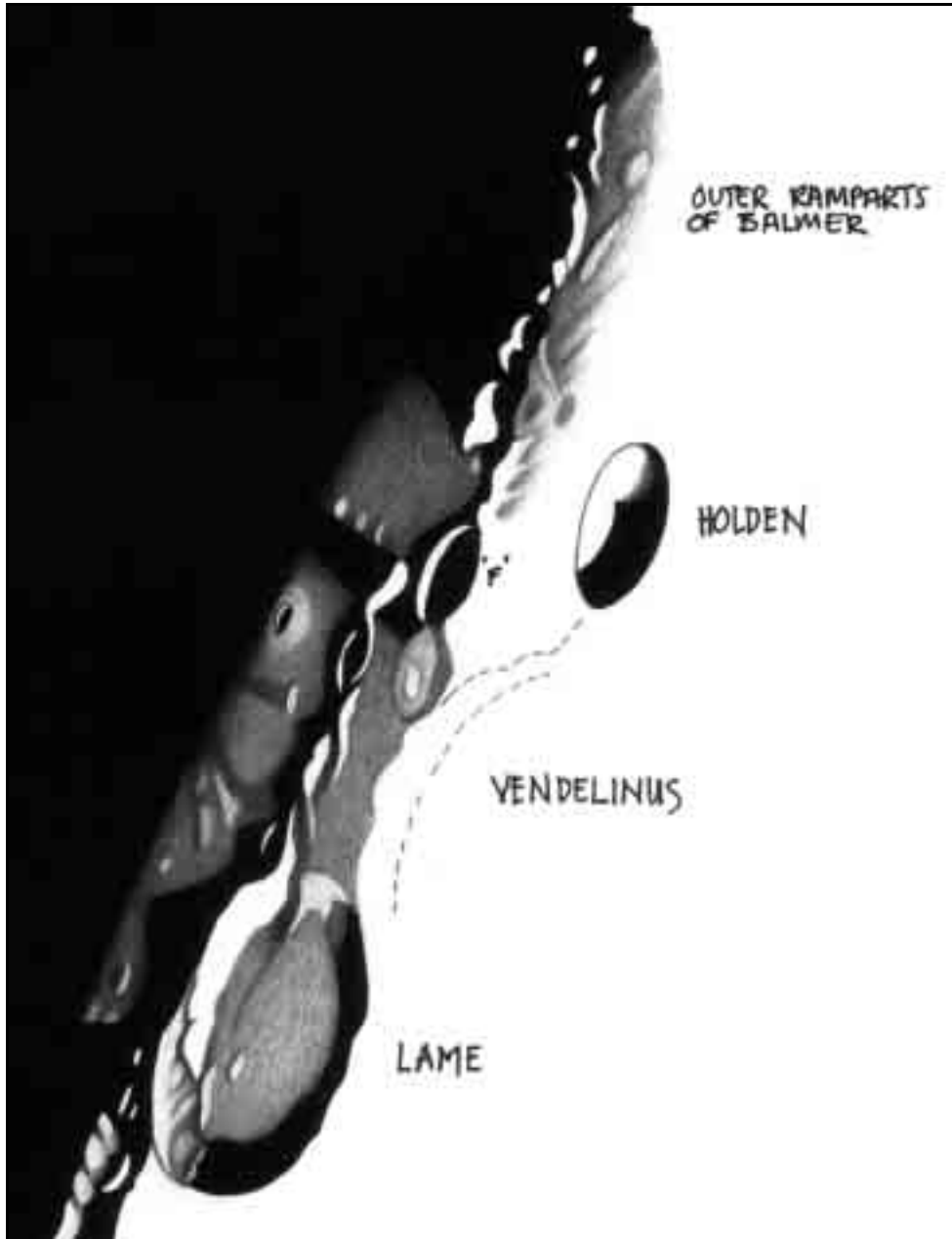
Observation by Peter Grego (Rednal, Birmingham, UK)
3 September 2004 01:10-01:50 UT
200mm Schmidt-Cassegrain x200
Seeing All Col. 132.9-133.3°

Notes: This is a further example of an observational drawing that was made directly onto a low-contrast printout of a CCD image that was captured just a few minutes before the drawing was made. Janssen was the subject of my first attempt at such a recording technique, on 23 March 2000. The main advantages of the technique is that the outlines and positions of all the main features are perfectly reproduced, saving a great deal of time, allowing the observer to get straight into recording the fine detail.

