Lunar Reconnaissance Orbiter Camera

Lunar Reconnaissance Orbiter Camera Image Retrieval
For the Big Moon Dig

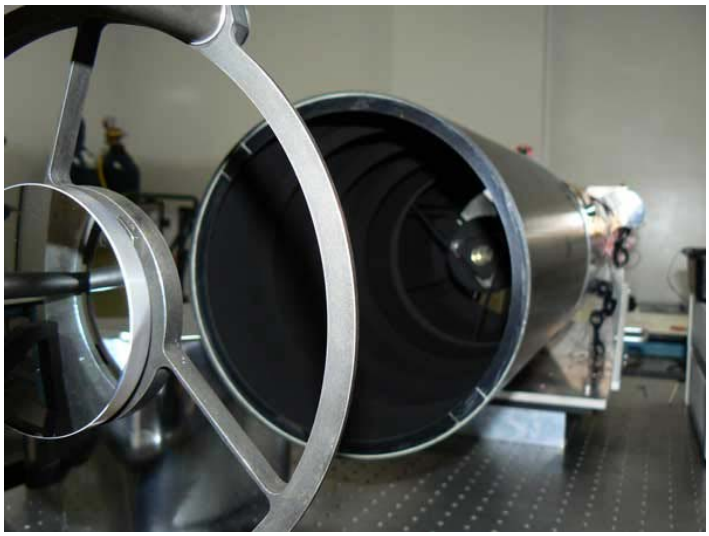
Tom Riley
TomRiley@WoodwareDesigns.com
November 22, 2014
File: LROCameraRetrivalmmdddyy.docx

Work in Progress

LRO in orbit (artist's conception)

1. Purpose

This process lets you down load LRO Camera images that cover your Lunar site of interest. Best resolution available is about 1 meter per pixel. The files are rather large and cover long strips south to north which will have to be turned into a mosaic.



LROC Narrow Angle Camera (NAC)

2. LRO Camera URL

The LROC Cameras site is at http://wms.lroc.asu.edu/lroc/ . There you can download the NAC image for specific areas. You will need the "Image Search" tab to fine specific images.

