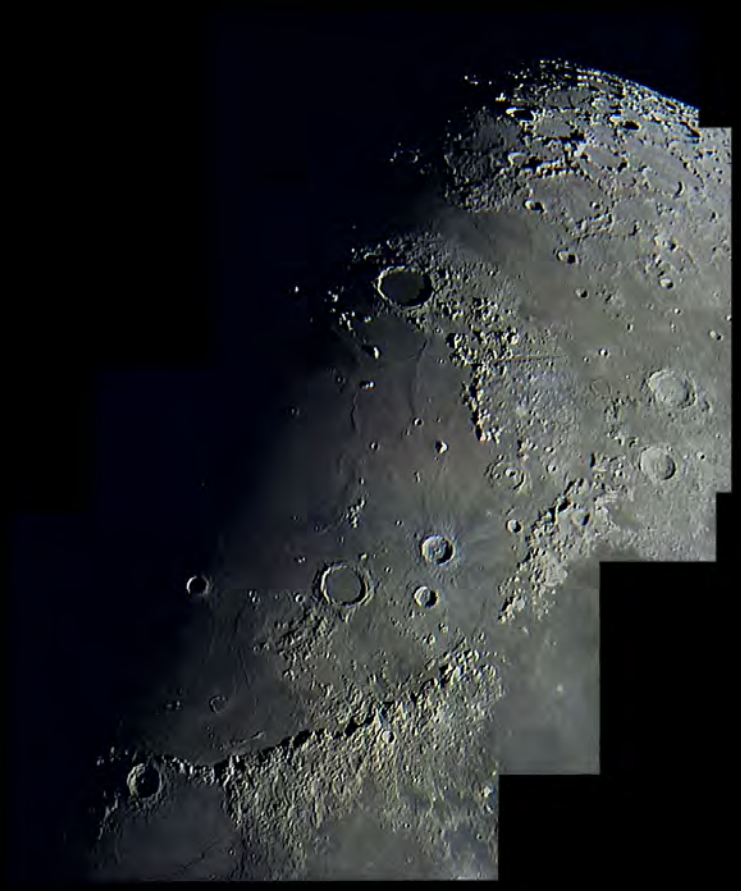
Lunar Mosaics



An Astrophoto Album
by
David B. Viscio

October 10, 2017

Introduction

A primary goal for astrophotographers is to obtain high-resolution images of the wonders of the universe. Capturing detail in deep-sky, planetary, lunar and solar images is almost the 'holy grail'. Amateurs often face daunting trade-offs and compromises to obtain high-resolution, wide-field images. To obtain wide-angle images they must settle for lower resolution. To obtain high-resolution images, they must choose narrow fields of view.

There are two approaches to this challenge. The first option is to acquire a camera with a huge imaging chip with many megapixels of small pixels. This option can be extremely expensive and not attainable to most amateurs. The second option is to capture many overlapping high-resolution, narrow-field images and 'stitch' them together into a single high-resolution, wide-field mosaic image. As images published in *Sky & Telescope* have often revealed, this option can be used successfully for all types of astroimaging and yield spectacular images.

This album presents 8 mosaic images of the moon constructed over 17 years. They consist of mosaics using 2 image frames up to 25 image frames. In addition, the album shows the separate image frames that make the mosaic and how those frames were aligned to make the mosaic.

Cameras

- Nikon Coolpix 990 digital camera
- Philips ToUCam PCVC 740K webcam
- Canon EOS 60Da digital single lens reflex camera

Optical Systems

- Celestron C8 8-inch f/10 Schmidt-Cassegrain telescope
- Celestron C5+ 5-inch f/10 Schmidt-Cassegrain telescope
- Stellarvue SV115 f/7 triplet apochromatic refractor

A variety of power amplifiers were used to increase the image size.

- ScopeTronix 1.6x MaxPower
- TeleVue 1.8x barlow
- Televue 2.5x barlow
- Celestron Ultima 2x barlow
- Televue 2.5x Powermate

Mounts

- Vixen GPDX equatorial mount with SkySensor 2000
- Software Bisque Paramount MX German equatorial mount on a permanent pier controlled by TheSkyX Pro on an Apple MacBook Pro laptop computer.

The Celestron C5+ and C8 telescopes were on their own motor-driven fork mounts and equatorial wedges.

Basic Principles

To successfully make a mosaic image, several basic principles must be followed:

First, ensure each image frame overlaps an adjacent frame by at least 1/3. This will make aligning frames relatively straightforward.