The drawing above is a scan of the actual unretouched drawing made at the eyepiece.

Janssen, a large ancient and considerably eroded crater. 190 km in diameter, it is one of the near-side's largest non-mare filled craters. Its state of erosion means that it is only an object of prominence when located near to the sunrise or sunset terminator. Under a high Sun, it cannot be seen at all. The deep crater Fabricius lies on Janssen's floor. From Frabricius' southern ramparts a large rille curves across Janssen's floor to its inner southern wall.

Balmer to Lame—evening terminator

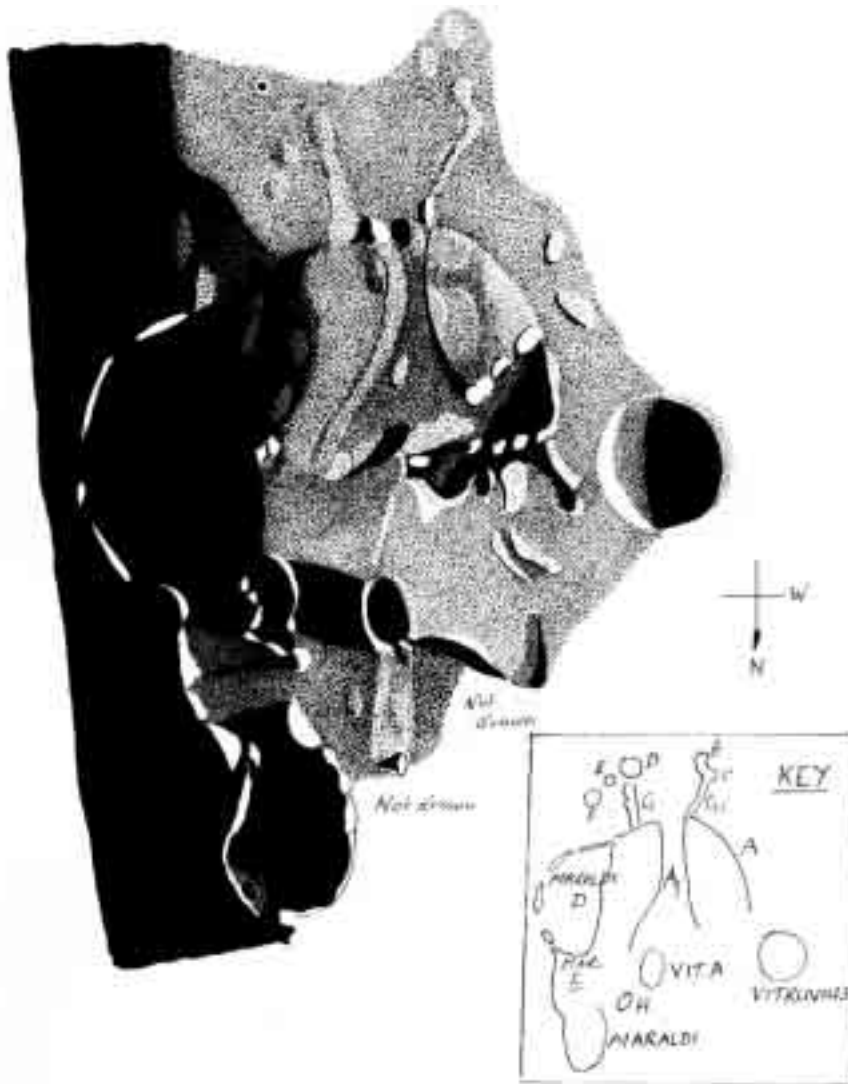


Observation by Nigel Longshaw (Chadderton, Oldham, UK)
28 November 2004 21:36-22:07 UT
125mm Maksutov-Cassegrain x152
Seeing All-III Transp Good
Col. 111.77-112.02°

