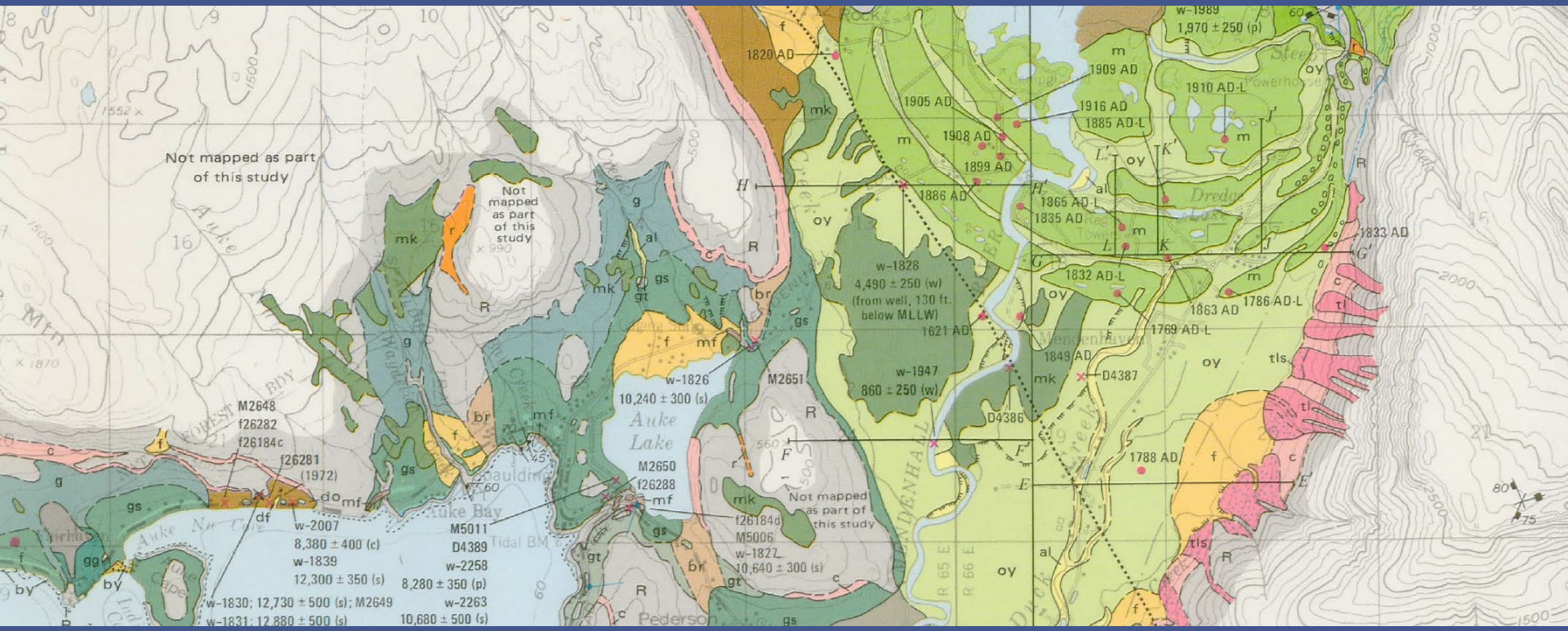
Contracting out geologic map digitization and attribution using the GeMS standard, Version 2.0



Wes Buchanan and Chris Wyatt

Alaska Division of Geological and Geophysical Surveys

Digital Mapping Techniques 2023

Anchorage, AK

May 21-24, 2023

FFY22 STATEMAP GeMS Conversions

22 GeMS conversion projects from previous publications

50/50 – **Has** legacy GIS data versus **No** GIS data available

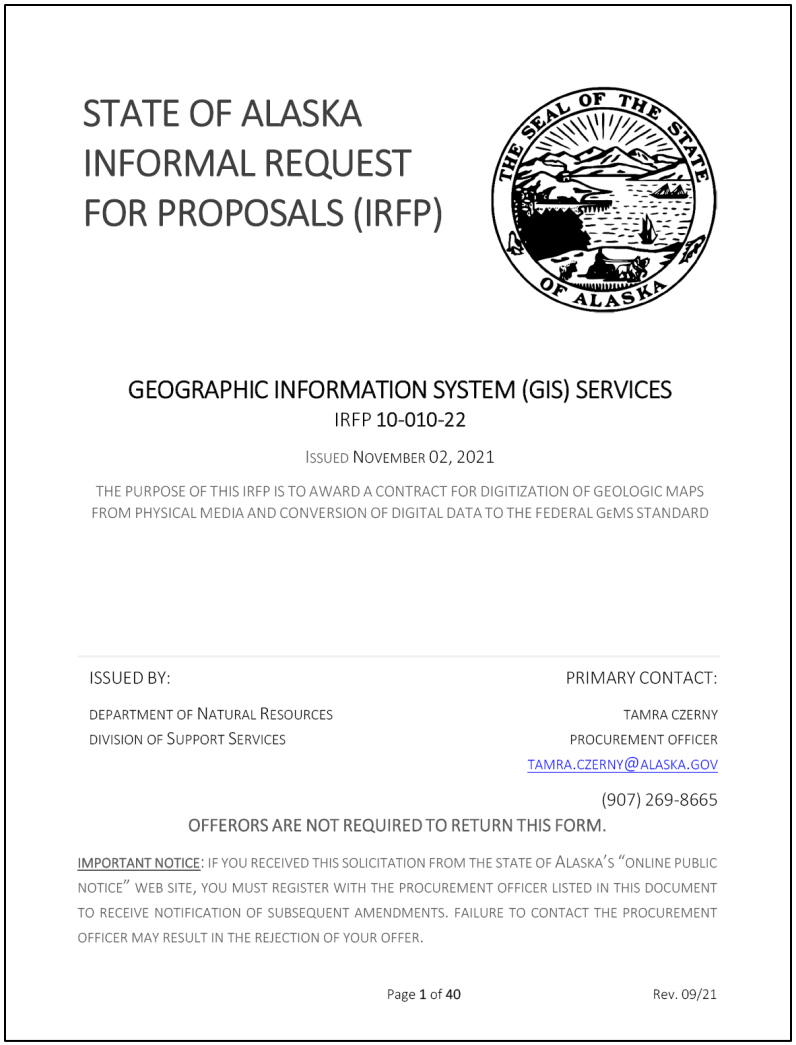
Digitization of map features needed for conversion to GeMS standard

Elected to contract out digitization – 2nd year changes in approach

Version 1.0/2.0 – Starting the Process

Request for Proposals

- Bidding procedures
- Billing details
- Minimum experience: 6 months of geoscience position working with maps and 2 years of GIS
- Technology requirements
- Documentation and available data
- Completion timetables
- Deliverables
- Communication expectations



STATE OF ALASKA
INFORMAL REQUEST
FOR PROPOSALS (IRFP)

GEOGRAPHIC INFORMATION SYSTEM (GIS) SERVICES
IRFP 10-010-22

ISSUED NOVEMBER 02, 2021

THE PURPOSE OF THIS IRFP IS TO AWARD A CONTRACT FOR DIGITIZATION OF GEOLOGIC MAPS FROM PHYSICAL MEDIA AND CONVERSION OF DIGITAL DATA TO THE FEDERAL GEMS STANDARD

ISSUED BY:
DEPARTMENT OF NATURAL RESOURCES
DIVISION OF SUPPORT SERVICES

PRIMARY CONTACT:
TAMRA CZERNY
PROCUREMENT OFFICER
TAMRA.CZERNY@ALASKA.GOV
(907) 269-8665

OFFERORS ARE NOT REQUIRED TO RETURN THIS FORM.

IMPORTANT NOTICE: IF YOU RECEIVED THIS SOLICITATION FROM THE STATE OF ALASKA'S "ONLINE PUBLIC NOTICE" WEB SITE, YOU MUST REGISTER WITH THE PROCUREMENT OFFICER LISTED IN THIS DOCUMENT TO RECEIVE NOTIFICATION OF SUBSEQUENT AMENDMENTS. FAILURE TO CONTACT THE PROCUREMENT OFFICER MAY RESULT IN THE REJECTION OF YOUR OFFER.

Page 1 of 40 Rev. 09/21

Version 1.0 – Project Implementation

Documentation

- GeMS and AK GeMS docs
- FGDC cartographic standard

Resources and Data

- Blank GeMS Geodatabase
- Link to map's DGGS citation page
- General feature templates
- Style file
- Tools and scripts

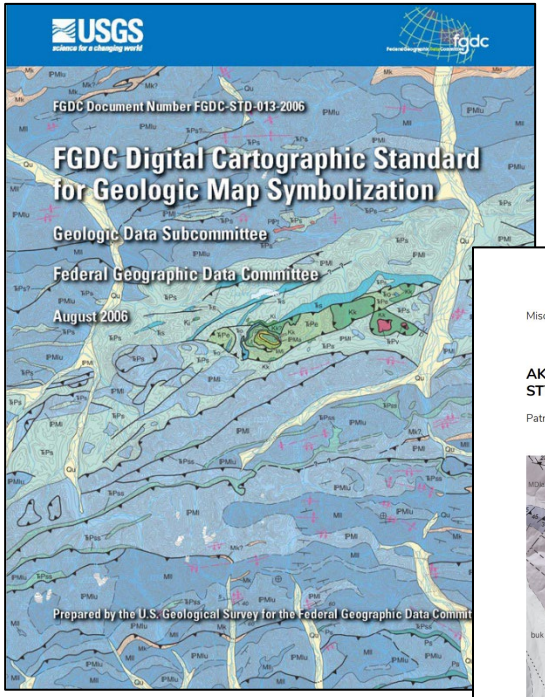
Training

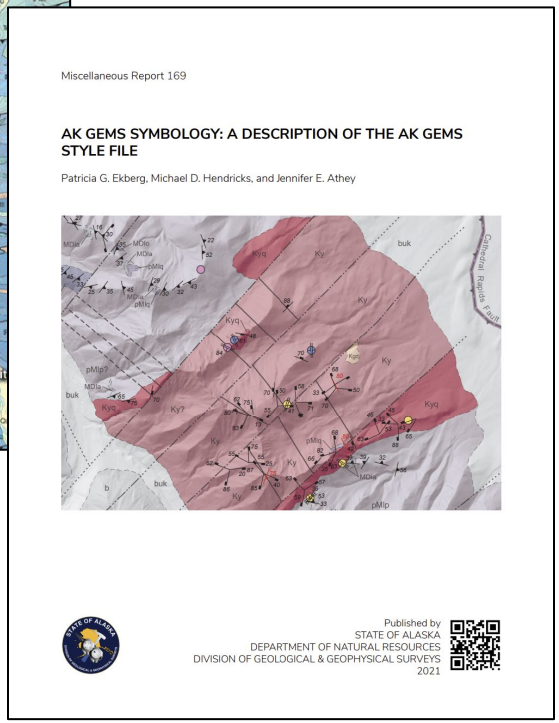
- 2 hours of GeMS basics
- Digitizing tips/tool use

Communication

- MS Teams meetings

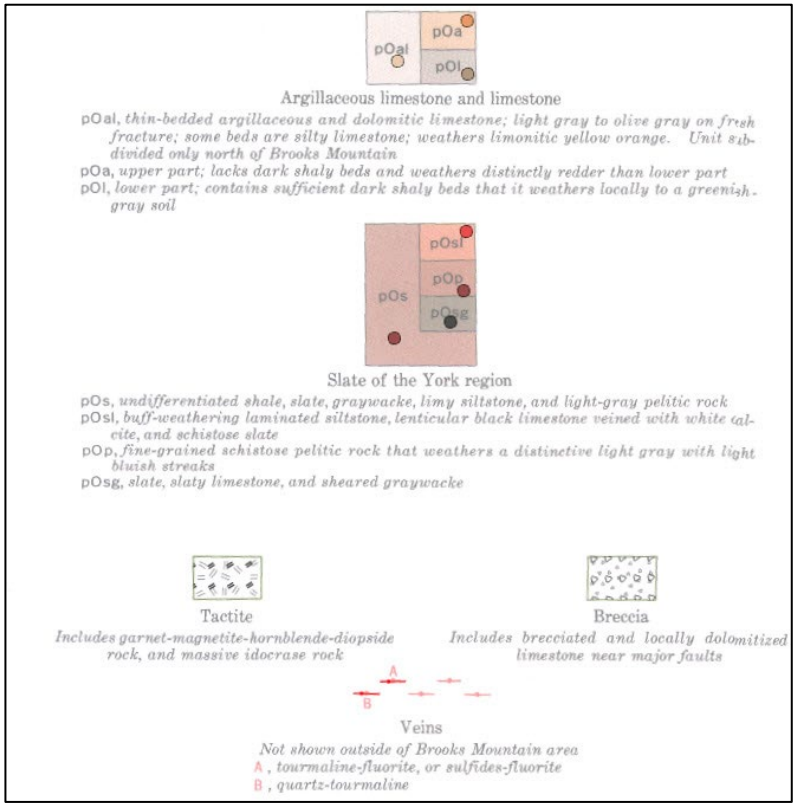
AK GeMS – Extension to the GeMS standard with additional attribute fields and feature classes





Version 1.0 – Digitizing Process

- Color/Patterns/Symbols – Figure out how to represent map features
- Fit data into generalized feature templates
- Contacts and faults linework
- Map unit points
- Build Polygons – toolbox script



Simplified AK GeMS

Heads-up digitized linework into AK GeMS feature classes:

- map unit points
- contacts and faults
- structure lines
- orientation points

- cartographic points
- cartographic lines
- cartographic polys

Version 1.0 – DGGS Quality Control Process

Map Geometry QC

- Visual scan/inspection at 2-3 times scale
- Topology Error Inspector

Attribute QC

- Every field in every table gets, at least, a glance
- Sort by different fields/attributes and spot check. Multiple errors lead to more thorough investigation

From: Wyatt, Chris (DNR)
Sent: Thursday, April 28, 2022 2:21 PM
To: Lars Arneson
Subject: council_surficial .gdb review notes

Hi Lars-- Here are some notes for the council_surficial map .gdb"
A few of these are marked on the review_items_point layer, too, attribute issues mostly.

Some of these might apply to big_hurrah_surficial as well? I'll start looking at that .gdb next.

