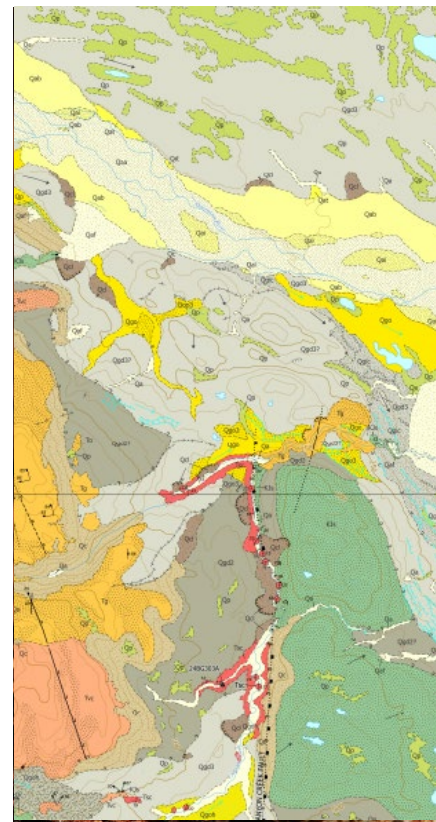


QA/QC of the Alaska GeMS Geologic Mapping System

*Challenges and Successes with ArcPro
Attribute Rules*

Ally Steinleitner, AKDGGS



Agenda

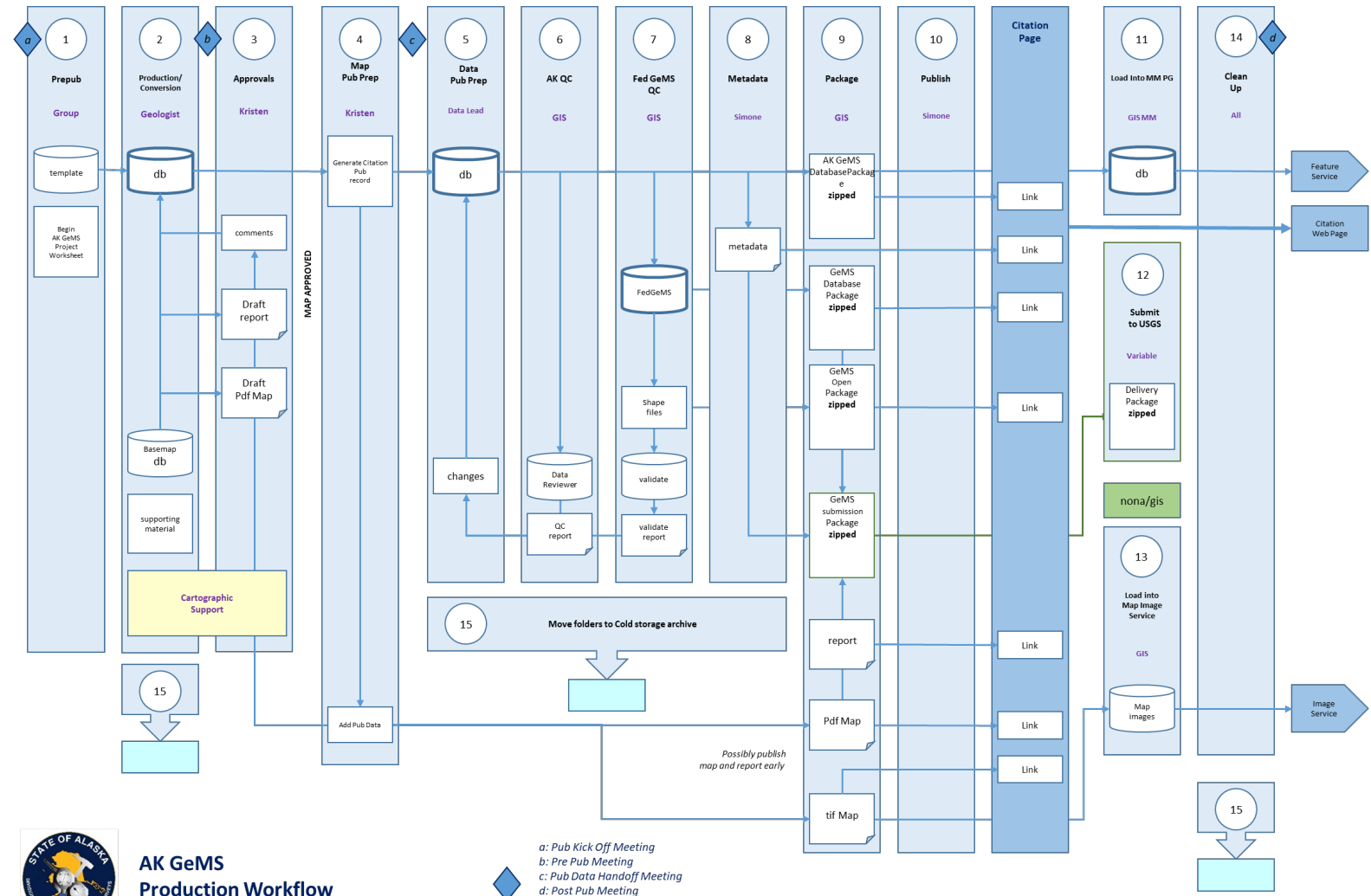
1. Recent transition of QA/QC process at DGGS
2. Challenges with Attribute Rules
3. Updated Workflow



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 through production, quality control, publication, and archiving
- The workflow identifies:
 - **Order**
 - **Responsibilities**
 - **Location of data**
 - **Production meetings**
 - **Products**



