

Asteroid sample return missions: Sample Analysis of Returned Sample by OSIRIS-REx

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The Origins Spectral Interpretation, Resource Identification, and Security-Regolith Explorer (OSIRIS-REx) spacecraft launched flawlessly on September 8, 2016, as NASA's third New Frontiers mission. The primary requirement of the OSIRIS-REx mission is to collect and return a pristine sample from the surface of a near-Earth asteroid. OSIRIS-REx will arrive at B-type asteroid (101955) Bennu [1] in August 2018. This asteroid was targeted owing to its spectral similarity to carbonaceous chondrites, appropriate size, and favorable orbit. After detailed geological and spectral mapping, OSIRIS-REx will collect up to 2 kg of surface regolith samples from a carefully-selected site in mid-2020. The surface regolith from Bennu will be pristine samples with a record of the entire history of Bennu from the interstellar medium to the recent dynamical evolution and surface geological processes [2]. The sample return capsule will deliver these samples to the Earth in September 2023.

The *Sample Analysis Plan*, a document to be developed by the OSIRIS-REx project in 2019, will outline systematic, coordinated analysis of the returned samples by the international OSIRIS-REx sample analysis team. The Sample Analysis Working Group will create this plan. The *Sample Analysis Plan* contains 31 hypotheses, recorded in the OSIRIS-REx *Sample Analysis Science Plan*, (SASP) testable by the analysis of the returned sample. The SASP is a requirements document that contains primary hypotheses that have sub-hypotheses flowing from them. Laboratory analyses of the returned sample viewed in the context of remote sensing observations and the geological context of the sample will test these hypotheses. The organization of the sample analysis team will reflect the outline of the *Sample Analysis Science Plan*. A total of six sub-teams will exist, with a central overarching nucleus of team members both US and international-based that will guide the entire analysis process. These six sub-teams are the: (1) Pre-solar Epoch Team, (2) Protoplanetary Disk Epoch Team, (3) Geological Activity Epoch team, (4) Regolith Evolution Epoch Team, (5) Dynamical History Epoch Team, (6) OSIRIS-REx Epoch Team. Each of these teams will test the hypotheses spelled out in the *Sample Analysis Sample Report* that falls under their respective historical epochs. Approximately 1-2 years before the sample returns a series of Sample Analysis Readiness Tests (SART) will be performed to prepare the sample analysis team for analysis of actual returned OSIRIS-REx samples. Our SART will incorporate lessons learned and science from the analysis of samples returned from asteroid Ryugu by Hayabusa2, with whom members of the OSIRIS-REx team will be working with closely.

[1] D. S. Lauretta et al. (2014) *Meteorit. Planet. Sci.* 50, 834-849.

[2] H. C. Connolly, Jr. et al. (2015) *Earth Planets Space* 67, 1-6.

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