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High-Value Thematic Maps and the Importance of Standardized Geology

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INTRODUCTION

Incorporating all of the pieces of the NCGMP09 geologic database standard (http://ngmdb.usgs.gov/Info/standards/NCGMP09/) into an office's map-making workflow can take a lot of time, especially when geologists and GIS staff are learning the standard. In particular, NCGMP09's mandatory General Lithology fields and optional Standard Lithology table might seem less important to the map's author and therefore not get populated, because these data are meant to provide a "least-common-denominator" description to facilitate sharing geologic information with others and a simpler creation of compilation maps. To create these useful data-sharing fields, some standardization of the lithologic units must be applied to the geologic dataset. The importance of data standardization and use of defined term lists is demonstrated in the multi-step process of transitioning from standardized individual map databases to a compilation map to endless possible thematic maps (presented at the DMT'15 meeting, see http://ngmdb.usgs.gov/Info/dmt/docs/DMT15_Athey.pdf and http://ngmdb.usgs.gov/Info/dmt/docs/DMT15_Athey2.pdf).

STANDARDIZED GEOLOGY AND THE NCGMP09 MODEL

Many geologists are wary of "standardized geology" because they may be expected to use a defined term list. In our experience, geologists generally feel that defined term lists curtail their ability to adequately describe their observations to their audience, which might promote misunderstanding and misuse of the data. (Note that NCGMP09 General Lithology and Standard Lithology fields are in addition to the tables describing the original geologic map data.) It is a dilemma. While there is always potential for misuse of data, geologic data are used by many other science disciplines and laypersons, from habitat studies to insurance companies. Because many users do not have the science background to synthesize detailed data or local knowledge to harness area-specific geologic data for their own purposes, who could be better than the geologist-authors themselves to extract the critical bits of data and make them accessible to a wider audience?

The General Lithology and Standard Lithology fields are designed to simplify the creation of compilation maps. Both parts of the standard use defined term lists to describe a geologic unit. General Lithology, which consists of two fields in the Description of Map Units table, is mandatory to populate, and it makes use of an abbreviated term list to reduce complex geologic units down to one term that is consumable by the general public. General Lithology includes a field that describes how well that one term actually correlates with the original geologic map unit.

The Standard Lithology table utilizes the CGI term list (https://www.seegrid.csiro.au/wiki/CGIModel/ConceptDefinitionsTG), which is also a GeoSciML vocabulary (http://www.geosciml.org/). The Standard Geology table allows quite a bit of detail and flexibility in how a geologic unit is defined; multiple lithologies may be selected, including fields that describe where in the unit the lithology is found and its proportion as a text descriptor or percentage. This table also takes more time to populate than the General Lithology fields, because it is more complex.

CREATING A MAP FROM STANDARDIZED DATA

The Alaska Division of Geological & Geophysical Surveys (DGGS) recently had an opportunity to observe how the General Lithology and Standard Lithology fields could be used for geologic research. In 2014, DGGS was contracted by the Alaska Department of Transportation & Public Facilities to create a statewide map evaluating the potential of bedrock geologic units to contain naturally occurring asbestos (NOA; Solie and Athey, 2015). The product is a thematic map of bedrock polygons color-coded to display various levels of NOA potential. The underlying compilation map is composed of 27 U.S. Geological Survey (USGS) geologic maps of various scales covering the state, many of which had been created using a database standard other than NCGMP09 (e.g., Wilson and others, 2009). In particular, the USGS field “NSA class”, which was very useful in our efforts, is analogous to the General Lithology fields in the NCGMP09 national standardization schema. Some of the USGS maps also contained additional fields with information about multiple lithologies and their proportions similar to the Standard Geology table in NCGMP09. We used this information for compilation and NOA-potential categorization, but also relied heavily on the text descriptions of the geologic units.

The project did not require a cohesive statewide map created by concatenating units across adjacent map boundaries. Geologic bedrock polygons were taken directly from the published digital maps and evaluated for NOA potential, except in areas where existing digital maps were not available. Standardization of lithologic units via defined term lists (primarily the “NSA class” field) helped facilitate categorization of bedrock units into the most appropriate NOA-potential grouping, enabling us to relatively quickly create the NOA-potential thematic map. We observed situations where standardized lithologic data facilitated compilation during the process of producing the map, and situations where the original map data made compilation and NOA-potential assignments problematic despite any standardization that might be applied to them (table 1).

Table 1. Situations encountered during the NOA-potential mapping process that did or did not benefit from standardization of the original map data.

Standardization facilitated mapping process

Similarly formatted map data from different publications were quickly assimilated into the compilation, because the information was predictable and well documented.
Similarly formatted map data made specific information easy to find.
Defined term-list lithologies facilitated correlation of map units, providing an authoritative descriptor when the map unit text description was ambiguous or insufficient in detail.
Standardized attributes were defined and applied to more than one map. Definitions were available online via URLs.
Defined term-list lithologies were queried to easily populate other map-specific attributes and bulk-assign ratings.
Standardized attribute data from the original publications were used directly and did not have to be edited.
Simple standardized data facilitated data analysis and multiple thematic maps on a variety of topics.
Robust standardized data, such as geologic units defined by multiple term-list lithologies and their proportions, provided more opportunities to create thematic maps – you can do more with more data.
Standardized data facilitated online products.

Standardization did not facilitate mapping process

Geologic units were grouped differently on adjoining maps and could not be correlated seamlessly across the maps. Reasons for grouping lithologies include: • scale of mapping: smaller-scale maps will be more generalized, and larger-scale maps will be more detailed. • author's philosophy on "lumping" versus "splitting": lithologies may be combined in multiple ways depending on the interpretation of the author. • purpose of the map: certain lithologies may be required to be portrayed in more or less detail to ensure readability and understanding. • available data: units may be redefined with the availability of new information, such as ages, models, and correlative lithologic units.
Authors used geologic terms differently. The same term may mean different things, or different terms may describe the same rock. Even in defined-term lists there may be some ambiguity.
Text unit descriptions of varying length, detail, and content required manual editing.
Publications contained non-human-readable attributes whose definitions were not well documented.
Multiple tables had to be joined together to answer a question because the GIS tables and data were normalized.
Gaps and overlaps in the GIS data were created at the boundaries of maps that were not coincident.

CONCLUSION

Creation of the naturally-occurring-asbestos-potential maps went fairly smoothly given all of the documented, standardized information at our disposal. Defined terms, robust data, and a predictable data format were extremely helpful for breaking down geologic units into their component lithologies and creating thematic maps, but because geologic units can be combined and defined in many different ways, joining maps together is inherently problematic. We will be more proactive to ensure that data we create are useable to a wider audience now that we have experienced map compilation from the consumer side. The NGCMP09 General Lithology and Standard Lithology fields are ready tools for sharing data.

REFERENCES

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