

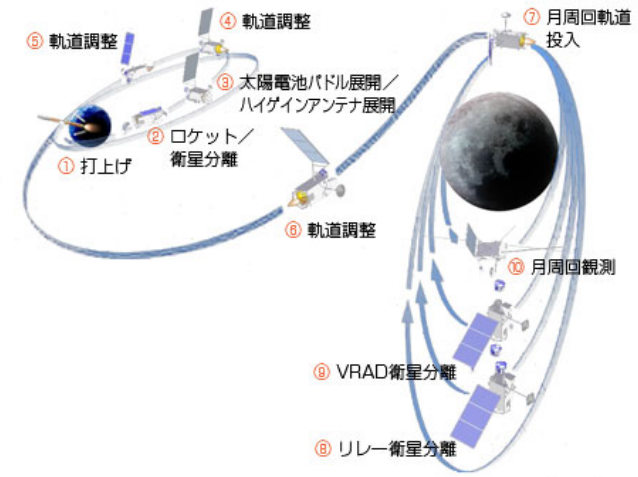
Japan's Lunar Exploration Strategy and Its Role in International Coordination

October 2, 2007

JAXA Space Exploration Center

Kaguya (SELENE) (Launched on Sept. 14th, 2007)

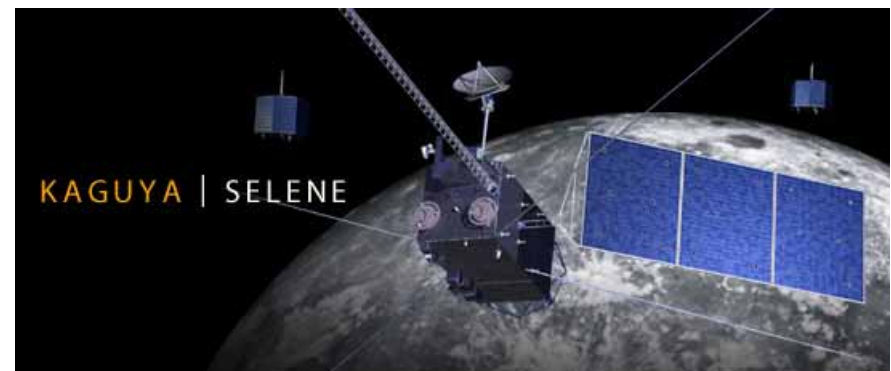
The major objectives of the KAGUYA(SELENE) mission are to obtain scientific data of the lunar origin and evolution and to develop the technology for the future lunar exploration. KAGUYA(SELENE) consists of a main orbiting satellite at about **100km altitude** and two small satellites (Relay Satellite and VRAD Satellite) in polar orbit. The orbiters will carry instruments for scientific investigation of the Moon, on the Moon, and from the Moon.



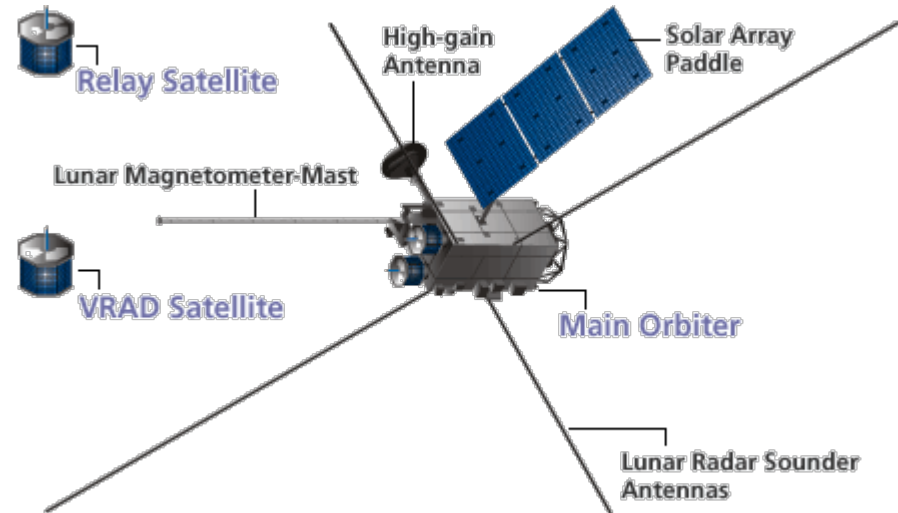
Mission Sequence



Kaguya waiting for launch



KAGUYA smoothly traveling to the Moon



The lunar explorer "KAGUYA" (SELENE) launched by the H-IIA F13 on Sep. 14 from the Tanegashima Space Center is smoothly heading for the moon's orbit with its solar array paddle and high gain antenna successfully deployed.