Notes: A good view of this complex region, and a chance to do a little more work on the area. Seeing however was rather variable, so the detail towards the terminator was concentrated on.

The row of 'ridges' and dark areas stretching south from Lame is a shallow crater chain. The shallow 'saucer-like' depression north of 'F' was interesting. The area to the north of this was not drawn in detail.

Region west of Maraldi D



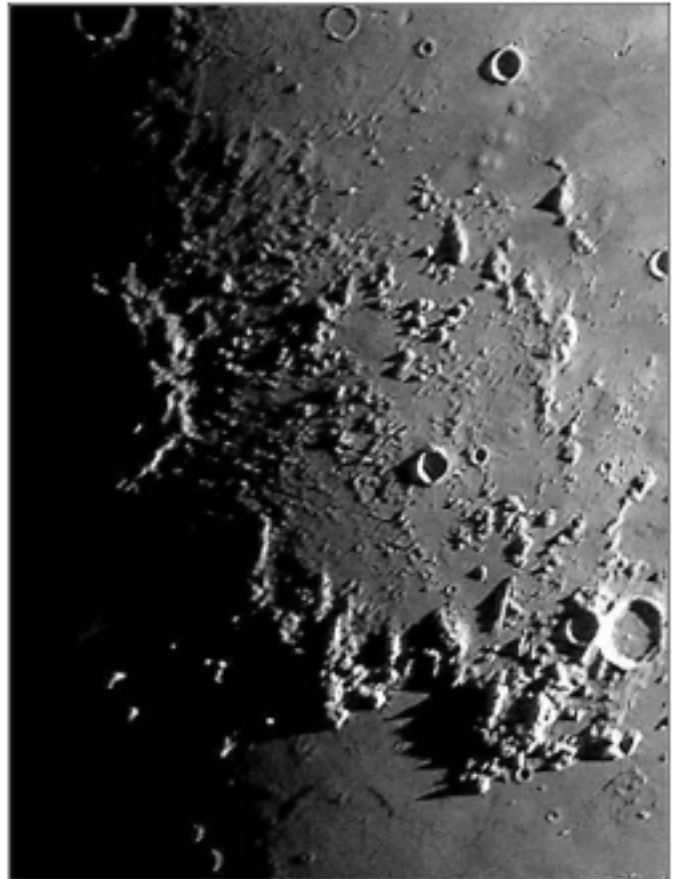
Observation by Colin Ebdon (Fordham Heath, UK)
 17 August 2003 00:45-01:45 UT
 250mm Newtonian x236
 Seeing All $\text{Col. } 143.82\text{-}144.32^\circ$ Lunation 997

Notes: This was an opportunist observation in that the writer had been observing Mars and had not planned to view the Moon. However, on preliminary inspection, the area covered by the drawing stood out on the terminator as a rough 'plateau' like feature, rather like a simplified version of Rümker and seemed worthy of closer inspection.

There appeared to be a smooth 'cleft' or valley, marked A1 on the key, dividing the plateau into two distinct halves. The shield shaped feature marked A was the smoother and more well defined segment of the plateau. The main features of note on the surrounding Mare Floor were what appeared at first sight to be wrinkle-ridges at G and G1. As the Sun set however, G1 appeared to terminate in very shallow dome like features marked B and C, joined by a 'tube'. G became gradually more well defined, but did not appear as the three fairly distinct small mountains as shown in the *Times Atlas*. Close to the Southern end of G were 3 very shallow dome like objects which would vanish very quickly away from the terminator. These seem to be clearly recorded in the 'Times' Atlas close to the crater Maraldi B. There was a small but well defined 'classical' lunar dome between Vitruvius A and Maraldi itself.