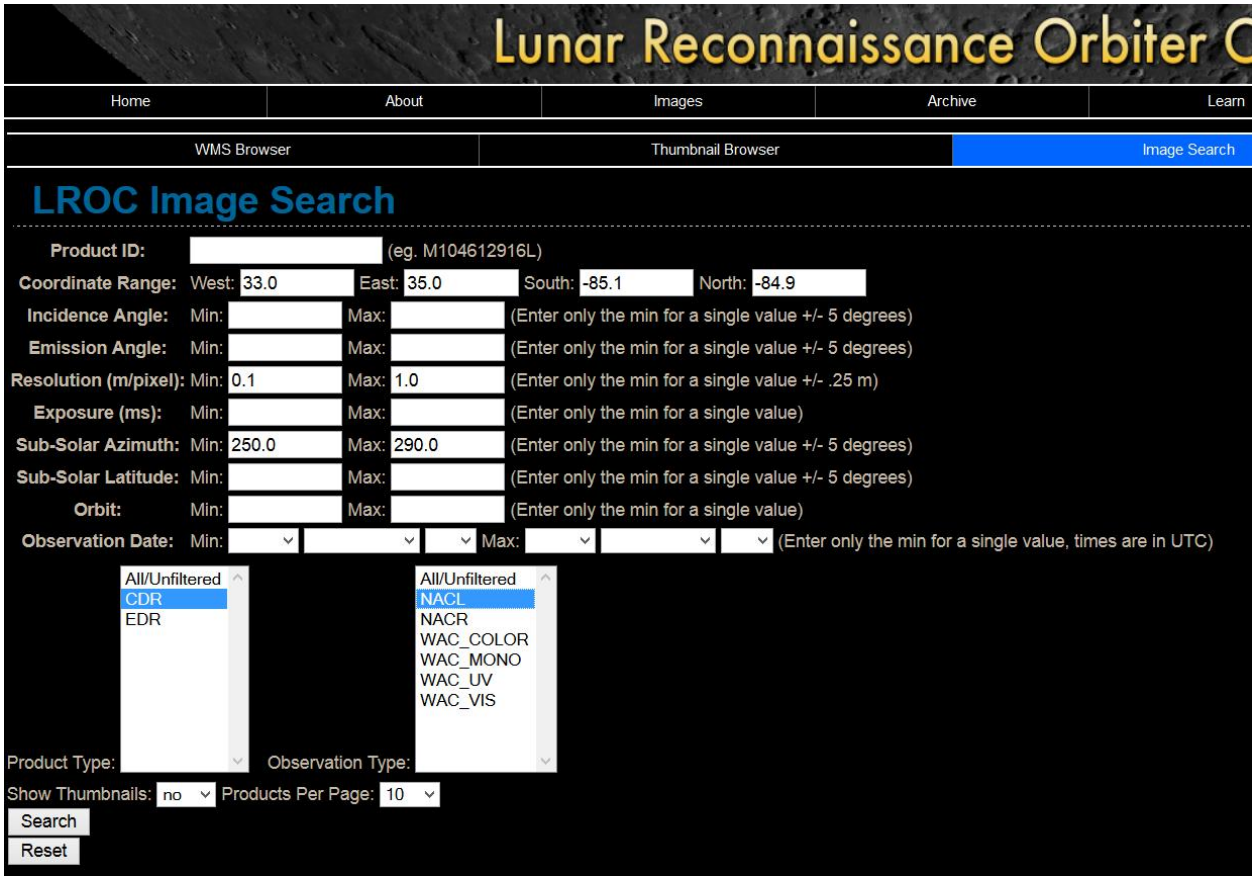


Image Search Page

3. Image Search

Use the Image Search tab to find the image you need:

a. Parameter Input

Coordination Range: -- The range of latitude and longitude of a box in the middle of the area you are trying to cover.
Resolution: -- We want images in the around 1 meter/pixel and not 10 meters/pixel.
Sub-Solar Azimuth: -- We usually want images with the Sun in near noon (see "Sub-Solar Azimuth below).
CDR – The "C" stands for calibrated
NACL – Narrow Angle Camera Left (see image above)

b. Sub-Solar Azimuth

This is the angle of the Sun along the horizon and requires some explanation. Mentally draw a line from the central location of the image through the sun and then

down to the horizon. Then mentally draw a line from the central point to where the first line crosses the horizon.

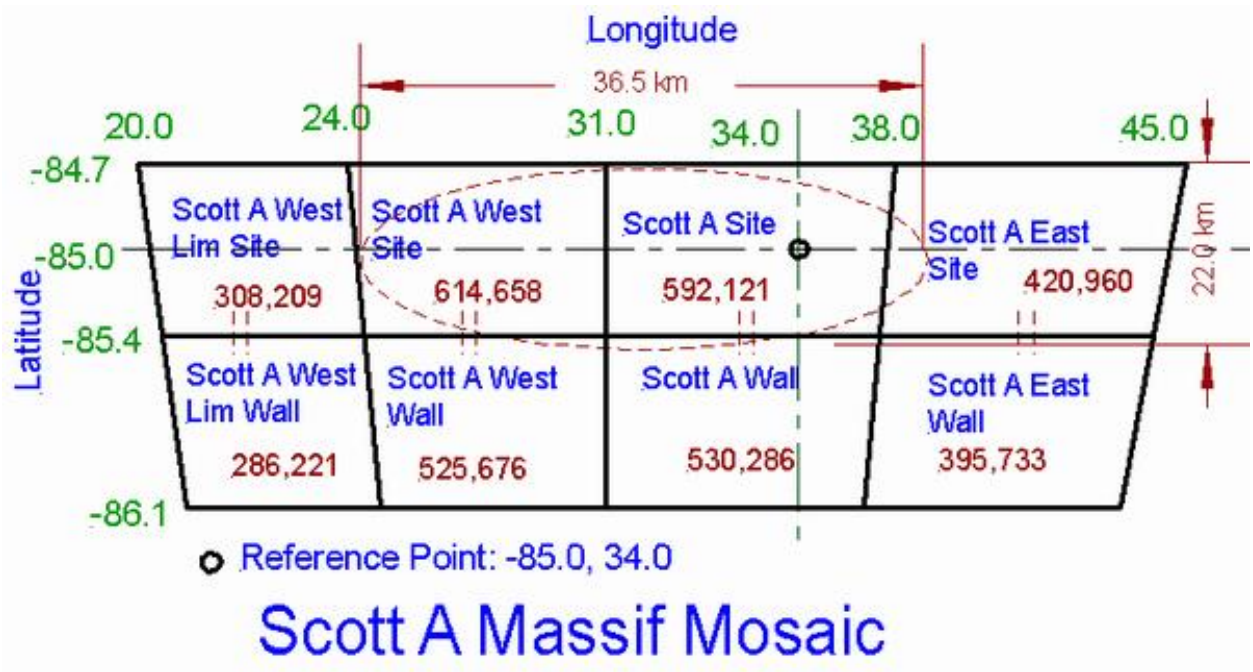
The Sub-Solar Azimuth is the angle between due North and your second line. For some reason, zero was placed at the 3:00 position and the angle is read clockwise as positive. This means that:

Noon	270	(suggested range 250 to 290)
Midnight	90	(suggested range 60 to 110)

We are most interested for images around noon. You can narrow or widen the minimum and maximum angles entered to reduce or increase the number of images found by a search.

c. Search

Click on "Search". Wait for it.



