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Abstract:

The 50 Constellation Priority Sites – Noble, Joosten, French, Eppler, Gruener, Mendell, Plescia, Spudis, Wargo, Robinson, Lucey

The Constellation program (CxP) has developed a list of 50 sites of interest on the Moon which will be targeted by the LRO narrow angle camera. The list has also been provided to the M^3 team to supplement their targeting list. This list does not represent a "site selection" process; rather the goal was to find "representative" sites and terrains to understand the range of possible surface conditions for human lunar exploration to aid engineering design and operational planning. The list compilers leveraged heavily on past site selection work (e.g. Geoscience and a Lunar Base Workshop – 1988, Site Selection Strategy for a Lunar Outpost – 1990, Exploration Systems Architecture Study (ESAS) – 2005). Considerations included scientific, resource utilization, and operational merits, and a desire to span lunar terrain types.

The targets have been organized into two "tiers" of 25 sites each to provide a relative priority ranking in the event of mutual interference. A LEAG SAT (special action team) was established to validate and recommend modifications to the list. This SAT was chaired by Dr. Paul Lucey. They provided their final results to CxP in May. Dr. Wendell Mendell will organize an on-going analysis of the data as they come down to ensure data quality and determine if and when a site has sufficient data to be retired from the list. The list was compiled using the best available data, however, it is understood that with the flood of new lunar data, minor modifications or adjustments may be required.

The 50 Constellation Priority Sites

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The Constellation program (CxP) has developed a list of 50 sites of interest on the Moon which will be targeted by the LRO narrow angle camera. The list has also been provided to the M3 team to supplement their targeting list. This list does not represent a "site selection" process; rather the goal was to find "representative" sites and terrains to understand the range of possible surface conditions for human lunar exploration to aid engineering design and operational planning.

The regions of interest were selected based on three criteria:

1. **Science rationale** - the 50 sites are of unique scientific interest or are scientifically complex requiring intensive field work with human interaction.
2. **Resource potential** - as a whole, the 50 sites are representative of the type of natural resources available for development and exploitation.
3. **Operational perspective** - as a whole, the 50 sites are representative of the different terrain types that the Altair lunar lander and the various lunar surface systems may encounter.

The list was compiled by a committee derived from both CxP and the science community (Eppler/Cx, French/LMMP, Gruener/Cx, Joosten/Cx, Mendell/Cx, Plescia/APL, Spudis/USRA, Wargo/ESMD). They leveraged heavily on past site selection work (e.g. Geoscience and a Lunar Base Workshop - 1988, Site Selection Strategy for a Lunar Outpost - 1990, Exploration Systems Architecture Study (ESAS) - 2005).

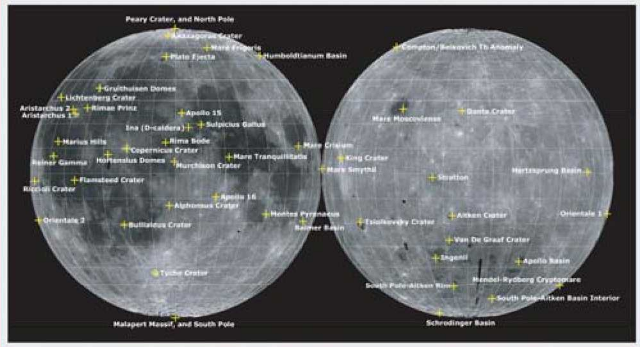
A LEAG special action team, chaired by Paul Lucey, was established to validate and recommend modifications to the list. They provided their final results to CxP in May.

The targets have been added as priority one to the LROC targeting database.

Wendell Mendell, Cx chief scientist, will organize an on-going analysis of the data as they come down to ensure data quality and determine if and when a site has sufficient data to be retired from the list.

Location of the 50 sites

Near Side | Far Side


Peary Crater, and North Pole
Anaxagoras Crater
Mare Frigoris
Plato Ejecta
Humboldtianum Basin
Gruithuisen Domes
Lichtenberg Crater
Aristarchus 2
Aristarchus 1
Rimae Prinz
Apollo 15
Ina (D-caldera)
Sulpicius Gallus
Marius Hills
Rima Bode
Copernicus Crater
Reiner Gamma
Hortensius Domes
Murchison Crater
Mare Tranquillitatis
Flamsteed Crater
Riccioli Crater
Apollo 16
Alphonsus Crater
Orientale 2
Bullialdus Crater
Montes Pyrenaeus
Tycho Crater
Malapert Massif, and South Pole
Compton/Belkovich Th Anomaly
Mare Moscoviense
Dante Crater
Mare Crisium
King Crater
Mare Smythii
Stratton
Hertzsprung Basin
Balmer Basin
Tsiolkovsky Crater
Aitken Crater
Orientale 1
Van De Graaf Crater
Ingenii
Apollo Basin
South Pole-Aitken Rim
Mendel-Rydberg Cryptomare
South Pole-Aitken Basin Interior
Schrodinger Basin

The targets have been organized into two "tiers" of 25 sites each to provide a relative priority ranking in the event of mutual interference. They are not prioritized within the tiers.

