

# *SMART-1 input to breakout sessions*

- **Data archiving**
  - ESA PSA Planetary Science Archive (PDS)
  - Ongoing data calibration and validation
  - Early access to data on collaborative basis
- **Lunar mapping and data merging**
  - Ongoing effort with space agencies and European Geological Surveys
- **Lunar coordinates**
  - Mismatch old Clementine reference (eg 4km W)
  - Insufficient lunar grid & topography model
  - Corrections to achieve SMART-1 impact within 1 s
  - Agree with LRO coordinates white paper

# SMART-1 *input to breakout sessions*

- **Calibration Targets**
  - Observed for imaging, infrared and X-ray spectrometry
  - Instruments & space/ground intercalibration
  - Support Int'l Calibration targets effort (COSPAR, ILEWG)
  - Link with sample ground truth
- **SMART-1 collaboration with upcoming missions**
  - Feed forward, experience and data

([www.esa.int](http://www.esa.int) & [sci.esa.int/smart-1](http://sci.esa.int/smart-1), [sci.esa.int/ilewg](http://sci.esa.int/ilewg))

# Cooperative Scientific Opportunities

- Overall science and exploration goals
- Measurements objectives
- Observations conditions & SMART-1 planning tools
- Spacecraft and data download constraints
- Measurements modes
- Establish Targets lists and goals descriptors
- Specific actions on impacts (LCROSS, Selene, ...)
- Specific actions and future landing sites

# SMART-1: Science Exploration Themes & SubThemes

A) TECHNOLOGY DEMONSTRATION

B) CRUISE PHASE NAVIGATION, TECHNOLOGY AND SCIENCE

C) *HOW DO EARTH-LIKE PLANETS WORK?*

GEOPHYSICS: volcanism, tectonics, cratering, erosion, space weather , ices

D) *HOW DO ROCKY PLANETS FORM AND EVOLVE?*

GEOCHEMISTRY: chemical composition, Earth-Moon origin, Moon evolution  
accretion and collisions, giant bombardment

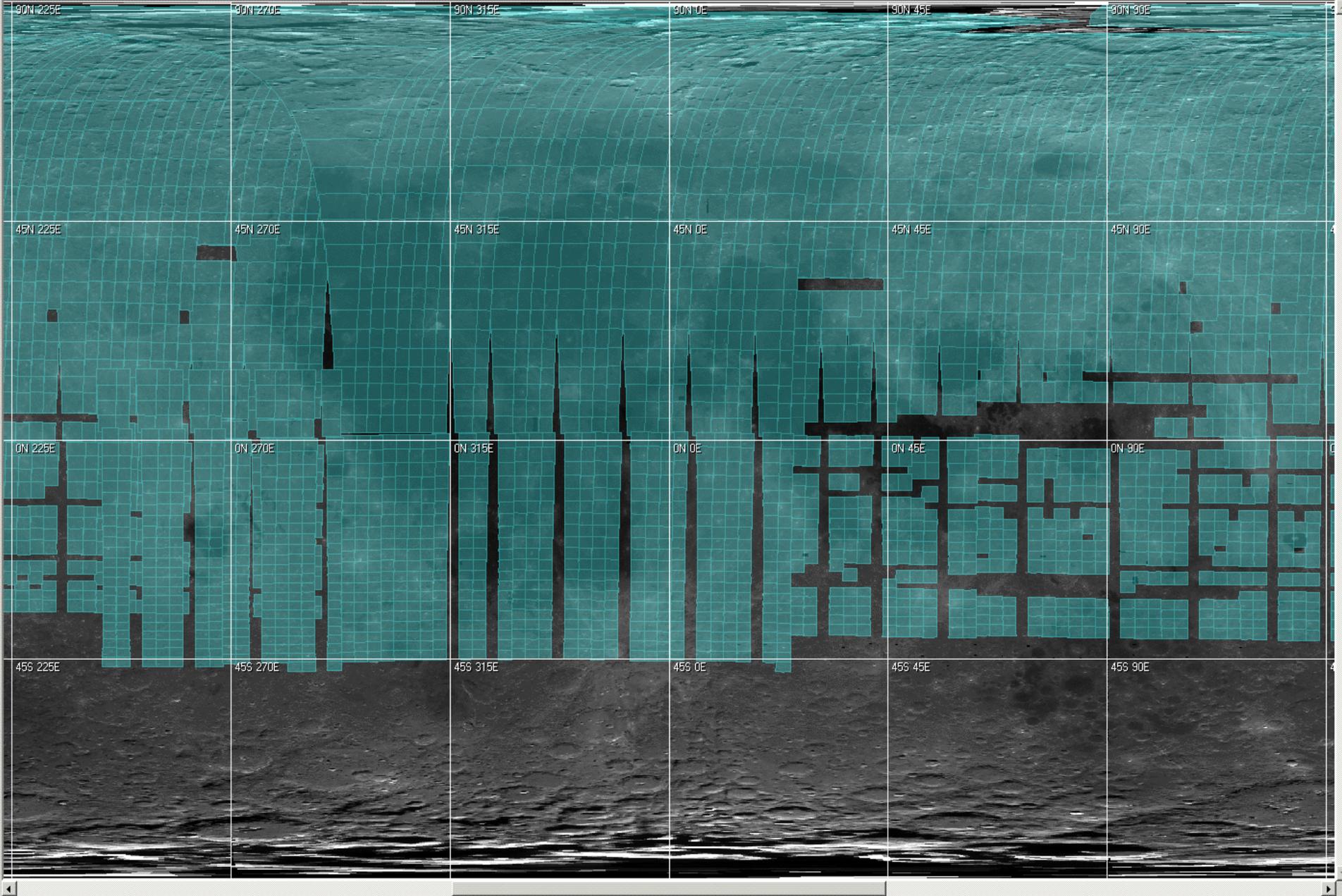
E) PREPARING FUTURE LUNAR/PLANETARY EXPLORATION