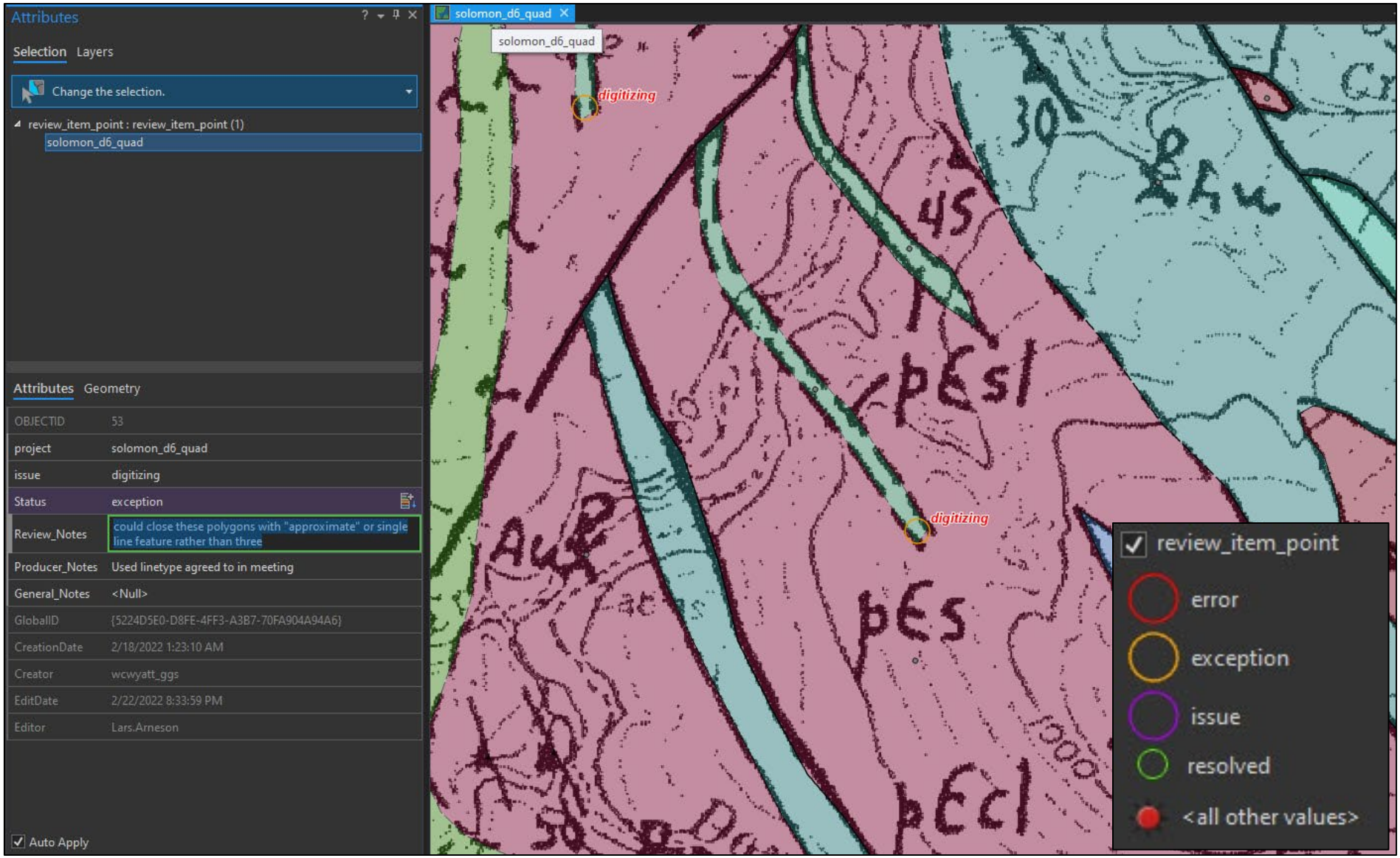
contacts_and_faults
typo in 'notes' field: "approximate"
set the notes field to match the raster PDF "MAP SYMBOL" description for these, since it's not clear from the FGDC symbol or category/type: "Photointerpreted contact – Approximately located"
'layer' field: contacts/faults that touch surficial polygons are layer = 1
contacts/faults that touch only bedrock polygons are layer = -1
faults are almost always a bedrock feature, or layer = -1
boundary = 0
This is a little tricky to assign, with a series of select-by steps to separate the surficial and bedrock features; I can populate 'layer' or show you how I do it.

map_unit_polys
'layer' field: surficial polygons are layer = 1
bedrock polygons are layer = -1
water is layer = 1
Where map_unit_polys 'label' is queried with "?", set map_unit_polys 'identity_confidence' to "questionable"

geologic_lines
flow direction indicators are missing attributes

Version 1.0 – QC Review Layer - AGOL

Pre-Cambrian slivers digitized as parallel lines instead of polygons – lacking geologic knowledge

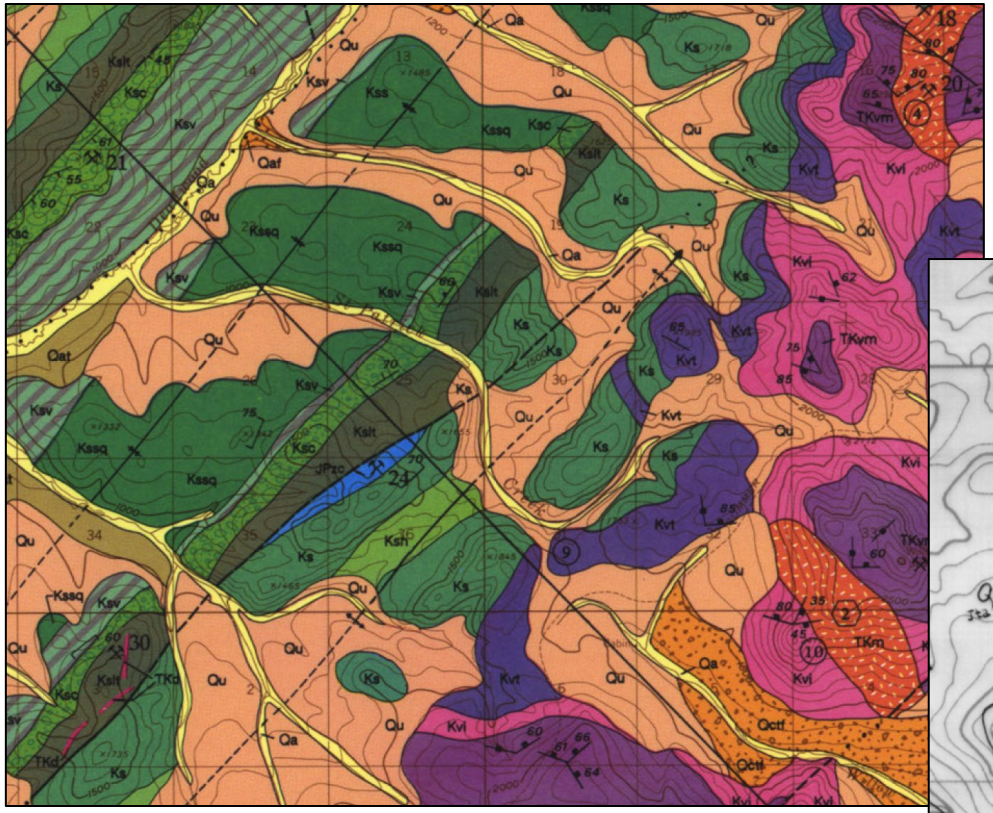


Version 1.0 – Lessons Learned

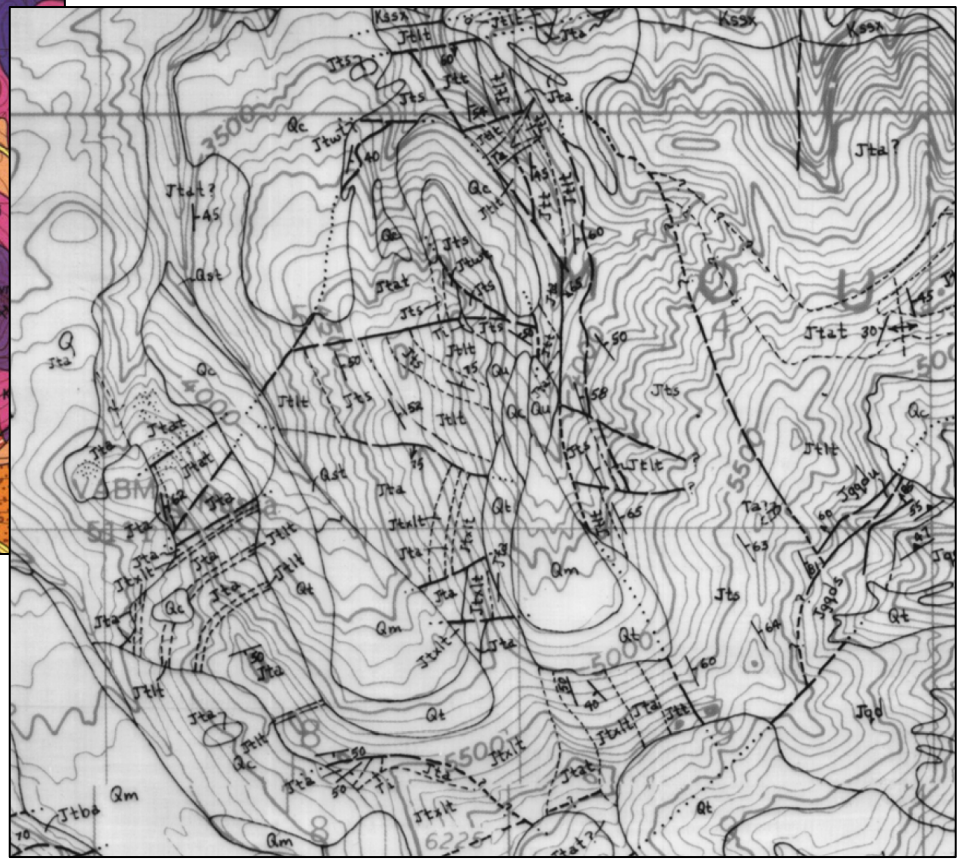
- Several map projects needed to understand categorizing/symbolizing features
- GIS proficiency is a must for the contractor (digitizing basics/portal use/data sharing)
- Geologic knowledge and map aptitude requirements could be stronger
- General feature templates provided were very helpful
- Contractor spent a lot of time digging through documentation
- Provided trainings could be broken down and progressively move into deeper topics
- Need standards for digitizing linework (vertex density)
- QC review layer on AGOL was very effective
- Communication with MS Teams was efficient

Version 2.0 – Geologic "Paper" Map to Geodatabase

Digitization of 11 map projects (13 total sheets)
Mixture of bedrock, surficial, engineering, and hazard maps