Second, make the exposures for each frame in a set identical. Otherwise the brightness/darkness of the frames will vary, requiring adjustments to

the brightness/darkness of each frame and dramatically increasing the difficulty of mosaic assembly.

Third, for objects possessing a wide brightness range (like the moon), set the exposure parameters with the brightest part of the object, then capture all image frames using those exposure parameters. This ensures the brightest areas will not be over-exposed and useless.

Video Capture and Processing

The majority of the image frames were obtained from videos using frame stacking and wavelet processing with either the Philips ToUCam or the Canon EOS 60Da.

Philips ToUCam

AVI format videos were captured at 5 frames per second using QCFocus camera control software on a Dell Inspiron 8600 computer and Windows XP. The videos were routinely 300 seconds in duration, yielding videos with about 1500 image frames.

The AVI videos were processed with Registax 4. The best 300 frames were selected and stacked. The resulting raw image was saved in 16-bit color TIFF format. This raw image was optimized using wavelet processing to yield a final image that I deemed pleasing. The final images were saved in 16-bit color TIFF format.

To ensure consistency among image frames in a mosaic set, video length, number of video frames stacked and the wavelet processing parameters were the same.

Canon EOS 60Da

MOV format videos were captured at 60 frames per second, ISO 400 to 1600, using Canon EOS Utility (included with camera) on MacBook Pro computers and OS 10.6 or 10.11. The camera was in Crop 640x480 video mode. Videos were 3 to 5 minutes in duration, yielding approximately

10,800 or 18,000 image frames.

Two methods were used to process the lunar videos. Initially the original MOV format videos were processed with Astro IIDC, an Apple OSX program. Approximately the best 10% of the frames were selected and stacked. The resulting raw stacked image was saved in 16-bit color TIFF format. This raw image was optimized using wavelet processing to yield a final image that I deemed pleasing. The final images were saved in 16-bit color TIFF format.

A subsequent comparison of Astro IIDC and Registax 6, a Windows program running on the MacBook using Parallels and Windows 7, revealed Registax 6 delivered better results and is now used for all video processing. However, Registax 6 cannot use MOV format videos so a multistep process must be utilized. First, the MOV videos are converted to AVI with Quicktime 7 Pro under Mac OSX. In Windows 7 the AVI file is preprocessed with VirtualDub, making an AVI format file readable by Registax 6.

With Registax 6 the best 3000-4000 frames were selected and stacked. The resulting raw image was saved in 16-bit color TIFF format. This raw image was optimized using wavelet processing to yield a final image that I deemed pleasing. The final images were saved in 16-bit color TIFF format.

To ensure consistency among image frames in a mosaic set, video length, number of video frames stacked and the wavelet processing parameters were the same.

Mosaic Assembly and Mosaic Optimization

Assembly of the mosaic images was performed with Adobe Photoshop CS6 manually. Each image frame was placed in a separate layer, than placement adjusted to properly overlap previous frames. In some cases slight adjustment of image Brightness or Curves was necessary to make frames ‘seamlessly’ match each other. Once all adjustments were achieved, the Layers were flattened to make the mosaic. Additional adjustments and optimizations of Levels, Curves and Shadows/Highlights were then made, producing the final mosaic image. The final mosaic

images were saved as 16-bit color images.

