AK GeMS
Geologic Mapping System
Status Report

Describes the Alaska Geologic Mapping System developed and used by DGGS through June 30, 2023.

This document was also a deliverable for USGS Cooperative Agreement award G21AC10712


ALASKA GEMS GEOLOGIC MAPPING SYSTEM STATUS REPORT:
JANUARY 1, 2016–JUNE 30, 2023

Michael D. Hendricks, Jennifer E. Athey, Simone Montayne, W. Chris Wyatt, Amy E. Macpherson, and Wes Buchanan

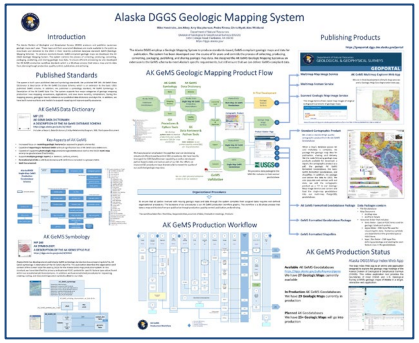
Miscellaneous Report 175

2024
STATE OF ALASKA
DEPARTMENT OF NATURAL RESOURCES
DIVISION OF GEOLOGICAL & GEOPHYSICAL SURVEYS

Bibliographic Reference

Hendricks, M.D., Athey, J.E., Montayne, Simone, Wyatt, W.C., Macpherson, A.E., and Buchanan, Wes, 2024, Alaska GeMS geologic mapping system status report: January 1, 2016-June 30, 2023: Alaska Division of Geological & Geophysical Surveys Miscellaneous Publication 175, 33 p. https://doi.org/10.14509/31088 or https://dggs.alaska.gov/pubs/id/31088

Poster View of System



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Alaska Division of Geological & Geophysical Surveys
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- History
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- GIS Data and Symbology Standards
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Some History

2001

DIGITAL GEOLOGIC DATABASE PROJECT

Contact: Larry Freeman, Geologic Communications Section, 907-451-5027, larry@dnr.state.ak.us

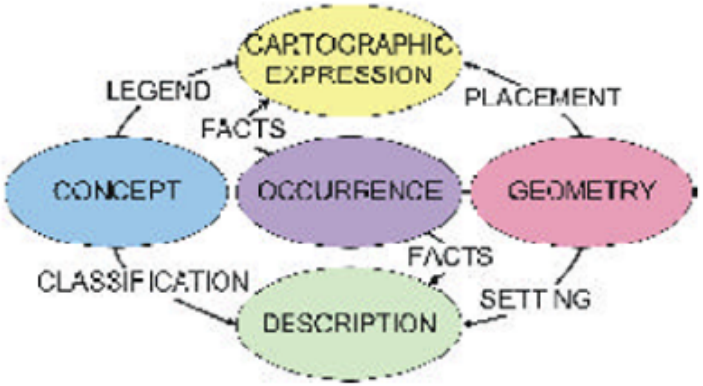
In October 2000, the Division of Geological & Geophysical Surveys (DGGS) began creating a geologic database system that will provide consistent data and information input, organization, and storage architecture. The database system will also provide data identification and retrieval functions that will guide and encourage users to access appropriate data on-line. This project is part of the federally funded Minerals Data and Information Rescue in Alaska program.

The first objective of the Geologic Database Project is to implement a spatially referenced geologic database system that will maintain a centralized data and information archive. The system will also provide consistent input, organization, and storage infrastructure for new geologic data, in a networked environment. The second objective of this project is to create a functional on-line system that allows the public to find and identify the type and geographic locations of geologic data available from DGGS. The user will be able to view and download the data in usable formats to a personal computer.

During the first year, project personnel have identified, gathered, and modeled geologic data for inclusion in the database. A data model was created to guide development of the architecture of the database system. DGGS is implementing that database system through a contractor that will design, program, and install the system hardware, software, and data loading utilities. By early 2002, when this phase of the project is complete, DGGS will have the database infrastructure in place and will

in the database include bibliographic information, geologic map features, field observations, sample descriptions and analyses, minerals resource data, information for evaluating geologic hazards, and definitions of terms used to classify objects in the database. Combining spatially referenced features with descriptive and analytic information in a relational database structure will allow the community to search more effectively for geologic information specific to their needs.

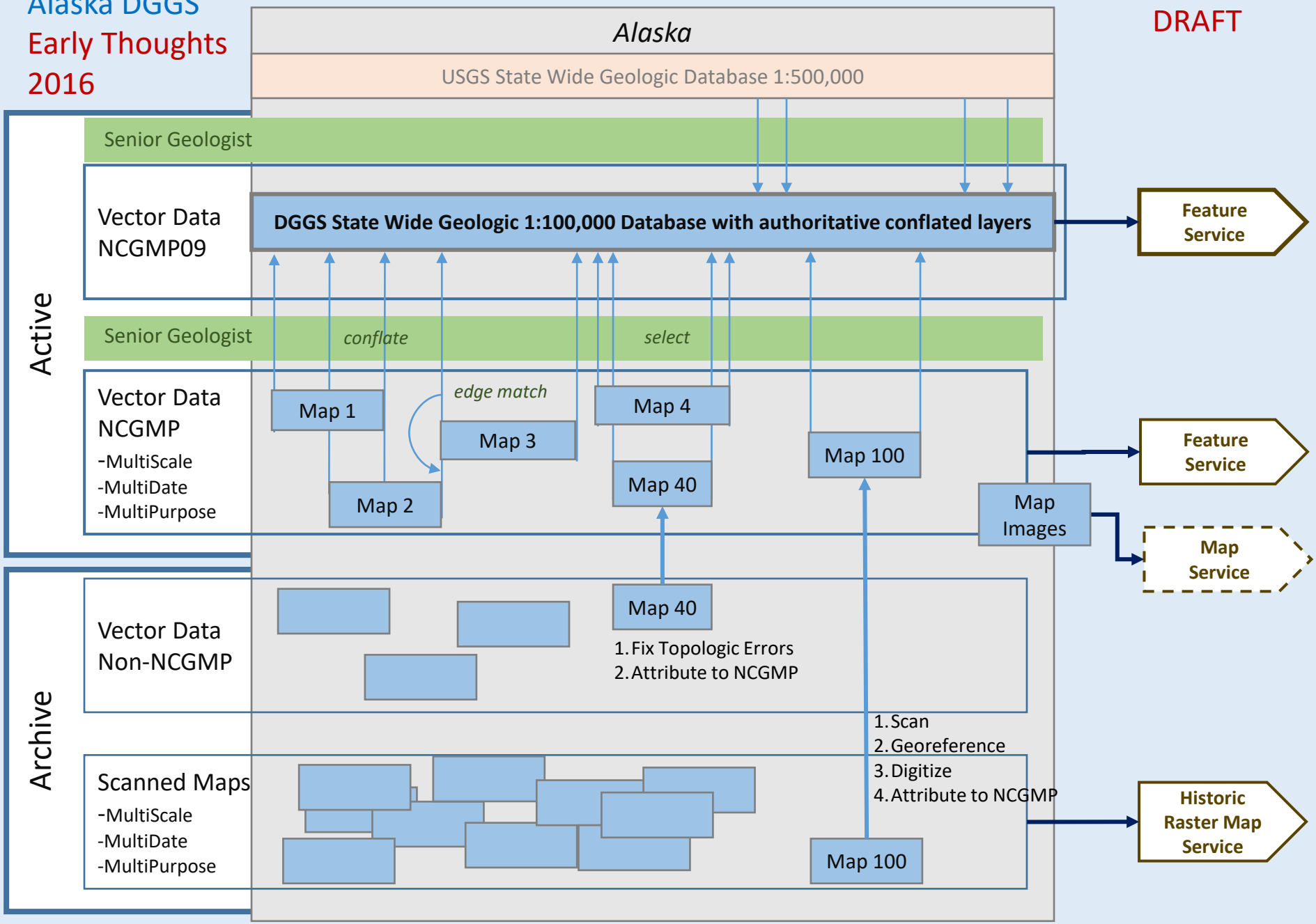
The database system infrastructure will consist of a data server, relational database management software, and utilities to interface with the DGGS LAN and GIS. The database will be available to DGGS staff through the DGGS LAN. Oracle 9i and Oracle Spatial data files will



