DIGITAL MAPPING TECHNIQUES 2015

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from the DMT Meetings (1997-2015)

http://ngmdb.usgs.gov/info/dmt/

HIGH-VALUE THEMATIC MAPS AND THE IMPORTANCE OF STANDARDIZED GEOLOGY:

Example Maps of Naturally Occurring Asbestos in Alaska

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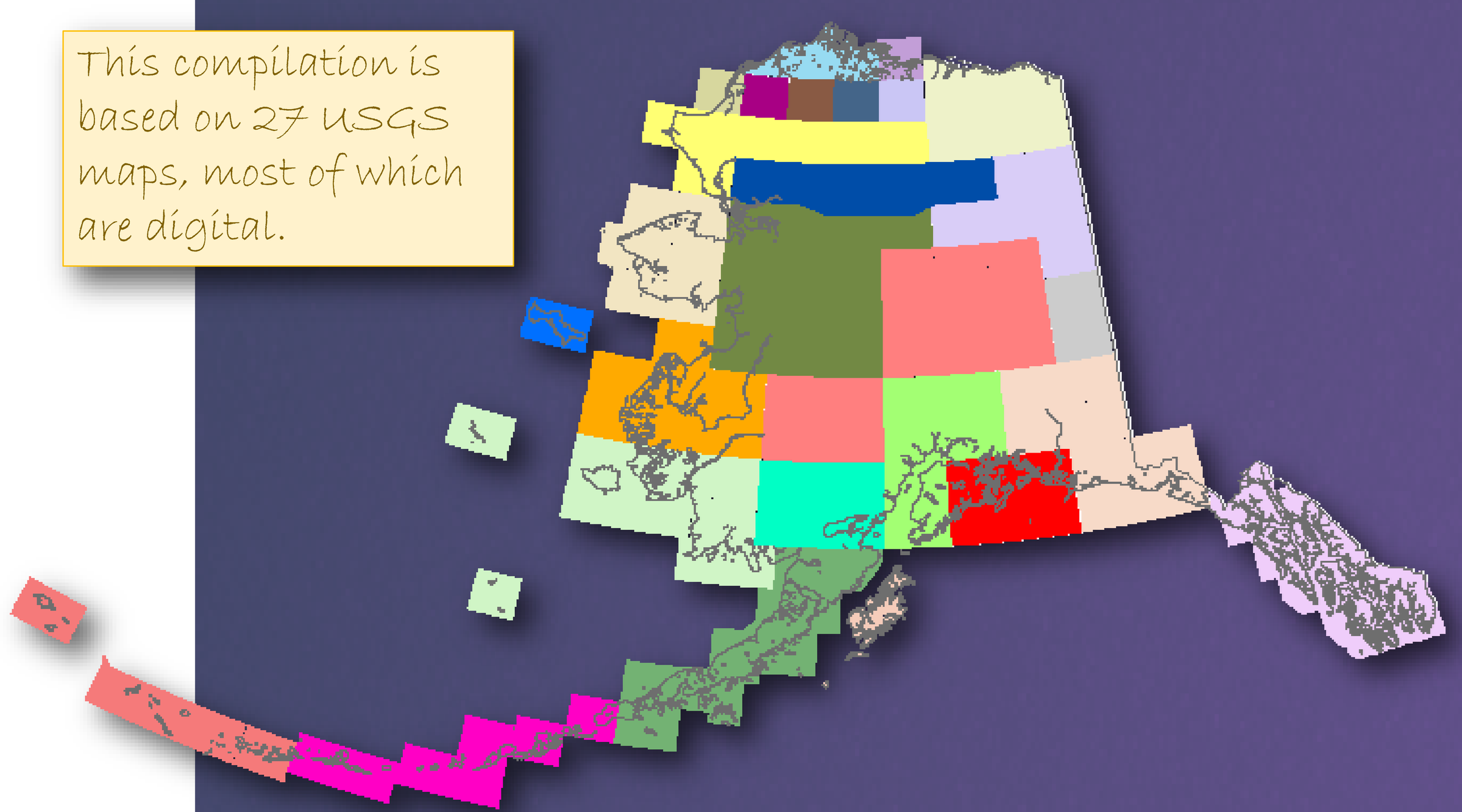
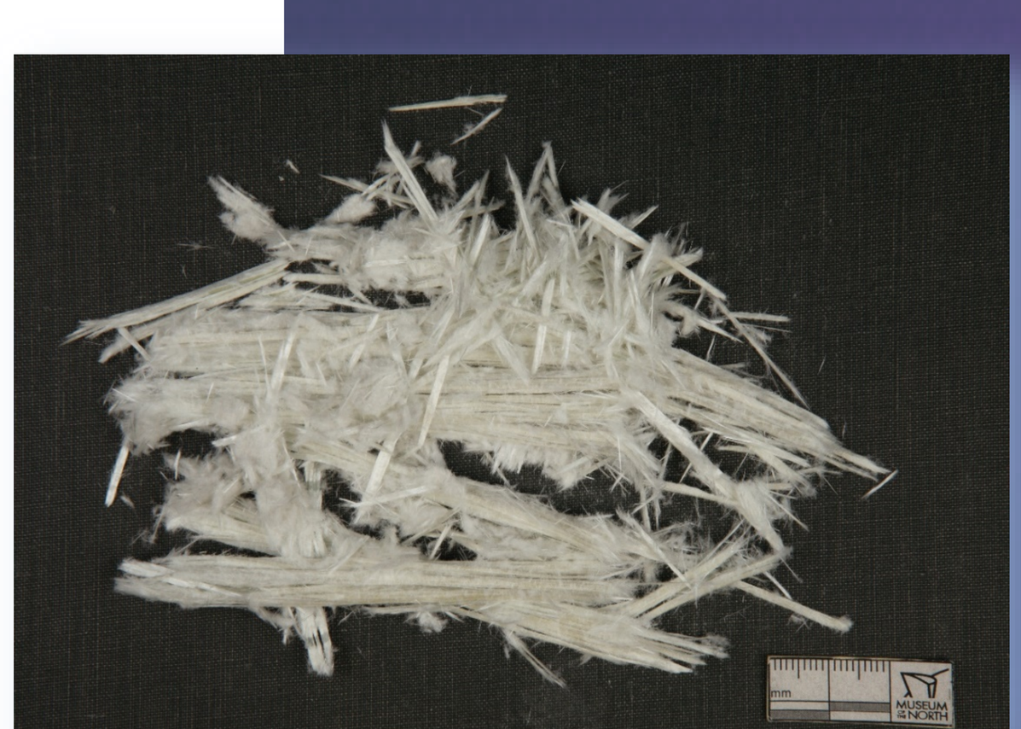
Naturally Occurring Asbestos Project