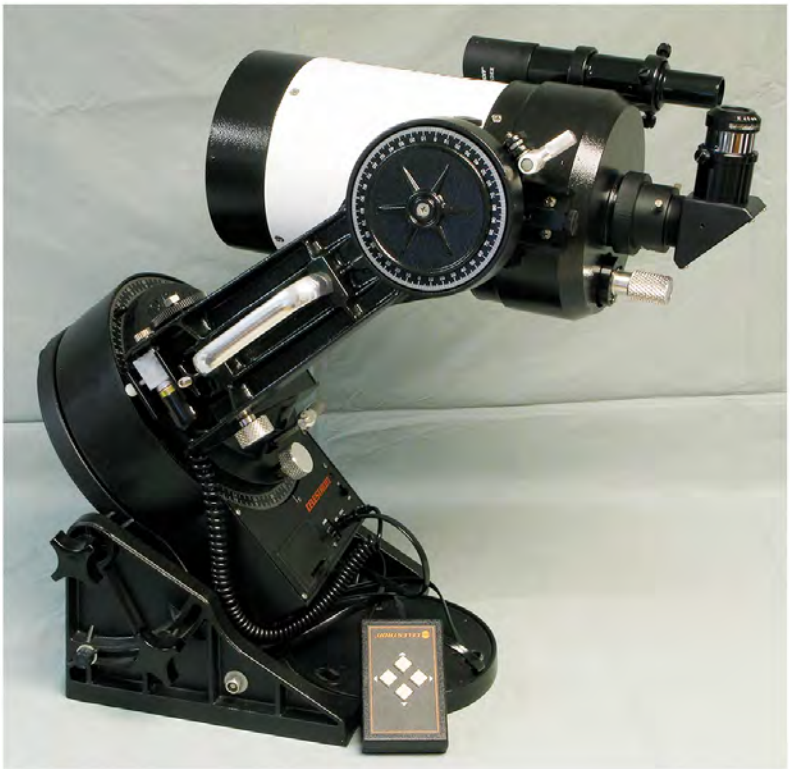
For this album, all images were converted to 8-bit color.

Final Thoughts

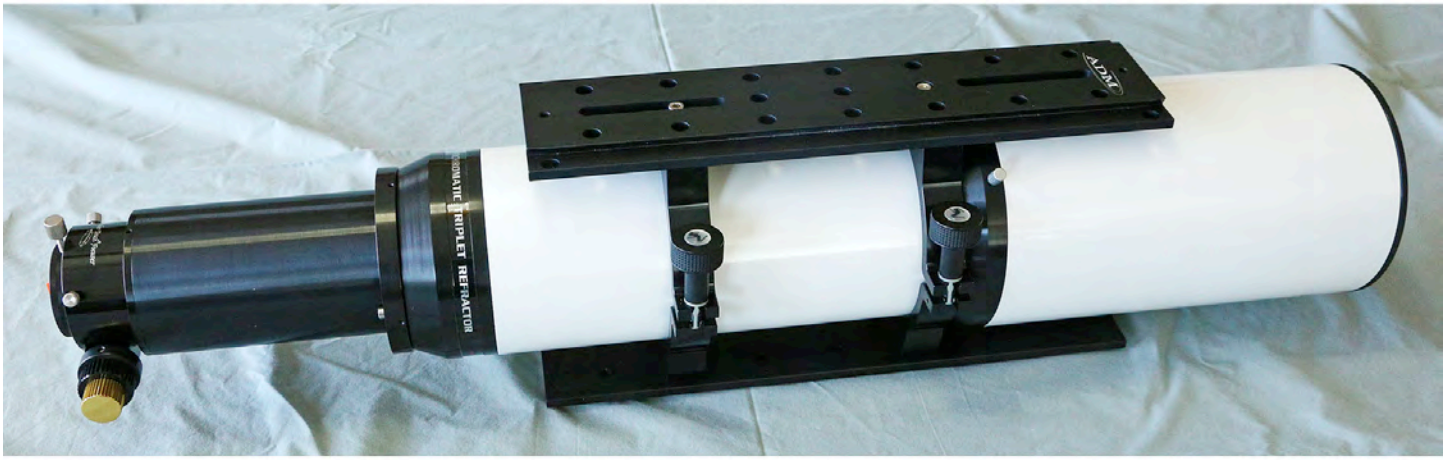
Making mosaic images is not for the ‘faint-of-heart’. Large mosaics require a lot of work and planning. Most of the mosaics in this album are ad-hoc, assembled as an after-thought once the image frames had been processed and examined. Only mosaics 4 and 8 were planned in advance. Mosaic 8 exemplifies the challenges in making large mosaics. It used 25 image frames, requiring 1 evening to capture the videos, 3 days to process all the videos, and another day to assemble the mosaic. Only then did I discover I had missed 3 small sections of the moon.