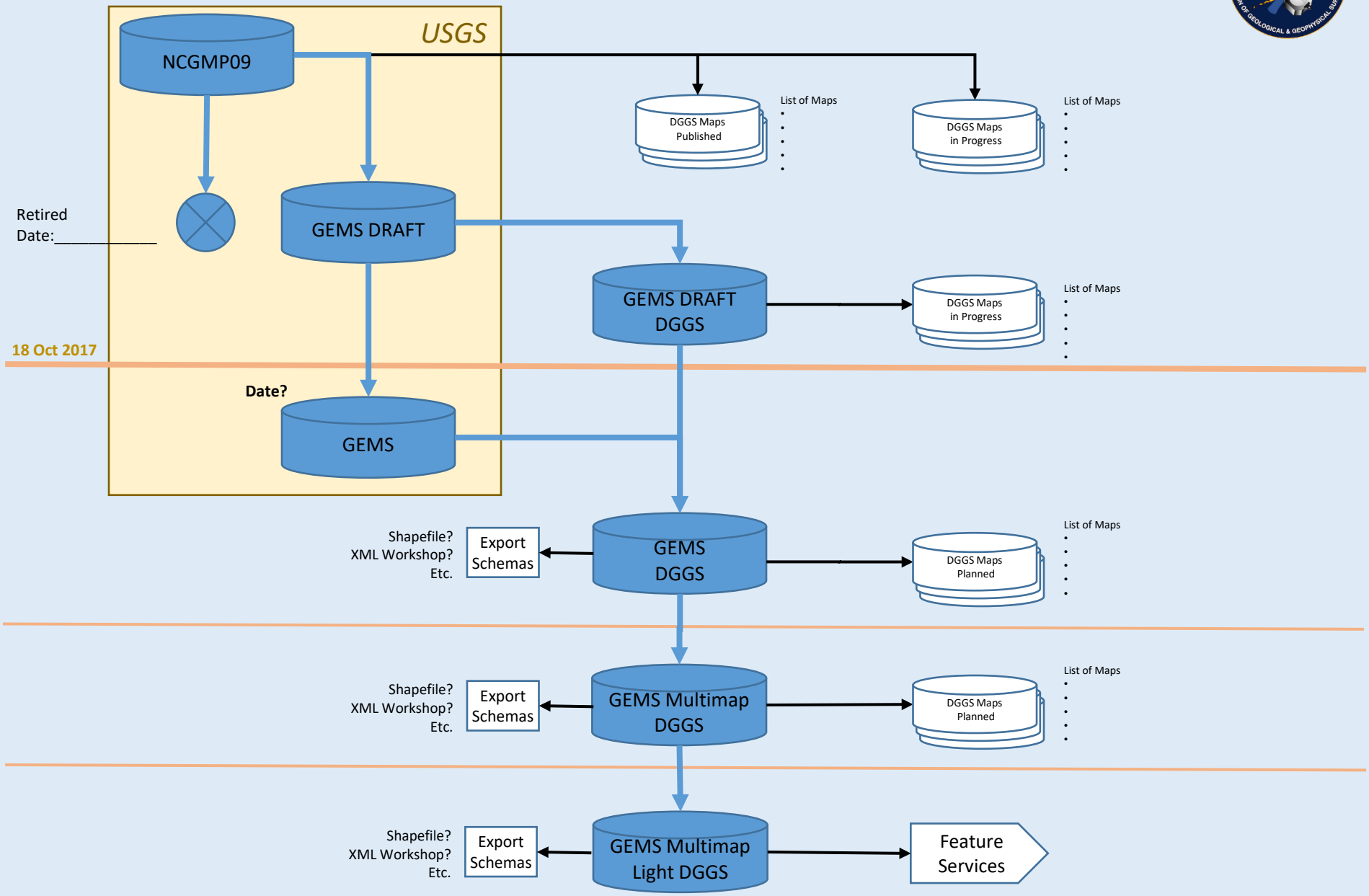
be stored on a Sun or Windows NT data server. DGGS will add ArcSDE to facilitate transfer of spatial data between project files and the database. DGGS intends to continue to use ArcGIS as a project-level geologic

