SAMIS: A MICRO-INFORMATION SYSTEM FOR OSIRIS-REX SAMPLE ANALYSIS DATA MANAGEMENT. P. Haenecour[1], C. A. Bennett[1], M. M. Westermann[1], M. K. Crombie[2], M. Fitzgibbon[1], T. Ferro[1], D. Hammond[1], E. McDonough[1], K. Domanik[1], L. Smith[1], J. Barnes[1], H. C. Connolly, Jr.[3,1], and D. S. Lauretta[1]. [1]Lunar and Planetary Laboratory, The University of Arizona, 1629 E. University Blvd., Tucson, AZ 85721-0092 (haenecour@arizona.edu). [2]Indigo Information Services, Tucson, AZ 85745. [3]Department of Geology, Rowan University, Glassboro, NJ 08028.

Introduction. In preparation for the return to Earth of samples collected from the surface of asteroid (101955) Bennu, the OSIRIS-REx mission has developed an hypotheses-driven Sample Analysis Plan to constrain the origin and history of the asteroid and its building blocks. To test these hypotheses, the sample analysis program is using a coordinated analytical approach that minimizes the amount of sample that is consumed from destructive analysis. With close to 50 analytical techniques in dozens of laboratories across the world, the sample analysis program will generate many raw data files, as well as calibrated and higher-level data products. To manage all of these data and maximize the scientific outputs from sample analysis, the team is developing a comprehensive information system called SAMIS: the Sample Analysis Micro-Information System.

SAMIS Design. The SAMIS will create a unified system of spatial and relational database capabilities that facilitates the processing, visualization, and preservation of the total dataset resulting from the OSIRIS-REx sample analysis effort across institutions and techniques [1]. Like a traditional information system (IS), the SAMIS is a collection of components that includes hardware, software, and sociotechnical elements designed to collect, process, store, and distribute information.

By recognizing the spatial nature of many of the data products produced by the OSIRIS-REx sample scientists, and carefully customizing off-the-shelf Geographic Information Systems (GIS) tools and technology, we will harness three important aspects of a GIS that will help with the storage, sharing, and analysis of OSIRIS-REx sample analysis data (1) The conversion of sample analysis data products into well-established spatial data types where applicable. (2) The ability to co-register spatial data from the same sample, regardless of the form of the sample, such as an unprocessed particle or a thin section. Data can be co-registered across a wide range of formats, come from different analytical techniques and instruments, and span a vast range of spatial resolutions. (3) Access to GIS visualization programs, spatial search capabilities, and spatial analysis tools which will make the analysis of data across labs and instrument teams easier and more intuitive for the OSIRIS-REx Sample Analysis Team.

SAMIS consists of four main components (Fig. 1) to collect, store, and share all data generated during OSIRIS-REx sample analysis:

(1) the *Sample Analysis Tracking Application* (SATA), which will track the physical location and state of the samples as they move between laboratories.
(2) the *Sample Analysis Desktop Application* (SADA), which will allow all team members to upload, download, search, share, and view the sample analysis data generated by all laboratory and instruments on the mission.
(3) the *SAMIS Server*, which controls SATA and SADA access to the SAMIS Database.
(4) the *SAMIS Database*, a relational database with a GIS (spatial) extension that will store all data and metadata from the sample analysis phase of the mission and perform automatic spatial registration between datasets.

The database will be integrated with a visualization tool that will be hosted on the SADA. The tool will be based on the ArcGIS Enterprise software and will allow team members to visualize, analyze, and share spatially registered sample analysis data project-wide.

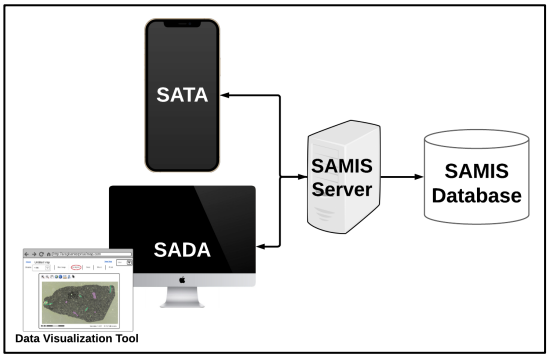

Fig. 1. Schematic of the SAMIS components.

Data Management. SAMIS will include sample tracking and physical state information, raw data (measurement signal as the instrument records it in a format that is accessible without the use of proprietary software and with as minimal processing as possible), calibrated data (application of all corrections and calibrations to raw data to produce a science-ready data product), and documentation of all algorithms, software, and/or other relevant analytical data used to produce calibrated and higher-level data products [1].