We will provide updated information on the "KAGUYA" flight through the Special Site including orbit adjustment, separation of the two baby satellites, the Relay and VRAD satellites, and start of the regular observation orbit flight.

(September 27, 2007 Updated)

KAGUYA Flight Schedule Ahead

Event	Date	Time
Completion of the initial checkout and regular observation start.	Mid-December	
Injection into the regular observation orbit and initial checkout of the bus and mission equipment.	Early November	
Injection into the lunar orbit which is the regular observation orbit (at an altitude of 100 km)	October 19	
VRAD satellite separation	October 12	
Relay satellite separation	October 9	
Lunar orbit injection maneuver (LOI1)	October 4	
Period Adjustment Maneuver	September 19	

14 (15) Instruments Aboard

- ❑ X-ray Spectrometer (XRS)
- ❑ Multi band Imager (MI)
- ❑ Terrain Camera (TC)
- ❑ Laser Altimeter (LALT)
- ❑ Charged Particle Spectrometer (CPS)
- ❑ Radio science (RS)
- ❑ Four way Doppler measurements by Relay satellite and Main Orbiter transponder (RSAT)
- ❑ High Definition Television (HDTV)
- ❑ Gamma Ray Spectrometer (GRS)
- ❑ Spectral Profiler (SP)
- ❑ Lunar Radar Sounder (LRS)
- ❑ Lunar Magnetometer (LMAG)
- ❑ Plasma energy Angle and Composition Experiment (PACE)
- ❑ Upper-atmosphere and Plasma Imager (UPI)
- ❑ Differential VLBI Radio Source (VRAD)

KAGUYA (SELENE) Successful Image Taking by the High Definition Television (HDTV)

- JAXA and NHK (Japan Broadcasting Corporation) have successfully taken high definition moving images through the KAGUYA (SELENE) for the first time.

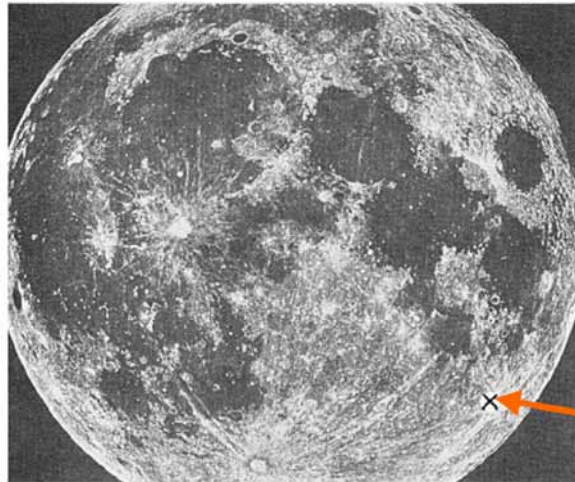
The images were taken by the KAGUYA's onboard High Definition Television (HDTV), which was developed by NHK for space use. It is the first high-definition image shooting of the Earth from so deep in space - about 110,000 km away from the Earth - in human history.

(October 1, 2007 Updated)



Japan has already had Two Lunar Orbiters and A Hard-Lander

- In 1990 and 1992, 'Hagoromo' and 'Hiten' were placed on the orbit around the Moon.
- In 1993, 'Hiten' was made a Hard-Landing on the Moon.
- **Kaguya (SELENE) makes the most in-depth Lunar Exploration since Apollo.**