2006

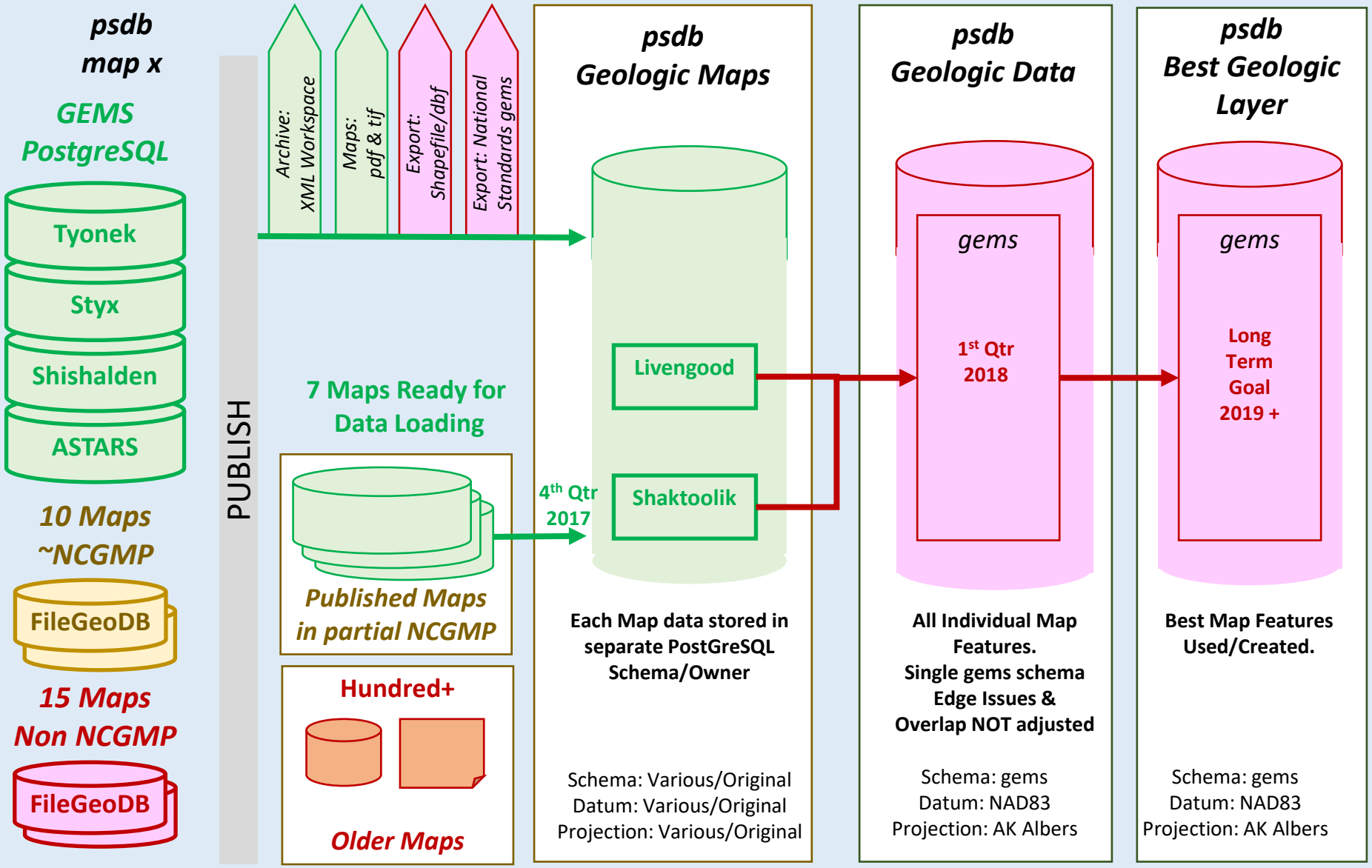

MDIRA GEOLOGIC MAP INDEX SEARCH
DGGS WEBGEOCHEM
DGGS PUBLICATION PAGES
INTERNET
INTERNET
INTERNET
MDIRA Web Server
DGGS Web Server
INTERNET
MDIRA INTERAGENCY BIBLIOGRAPHY
ODBC INTERFACE
GIS INTERFACE
INTERNET
State WAN
DGGS LAN
DGGS LAN
DGGS LAN
MDIRA INTEGRATED DATA DELIVERY
DGGS Geologic Database "GERILA"
WEB BASED DATA INPUT FORMS


Alaska DGGS
Early Thoughts
2016
DRAFT
Alaska
USGS State Wide Geologic Database 1:500,000
Active
Senior Geologist
Vector Data
NCGMP09
DGGS State Wide Geologic 1:100,000 Database with authoritative conflated layers
Feature Service
Senior Geologist
conflate
select
Vector Data
NCGMP
-MultiScale
-MultiDate
-MultiPurpose
Map 1
Map 2
edge match
Map 3
Map 4
Map 40
Map 100
Feature Service
Map Images
Map Service
Archive
Vector Data
Non-NCGMP
Map 40
1. Fix Topologic Errors
2. Attribute to NCGMP
1. Scan
2. Georeference
3. Digitize
4. Attribute to NCGMP
Scanned Maps
-MultiScale
-MultiDate
-MultiPurpose
Map 100
Historic Raster Map Service

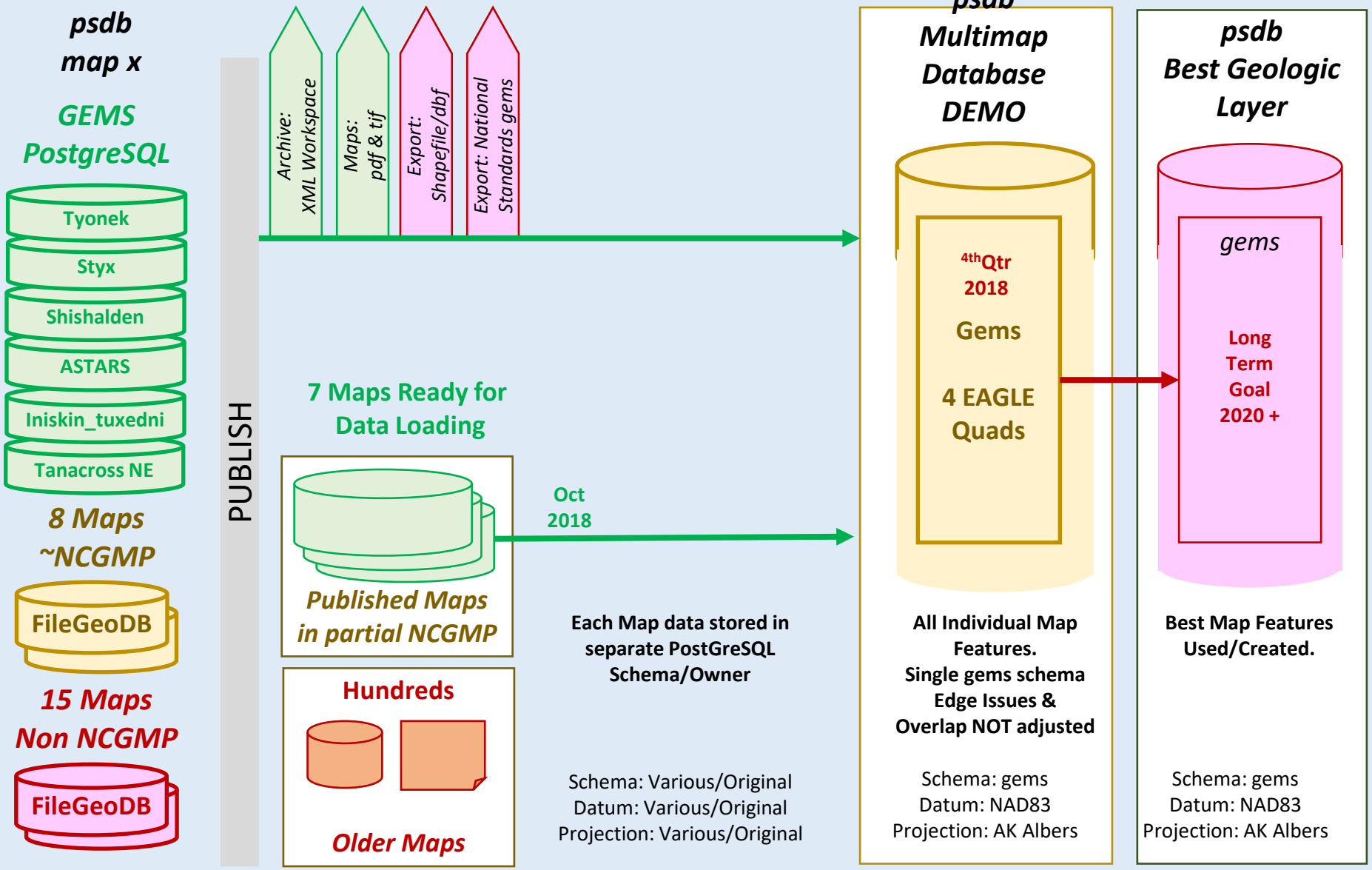
2017 Geologic Map Schema History & Future



