PLANETARY GEOSCIENCE MAP GATEWAY: IMPLEMENTATION OF THE MARS GLOBAL DIGITAL DUNE DATABASE.
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Introduction: The USGS Astrogeology Science Center is currently developing a new data portal, the Planetary Geoscience Map Gateway (PGMG). It was identified through a recent MAPSIT Geoscience Mapping Survey [1] that a semantic, geo-spatially aware method (i.e., a way to search using a map or by search strings) for locating geoscience maps and thematic data was an important need for the planetary community. Therefore, the creation and goal for PGMG is to develop a standardized, interdisciplinary planetary geoscience on-line catalog for all solid-surface bodies in the solar system, with the exception of Earth.

Four datasets have been chosen as testbeds for PGMG, including the Mars Global Digital Dune Database (MGD^3), the Mars Cave Catalog, International Astronomical Union-approved nomenclature, and two overlapping geologic maps of Mars at different scales. The development of standards, schemas, ontologies (i.e., a shared or standardized vocabulary), and infrastructure necessary to stand up a first of its kind testbed server capable of processing semantic queries are currently underway for each of these datasets independently. Once a baseline ontology and format has been established, datasets will be merged to produce an open solutions on-line catalog that will be used to enhance data discovery [2,3].

We focus here on the MGD^3 and the development of ontologies and semantic queries.

Background: *Mars Global Digital Dune Database.* MGD^3 is a comprehensive database that has been compiled and released as four separate USGS Open-File Reports (OFR) [i.e., 4-7]. The first three reports were divided latitudinally into the North Polar (65°-90°N), the Equatorial (65°N-65°S), and the South Polar (65°-90°S) regions, and included a classification of dune morphology, slipface measurements, and estimated volume of sediment for medium to large-scale dune fields. The fourth installment included a detailed compositional analysis for dune fields ≥300 km^2 in area, thermal inertia values, a dune stability assessment, and results from two-component heterogeneity thermal physical modeling [8]. The continued goal for the MGD^3 is to provide a reliable and multifaceted repository of data for martian dunes, with the intention for such data to be easily accessible and used for future research.

Current Work: We are currently in the early stages of the PGMG project, working through the complexities of integrating different kinds of datasets into one functioning geospatial catalog.

Implementation of the MGD^3. The MGD^3 comprises a range of information, so it is crucial to determine the most straightforward method to merge and organize such large datasets (e.g., Figure 1). The dune field identification number, a seven-digit number derived from [9] and based on the dune field's centroid latitude and longitude, is a unique identifier assigned to each dune field. For this reason, each individual dune field ID number will be used as the primary key for deriving data.

At the present time, there are three main data sets that are included under the Dune field ID key: geometric (e.g., area, length, etc.), composition, and TES thermophysical data (i.e., the three main datasets from the MGD^3 OFRs). For each individual dune field, tables of each dataset can be accessed. We realize however, that accessing individual sets of data for each dune field may become cumbersome when the user wishes to gather larger sets of data for comparison studies or to identify geospatial trends across regions. Therefore, we are normalizing table views to enable programmatic access to subsets of data pertaining directly to their specific data inquiry. For example, a search can be carried out for dune fields that have a high sulfate content (i.e., >10% in abundance). This request is entered into the query search and a populated list of dune fields is then generated.

These semantic queries will include (but are not limited to) area, location, composition, Stability Index, and thermal inertia. A key approach to making the PGMG a reliable and easily accessible catalog is to ensure that the terminology we use is a standardized, shared vocabulary that spans

across interdisciplinary fields, as well as fits within a planetary-specific metadata profile [10]. Therefore, the ontologies used for these databases and its corresponding metadata are expected to undergo iterations as new data are incorporated.

Future Work: Once the MGD³ has been tested and we have a reached a consensus on ideal query criteria, we plan to expand the database to include dune field data from other peer-reviewed published work. This next step will bring in new complexities, such as merging datasets that have similar labels but were collected using different parameters, how to represent all data accurately, and how to achieve interoperability.