The Alaska Department of Transportation & Public Facilities (DOT&PF) has been impacted by naturally occurring asbestos (NOA) deposits during the course of several projects since 2000 (Perkins and others, 2009). Since then, the department established a NOA task force, which has gathered information and posted it on the DOT&PF website: http://www.dot.alaska.gov/stwddes/desmaterials/noa.shtml. DOT&PF's NOA program has been instrumental in developing Alaska Statutes regulating the testing and use of NOA in construction material sources in Alaska.

To better predict where NOA may exist in Alaska, DOT&PF contracted the Alaska Division of Geological & Geophysical Surveys (DGGS) to evaluate the bedrock geology of the state for NOA potential. Based on known geologic settings where asbestos is most likely to be present (Van Gosen, 2007; Buck and others, 2013; Hendrickx, 2009), we developed a set of criteria to rate relative NOA potential according to rock type. Using existing geologic map compilations of the state, we assigned a rating to each bedrock map unit. A series of maps show the resulting distribution of relative NOA potential in Alaska (Solie and Athey, 2015). Individual rating, relevant lithology (rock type), and the amount of a given lithology composing each NOA-favorable map unit are described for each polygon in the GIS attribute table. This estimate is based solely on the map unit description in the cited references.

This compilation is based on 27 USGS maps, most of which are digital.





Tremolite (UAMES 34960), displaying the soft, friable fibers of asbestiform minerals. Sample collected from the Cosmos Hills area, Kobuk District, Alaska, by Eskil Anderson. Image courtesy of the University of Alaska Museum Earth Sciences Department.

Rating Criteria for NOA Potential

High to Known
Map units are rated High to Known if they consist entirely of, or contain a major amount of, lithologies (rock types) known to host asbestos elsewhere in the world. NOA-favorable rock types are listed below; of these lithologies, serpentinite and ultramafic rocks are the most common hosts of NOA. However, the occurrence of any of these lithologies only signifies the potential to host NOA, not that there is necessarily NOA in them. Consider a rating of High to Known as guidance for where to be particularly alert to possible occurrences of asbestos. Rock types include:

- Serpentinite and ultramafic rocks
- Metamorphosed/metasomatized mafic intrusive and extrusive igneous rocks
- Metamorphosed dolostones, due to regional or contact metamorphism
- Metasomatized alkaline intrusive and extrusive igneous rocks
- Highly sheared, metasomatized igneous rocks, especially in regions of extensional deformation
- Metamorphosed iron formations

Medium
A map unit is rated Medium if it is either a compound unit consisting of multiple rock types that include one or more NOA-favorable lithologies, or a unit including rock types that may host NOA only in areas affected by metasomatism, metamorphism, or deformation. Thus, units rated with Medium NOA potential should be considered to possibly contain NOA in localized portions of the unit. More detailed mapping would be required to further refine the NOA potential of these units.

Zero to Low
Map units were rated Zero to Low if they contain zero to trace amounts of highly NOA-favorable lithologies (rock types), minor to major amounts of low-NOA-favorable lithologies (such as basalt, gabbro or marble), and NOA-unfavorable lithologies (such as metamorphic pelitic rocks). Overall these units are not likely to host NOA. However, due to the scale of mapping, units mapped with rock types unfavorable for hosting NOA cannot be guaranteed not to contain some portion of NOA-favorable rock types. Therefore, this category combines map units with zero NOA potential, low NOA potential, and trace amounts of high NOA potential.

Surficial Deposits
These map units, generally Quaternary (up to 2.4 million years) in age, consist of unconsolidated surficial deposits, and have not been evaluated for NOA potential. They can contain asbestos if there is asbestos in the source material from which the deposit is derived.

NCGMP09 Lithology Standardization

As described in the NCGMP09 v1.0 and v1.1 documentation, the General Lithology fields and Standard Lithology table are vehicles to help ensure consistent communication of geologic terms to the public, facilitate geologic database queries on common terms, and aid in the compilation of data across multiple maps.

GENERAL LITHOLOGY

Traditional map units can be classified by this hierarchical, defined list of "earth materials", i.e., one term per map unit.