PETAVIUS and WROTTESLEY 00.01 U.T. 29 December 2004
37cm Newtonian masked to 30cm, x2 Barlow F14
Toucam Pro 740, single frame out of 400, 0.01 second 5 fps
Processed in K3CCD Tools and Astroart
Seeing 2.3"/10, Transparency 10/10
Mike Brown



MONTES CARPATUM & HORTENSIUS DOMES
04.45 U.T. 8 OCTOBER 2004
37cm Newtonian masked to 30cm, 1.5x Barlow F10.5
Toucam Pro 30 frames out of 200
Seeing b2/10, Transparency 10/10
Mike Brown

Schickard and environs



CCD image by
Dusko Novakovic
(Yardley Gobion, UK)
6 April 2004
200mm f/8 Newtonian
Kyocera Finecam S3

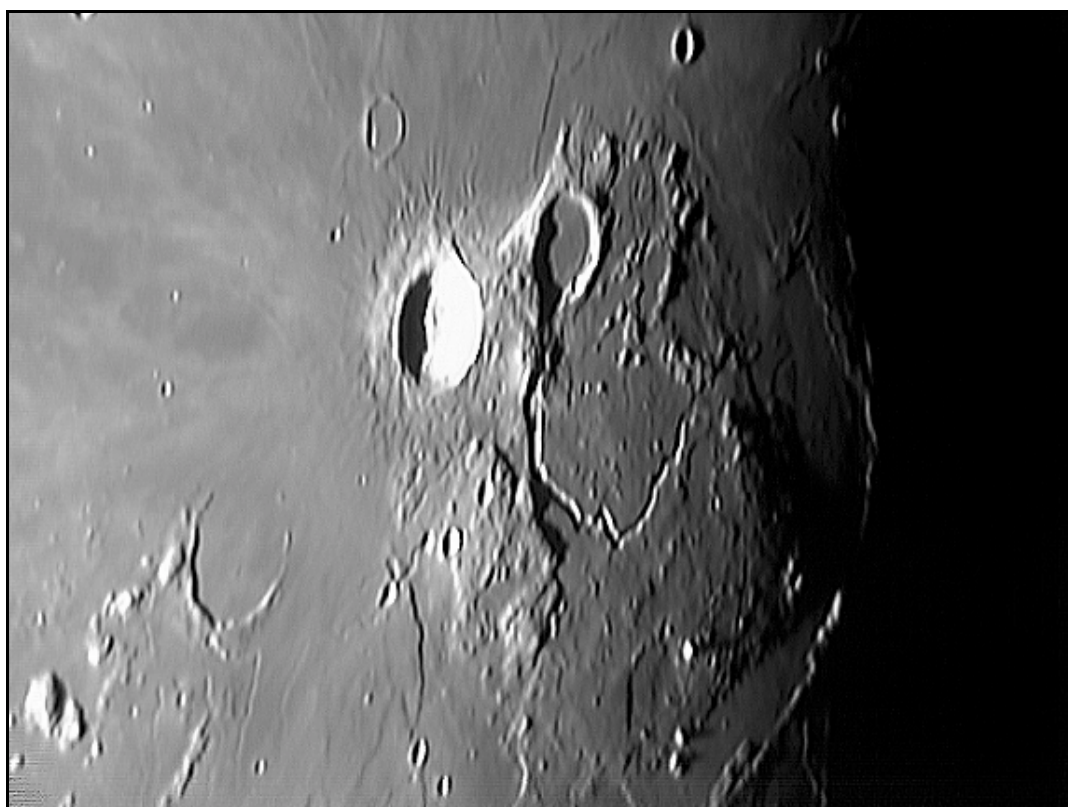
Western Oceanus Procellarum

Right: CCD image by
Jackie Cottam
(Manchester, UK)
21 May 2004
150mm Newtonian

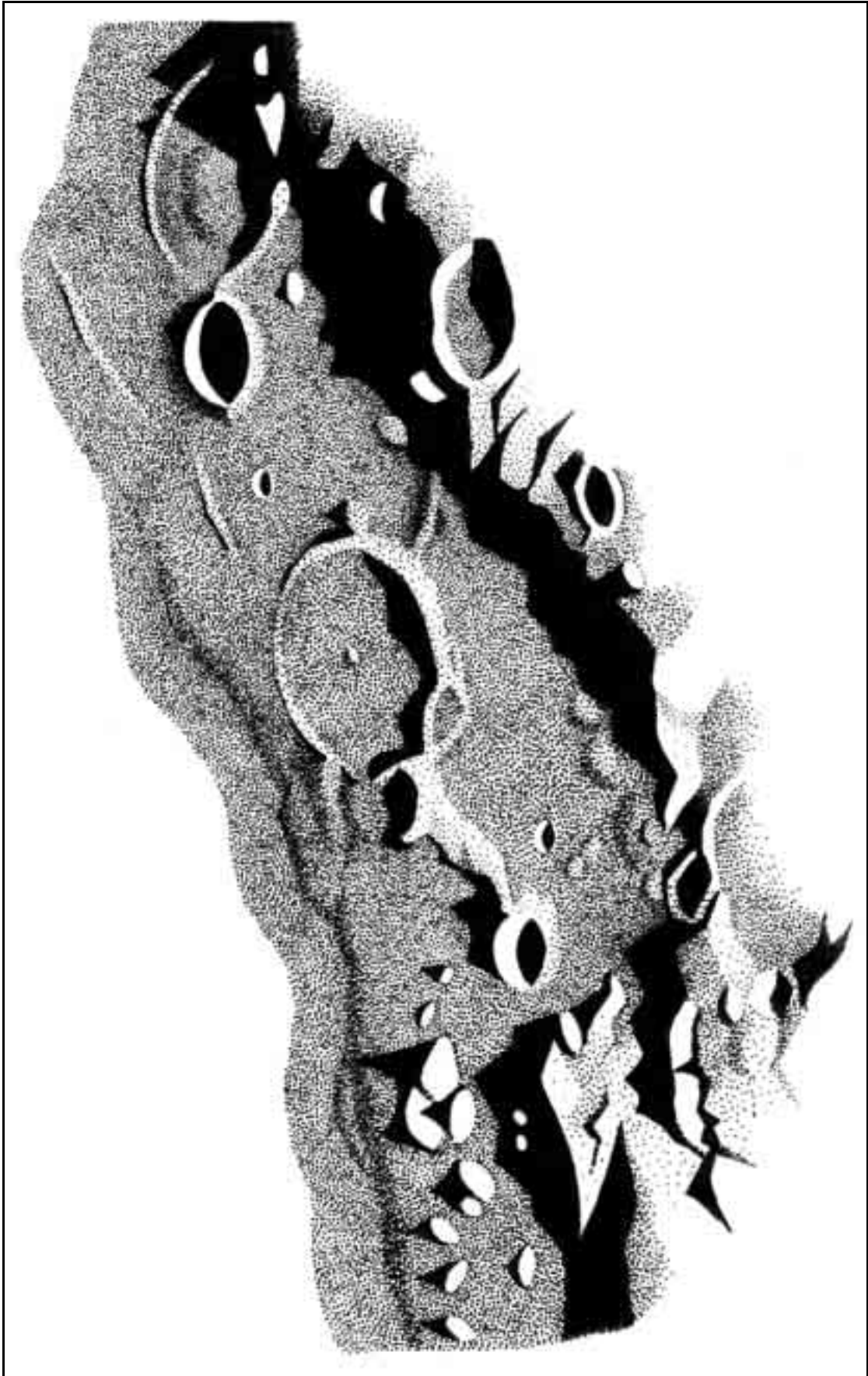
The bright ray crater is Kepler.
To its west is the crater Marius,
and further west near the termi-
nator can be seen the Marius
dome field. In the lower part of
the image is the Aristarchus Pla-
teau, with the bright Aristarchus,
Herodotus and Vallis Schroteri.