Summary: The PGMG is intended to be a useful open source solution within the planetary spatial data infrastructure. Metadata will be serviced through an Open Geospatial Consortium (OGC) Catalog Service for the Web (CSW). We will implement a standardized vocabulary through the use of ontologies authored by the World Wide Web Consortium standard Ontology Language (OWL2) [3,11]. The PGMG will be set up to allow the user to discover data using semantic-based queries in a GIS-based format that can then be ingested into multiple GIS applications. We intend to work with other institutions and researchers to develop open tools, schemas, and policies with the goal to create an open data community.

References: [1] Skinner, J.A. Jr. et al (2019) U.S.G.S. Open-File Report 2019-1012. [2] Laura, J.R. et . (2017) Towards a Planetary Spatial Data Infrastructure. *ISPRS, 6*(6). [3] Hunter M.A. et al (2019) *LPSC L,* Abstract #1107. [4] Hayward R.K. et al., (2006) U.S.G.S. Open-File Report 2007-1158. [5] Hayward R.K. et al., (2010) U.S.G.S. Open-File Report 2010-1170. [6] Hayward R.K. et al., (2012) U.S.G.S. Open-File Report 2012-1259. [7] Gullikson A.L. et al. (2018) U.S.G.S. Open-File Report 2018-1164. [8] Hoover et al. (2017) *LPSC XLVIII,* Abstract #1062. [9] Barlow, N.G (2003) *6th Int. Conf. on Mars,* Abstract #3073. [10] Hunter, M.A. et al. (2020) *LPSC LI,* Abstract #1157. [11] Musen, M.A. (2015) The Protégé Project: A look back and a look forward. *Association of Computing Machinery Specific Interest Group in Artificial Intelligence, 1*(4).
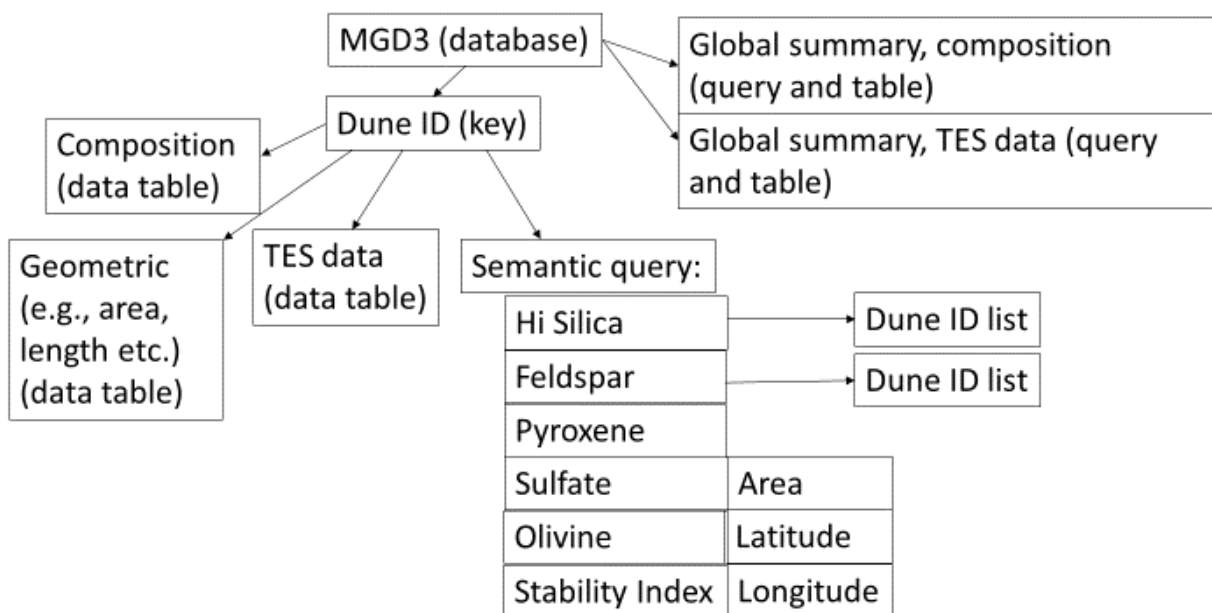

Figure 1. A graphical view of the MGD³ database and subclasses.