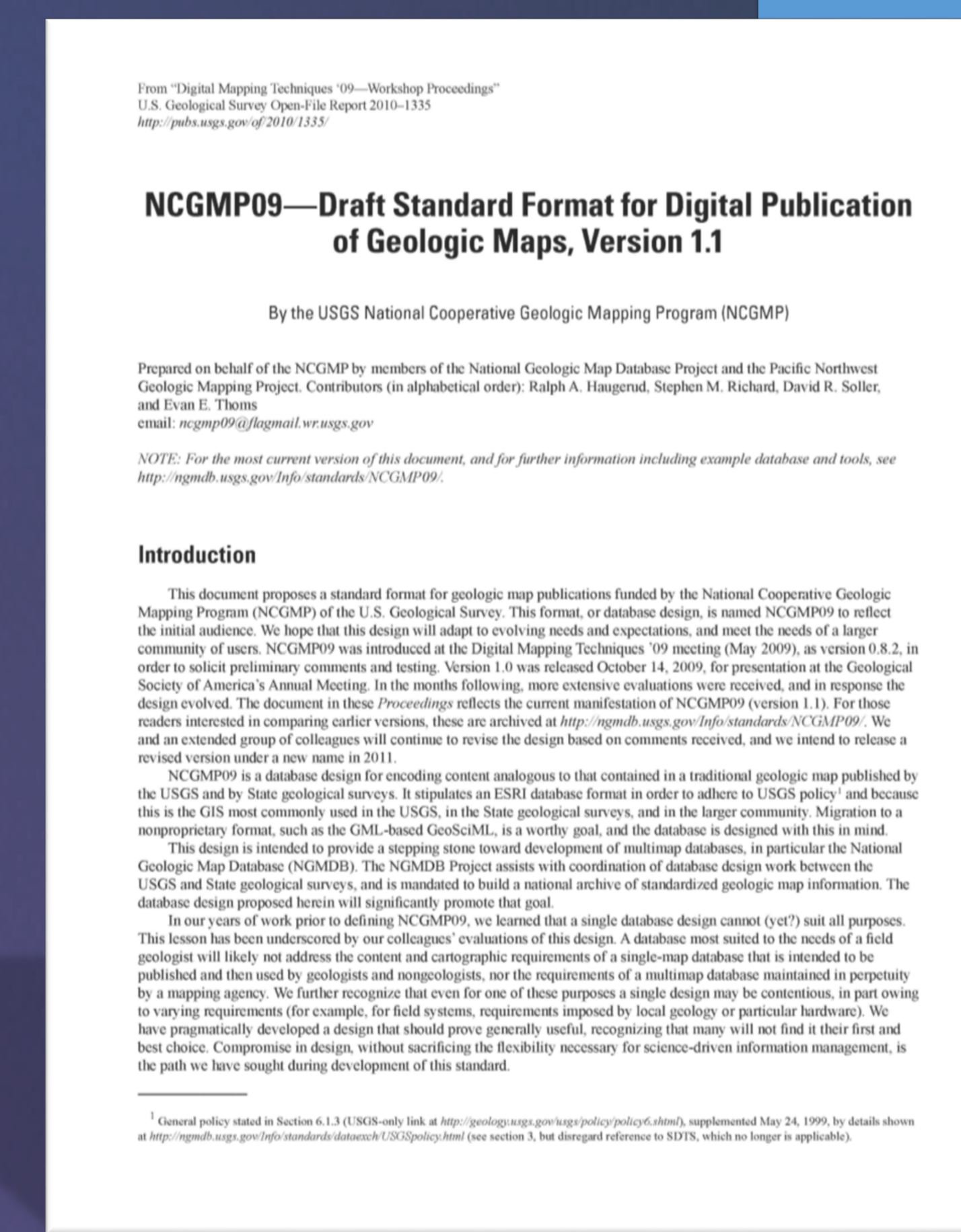
- Reduce jargon
- Provide for consistency among maps

STANDARD LITHOLOGY

Describe a map unit using multiple defined terms and their relative proportions

- Allows more flexibility in descriptions
- Requires more work

"StandardLithology was received with little enthusiasm by many of the reviewers of version 1.0." –v1.1 documentation



From "Digital Mapping Techniques '09—Workshop Proceedings"
U.S. Geological Survey Open-File Report 2010–1335
http://pubs.usgs.gov/of/2010/1335/

NCGMP09—Draft Standard Format for Digital Publication of Geologic Maps, Version 1.1

By the USGS National Cooperative Geologic Mapping Program (NCGMP)

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NOTE: For the most current version of this document, and for further information including example database and tools, see http://ngmdb.usgs.gov/Info/standards/NCGMP09/.