Celestron C8 8-Inch SCT

Celestron C5+ 5-Inch SCT



Stellarvue SV115 Triplet Apo Refractor



Nikon Coolpix 990

Philips ToUCam PCVC 740K

Canon EOS 60Da

Vixen GPDX Equatorial Mount with SkySensor 2000 on JMI Wheeley Bar

Software Bisque Paramount MX GEM

Mosaic 1

September 7, 2000

Celestron C5+ or C8

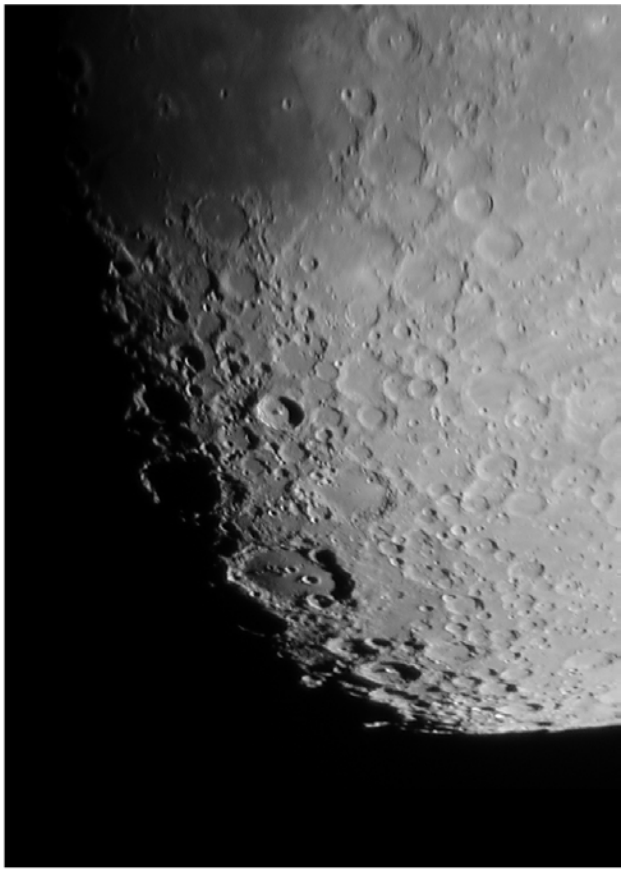