Below: CCD image by
Anthony Ayiomamitis
(Athens, Greece)
25 October 2004 17:46 UT
350mm Schmidt-Cassegrain
Philips ToUcam Pro

A much closer view of the
Aristarchus Plateau, captured at
a similar angle of illumination.

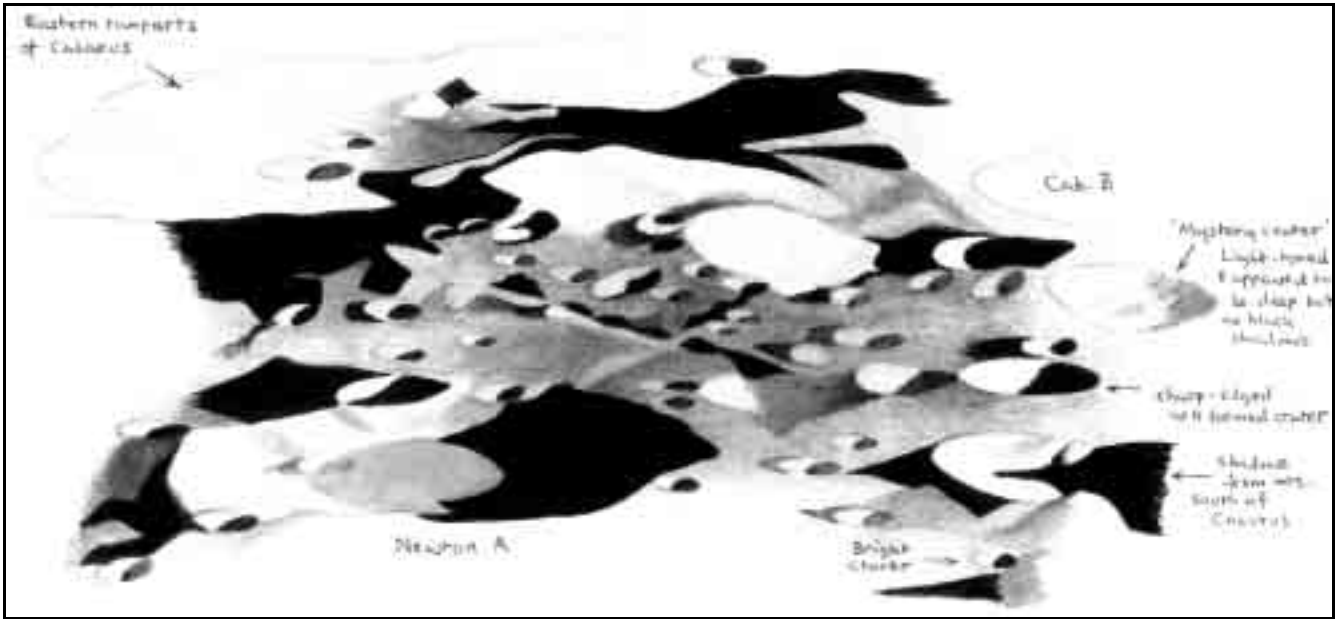


Yerkes



Observation by Grahame Wheatley (Long Eaton, UK)
15 August 2003 02:45-03:20 / 03:40-04:15 UT Col 120.52-121.28°
175mm Maksutov-Newtonian x176 & 294