Geologic Map Production & Management System
STATUS – 20 Nov 2017

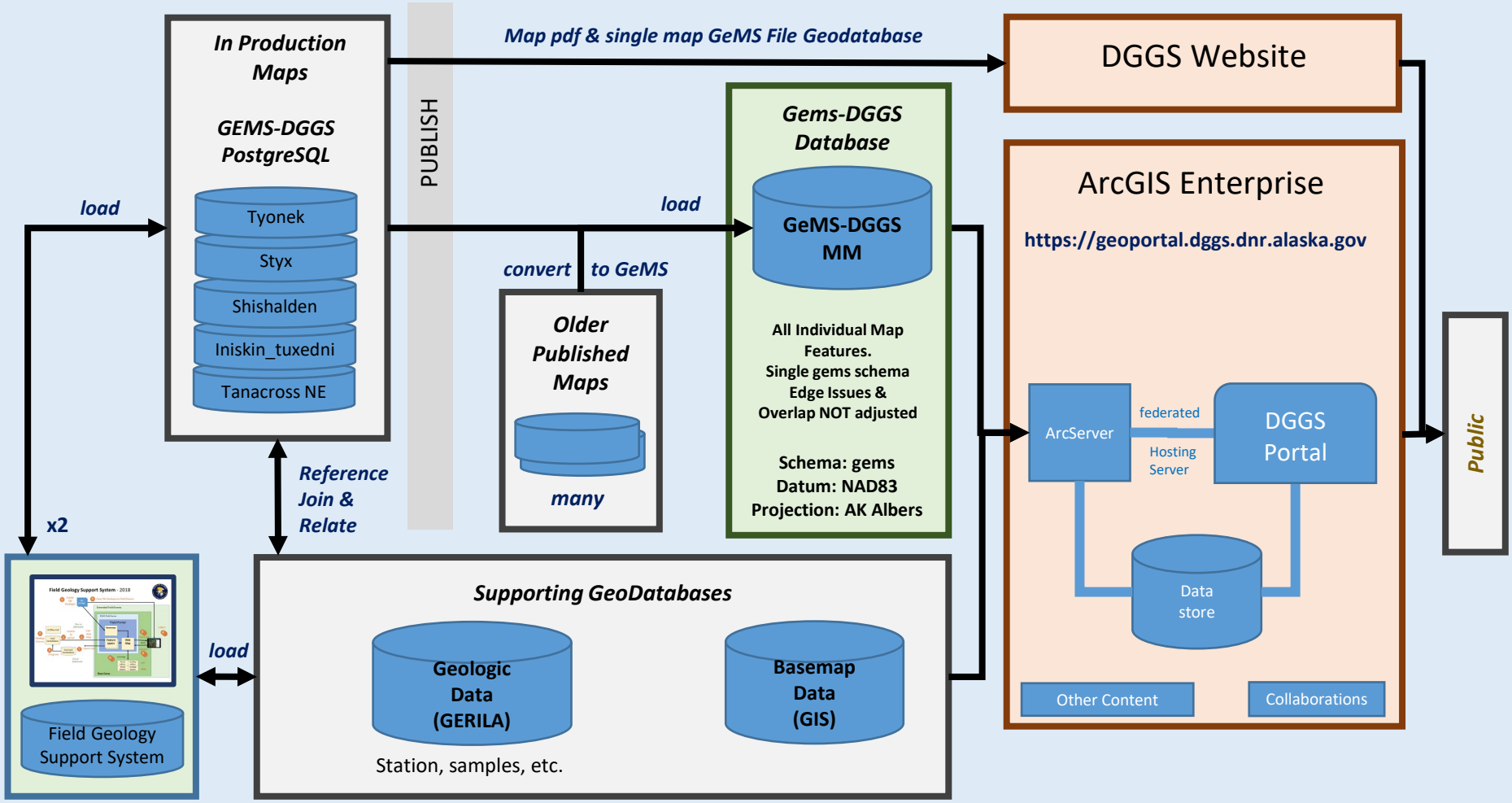


Geologic Map Production & Management System
STATUS – 08 Oct 2018



May 2019

AK DGGS Geologic Map Production & Management System

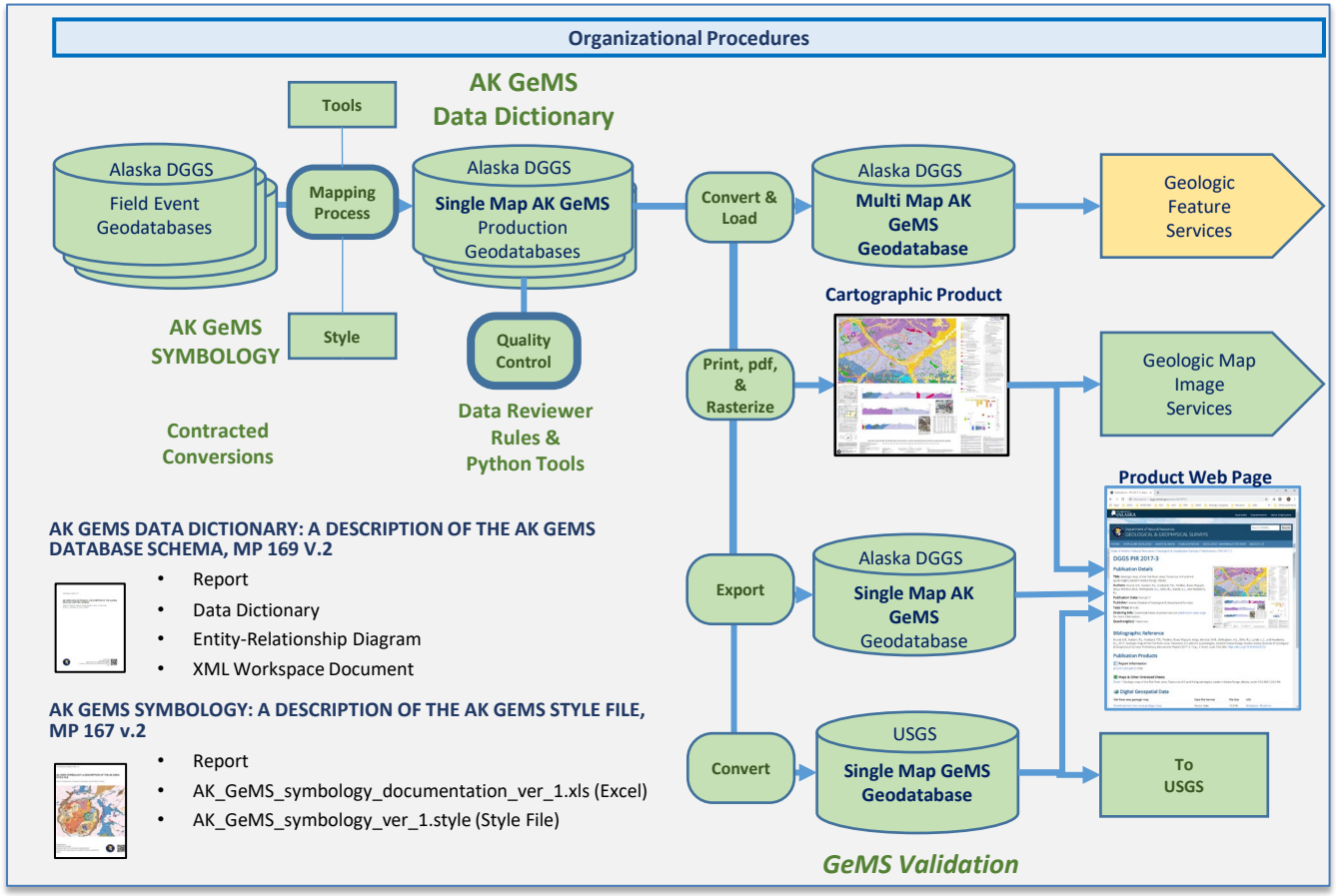


Back to the Present

Alaska Geologic Mapping System Overview

AK GeMS Recent Efforts

- Developed a **comprehensive AK GeMS Production Workflow** & Task List
- Developed a semi-automated **quality control process**
- Published **50+ AK GeMS Databases**
- Populating our **multi-map geodatabase** and began development of multi-map services and web apps
- Finalizing **Version 2.0** of published standards