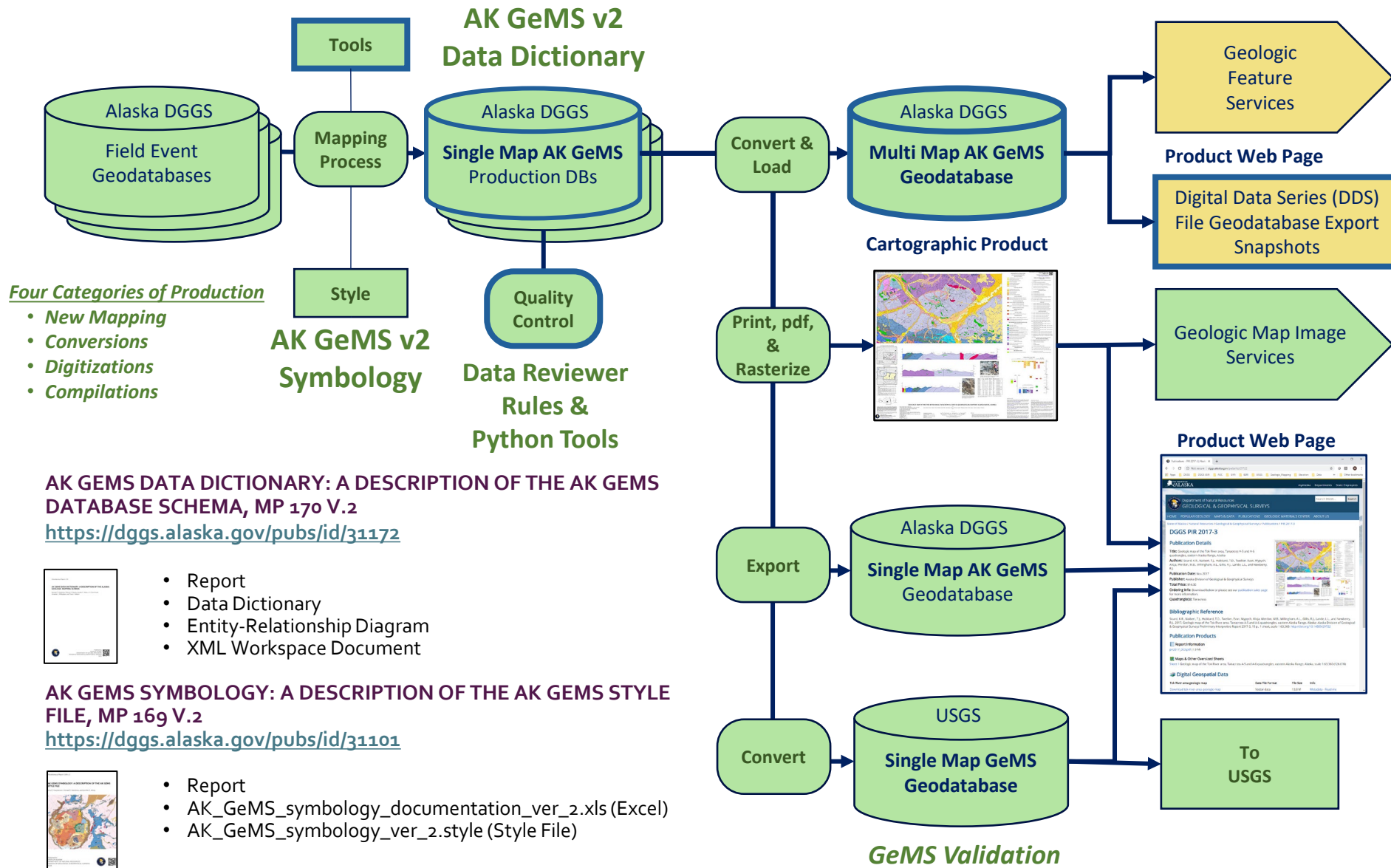
AK GeMS
Production Workflow

a: Pub Kick Off Meeting
b: Pre Pub Meeting
c: Pub Data Handoff Meeting
d: Post Pub Meeting



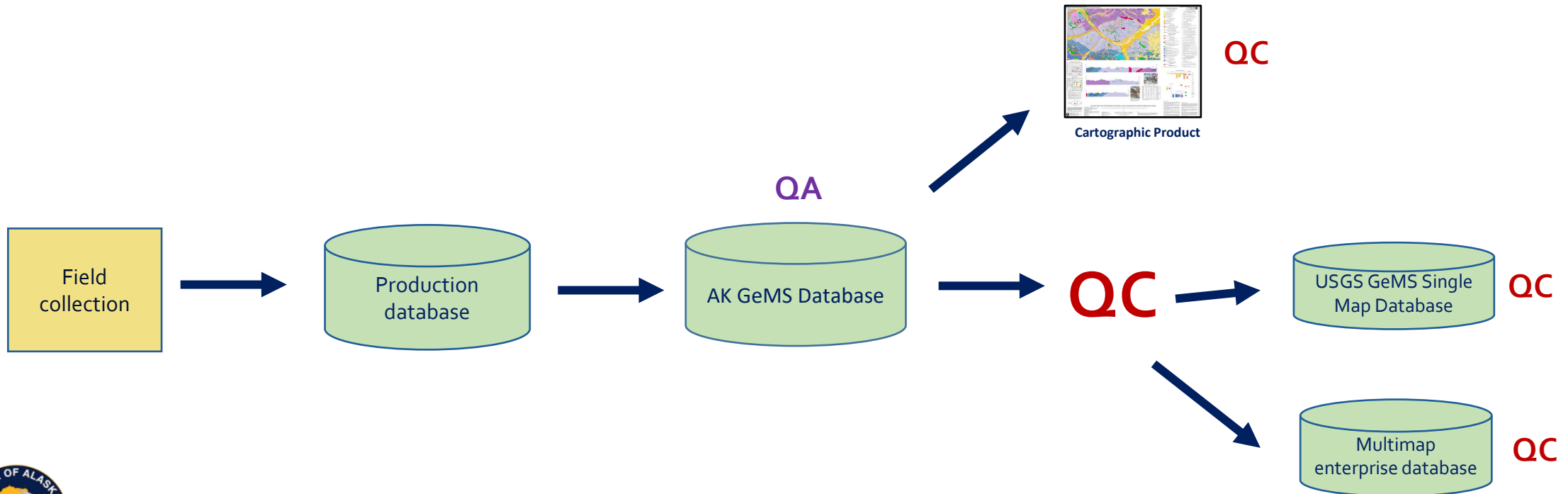
Alaska DGGs Geologic Mapping System Components

Organizational Procedures



Geospatial Data Quality Fundamentals

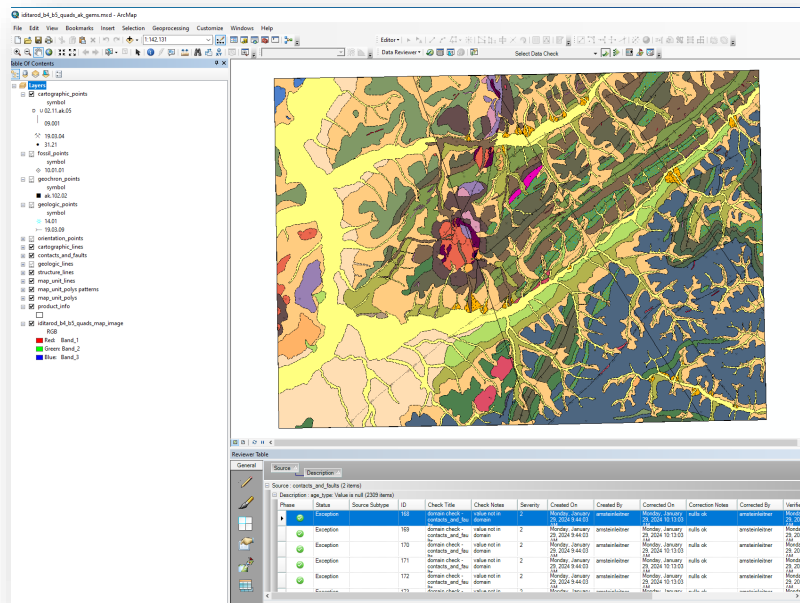
- **Quality Assurance:** Processes or methods to help prevent errors from being introduced in the data.
- **Quality Control:** Processes or tools to identify errors that are already in the data.



