Chang'E 5 Lunar Sample Return Mission Update

James w. Head
Department of Earth, Environmental and Planetary Sciences
Brown University
Providence, RI 02912 USA

Extraterrestrial Materials Analysis Group (ExMAG) Spring Meeting: April 7 - 8, 2021.

Extraterrestrial Materials Analysis Group (ExMAG) Spring Meeting
Barbara Cohen, ExMAG Chair. 2/10/21

- 1. Please provide an update on the ***Chang'e 5 Sample Return Mission.***
- 2. ***What is known of the collection so far?***
- 3. Please provide an ***overview of allocation procedures.***
- 4. Since US federally-funded researchers cannot work directly with China - ***Who outside of China is working with the mission team?***
- 5. We'd also appreciate your thoughts on: ***What NASA might be able to do to enable the US analysis community to collaborate on this sample collection?***

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- 1. Some Myths and Realities.
- 2. Organization of the Chinese Space Program.
- 3. Chinese Lunar Exploration Program (CLEP) context for Chang'e 5.
- 4. Chang'e 5 Landing Site Selection, Global Context, Key Questions, Mission Operations and Sample Return.
- 5. Returned Sample Location, Storage, Preliminary Analysis and Distribution.
- 6. Opportunities for International Cooperation.

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1. Some *Myths* and *Realities*.

- 1. The Chinese Space Program is secretive, you can't get any information about missions, and they don't release the data.
- 2. Like the USSR, they are more interested in "space spectaculars/firsts" than in the science.
- 3. Their program is very nationalistic and they don't participate in international meetings (LPSC, etc.).
- 4. The Chinese are in a "Space Race" with the United States.
- 5. The Chinese acquire all their technology through "stealth".

- 1. Like the NASA program, there is a complex organizational structure involving government, industry and academia; they have a PDS.
- 2. Their program is founded on "decadal survey" scientific documents and implemented by 5-10 year PRC Party Congress national priorities.
- 3. International cooperation is a cornerstone of the Chinese Space Program.
- 4. The long view: The "Peaceful Rise of China" the "Belt and Road Initiative" and the "Silk Road to Space".
- 5. Technology "osmosis" is always a national problem, but China's "home-grown" technology is impressive.

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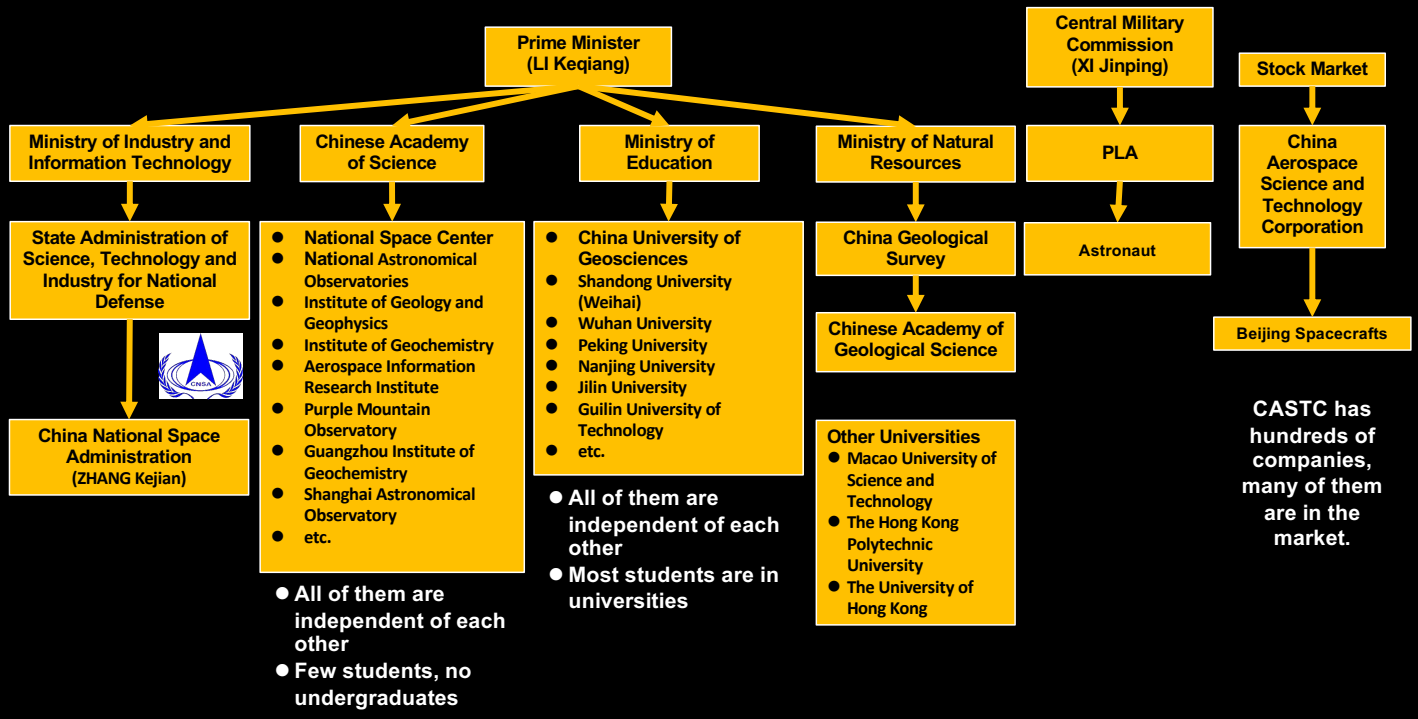
国家航天局
China National Space Administration
CNSA
CALT
中国航天科技集团公司
China Aerospace Science and Technology Corporation
CASC
八一
NAOC
中华人民共和国工业和信息化部
Ministry of Industry and Information Technology of the People's Republic of China
中国科学院
CHINESE ACADEMY OF SCIENCES
中国地质大学
CHINA UNIVERSITY OF GEOSCIENCES
澳門科技大學
MACAU UNIVERSITY OF SCIENCE AND TECHNOLOGY
格物致意
中国探月
CLEP

Human and Robotic Chinese Exploration Programs

The People's Republic of China (PRC) Space Program

-Administrative Level of Different Organizations-



The People's Republic of China (PRC) Space Program

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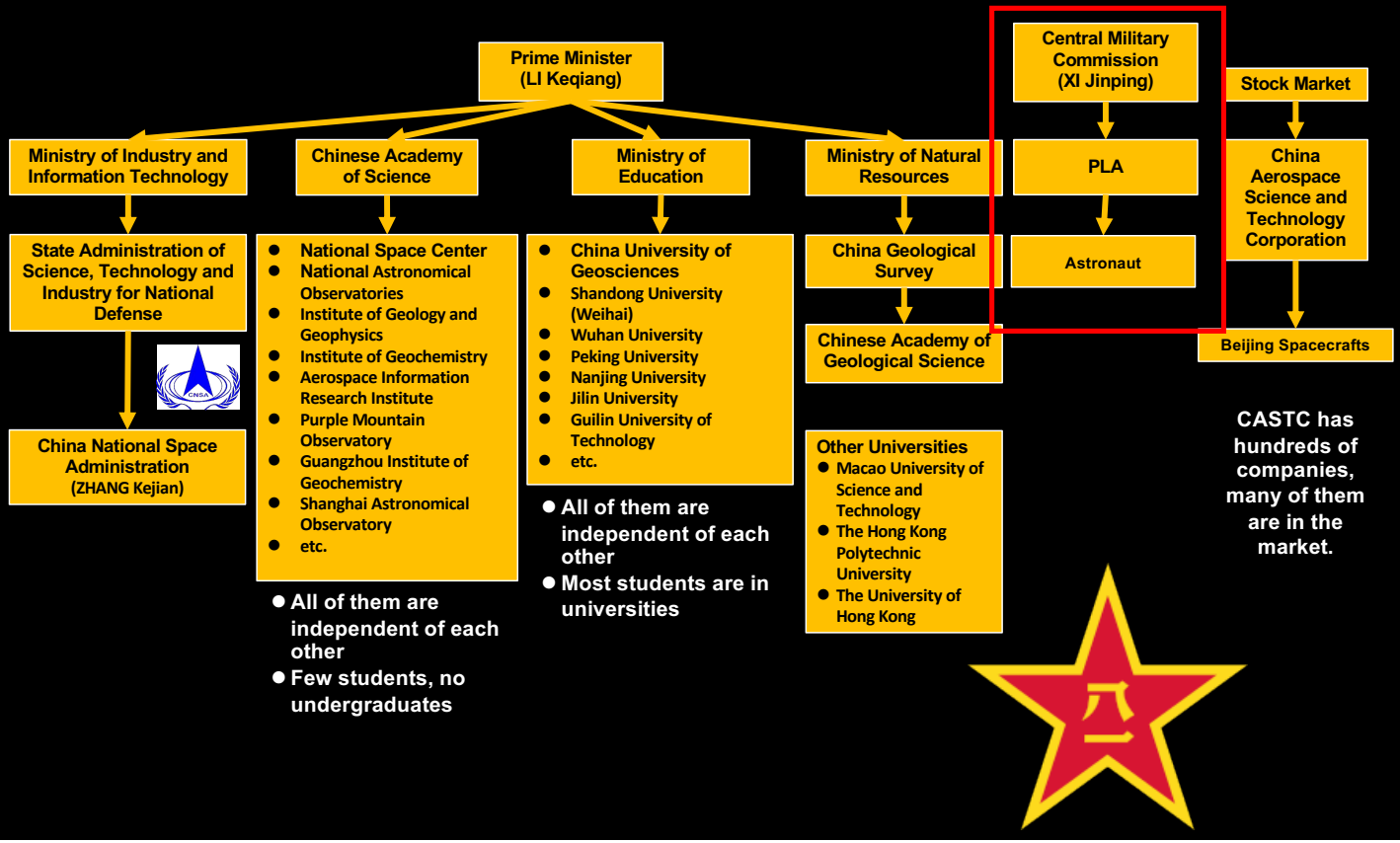

People's Liberation Army GAD (General Armaments Department) (CMSEO) (CMCEDD)

The People's Republic of China (PRC) Space Program

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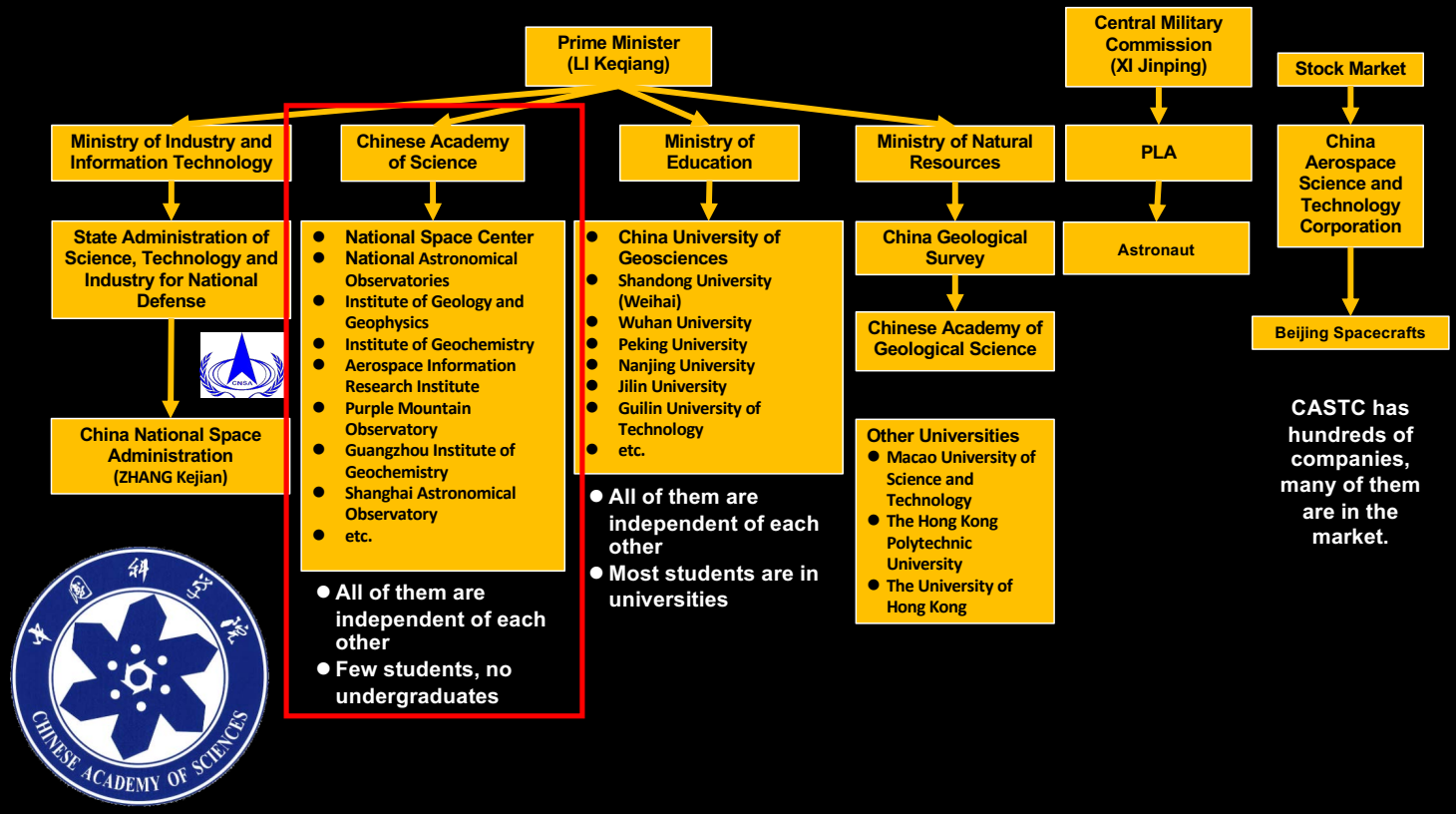
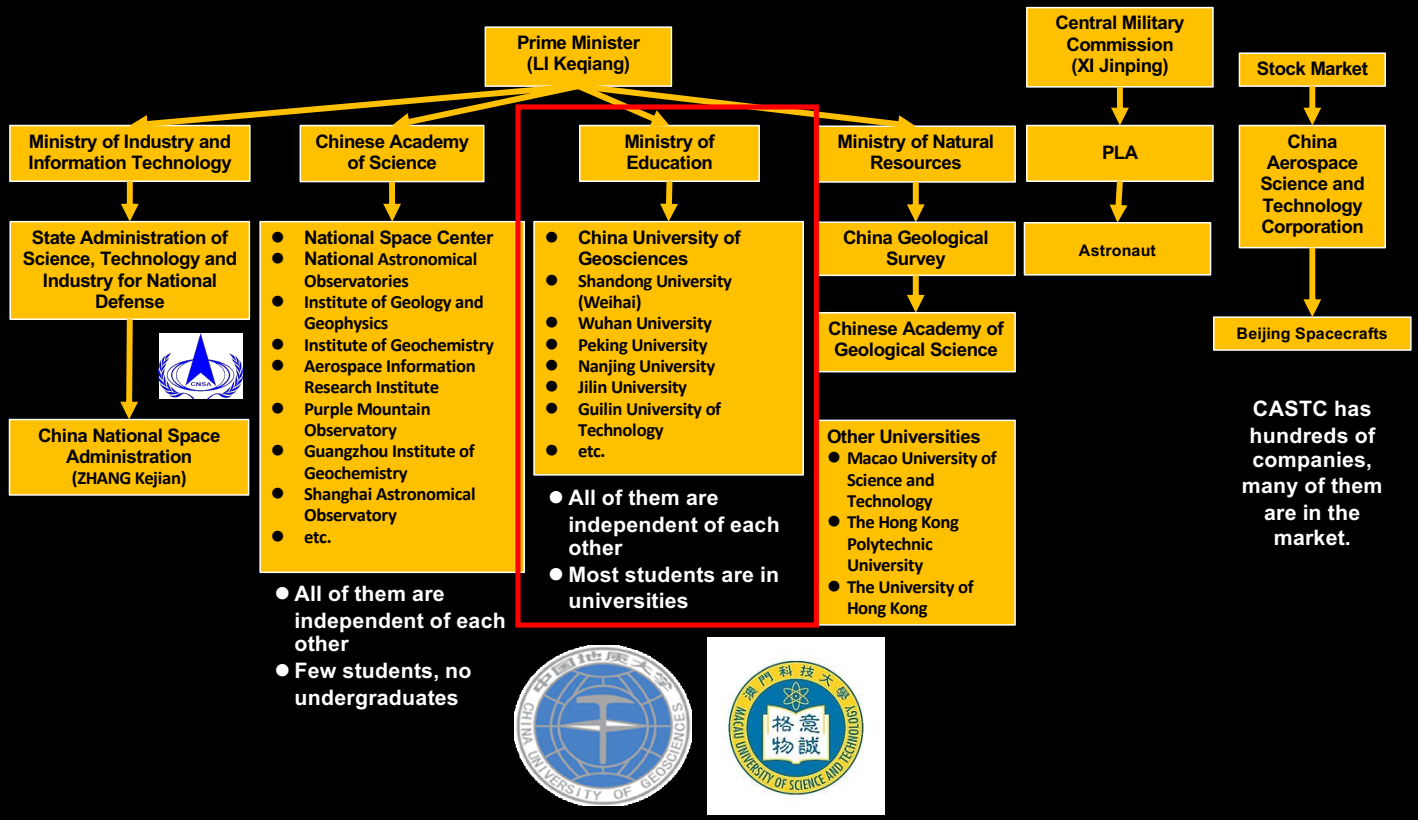