Nikon Coolpix 990 Digital Camera

Williams DCL-28 Eyepiece

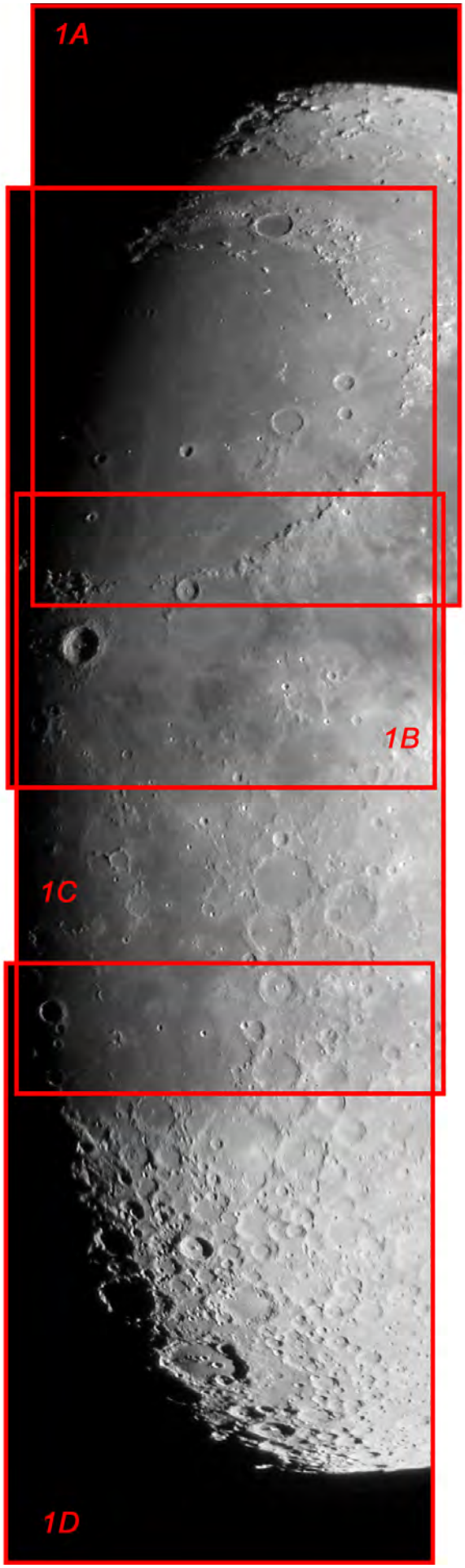
1A

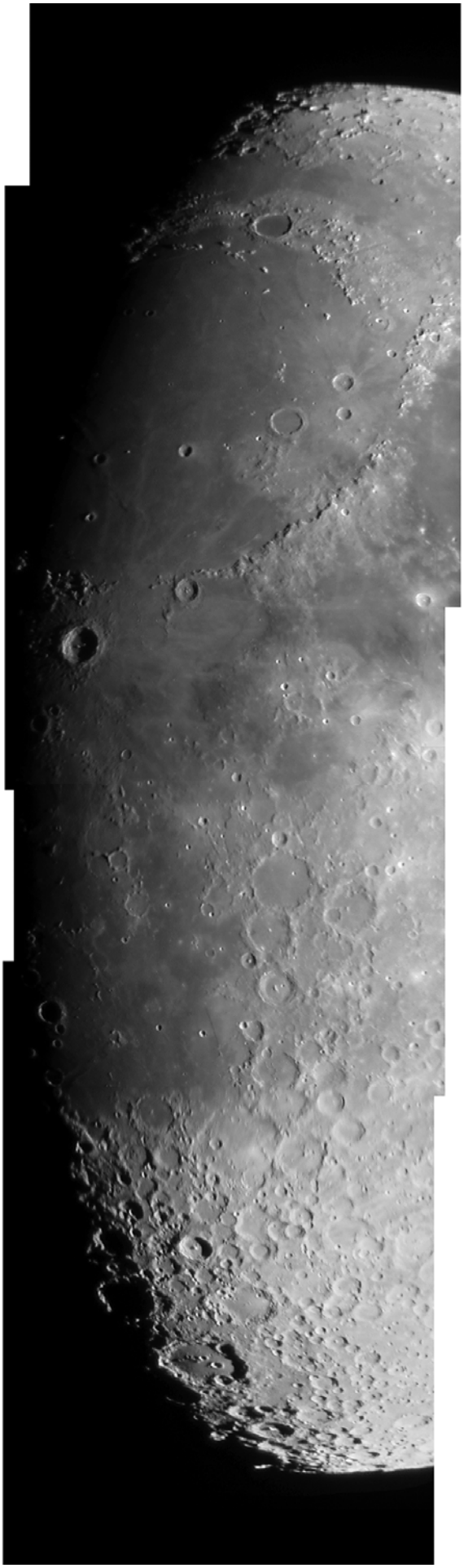
1B

1C



1D


1A
1B
1C
1D



Mosaics 2 & 3

April 21, 2007

Stellarvue SV115

Philips ToUCam PCVC 740K Webcam

Optical Power Amplifier - Unknown

2A

2B

3A

3B

Mosaics 4

June 23, 2007

Stellarvue SV115

