

MOONDB: RESTORATION AND SYNTHESIS OF LUNAR PETROLOGICAL AND GEOCHEMICAL DATA. Kerstin A. Lehnert¹, (Merry) Yue Cai^{1*}, Sara Mana¹, Nancy S.Todd², Ryan A. Zeigler³, Cindy A. Evans³, ¹Lamont-Doherty Earth Observatory, Columbia University, 61 Rt 9W, Palisades, NY, 10964, USA; *cai@ldeo.columbia.edu. ²UTC Aerospace Systems/JETS Contract, NASA Johnson Space Center, Mail Code XI2, Houston, TX 77058. ³NASA Johnson Space Center, 2101 NASA Rd 1, Mail Code XI2, Houston, TX 77058.

Overview: About 2,200 samples were collected from the Moon during the Apollo missions, forming a unique and irreplaceable legacy of the Apollo program. These samples, obtained at tremendous cost and great risk, are the only samples that have ever been returned by astronauts from the surface of another planetary body. These lunar samples have been curated at NASA Johnson Space Center and made available to the global research community. Over more than 45 years, a vast body of petrological, geochemical and geochronological studies of these samples have been amassed, which helped to expand our understanding of the history and evolution of the Moon, the Earth itself, and the history of our entire solar system.

Unfortunately, data from these studies are dispersed in the literature, often only available in analog format in older publications, and/or lacking sample metadata and analytical metadata (e.g., information about analytical procedure and data quality), which greatly limits their usage for new scientific endeavors. Even worse is that much lunar data have never been published, simply because no forum existed at the time (e.g., electronic supplements). Thousands of valuable analyses remain inaccessible, often preserved only in personal records, and are in danger of being lost forever, when investigators retire or pass away. Making these data and metadata publicly accessible in a digital format would dramatically help guide current and future research and eliminate duplicated analyses of precious lunar samples.

The Moon DB Project: MoonDB is a NASA-funded collaboration between Johnson Space Center and EarthChem [1], a data facility for geochemical data operated as part of the Interdisciplinary Earth Data Alliance (IEDA). MoonDB aims to digitally restore and synthesize lunar sample data from the literature as well as rescuing unpublished legacy data to make them “fit for re-use”. Working closely with domain scientists and the Astromaterials Acquisition and Curation Office (AACO) from NASA, MoonDB will be integrated with current and new sample information and imagery that are curated in data systems at the Johnson Space Center [2]. MoonDB will be able to preserve and curate all available lunar geochemical and petrological data, their associated sample and analytical metadata (instrument parameters, analytical statistics, etc) to ensure future utility of the original research.

MoonDB will be constructed based on the successful concept and architecture of the PetDB database, using existing data management infrastructure at EarthChem, providing an online search interface for users to easily locate, filter, integrate, and download data. MoonDB also allows users to submit and publish legacy and new datasets. Data products from this project will be preserved and curated at EarthChem and NASA Planetary Data System (PDS).

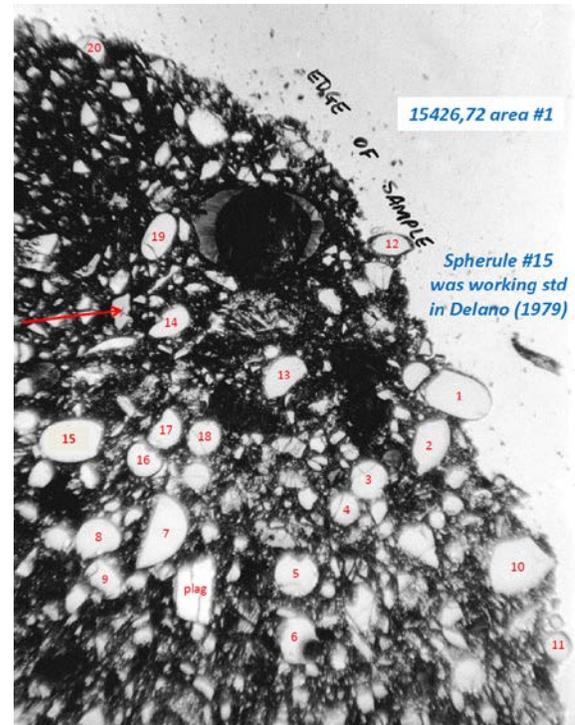


Figure 1. Annotated thin section showing Lunar Volcanic Glass spherules studied by [5] with previously unpublished metadata.

Current Activities: MoonDB’s contents are currently being ingested from a reference library that consists of over 3000 papers and abstracts, including but not limited to references from the Lunar Sample Compendium and the “Mare Basalt and Glass Database” compiled by Clive R. Neal. We have already ingested data from over 200 references [3].

Sample data from NASA data curation systems, including over 100,000 samples and their parentage history, mission-related and classification data, as well as

synthesized sample information from the Lunar Sample Compendium, are also being integrated into the MoonDB database.

Additionally, we are actively working with domain scientists to rescue legacy data - unpublished data and their associated analytical metadata - in order to generate long-term preserved and publicly accessible datasets. For example, through the IEDA data rescue mini-award program, John Delano scanned and labeled the original non-digital images of thin sections and accompanying major element datasets (e.g., Figure 1), which were published by EarthChem [4]. This type of data rescue effort will allow future investigators to directly compare new results with legacy data and better plan additional measurements of specific sample fragments or even individual grains using samples and thin sections that are currently archived at the Johnson Space Center.

Next Steps: We will reach out to domain scientists regarding unpublished analytical metadata to ensure long-term usability of existing data. We will integrate existing lunar sample naming scheme with the International Geo Sample Number (IGSNs) so that we can eliminate ambiguities in sample names and allow researchers to better keep track of the analytical history and availability of samples through persistent sample identifiers. We will also assist interested scientists with rescuing unpublished legacy data.

Conclusion: Adopting EarthChem's proven data curation tools and data quality-control policies, MoonDB will dramatically advance preservation, access and utility of lunar sample data, so that they can be fully explored to generate new scientific knowledge. It will have the capability to dynamically grow as new data are added and as modern cyberinfrastructure grows.

Community Outreach: We will be available at our poster and by appointment throughout the LPSC conference to assist interested researchers with preserving unpublished data and metadata. To best serve the needs of the scientific community, we cordially welcome your input. Delano J. W.

References:

- [1] <http://www.earthchem.org>
- [2] <http://curator.jsc.nasa.gov/lunar>
- [3] <http://www.moondb.org/biblio>
- [4] Delano J. W. (2014) EarthChem Library <http://www.earthchem.org/featured/delano>
- [5] Delano J. W. (1979) Proceedings of the 10th Lunar and Planetary Conference, Houston, TX. 1: 275-300