Scott A Mosaic ranges

d. Try Again

We would like to get only a few choices. If you get no choices then widen the parameter ranges above. If you get an enormous number of choices narrow the parameter ranges.

Review the choices looking for strips that cover the mosaic tile you are interested in from North to South. East to West you would like to slightly overlap the images you already have. Note that the NACL images to not run truly North to South and although there is a great amount of the area covered near the poles, there will be some gaps.

Enter the best candidates into the Excel Spreadsheet (see below) to better understand how the new image fits what you need. The second page calculates a number of parameters to help you evaluate the coverage.

4. Example NACL image heading:

The heading table for each image is rather long but we need only a few entries.

Product	**M157321873LE**
Pds dataset name	LRO-L-LROC-2-EDR-V1.0
Pds volume name	LROLRC_0007
Instrument host	LRO
Instrument	LROC
Original product	nacl0005ede5
Product version	v1.8
Mission phase name	SCIENCE MISSION
Rationale desc	TARGET OF OPPORTUNITY
Data quality	0
Nac preroll start time	(DOY:103) 2011-04-13T08:16:45
Start time	(DOY:103) 2011-04-13T08:16:45
Stop time	(DOY:103) 2011-04-13T08:17:10
Spacecraft clock partition	1
Nac spacecraft clock preroll count	324375405:6684
Spacecraft clock start count	324375405:45548
Spacecraft clock stop count	324375430:39461
Target name	MOON
Orbit number	8318
Slew angle	0.00908744341154581
Lro node crossing	D
Lro flight direction	-X
Nac line exposure duration	0.000576533333333333
Nac frame	LEFT
Nac dac reset	199
Nac channel a offset	77
Nac channel b offset	77
Instrument mode code	15
Compand select code	3
Mode compression	true

Mode test	false
Nac temperature scs	11.393
Nac temperature fpa	22.541
Nac temperature fpga	-5.978
Nac temperature telescope	9.399
Image lines	43008
Line samples	2532
Sample bits	8
Scaled pixel width	0.87
Scaled pixel height	0.94
Resolution	**0.904050789477077**
Emission angle	1.69
Incidence angle	86.68
Phase angle	87.22
North azimuth	308.17
Sub solar azimuth	**253.14**
Sub solar latitude	1.38
Sub solar longitude	59.87
Sub spacecraft latitude	-84.76
Sub spacecraft longitude	33.44
Solar distance	150129814.8
Solar longitude	111.57
Center latitude	-84.77
Center longitude	33.89
Upper right latitude	-85.42
Upper right longitude	32.37
Lower right latitude	-84.1
Lower right longitude	34.37
Lower left latitude	-84.11
Lower left longitude	35.07
Upper left latitude	-85.43
Upper left longitude	33.27
Spacecraft altitude	43.58
Target center distance	1780.99
Sub solar latitude	-1.26
Sub solar longitude	145.04
Sub spacecraft latitude	-85.14
Sub spacecraft longitude	214.72
Solar distance	151667693.1
Solar longitude	236.09
Center latitude	**-85.15**
Center longitude	**214.33**
Upper right latitude	**-84.95**
Upper right longitude	**214.17**

Lower right latitude -85.34
Lower right longitude 215.23
Lower left latitude -85.36
Lower left longitude 214.51
Upper left latitude -84.96
Upper left longitude 213.5
Spacecraft altitude 35.96
Target center distance 1773.34