LUNAR RESOURCES SURVEY (minerals, volatiles, illumination)

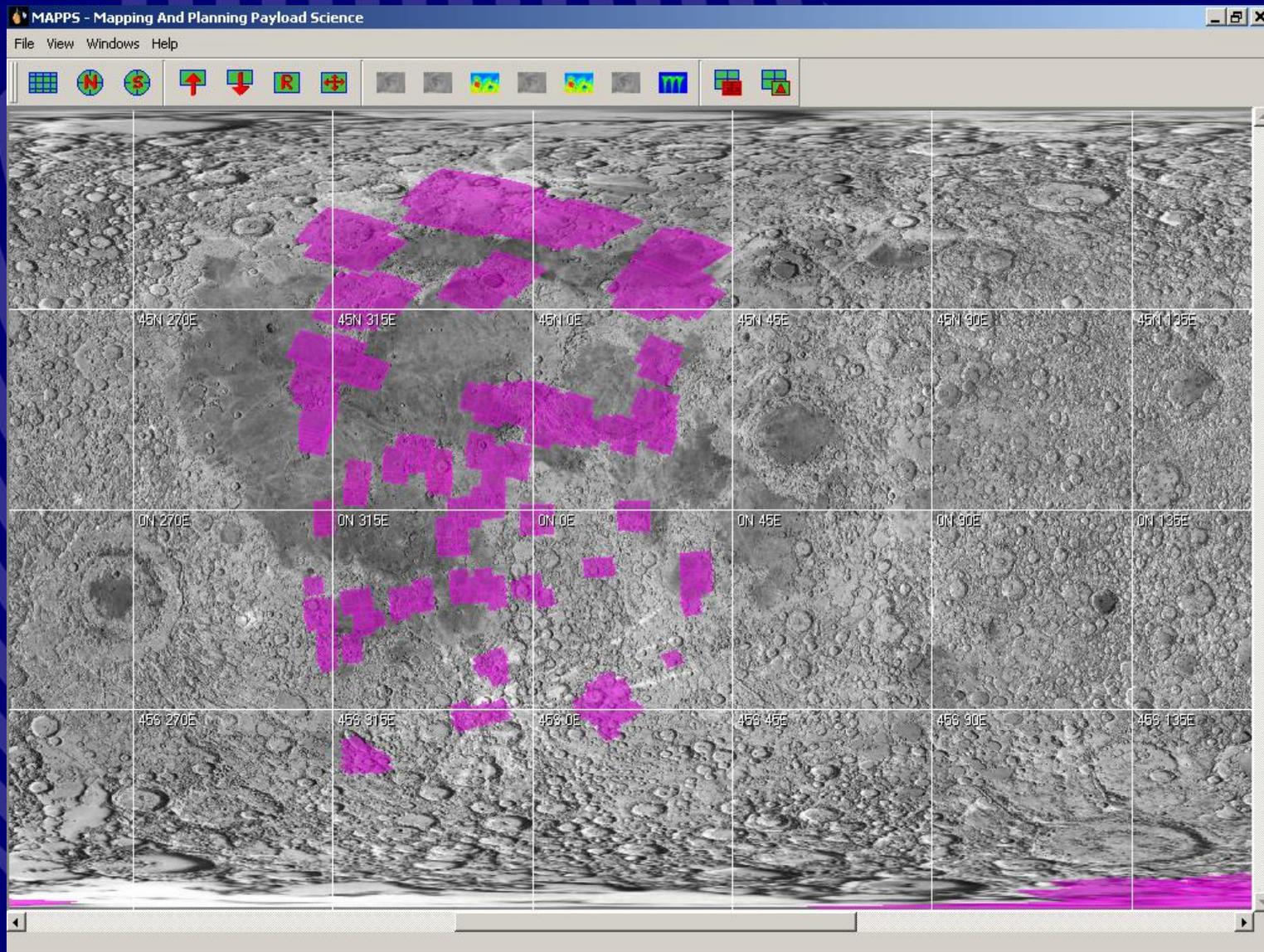
HIGH RESOLUTION MAPS for future landing sites and outposts