SAMIS will also foster data stewardship practices in accordance with the FAIR (Findable, Accessible, Interoperable, and Reusable) Data Principles that will be beneficial to future users and long-term data preservation and accessibility [2]. For example, all samples will have identifiers compliant with International Geo Sample Number (IGSN), and data will be submitted in SAMIS as well-established, machine-readable, and non-proprietary data formats. We are making a best-effort to ensure that all SAMIS data will also be compatible with metadata requirements of current planetary data repositories, e.g., the Planetary Data System (PDS) and Astromat (www.astromat.org)

Sample Analysis Tracking Application (SATA). The SATA is a custom phone application that will be used by every member of the Sample Analysis Team working with OSIRIS-REx samples. The SATA is specifically designed to track the physical location of a sample; the beginning, ending, and general information (e.g., instrument used) of analyses in a specific lab; any changes to the physical nature of the sample at a specific team member's lab; and, finally, the shipping of the sample to the next destination. Samples will be authenticated using a barcoding system described in the SATA Vision Document. All SATA data will be stored in and accessible from the SAMIS.

Sample Analysis Desktop Application (SADA). The SADA is a web application accessible via an internet browser that provides team members access to the SAMIS. This access includes user creation and management as well as upload, download, and querying capabilities for data managed by the SAMIS. All SADA data will be stored in and accessible from the SAMIS.

SAMIS Data Registration, Analysis and Visualization. A distinguishing component of SAMIS data processing is the use of GIS tools and techniques to automate spatial data registration and visualization of datasets produced across the entire team [3].

The SAMIS database connects to commercial online data visualization software from Environmental Systems Research Institute (ESRI's ArcGIS online Map Tool); however, SAMIS processes spatial data into industry-standard formats, such shapefiles (points, lines, and polygons) and rasters with spatial auxiliary files, making SAMIS data compatible with all standard GIS tools. Customizations are also included to adapt traditional GIS to the microscopic level. For example, fiducial markers (both macro- and microscopic) will be strategically and permanently etched onto each sample mount to define its own map and coordinate system. These fiducials ensure consistent sample orientation in the instruments and are also used as tie-points in the automated spatial registration process. Using the fiducial markers, images (e.g., optical microscope and SEM) acquired by the curation facility at NASA Johnson Space Center will be the basis for defining each sample's coordinate system and serve as basemap imagery in the SAMIS visualization tool [3]. Team members will be able to view all SAMIS spatially registered data in ESRI's ArcGIS online Map Tool through the SADA. The Map tool includes basic visualization capabilities such as data layering, zooming and panning, measuring, and coordinate location, as well as advanced operations to perform statistical analysis on a complete set of spatially registered data for a given sample (Fig. 2).

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References: [1] Bennett C. et al. (2021). Astromaterials2021, abstract #2016. [2] Wilkinson M. D. et al. (2016) *Scientific Data*, 3, 160018. [3] Westermann M. M. et al. (2021). Astromaterials2021, abstract #2029.

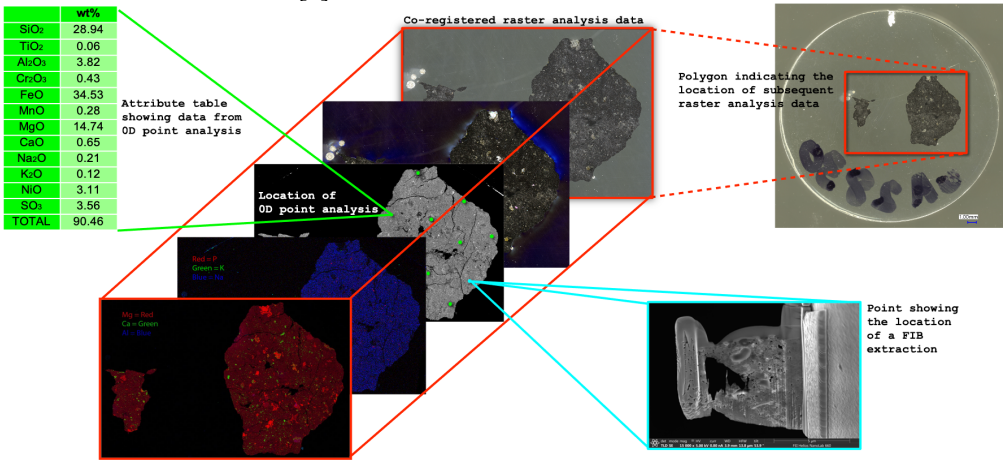

Fig. 2. Schematic of SAMIS automatic spatial data registration and visualization.