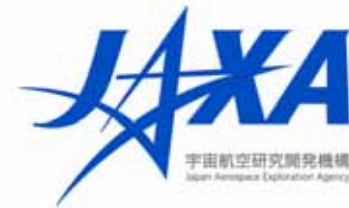


Impact image taken from
Australian observatory

Landing point

Hiten Lands on the Moon on April 10th, 1993

Status Regarding 'Exploration' at JAXA

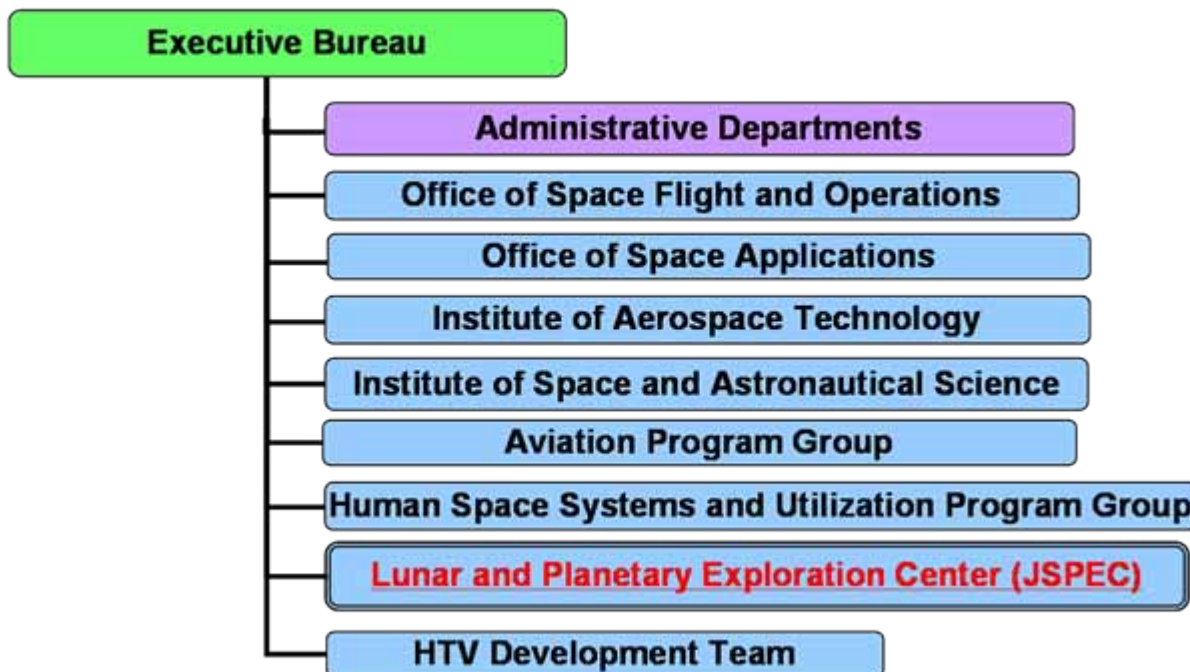


- JAXA built its Lunar and Planetary Exploration Center (JSPEC) this April.
JSPEC is doing not only the moon but planetary exploration encompassing from science to so-called exploration.
- Science WG under SAC (Space Activity Commission, J.gov) concluded and made a recommendation the Japan's Lunar and Planetary Exploration to be performed in Programmatic Manner at a certain interval. (Jan. 2007)
- Solar Exploration Road Map was completed.
- The Lunar Architecture Study at JAXA was preliminary done.
- Lunar Exploration WG under SAC (Space Activity Commission, J.gov) was established and started the strategic discussion in government level. (Sept. 2007)
- JAXA will start its next 5-year plan from 2008.
Any of the projects starting this period needs to commence the Phase-A study now and relevant teams were established.

JSPEC (JAXA Space Exploration Center)



- Elaborate **strategies** of science and technology, **program** planning and promotion of Space Exploration activities through domestic and international collaborations.
- Specific **R&D** activities for engineering and science
- **Development**, operation and other related activities for spacecraft
- **Research** and analysis of scientific and technical aspects for future missions



Principle & Objectives for Space Exploration JAXA thinks

Principle for Space Exploration

Achieve lofty themes such as expansion of human activities and contribute to evolution of civilization.

(1) Strategic & Political Objectives:

- To contribute and sustain to the **nation's economy and industry growth** to commensurate with its position in science & technology,
- To **expand human activities** as a stepping stone to Mars and beyond,
- To **foster human resources** of next generation for science and technologies in future.
- To contribute and formulate international collaboration and framework,

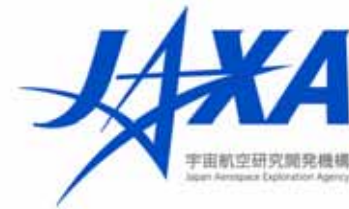
(2) Objectives from Technology and Innovation Point of View:

- To **develop fundamental systems skills** such as landing, return, mobility, etc enabling autonomous and perfectly controllable missions.
- Through the challenges, to **induce technological innovation and to promote spin-offs** so as to bring welfare and evolution to society.