AK DGGs QA/QC History

RETIRED:

ArcGIS Data Reviewer Extension



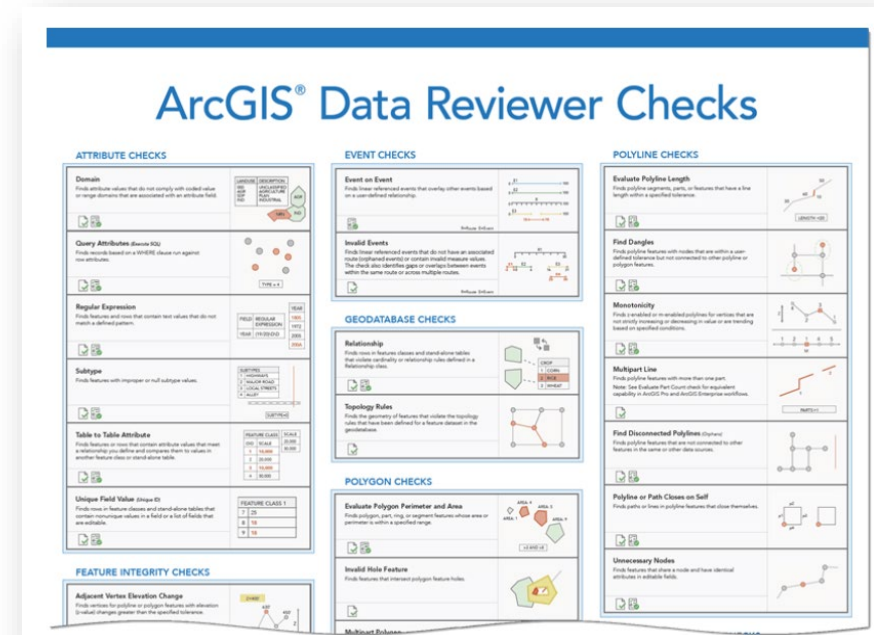
Provides

- Rule-based automated validation
- Semi-automated workflows
- Track and report quality



CURRENT:

ArcPro Data Reviewer and Attribute Rules



Provides

- Database embedded rules
- List of rules configured for specific feature class

Attribute Rule Types



Calculation Rule

- Automatically populate attributes based on editing pattern



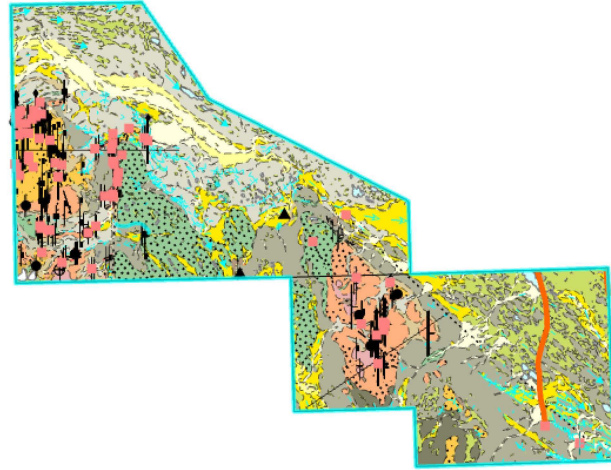
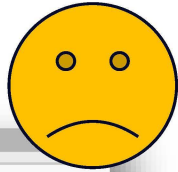
Constraint Rule

- Used to control the entry of data by user-defined requirements



Validation Rule

- Highlight errors in existing data



0 of 18,155 selected

1:445,864 152.1319855°W 61.7469582°N Selected Features:

Error Inspector: Map22

Source: Error Layers (Geodat) Evaluate Rules Filter: Fields Map Extent Selection: Zoom To Pan To Switch Clear Features Copy

Phase	Status	Shape	Rule Type	Exception	Feature ObjectID	Source Layer	Feature GlobalID	Error Number	Error Message	Rule N	Details
1	Reviewed		Validation		178	311	{59151F85-9903-4ADA-AACB-010667C23B32}	58	Point within polygon...	Correc	Property Value
2	Reviewed		Validation		176	311	{AEDCE336-316E-4F32-9E1C-9B21C83FDC29}	58	Point within polygon...	Correc	Id 0
3	Reviewed		Validation		1	311	{186BFE73-1EE4-4AB1-BA46-5E5E7973F96F}	58	Point within polygon...	Correc	Shape Point
4	Reviewed		Validation		170	311	{39BE6301-C312-43F0-9993-9A99EF663359}	58	Point within polygon...	Correc	Rule Type Validation
5	Reviewed		Validation		3	311	{8CFAB41-6C39-44DE-90FD-97348B20F377}	58	Point within polygon...	Correc	Exception <input type="checkbox"/>
6	Reviewed		Validation		423	311	{C0FB3173-DAE5-41F2-A852-0F481D65F161}	58	Point within polygon...	Correc	Feature ObjectID 178
7	Reviewed		Validation		18	311	{87DF7B3D-E0FE-420B-B896-CA0922DB6F56}	58	Point within polygon...	Correc	Source Layer 311
8	Reviewed		Validation		19	311	{D389AAC0-60AF-4E9F-B3F9-244B34291A2D}	58	Point within polygon...	Correc	Feature GlobalID {59151F85-9903-4ADA-AACB-010667C23B32}
9	Reviewed		Validation		49	311	{88131B7E-97C0-4DBD-BC9C-BF196504FD2F}	58	Point within polygon...	Correc	Error Number 58
10	Reviewed		Validation		171	311	{D6B47534-4C78-4127-9318-0A04B86529BF}	58	Point within polygon...	Correc	Error Message Point within polygon and attribute relati
11	Reviewed		Validation		51	311	{A15A2660-1F41-4443-B351-F358219FB0EC}	58	Point within polygon...	Correc	Rule Name Correct map_unit_assoc Rule
12	Reviewed		Validation		50	311	{28345D38-D6AB-4ABB-8210-C17F9D1043DC}	58	Point within polygon...	Correc	Rule ID 57
13	Reviewed		Validation		54	311	{CA033C1E-89A2-4F5C-B4CE-CA18D767C203}	58	Point within polygon...	Correc	Description The map unit value in the map_unit_asso
14	Reviewed		Validation		56	311	{25741387-0542-4ED0-B243-049B4830340D}	58	Point within polygon...	Correc	Severity 3

0 of 18,155 selected 100% 0 selected errors.