Introduction

This document proposes a standard format for geologic map publications funded by the National Cooperative Geologic Mapping Program (NCGMP) of the U.S. Geological Survey. This format, or database design, is named NCGMP09 to reflect the initial audience. We hope that this design will adapt to evolving needs and expectations, and meet the needs of a larger community of users. NCGMP09 was introduced at the Digital Mapping Techniques '09 meeting (May 2009), as version 0.8.2, in order to solicit preliminary comments and testing. Version 1.0 was released October 14, 2009, for presentation at the Geological Society of America's Annual Meeting. In the months following, more extensive evaluations were received, and in response the design evolved. The document in these *Proceedings* reflects the current manifestation of NCGMP09 (version 1.1). For those readers interested in comparing earlier versions, these are archived at *http://ngmdb.usgs.gov/Info/standards/NCGMP09/*. We and an extended group of colleagues will continue to revise the design based on comments received, and we intend to release a revised version under a new name in 2011.

NCGMP09 is a database design for encoding content analogous to that contained in a traditional geologic map published by the USGS and by State geological surveys. It stipulates an ESRI database format in order to adhere to USGS policy[1] and because this is the GIS most commonly used in the USGS, in the State geological surveys, and in the larger community. Migration to a nonproprietary format, such as the GML-based GeoSciML, is a worthy goal, and the database is designed with this in mind.

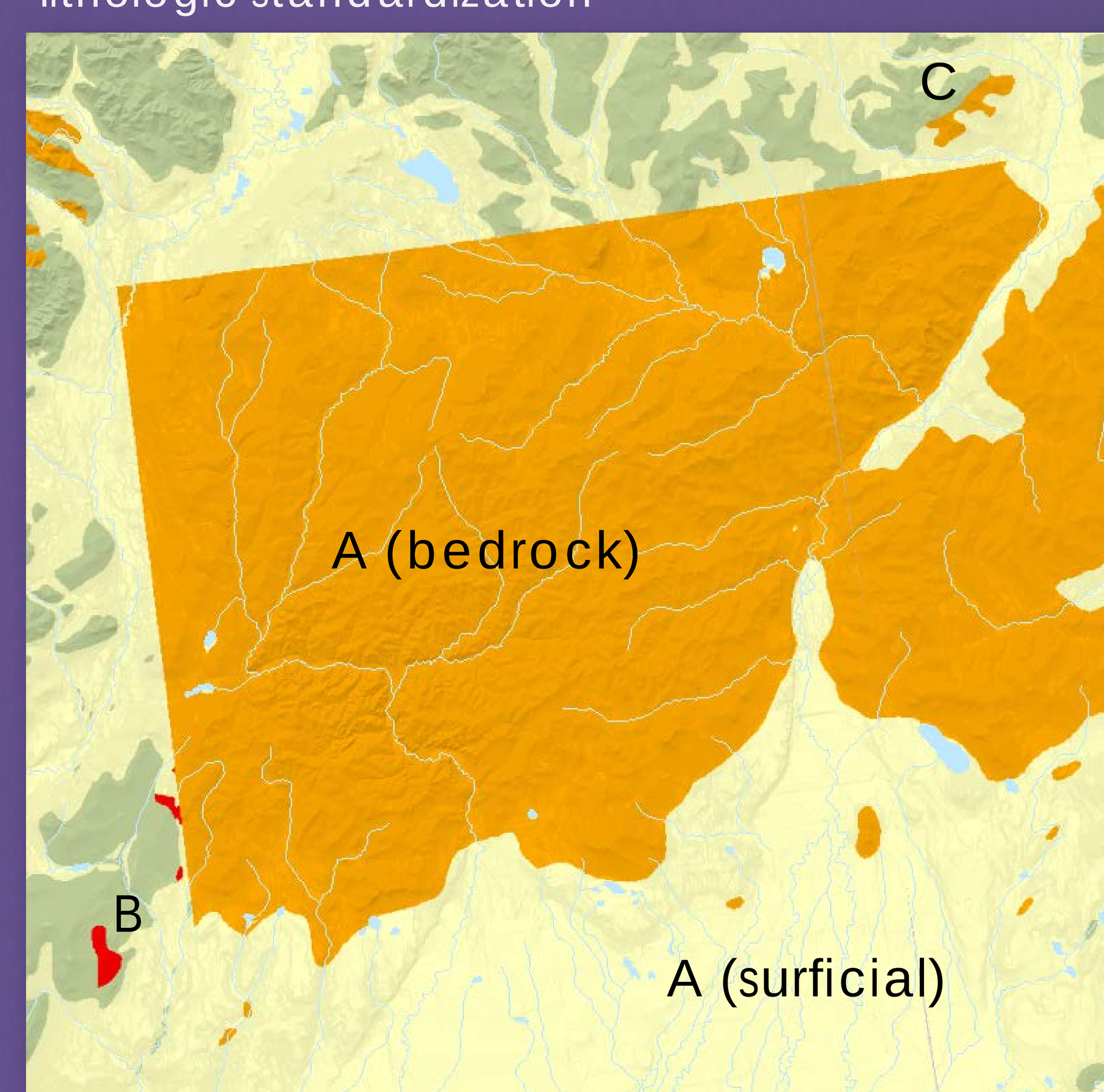
This design is intended to provide a stepping stone toward development of multimap databases, in particular the National Geologic Map Database (NGMDB). The NGMDB Project assists with coordination of database design work between the USGS and State geological surveys, and is mandated to build a national archive of standardized geologic map information. The database design proposed herein will significantly promote that goal.