SUPPORT TO FUTURE EXPLORATION and coordination with other missions

F) PUBLIC OUTREACH, INSPIRATION AND EDUCATION



# SMART-1 AMIE Coverage Week 2, January 2006



# Peaks of eternal light in northern winter

200 km

Far side

eternal peaks of light →  
North pole →

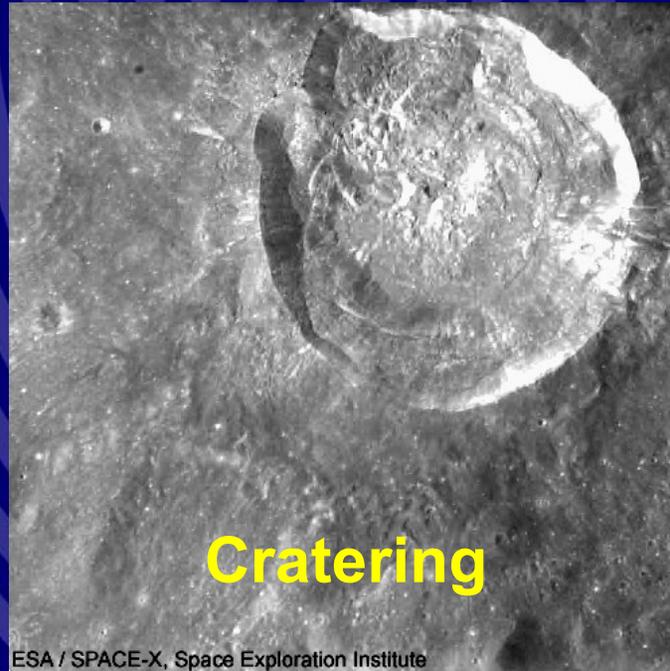
Near side



# What shapes rocky planets?

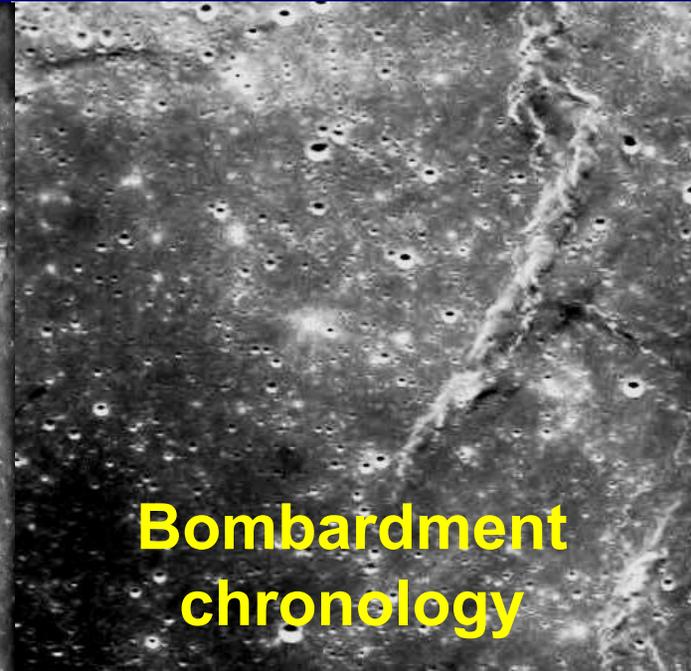
*Moon  
laboratory  
for Geophysics*

**Erosion,  
Polar volatiles**

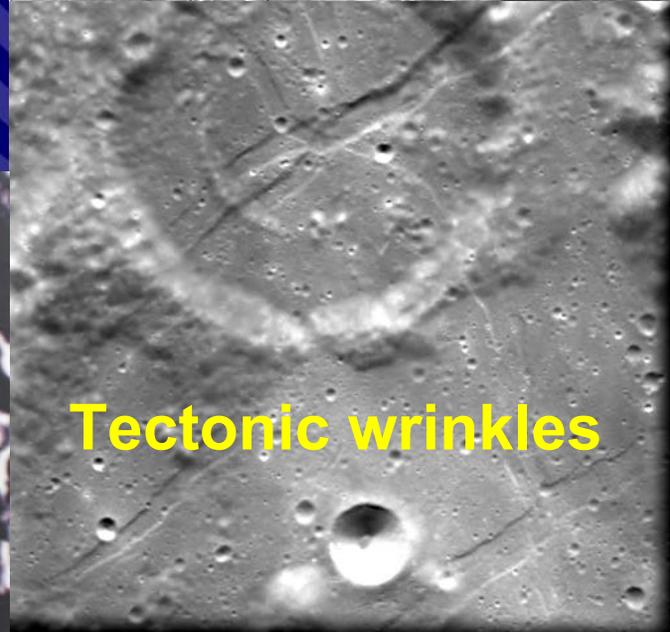


**Cratering**

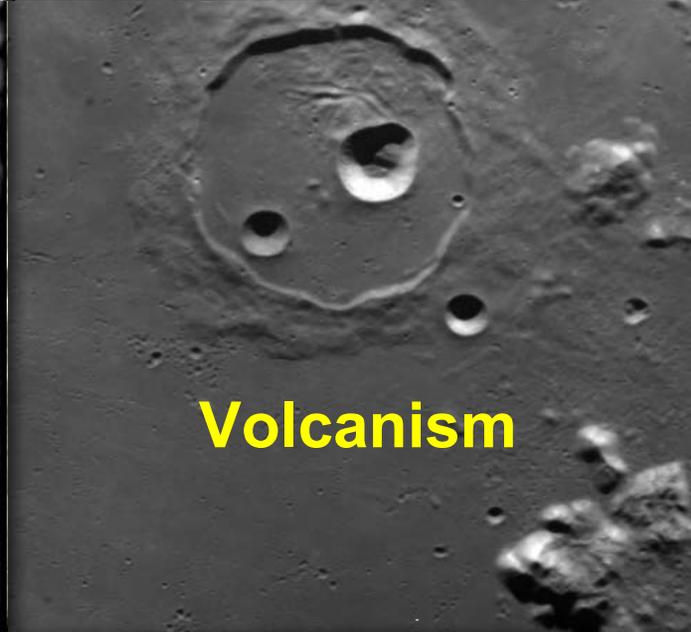
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**Bombardment  
chronology**