Attribute Rule Challenges

- Cannot sort or filter Error Inspector Table by rule type or feature class
- Rules must be imported for each feature class
- If one rule fails to import, entire importation fails
- Leftover validation fields

= A Very Inefficient Review Process

How can we reach a higher data quality standard in a more efficient way?



Attribute Rule Challenges

- Cannot sort or filter Error Inspector Table by rule type or feature class
- Rules must be imported for each feature class
- If one rule fails to import, entire importation fails
- Leftover validation fields

= A Very Inefficient Review Process



How can we reach a higher data quality standard in a more efficient way?



QA/QC of AK GeMS Database Phases



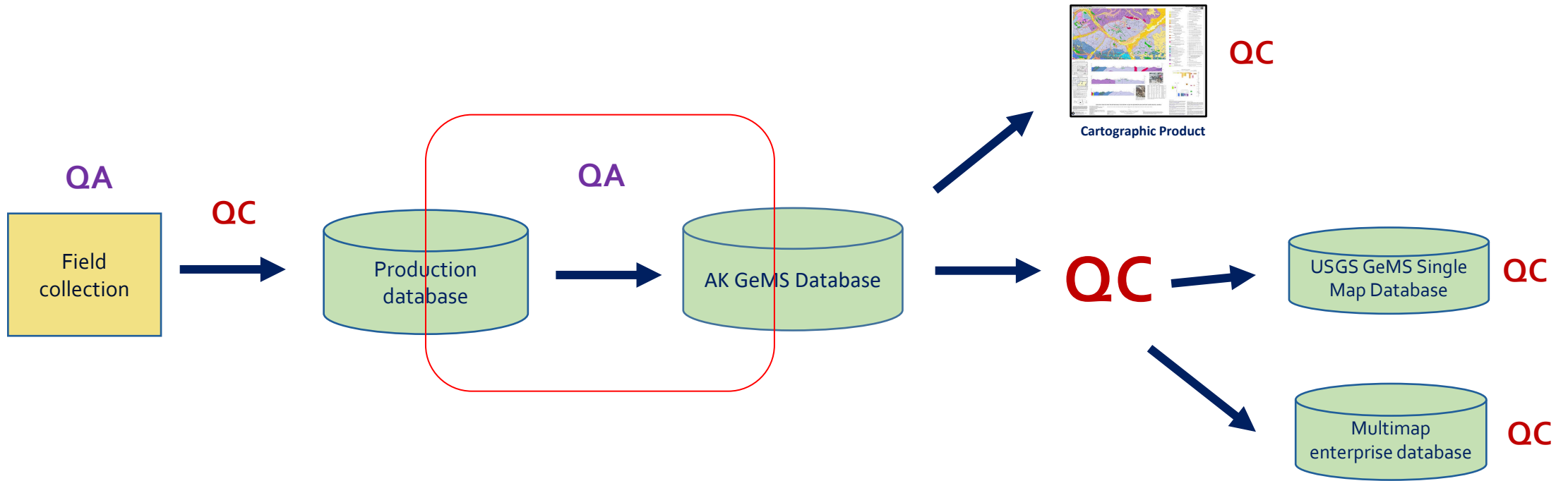
- Constraint Rules
- Calculation Rules
- Domains
- Custom Python Tools

- Custom Python Tools
- Manual Review
- Topology
- Schema Compare

- Validation Rules
- Data Review Table



1. AK GeMS Production Phase



1. AK GeMS Production Phase

Existing:

1. Domains
2. Custom Python tools

Domain Name	Description
age_type_dom	Age type coded domain.
age_units_dom	Age units coded domain.
analytical_method_dom	Analytical Method coded domain.
Attribute Rule Type	The attribute rule type that created the error record.
azimuth_dom	Azimuth range domain.
carto_ins_cat_dom	Cartographic lines category coded domain.
carto_ins_type_dom	Cartographic lines type coded domain.
carto_pts_cat_dom	Cartographic points category coded domain.
carto_pts_type_dom	Cartographic points type coded domain.
carto_pys_cat_dom	Cartographic polygons category coded domain.
carto_pys_type_dom	Cartographic polygons type coded domain.
cf_cat_dom	Contacts and faults category coded domain.
cf_modifier_dom	Contacts and faults modifier coded domain.
cf_type_dom	Contacts and faults type coded domain.

map_unit	symbol	type	category
Qs	0000	map unit, generic	map unit
Qs	0000	<Null>	map unit
Qs	0000	map unit, generic	map unit
Qs	0000	map unit, dike	map unit
Qs	0000	map unit, key bed	map unit
Qs	0000	other	map unit
Qs	0000	unknown	map unit
Qs	0000	unprovided	map unit
Qs	0000	map unit, generic	map unit

- AK_GeMS_production_toolbox.pyt
 - Phase 2 Production/Conversion
 - Analyze Vertice Count
 - Change Source Value
 - Create map unit polys from synthetic map_unit_points and contact_and_faults
 - Create mu points from mu polys
 - Disable Editor Tracking
 - Enable Editor Tracking
 - Planarize and OVERWRITE contacts_and_faults
 - Rebuild and OVERWRITE map_unit_polys from C&F
 - Set Field Visibility
 - Update a single AK GeMS layer toc legend from symbol code to other field
 - Update the active maps AK GeMS layers toc legend from symbol code to unit or type value
 - Phase 5 Data Pub Prep
 - Build Pub Prep Folder
 - Build Pub Prep Folder v2
 - Remove Empty Tables
 - Remove Leading and Trailing Spaces from ALL string fields in DB
 - Update Feature Extents
 - Update field_station_id field from GERILA Field Station FC
 - Update geo_material_dict_id field in the DMU
 - Update Location Confidence Fields
 - Update map unit dmu_guid value
 - Update map unit dmu_guid value for a cross section
 - Update map_unit_assoc Field Value
 - Update Product id
 - Phase 6 QC
 - Check orientation_confidence_meters field Values
 - Color Distance Matrix
 - Convert AK GeMS to AK GeMS
 - Convert AK GeMS v1 to v2
 - Convert AK GeMS v1 to v2 Pro Pro3.5
 - Import Attribute Rules
 - Phase 7 GeMS QC
 - Convert AK GeMS to GeMS
 - Convert AK GeMS v2 to GeMS
 - Empty GeMS DBS
 - Phase 9 Packaging



