Planetary Science in the Next Decades: The Astromaterials Perspective

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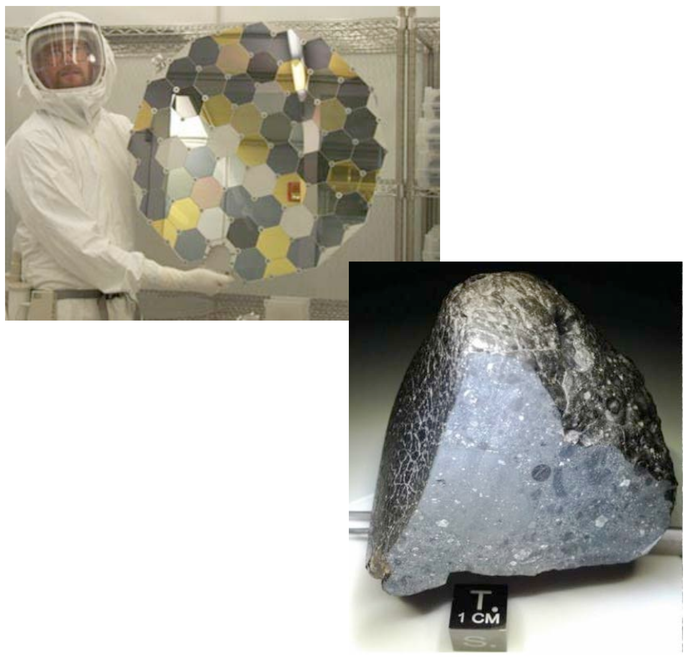
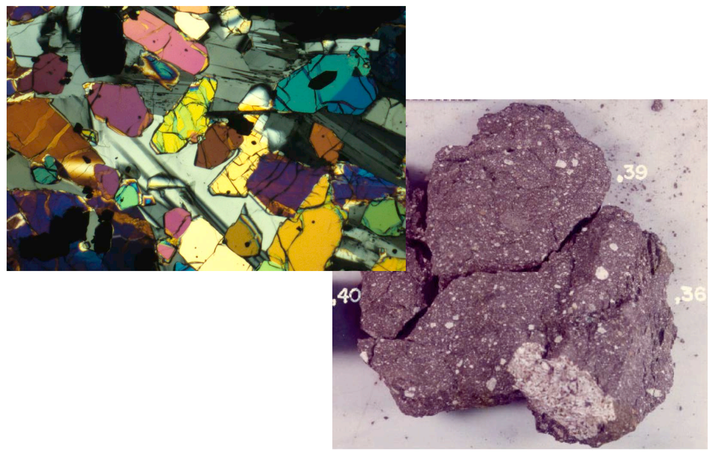
Introduction

- Extraterrestrial samples studied in the laboratory create the knowledge base needed for science-focused solar system exploration by ***answering questions no other avenue of research can***.
- Astromaterials are the "gift that keeps on giving" – the ability to ***apply new technologies that did not exist when samples were acquired*** enhances their value.



Getting the Most from Past Missions

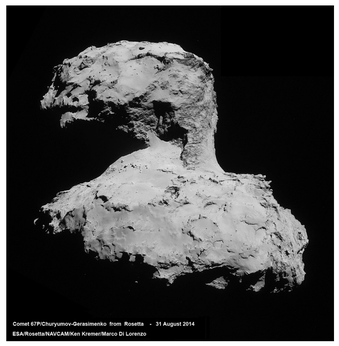
- The 382 kg of rocks and soils collected by Apollo astronauts are still providing new discoveries about the geology of the Moon.

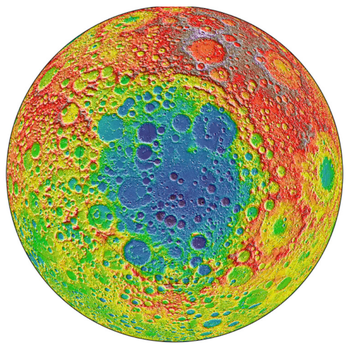


- Other NASA collections from past missions include comet dust from Stardust, solar wind from Genesis, and asteroid regolith from Hayabusa; these small samples are likely to become exhausted before 2050.

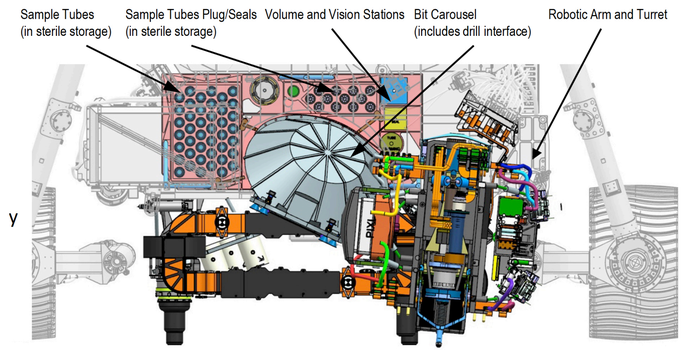
Vision for Sample Return Missions
Near Term (to ~2030)

- Complete the Planetary Decadal Survey's list of recommended ***New Frontiers sample return missions*** – samples from a comet nucleus and the lunar South Pole Aitken basin, whether or not they are selected in the current decade.





- Complete the sequence of missions that will return the carefully selected ***samples collected and cached by the Mars-2020 rover*** – the Decadal Survey's highest priority.



- Continue support for the Antarctic Search for Meteorites (***ANSMET***) program that has so far provided >20,000 meteorites from asteroids, the Moon and Mars – ***the cheapest sample return mission***.

Vision for Sample Return Missions
Long Term (to 2050)

- ***Cryogenic comet*** sample return, to begin to understand icy/volatile materials in the outer solar system.
- Missions to sample **additional asteroids**, building on OSIRIS-REx and HEO's Asteroid Redirect Mission, to begin to capture the compositional diversity of planetesimals. Sample return from a **Trojan asteroid** would be especially valuable.
- Sampling ***erupting jets from ocean worlds*** like Enceladus – the most technically plausible and affordable way to seek evidence for life in subsurface oceans.
- Sample ***the atmosphere and an organic lake on Titan***, to address goals about life and its organic precursors in the solar system.
- Sample **the atmosphere of Venus**, to understand the origin and evolution of planetary volatiles and atmospheres.
- ***A second Genesis mission*** to enlarge on the two-year sampling of the solar wind, that would improve the chemical and isotopic knowledge of the solar system's centerpiece and understand processes leading to ejection of matter from the Sun.
- Sample return from ***the surface of Mercury or Venus*** – either would be very challenging but should be considered for any long-term plan for solar system exploration.

Summary and Conclusions

➢ Samples studied in laboratories on Earth provide otherwise unobtainable information that addresses fundamental questions about solar system origin and evolution, and that motivates and enables future spacecraft missions.

➢ Future decades will offer many opportunities to conduct missions that will return samples to Earth, and these missions will be attractive for participation by the international spacefaring community.

CAPTEM*

- Curation and Analysis Planning Team for Extraterrestrial Materials