**Tectonic wrinkles**



**Volcanism**



15 km

# Ground /Remote truth & Preparing for Future Exploration

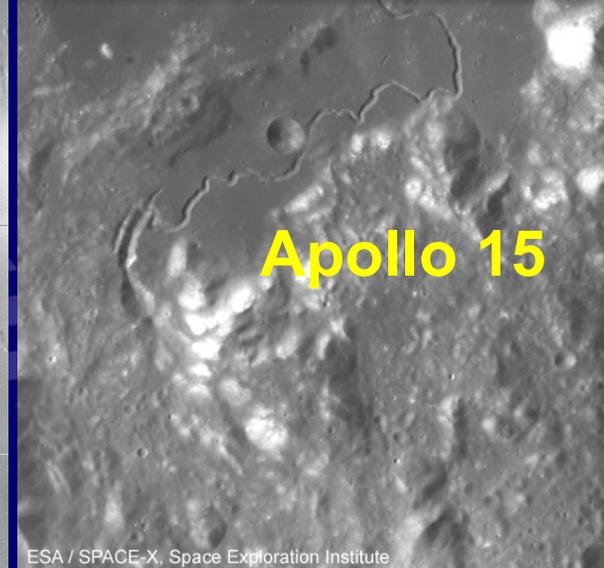
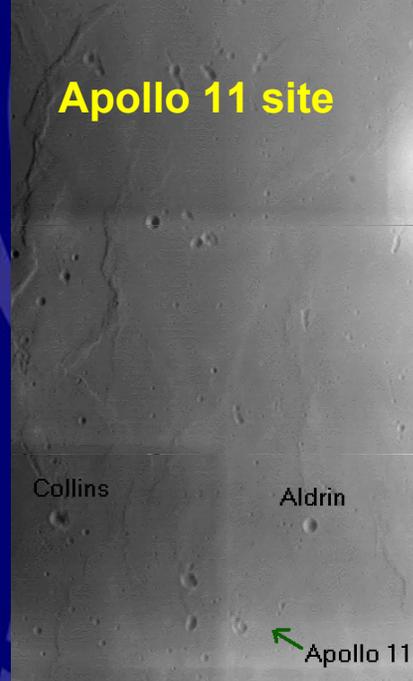
## Science data analysis and reconnaissance

- How do rocky planets work
- Earth-Moon formation
- Past and future landing sites

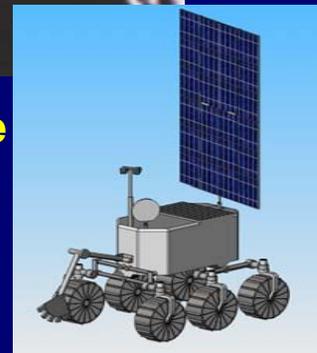
## Resources: minerals, light, ice

## Peaks of eternal light, shadows & illumination monitoring every 5 hours

## Maps for future landers, rovers, human bases



Peak of light near North pole



# SMART-1 collaboration with upcoming lunar missions

- **Science/exploration:**

- Earth-Moon formation & evolution
- water ice and resources
- conditions for future sciences & life
- sites for future robots/humans

- **SMART-1 precursor for future missions fleet**

2007 Chinese Chang'e 1 (science exchange & support)

2007 JAXA Selene (science exchange & support)

2008 Indian ISRO Chandrayaan-1 (3 ESA instruments)

2008 US Lunar Reconnaissance Orbiter/LCROSS

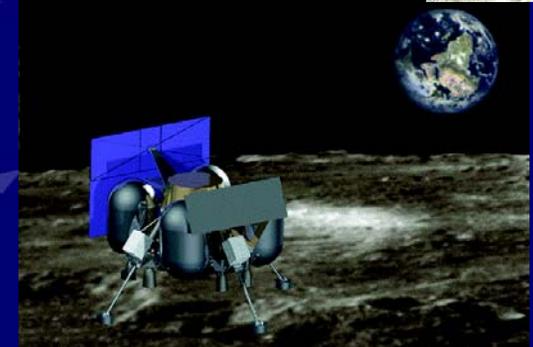
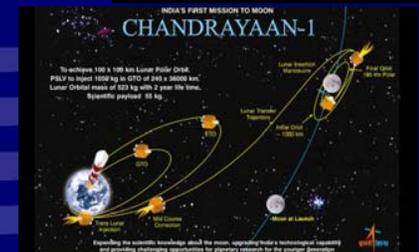
2009 JAXA Lunar A penetrator

2010-2012 landers, rovers, technology testbeds

(US, China, Japan, India, Europe)