1. AK GeMS Production Phase

Existing:

1. Domains
2. Custom Python tools

New:

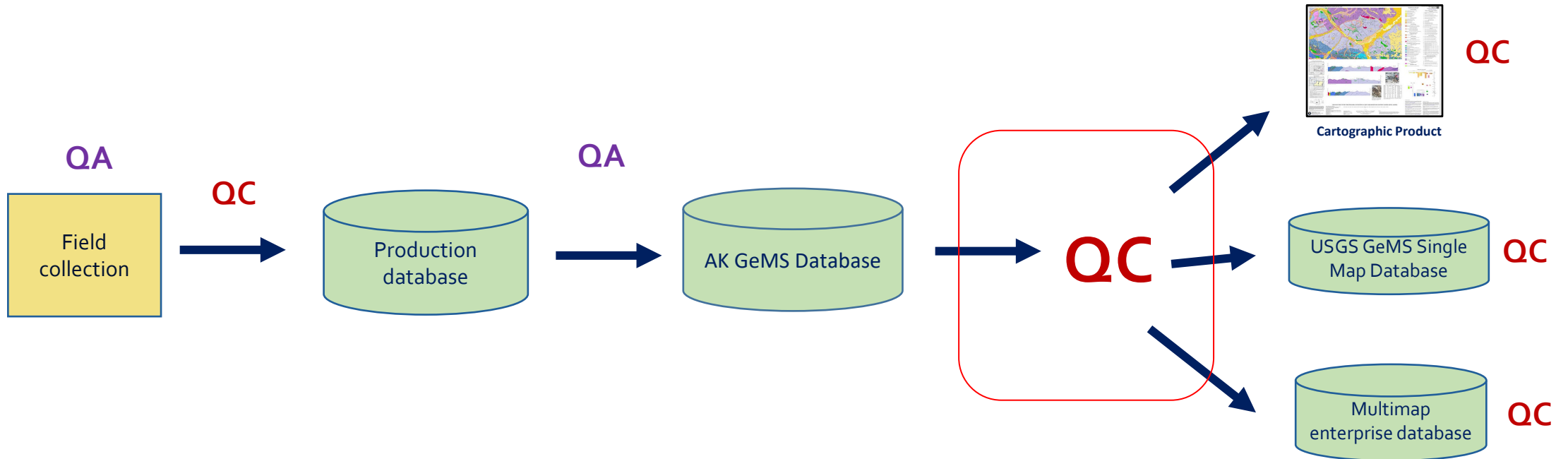
3. Attribute Rules

- Constraint
- Calculation

ATTRIBUTE CHECKS	EVENT CHECKS	FEATURE INTEGRITY CHECKS
<p>Domain Finds attribute values that do not comply with coded value or range domains that are associated with an attribute field.</p> <p>Query Attributes Finds records based on a SQL expression run against one attribute.</p> <p>Regular Expression Finds features and uses that contain text values that do not match a defined pattern.</p> <p>Relationship Finds rows in feature classes and stand-alone tables that violate cardinality or relationship rules defined in a relationship class.</p> <p>Subtype Finds features with integer or real subtype values.</p> <p>Table to Table Attribute Finds features or uses that contain attribute values that meet a relationship you define and compares them to values in another feature class or stand-alone table.</p> <p>Unique Field Value Finds rows in feature classes and stand-alone tables that contain nonunique values in a field or a list of fields that are editable.</p>	<p>Event on Event Finds linear referenced events that overlap other events based on a user-defined relationship.</p> <p>Find Orphan Events Finds linear referenced events that have no association to a source feature.</p> <p>Find Event Gaps Finds linear referenced events with gaps between events of the same category, in the same route, or across multiple routes.</p> <p>Find Event Overlaps Finds linear referenced events that have overlaps with events of the same category, in the same route, or across multiple routes.</p> <p>Invalid Event Measures Finds linear referenced events that contain invalid measure values in the same route or across multiple routes.</p>	<p>Check Geometry Finds features whose geometry is empty, null/zero, or not simple, as well as features with empty envelopes.</p> <p>Callbacks Finds segments where the angle between segments in a polygon or polyline is below a specified minimum value.</p> <p>Duplicate Vertices Finds vertices from the same feature that are collocated or within a specified tolerance of one another.</p> <p>Evaluate Part Count Finds features with a part count that is within a specified value.</p> <p>Evaluate Vertex Count Finds polyline or polygon features that have a vertex count within a specified tolerance.</p> <p>Nonlinear Segment Finds polyline or polygon features that contain nonlinear segments such as arcs and curves.</p>
POLYGON CHECKS	POLYLINE CHECKS	SPATIAL RELATIONSHIP CHECKS
<p>Evaluate Polygon Perimeter and Area Finds polygon features based on the area or perimeter of the entire polygon or its individual parts or segments.</p> <p>Find Polygon with Holes Finds polygon features that have holes.</p> <p>Polygon Gap is Sliver Finds gaps between polygon features that are below a specified tolerance ratio.</p> <p>Polygon Overlap is Sliver Finds overlaps between polygon features that are below a specified tolerance ratio.</p> <p>Polygon Sliver Finds polygons below a specified thickness ratio (T) and especially whose area is within a specified threshold.</p> <p>Unclosed Polygon Finds unclosed rings in polygon features.</p> <p>Unnecessary Polygon Boundaries Finds border geometries for polygons that share a common boundary and identical attributes.</p>	<p>Evaluate Polyline Length Finds polyline segments, parts, or features that have a line length within a specified tolerance.</p> <p>Find Dangles Finds polyline features with nodes that are neither in user-defined tolerance but not connected to other polyline or polygon features.</p> <p>Find Disconnected Polylines Finds polyline features that are not connected to other features in the same or other data sources.</p> <p>Monotonicity Finds vertices in enabled or re-enabled polylines that are not strictly increasing or decreasing in value or are trending based on specified conditions.</p> <p>Polyline or Path Closes on Self Finds paths or lines in polyline features that close themselves.</p> <p>Unnecessary Nodes Finds features that share a node and have identical attributes in editable fields.</p>	<p>Composite Finds features or uses based on the result from multiple Data Reviewer checks.</p> <p>Duplicate Feature Finds features that contain duplicate geometry and attribute values.</p> <p>Evaluate Intersection Count Finds vertices for polyline features in one feature class that intersect polyline or polygon features in a second feature class a specified number of times.</p> <p>Feature on Feature Finds features that have a specific relationship other than two feature types or within the same feature type.</p> <p>Valency Finds points or nodes of linear features that intersect with a specified number of linear features.</p>
	LEGEND	
	<p>VALIDATION ATTRIBUTE RULES Data Reviewer checks that are used to validate the quality of features and their attributes. Rules can be created using the GUI or manually using the ArcGIS API for Desktop. The rules are used to validate the quality of features and their attributes. Rules can be created using the GUI or manually using the ArcGIS API for Desktop. The rules are used to validate the quality of features and their attributes.</p> <p>CONSTRAINT ATTRIBUTE RULES Data Reviewer checks that are used to validate the quality of features and their attributes. Rules can be created using the GUI or manually using the ArcGIS API for Desktop. The rules are used to validate the quality of features and their attributes.</p> <p>RUN DATA CHECKS The workflow consists of the execution of feature quality checks through Data Reviewer checks. Rules are created and executed by the GUI or manually using the ArcGIS API for Desktop. The rules are used to validate the quality of features and their attributes.</p>	
		Z-VALUE CHECKS
		<p>Adjacent Vertex Elevation Change Finds vertices for polyline or polygon features with elevation Z-value changes greater than the specified tolerance.</p> <p>Different Z at Intersection Finds features intersecting the features whose Z-value difference is within the minimum/maximum specified range at the point where they intersect.</p> <p>Evaluate Z Values Finds features whose Z values are within a specified range.</p>



