

National Aeronautics and  
Space Administration

Headquarters  
Washington, DC 20546-0001

JUL 15 2019



Reply to Attn of: Science Mission Directorate/Deputy Associate Administrator for Research

Dr. Margaret Kivelson  
Chair, Space Studies Board  
National Academies of Science, Engineering, and Medicine  
500 5<sup>th</sup> Street NW  
Washington, DC 20001

Dear Dr. Kivelson,

I would like to express my sincere appreciation for the Committee's report, Strategic Investments in Instrumentation and Facilities for Extraterrestrial Sample Curation and Analysis. NASA appreciates the Committee's comprehensive review which provides valuable insights and considerations as we plan for potential future sample returns from the Moon, Mars and other destinations. I would also like to express our gratitude and congratulations to Dr. Roberta Rudnick, the Committee's chair; the volunteer members; and the National Academies staff for their diligent support of this effort.

I have reviewed the findings and recommendations of the report, and I am pleased to convey NASA's responses to them. In general, our existing planning appears well-aligned with the report, although anticipated budgets cannot currently accomplish the full suite of recommendations. Please do not hesitate to contact Dr. Michael New with any questions about NASA's response. He can be reached at (202) 358-1766 or michael.h.new@nasa.gov.

Sincerely,

A handwritten signature in black ink, appearing to read "T. Zurbuchen".

Thomas H. Zurbuchen, Ph.D.  
Associate Administrator,  
Science Mission Directorate

CC: Space Studies Board/Colleen Hartman  
• A. Sheffer  
Science Mission Directorate/Michael New  
• L. Glaze

## **NASA Response to the NASEM Strategic Investments in Instrumentation and Facilities for Extraterrestrial Sample Curation and Analysis Report**

**Recommendation:** NASA Planetary Science Division (PSD) should consider opening the Laboratory Analysis of Returned Samples (LARS) grant program to all mission-returned extraterrestrial samples.

**Response:** NASA agrees with this recommendation and does actively consider which aspects of returned-sample science should be enhanced through the LARS program each year. However, NASA does not concur that *all* former sample-return missions must be covered by LARS. LARS is a strategic program intended to maximize the scientific return of recent and upcoming sample-return missions. The sample-analysis portion of LARS is analogous to Data Analysis Programs (DAPs), which maximize the scientific return on our missions through analysis of their returned data. The philosophy is that every mission has a life-cycle, during which, we want to highlight (and invest more) in the scientific return for a period of time following the completion of the mission. After such time, the research can then be proposed in competition with other types of science within our core programs.

Currently, all Apollo sample research (with the exception of the special Apollo Next Generation Sample Analysis (ANGSA) program), is solicited in Emerging Worlds (EW) and Solar System Workings (SSW), and historically this type of research has been well supported. In ROSES-2019, NASA made submission of lunar sample-science proposals easier by moving the majority into EW; thereby, erasing a confusing border between EW and SSW. However, PSD has the ability to take aspects of older missions and re-emphasize them when specific opportunities arise, such as we are currently doing with the ANGSA program. Given NASA's recent initiative to return to the Moon, PSD will evaluate for ROSES 2020 whether it is fitting to identify areas where an increased cadence of lunar sample science would be advantageous and consider augmenting the scope of LARS, as appropriate, within the constraints of available funding.

**Recommendation:** NASA Planetary Science Division should continue to engage in and encourage cost-sharing arrangements for laboratory analytical equipment with other funding sources.

**Response:** NASA concurs with this recommendation. Cost sharing has long been encouraged in our Planetary Major Equipment and Facilities program (and its predecessors), and will be part of any future programs to invest in ground-based equipment or facilities.

**Recommendation:** NASA Planetary Science Division should continue to invest in both multiuser facilities and individual principal investigator laboratories.

**Response:** NASA concurs with this recommendation, and intends to do so, within the constraints of available funding.

**Recommendation:** NASA Planetary Science Division should provide means for longer-term (e.g., 5-year) funding of technical staff support.

**Response:** NASA concurs that long-term support is desirable. In the coming year, NASA will initiate discussions and consider options for how we could potentially support technical staff at certain competitively selected multiuser facilities longer term and within the constraints of available funding. However, NASA does not concur that technical staff should be supported in individual laboratories beyond normal grant/award periods of performance.

**Recommendation:** NASA Planetary Science Division should make appropriate investments in the technological development of novel instrumentation and unconventional analytical techniques, specifically for curation, as well as characterization and analysis of nontraditional samples that are expected to be returned from future missions. These would likely include gases, ices, and organic matter, including volatile organic compounds and related hybrids and complexes.

**Response:** NASA concurs with this recommendation and currently funds an advanced curation program at Johnson Space Center (JSC) to work on such curation techniques. NASA also recognizes that the pace and scale of such investments would likely need to be increased as plans to return challenging types of samples, such as lunar polar volatile-rich materials, become more comprehensive. In addition, the LARS program will continue to support proposals to develop ground-based instruments needed to analyze such samples.