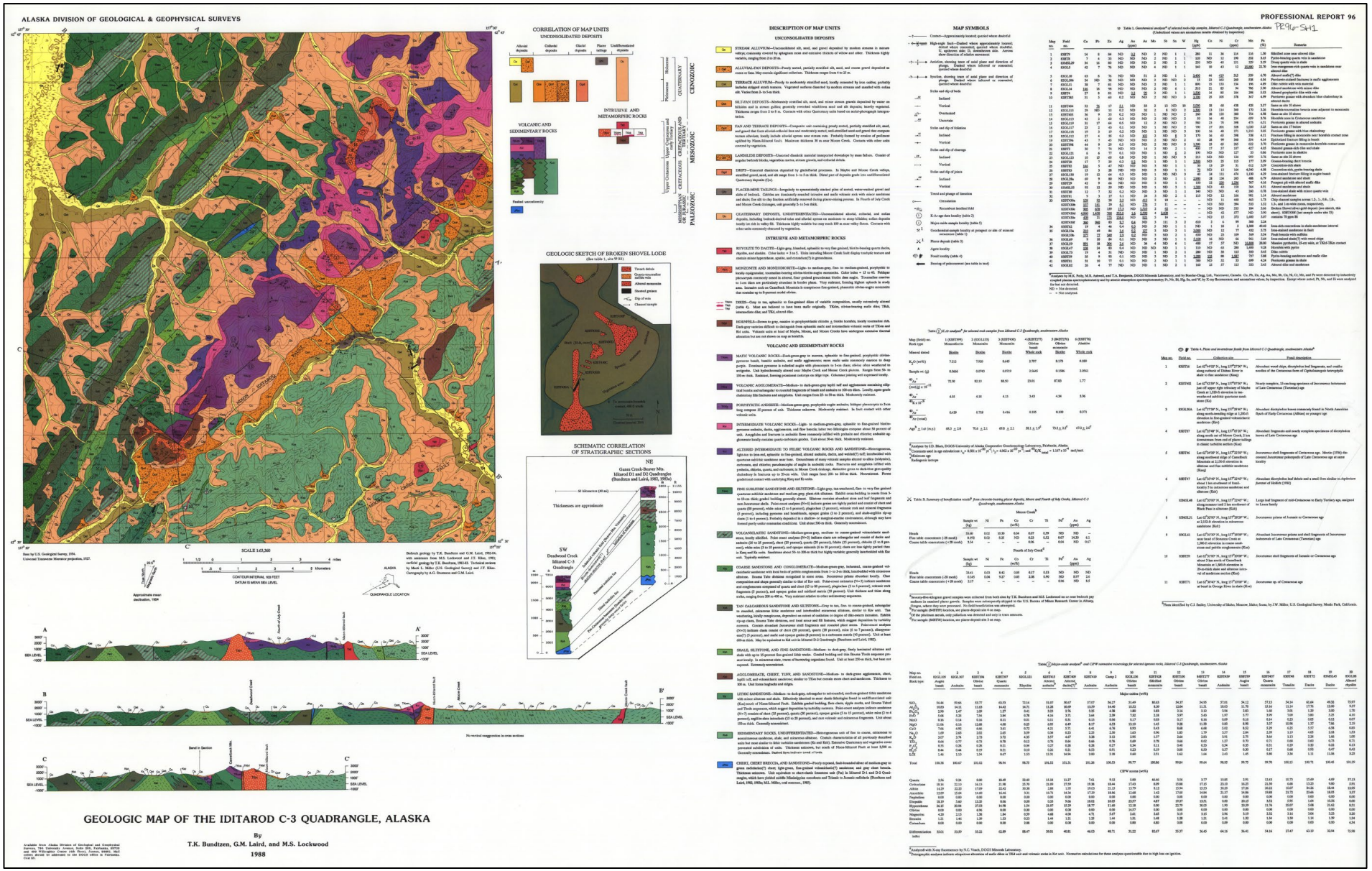


Full color and greyscale

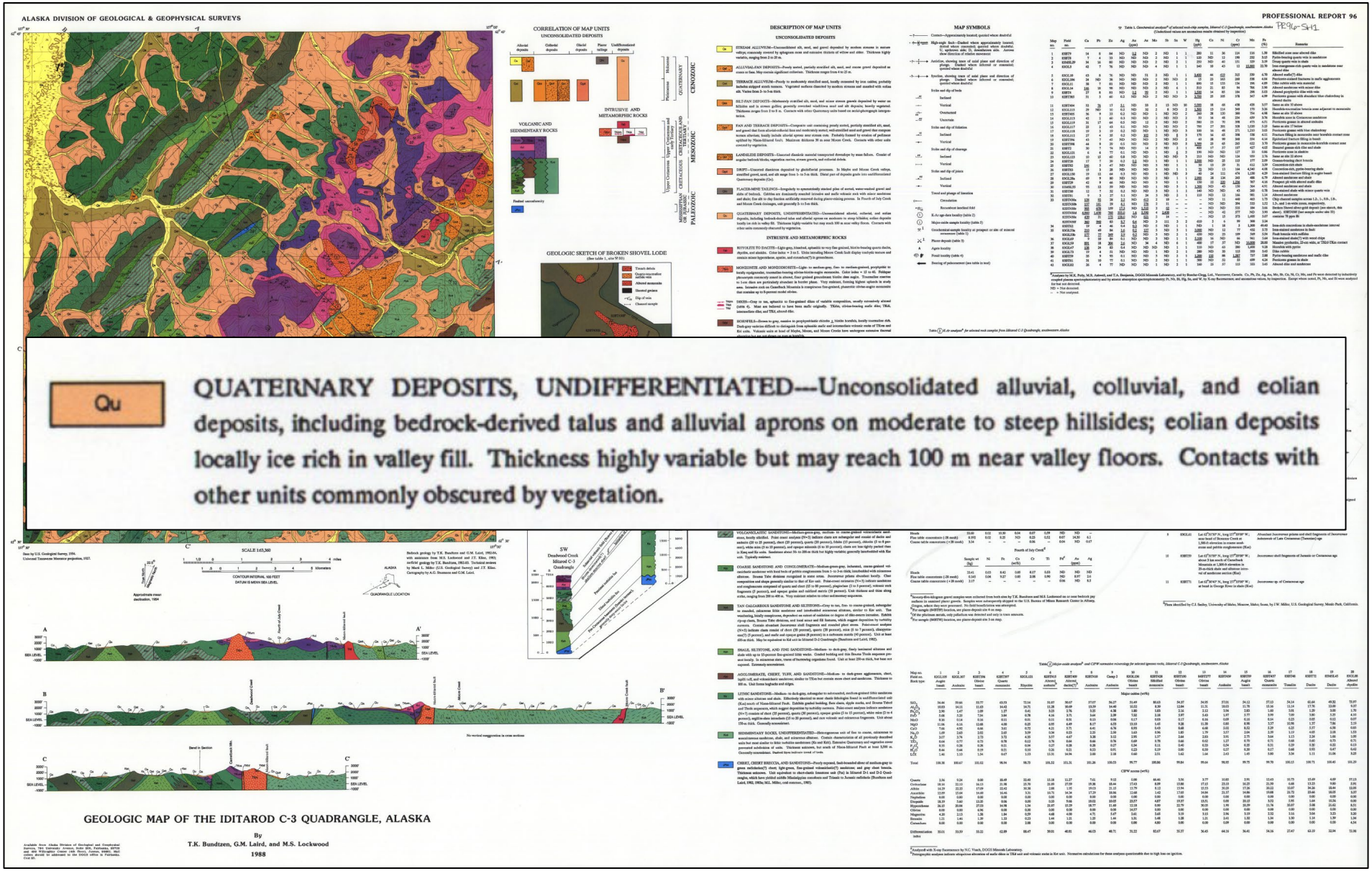


300 DPI resolution scans

Representative Map for Digitization/Conversion



Representative Map for Digitization/Conversion



Version 2.0 – Shift in Procedures

Play to the strengths of the teams involved

DGGS Strengths

- Experienced with GeMS (56 GeMS compliant publications to date)
- Knowledge of Alaskan geology
- Understanding of geodatabase structure
- Quicker problem solving for categorizing and attributing feature data

Contractor Strengths (hopeful)

- ArcGIS proficiency
- Ability for narrower task focusing (DGGS can be a hectic/busy place)
- Precise and accurate digitizing skills

Version 2.0 – Digitization/Conversion Streamlining

Project Design Aspirations

- Remove ambiguity for the contractor and reduce GeMS learning curve
- Create procedures to capitalize on strengths and maximize efficiency in order to reduce costs, project timelines, and DGGS time commitments (clarifications/QC)

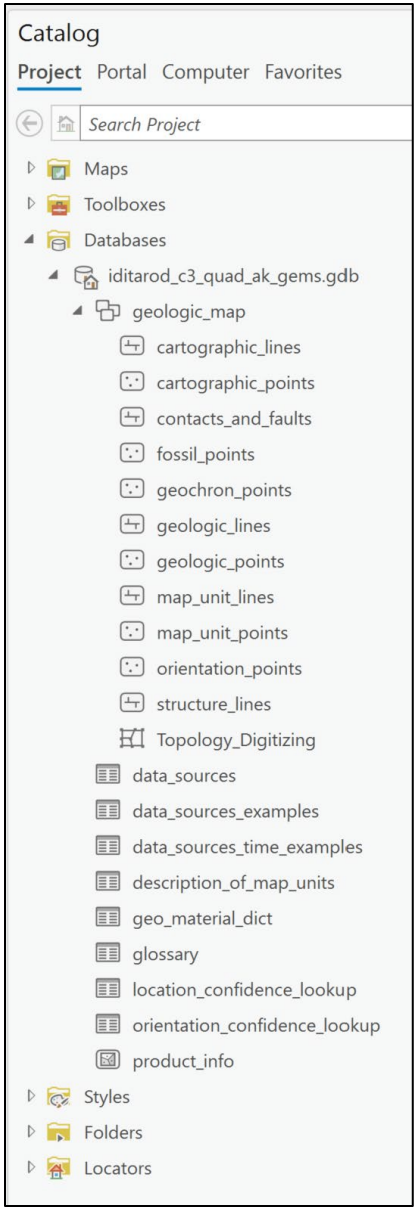
Implementation Plan

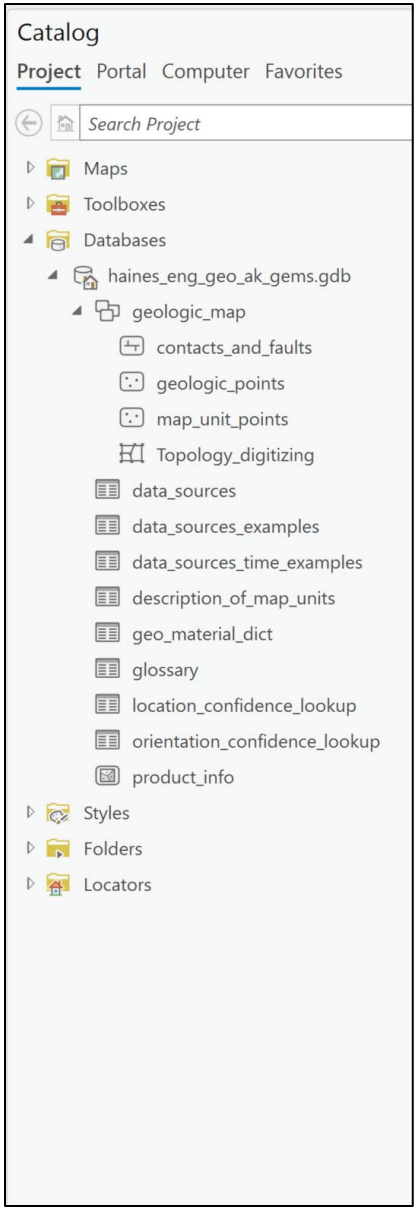
- The contractor will focus on the digitization with only essential feature attribution
- DGGS will focus on complete feature attribution and full map conversion
- Tailor make map specific packages for each conversion project based on geology
- Provide upfront the resources needed for the project - from **bidding** to **completion**

Version 2.0 - Geodatabase

Each project has an associated geodatabase

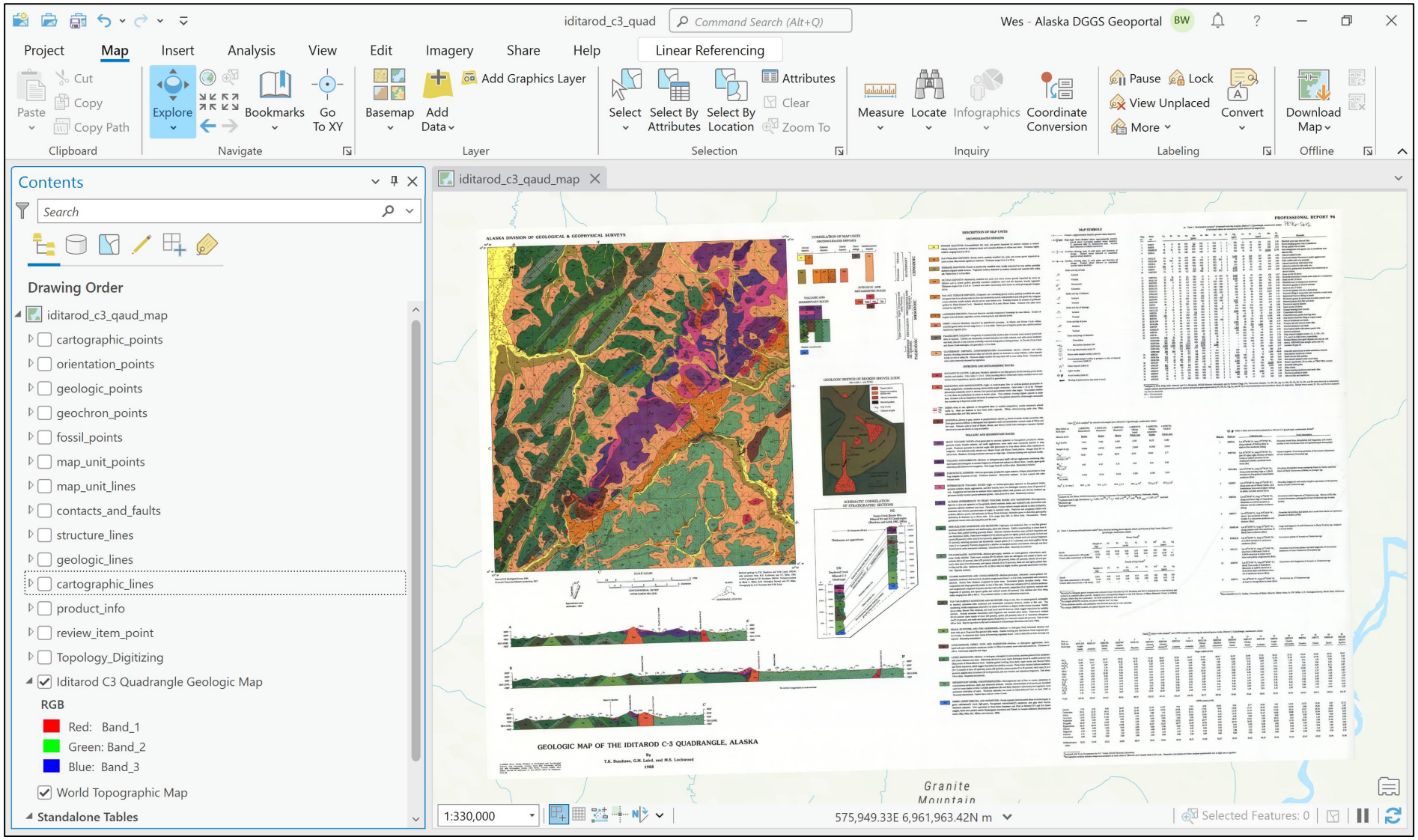
- Geodatabase has project “nickname”
- Geologic map feature dataset has correctly projected coordinate system
- Only needed feature classes are present
- Digitization directly into appropriate AK GeMS feature class
- Editor tracking enabled