2. QC Precheck Phase



2. QC Precheck Phase

1. Topology
2. Manual Review
3. **Compare Schema**
4. Custom Python Tools

The screenshot shows the ArcGIS interface for Feature Classes. The 'List' pane on the left contains the following items:

- cartographic_lines (Polyline)
- cartographic_points (Point)
- cartographic_polys (Polygon)
- cmu_lines (Polyline)
- cmu_points (Point)
- cmu_polys (Polygon)
- contacts_and_faults (Polyline)
- csa_contacts_and_faults (Polyline)
- csa_map_unit_lines (Polyline)
- csa map unit points (Point)

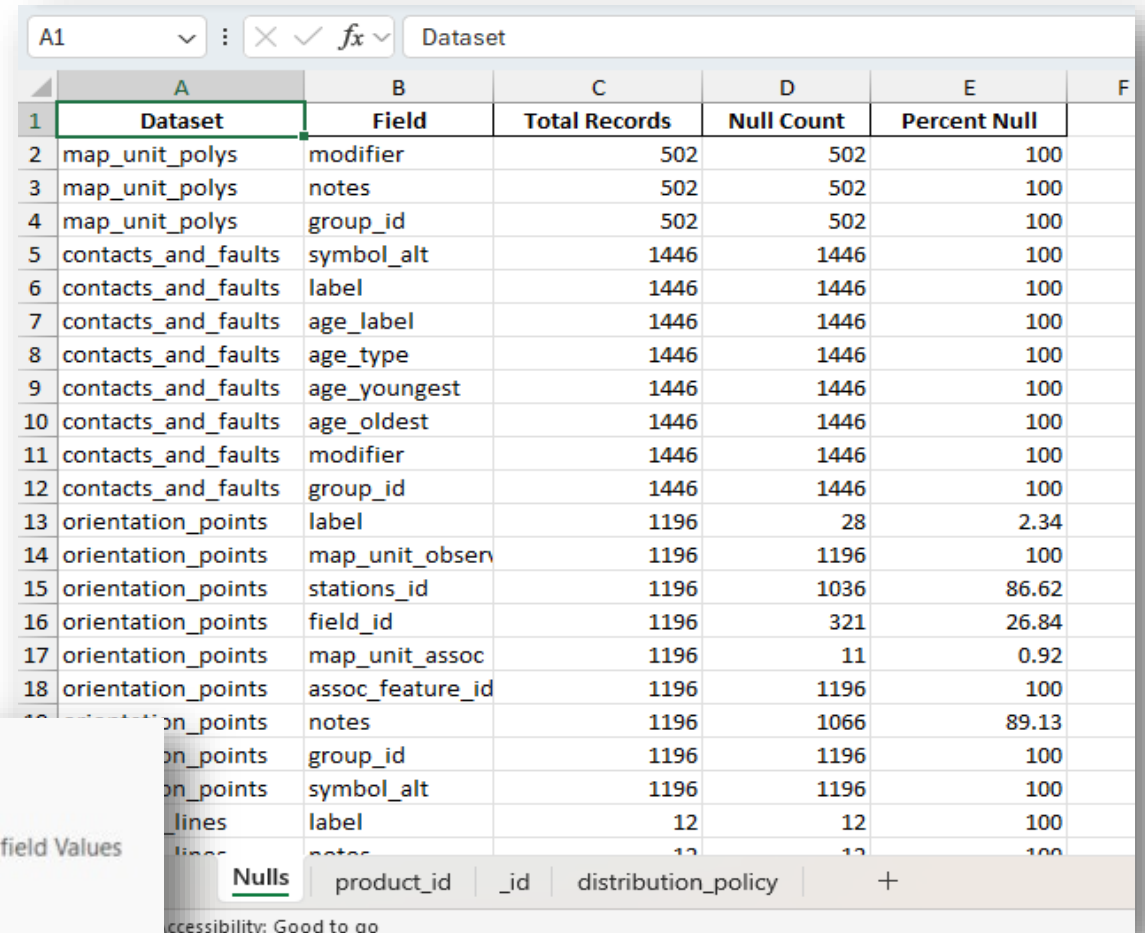
The 'Geoprocessing' window is open, showing the 'Compare Schema' tool. The parameters are:

- Base Source: ak_gems_template_ver_2.0.gdb
- Test Source: bendeleben_a4_b3_b4_part_ak_gems.gdb
- Output Location: test
- Name: bendeleben_a4_b3_b4_part_ak_gems_schema_compare
- Formats: Dynamic HTML