Sample Image Table – parameters of interest are bold

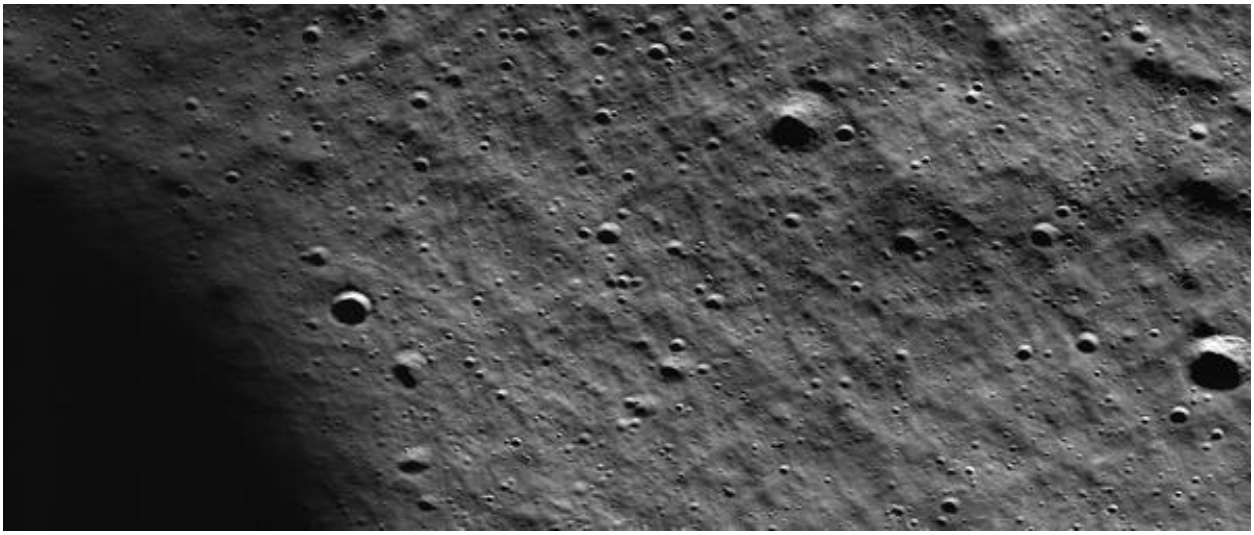
This table can be selected and copied into Excel spread sheet. Place it in a temporary position on the front page below the main table. The unneeded lines can then be cut out and the remaining needed lines copied and pasted (swapping vertical for horizontal) into the main listing.

5. **Save image Files**

Down load the following two image files:

- **Download CDR** – Yields an .IMG file that is precise and lossless, but is large and not easily read.
- **Download CDR PTIF (multi-resolution, lossy compression)** -- Yields a _pyr.tif file that is easy to read and small, but may have some loss.

Note that the file names match the "Product" entry in the table. Move these images from the "Down Load" folder to a more permanent location.



Sample of NACL tif Image

6. Example Image

The NACL tif image above is only a small part of a long strip. Note that although it is almost noon, the sun is coming from the lower left.

7. Excel Spreadsheet

Useful analysis of the image tables is provided by the spread sheet: LROC_CDR_NACL_Filesmmddyy.xlsx.

a. Sheet One, "Data"

This image table can be selected and copied into Excel spread sheet. Place it in a temporary position on Sheet One below the main table. The unneeded lines (bold above) can then be cut out and the remaining needed lines copied and pasted (swapping vertical for horizontal) into the main listing. The column headings are the same as the remaining table line names only swapped into the vertical.

b. Sheet Two, "Refined"

Sheet Two, "Refined" calculates a number of helpful parameters:

1. Delta Lat – How wide the strip is East to West in degrees.
2. Delta Long – How long the strip is South to North in degrees.
3. Delta Lat, km – How wide the strip is East to West in kilometers
4. Delta Long, km – How long the strip is South to North in kilometers.
5. Deviation, degree – How much the strip various from true North in degrees
6. Deviation, meter – How much the strip varies form true North in meters for the width of mosaic block.
7. Sun Angle, Noon, degree – The angle of the Sun compared to Noon, in degrees.
8. Scott Chop, Pixel – Where to chop the long strip north and south. Note that the image is hot reversed here.

More columns can be added to this page as needed.

8. Additional Work Required

Specifically we need to:

1. **Crop Large Image Files** – Cut off any pixels that are not in the specific mosaic block.
2. **Rotate Large Image Files** – First rotate 180 degrees to get the Sun angle right and then adjust a fraction of a degree for the orbit angle.

Unfortunately the light-weight image editing programs we currently have for Windows do not handle these large files well. This means we will either have to:

1. **Buy a Mac laptop** – Mac's are known to be superior at image work and have a documented working history with these particular files. Cost: $1600.00 with software.
2. **Find superior Windows Image Software** – There must be professional image editing software for Windows that can handle these files. Cost: Photo Shop, $700.00; Gimp, free?

_____-