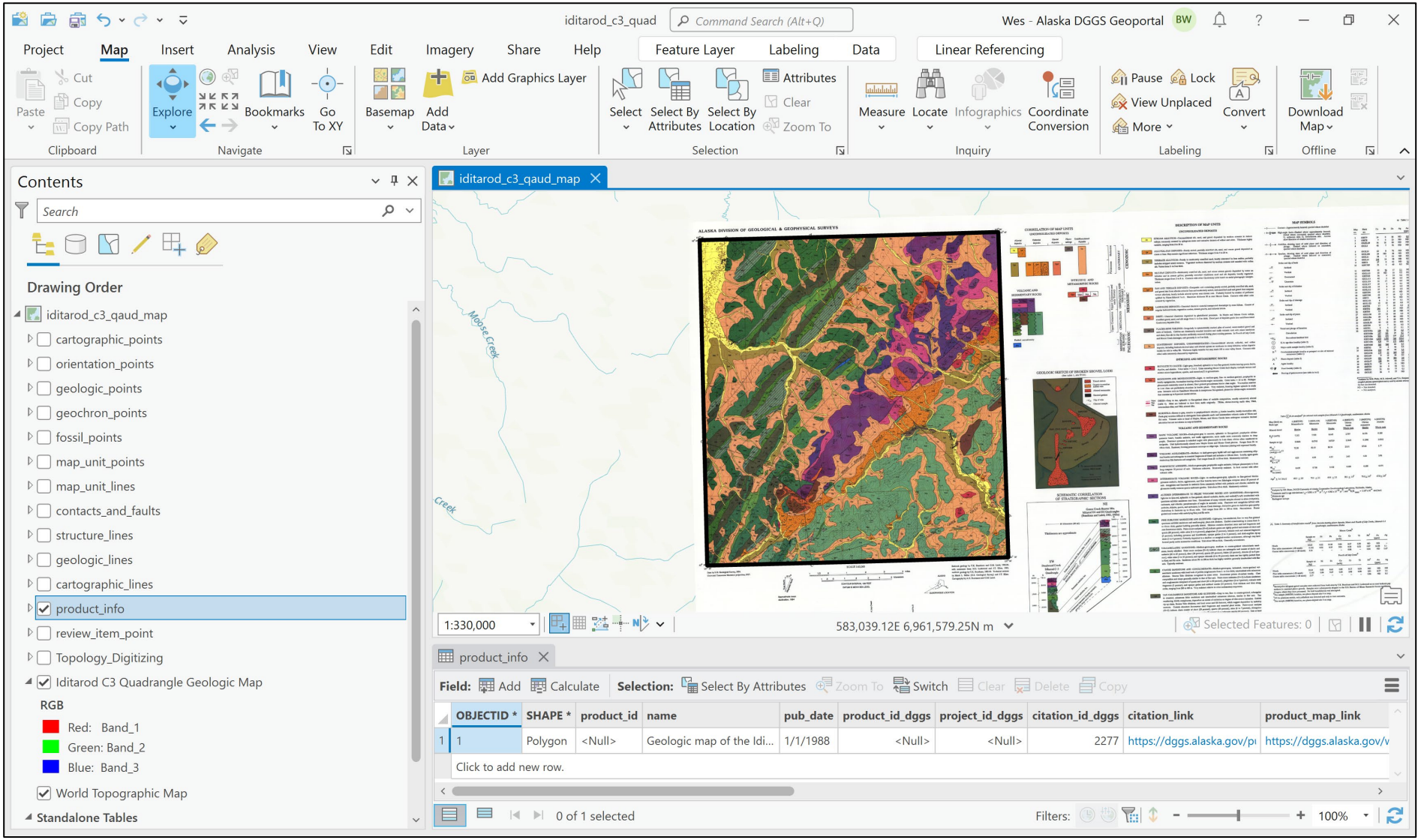
Version 2.0 – Prebuilt ArcGIS Pro Projects

- Correctly projected map frame
- Georeferenced scanned map from DGGS web service



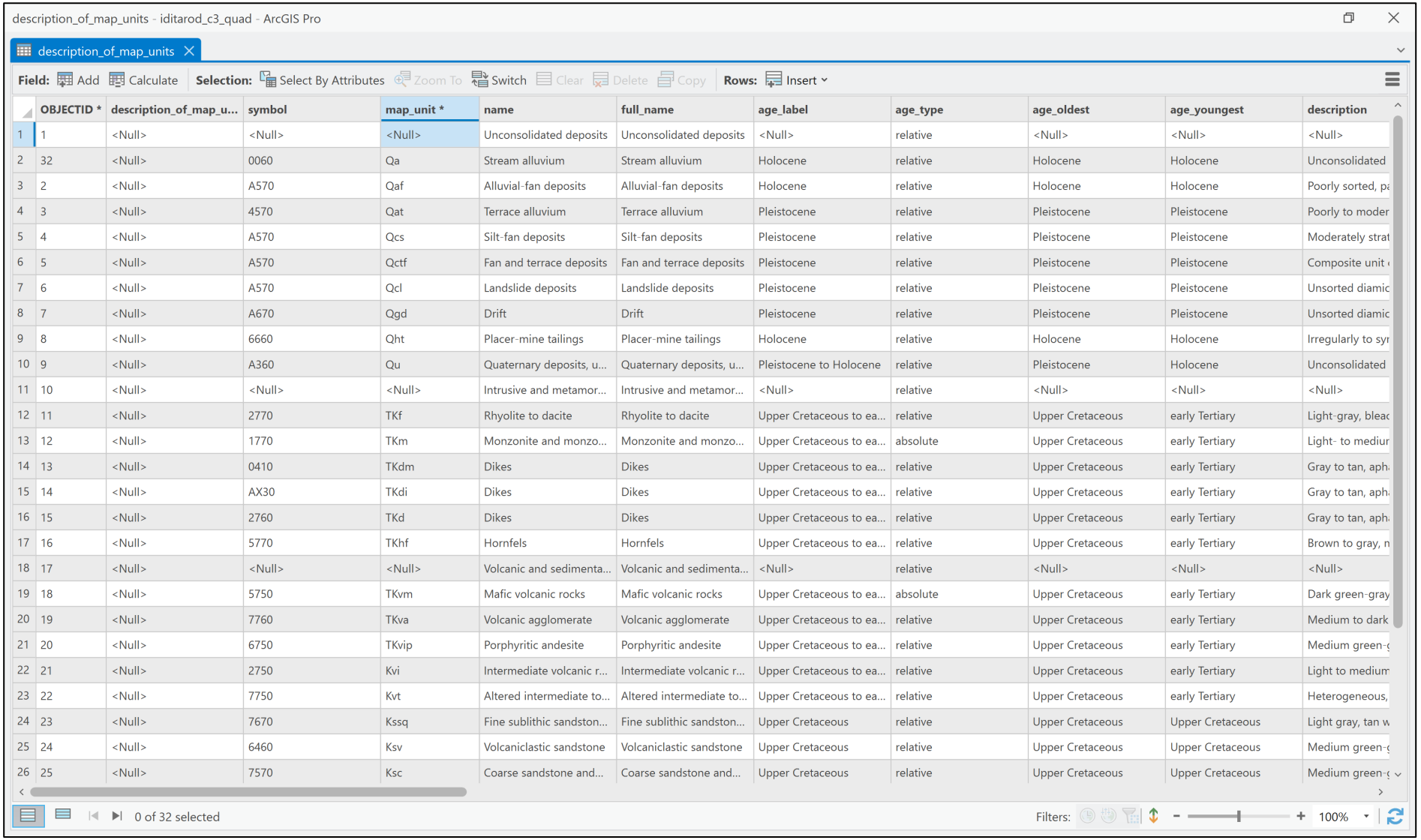
Version 2.0 – product_info (AK GeMS specific)

- Digitized and attributed
- Provides map boundary for line digitization snapping



Version 2.0 – description_of_map_units

- Fully attributed
- Issues avoided: hierarchy_key, age fields, geo_materials, colors/patterns



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2	32	<Null>	0060	Qa	Stream alluvium	Stream alluvium	Holocene	relative	Holocene	Holocene	Unconsolidated
3	2	<Null>	A570	Qaf	Alluvial-fan deposits	Alluvial-fan deposits	Holocene	relative	Holocene	Holocene	Poorly sorted, pa
4	3	<Null>	4570	Qat	Terrace alluvium	Terrace alluvium	Pleistocene	relative	Pleistocene	Pleistocene	Poorly to moder
5	4	<Null>	A570	Qcs	Silt-fan deposits	Silt-fan deposits	Pleistocene	relative	Pleistocene	Pleistocene	Moderately strat
6	5	<Null>	A570	Qctf	Fan and terrace deposits	Fan and terrace deposits	Pleistocene	relative	Pleistocene	Pleistocene	Composite unit (
7	6	<Null>	A570	Qcl	Landslide deposits	Landslide deposits	Pleistocene	relative	Pleistocene	Pleistocene	Unsorted diamic
8	7	<Null>	A670	Qgd	Drift	Drift	Pleistocene	relative	Pleistocene	Pleistocene	Unsorted diamic
9	8	<Null>	6660	Qht	Placer-mine tailings	Placer-mine tailings	Holocene	relative	Holocene	Holocene	Irregularly to syr
10	9	<Null>	A360	Qu	Quaternary deposits, u...	Quaternary deposits, u...	Pleistocene to Holocene	relative	Pleistocene	Holocene	Unconsolidated
11	10	<Null>	<Null>	<Null>	Intrusive and metamor...	Intrusive and metamor...	<Null>	relative	<Null>	<Null>	<Null>
12	11	<Null>	2770	TKf	Rhyolite to dacite	Rhyolite to dacite	Upper Cretaceous to ea...	relative	Upper Cretaceous	early Tertiary	Light-gray, bleac
13	12	<Null>	1770	TKm	Monzonite and monzo...	Monzonite and monzo...	Upper Cretaceous to ea...	absolute	Upper Cretaceous	early Tertiary	Light- to mediur
14	13	<Null>	0410	TKdm	Dikes	Dikes	Upper Cretaceous to ea...	relative	Upper Cretaceous	early Tertiary	Gray to tan, aph
15	14	<Null>	AX30	TKdi	Dikes	Dikes	Upper Cretaceous to ea...	relative	Upper Cretaceous	early Tertiary	Gray to tan, aph
16	15	<Null>	2760	TKd	Dikes	Dikes	Upper Cretaceous to ea...	relative	Upper Cretaceous	early Tertiary	Gray to tan, aph
17	16	<Null>	5770	TKhf	Hornfels	Hornfels	Upper Cretaceous to ea...	relative	Upper Cretaceous	early Tertiary	Brown to gray, n
18	17	<Null>	<Null>	<Null>	Volcanic and sedimenta...	Volcanic and sedimenta...	<Null>	relative	<Null>	<Null>	<Null>
19	18	<Null>	5750	TKvm	Mafic volcanic rocks	Mafic volcanic rocks	Upper Cretaceous to ea...	absolute	Upper Cretaceous	early Tertiary	Dark green-gray
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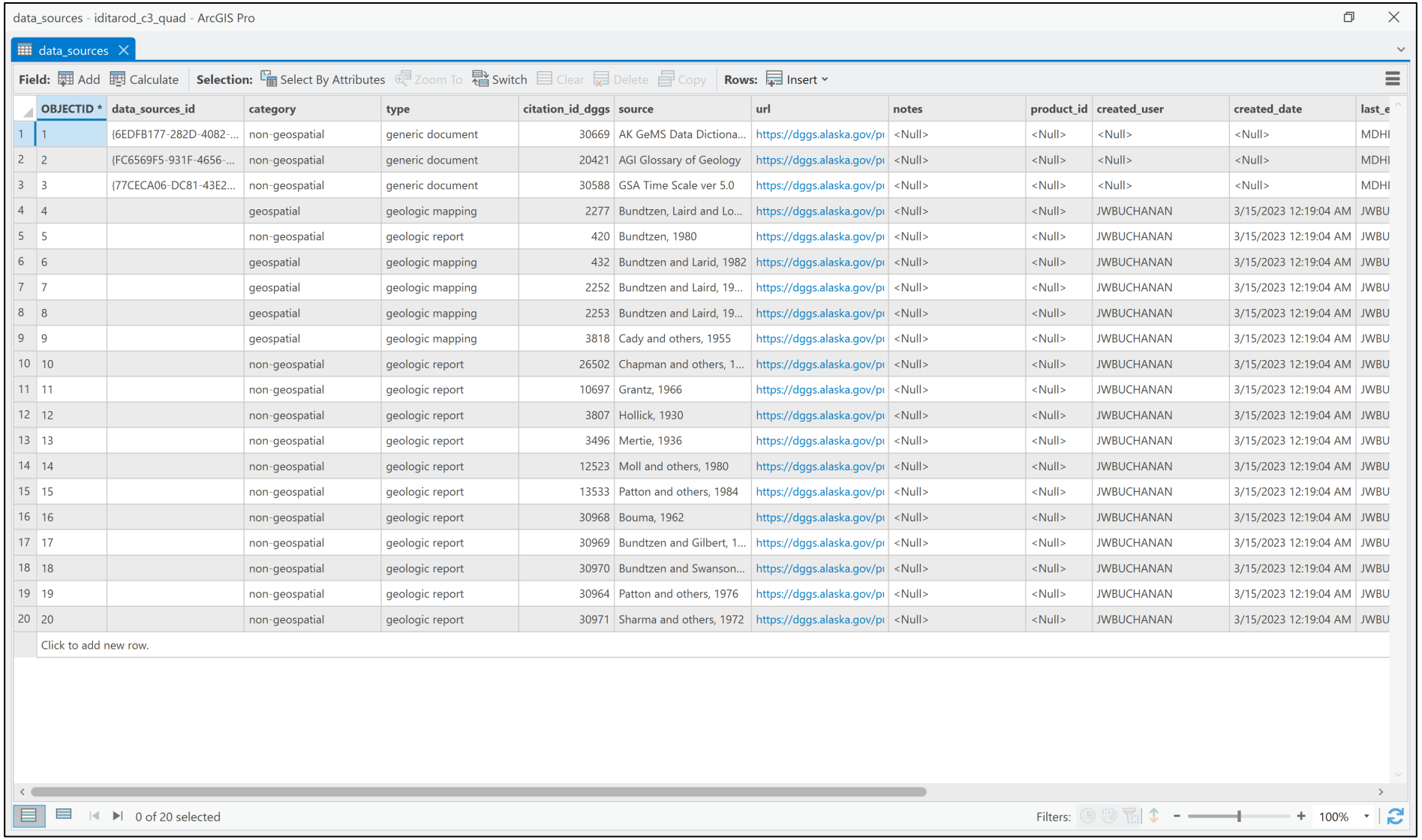
21	20	<Null>	6750	TKvip	Porphyritic andesite	Porphyritic andesite	Upper Cretaceous to ea...	relative	Upper Cretaceous	early Tertiary	Medium green-(
22	21	<Null>	2750	Kvi	Intermediate volcanic r...	Intermediate volcanic r...	Upper Cretaceous to ea...	relative	Upper Cretaceous	early Tertiary	Light to medium
23	22	<Null>	7750	Kvt	Altered intermediate to...	Altered intermediate to...	Upper Cretaceous to ea...	relative	Upper Cretaceous	early Tertiary	Heterogeneous,
24	23	<Null>	7670	Kssq	Fine sublithic sandston...	Fine sublithic sandston...	Upper Cretaceous	relative	Upper Cretaceous	Upper Cretaceous	Light gray, tan w
25	24	<Null>	6460	Ksv	Volcaniclastic sandstone	Volcaniclastic sandstone	Upper Cretaceous	relative	Upper Cretaceous	Upper Cretaceous	Medium green-(
26	25	<Null>	7570	Ksc	Coarse sandstone and...	Coarse sandstone and...	Upper Cretaceous	relative	Upper Cretaceous	Upper Cretaceous	Medium green-(

Version 2.0 – data_sources

- Completed data_sources table taken from map reference list


data_sources - iditarod_c3_quad - ArcGIS Pro

data_sources

Field: Add Calculate | Selection: Select By Attributes Zoom To Switch Clear Delete Copy | Rows: Insert

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3	3	{77CECA06-DC81-43E2...	non-geospatial	generic document	30588	GSA Time Scale ver 5.0	https://dggs.alaska.gov/pı	<Null>	<Null>	<Null>	<Null>	MDHI
4	4		geospatial	geologic mapping	2277	Bundtzen, Laird and Lo...	https://dggs.alaska.gov/pı	<Null>	<Null>	JWBUCHANAN	3/15/2023 12:19:04 AM	JWBU
5	5		non-geospatial	geologic report	420	Bundtzen, 1980	https://dggs.alaska.gov/pı	<Null>	<Null>	JWBUCHANAN	3/15/2023 12:19:04 AM	JWBU
6	6		geospatial	geologic mapping	432	Bundtzen and Larid, 1982	https://dggs.alaska.gov/pı	<Null>	<Null>	JWBUCHANAN	3/15/2023 12:19:04 AM	JWBU
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12	12		non-geospatial	geologic report	3807	Hollick, 1930	https://dggs.alaska.gov/pı	<Null>	<Null>	JWBUCHANAN	3/15/2023 12:19:04 AM	JWBU
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Click to add new row.