(3) Objectives from Science and knowledge point of view :

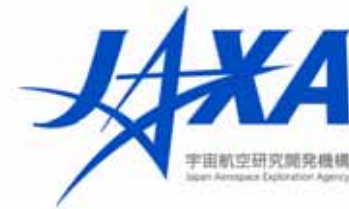
- To **lead the top science, and to obtain new knowledge**, and to contribute for the creation of new culture,
- To investigate the environment **for full scale manned exploration to the moon and beyond.**

Exploration or Science ?



- JSPEC/JAXA looks at both Exploration together with Science Missions.
- JAXA's Exploration includes :
Moon, Mars and NEOs,
Plus
Primitive Bodies, and Atmospheric, Plasma and Surface Missions.
- JAXA intends to contribute to coordination bridging between Exploration and Science.
Existing mechanism:
ECG-GES team activity among agencies.
with IMEWG, ILEWG, COSPAR....

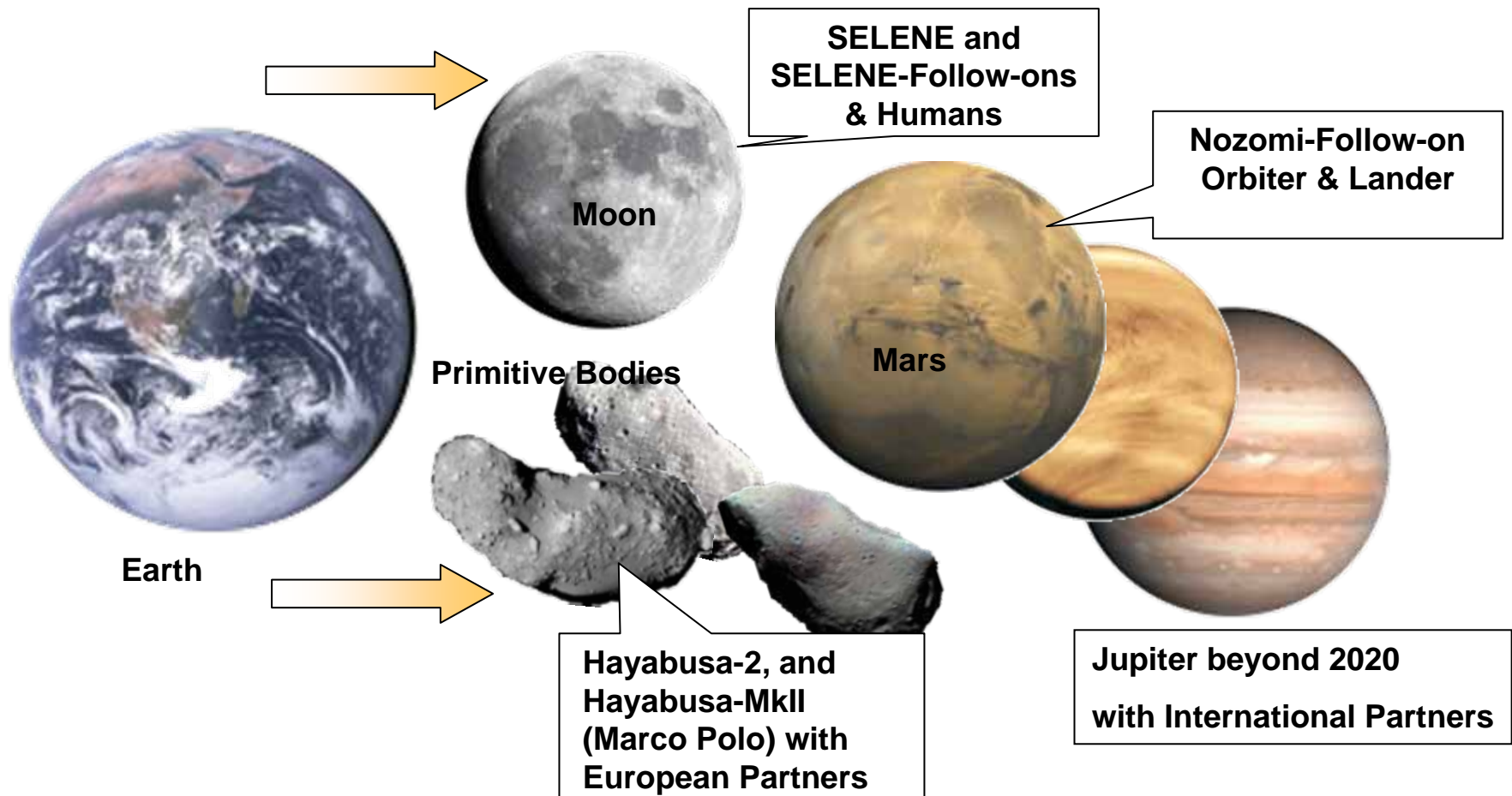
JSPEC/JAXA Initiative for Solar System Exploration



Concentrates to:

Primitive Bodies Exploration, and
Planetary Environmental Exploration

Putting each Mission in Programmatic way every several years.