**Recommendation:** With the rapid developments in related fields such as molecular biology, and concomitant advances in bio-organic analytical methodologies, NASA should consider partnerships with relevant federal agencies (e.g., the Department of Energy and the National Institutes of Health) and laboratories (e.g., the National Laboratories). NASA should implement information exchange activities (e.g., joint workshops) to enhance cross-fertilization and cooperative development of analytical instrumentation and methods, specifically to enhance analysis of organic matter (both macromolecular/polymeric and molecular-moderate molecular masses, as well as volatiles-low molecular weight compounds), in the study of extraterrestrial returned samples.

**Response:** NASA concurs that other federal agencies and national labs have much to offer in the field of organic chemistry and other types of laboratory analysis. NASA currently supports an array of analytical research and development for planetary science with entities such as the Los Alamos National Laboratory, Lawrence Livermore National Laboratory, and the Naval Research Laboratory. NASA will continue to explore the possibility of establishing additional partnerships and investigate any shared interests we might have with agencies such as DOE and NIH.

**Recommendation:** NASA Planetary Science Division should continue to engage in strategic relationships with international partners to ensure that the best science possible is extracted from extraterrestrial samples with the limited resources available to all space agencies.

**Response:** NASA concurs that international partnerships are critical for missions designed to collect extraterrestrial samples as well as for the subsequent analysis of the samples. Current sample return missions such as OSIRIS-REx and Hayabusa2 have strong international components, with agreements in place for shared samples and participating scientist programs that will undoubtedly increase the scientific return. Further, the Mars Sample Return campaign is being planned as a highly international effort in all ways, ranging from spacecraft and instrument payload contributions to curation and sample analysis instrumentation and scientific collaboration. NASA will continue to support international participation in similar ways with future missions.

**Recommendation:** NASA Planetary Science Division should consider ways to facilitate the dissemination of information about present and future international, state-of-the-art facilities relevant to sample analysis. This could, for example, include organizing workshops to be held with existing international conferences.

**Response:** NASA concurs with this recommendation and plans to maintain a public list on its SARA website of all current and future supported facilities, including their capabilities and guides for obtaining access. NASA will also consider options for extending this list to facilities that do not have direct support.

**Recommendation:** NASA Planetary Science Division should encourage principal investigators to specifically address in their research proposals how the work will contribute toward training future generations of laboratory-based planetary scientists.

**Response:** NASA agrees that supporting future generations of scientists is beneficial but does not concur with this specific recommendation. NASA supports research from a broad range of institutions, many of which do not have significant educational or training programs. Any requirement to demonstrate that proposals contribute toward training future generations of laboratory-based scientists might put these institutions at a competitive disadvantage, which would negatively affect NASA's research portfolio. While training researchers is not specifically part of NASA's mission, NASA will continue to support future generations of scientists (of all kinds) through programs such as FINESST by providing funding for early-career scientists to attend workshops and conferences, and through the support of early-career scientists on proposals from both educational and non-educational institutions.

**Recommendation:** NASA Planetary Science Division should increase support for Johnson Space Center to develop appropriate curatorial and characterization facilities relevant to and necessary for future sample returns of organic matter, ices, and gases.

**Response:** NASA agrees that Johnson Space Center (JSC) facilities are a critical part of our curation and analysis activities and PSD has augmented the JSC curation budget in recent years, both in preparation for selected sample return missions like OSIRIS-REx and Hayabusa2, but also to conduct advanced curation research in anticipation of future sample returns. NASA expects to continue funding JSC at an appropriate, and if necessary, increased level as new sample return opportunities come online, and to help prepare for anticipated future lunar and Martian samples.

**Recommendation:** NASA Planetary Science Division should accelerate planning for curation of returned Martian samples, seeking partnerships with other countries, as appropriate.

**Response:** NASA agrees that early planning and establishment of partnerships are critical when formulating sample return missions. Johnson Space Center Astromaterials Curation is already involved in the planning of such activities, and will play a key role. As mentioned previously, the Mars Sample Return (MSR) campaign is being planned as a highly international effort in all ways, ranging from spacecraft and instrument contributions to curation and sample analysis collaboration. In particular, an MSR Science Planning Group (MSPG) has been established by NASA and ESA to help develop a stable foundation for international scientific cooperation for the purposes of analyzing samples returned from Mars. NASA will continue to engage potential partners and the curation community as the campaign is further developed.

**Recommendation:** NASA Planetary Science Division should place high priority on investment in analytical instrumentation (including purchase, maintenance, technical oversight, and development) and curation (facilities and protocols) sufficient to provide for both replacement of existing capacity and development of new capabilities. This will maximize the benefit from the significant investment necessary to return samples for laboratory analysis from asteroids, comets, the Moon, and eventually Mars and outer solar system moons.

**Response:** NASA concurs that investing in instrumentation and curation facilities is of high importance and as such, strives to implement appropriate investments across a balanced portfolio and within the constraints of available funding. For example, NASA recently invested funds for new instruments, such as micro-CT and MC-ICPMS at JSC, and for a variety of new instruments relevant to OSIRIS-REx and Hayabusa2 through the LARS program. NASA will continue to consider additional upgrades and investments appropriate for future sample returns as plans are further developed.