In our years of work prior to defining NCGMP09, we learned that a single database design cannot (yet?) suit all purposes. This lesson has been underscored by our colleagues' evaluations of this design. A database most suited to the needs of a field geologist will likely not address the content and cartographic requirements of a single-map database that is intended to be published and then used by geologists and nongeologists, nor the requirements of a multimap database maintained in perpetuity by a mapping agency. We further recognize that even for one of these purposes a single design may be contentious, in part owing to varying requirements (for example, for field systems, requirements imposed by local geology or particular hardware). We have pragmatically developed a design that should prove generally useful, recognizing that many will not find it their first and best choice. Compromise in design, without sacrificing the flexibility necessary for science-driven information management, is the path we have sought during development of this standard.

[1] General policy stated in Section 6.1.3 (USGS-only link at *http://geology.usgs.gov/usgs/policy/policy6.shtml*), supplemented May 24, 1999, by details shown at *http://ngmdb.usgs.gov/Info/standards/dataexch/USGSpolicy.html* (see section 3, but disregard reference to SDTS, which no longer is applicable).

http://ngmdb.usgs.gov/Info/standards/NCGMP09/

Example of compilation without lithologic standardization



Discussion of Map Example

- All maps in this example are published at a scale of 1:500,000.
- Maps A and B are by the same author and published two years apart. However:
  - In map A, the surficial geology (yellow) and bedrock geology (orange) are mapped in less detail and are more generalized than maps B and C.
  - Adjacent bedrock units in map A (all colored orange) contain quite a few different lithologies, and it was difficult to decide on an overall rating for the unit. Ultimately the rating was determined to be Medium due to the presence of altered mafic and ultramafic rocks.
- Maps B and C both describe a basalt unit, but its state of metamorphism may be variable. Could this be the same unit? Is the basalt truly variably metamorphosed or did the authors just describe it differently?

In this situation, you just work with the data that you have. We saved information about the original publications for every polygon in the attribute files.