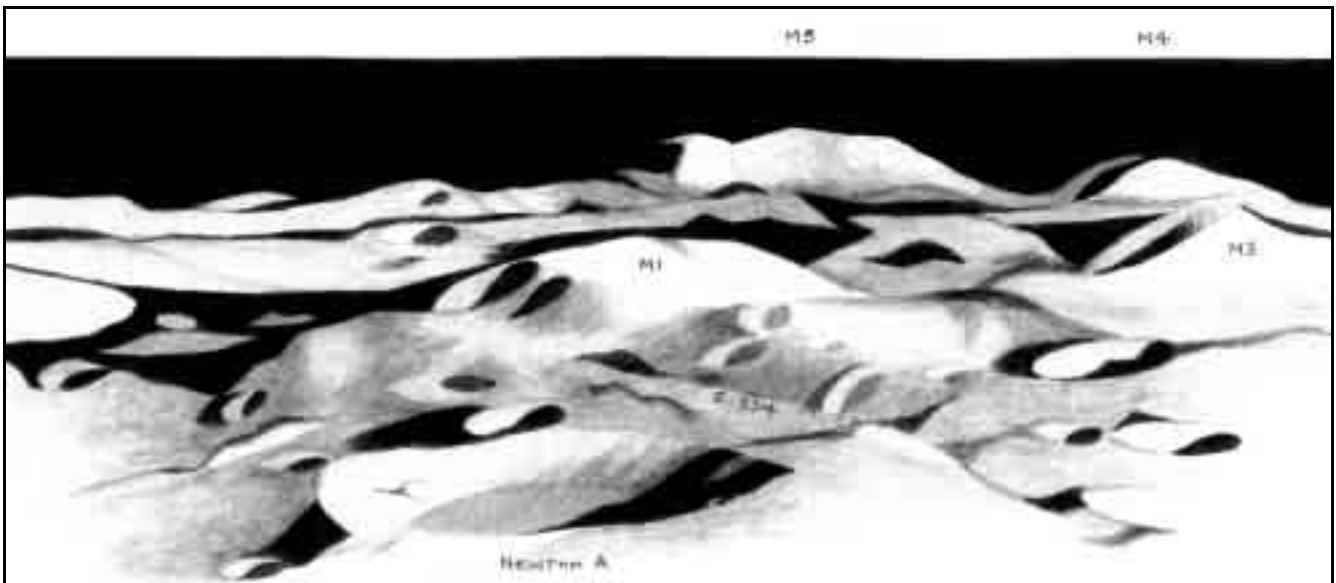
Newton A, S.334 region



Observation by Grahame Wheatley (Long Eaton, UK)
 15 December 2003 05:15-07:15 UT Col 168.9-169.9°
 175mm Maksutov-Newtonian x294 & 350
 Seeing Variable AIII-II Transp. Excellent

Notes: The northern rim of Cabaeus A appeared to be ringed with small craters (?). This could be the result of misreading light and dark spots. Other small craters (?) noted in the area. The suspected 'mount' in Newton A was seen as a small crater (?). The valley/rille crossing S.334 was well seen. A reasonable impression was gained of S.334 and environs.