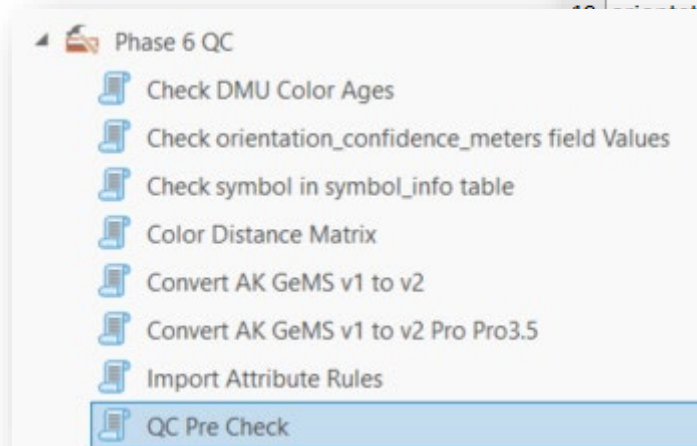
2. QC Precheck Phase

1. Topology
2. Manual Review
3. Compare Schema
4. **Custom Python Tools- QC Precheck Report**



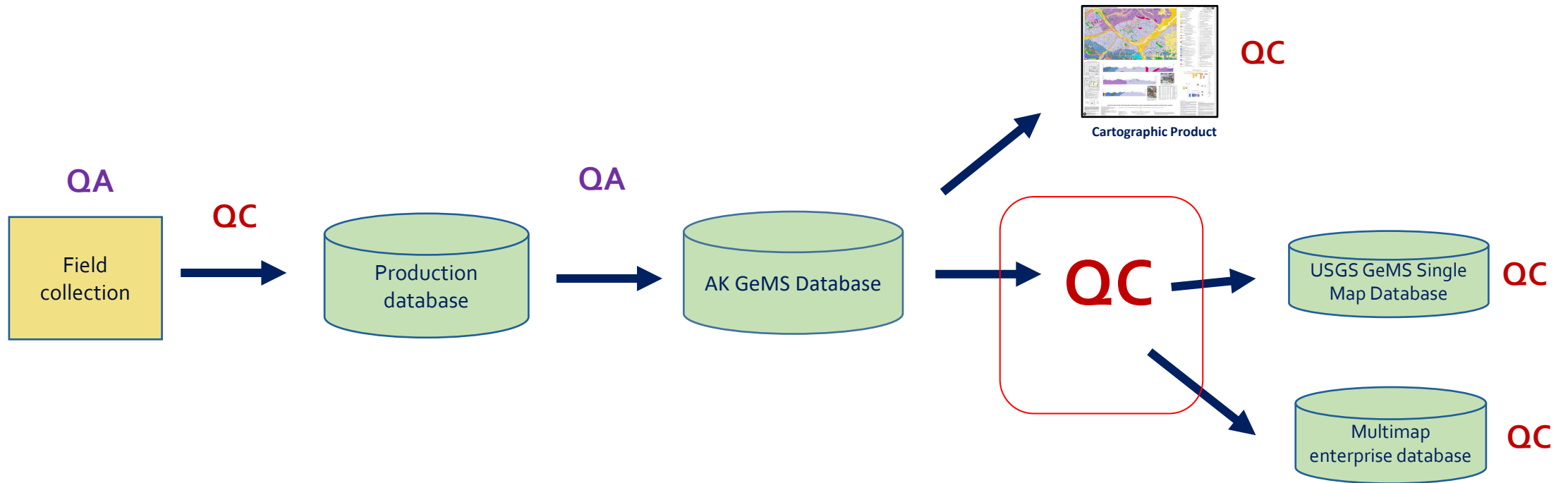
The screenshot shows a data table with columns: Dataset, Field, Total Records, Null Count, and Percent Null. The table lists 18 rows of data for various datasets and fields. A 'Nulls' tab is visible at the bottom of the table.

	A	B	C	D	E	F
1	Dataset	Field	Total Records	Null Count	Percent Null	
2	map_unit_polys	modifier	502	502	100	
3	map_unit_polys	notes	502	502	100	
4	map_unit_polys	group_id	502	502	100	
5	contacts_and_faults	symbol_alt	1446	1446	100	
6	contacts_and_faults	label	1446	1446	100	
7	contacts_and_faults	age_label	1446	1446	100	
8	contacts_and_faults	age_type	1446	1446	100	
9	contacts_and_faults	age_youngest	1446	1446	100	
10	contacts_and_faults	age_oldest	1446	1446	100	
11	contacts_and_faults	modifier	1446	1446	100	
12	contacts_and_faults	group_id	1446	1446	100	
13	orientation_points	label	1196	28	2.34	
14	orientation_points	map_unit_observed	1196	1196	100	
15	orientation_points	stations_id	1196	1036	86.62	
16	orientation_points	field_id	1196	321	26.84	
17	orientation_points	map_unit_assoc	1196	11	0.92	
18	orientation_points	assoc_feature_id	1196	1196	100	
19	orientation_points	notes	1196	1066	89.13	
20	orientation_points	group_id	1196	1196	100	
21	orientation_points	symbol_alt	1196	1196	100	
22	lines	label	12	12	100	
23	lines	notes	12	12	100	



3. Attribute Rules QC

1. Batch Validation Rules



3. Attribute Rules QC

1. Bulk Validation Rules: 54 checks across db

The screenshot displays the ArcGIS interface with several key components:

- Validation Rules Table:** A table listing 22 validation rules. The 'Short Lines Check' is highlighted in blue. The table includes columns for 'Disabled', 'Rule Name', 'Subtype', 'Min Pro Release', 'Min Enterprise Release', and 'Min Arcade Release'.
- Short Lines Check Details:** A panel on the right showing configuration for the 'Short Lines Check', including 'Input Filters' (set to 'All'), 'Check Parameters' (Type: Polyline, Length: is greater than or equal to 10), and 'Details'.
- Map View:** A map showing a geologic map with various colored regions and a network of lines. A 'Close' dialog box is open over the map, showing options for severity (1-5), exception (True/False), status (Reviewed, Resolved, Mark As Exception, Acceptable, Unacceptable), and phase (Point, Polyline, Polygon, Table).
- Error Inspector:** A table at the bottom showing a list of 14 errors. The table has columns for Phase, Status, Shape, Rule Type, Exception, Feature ObjectID, Source Layer, Feature GlobalID, Error Number, Error Message, Rule ID, and Details.