The People's Republic of China (PRC) Space Program

-Administrative Level of Different Organizations-



The People's Republic of China (PRC) Space Program

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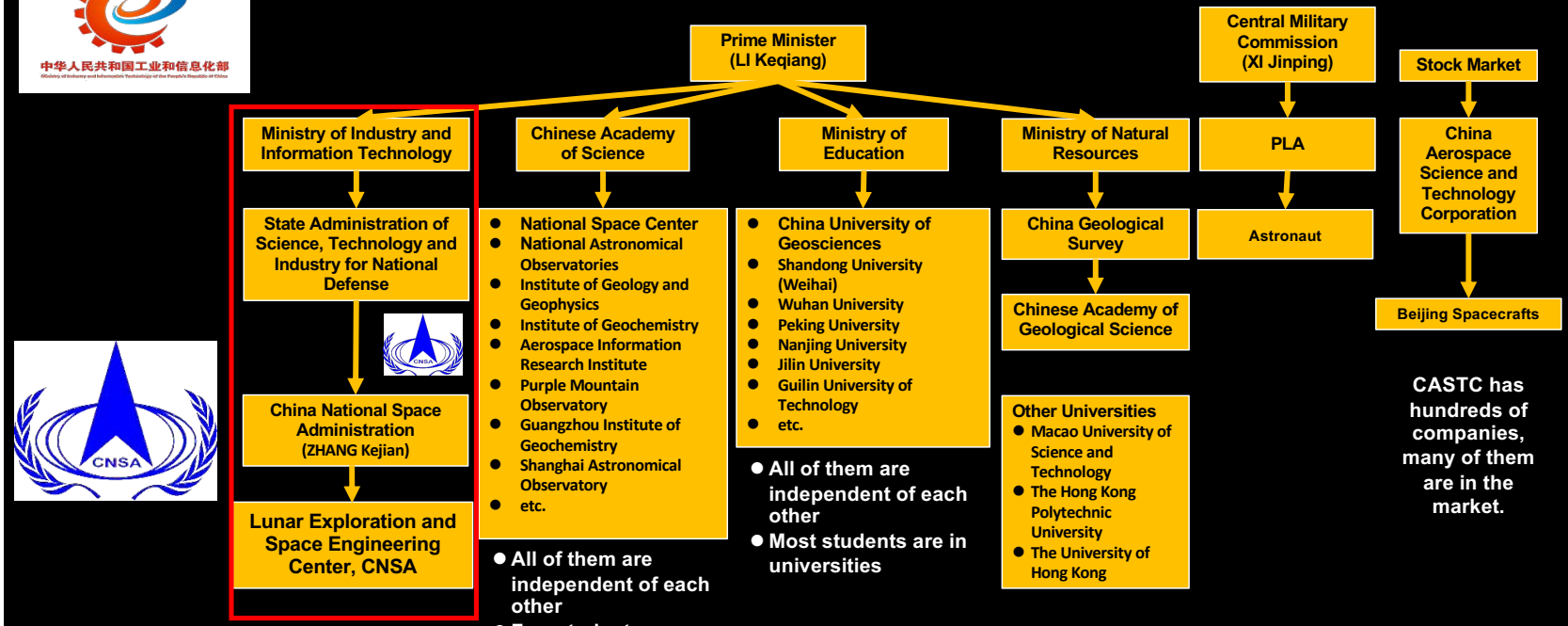

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中国探月

CLEP

Chinese Lunar Exploration Program

国家航天局

China National Space Administration

Chinese Lunar Exploration Program (CLEP) (中国探月)

Academician
Ouyang Ziyuan

Institute of Geochemistry
Chinese Academy of Sciences

- Prominent Chinese geologist, chemical cosmologist.
- Among the first to advocate exploitation of known lunar metals reserves (titanium).
- Served as Chief Scientist of CLEP.

Chinese Lunar Exploration Program (CLEP) (中国探月)

-Ongoing series of robotic Moon missions: Chinese National Space Administration (CNSA).

-*Leading up to Chinese human exploration of the Moon* (Taikonauts) near end of the decade.

-The *Chang'e Program* incorporates *lunar orbiters, landers, rovers and sample return spacecraft*. Launched using Long March Rockets.

-Launches and flights monitored by a *Telemetry, Tracking and Command (TT&C) system*:

-TT&C uses 50-meter (160-foot) radio antennas in Beijing and 40-meter (130-foot) antennas in Kunming, Shanghai, Urumqi, to form a 3,000-kilometre (1,900-mile) VLBI antenna.

-A ground application system is responsible for downlink data reception.

-*Data are available on the Chinese equivalent of the NASA Planetary Data System.*

-*Chang'e 1:* (2007) Orbiter derived mineralogy, geochemistry, high definition imaging, 3D topogrphy as a reference for future soft landings.

-*Chang'e 2:* (2010) mapped the Moon in even greater detail; thenleft lunar orbit and headed for the Earth–Sun L2 Lagrangian point in order to test the TT&C network; then completed a flyby of asteroid 4179 Toutatis, heading into deep space to further test the TT&C network.

-*Chang'e 3:* (2013) delivered to Mare Imbrium a 140 kg lunar rover named Yutu, to explore an area of 3 square kilometers (1.2 sq mi) during a 3-month mission.

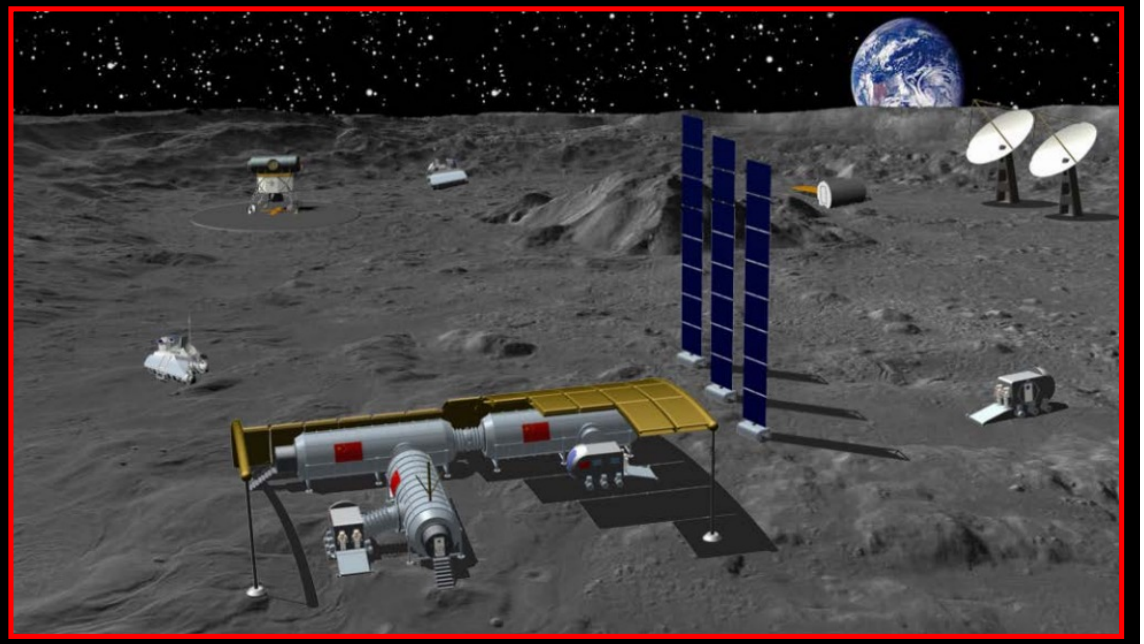
-*Chang'e 4:* (2020) Utilized Magpie Bridge communication satellite to accomplish lunar farside lander-rover mission (Yutu-2). Currently actively operating and exploring von Karmen crater/Finsen secondary ejecta.

-*Chang'e 5-T1:* (2014). Designed to test the lunar return spacecraft.

Ultimate Goal of the CLEP

The ultimate objective of the program is to pave the way for human missions to the Moon. Such a mission may occur in the 2020s-2030s.

中国探月
CLEP



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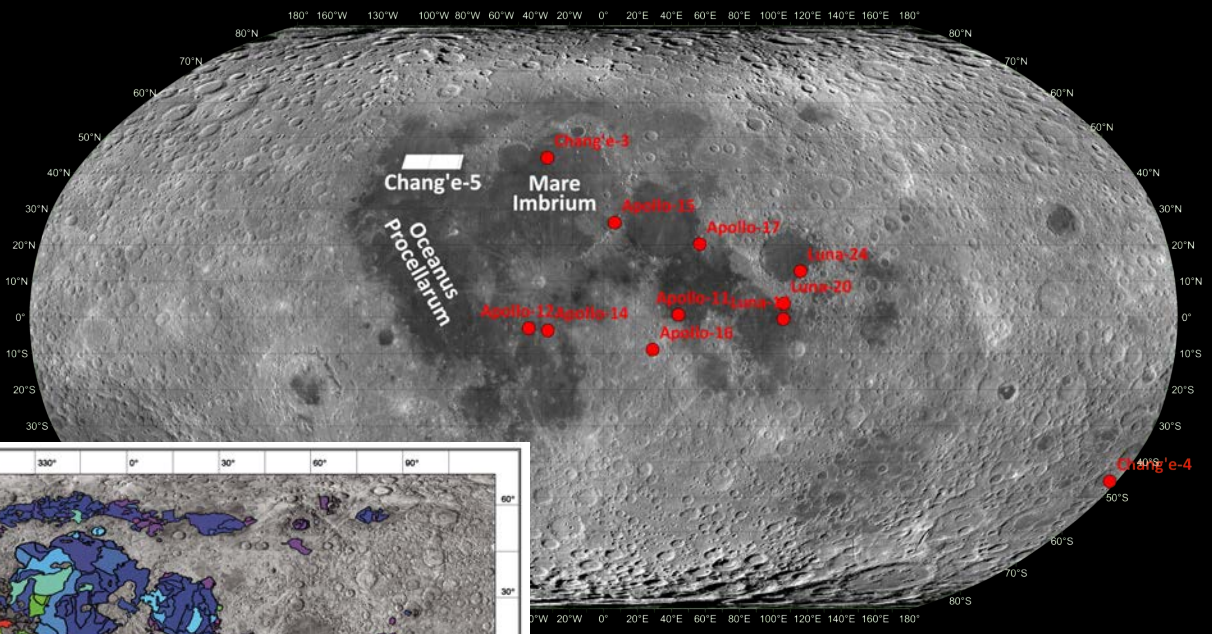
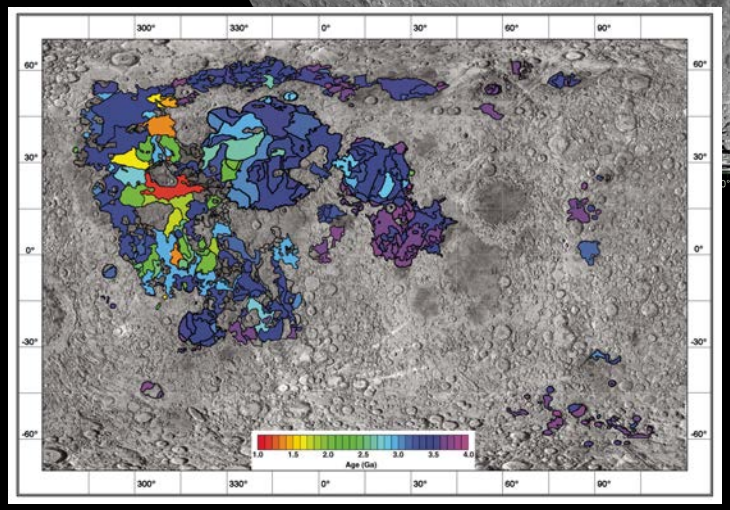
CHANG'E-5 LANDING REGION: RÜMKER REGION