**Sample return missions**

**Preparation for human lunar missions**



# International Science Coordination/ Calibration targets

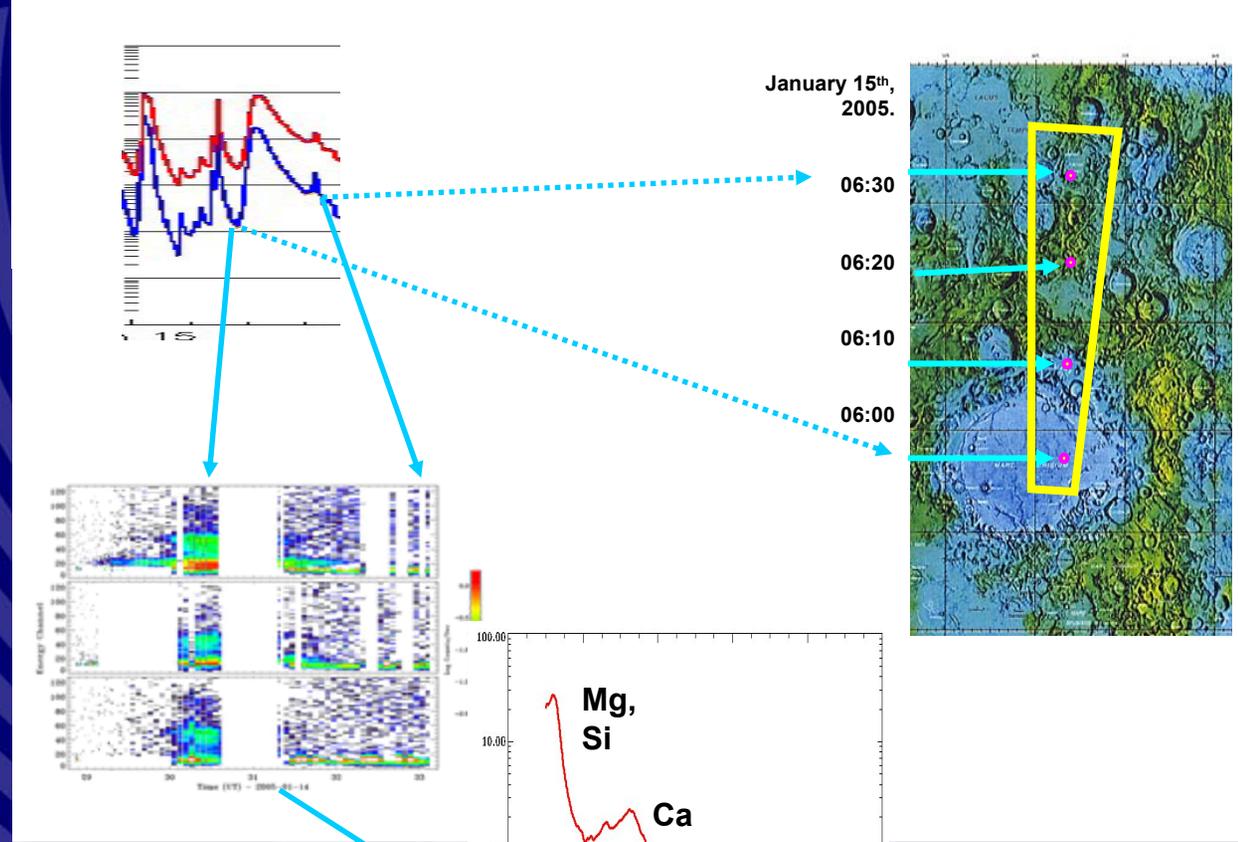
- Overall science and exploration goals
- Measurements objectives, modes & specific calibrations
  - Imaging
  - Spectrometry
  - Microwave
  - High energy (X Fluorescence, gamma Ray)
  - Time varying conditions
  - Solar and Space radiation standards
- Observations conditions, solar illumination angle
- Methods and procedures for calibration
- Ground based observations
  - multi wavelength, intercalibration
- Coordination Time critical Calibration Observations

# International Science Coordination/ Calibration targets

- Targets lists and descriptors
- Core calibration targets (agree with recommendation COSPAR/ILEWG)
- Specific calibration actions on past and future landing sites (ground truth)
- Secondary calibrations targets
  - Polar calibration repeated targets (straylight, )
  - Use of Sun, Earth, Standard Stars for Calibration
- Landing site candidates
  - science, exploration interests, safety, access
- Size of targets vs homogeneity and instruments FOV