A (bedrock) – group of large, adjacent, orange polygons (NOA potential is Medium)

Table
YukonFlatsRegion_NOA_potential_clip

NOA_POTENTIAL	NOA_FAV_LITHOLOGY	AMOUNT_NOA	UNIT_ABBREV	NSA_CLASS_URL	REFERENCE	LITHOLOGY
Medium	mafic igneous/metamafic/ultramafic	moderate/minor/trace	JDat	http://mrdata.usgs.gov/geology/state/ak/akgeo-unit.php?unit=5133	Till and others (2006)	Igneous and sedimentary rocks of oceanic affinity, including ultramafic and other mafic igneous rocks
Medium	greenstone/mafic igneous rocks	minor/minor	Pzvu	http://mrdata.usgs.gov/geology/state/ak/akgeo-unit.php?unit=5335	Till and others (2006)	Semischist, phyllite, and thin layers of mafic rock
Medium	metagabbro/metacarbonates	minor/moderate	PzpCh	http://mrdata.usgs.gov/geology/state/ak/akgeo-unit.php?unit=8850	Till and others (2006)	Metacarbonate rocks, metasiliciclastics, metamorphosed calcareous sedimentary rocks, and minor mafic metagabbro and metafelsite
Medium	metagabbro/metacarbonates	minor/moderate	PzpCh	http://mrdata.usgs.gov/geology/state/ak/akgeo-unit.php?unit=8850	Till and others (2006)	Metacarbonate rocks, metasiliciclastics, metamorphosed calcareous sedimentary rocks, and minor mafic metagabbro and metafelsite
Medium	mafic igneous/metamafic/ultramafic	moderate/minor/trace	JDat	http://mrdata.usgs.gov/geology/state/ak/akgeo-unit.php?unit=5133	Till and others (2006)	Igneous and sedimentary rocks of oceanic affinity, including ultramafic and other mafic igneous rocks

B – small red polygons (NOA potential is High to Known)

Table
SouthernBrooksRange_NOA_potential

NOA_POTENTIAL	NOA_FAV_LITHOLOGY	AMOUNT_NOA	UNIT_ABBREV	NSA_CLASS_URL	REFERENCE	LITHOLOGY
High to known	meta-basalt/meta-diabase	moderate/mode	JDab	http://mrdata.usgs.gov/geology/state/ak/akgeo-unit.php?unit=5140	Till and others (2008)	Mafic metavolcanic and metaintrusive rocks, metachert, metalimestone, and amphibolite of the Angayucham terrane, Angayucham Terrane, Serpentinite
High to known	meta-basalt/meta-diabase	moderate/mode	JDab	http://mrdata.usgs.gov/geology/state/ak/akgeo-unit.php?unit=5140	Till and others (2008)	Mafic metavolcanic and metaintrusive rocks, metachert, metalimestone, and amphibolite of the Angayucham terrane, Angayucham Terrane, Serpentinite
High to known	meta-basalt/meta-diabase	moderate/mode	JDab	http://mrdata.usgs.gov/geology/state/ak/akgeo-unit.php?unit=5140	Till and others (2008)	Mafic metavolcanic and metaintrusive rocks, metachert, metalimestone, and amphibolite of the Angayucham terrane, Angayucham Terrane, Serpentinite

C – small orange polygon (NOA potential is Medium)

Table
NorthSlope_ANWR_NOA_potential

NOA_POTENTIAL	NOA_FAV_LITHOLOGY	AMOUNT_NOA	UNIT_ABBREV	NSA_CLASS_URL	REFERENCE	LITHOLOGY
Medium	basalt, possibly metamorp	major/moderate	MzPzv	<Null>	Imm and others (1993)	Basalt, chert, marble, diabase, gabbro

Looking Toward the Future

Filling the General Lithology or Standard Lithology fields with data might significantly help with compilation projects. However, there will likely always be inconsistencies among authors to iron out.

Once we had compiled the USGS maps for the naturally occurring asbestos project, we received several requests for the data to be used for a variety of other projects. These included DGGS Minerals section project planning, a generalized map for display at a museum dinosaur exhibit, and developing new sources of construction materials for road projects.

Mineral extraction in Alaska; Photo courtesy of Fort Knox Gold Mine

UAF Museum of the North; Photo courtesy of Andrei from New York City/Juneau, USA

Dalton Highway overflow ice; Photo courtesy of Alaska DOT&PF

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