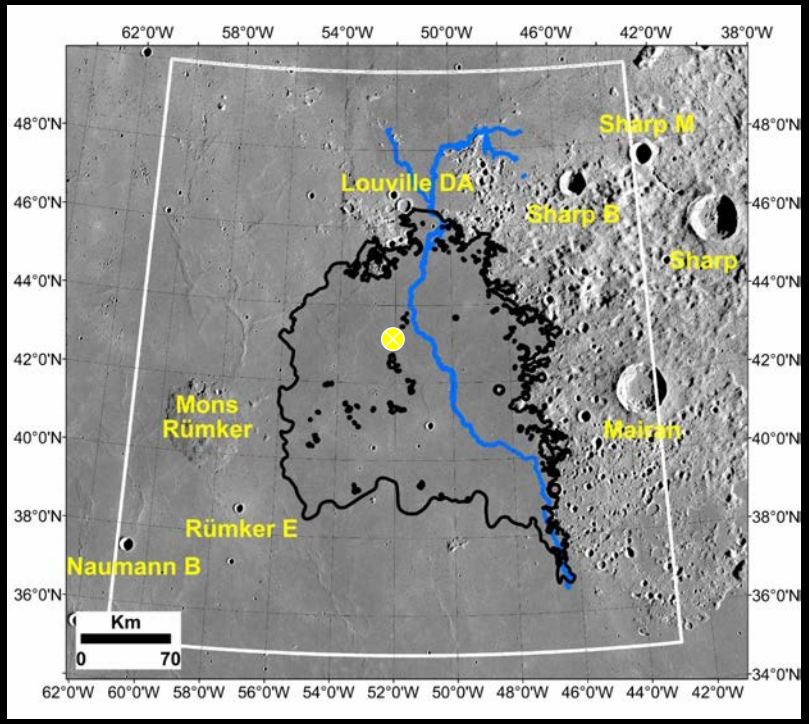
NW
Nearside





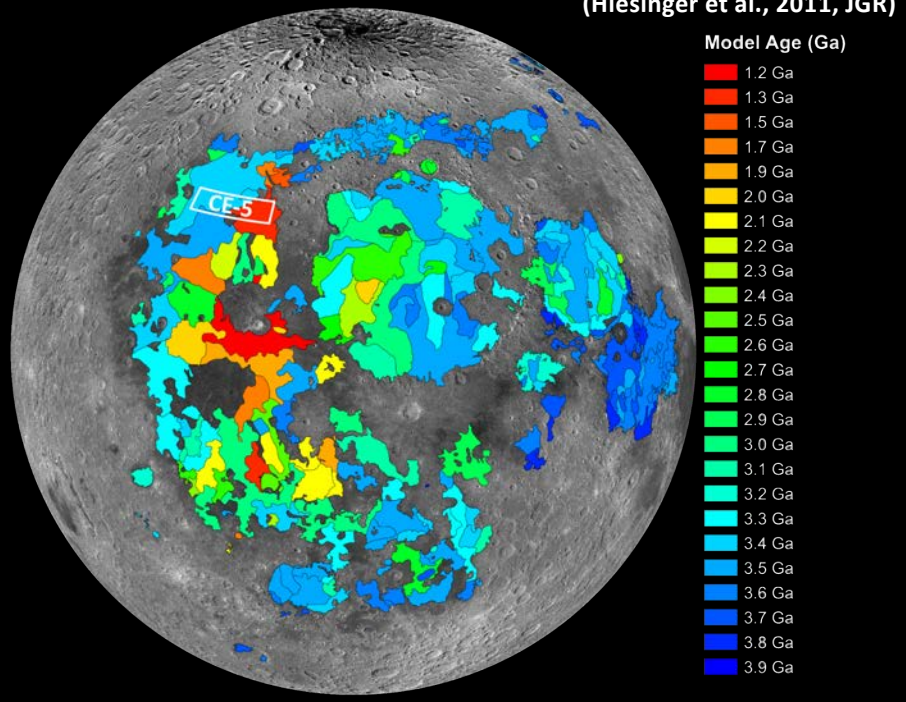
Northern Oceanus Procellarum
41-45 N, 49-69 W, 55000 km^2

Young Mare Basalts



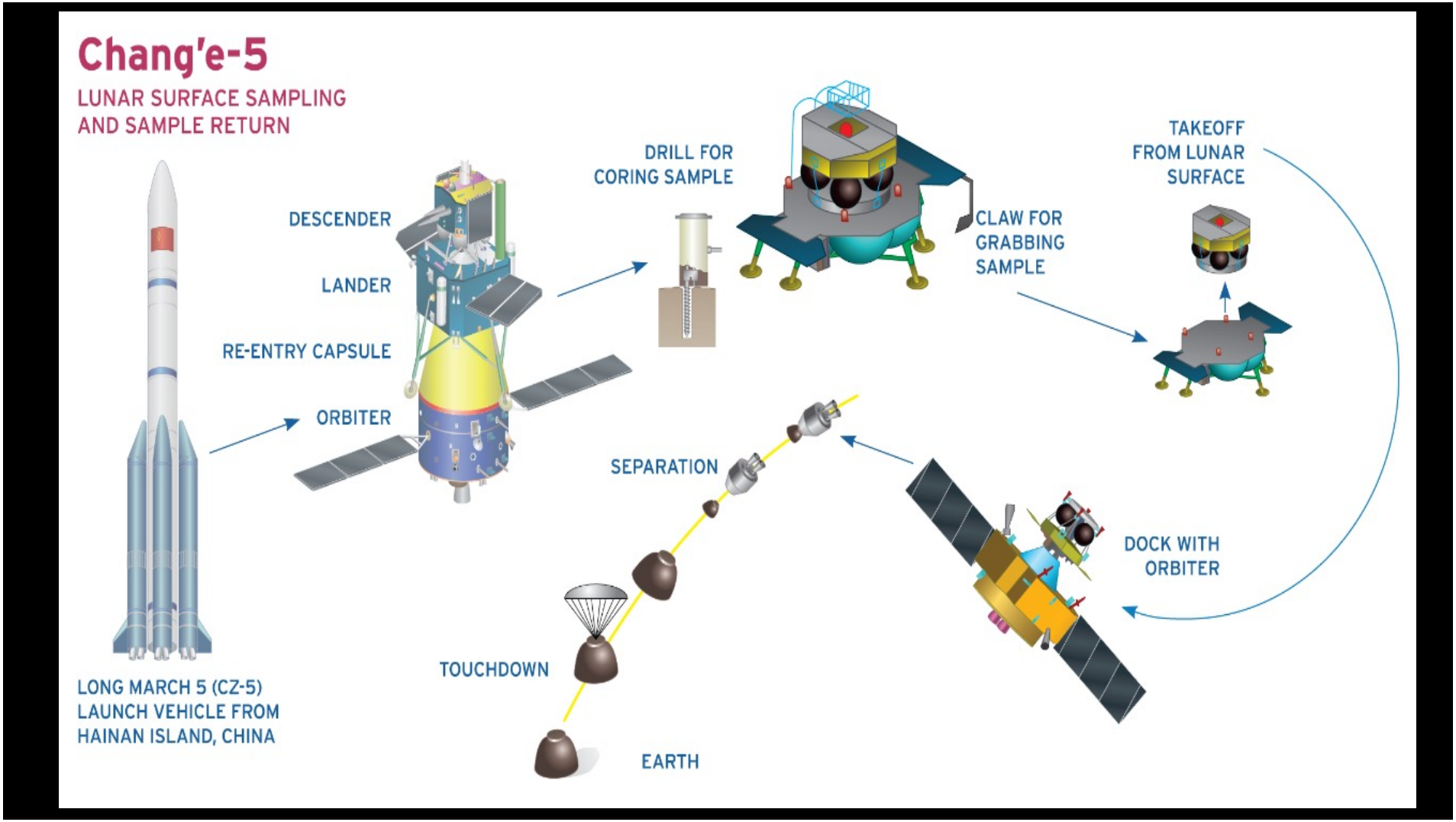
Em4/P58 Intermediate-Ti Mare Basalts (~1.53 Ga, Qian et al., 2021, EPSL)

(Hiesinger et al., 2011, JGR)

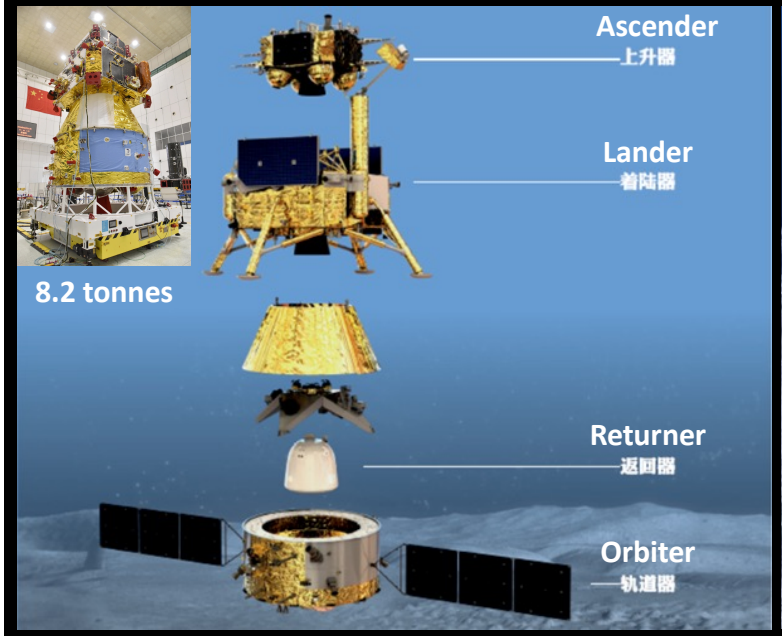


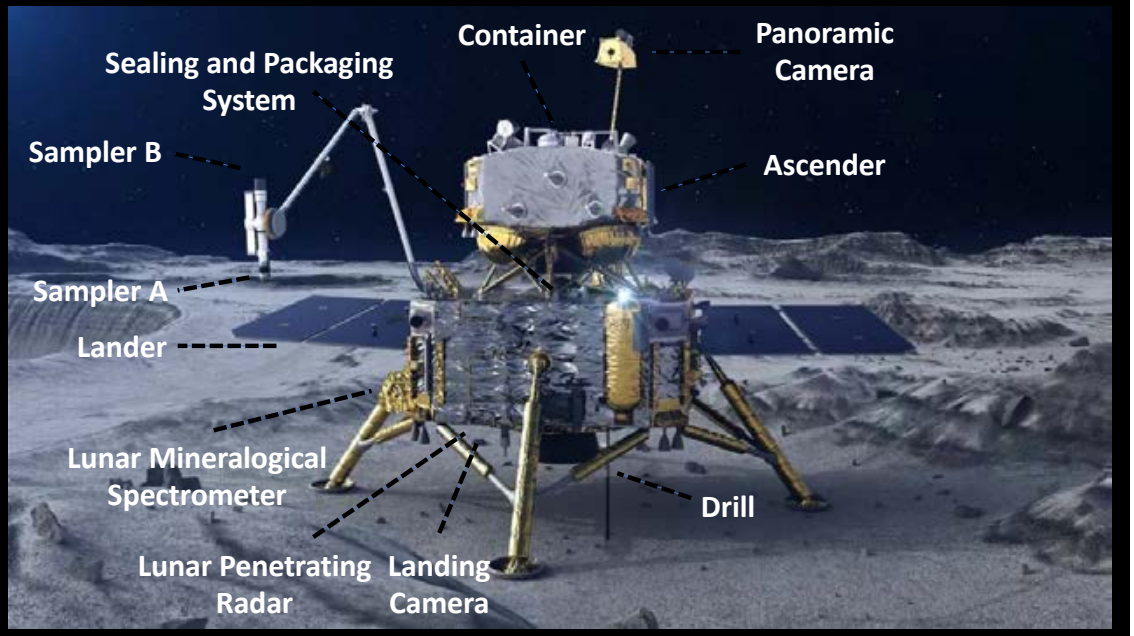
Publications Relevant to Geologic Setting of Chang'e 5 Site and Initial Characterization of the Landing Site

- 5284 - Qian, Y. Q., L. Xiao, S. Y. Zhao, J. N. Zhao, J. Huang, J. Flahaut, M. Martinot, J. W. Head III, H. Hiesinger, and G. X. Wang (2018), Geology and scientific significance of the Rümker region in northern Oceanus Procellarum: China's Chang'E-5 landing region, J. Geophys. Res., 123, 1407-1430, doi: 10.1029/2018JE005595
- 5439 - Qian, Y., L. Xiao, S. Yin, M. Zhang, M. Zhao, S. Zhao, Y. Pang, J. Wang, G. Wang, and J. W. Head III (2020), The regolith properties of the Chang'e-5 landing region and the ground drilling experiments using lunar regolith simulants, Icarus, 337, 113508, doi: 10.1016/j.icarus.2019.113508.
- 5491 - Qian, Y., L. Xiao, J. W. Head III, C. H. van der Bogert, H. Hiesinger, and L. Wilson (2021), Young lunar mare basalts in the Chang'e-5 return region, northern Oceanus Procellarum, Earth and Planetary Science Letters, 555, 116702, doi: 10.1016/j.epsl.2020.116702.
- 5520 - Qian, Y., L. Xiao, Q. Wang, J. W. Head III, R. Yang, Y. Kang, C. H. van der Bogert, H. Hiesinger, X. Lai, G. Wang, Y. Pang, N. Zhang, Y. Yuan, Q. He, J. Huang, J. Zhao, J. Wang, and S. Zhao (2021), China's Chang'e-5 landing site: Geology, stratigraphy, and provenance of materials, Earth and Planetary Science, 561, 116855, doi: 10.1016/j.epsl.2021.116855.