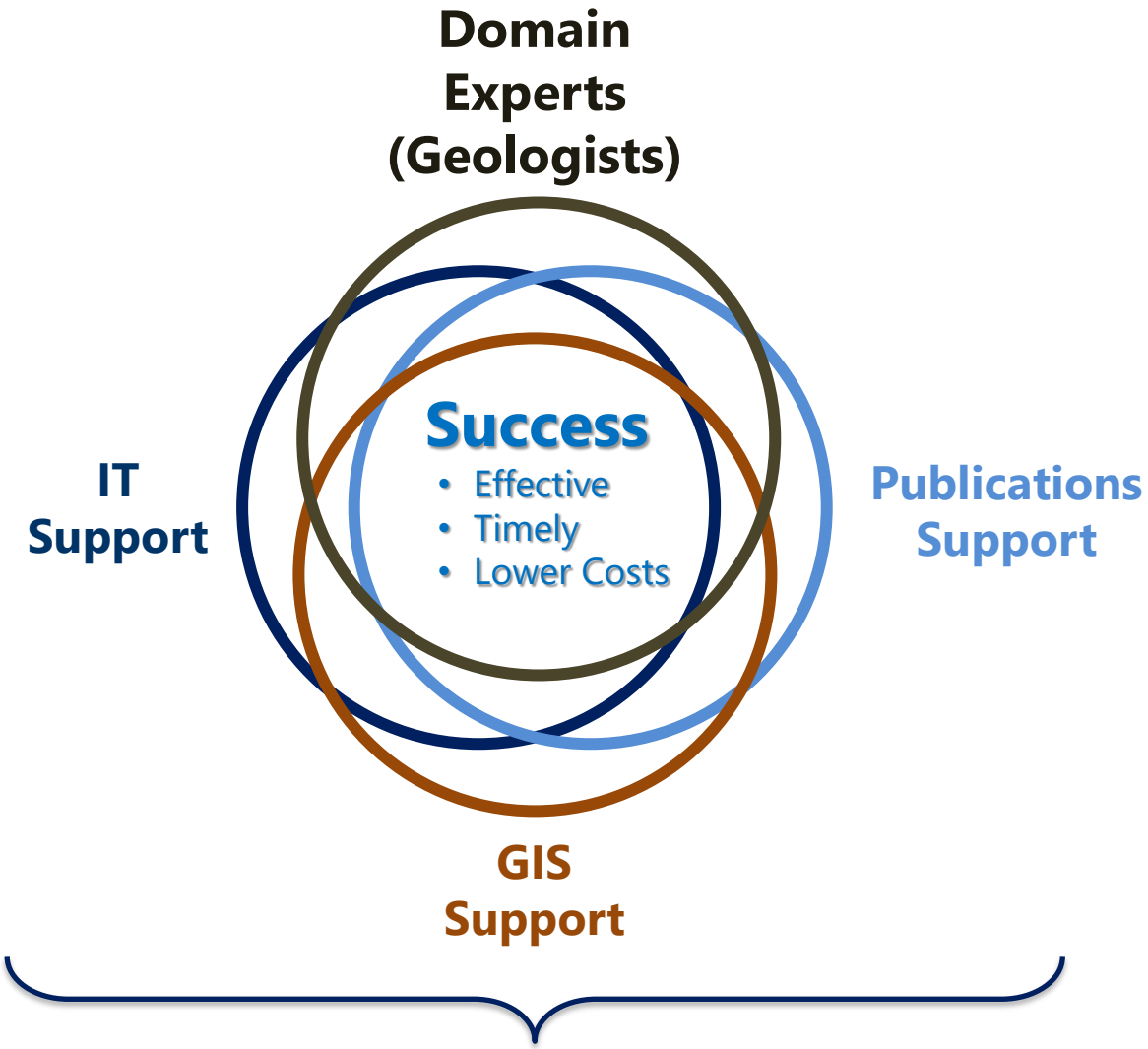


This system controls the process of:
collecting, producing, converting, packaging, publishing, and sharing geologic map data.

Alaska Geologic Mapping System Overview

Integrated Team Is Essential!

- **Dedicated and Embedded IT support** at the Division Level is Absolutely Critical
- **Regularly scheduled coordination meetings:**
  - Weekly GEDI meetings (Geologic Data Inquiry)
  - Bi-weekly Division Publications Meetings
  - Weekly GeMS Multimap Meetings
  - Individual Product Production Status Meetings
  - Other Spin Off Meetings
- **Emphasis on Training:**
  - Weekly GIS Tips & Tricks
  - Illustrator sessions
  - ESRI Training emphasis
  - One-on-one training and support from IT, GIS, & Publications



GIS Data and Symbology Standards

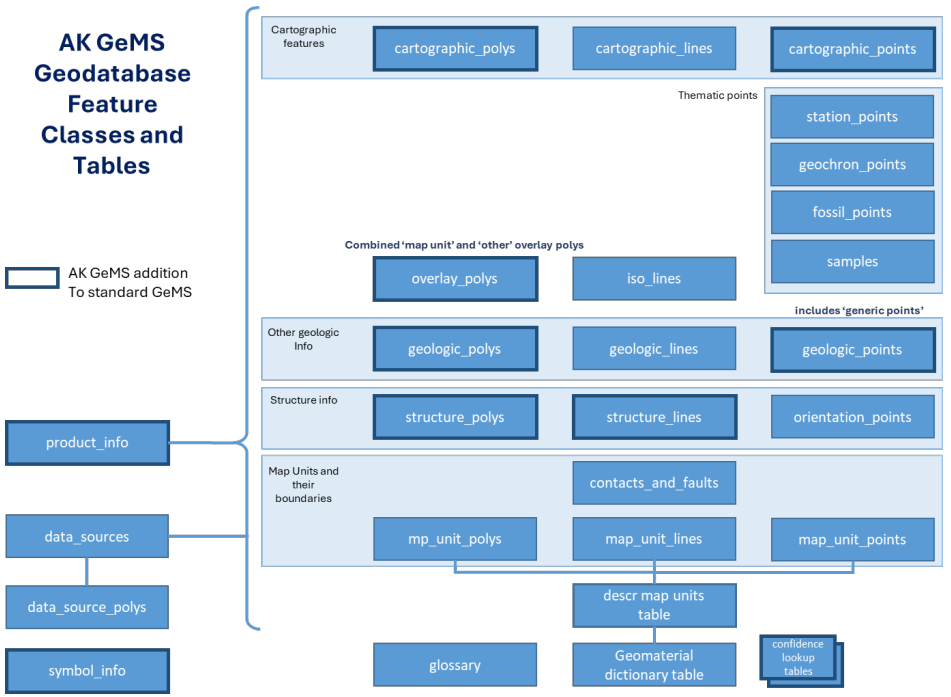
AK GeMS Data Dictionary

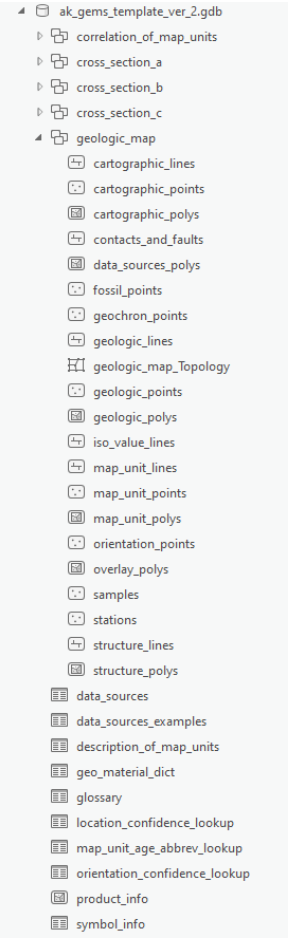
Key Aspects

- Increased focus on **modeling geologic features**
- Capable of **exporting to National GeMS**
- Capable of supporting **both single-map** geodatabases as well as the DGGS **multi-map** enterprise geodatabase (PostGreSQL)
- Support **multiple geologic layers** (i.e. bedrock, surficial, others)
- **Formalized pick lists** as attribute domains.
  - Over 75 domains
  - Over 400 controlled & defined values
- **Well documented**

