OBTAINING AND USING PLANETARY SPATIAL DATA INTO THE FUTURE: THE ROLE OF THE MAPPING AND PLANETARY SPATIAL INFRASTRUCTURE TEAM (MAPSIT). J. Radebaugh[1], B. J. Thomson[2], B. Archinal[3], J. Hagerty[3], L. Gaddis[3], S. J. Lawrence[4], S. Sutton[5], and the MAPSIT Steering Committee. [1]Department of Geological Sciences, Brigham Young Univ., Provo, UT, janirad@byu.edu; [2]Department of Earth and Planetary Sciences, Univ. of Tennessee, Knoxville, TN; [3]USGS, Astrogeology Science Center, Flagstaff, AZ; [4]NASA Johnson Space Center, Houston, TX; [5]Lunar and Planetary Laboratory, Univ. of Arizona, Tucson, AZ.

Introduction: Planetary spatial data, which include any remote sensing data or derived products with sufficient positional information such that they can be projected onto a planetary body, continue to rapidly increase in volume and complexity. These data are the hard-earned fruits of decades of planetary exploration, and are the end result of mission planning and execution. Maintaining these data using accessible formats and standards for all scientists has been necessary for the success of past, present, and future planetary missions. The Mapping and Planetary Spatial Infrastructure Team (MAPSIT) is a group of planetary community members tasked by NASA Headquarters to work with the planetary science community to identify and prioritize their planetary spatial data needs to help determine the best pathways for new data acquisition, usable product derivation, and tools/capability development that supports NASA's planetary science missions.

Planetary Spatial Data and MAPSIT: The conversion from raw data to spatially-registered knowledge involves major efforts in time and research. In order to convert data to knowledge, goals need to be identified, missions need to be properly designed, and instruments need to be appropriately developed and calibrated. The software tools and content distribution platforms required for scientists to obtain, process, and analyze planetary mission data need continuing development and maintenance. For these reasons, community coordination and strategic planning for the use of planetary spatial data are essential for the success of the planetary exploration enterprise.

To address the critical lack of a community-based organization driving strategic spatial infrastructure planning for planetary science and exploration, the Planetary Science Subcommittee of the NASA Advisory Council (NAC) endorsed the formation of a group to coordinate NASA strategic planning needs for planetary spatial data. To this end, NASA and the USGS have worked together to establish MAPSIT, which has steering committee membership drawing from most aspects of planetary spatial data expertise and solar system bodies. MAPSIT's mission is to ensure that ***planetary spatial data are readily available for any conceivable investigation, now or in the future***. MAPSIT has several functions: (1) Provide community findings concerning the scientific rationale, objectives, technology, and long-range strategic priorities for geologic mapping [1] and spatial software development (e.g., [2]); (2) Encourage the development of standards for present and future flight missions and research activities, coordinate systems, mapping, geologic mapping, cartographic methods and nomenclature; (3) Help define community needs for critical research and planetary mission infrastructure, particularly software tools and content archival and delivery systems; (4) Provide findings on the accuracy and precision required for spatial technologies and products; and (5) Coordinate and promote the registration of data sets from international missions with those from US missions to optimize their combined utility.

MAPSIT will help enable the broad spectrum of planetary spatial data and programmatic capabilities required to effectively execute robotic precursor and human exploration of the Solar System. These include (but are not limited to) the science analysis of planetary surfaces, the identification of safe landing sites, the down-selection of sample acquisition locations, hazard assessment, and the spatial characterization of in-situ resources [3,4,5].

Immediate Goals: There are numerous, high-priority goals that MAPSIT-represented community is focused on addressing in the near future, including:

- How should the current, unprecedented influx of high-volume, planetary mission data (e.g., Mars Reconnaissance Orbiter, Lunar Reconnaissance Orbiter, MESSENGER) be geodetically controlled and integrated to enable science and operation of current and future missions?
- How should global, regional, and local topographic models be created from multiple data sets?
- What requirements should be developed for missions to follow during the formulation and definition stages to mitigate subsequent growth of costs?
- How can research and analysis programs support strategic development of mapping procedures for new and complex products?
- How should community input be obtained and used to prioritize product development on near-term time scales?
- How can planetary spatial data products be used to enable and facilitate future human exploration and in-situ resource utilization? [6]
- When and how should geodetic analysis and mapping tools be developed and be tested for accuracy and usability?