Chang'e-5
LUNAR SURFACE SAMPLING
AND SAMPLE RETURN
DESCENDER
LANDER
RE-ENTRY CAPSULE
ORBITER
DRILL FOR
CORING SAMPLE
CLAW FOR
GRABBING
SAMPLE
TAKEOFF
FROM LUNAR
SURFACE
DOCK WITH
ORBITER
SEPARATION
TOUCHDOWN
EARTH
LONG MARCH 5 (CZ-5)
LAUNCH VEHICLE FROM
HAINAN ISLAND, CHINA

Chang'e-5 Spacecraft



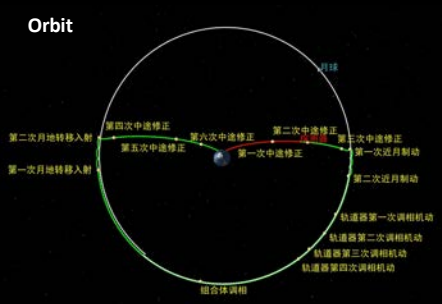


1) Total returned sample mass: 1731 g
2) ~1 meter core, with a mass of around ~250 g, and ~1500 g in the sampler;
3) Sampler A: Around 35 cm in length, Sampler A in the shape of a shovel, is specifically engineered for collecting loose regolith.
Sampler B: ~30 cm in length, used for collecting sticky samples by coring into the ground with teeth-like metal flaps when open:
https://www.polyu.edu.hk/en/media/media-releases/2020/1208_polyu_space_instruments_complete_lunar_sampling_for_chang_e-5/
5) 12 scoops were made for the sample:

ORBITAL OPERATIONS

- Orbiter Lander Seperation: 4:40 AM, Nov. 30, 2020

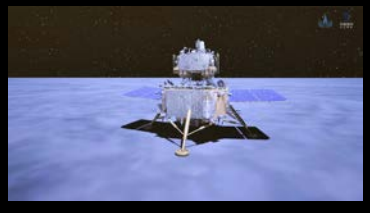
Orbit



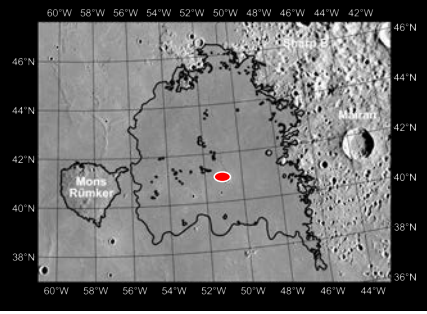
- First Orbit Correction: 10:06 PM, Nov. 24, 2020, 3000 N engine boosted 2 seconds
- Second Orbit Correction: 10:06 PM, Nov. 25, 2020, two 150 N engine boosted 6 seconds
- Lunar Orbit (Elliptical): 10:58 PM, Nov. 28, 2020, 3000 N engine boosted 17 minutes
- Lunar Orbit (Circular): 08:23 PM, Nov. 29, 2020

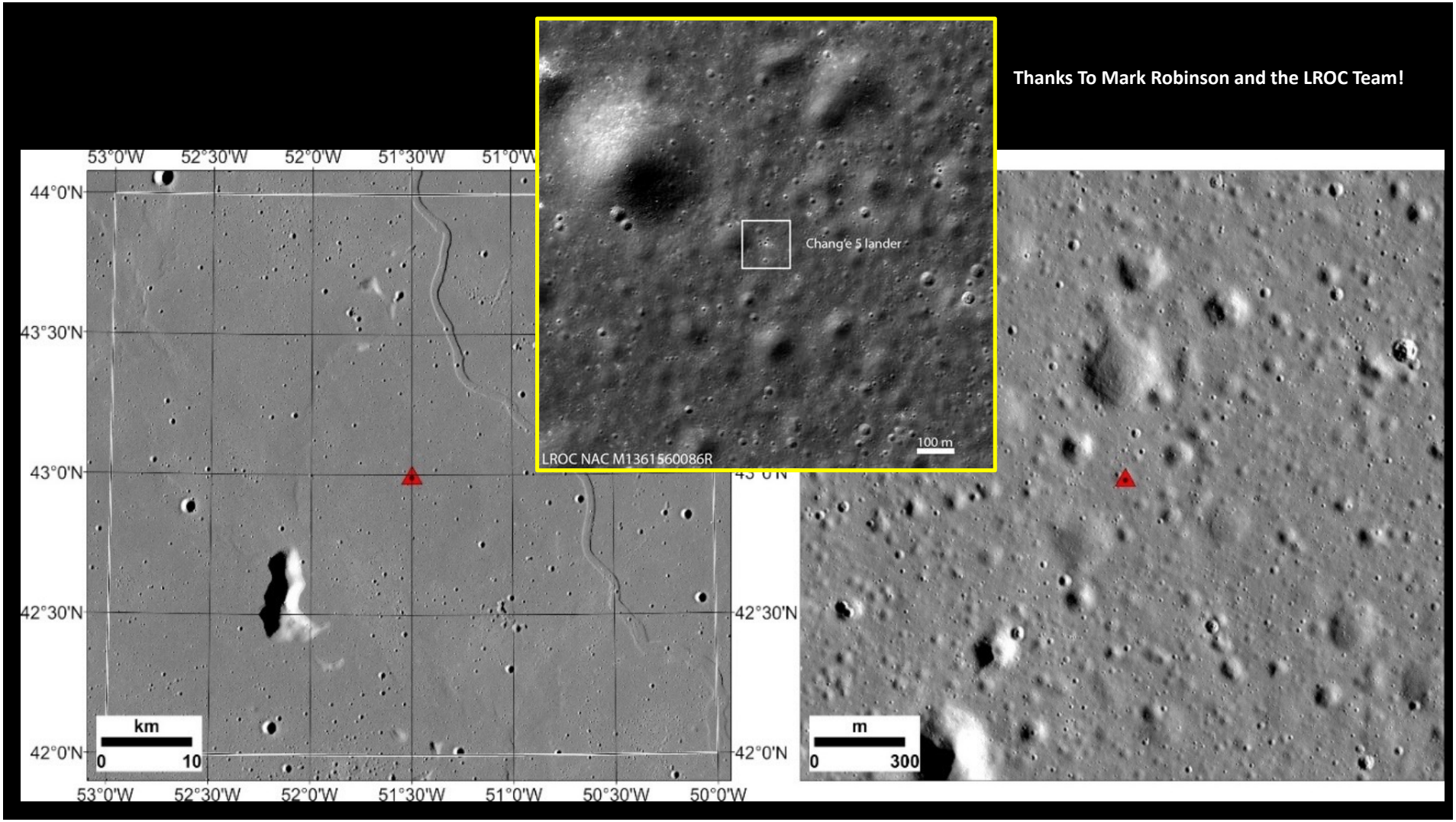
LANDING

Chang'e-5 landing
(Onboard Camera View)



Landing
Start: 10:57 PM, Dec. 01, 2020
Stop: 11:13 PM, Dec. 01, 2020




Thanks To Mark Robinson and the LROC Team!
Chang'e 5 lander
LROC NAC M1361560086R
100 m
53°0'W
52°30'W
52°0'W
51°30'W
51°0'W
50°30'W
50°0'W
44°0'N
43°30'N
43°0'N
42°30'N
42°0'N
km
0
10
m
0
300

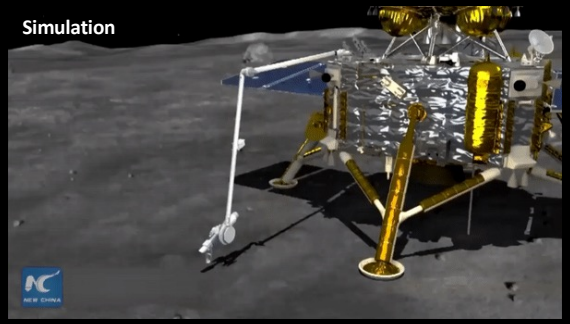
SAMPLING: DRILLING

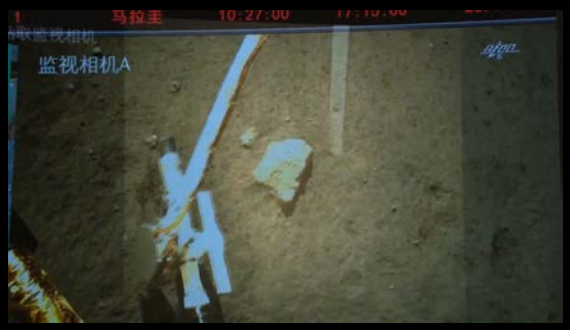
Monitoring Camera

SAMPLING: DRILLING

(CNSA)

Simulation

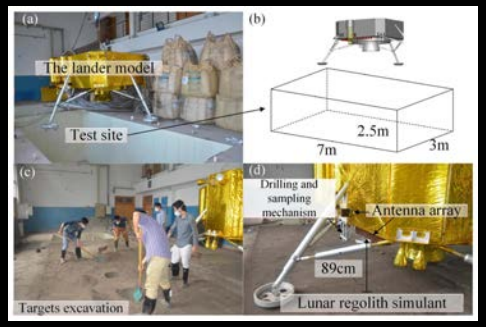


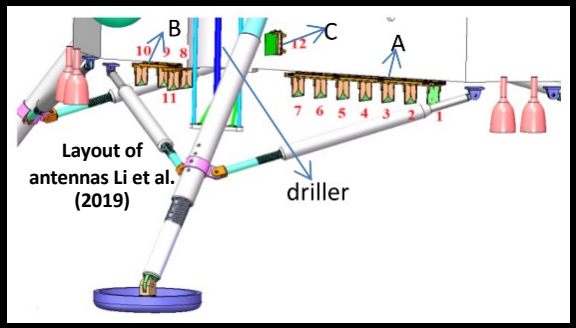


Monitoring Camera

Lunar Mineralogical Spectrometer (LMS)

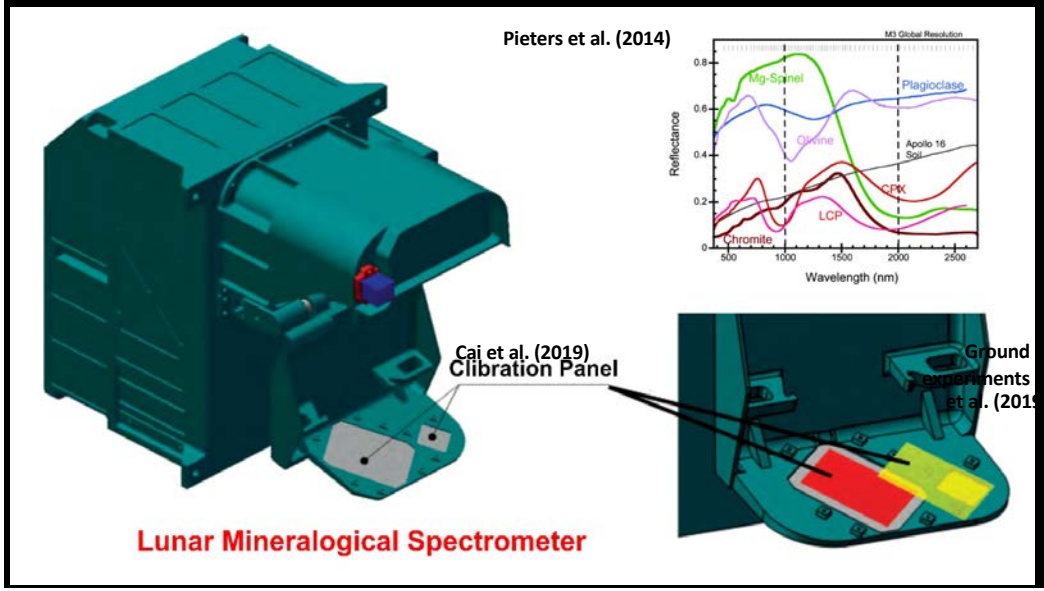
- Spectra Coverage (480 ~ 3200 nm): VIS/NIR (visible, 480 ~ 950 nm; near-infrared, 900 ~ 1450 nm) Module and IR Module (short infrared, 1400 ~ 2450 nm; middle infrared, 2400 ~ 2450 nm)
- Spectra Resolution: 5 ~ 25 nm
- Detection Distance: 2 ~ 5 m
- Field of view (FOV): 3 degrees x 3 degrees
- Filter: Acousto-optic tunable filters (AOTFs)
- Usage: Acquire the spectra of the sampling site