The Sun shines X-rays

The Moon glows  
→ D-CIXS



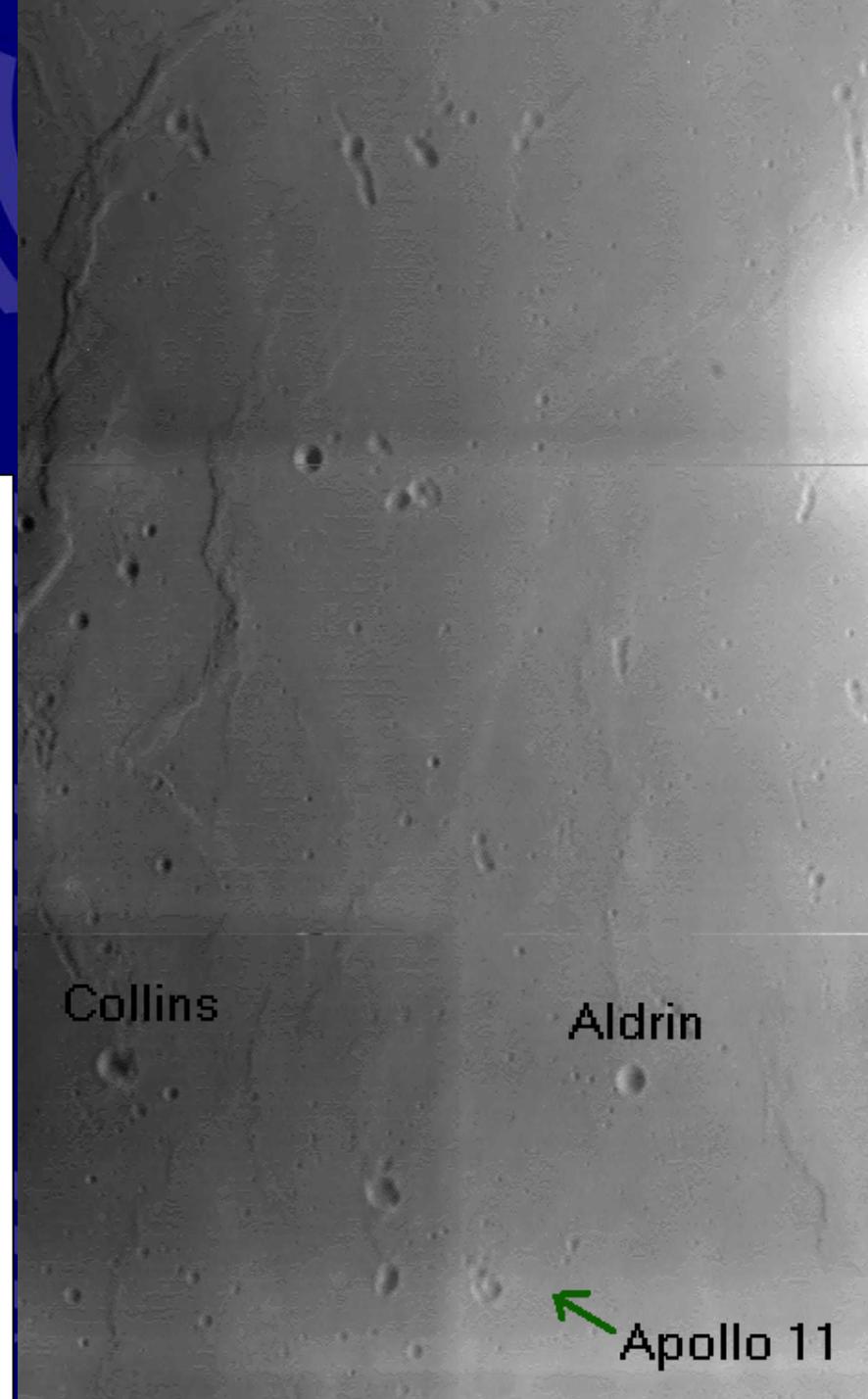
Derived elemental composition

1<sup>st</sup> detection of Calcium and Magnesium ,  
comparison Luna 24 samples

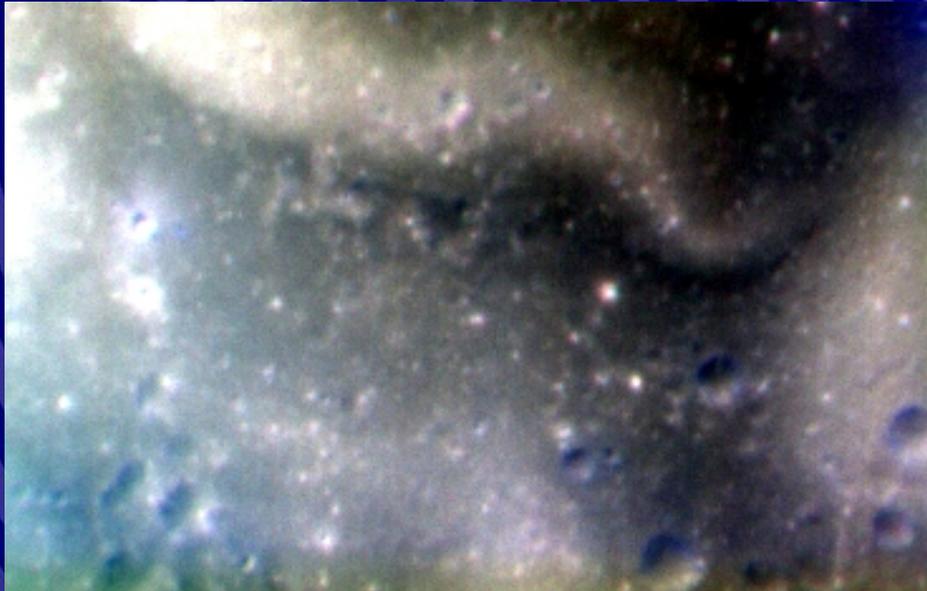
( D-CIXS) Planetary Space Science, in press

SMART-1 survey  
of Apollo 11 landing site  
20 July 1969  
37<sup>th</sup> birthday card release

- Apollo 11
- Long 23.9 lat 1.7
- Orbit 1888
- 5 Feb 2006
- Distance 1764 km
- FOV 80 x 120 km