0 of 20 selected

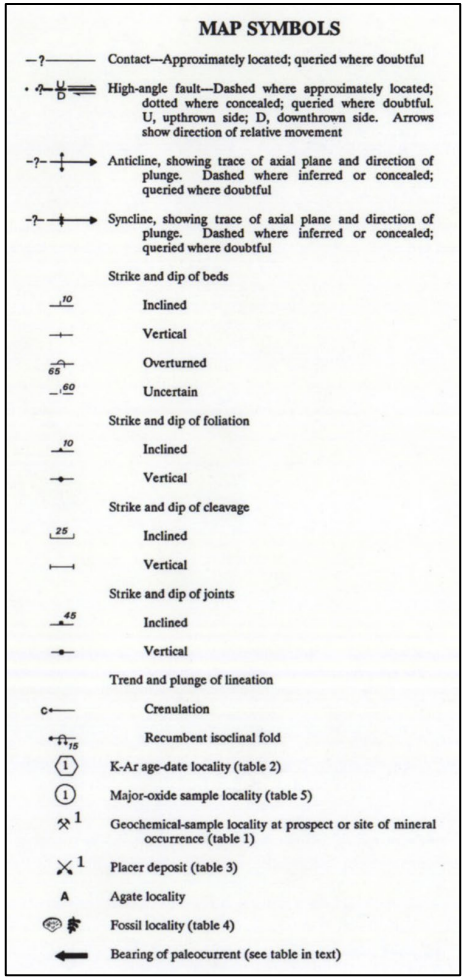
Filters: 100%

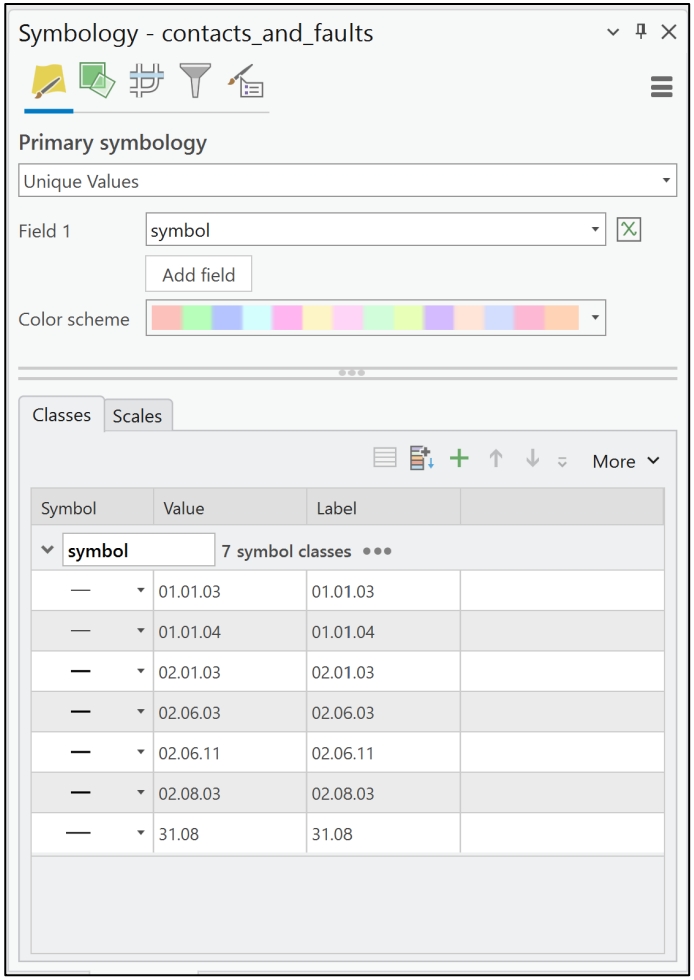
Version 2.0 – Feature Templates

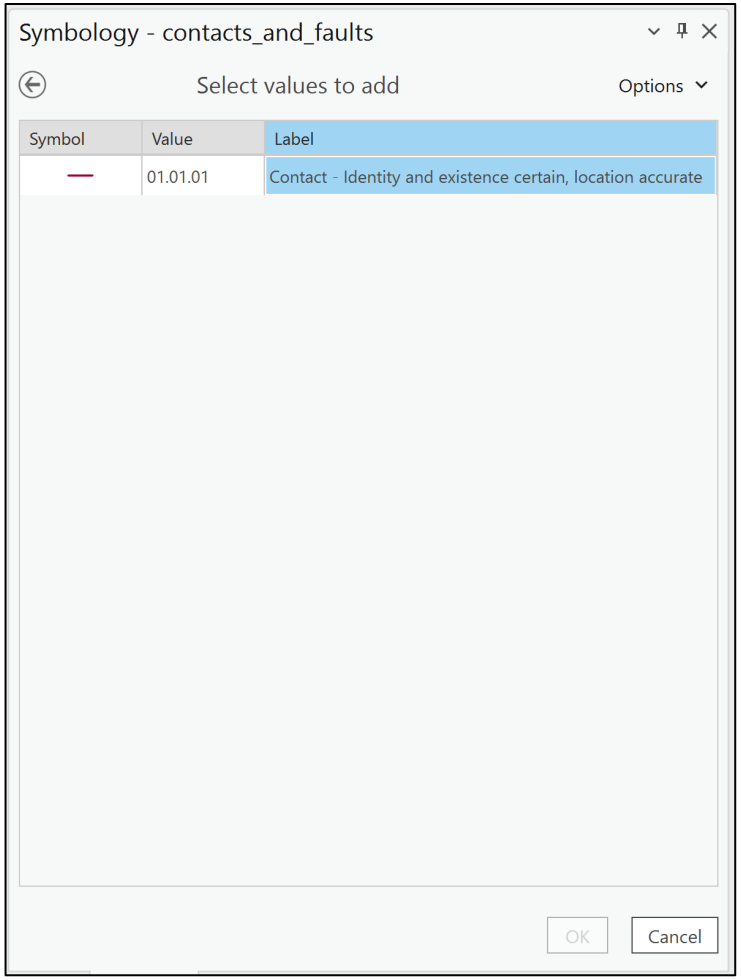
- Simply stated - feature templates create features
- They comprise a set of construction tools, default attribute values, source layer information, and other properties for creating features on specific layers
- Feature templates were created for every feature class in the geodatabase to represent all data within the geologic map
- Uses the style file to correctly symbolize each feature with respect to the FGDC standard
- When creating features, essential fields are prompted for contractor attributing

Version 2.0 – Feature Templates – Set Up

Use Symbology pane to add map features with symbol code

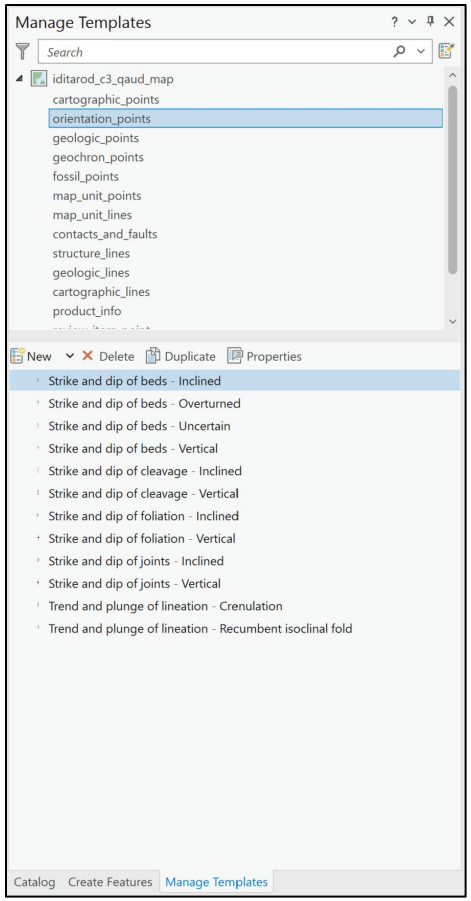


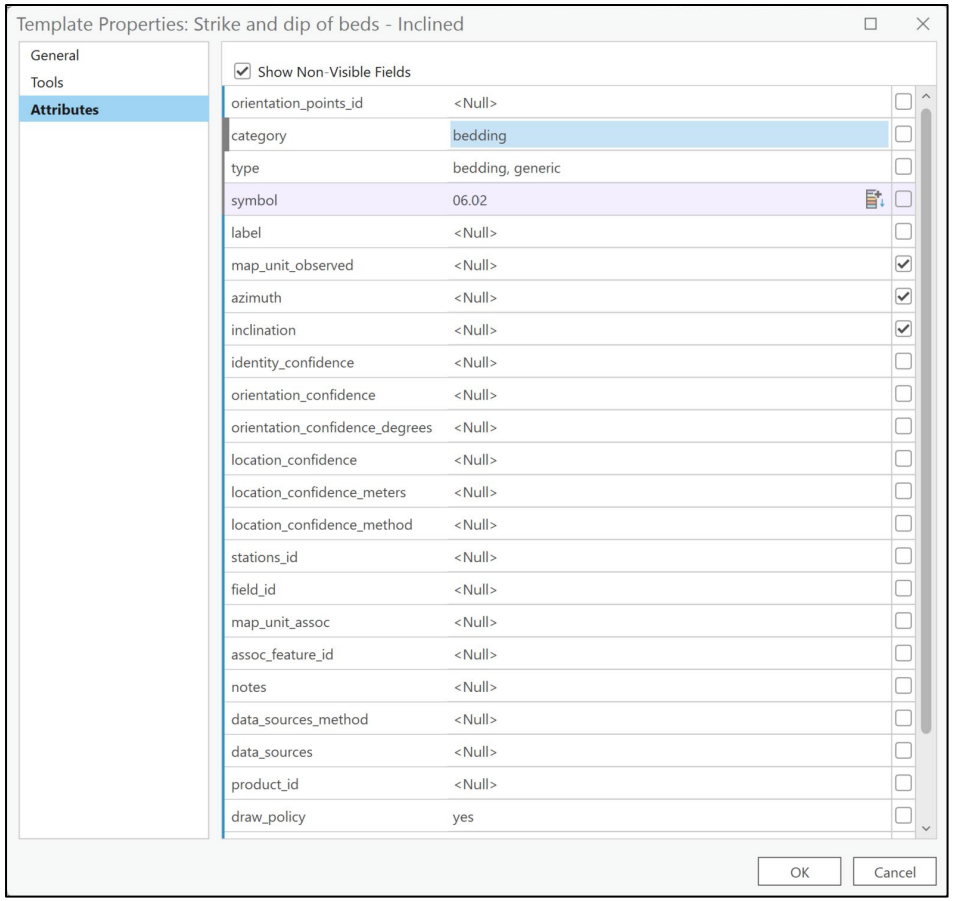


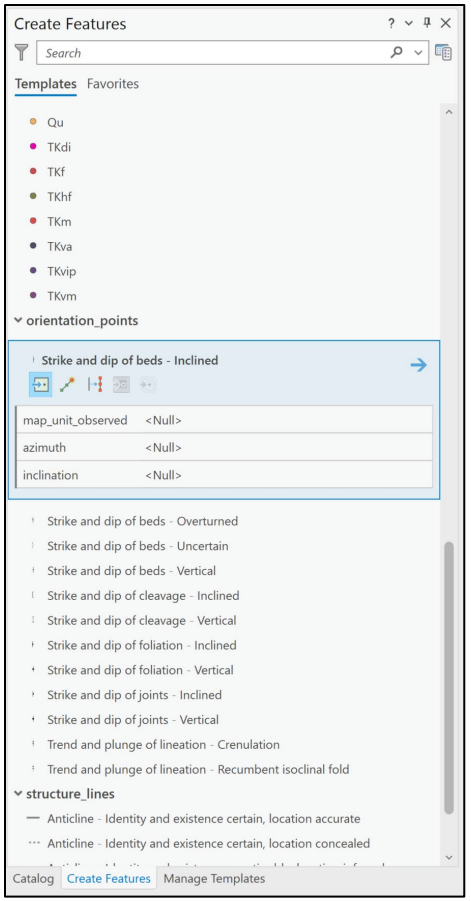


Version 2.0 – Feature Templates – Set Up

- Feature templates are managed in the Manage Template pane
- Clicking on New will add templates for all values added from the Symbology pane
- Ability to change the template properties
- When creating features, user is prompted for specified attributes