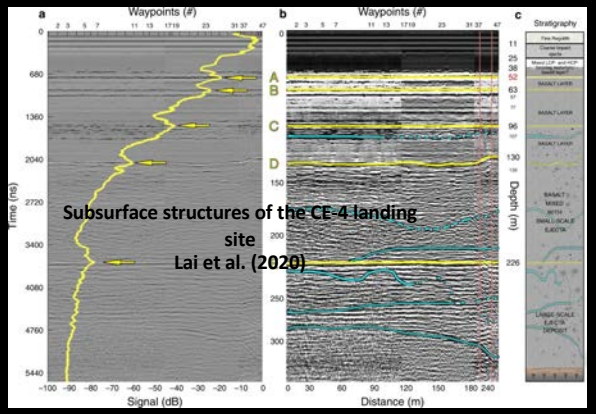




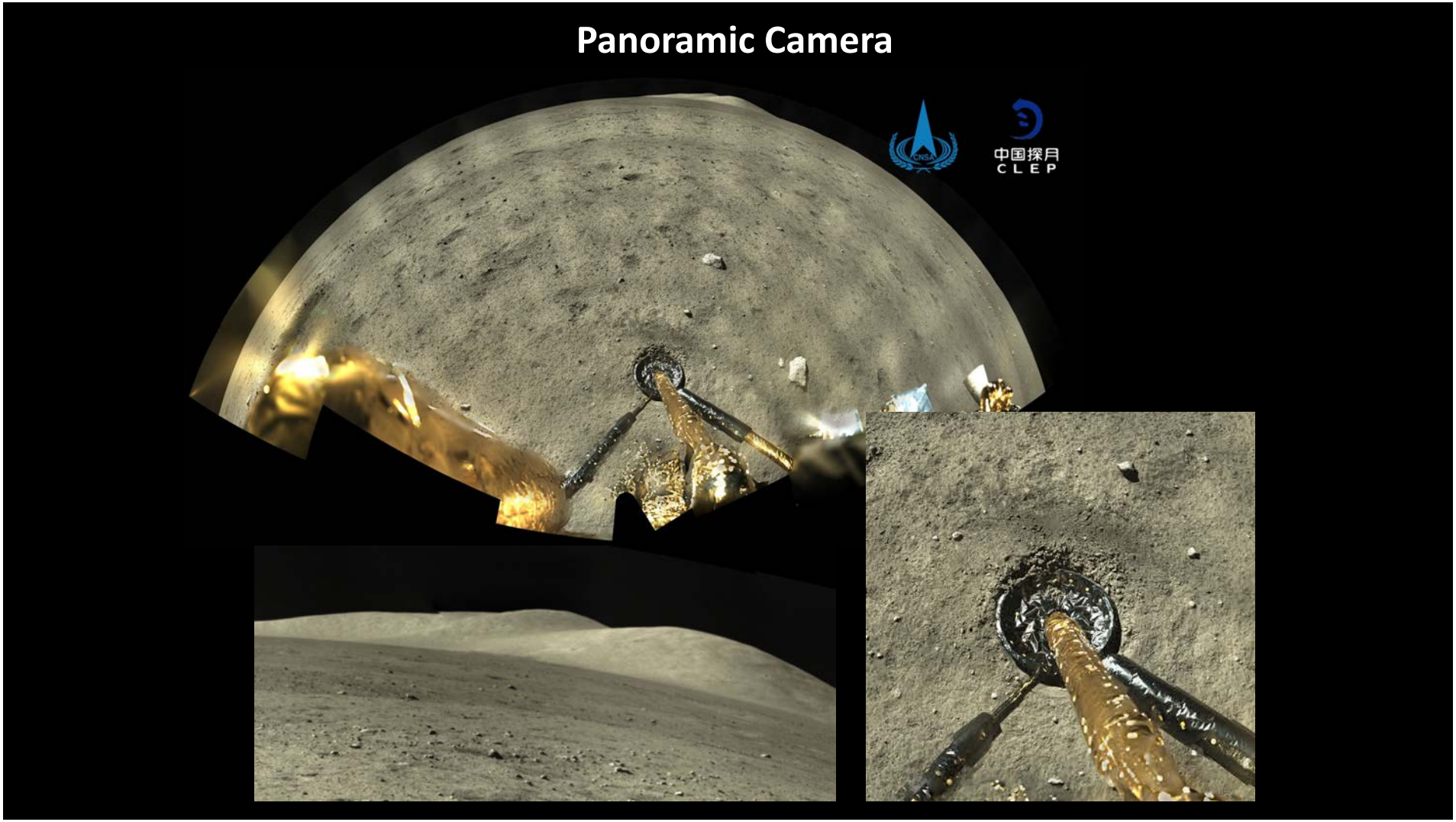
Lunar Regolith Penetrating Radar (LRPR)

- Ultra-wideband array-based ground penetrating radar
- The antenna array consists of 12 bow-tie antennas with a working frequency range of 1 ~ 3 GHz; these are asymmetrically mounted around the drill (90 cm above the ground).
- Frequency Coverage: 1 ~ 3 GHz
- Vertical spatial resolution: <= 5 cm
- Detection Distance: >= 2 m
- Usage: Detect the subsurface structures of the sampling site; Support drilling and sampling operations



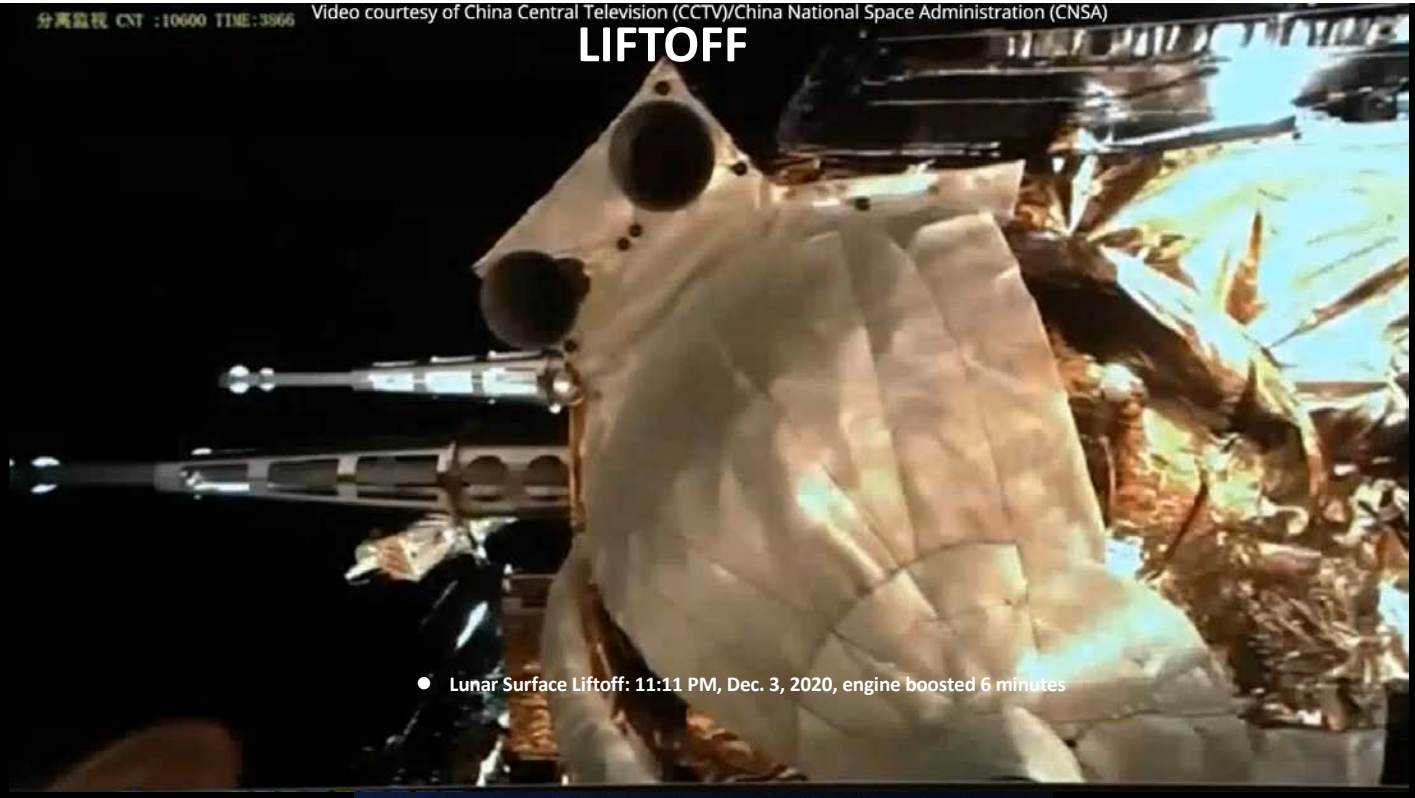


Panoramic Camera



Video courtesy of China Central Television (CCTV)/China National Space Administration (CNSA)

LIFTOFF



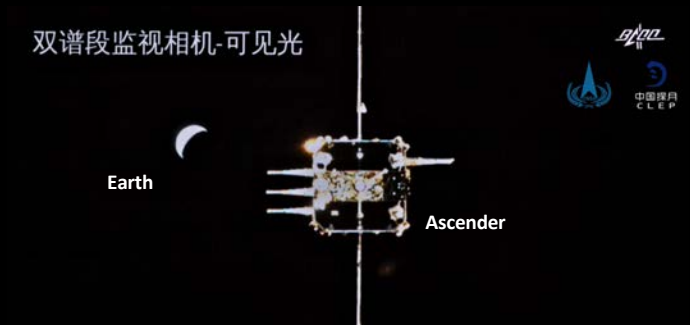
- **Lunar Surface Liftoff: 11:11 PM, Dec. 3, 2020, engine boosted 6 minutes**

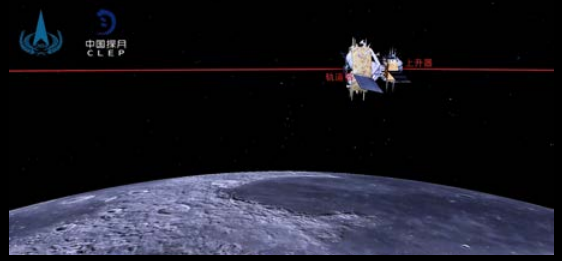
DOCKING

Chang'e-5 ascender docks with
the orbiter-sample return vehicle

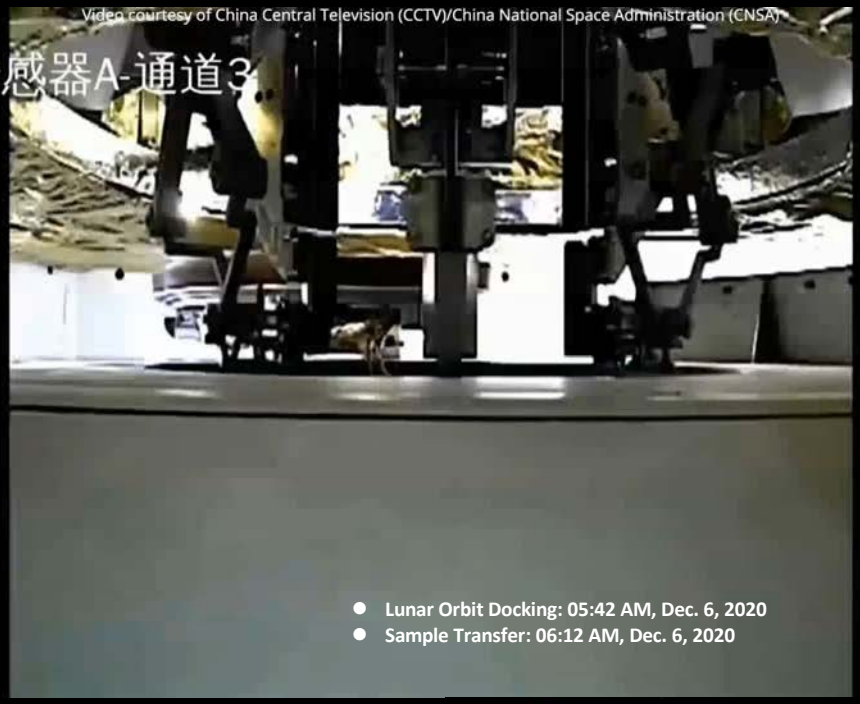
x4 Speed

- Lunar Orbit Docking: 05:42 AM, Dec. 6, 2020





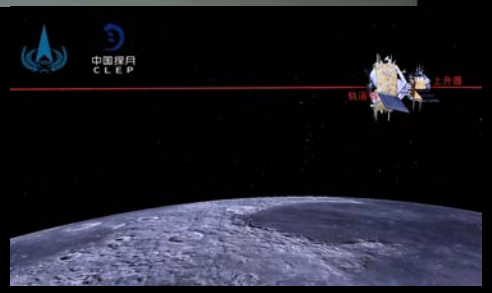
SAMPLE TRANSFER



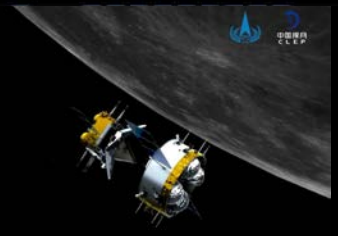
x4 Speed

- Lunar Orbit Docking: 05:42 AM, Dec. 6, 2020
- Sample Transfer: 06:12 AM, Dec. 6, 2020