# AMIE Colour results Orbit 1438

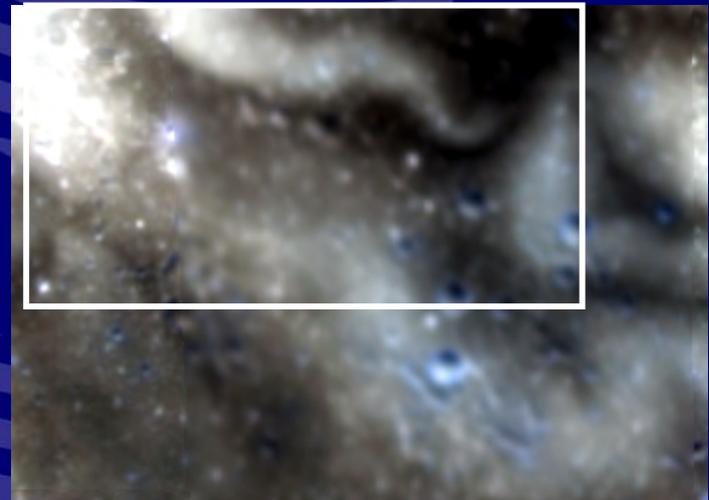


AMIE colour image

Reiner gamma

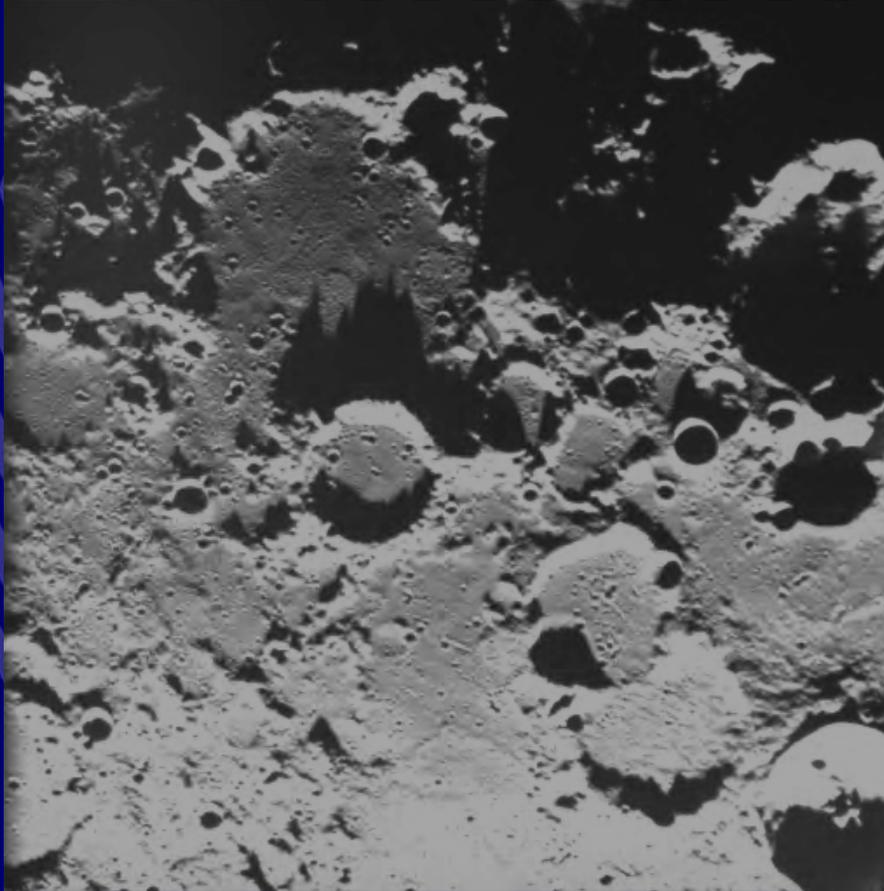


Clementine



# North polar winter shadows variations: near side around Byrd crater

29 Dec



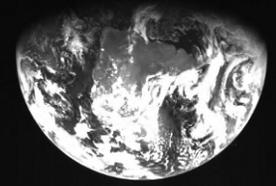
19 Jan



# Part of Hopmann crater at edge of South Pole Aitken Basin: search for anomalous composition material



# **SMART-1 Media and outreach**



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## **SMART-1 websites**

- **ESA Public corporate PR [www.esa.int](http://www.esa.int)**

Google “SMART-1” 2.5 Mega-quotes

PR multimedia products--> thousands of News articles,

- **SciTec SMART-1 website [sci.esa.int/SMART-1/](http://sci.esa.int/SMART-1/)**

60 webstories, image gallery (hundreds of images),  
publications , conferences, resources

- **ILEWG website <http://sci.esa.int/ILEWG>**

lunar calendar, link lunar missions, lunar website resources,  
EPO task group and Young Lunar Explorers

# ***SMART-1 Media and outreach***

## ***Messages:***

- **Smart Technology (electric propulsion, miniaturisation)**
- **Launch, Journey from Earth to Moon on 60 l fuel**
- **Why the Moon?**
  - Origins, Earth's daughter, planetary laboratory, future**
- **Engaging Public: Europe to the Moon**
- **Lunar results & achievements**
- **SMART-1 Precursor to future lunar exploration**