As to the Lunar Exploration Status at JAXA

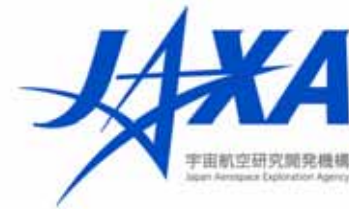


JAXA completed the MDR (Mission Definition Review) for the SELENE-2 this July, and established the Phase-A study team, aiming at the launch in 2012-14.

The special WG on the Lunar Exploration under SAC (Space Activity Commission, J. gov) was established and started the program strategy discussion from this September, and will have a report in November.

Here is shown JAXA's strategy as to the Lunar exploration:

JAXA's Moon Exploration Strategy



Lunar Exploration Program :

leading to International Cooperation, Discovery and Innovation

- Robotic Lunar Missions:

Until the middle of 2010s, in-depth scientific measurements and utilization.

- Human Lunar Missions:

Autonomous missions with its own objectives, making use of humans related technologies.

Pursuing the Japanese astronaut on the moon as early as possible in international activity to commensurate with its international status.

Lunar Surface activity by Japan's own space systems awaits for the governmental decision in the middle of 2010s.

Robotic Lunar Missions concentrate:

- Untrodden, New Missions.
- Establish Technology Means to contribute international efforts.

Human Lunar Missions concentrate:

- The Japanese astronaut on the surface for human in-situ operations, to distill experience for further destinations.

**Robotic Lander
for Surface Exploration**

**Japanese Astronaut on the Surface
among International Crews**

SELENE-2 (plan)

- Launch : 2012-14 by H2A (or H2B) rocket
- Total spacecraft mass :
4000 - 2000 kg (Wet)
- Lander including rover (ca 100 kg) :
500 -1,000 kg (Dry)
- Orbiter for communication relay (TBC)
approx. 100kg
- Landing area
such as Quasi- eternal sun-lit area
in polar region, or some other locations
- Mission life (Lander)
one month at least



SELENE-X Under Study (Examples)

Appears in late 2010s, in view of the Japan's participation in Humans Lunar Activity foreseen:

SELENE-X may perform either of the following demonstrations.

- **Option-1 : Technology Demonstration for Building Outpost
Excavation, ... Construction of Infrastructure**
- **Option-2 : Logistics Capability Demonstration
Building Common Landers for both Transportation and
JAXA's own robotic missions.**
- **Option-3 : Highly sophisticated In-situ Robotic Lander
or Returning Sample of the Surface Soil to the Earth,
including the Development of High Speed Reentry Capsule.**

Excavation



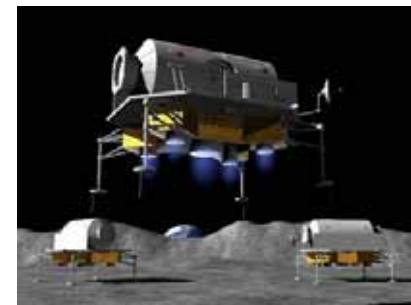
Drilling



Logistics



Common Landers



Japan's Humans Lunar Mission (2020 or beyond)



Global space exploration views

- Humans Lunar Exploration and to the Mars and beyond.
- Humans exploration is a fundamental character toward the lofty expansion of its sphere of activity toward advancing the culture.

Significance of Human Exploration

- An **ultimate in-situ operation and observation** beyond robotic capability,
- Japan shall make its **active contribution** to acquiring the human related technologies,
- And shall play a key and **appropriate Governance role** in lunar exploration.

Japan's policy as to the Humans Lunar Mission

- Having an astronaut be present on the surface as an international crew member,
- And may start its independent humans lunar mission if the government acknowledge and identify its significance.
- Toward it, Japan will nurture and accumulate human-related technologies through JEM/ISS and HTV.