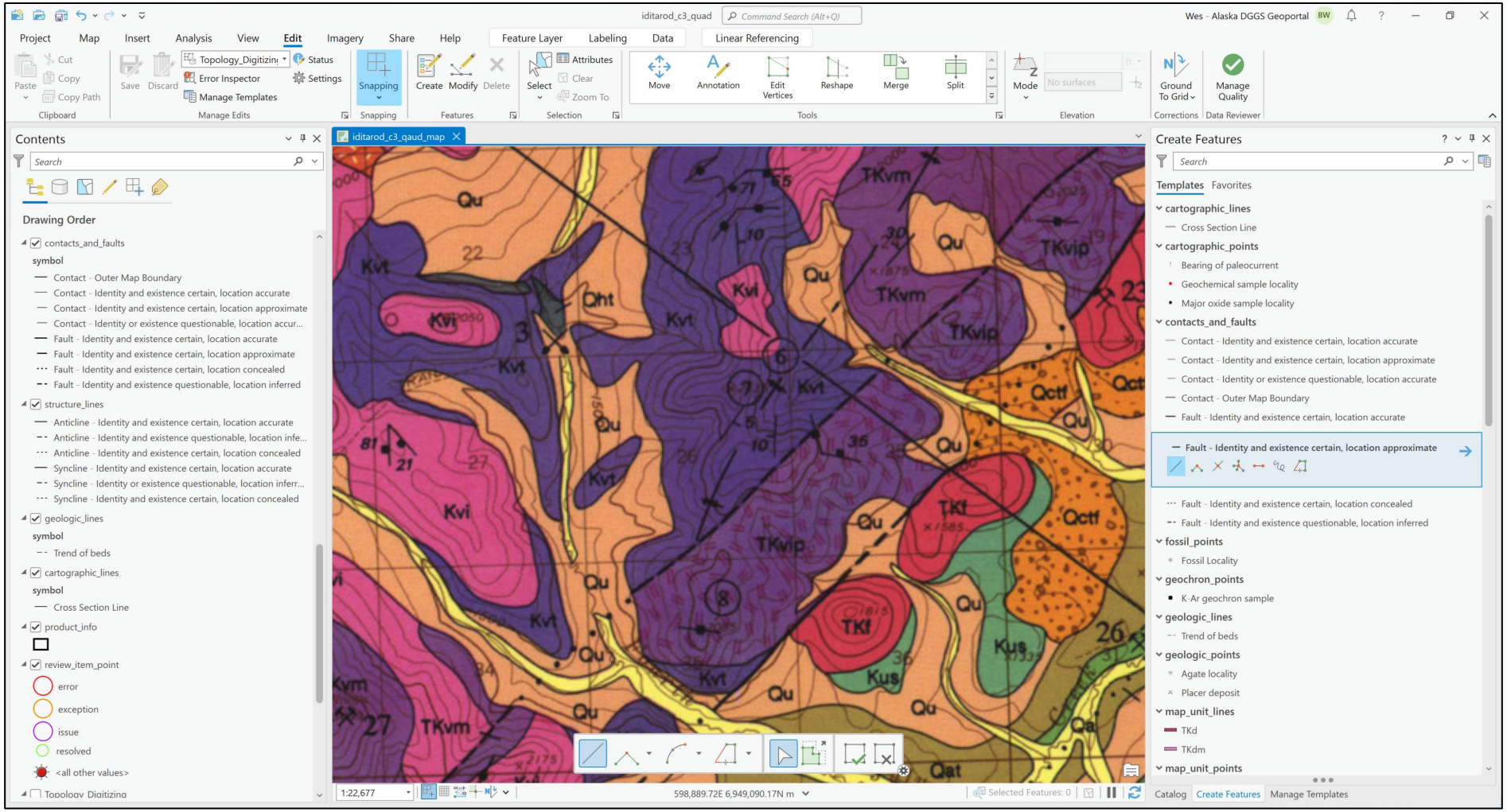




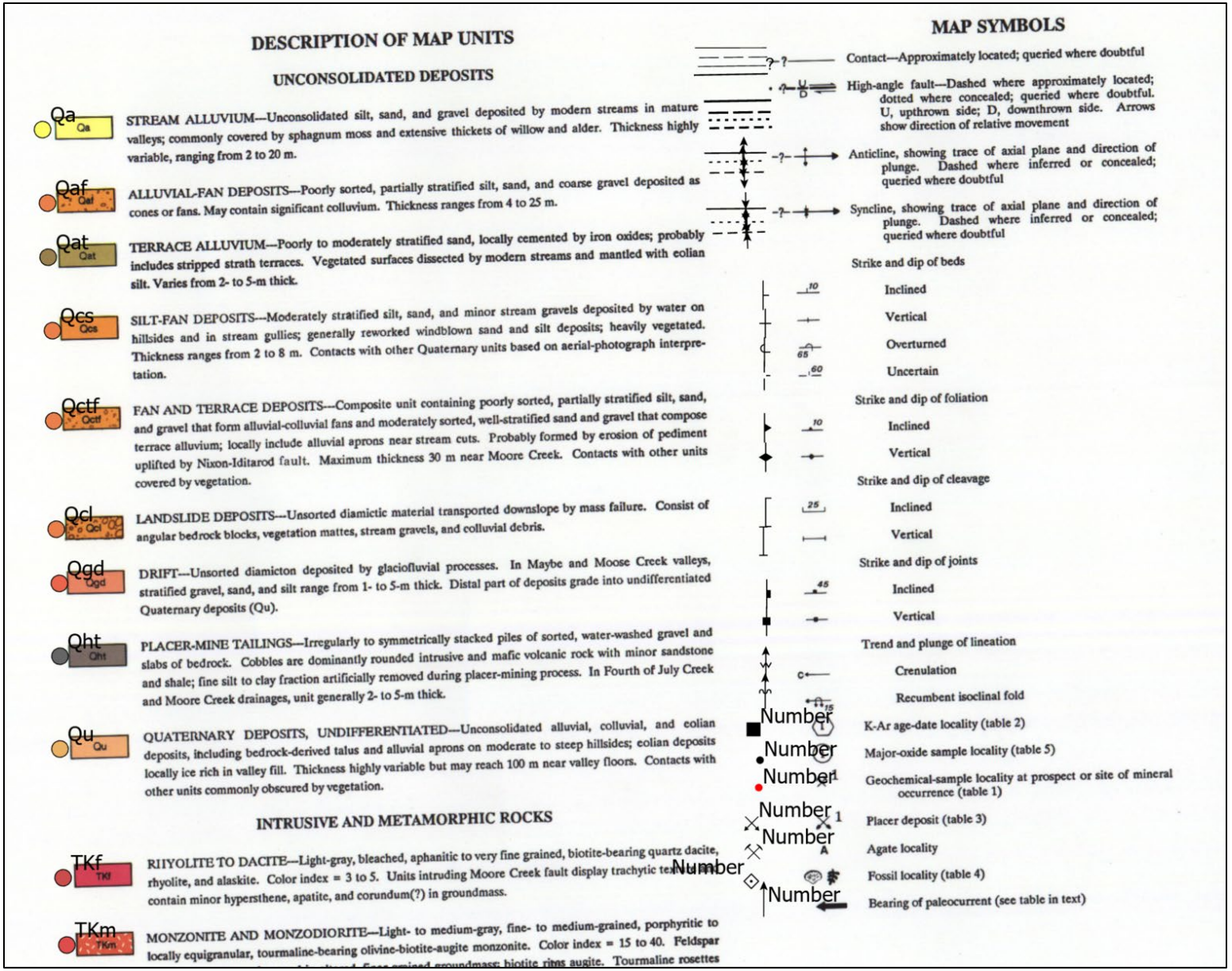


Version 2.0 – Creating Features from Templates

Contents pane contains symbols with FGDC descriptions



Version 2.0 – Digitized Legend



DESCRIPTION OF MAP UNITS

UNCONSOLIDATED DEPOSITS

Qa — STREAM ALLUVIUM—Unconsolidated silt, sand, and gravel deposited by modern streams in mature valleys; commonly covered by sphagnum moss and extensive thickets of willow and alder. Thickness highly variable, ranging from 2 to 20 m.

Qaf — ALLUVIAL-FAN DEPOSITS—Poorly sorted, partially stratified silt, sand, and coarse gravel deposited as cones or fans. May contain significant colluvium. Thickness ranges from 4 to 25 m.

Qat — TERRACE ALLUVIUM—Poorly to moderately stratified sand, locally cemented by iron oxides; probably includes stripped strath terraces. Vegetated surfaces dissected by modern streams and mantled with eolian silt. Varies from 2- to 5-m thick.

Qcs — SILT-FAN DEPOSITS—Moderately stratified silt, sand, and minor stream gravels deposited by water on hillsides and in stream gullies; generally reworked windblown sand and silt deposits; heavily vegetated. Thickness ranges from 2 to 8 m. Contacts with other Quaternary units based on aerial-photograph interpretation.

Qctf — FAN AND TERRACE DEPOSITS—Composite unit containing poorly sorted, partially stratified silt, sand, and gravel that form alluvial-colluvial fans and moderately sorted, well-stratified sand and gravel that compose terrace alluvium; locally include alluvial aprons near stream cuts. Probably formed by erosion of pediment uplifted by Nixon-Iditarod fault. Maximum thickness 30 m near Moore Creek. Contacts with other units covered by vegetation.

Qcl — LANDSLIDE DEPOSITS—Unsorted diamictic material transported downslope by mass failure. Consist of angular bedrock blocks, vegetation mattes, stream gravels, and colluvial debris.

Qgd — DRIFT—Unsorted diamicton deposited by glaciofluvial processes. In Maybe and Moose Creek valleys, stratified gravel, sand, and silt range from 1- to 5-m thick. Distal part of deposits grade into undifferentiated Quaternary deposits (Qu).

Qht — PLACER-MINE TAILINGS—Irregularly to symmetrically stacked piles of sorted, water-washed gravel and slabs of bedrock. Cobbles are dominantly rounded intrusive and mafic volcanic rock with minor sandstone and shale; fine silt to clay fraction artificially removed during placer-mining process. In Fourth of July Creek and Moore Creek drainages, unit generally 2- to 5-m thick.

Qu — QUATERNARY DEPOSITS, UNDIFFERENTIATED—Unconsolidated alluvial, colluvial, and eolian deposits, including bedrock-derived talus and alluvial aprons on moderate to steep hillsides; eolian deposits locally ice rich in valley fill. Thickness highly variable but may reach 100 m near valley floors. Contacts with other units commonly obscured by vegetation.

INTRUSIVE AND METAMORPHIC ROCKS

TKf — RHYOLITE TO DACITE—Light-gray, bleached, aphanitic to very fine grained, biotite-bearing quartz dacite, rhyolite, and alaskite. Color index = 3 to 5. Units intruding Moore Creek fault display trachytic texture; contain minor hypersthene, apatite, and corundum(?) in groundmass.

TKm — MONZONITE AND MONZODIORITE—Light- to medium-gray, fine- to medium-grained, porphyritic to locally equigranular, tourmaline-bearing olivine-biotite-augite monzonite. Color index = 15 to 40. Feldspar [illegible] groundmass; biotite rims augite. Tourmaline rosettes

MAP SYMBOLS

- Contact—Approximately located; queried where doubtful
- High-angle fault—Dashed where approximately located; dotted where concealed; queried where doubtful. U, upthrown side; D, downthrown side. Arrows show direction of relative movement
- Anticline, showing trace of axial plane and direction of plunge. Dashed where inferred or concealed; queried where doubtful
- Syncline, showing trace of axial plane and direction of plunge. Dashed where inferred or concealed; queried where doubtful

Strike and dip of beds
- Inclined
- Vertical
- Overturned
- Uncertain

Strike and dip of foliation
- Inclined
- Vertical

Strike and dip of cleavage
- Inclined
- Vertical

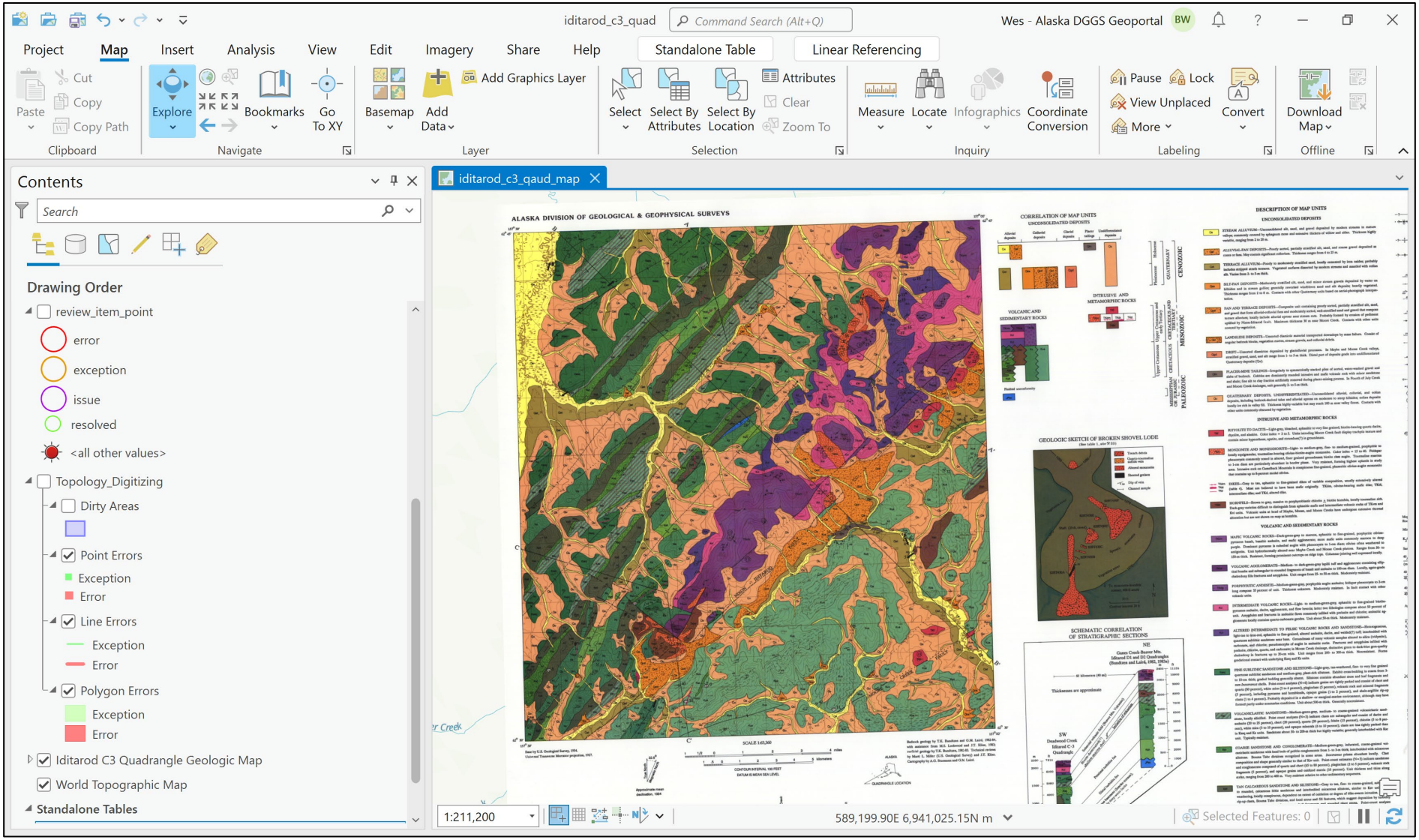
Strike and dip of joints
- Inclined
- Vertical