# The Moon as a planetary education tool: What shapes rocky planets?

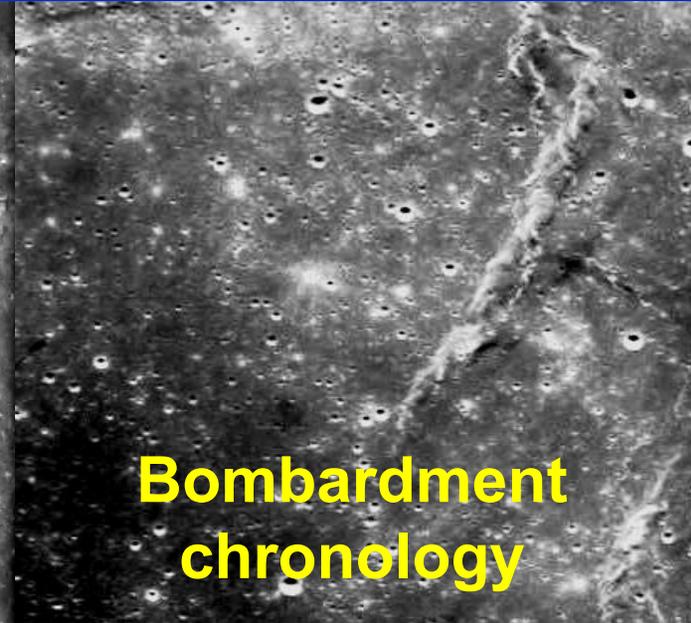
## *Moon laboratory for Geophysics*

## **Erosion, Polar volatiles**

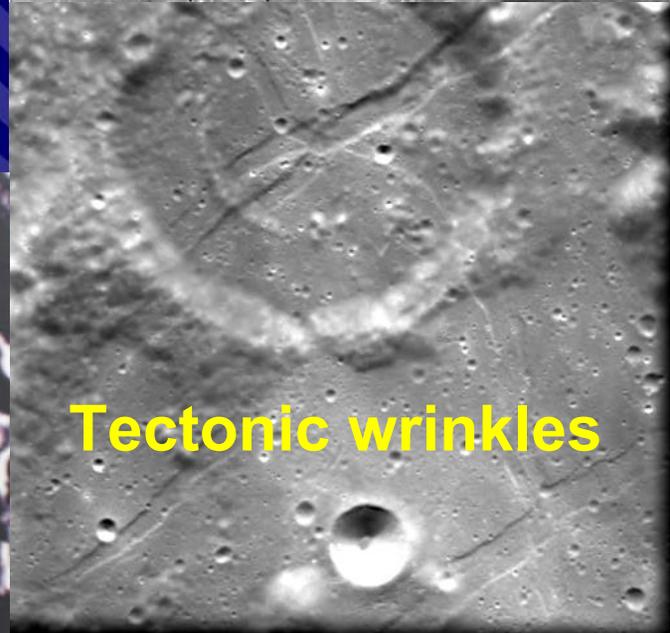


**Cratering**

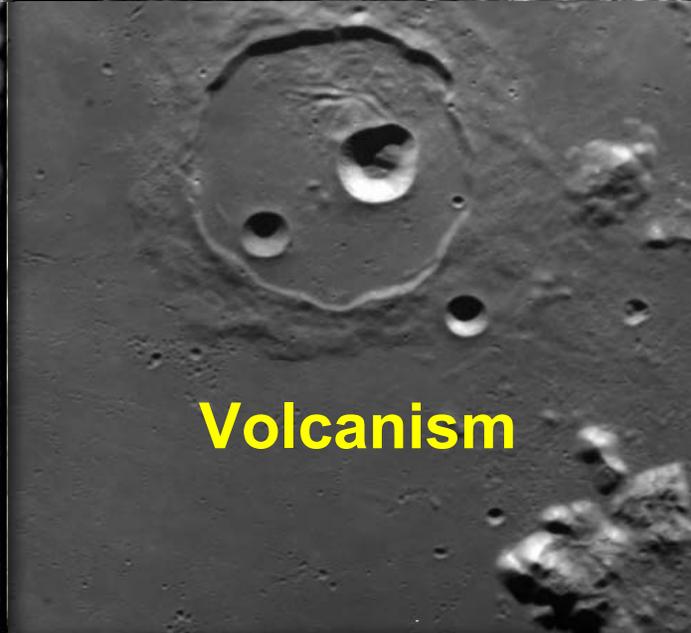
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**Bombardment  
chronology**



**Tectonic wrinkles**



**Volcanism**



15 km

# *SMART-1 last orbit*



ESA / SPACE-X Space Exploration Institute

# ***SMART-1 Media and outreach***

## **Impact campaign**

- **Jan 06: call to astronomers, lunar & impact experts (resistance: nothing will be seen ...)**
- **Low key low budget for media event**
- **Address issues on impact & lunar environment before,**
- **Call for amateur involvement**
- **3 Month info campaign: 30 webstories, images/animations**
- **Intense last month briefings, daily stories on last week**
- **websites peaks 1 MHit on 3-4 Sept**

**Prime TV, survey 68 news for 100 M viewers in 7 states**

- **191 news reports in 24 Hours broadcast**
- **1500 multi-lingual News stories on Web**
- **> 300 million viewers over the world**

# ***SMART-1 Media and outreach***

## **SMART-1 EPO**

- **EPO events, Exhibition material, SMART-1 /lunar content**
- **Use of SMART-1 EPO network**
- **Teacher's notes & Education material**
- **Earth views, Adopt a Crater**
- **Videos, Multi-lingual material**
- **Young Lunar Explorers (<http://lunarexplorer.org>),**

## **ESA Education and Outreach**

- **ESA education division**
  - **Partnership with education national institutions**
  - **Hands on projects SSETI, Student Moon Orbiter**