Philips ToUCam PCVC 740K Webcam

Optical Power Amplifier - Unknown

4A

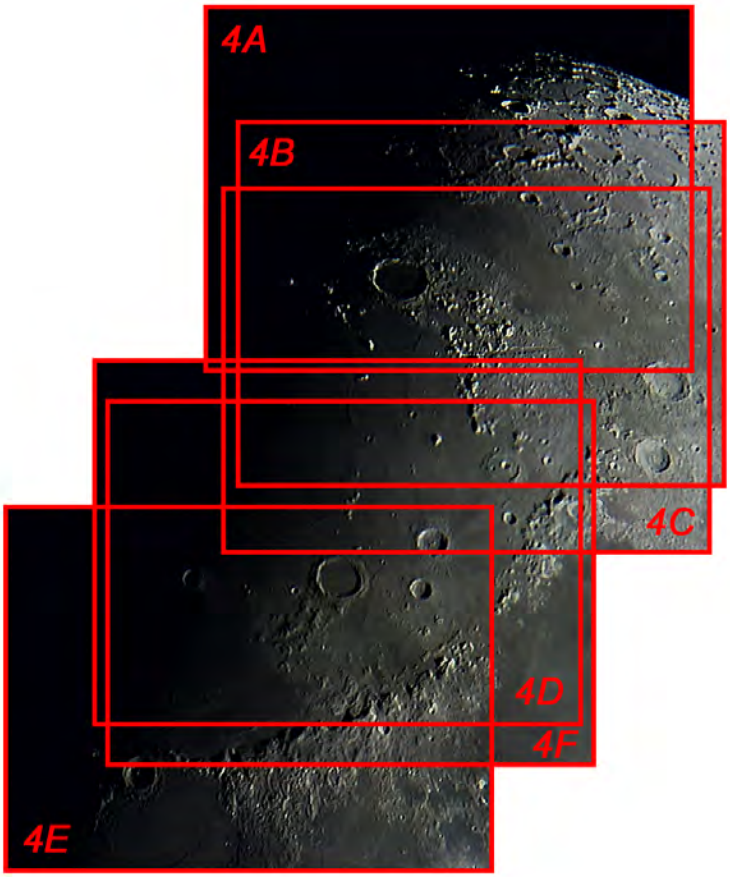
4B

4C

4D

4E

4F


4A
4B
4C
4D
4E
4F

Mosaic 5

April 17, 2008

Stellarvue SV115

Philips ToUCam PCVC 740K Webcam

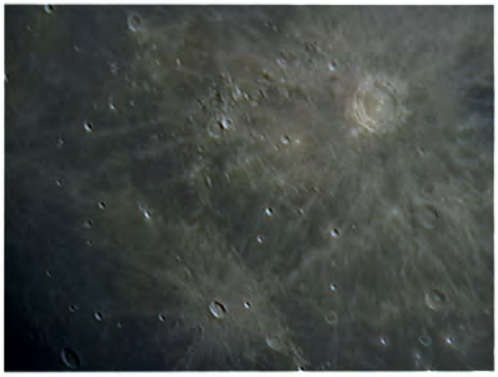
Optical Power Amplifier - Unknown

5A

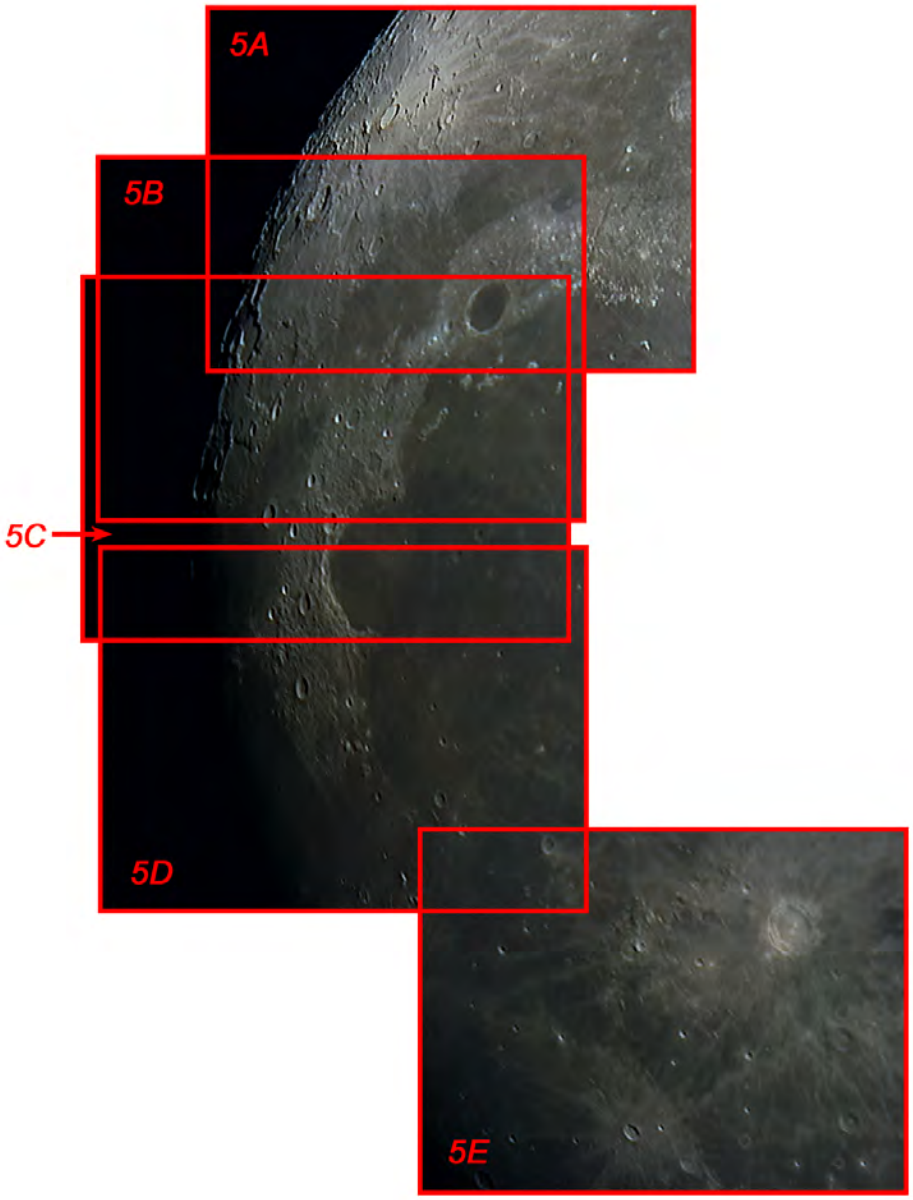