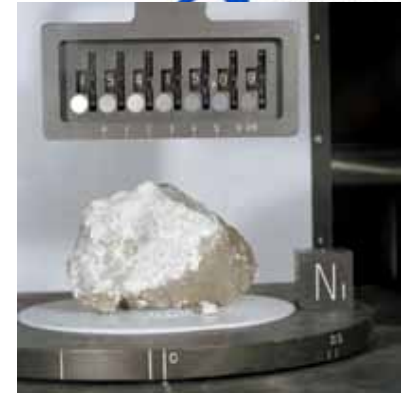
Ultimate Human's Capability Example



Genesis Rock (Apollo 15)

The Genesis Rock proved to be a chunk of anorthosite, part of the original lunar crust and older than any Moon rock previously found. This one rock helped revolutionize ideas about lunar formation, and gave us new insights into the age of the solar system.

For the first time, the astronauts were extensively trained as geologists and could make scientific observations, both on the surface and from orbit.



Genesis Rock

Seatbelt Basalt (Apollo 15)

As they were driving along Scott spotted a piece of basalt that looked different to anything around it and decided to pick it up for the collection. It was sitting out there, all by itself with no other fragments around. Very vesicular; very black and rounded. Scott felt, "That one, I could not pass up. It was just too different." Knowing Houston would not agree to their stopping to pick it up, they pretended they were having trouble with their seatbelts, when in actual fact Scott had stopped the Rover to pick up the sample. It was a scoriaceous basalt with lots and lots of vesicles, or bubbles, and was nicknamed the 'seatbelt basalt.'

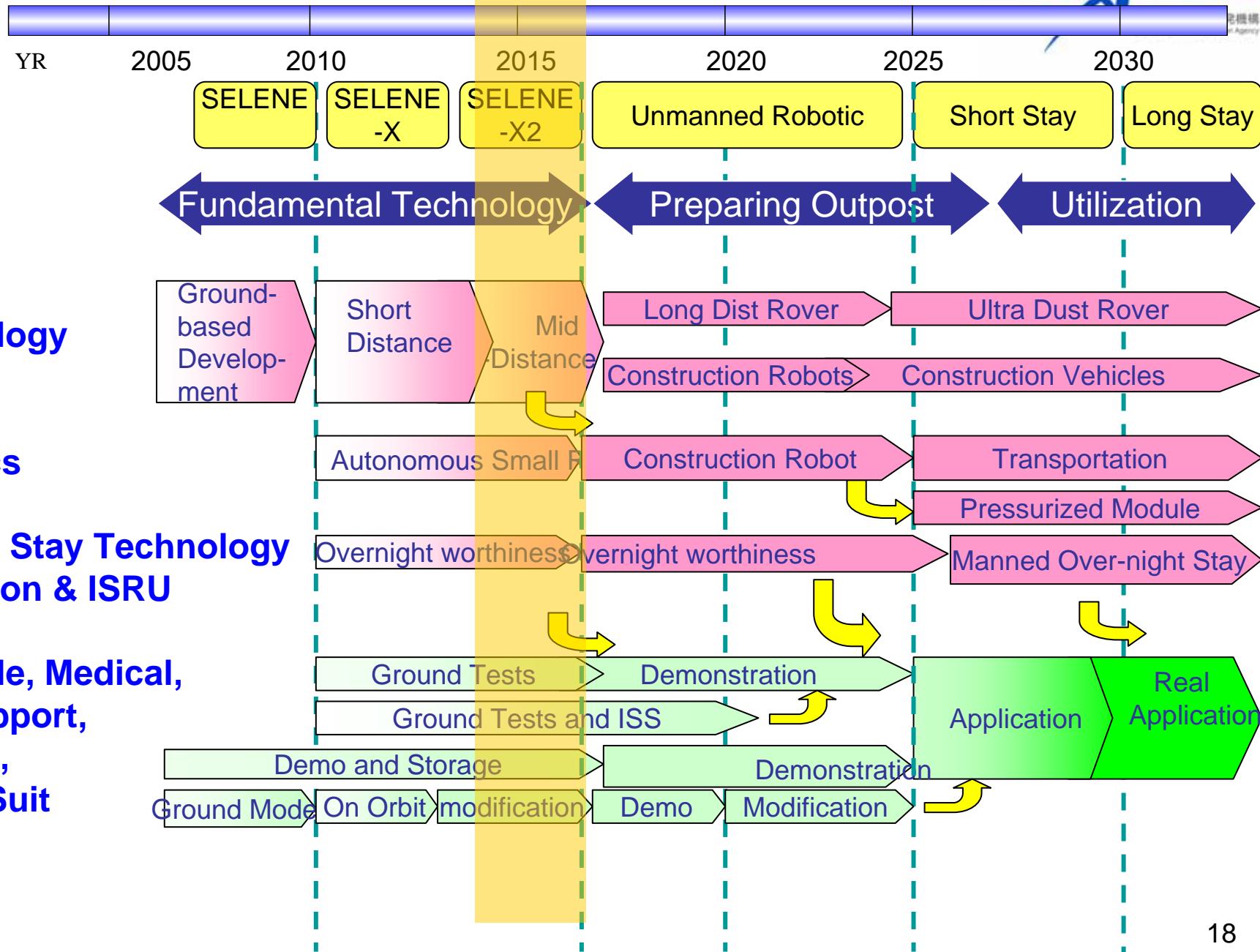
Orange Soil (Apollo 17)