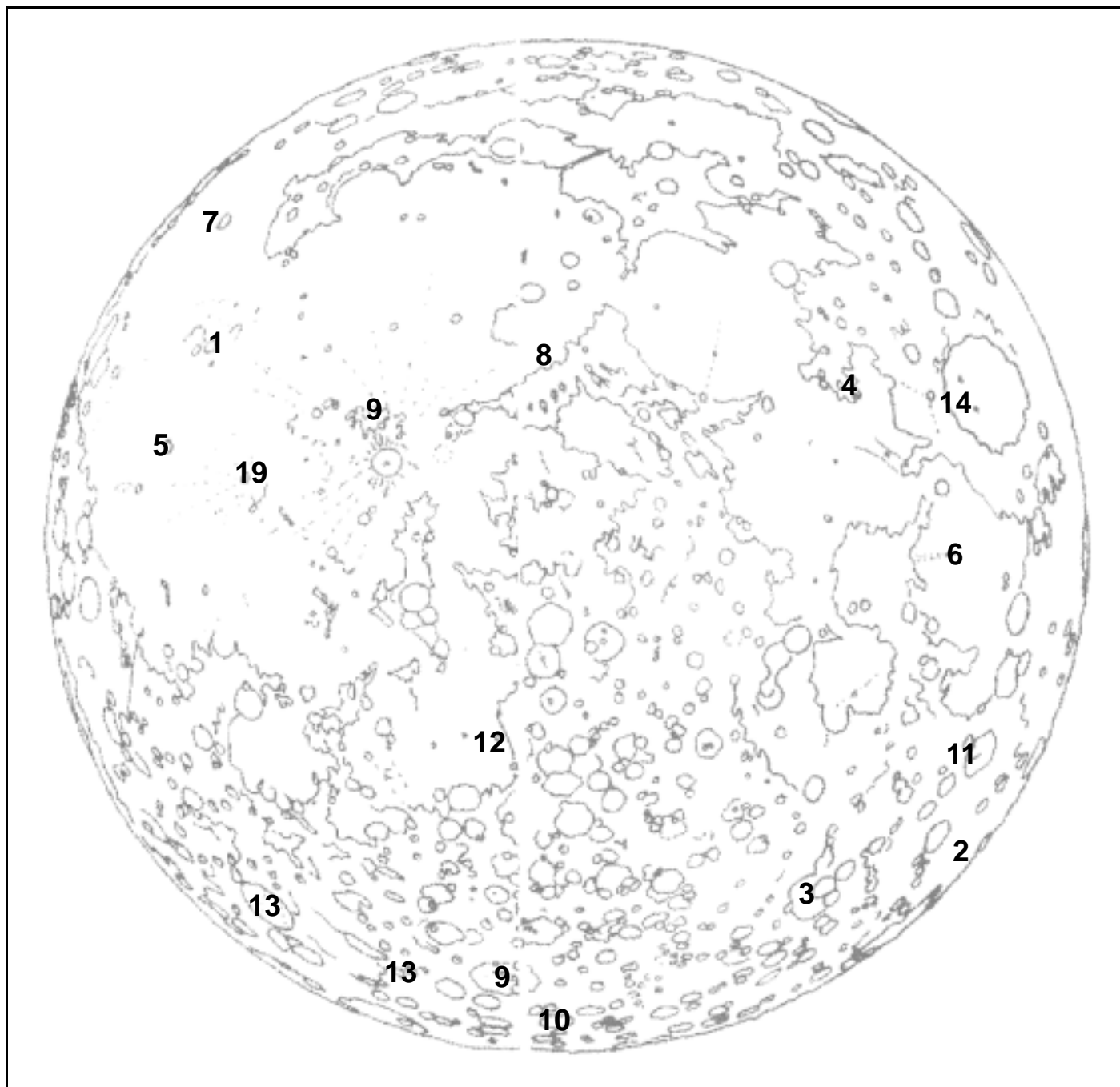
Newton A, S.334, south polar region



Observation by Grahame Wheatley (Long Eaton, UK)
 15 October 2003 01:15-02:45 UT Col 144.1-144.9°
 175mm Maksutov-Newtonian x350
 Seeing AII-III Transp. Very good

Feature Finder

Showing the locations of features in this issue



- | | | | |
|---|-------------|----|------------------|
| 1 | Aristarchus | 8 | Montes Apenninus |
| 2 | Balmer | 9 | Montes Carpatus |
| 3 | Janssen | 10 | Newton |
| 4 | Maraldi D | 11 | Petavius |
| 5 | Marius | 12 | Rima Birt |
| 6 | Messier A | 13 | Schickard |
| 7 | Mons Rümker | 14 | Yerkes |

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We regret that back issues of *Luna* are not currently available

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