5B

5C

5D



5E


5A
5B
5C
5D
5E

Mosaics 6 & 7

April 17, 2016

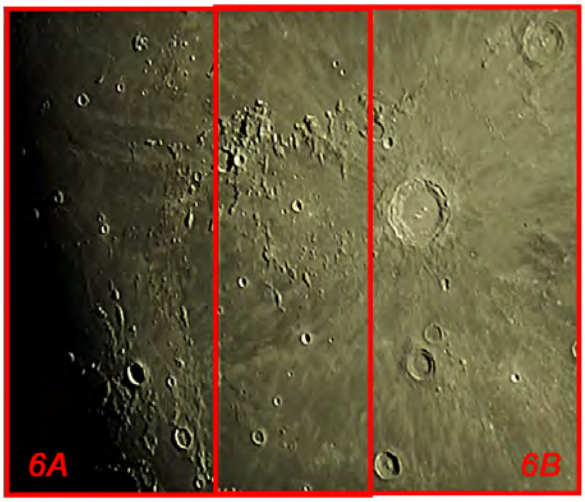
Stellarvue SV115

Canon EOS 60Da

Televue 2.5x Powermate

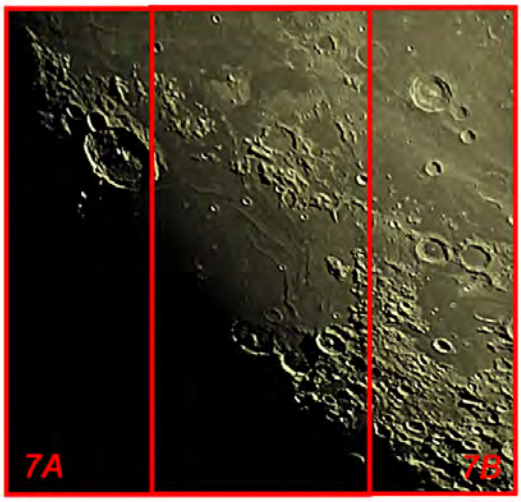
6A

6B



7A

7B



Mosaic 8

May 10, 2016

Stellarvue SV115

Canon EOS 60Da

Televue 2.5x Powermate

8A

8B

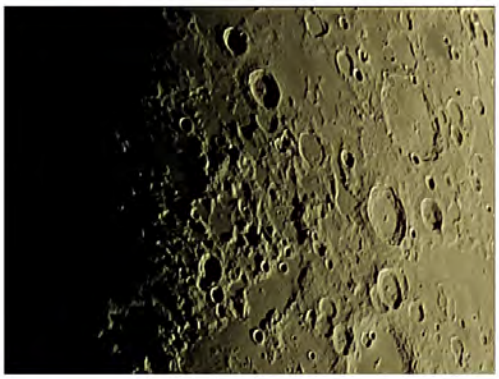