Version 2.0 scheduled for June 2024

AK GeMS Schema





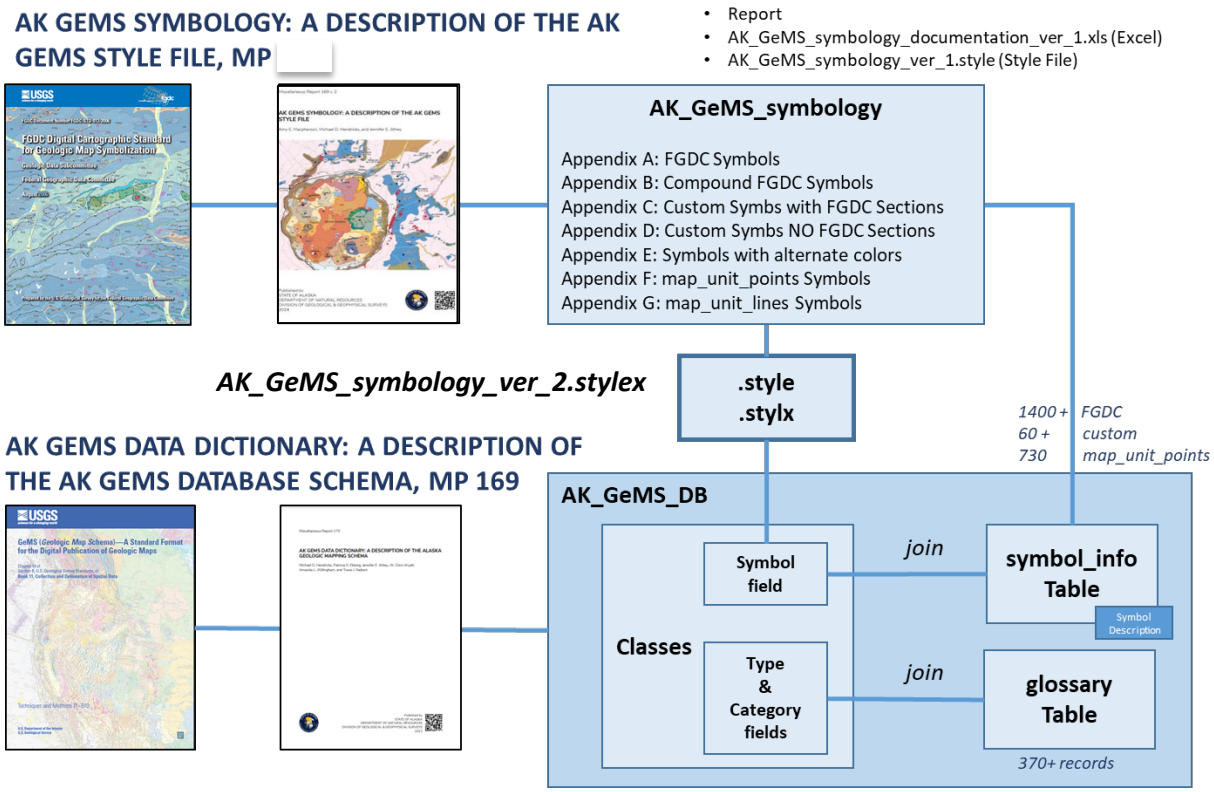
AK GeMS Data Dictionary: A description of the AK GeMS database schema, MP 170
https://dggs.alaska.gov/pubs/id/30669

GIS Data and Symbology Standards

AK GeMS Symbology

- Alaska DGGS has developed and **published a GeMS symbology standard** and accompanying **style file**
- **Describes the organization and content of the style file** used by DGGS for the Alaska GeMS map production system
- **Established procedures** for requesting, creating, coding, and documenting **custom symbols** added to our style

AK GeMS Symbology Architecture



Version 2.0 published March 2024

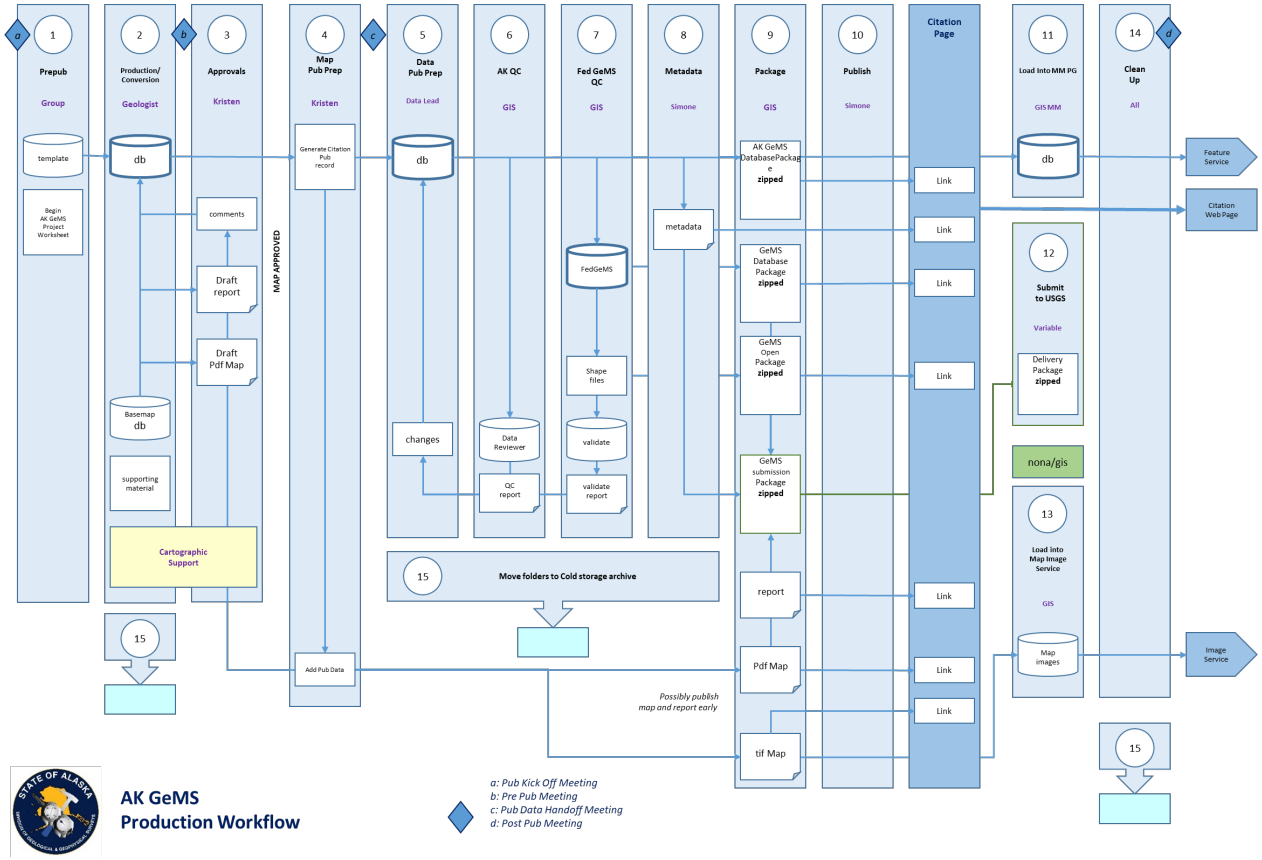
AK GeMS symbology: A description of the AK GeMS style file, MP 169 v. 2
https://dggs.alaska.gov/pubs/id/31101