Scientist-Astronaut Harrison J. Schmitt discovered the orange soil at Shorty Crater. The orange soil is probably of volcanic origin and not the product of meteorite impact.



Orange Soil

JAXA's Technology Development Roadmap for Moon



Summary of Strategy



1. Principle of Lunar Exploration

- Strategic Objectives including international contribution, attributing Japan's sustainable evolution, and education of next generation.
- Technology development and innovation
- Science and knowledge

2. SELENE Program

Up to the middle of 2010 decade, technology demonstration, science observation, investigation for utilization will be thoroughly done by robotic exploration program, "SELENE series".

3. Foster Human Exploration Technologies

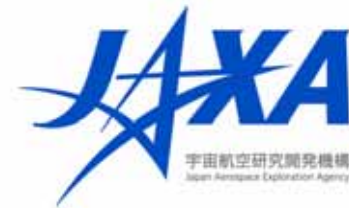
Key technologies for human exploration will be developed and demonstrated gradually through SELENE series, ISS/HTV, etc.

4. Japanese Astronaut participation

As a leading country in lunar exploration and space development, participation of Japanese Astronaut in the international human lunar exploration is strongly craved.

Payload Exchange opportunity (Code-Share Payload Concept)
& Data Archiving/Analysis Facility
As concrete example for coordination way

ECG/GES Workshops



- There have been a variety levels of coordination discussion deployed by now.
- The process proposed here may be performed by the 'ECG' with some secretariat functions.
- The platform and secretariat of the ECG may work toward this proposal.
- However, honestly, a bit skeptical about the organizational discussion such as 'Terms of Ref' that has started, while the basic cooperation/coordination function is not seen yet.

Ways seen for Coordinated Exploration



- There are two ways in Coordination :
 1. Restricting exploration missions performed at each nation/organization more or less to be done 'collaboratedly' or in 'coordinated-manner way',

or

2. Leaving autonomous missions at each nation/organization, while encouraging and facilitating those to take part in the coordination mechanism.

I support the method 2.

It is the cooperation promotion process for peaceful co-existence, rather than coordination process.

ICM (International Coordination Mechanism) Organizational References



1) GEOSS type - A Certain Binding

Program of Programs (System of Systems)

Permanent Secretariat

Earth Observation fits for this. Regional Responsibility.

2) Conference type - No obligation. No binding.

Joint Statement. Weak.

3) COSPAR / IAA / IACG type - Less binding.

Indication via Resolution.

Recommendation to Member Countries & Organization. Weak?

4) ISS type - Legal Binding

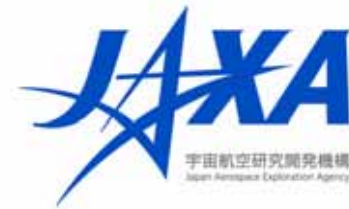
Single Program, Not welcome?

5) CCSDS type - No obligation. Bottom-Up approach.

Merit-driven Binding. No resource flow is assumed.

A Proposal as to ICM and INSECT

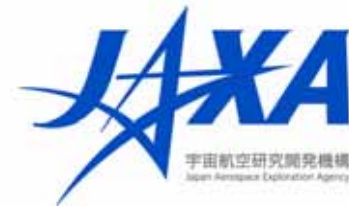
* INSECT (International Space Exploration Coordination Tool)



- Had better be a **Give & Take mechanism with certain merits**,
- Any Exploration mission shall **spare a certain payload portion** to be coordinated/selected as ECG payload ('**code-share**' payload). How ECG payload is shared and allotted is under ECG resolution.
- **Contribution measure** to the ECG shall be defined to indicate the effort, and may be used for ECG payload selection as credits ('**Mileage**').