- How can training in planetary spatial data be established or encouraged so that existing expertise is passed on to next-generation workers?
- How can we fully leverage the vast and continuing increases in computer capability as well as the larger software-driven "Big Data" community to further planetary science goals?

One example of in-depth assessment that MAPSIT can facilitate includes addressing the needs for software tools to handle the increasingly complex instruments and vast data volumes of current and planned missions. Such software needs include: (1) faster and more robust matching between disparate data types, enabling new types of data fusion; (2) the ability to simultaneously adjust data from different platforms (e.g., orbital, descent, lander, and rover) and data types (e.g., images, radar, and altimetry); and (3) new tools to combine different methods for generating topographic information.

Planetary Data in 2050: By 2050, we anticipate that extensive planetary science mission activities will have driven NASA and its international partners to make great advances in the tools and practices necessary for planetary spatial data. Following current computing trends, it is likely that artificial intelligence specifically and heuristic algorithms generally, coupled with improvements in computing power and user interface design, will have dramatically decreased the computational and personnel overhead required to derive useful data products.

A New Strategic Plan: MAPSIT's first task is to synthesize a new cohesive Planetary Geospatial Strategic Plan (PGSP). To build the strategic plan, MAPSIT will solicit broad stakeholder input through community surveys and town hall meetings, such as at LPSC and a MAPSIT community meeting in conjunction with the June 2017 Planetary Data Workshop. A partial goal is to recommend and prioritize the needed data products and infrastructural developments, following a process much like that of the Lunar Exploration Roadmap [7], the 2015 SBAG Goals Document [8] and in part the OPAG Roadmap for Ocean Worlds. The roadmap will build on the Planetary Spatial Data Infrastructure (PSDI) document [9], which outlines and defines all aspects of planetary spatial data and lays out the needs, capabilities and tasks of the community. This builds on a similar document for Earth Sciences, the National Spatial Data Infrastructure (NSDI) document [10]. It is envisioned that the roadmap will be a living document that evolves over time as milestones are met and the state of the art advances.

A Future Using Planetary Spatial Data: One component of planetary spatial data infrastructure is the assumption that there are foundational data sets. For planetary exploration, these could be identified as geodetic control or reference frames, topography, and orthoimages [9]. All data sets have value, but these can be the underlying framework for the registration and understanding of all others. Collecting such data sets and making such products at the highest resolution possible for each body in the Solar System should be planned for and could even be feasibly accomplished over the next three decades. In limited cases, some of these data products exist already at moderate resolution (e.g., topography for the Moon at ~100 m resolution or better). In many cases the data exist but have not yet been processed (e.g., early 1970's Apollo data is only now being processed into topography and orthoimages [11]), so a fundamental goal in the coming decade would be to control all existing data sets and make appropriate fundamental products.

For the 2030's to 2050, we should look forward to new missions, instruments, algorithms, software tools, and skilled personnel that will allow us to make a set of such meter-scale products for all Solar System bodies of major interest, which would allow for essentially any type of scientific studies or exploration operations to be performed on those bodies. It would include the capability to land safely anywhere on bodies such as the Moon, Mars, Venus, Mercury, the Galilean moons, and Titan and the icy Saturnian moons. Other capabilities include 4D mapping and continuous change detection, and the identification of volatiles and resources at the same meter spatial scale.

Conclusions: The planetary science community faces numerous issues relating to NASA strategic planetary spatial data infrastructure planning for the coming decade and beyond, particularly as the US and international partners aim to carry out ambitious planetary missions throughout the Solar System. By involving key stakeholders in the process and by inclusively building an active and productive community, MAPSIT will help NASA drive future discovery and innovation. Just as this type of planning was required starting 50 years ago during human exploration of the Moon and our initial forays into the Solar System [12], we can be sure it will be even more necessary in 2050 and beyond.

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