Trend and plunge of lineation
- Crenulation
- Recumbent isoclinal fold

- Number — K-Ar age-date locality (table 2)
- Number — Major-oxide sample locality (table 5)
- Number — Geochemical-sample locality at prospect or site of mineral occurrence (table 1)
- Number — Placer deposit (table 3)
- Number — Agate locality
- Number — Fossil locality (table 4)
- Number — Bearing of paleocurrent (see table in text)

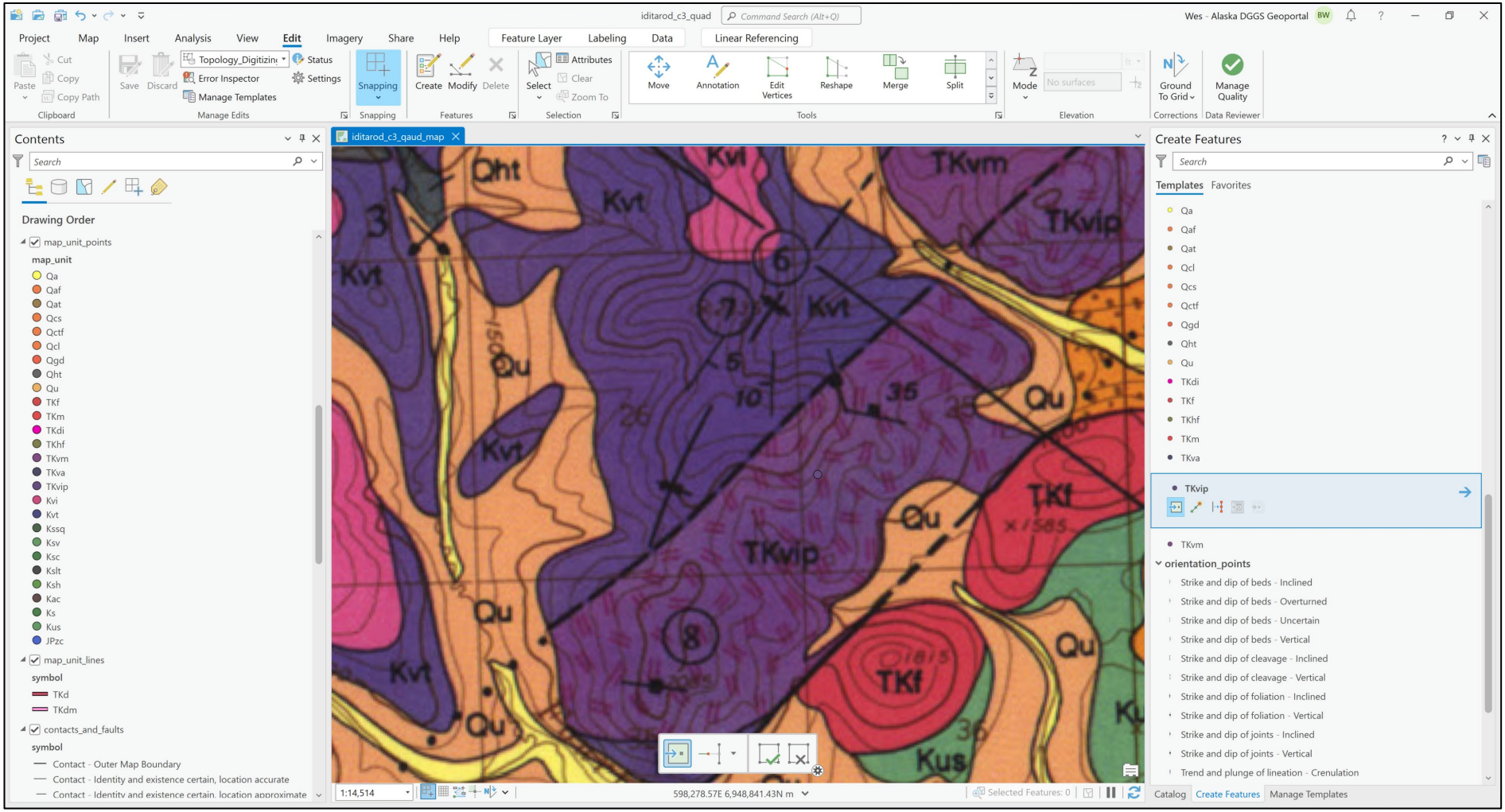
Version 2.0 – Topology & QC Review

Simplified topology layer based only on contacts and faults – no dangles or self intersections



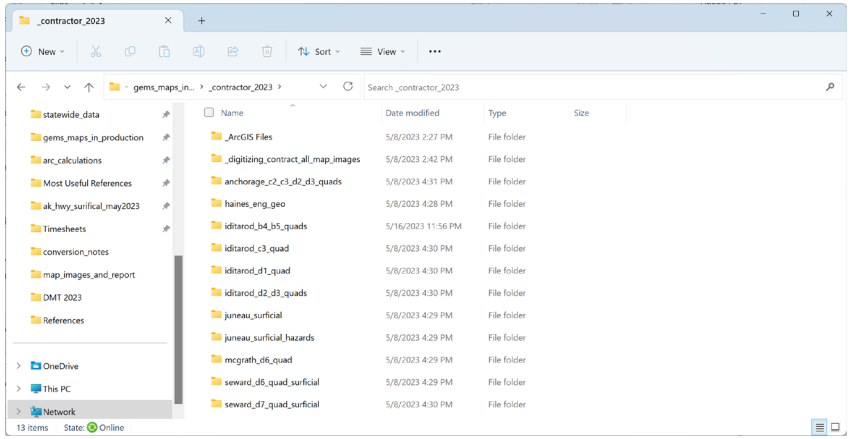
Version 2.0 – Creating map_unit_polys

- Drop map_unit_point inside contacts_and_faults boundary
- Script run by DGGS

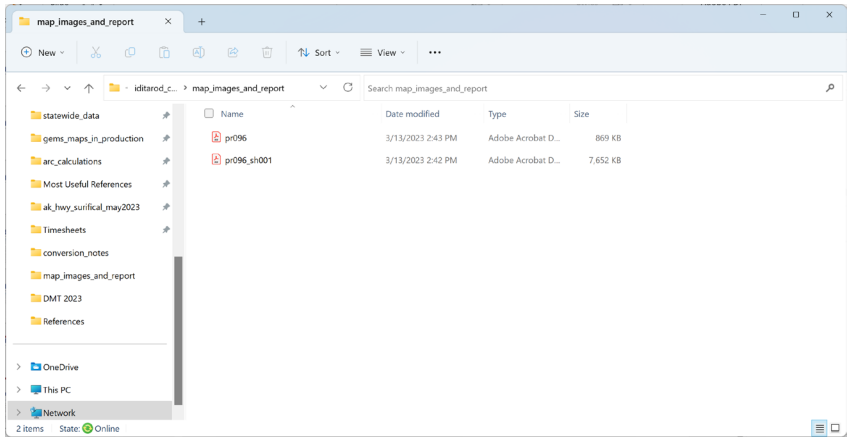


Version 2.0 – Provided Files

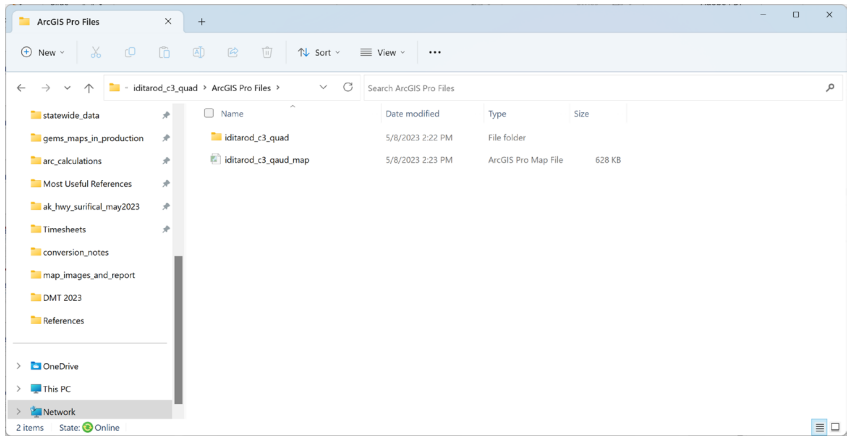
Project folders; with styles, fonts, and toolboxes



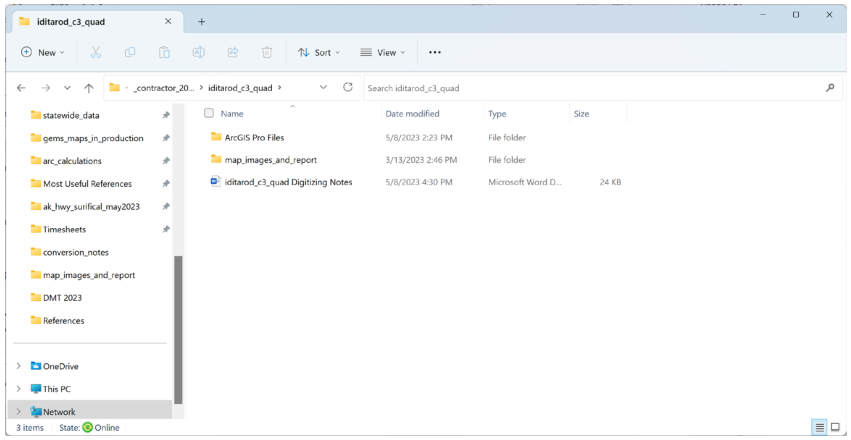
Map and report PDF



Geodatabase, project file, and map file

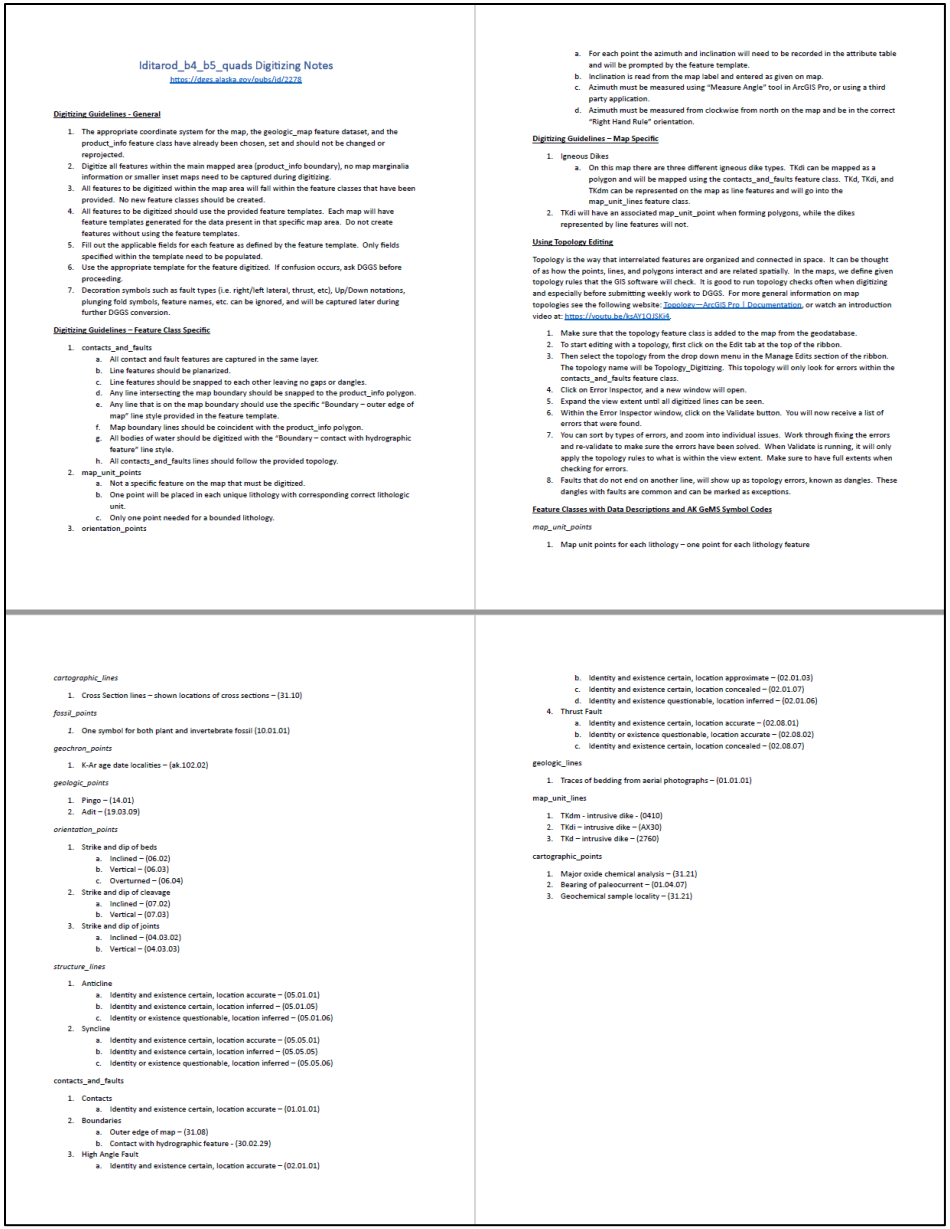


Map specific digitizing notes



Version 2.0 – Digitizing Notes

Each project has digitizing notes specific to the features on the geologic map



Iditarod_b4_b5_quads Digitizing Notes

https://dggs.alaska.gov/pubs/id/2278

Digitizing Guidelines - General

1. The appropriate coordinate system for the map, the geologic_map feature dataset, and the product_info feature class have already been chosen, set and should not be changed or reprojected.
2. Digitize all features within the main mapped area (product_info boundary), no map marginalia information or smaller inset maps need to be captured during digitizing.
3. All features to be digitized within the map area will fall within the feature classes that have been provided. No new feature classes should be created.
4. All features to be digitized should use the provided feature templates. Each map will have feature templates generated for the data present in that specific map area. Do not create features without using the feature templates.
5. Fill out the applicable fields for each feature as defined by the feature template. Only fields specified within the template need to be populated.
6. Use the appropriate template for the feature digitized. If confusion occurs, ask DGGS before proceeding.
7. Decoration symbols such as fault types (i.e. right/left lateral, thrust, etc), Up/Down notations, plunging fold symbols, feature names, etc. can be ignored, and will be captured later during further DGGS conversion.