This process allows any agency/organization to take part in the Exploration without having actual means.

Proposal



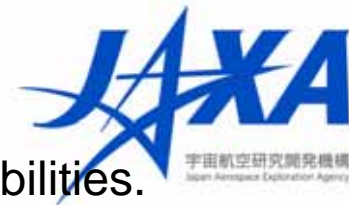
ICM : to be a 'Merit-Driven Mechanism',

INSECT: to solidify Merits through ECG acknowledgement such as credits.

How:

- Introduction of 'Code-Share Payload' as a kind of INSECTs (Actual Tools).
Any Exploration shall spare some 'Code-Share Payload'.
To be selected and adjusted based on the Credits like 'Mileage'.
- 'Mileage' shall be credited, in case
An agency/organization **contributes to ECG** is given some credits,
even on the ground: such as building IPDA, ground networks/infrastructure, etc.
If an agency/organization who **spares 'Code-Share Payload'** shall be given some
credits for ECG Payload or Non-Flight Exploration Resources bartered:
such as the right of having researchers more at the ground archiving facilities
related, and so on.
- ECG will build **relevant facilities** assisted by the participating
agencies/organizations, so that the they can function and be used for members.

What is 'Code-Share Payload' ?



- 1) What is not afforded by a single agency in terms of resources, capabilities. What each agency may boast it is the agency's payload, even in the case the agency does not have actual flight capability.
- 2) Not an AO process but P/L's Volume & Mass to be intentionally reserved / left for the collaboration (ECG) that facilitates the purposes of the ECG. May be called as 'ECG Payload'.
- 3) For the ICM, this 'Code-Share Payload' acts as:
Not legal & bureaucratic bindings but Science & Technology 'Merit-Based bindings', with relatively loose constraint with less bureaucratic agreements.
- 4) ECG to find / coordinate P/L's resources for those agencies who have contributed to the ECG. The measure shall be established as credits ('Mileage').
- 5) ECG organization to request the agencies who perform their own Exploration missions to leave some portion of the P/L Volume & Mass (resources).
- 6) A certain I/F to be standardized for 'Code-Share Payloads' to comply the inter-operability guideline that ECG activity to define.

ECG Payload & Data

Each Agency or Organization

(Member ECG)

Members with Flight Capabilities

Members with no Flight Capabilities

Credits (Points or Mileage): given when members contribute to accumulation of the ECG capital.

Contribution



Credits

Award Req.



Award:
Payload Opportunities,
or
Research/Data Right

ECG (Exploration Coordination Group)

Capital:

Payload Volume & Mass contributed from Member Agencies,

Research/Data Access Facilities & Resources contributed from Member Agencies.

Merits expected through the process



- For Developed agencies/organizations:
merit: their missions not restricted but acknowledged with the expense for providing opportunities to others.
- For Developing agencies/organizations:
merit: their missions opportunities can be coordinated and provided with the expense of contributing efforts to ECG activity.

JAXA will try to show the way toward this proposal;



- JAXA will try to make SELENE-2 to be an Example that can show
‘Exchange of the Payload Opportunities’
and
the ‘Data Archiving’ activity with international partners.
- May discuss together with the ‘ECG’ initiative soon.
JAXA expects this function to be looked at ECG.
- JAXA is for ECG (‘Exploration Consultative Group’) consisting of destination-discredited WGs plus Strategy & Planning sub-groups.

**International Space Exploration Workshop
Kyoto, Japan
7 - 9 March, 2007**



JAXA's Role in ECG ('Exploration Coordination Group')



- JAXA will host next Exploration ECG-GES meeting next January (Jan. 15-17) in Okinawa, Japan.
- It accompanies the IPEWG (International Primitive Bodies Working Group meeting) and the discussion on the Data Archiving, Sharing and Distribution mechanism (Discussing how science data in Exploration are archived and accessed to scientists community, in relation to IPDA activity.)
- JAXA has proposed a 'Code-Share Payload' concept among the agencies, and it will encourage the payload opportunities exchanged among agencies.

JAXA welcomes Collaborative Missions with International Partners for Lunar & Planetary Exploration missions.