Lunar Sample Automatic Sealing Device

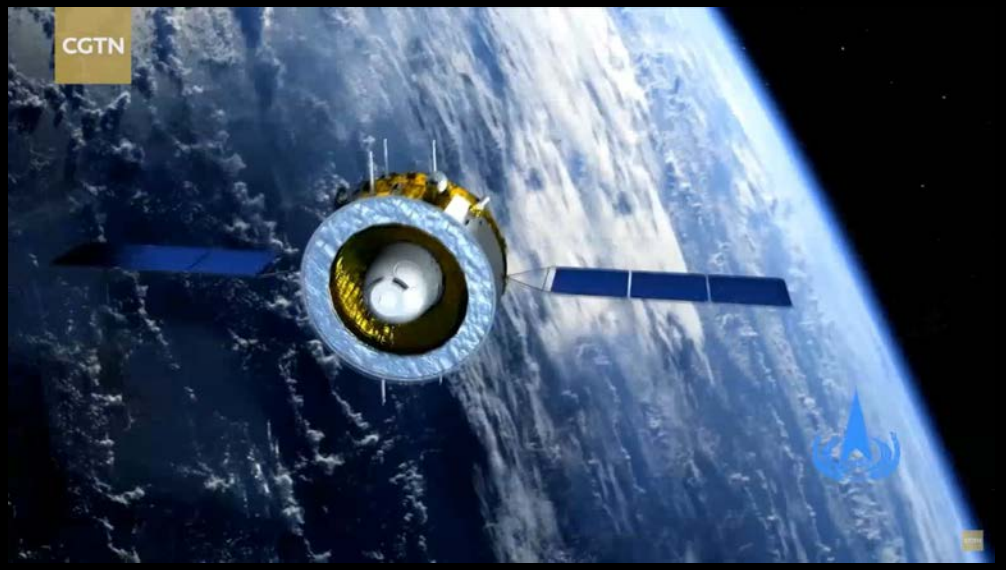


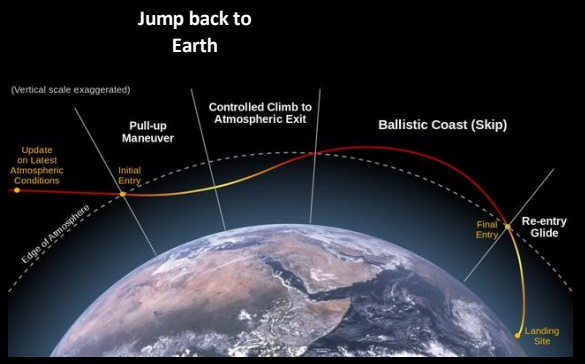
ASCENDER-ORBITER SEPARATION



- Lunar Orbit Docking: 05:42 AM, Dec. 6, 2020
- Sample Transfer: 06:12 AM, Dec. 6, 2020
- Ascender-Orbiter Separation: 12:25 AM, Dec. 6, 2020

RETURN TO EARTH





RETURN TO EARTH

- Lunar Orbit Docking: 05:42 AM, Dec. 6, 2020
- Sample Transfer: 06:12 AM, Dec. 6, 2020
- Ascender-Orbiter Separation: 12:25 AM, Dec. 6, 2020
- Ascender Smashed on the Moon: 6:59 AM, Dec. 8, 2020
- First Maneuver: 9:54 AM, Dec. 12, 2020, circular orbit to elliptical orbit (perilune @ 200 km)
- Second Maneuver: 9:51 AM, Dec. 13, elliptical orbit to Moon-Earth Transfer Orbit
- Landing on the Earth: 01:59 AM, Dec. 17, Siziwang Banner (parachute open at ~ 10 km)

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- 3. Chinese Lunar Exploration Program (CLEP) context for Chang'e 5.
- 4. Chang'e 5 Landing Site Selection, Global Context, Key Questions, Mission Operations and Sample Return.
- 5. Returned Sample Location, Storage, Preliminary Analysis and Distribution.
- 6. Opportunities for International Cooperation.

Sample Curation

Ground Research Application System (GRAS)

Article 7 The main responsibilities of the *Main Curatorial Agency* include (Lunar Sample Policy, CNSA)

(1) Formulating *Standards and Operating Procedures* related to lunar samples;
(2) Implementing the *unsealing, classification, preparation, documentation, and storage of lunar samples*;
(3) *Implementing the distribution, return* and dispositioning of lunar samples in accordance with the procedures;
(4) Building and maintaining the *Lunar Sample Storage Facilities*, to make sure that these facilities have the capability to carry out the necessary work; and
(5) Establishing a *Lunar Sample Curation Catalog*, thus to secure the information safety of the lunar samples.

Sample Curation

Ground Research Application System (GRAS)


Lunar Sample Lab Overview


Unsealing Device

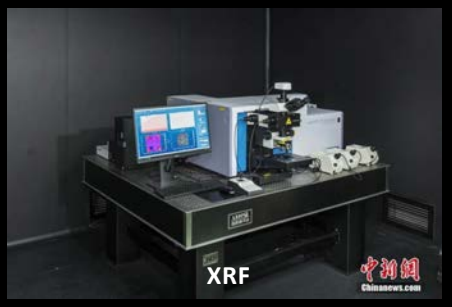

Scooped Sample Temporary Storage Device


Drilling Sample Temporary Storage Device


Pure Nitrogen Supply System


Electronic Probe


Scanning Electron Microscope


XRF


Microscopic Observation Device


Mass Spectrometer

Sample Curation

Ground Research Application System (GRAS)

1) GENERAL GUIDELINES:

-The returned lunar samples will be divided into scooped samples and drilled samples after entering the lab.

-Secondly, both scooped and drilled samples will be then divided into four categories:

1. permanent storage samples, 2. backup permanent storage samples, 3. scientific research samples and 4. exhibition samples.

2) DETAILED PROCEDURES:

(1) Handing over and transferring: GRAS receives the sealed package from the spacecraft system. After that, the sealed package will be placed in a transfer box whose inside will be filled and protected by nitrogen. Then, the transfer box is placed in a transport vehicle and transferred to the Lunar Samples Laboratory. After arriving, The sealed package will be taken out from the transfer box and transferred to the room specially designed for Sample Storage and Unblocking.

(2) Unsealing of the sample package: First, the accessories of the sealed package will be removed. Then, the sealed package is sent to the operation cabin of the unsealing glove box to install the unsealing tool. Second, the sealed package enters the unsealing cabin to open the package and collect released gases (for subsequent gas components analysis). Third, the unsealed package will be is returned to the operation cabin. At this stage, there are another two unsealed containers inside the unsealed package. One is for scooped samples and the other is for drilled sample. We will take out both of these two containers from the unsealed package finally.

(3) Drilled samples division: First, take the soft bag containing drilled samples out of the sealed container, and cut it into several sections of 15cm each. Then, separate the research samples from each section and leave the remaining in the soft bag as permanent storage samples.

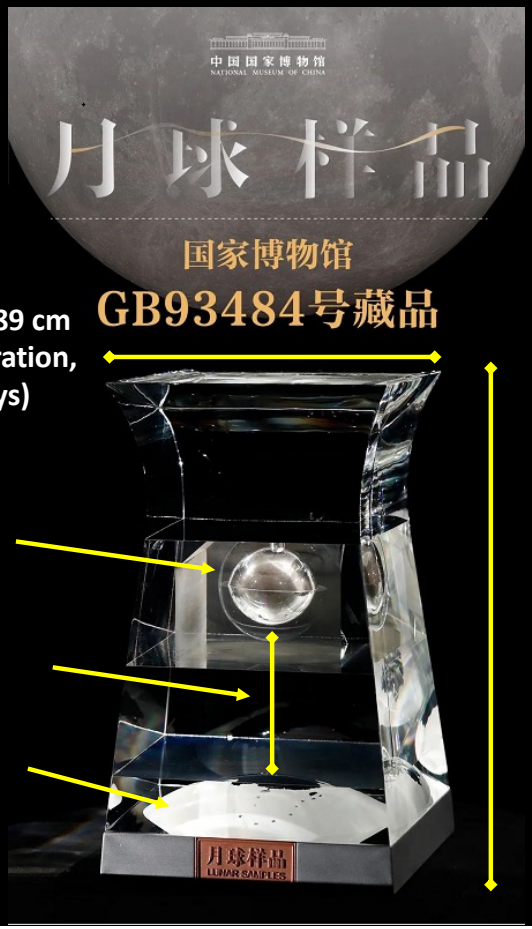
(4) Scooped samples division: First, using the unblocking tool specially designed to open the sealed container and then collect the samples into a squared container. Then, and using the geologically commonly used 16 equal division method for sampling. After this process, the scooped samples will be divided into research samples, permanent storage and backup permanent storage samples. All these samples will be placed into the corresponding sample boxes.

(Zhang et al., 2020)

FIRST VIEWS OF CHANG'E 5 SAMPLES

In Display in National Museum of China
(~100 g)

FIRST VIEWS OF CHANG'E 5 SAMPLES



Width = 22.89 cm
(Mission Duration,
22.89 days)

Lunar Soil
(Moon)

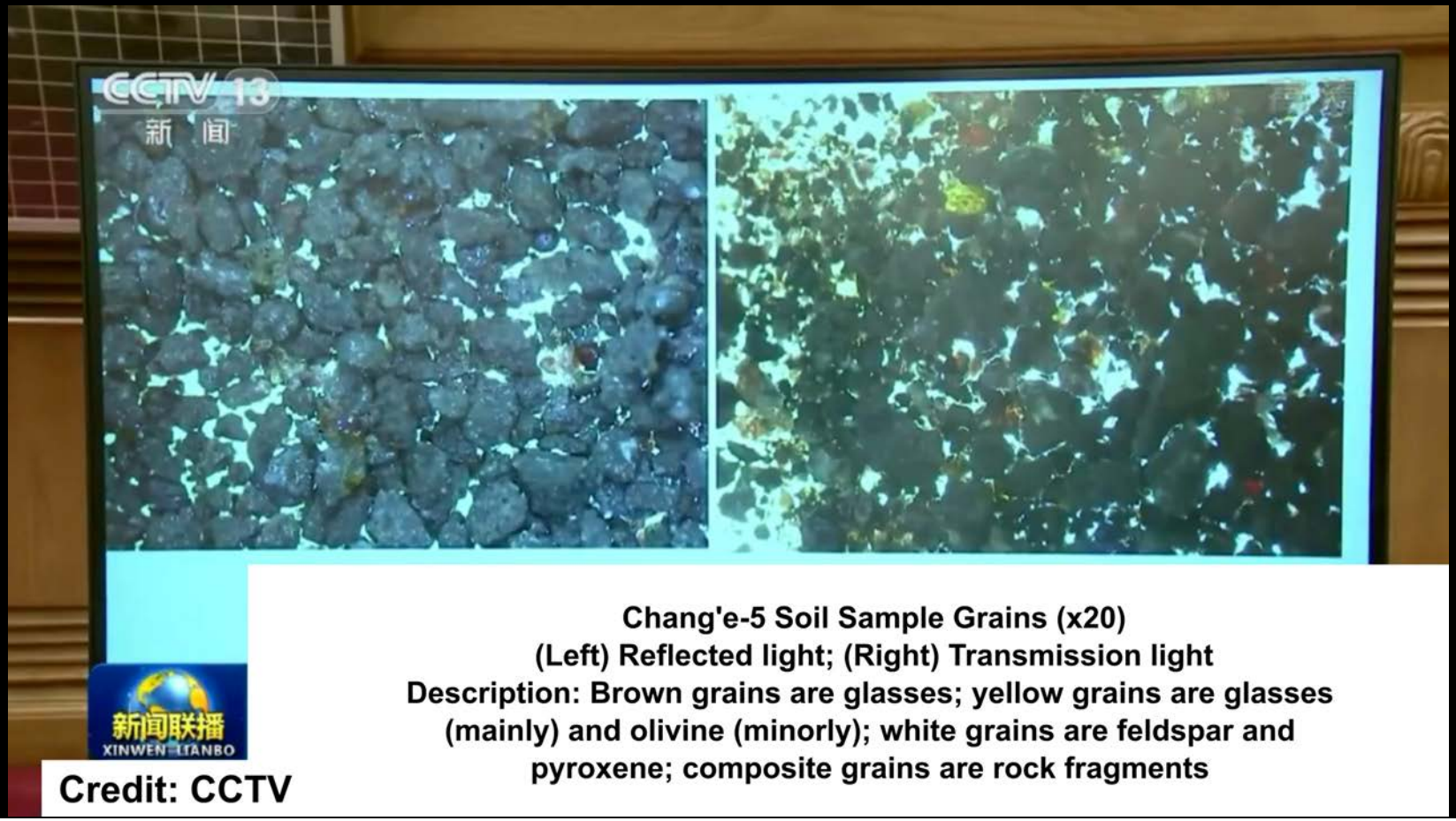
Distance = 9.9 cm
(9 Heavens)

Earth Map

Height = 38.44 cm
(Earth-Moon Distance,
384,400 km)

"Zun" for sacrifice ceremony (pre-1046 BC)
Alcohol Container

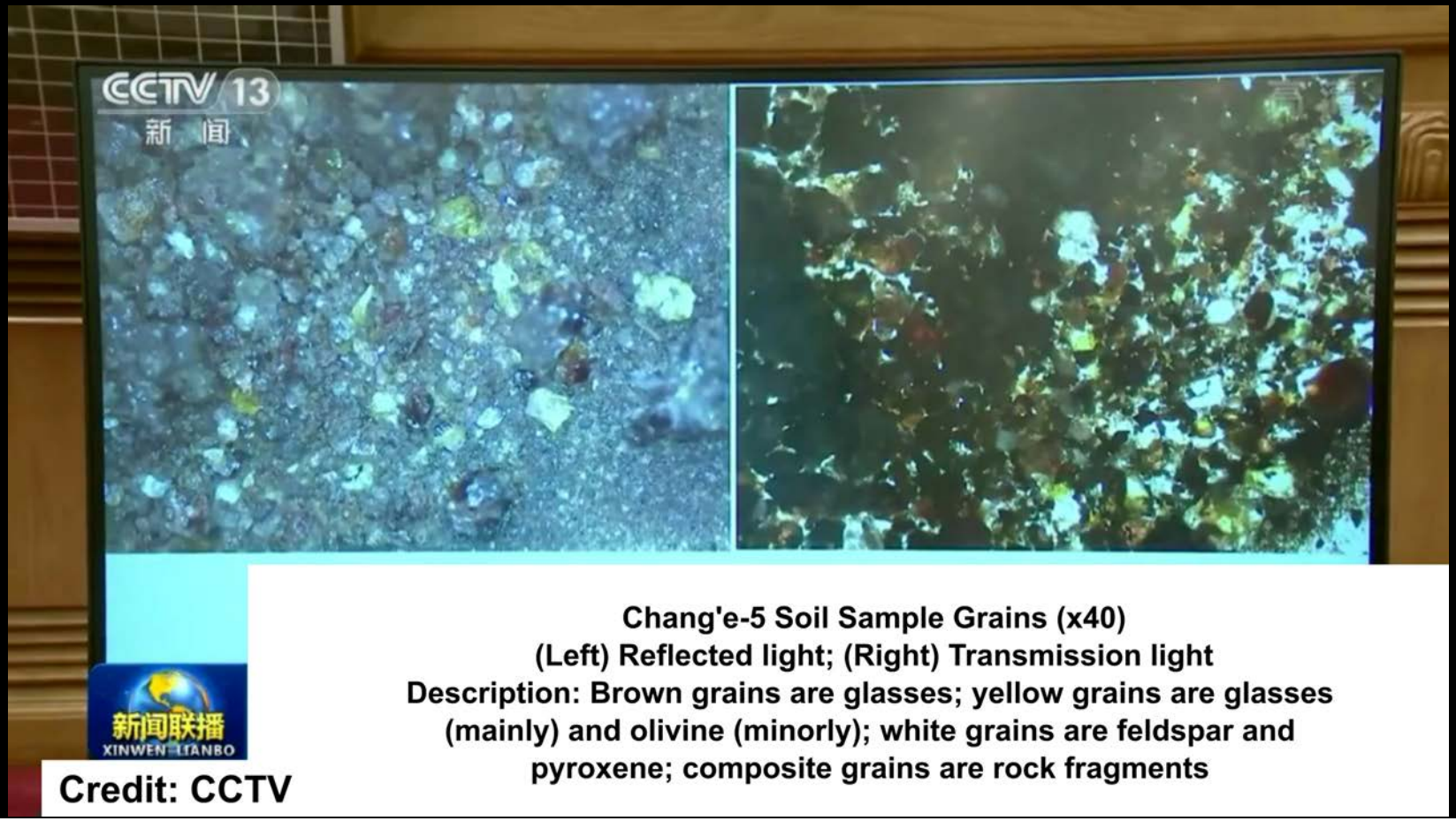
FIRST VIEWS OF CHANG'E 5 SAMPLES



Chang'e-5 Soil Sample Grains (x20)
(Left) Reflected light; (Right) Transmission light
Description: Brown grains are glasses; yellow grains are glasses (mainly) and olivine (minorly); white grains are feldspar and pyroxene; composite grains are rock fragments