Tier 1 Sites

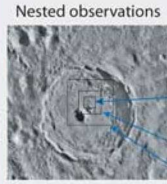
Site	Objective	Terrain Type	Longitude	Latitude
Aitken Crater	basin geology - floor	mare	173.40	-16.80
Alphonsus	volcanism	basin ejecta plains	-2.16	-12.56
Anaxagoras	pure anorthosite - central peak	highlands	-9.30	73.48
Apollo 15	Apennine - surface space weathering - LDEF	mare	3.66	26.08
Apollo 16	surface space weathering - LDEF	highlands	15.47	-9.00
Apollo Basin	anorthosite	highlands	-153.72	-37.05
Aristarchus plateau 1	pyroxenes	ejecta, volcanic materials	-48.95	24.56
Aristarchus plateau 2	resources - pyroclastics	pyroclastic	-52.40	27.70
Bullialdus	complex highland crater with central peak	highlands	-22.50	-20.70
Copernicus	young impact crater	crater floor - rough	-20.01	9.83
Gruithuisen domes	volcanism - domes (felsic?)	mare	-40.14	36.03
Hertzsprung	basin geology - inner ring	mare	-125.56	0.09
King Crater	highlands	melt sheet	119.91	6.39
Malapert Massif	basin geology (SPA), earth view	highland massif	-2.93	-85.99
Mare Crisium	mare / basin (southern rim) (near Picard)	mare	58.84	10.86
Murchison Crater	highlands - ejected Imbrium melt pond	highlands	-0.42	4.74
North Pole	polar volatiles, extended sunlight	highlands	76.19	89.60
Orientale 1	melt sheet, mare ponds	mare / highland plains	-95.38	-26.20
Peary Crater	Polar volatiles	highlands	30.00	88.50
Rima Bode	resources	pyroclastics	-3.80	12.90
South Pole	basin geology (SPA), Shackleton crater	highlands	-130.00	-89.30
SPA Basin Interior	basin floor materials, impact melt	highland	-159.94	-60.00
Stratton	Fe anomaly	highlands	166.88	-2.08
Sulpicius Gallus	pyroclastics - resources	pyroclastics	10.37	19.87
Tycho	young impact crater	crater floor - rough	-11.20	-42.99

Tier 2 Sites

Site	Objective	Terrain Type	Longitude	Latitude
Balmer Basin	ancient mare / basin	mare	69.82	-18.69
Compton/Belkovich	farside KREEP Th anomaly	highlands	99.45	61.11
Dante	pyroxenes - ancient crust	highlands	177.70	26.14
Flamsteed	Surveyor 1 site, young lavas, resources - hi - Ti	mare	-43.22	-2.45
Hortensius Domes	low shields	mare	-27.67	7.48
Humboldtianum Basin	basin geology	melt sheet	77.14	54.54
Ina ("D-caldera")	young collapse feature - vent site for volatiles?	mare	5.29	18.65
Ingenii	far side mare, magnetic anomaly/swirls	mare	164.42	-35.00
Lichtenberg	young thin lavas	mare	-67.23	31.69
Mare Frigoris	low Fe, low Ti basalts	mare	26.10	59.80
Moscoviense	basin and mare fills	mare	150.47	26.19
Mare Smythii	mare site, ancient basin floor	mare	85.33	2.15
Mare Tranquillitatis	resources hi -Ti basalts	mare	22.96	6.93
Marius Hills	volcanism	mare	-55.80	13.58
Mendel-Rydberg Cryptomare	cryptomare ancient basin	mare	-93.87	-51.14
Montes Pyrenaeus	basin geology - Nectaris	mare	40.81	-15.91
Orientale 2	Kopff crater geology, basin geology	rough highlands	-87.91	-18.04
Plato ejecta	radar dark anomaly	crater ejecta	-5.21	53.37
Reiner Gamma	magnetic field - albedo swirls	mare	-58.56	7.53
Riccioli	Orientale ejecta, thin mare	mare	-74.28	-3.04
Rimae Prinz	rilles, vents, lava tubes	highlands fractured floor	-41.72	27.41
Schrodinger	pyroclastics - basin geology	pyroclastics	138.77	-75.40
South Pole-Aitken Rim	basin geology - SPA, Th anomaly	highlands	170.92	-51.00
Tsiolkovsky	old far side mare, central uplift (ancient crust)	mare	128.51	-19.33
Van de Graaf	antipode to Imbrium - magnetic (422 orange)	highlands	172.08	-26.92

Nested observations

Because the Cx imaging requests exceed the LROC capabilities, at least during the ESMD mission phase, a nested approach has been employed where the highest priority is placed on achieving full observation sets for 10x10 km regions at all 50 sites and additional observations will be obtained with the priority listed below.



Priority 1: All Targets with full observations 10x10 km

Priority 2: Other LROC Level 1 measurement requirements

Priority 3: All Targets "best effort" full observations 20x20 km

Priority 4: All Targets "best effort" nadir mosaics 40x40 km

A full set of observations will include:

1. Geometric stereo images
   - 2 observations - one nadir, one at 20° off nadir (requires s/c slew)
   - Solar incidence angle 50-68° off vertical if possible
2. Photometric stereo images
   - 4 observations with different solar azimuths - all nadir
3. Hazards (craters and boulders)
   - 2 observations

One at solar incidence angle of 66-72° off vertical, one near 80° off vertical

The actual number of images will depend on specific orbit groundtracks, lighting, interference etc. and could be substantially more.

Through the Lunar Mapping and Modeling Project (LMMP), data for these 50 sites from the LROC narrow angle camera and other instruments will be compiled and made available to the Constellation Program, the science community, and any other interested parties. In addition to imagery, digital elevation maps will be created. Hazard assessment maps will be produced, including crater and boulder distributions and slope and surface roughness maps. Hyperspectral data from M3 and/or multispectral data from the LROC WAC will be provided where available.

The Constellation Program will utilize this data for:

- planning tasks in the areas of landing site evaluation and selection
- design and placement of landers and other stationary assets
- design of rovers and other mobile assets
- developing terrain-relative navigation (TRN) capabilities
- assessment and planning of science traverses