Well-defined organizational procedures are critical

AK GeMS Production Workflow

Key Aspects

- The backbone of our procedures is our **AK GeMS production workflow graphic**
- This workflow is a **16-phase process** that takes a map and its data from pre-publication though production, quality control, publication, and archiving
- The workflow identifies:
  - **Order**
  - **Responsibilities**
  - **Location of data**
  - **Production meetings**
  - **Products**



CDEFG-Identified Specifications for a system supporting a Multi-Map Database

- Early in the development process, CDEFG group members identified **29 key specifications** for a multi-map database.
- These specifications helped develop the development of all aspects of the Alaska Geologic Mapping System.
- Overall, we rate the Alaska Geologic Mapping System with a **current score of 2 out of 3 based on these specifications**.

Importance (1-3)	Acceptance	Specification	Category	Grade	Notes
1.08	accepted	Topologic consistency	DB model	3	All data is checked for topologic consistency with both AK GeMS QC and GeMS Validation scripts and tools. In addition, we ensure all contacts and faults are planarized.
1.15	accepted	Data are queryable across multiple maps	DB model	3	Yes when contained with the multimap database.
1.23	accepted	Flexible model	DB model	2	Our AK GeMS data model allows for flexibility in a number of ways.
1.31	accepted	Manage multi-scale, multi-temporal data sets.	DB model	2	We have numerous scaled data that is included in our geodatabase. We have not addressed temporal changes beyond tracking the data of publication. However, our archiving enabled multimap geodatabase have the ability to track changes in the database over time.
1.31	accepted	Ease of use for staff	General	2	The Alaska Geologic Mapping System is well documented. However, to address all aspects that wanted to addressed the system has a lot of components and as a result is not overly simple to use.
1.31	accepted	Tool to check data sets/structure for errors	Tools	3	We have a robust set of technology and scripts to check for errors.
1.31	accepted	Schema, scripts, and other reusable components will be made available through Github (or some other commonly used open source code host) and the NGMDB website as appropriate	workflows	1	We have set up a Github site but have not implemented it yet.
1.38	accepted	Scalable – some data sets will be huge.	DB model	2	Our system on an Enterprise Geodatabase is scalable. We however, have not completed all testing.
1.38	accepted	Have the database structure and/or scripts enforce QA/QC	DB model	3	Our QA/QC process enforces quality. The ArcPro implementation in our next version will embed QA into the database much more than the ArcMap capability.

Importance (1-3)	Acceptance	Specification	Category	Grade	Notes
1.38	accepted	Reasonable speed of access to data	Technical	2	Our system on an Enterprise Geodatabase is scalable. We however, have not completed all testing.
1.42	accepted	Allow single and multi-map unit descriptions	DB model	3	The DMU table stores unit descriptions. In addition we employee a DMU_GUID field with the map unit poly, line, and point features classes to ensure we relate to the correct unit description within our multimap database.
1.46	accepted	Manage bibliographic information and metadata	DB model	2	
1.46	accepted	Common vocabularies stored as tables in the database	DB model	3	Our glossary table defines all domain values, as well as other required values. We currently have 375 defined items in the glossary.
1.46	accepted	Ability to integrate with data in	DB model	3	The uses of GUIDs, and key fields
1.54	optional	Tool to create FGDC or ISO	Tools	2	Metadata creation for GeMS Databases is semi-automated.
1.62	accepted	Reuse the NCGMP09 Glossary, DataSources, DescriptionOfMapUnits, GeologicEvents, and StandardLithology tables for multiple maps	DB model	2	We have a standard Glossary in AK GeMS.
1.62	accepted	Create compilation maps more efficiently	General	2	Having more and more of our geologic map data in a single database with a single schema is conducive to creating compilation maps.
1.62	accepted	Low administrative and technical overhead	Technical	2	Though we have automated and semi-automated procedures to work with AK Gems Single Map, Multi Map and GeMS required considerable technical expertise.
1.62	accepted	Facilitate data services	Technical	2	The ESRI environment that we employ makes creating services from the data stored in our enterprise multi-map database relatively straight forward. Symbology is challenging for feature services.

Importance (1-3)	Acceptance	Specification	Category	Grade	Notes
1.69	accepted	Common unit descriptions	DB model	1	We do not have a common unit description list at DGGS.
1.69	accepted	Provide standardization across geologic data sets in multiple organizations	General	2	Having an established map database standard at the national level is helpful for data sharing. However, this national standard does not always meet the needs of State geologic surveys. Our extension to GeMS, the AK GeMS is specific to the Alaska DGGS, but maintains the ability to convert between the two.
1.69	accepted	Allow for tools and scripts to be built to increase efficiency	General	3	Building the system within the ESRI environment allows multiple level of user to create and use tools to increase efficiency.
1.69	accepted	Enable metadata to be harvested by other data	Technical	3	Our embedded and standalone mxl metadata files are easily harvested.
1.77	optional	Manage original data – either in the same database or a relatable database.	DB model	2	Our Alaska Geologic Mapping System has organizational procedures to store original field and production data. The AK GeMS Schema and resulting geodatabase, however, does not store original data.
1.85	optional	Manage analytical data	DB model	0	Our system does not dictate a field collection schema.
1.92	accepted	Manage unpublished data.	DB model	3	We have a distribution policy field in all tables to store the how each record can be shared.
2.08	optional	Manage field data	DB model	0	Our system does not dictate a field collection schema.
2.38	optional	Manage ephemeral interim products and processes, such as unpublished interpretations etc.	DB model	0	Our system does not explicitly manage this.
	optional	Manage multi-scale, multi-temporal, and multi-dimensional (3D mapping) data sets.	DB model	2	The AK GeMS database schema does not address true 3D data.

Strengths
of the Alaska Geologic Mapping System

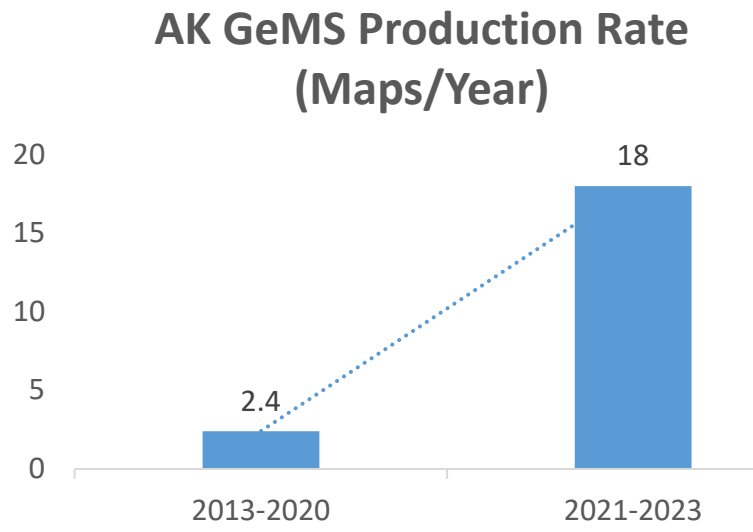
Establishing a more standardized and documented system based on published data and symbology standards is a success.