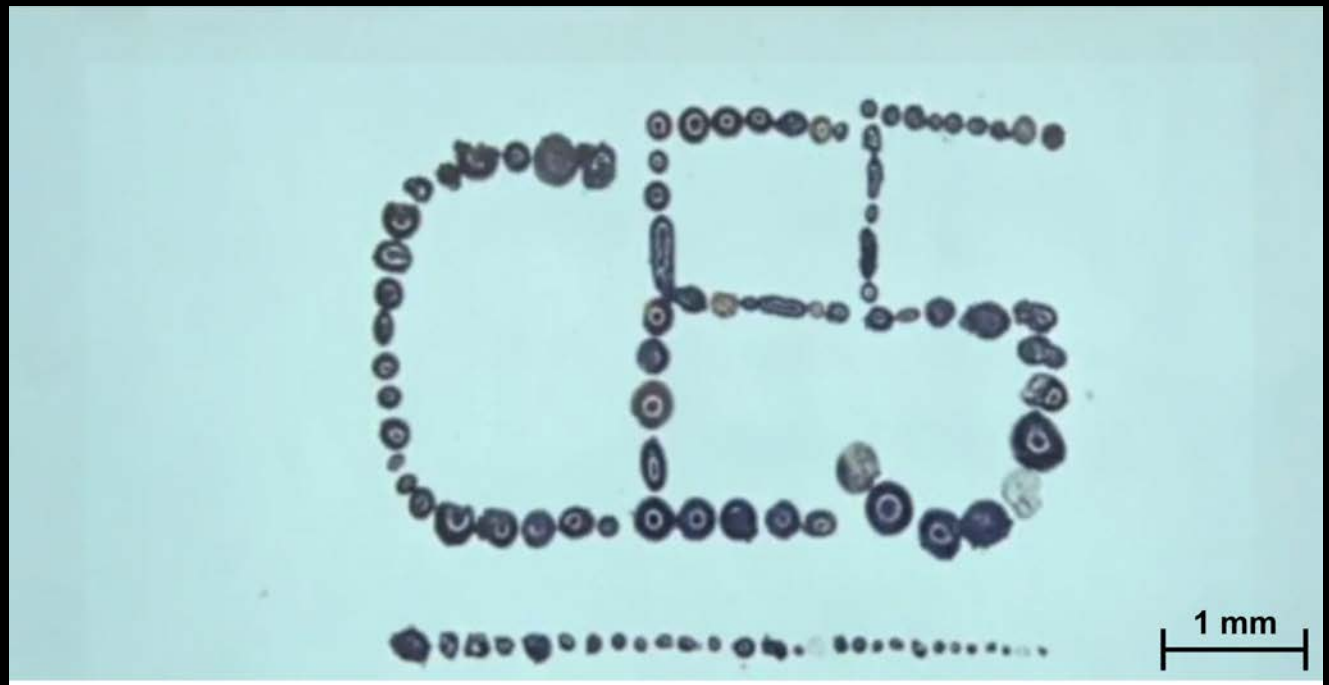
Credit: CCTV

FIRST VIEWS OF CHANG'E 5 SAMPLES



Chang'e-5 Soil Sample Grains (x40)
(Left) Reflected light; (Right) Transmission light
Description: Brown grains are glasses; yellow grains are glasses (mainly) and olivine (minorly); white grains are feldspar and pyroxene; composite grains are rock fragments

FIRST VIEWS OF CHANG'E 5 SAMPLES



Chang'e-5 Regolith Glasses

Credit: Xinhua Net

FIRST VIEWS OF CHANG'E 5 SAMPLES

CHANGE'E 5 GABBRO ROCK FRAGMENT

Credit: Xinhua Net

Lunar Sample Policy, CNSA

Chapter 1 General Provisions

国家航天局
China National Space Administration

- **Article 1** These Procedures are established for the proper storage, management and usage of lunar samples for scientific research and social benefits.
-
- **Article 2** The lunar samples refer to the materials collected on and below the surface of the Moon through China's lunar exploration program and the lunar materials obtained by China National Space Administration (CNSA) through other means.
-
- **Article 3** The present Procedures shall be applicable to the overall process of unsealing, classification, preparation, documentation, storage, application, distribution, transportation, use, return, dispositioning, management of information, and documentation of results.

Chapter 2 Responsibilities

- **Article 4** China National Space Administration is the management authority of lunar samples, with main responsibilities that include:
- (1) Formulating policies and regulations for the management of lunar samples;
- (2) Supervising application and commercialization of scientific research achievements; and
- (3) International cooperation on lunar sample studies.

Chapter 2 Responsibilities

- **Article 5** CNSA's *Lunar Exploration and Space Engineering Center (hereinafter referred to as LESEC) has been entrusted to carry out the management of lunar samples, with main responsibilities including:*
- (1) Reviewing Standards and Operating Procedures formulated by the curatorial agencies;
- (2) Establishing an expert committee on lunar samples;
- (3) Reviewing applications for requesting lunar samples;
- (4) Supervising and coordinating the process of unsealing, classification, preparation, documentation, storage, application, distribution, transportation, use, return, dispositioning, management of information, and documentation of results.;
- (5) Publishing dynamic information on lunar samples on a regular basis through data information platform; and
- (6) Implementing the monitoring of science returns and its applications, and preparing and publishing a list of publications and achievements.
- **Article 6** *The lunar samples are stored at CNSA and its designated curatorial agencies. The main curatorial agency is the National Astronomical Observatories of the Chinese Academy of Sciences, and a backup curatorial agency is also established.*
- The curatorial agencies, under the supervision of CNSA and specific guidance of LESEC, shall provide information, from preliminary examination, on lunar samples in a timely manner, and report the curation and distribution of lunar samples to LESEC on a regular basis. Any emergency case such as lunar sample contamination and damage shall be reported to LESEC immediately.
- The curatorial agencies shall adopt the following procedures for sample handling.

Chapter 2 Responsibilities

- **Article 7** The main responsibilities of the main curatorial agency include:
- (1) Formulating standards and Operating Procedures related to lunar samples;
- (2) Implementing the unsealing, classification, preparation, documentation, and storage of lunar samples;
- (3) Implementing the distribution, return and dispositioning of lunar samples in accordance with the procedures;
- (4) Building and maintaining the lunar sample storage facilities, to make sure that these facilities have the capability to carry out the necessary work; and
- (5) Establishing a lunar sample curation catalog, thus to secure the information safety of the lunar samples.
-
- **Article 8** The main responsibilities of the backup curatorial agency include:
- (1) Participating in the formulation of the standards and operating procedures related to lunar samples;
- (2) Building and maintaining storage facilities; and
- (3) Establishing a lunar sample information catalog to guarantee the security of lunar samples stored.

Chapter 2 Responsibilities

- **Article 9** Requesting of lunar samples shall be made by a legal person (hereinafter referred to as the requesting subject), and the main responsibilities of the requesting subject shall include:
- (1) Conducting scientific research or socially beneficial activities in accordance with the relevant content of approval and agreement;
- (2) Responsible for the security of the lunar samples, and bearing responsibilities for their damage, contamination, or loss due to operational and storage negligence;
- (3) A dedicated person shall be appointed to be responsible for the safe use of the sample. Clear instructions shall be given to the person or persons responsible for sample handling; and
- (4) Reporting in the scientific research results of lunar samples to LESEC.

Chapter 3 Classification, Handling and Information Release

- **Article 10** According to basic uses, lunar samples are divided into four types in principle: permanently stored samples, permanently stored backup samples, research samples, and samples for public beneficial activities, of which permanently stored samples and permanently stored backup samples are sealed and maintained in a pristine state as original samples, research samples are used for scientific investigation and analysis, and the samples for public beneficial activities are used for activities such as exhibition, public outreach, and education.
- **Article 11** The main curatorial agency shall receive and keep the lunar samples for a period of not more than six months, according to different basic uses, to conduct preliminary sample handing and to form a set of relevant information.
- **Article 12** After the end of the above (initial) sample handling period, LESEC will publish lunar sample information to the public through the data information platform, and update the sample information dynamically according to the status of sample requests.

Chapter 4 Request and Distribution

- **Article 13** Request refers to the use of lunar samples for scientific research (non-destructive and destructive experiments) and public beneficial activities (education, exhibition, etc.) and the return of samples at an agreed time after the completion of such activities.
- **Article 14** The requesting subject shall be able to ensure the safety and storage of the sample, and the requesting subject that will conduct the sample research shall have the corresponding investigation competence as being proposed.
- **Article 15** The requesting subject shall submit a request application form for lunar samples on the data information platform (see Annexes 1 and 2).
- **Article 16** LESEC will conduct a centralized review of request applications at the end of each quarter and provide timely feedback on the results of the review to the requesting subjects. LESEC will sign a Lunar Sample Loan Agreement (see Annex 3) with the requesting subject, and the main curatorial agency will allocate the sample according to the procedures.

Chapter 4 Request and Distribution

- **Article 17** The term for request of a research sample shall, in principle, not exceed one year. If it is absolutely necessary, the request can be renewed once for a period not exceeding six months. The requesting subject shall submit an application for renewal to LESEC at least thirty days before the expiration of the request.
- **Article 18** In view of the precious nature of lunar samples, the requested research samples shall be used sparingly. Destructive experiments on research samples shall be reduced to the minimum and demonstrated and explained in detail in the research plan.
- **Article 19** The term for requesting of sample for public beneficial activities generally does not exceed two months. If it is really necessary, a request can be renewed once for a period not exceeding one month. The requesting subject shall submit an application for renewal to LESEC fifteen days before the expiration.
- **Article 20** The main curatorial agency shall complete the preparation and distribution of the corresponding sample within thirty days in accordance with the written notice of LESEC, the approved request application form and the signed Lunar Sample Loan Agreement, and give feedback to LESEC.

Chapter 5 Use and Return

- **Article 21** The requesting subject shall record the entire use of lunar sample in writing, and the destructive experiments must be recorded in video, so as to ensure the traceability of the use of sample and facilitate the supervision, return and redistribution of the lunar sample.
- **Article 22** The requesting subject is subject to inspection by LESEC on the use of lunar samples.
- **Article 23** The requesting subject has no right to provide the lunar sample to a third party. Experiments, testing and other related work to be conducted by a third party shall be explained in the original request application form by the requesting subject, and must be approved before implementation.

Chapter 5 Use and Return

- **Article 24** If the requesting subject violates the provisions of the request agreement during the use of lunar sample, LESEC shall have the right to terminate the agreement in advance and request the requesting subject to return the sample immediately.
- **Article 25** Within five working days after the expiration of the request, the requesting subject shall submit a return application form (see Annex 4) to the main curatorial agency in a timely manner, with the lunar sample, loan agreement and necessary documents attached. The sample use record in the return application form shall be filled in clearly and completely, and video record of relevant destructive experiments (including complete destruction without any remaining material) shall be provided. The requested sample shall be returned in full, and for any sample that cannot be returned completely due to destructive experiments, the remaining part shall be returned.
- **Article 26** The main curatorial agency shall organize the verification of the integrity of the items returned after receiving the return application form. In case of any missing items, the requesting subject shall make supplementary submission within the specified period. The main curatorial agency will inspect the returned lunar sample, form an inspection opinion, and report to LESEC. LESEC will organize a review by the committee of experts as appropriate and draw a conclusion. If the returned sample meets the requirements, the main curatorial agency shall be responsible for the registration, storage, and other related work. If the returned sample does not meet the requirements, the main curatorial agency shall be responsible for the treatment in accordance with the relevant provisions of Lunar Sample Loan Agreement.

Chapter 6 Publication of Scientific Results

- **Article 27** Publication of papers, academic exchanges and other activities that use the research achievements of lunar sample analysis shall clearly identify the serial number of the lunar sample and indicate that "Lunar Sample Provided by CNSA".
- **Article 28** Publication of papers and declaration of intellectual property that derived from the usage of lunar samples shall be reported through the data information platform within three months and will be collected and published by LESEC to promote the sharing of scientific research results from the analysis of lunar samples.
- **Article 29** LESEC organizes a committee of experts to evaluate the scientific research achievements of lunar sample analysis on a regular basis, and to promote the transformation and application of scientific and technological achievements.
- **Article 30** Commercial activities to be conducted using lunar samples or relevant scientific research achievements and products by a requesting subject shall be subject to written approval by LESEC and follow the Lunar Sample Loan Agreement.