8C

8D

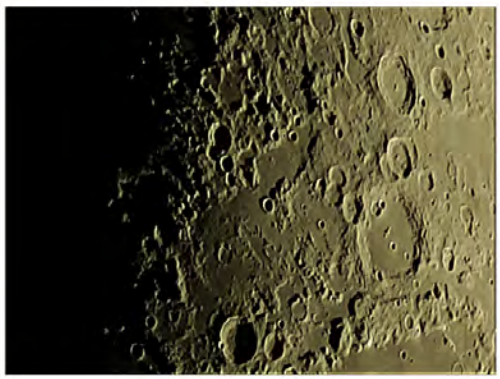
8E

8F

8G



8H



8I

8J

8K

8L

8M

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8O

8P

8Q

8R

8S

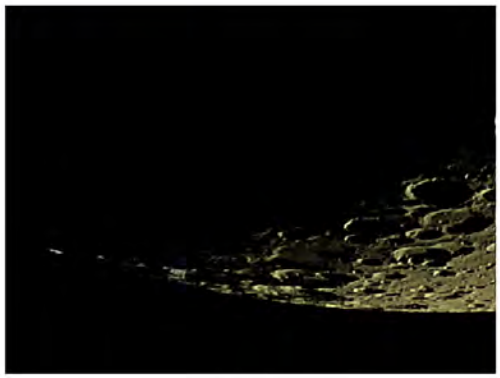
8T

8U

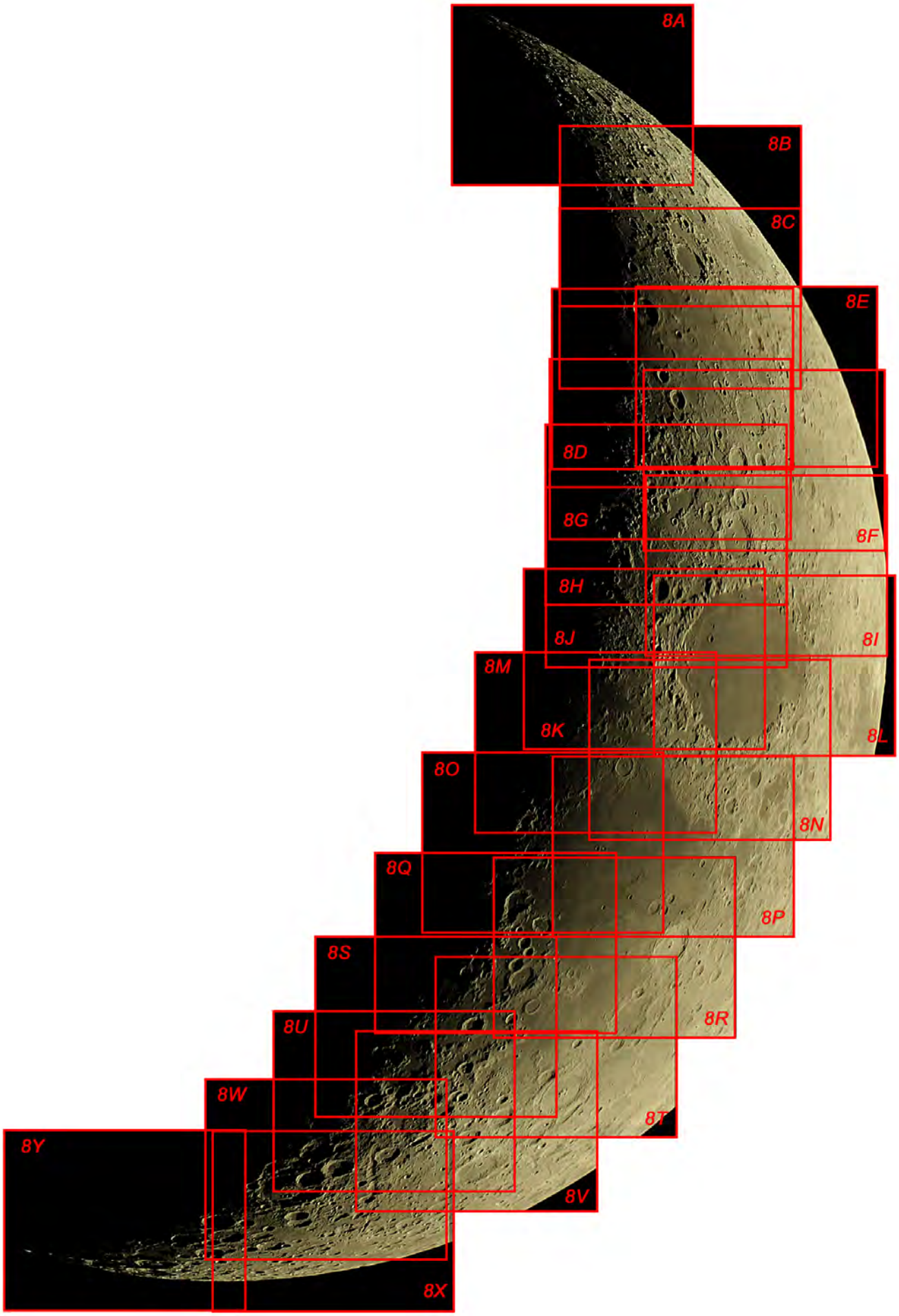
8V

8W

8X



8Y


8A
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