Digitizing Guidelines – Feature Class Specific

1. contacts_and_faults
   a. All contact and fault features are captured in the same layer.
   b. Line features should be planarized.
   c. Line features should be snapped to each other leaving no gaps or dangles.
   d. Any line intersecting the map boundary should be snapped to the product_info polygon.
   e. Any line that is on the map boundary should use the specific "Boundary – outer edge of map" line style provided in the feature template.
   f. Map boundary lines should be coincident with the product_info polygon.
   g. All bodies of water should be digitized with the "Boundary – contact with hydrographic feature" line style.
   h. All contacts_and_faults lines should follow the provided topology.
2. map_unit_points
   a. Not a specific feature on the map that must be digitized.
   b. One point will be placed in each unique lithology with corresponding correct lithologic unit.
   c. Only one point needed for a bounded lithology.
3. orientation_points
   a. For each point the azimuth and inclination will need to be recorded in the attribute table and will be prompted by the feature template.
   b. Inclination is read from the map label and entered as given on map.
   c. Azimuth must be measured using "Measure Angle" tool in ArcGIS Pro, or using a third party application.
   d. Azimuth must be measured from clockwise from north on the map and be in the correct "Right Hand Rule" orientation.

Digitizing Guidelines – Map Specific

1. Igneous Dikes
   a. On this map there are three different igneous dike types. TKdi can be mapped as a polygon and will be mapped using the contacts_and_faults feature class. TKd, TKdi, and TKdm can be represented on the map as line features and will go into the map_unit_lines feature class.
2. TKdi will have an associated map_unit_point when forming polygons, while the dikes represented by line features will not.

Using Topology Editing

Topology is the way that interrelated features are organized and connected in space. It can be thought of as how the points, lines, and polygons interact and are related spatially. In the maps, we define given topology rules that the GIS software will check. It is good to run topology checks often when digitizing and especially before submitting weekly work to DGGS. For more general information on map topologies see the following website: Topology—ArcGIS Pro | Documentation, or watch an introduction video at: https://youtu.be/kcAY1OJSK4.

1. Make sure that the topology feature class is added to the map from the geodatabase.
2. To start editing with a topology, first click on the Edit tab at the top of the ribbon.
3. Then select the topology from the drop down menu in the Manage Edits section of the ribbon. The topology name will be Topology_Digitizing. This topology will only look for errors within the contacts_and_faults feature class.
4. Click on Error Inspector, and a new window will open.
5. Expand the view extent until all digitized lines can be seen.
6. Within the Error Inspector window, click on the Validate button. You will now receive a list of errors that were found.
7. You can sort by types of errors, and zoom into individual issues. Work through fixing the errors and re-validate to make sure the errors have been solved. When Validate is running, it will only apply the topology rules to what is within the view extent. Make sure to have full extents when checking for errors.
8. Faults that do not end on another line, will show up as topology errors, known as dangles. These dangles with faults are common and can be marked as exceptions.

Feature Classes with Data Descriptions and AK GeMS Symbol Codes

map_unit_points

1. Map unit points for each lithology – one point for each lithology feature

cartographic_lines

1. Cross Section lines – shown locations of cross sections – (31.10)

fossil_points

1. One symbol for both plant and invertebrate fossil (10.01.01)

geochron_points

1. K-Ar age date localities – (ak.102.02)

geologic_points

1. Pingo – (14.01)
2. Adit – (19.03.09)

orientation_points

1. Strike and dip of beds
   a. Inclined – (06.02)
   b. Vertical – (06.03)
   c. Overturned – (06.04)
2. Strike and dip of cleavage
   a. Inclined – (07.02)
   b. Vertical – (07.03)
3. Strike and dip of joints
   a. Inclined – (04.03.02)
   b. Vertical – (04.03.03)

structure_lines

1. Anticline
   a. Identity and existence certain, location accurate – (05.01.01)
   b. Identity and existence certain, location inferred – (05.01.05)
   c. Identity or existence questionable, location inferred – (05.01.06)
2. Syncline
   a. Identity and existence certain, location accurate – (05.05.01)
   b. Identity and existence certain, location inferred – (05.05.05)
   c. Identity or existence questionable, location inferred – (05.05.06)

contacts_and_faults

1. Contacts
   a. Identity and existence certain, location accurate – (01.01.01)
2. Boundaries
   a. Outer edge of map – (31.08)
   b. Contact with hydrographic feature - (30.02.29)
3. High Angle Fault
   a. Identity and existence certain, location accurate – (02.01.01)
   b. Identity and existence certain, location approximate – (02.01.03)
   c. Identity and existence certain, location concealed – (02.01.07)
   d. Identity and existence questionable, location inferred – (02.01.06)
4. Thrust Fault
   a. Identity and existence certain, location accurate – (02.08.01)
   b. Identity or existence questionable, location accurate – (02.08.02)
   c. Identity and existence certain, location concealed – (02.08.07)

geologic_lines

1. Traces of bedding from aerial photographs – (01.01.01)

map_unit_lines

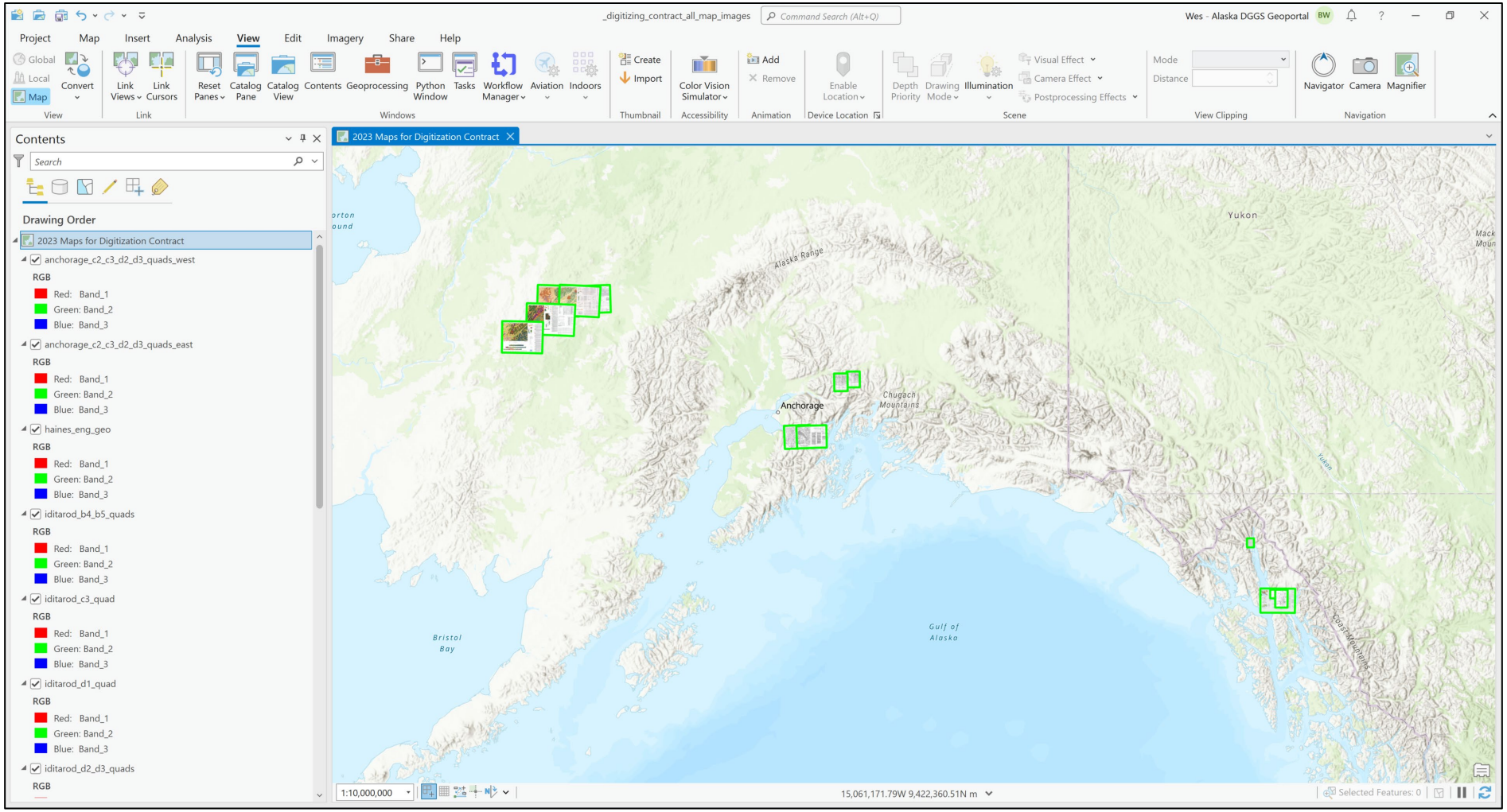
1. TKdm - intrusive dike - (0410)
2. TKdi – intrusive dike – (AX30)
3. TKd – intrusive dike – (2760)

cartographic_points

1. Major oxide chemical analysis – (31.21)
2. Bearing of paleocurrent – (01.04.07)
3. Geochemical sample locality – (31.21)

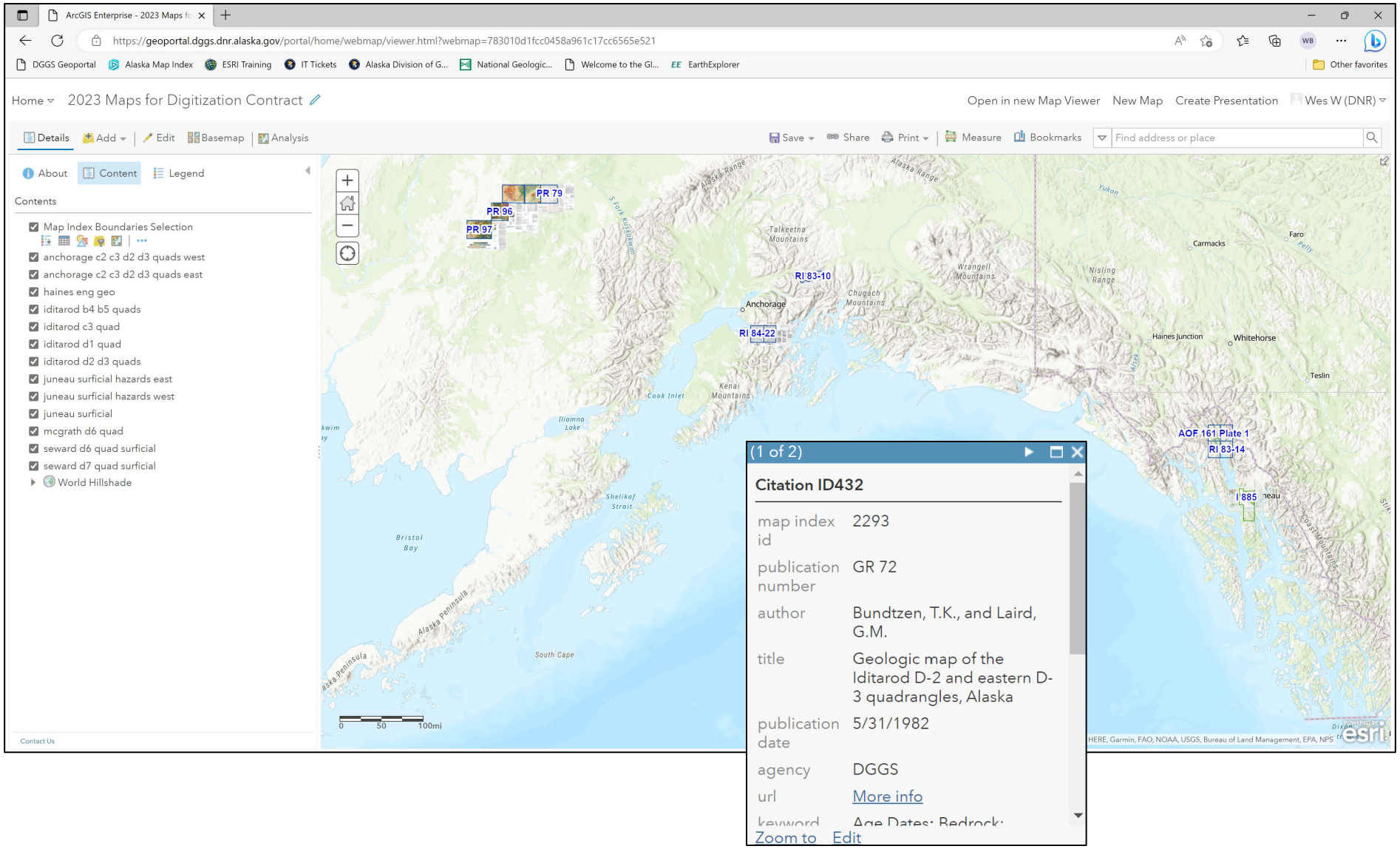
Version 2.0 – Map Images Project

Individual map image layers from web service, queried and locked



Version 2.0 – AGOL Web Map

Provided during the contract bidding process



Resource Comparison – Version 1.0

- Blank GeMS Geodatabase
- Link to map's DGGS citation page
- General feature templates
- Style file

Resource Comparison – Version 2.0

- GeMS Geodatabase – project specific
- Correctly projected feature dataset
- ArcGIS Pro project and map files
- Correctly projected map frame
- Georeferenced map images
- Completed DMU table
- Completed data sources table
- Completed product info table
- Only pertinent feature classes
- Project specific feature templates
- Digitized legend
- Simplified topology rules
- Project specific digitizing notes

Contracting Geologic Map Digitization – Summary

- Working with the GeMS standard has a steep learning curve
- Map digitization/conversion requires time/effort and are affected by geologic complexity
- Capitalize on the strengths of the team members
- Simplify the process to remove ambiguity and confusion
- Upfront planning and attention to detail should pay dividends when it comes to the project completion timeline and budget