Chapter 7 Security Management

- **Article 31** The requesting subject shall possess the corresponding security assurance and management conditions, to ensure that the lunar sample is secure and free from contamination.
- **Article 32** If a lunar sample is lost, the requesting subject shall notify the local police immediately and report to LESEC. In case of contamination, damage, etc., the requesting subject shall submit a written explanation within 24 hours. In serious cases, LESEC will request CNSA and other relevant authorities to investigate and pressing legal charges in accordance with the law.

Chapter 8 International Cooperation

- **Article 33** The management and use of lunar samples shall comply with the *relevant international conventions that the People's Republic of China has established or adopted.*
- **Article 34** *CNSA encourages lunar sample-based joint international research, and supports the international sharing of science results.*
- **Article 35** *LESEC shall organize joint research, exchanges, exhibition, and goodwill gifts related to lunar samples, in accordance with the relevant agreements and approvals of CNSA.*

Chapter 9 Supplementary Articles

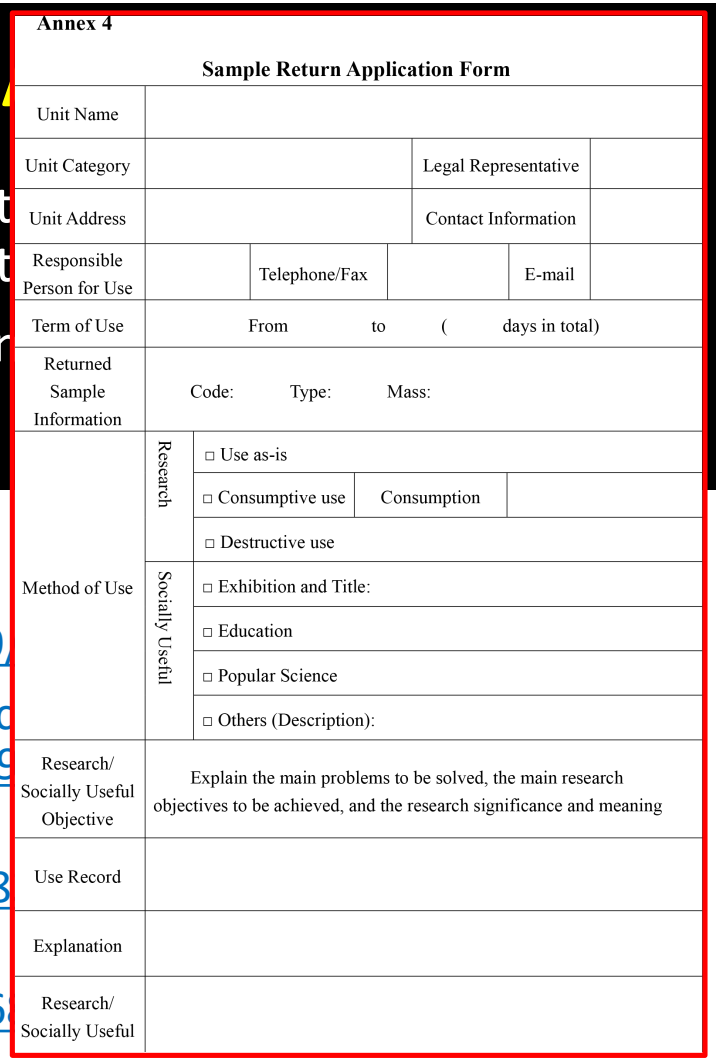
- **Article 36** Whoever violates the provisions of the present Procedure shall be subject to investigation by CNSA and other authorities for legal responsibility.
- **Article 37** The present Procedure shall come into force as of the date of publication, and CNSA shall be responsible for its interpretation.

- **Annex**
- Annex 1 Request Application Form of Research Samples: http://www.cnsa.gov.cn/n6758823/n6758839/c6811124/part/6786064.docx
- Annex 2 Request Application Form of Samples for Public Beneficial Activities: http://www.cnsa.gov.cn/n6758823/n6758839/c6811124/part/6786065.docx
- Annex 3 Lunar Sample Loan Agreement: http://www.cnsa.gov.cn/n6758823/n6758839/c6811124/part/6786066.docx
- Annex 4 Sample Return Application Form: http://www.cnsa.gov.cn/n6758823/n6758839/c6811124/part/6786067.docx

Chapter 9 Supplementary A

- **Article 36** Whoever violates the provisions of t subject to investigation by CNSA and other aut
- **Article 37** The present Procedure shall come ir publication, and CNSA shall be responsible for

- **Annex**
- Annex 1 Request Application Form of Research Samples: http://www.cnsa.gov.cn/n6758823/n6758839/
- Annex 2 Request Application Form of Samples for Public Activities: http://www.cnsa.gov.cn/n6758823/n675883
- Annex 3 Lunar Sample Loan Agreement: http://www.cnsa.gov.cn/n6758823/n6758
- Annex 4 Sample Return Application Form: http://www.cnsa.gov.cn/n6758823/n6758839/c6



Annex 4

Sample Return Application Form

Unit Name					
Unit Category			Legal Representative		
Unit Address			Contact Information		
Responsible Person for Use		Telephone/Fax		E-mail	
Term of Use	From to (days in total)				
Returned Sample Information	Code: Type: Mass:				
Method of Use	Research	□ Use as-is			
		□ Consumptive use	Consumption		
		□ Destructive use			
	Socially Useful	□ Exhibition and Title:			
		□ Education			
		□ Popular Science			
		□ Others (Description):			
Research/ Socially Useful Objective	Explain the main problems to be solved, the main research objectives to be achieved, and the research significance and meaning				
Use Record					
Explanation					
Research/ Socially Useful					

Chapter 9 Supplementary A

- **Article 36** Whoever violates the provisions of t
  subject to investigation by CNSA and other aut
- **Article 37** The present Procedure shall come ir
  publication, and CNSA shall be responsible for

- **Annex**
- Annex 1 Request Application Form of Researc
  Samples: http://www.cnsa.gov.cn/n6758823/
- Annex 2 Request Application Form of Samples for Public
  Activities: http://www.cnsa.gov.cn/n6758823/n675883
- Annex 3 Lunar Sample Loan
  Agreement: http://www.cnsa.gov.cn/n6758823/n6758
- Annex 4 Sample Return Application
  Form: http://www.cnsa.gov.cn/n6758823/n6758839/c6

Timeline:

-6 months curation and preliminary analysis in GRAS.
-Sample applications from Chinese investigators this summer.
-Proposal Allocation Committee meets several times a year.
-CNSA involved in international allocations.

Annex 4

Sample Return Application Form

Unit Name					
Unit Category			Legal Representative		
Unit Address			Contact Information		
Responsible Person for Use		Telephone/Fax		E-mail	
Term of Use	From to (days in total)				
Returned Sample Information	Code: Type: Mass:				
	□ Popular Science				
	□ Others (Description):				
Research/ Socially Useful Objective	Explain the main problems to be solved, the main research objectives to be achieved, and the research significance and meaning				
Use Record					
Explanation					
Research/ Socially Useful					

Operator: GRAS

Data Release and Information Service System of China's Lunar Exploration Program
(https://moon.bao.ac.cn/index_en.jsp)
Email: lpdc@nao.cas.cn

- **Researcher outside China may use this website to apply Chang'e samples when available**
- **This website has a Chinese and an English version**

Operator: LESEC, CNSA

Yellow texts are translations

Lunar and Deep Space Exploration Scientific Data and Sample Release System
(http://202.106.152.98:8081/moondata/web/datainfo/main.action#)

- Chinese researchers will use this website to apply for Chang'e samples when available
- This website only has a Chinese version

Operator: LESEC, CNSA

Red text are translations

Lunar and Deep Space Exploration Scientific Data and Sample Release System (http://202.106.152.98:8081/moondata/web/datainfo/main.action#)

- **Chinese researchers will use this website to apply for Chang'e samples when available**
- **This website only has a Chinese version**

Extraterrestrial Materials Analysis Group (ExMAG) Spring Meeting
Barbara Cohen, ExMAG Chair. 2/10/21

- 1. Some Myths and Realities.
- 2. Organization of the Chinese Space Program.
- 3. Chinese Lunar Exploration Program (CLEP) context for Chang'e 5.
- 4. Chang'e 5 Landing Site Selection, Global Context, Key Questions, Mission Operations and Sample Return.
- 5. Returned Sample Location, Storage, Preliminary Analysis and Distribution.
- 6. Opportunities for International Cooperation.

Extraterrestrial Materials Analysis Group (ExMAG) Spring Meeting
Barbara Cohen, ExMAG Chair. 2/10/21

- 1. Please provide an update on the ***Chang'e 5 Sample Return Mission.***
- 2. ***What is known of the collection so far?***
- 3. Please provide an ***overview of allocation procedures.***
- 4. Since US federally-funded researchers cannot work directly with China - ***Who outside of China is working with the mission team?***
- 5. We'd also appreciate your thoughts on: ***What NASA might be able to do to enable the US analysis community to collaborate on this sample collection?***

Lunar Sample Policy:
Chinese National Space Administration (CNSA)

国家航天局
China National Space Administration

- January 21, 2021-The China National Space Administration (CNSA) rolled out on Monday *regulations on the management of lunar samples brought back to Earth by the country's Chang'e-5 Moon probe*, which is an important manifestation of China's efforts to carry out practical international cooperation and exchanges on studying the samples.
- The CNSA, together with the Chinese Academy of Sciences (CAS), held the "Access to China's Lunar Exploration Program" activity on Jan. 18, during which *officials from foreign embassies in China and international organizations were invited to visit the lunar sample storage and processing facilities in the National Astronomical Observatories of China under the CAS, the overall unit for the ground application system of the Chang'e-5 mission.*
- The regulations on lunar sample management were introduced to participants in the activity, which were *attended by representatives from France, Russia, the European Union (EU), the Asia-Pacific Space Cooperation Organization (APSCO) and other countries and international organizations.*

人民网 en.people.cn

China-European Space Agency (ESA) Formal Cooperation has been underway for decades

Ultimate Goal of the CLEP

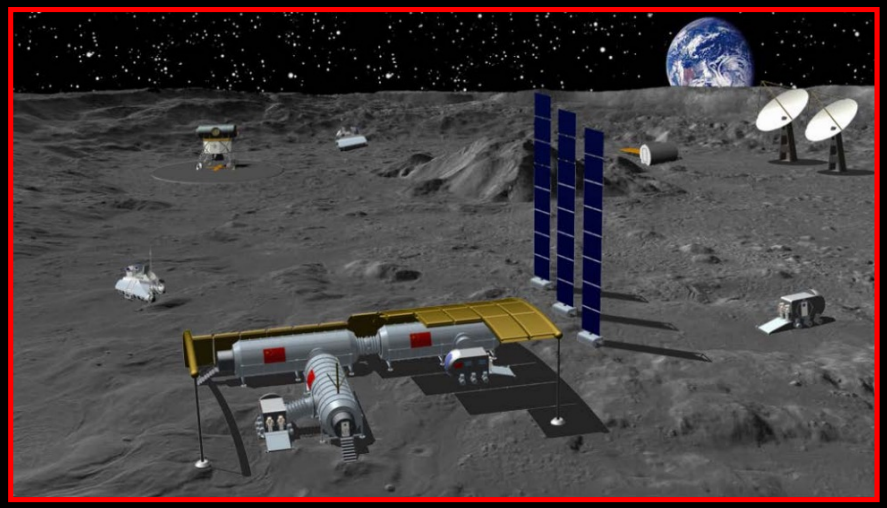
The ultimate objective of the CLEP is to ***pave the way for human missions to the Moon***. Such missions may occur in the 2020s-2030s.

Recent Developments

1. CLEP is designed as an ”international infrastructure enabler”. Enable all countries to participate (kind of an “international infrastructure CLPS program”).

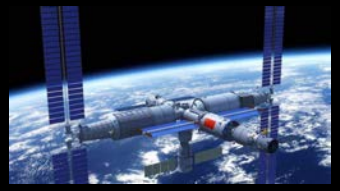
2. China and Russia recently signed an expansive joint lunar exploration agreement.

中国探月
CLEP



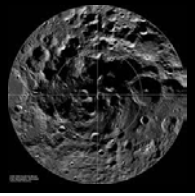
China's Lunar and Planetary Exploration Program

China's Space Station (2020-2023, 11 launches)



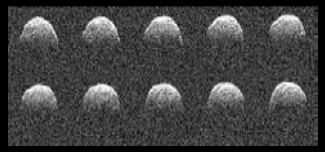
Tianwen-1 (2020, Mars)
Tianwen-? (2028, Mars Sample Return)
Tianwen-? (2030, Jupiter)

Chang'e-5 (2020)
Chang'e-6 (2023)
Chang'e-7 (2024)
Chang'e-8 (Late 2020s)
Human Mission (2030)



Asteroid Exploration

Zhenghe (2024)
Asteroid Sample Return
2016HO3



Quasi-Moon,
Near Earth Asteroid,
40 – 100 m

5. What NASA might be able to do to enable the US analysis community to collaborate on this sample collection?

- NASA/OSTP Restricted from bilateral negotiations/discussions/collaborations with PRC due to Federal Law (Public Law 112–10, Sec. 1340; the "Wolf Amendment"). Initial basis was for technology transfer concerns.
- (https://en.wikipedia.org/wiki/China_exclusion_policy_of_NASA)
- (https://www.spacelegalissues.com/understanding-the-wolf-agreement/)
- Major concern is technology transfer: Sample Exchange does not involve this.
- There are numerous provisions and clarifications: Multilateral are permitted; petition to Congress for specific permissions/exemptions. Etc..
- Recent Developments and Perspectives from my US/USSR experiences:
  - Renewed high-level discussions: US/China Alaska Meeting.
  - Recent Mars Orbiter NASA/CNSA Data Exchange:
  - Artemis Accords.
  - US-USSR Sample Exchange Experience.
  - Cultivate European and Chinese colleagues and consortia for multilateral analysis.
- Think Broadly Multilateral: IACG experience for Halley's Comet; Perfect for Sample Discussions and Exchanges: Explore with NASA SMD, Chief Scientist and Code I.