DGGS now produces higher quality standards-based map products at a significantly faster rate than in the past.

Between 2013 and 2020 we published 19 new geologic maps, (in various data formats), at a production rate of 2.4 a year.

With the Alaska Geologic Mapping System operational we have published, since 2021, 7 new maps and converted 45 maps into our AK GeMS data standard, at a production rate of 18 a year.

This is over a 7-fold increase in productivity!



Strengths
of the Alaska Geologic Mapping System

- **Extending GeMS** to include Alaska requirements allows DGGS to implement additional capability while still retaining the ability to deliver GeMS-compliant data.
- A comprehensive, well-established geologic mapping system ensures that all aspects of production are considered and addressed, which **increases efficiency and decreases confusion**.
- A standardized, published database schema with established, defined domain values dramatically **improves efficiency, data assurance, and data quality**.
- **Metadata production is more efficient** and comprehensive. What used to take sometimes a week per map to create metadata can now easily be accomplished in an hour.

Strengths
of the Alaska Geologic Mapping System

- Having a managed **multi-map repository geodatabase** provides DGGS an single location to find authoritative geologic map data in a standard schema.
- A comprehensive and well-documented **style file** customized for Alaska geology enhances cartographic standardization across DGGS products.
- A well-established and documented **workflow** dramatically increases organizational efficiency.
- The establishment of automated and semi-automated **quality assurance and quality control** procedures has improved data quality.
- Customized geoprocessing tools have increased efficiency.
- Moving toward a more database-focused product that has value beyond the cartographic product is important for future access to information.
- The division's emphasis on training is a critical strength of the overall system.

Weaknesses
of the Alaska Geologic Mapping System

- The system can be complicated for both the general user and administrators.
- Converting between AK GeMS and GeMS is supported but requires tools to make this efficient.
- Handling layered units (surficial/bedrock) has been a challenge. We have added a field named layer and documented processes to employ its use, but we still have not come up with a well-defined process or tool to support working in a multi-layered environment.
- Workflows for compilation databases are not yet established (however, they are being discussed).

AK GeMS Multi-Map Scalability Testing

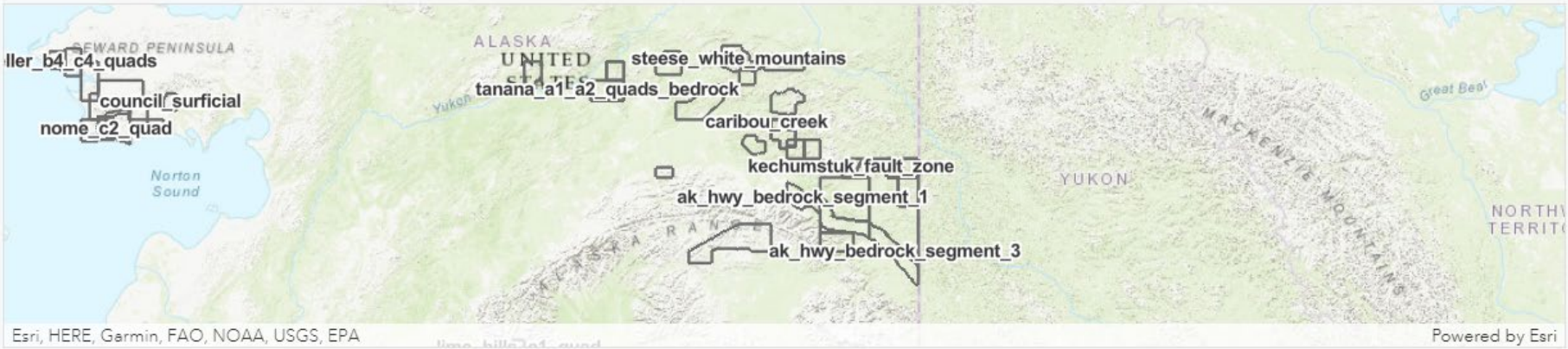
- As of June 26, 2023, the AK GeMS multi-map database held 51 geologic map database products. To test the scalability of the multi-map database, we loaded a very large database, the “Geologic Map of Alaska” (GMA; Wilson and others, 2015), into the Test environment. Adding the GMA increased the number of contacts and faults by 780 percent and map unit polygons by 913 percent.
- Test results showed a marked slowdown in display speed. The slowdown is a result of the large number of linear and polygon features. We discussed these performance challenges with Esri, who indicated that the nearly 300,000 map unit polygons and over 600,000 contacts and faults represent a very large database.
- Accordingly, Esri expected performance to be slow given the number of features, without employing procedures such as scale-dependent drawing.

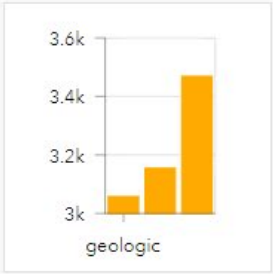
Future work

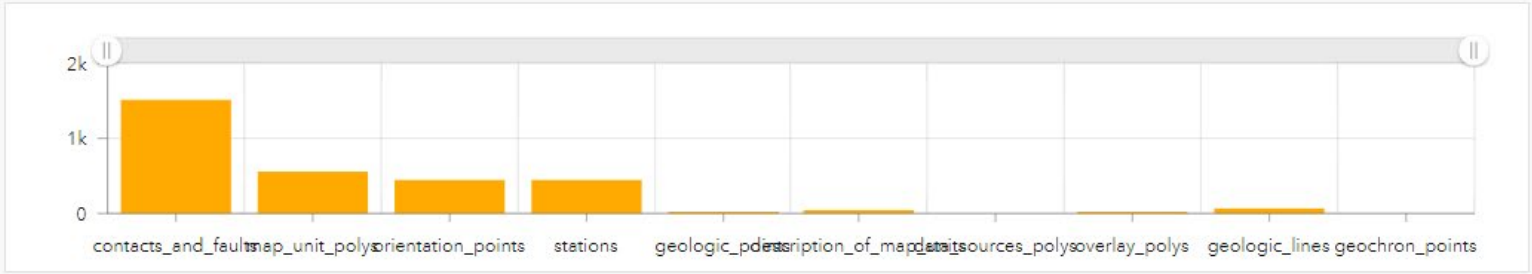
- Publication of AK GeMS version 2.0
- Adjust the schema in ver 3.0 to better support compilations and create documentation of compilation workflows (planned).
- Public and internal access to a multi-map database (in progress).
- Dashboard to display operational multi-map database statistics to increase management awareness and monitoring (in progress).
- Develop and implement web friendly symbolization for geologic map feature services and map services (in progress).
- Continue cartographic support and evolution (e.g., workflows for the generation of cross sections and legends) (in progress).
- Fully leverage ArcGIS Pro's ability to embed QA checks into the schema (in progress).
- Improve support for 3D data.

AK GeMS MM Product Web App Dashboard

Alaska DGGS
akdggs







Number of AK GeMS MM Databases

56

Number of AK GeMS Multi-Map Database

52