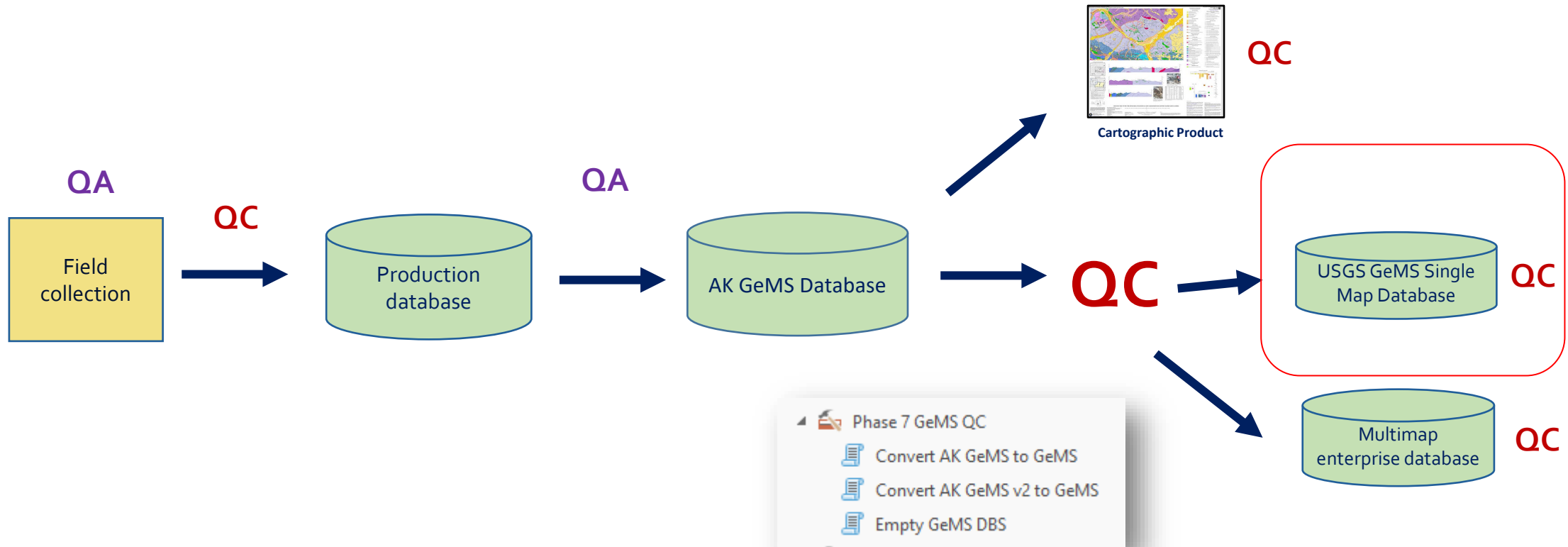
Disabled	Rule Name	Subtype	Min Pro Release	Min Enterprise Release	Min Arcade Release
<input type="checkbox"/>	Domain Rule	<All>	2.7	10.9	1.0.0
<input type="checkbox"/>	Evaluate Part Count Check	<All>	2.5	10.8	1.0.0
<input type="checkbox"/>	Nonlinear Segment Check	<All>	2.6	10.8.1	1.0.0
<input type="checkbox"/>	Identify Confidence Label Check	<All>	2.5	10.8	1.0.0
<input type="checkbox"/>	product_id Check	<All>	2.7	10.9	1.0.0
<input type="checkbox"/>	Data Sources Check	<All>	2.7	10.9	1.0.0
<input type="checkbox"/>	Other in type or category Check	<All>	2.5	10.8	1.0.0
<input checked="" type="checkbox"/>	Polyline or Path Closes on Self Rule	<All>	2.5	10.8	1.0.0
<input type="checkbox"/>	Find Disconnected Polyline Rule	<All>	2.9	10.9.1	1.0.0
<input type="checkbox"/>	Nulls Check	<All>	2.7	10.9	1.12.0
<input type="checkbox"/>	Leading and Trailing Spaces Check	<All>	2.7	10.9	1.12.0
<input type="checkbox"/>	Map Boundary Check	<All>	2.7	10.9	1.0.0
<input type="checkbox"/>	Distribution Policy Check	<All>	2.5	10.8	1.0.0
<input type="checkbox"/>	Logical category and type Check	<All>	2.5	10.8	1.0.0
<input checked="" type="checkbox"/>	Short Lines Check	<All>	2.5	10.8	1.0.0
<input type="checkbox"/>	Invalid Geometry Check	<All>	3.0	11.0	1.0.0
<input type="checkbox"/>	Unique id Value Check	<All>	2.9	10.9.1	1.0.0
<input type="checkbox"/>	Duplicate Feature Check	<All>	2.7	10.9	1.0.0
<input type="checkbox"/>	Unnecessary Nodes Check	<All>	2.7	10.9	1.0.0
<input type="checkbox"/>	Duplicate Vertex Check	<All>	2.5	10.8	1.0.0
<input checked="" type="checkbox"/>	Symbol in symbol_info Check	<All>	2.3	10.7	1.5.0
<input type="checkbox"/>	Symbol Logical with type Check	<All>	2.3	10.7	1.5.0

Phase	Status	Shape	Rule Type	Exception	Feature ObjectID	Source Layer	Feature GlobalID	Error Number	Error Message	Rule ID	Details
1	?	<Null>	Validation		29 311	[0DEDD49-D1D7-4193-8638-653E0878616A]		6	Symbol not in symbol_...	Symbo	Property: Value: 45
2	?	<Null>	Validation		294 311	[FA641384-2A3B-470A-4FA1-EB866E4858DB]		6	Symbol not in symbol_...	Symbo	Property: Value: 45
3	?	<Null>	Validation		36688 300	[057B15C4-768F-4897-8E82-4B86F8C511E]		228	Feature/Row matches	Distrib	Rule Type: Validation
4	?	Reviewed	Validation		36676 300	[04E8E49F-3491-4902-8307-ECF92027E6D0]		228	Feature/Row matches	Distrib	Exception: <input type="checkbox"/>
5	?	Reviewed	Validation		36539 300	[E19A92A6-ABA2-4C7C-4752-13660A538449]		228	Feature/Row matches	Distrib	Feature ObjectID: 29
6	?	Reviewed	Validation		37042 300	[570277F6-1638-4E6A-A4E4-A0D7314D6873]		228	Feature/Row matches	Distrib	Source Layer: 311
7	?	Reviewed	Validation		36474 300	[4248B073-32BC-4137-8BC5-BFF086538008]		228	Feature/Row matches	Distrib	Feature GlobalID: [0DEDD49-D1D7-4193-8638-653E0878616A]
8	?	Reviewed	Validation		36477 300	[CBEA4C17-4034-4BF7-9577-DA9BA4601206]		228	Feature/Row matches	Distrib	Error Number: 6
9	?	Reviewed	Validation		36625 300	[303C2540-1A30-4A4C-8049-A842A5077433]		228	Feature/Row matches	Distrib	Error Message: Symbol not in symbol_info table.
10	?	Reviewed	Validation		36516 300	[4B50BD6A-AFF6-4641-80F5-D5D775436F6E]		228	Feature/Row matches	Distrib	Rule Name: Symbol in symbol_info Check
11	?	Reviewed	Validation		36463 300	[0A592ECE-4658-4A64-ABE1-FD66FD899558]		228	Feature/Row matches	Distrib	Rule ID: 58
12	?	Reviewed	Validation		36626 300	[BD562240-C237-4DCC-8C2C-D2A05A005E97]		228	Feature/Row matches	Distrib	Description: Values in the symbol field must exist in the symbol_info.t
13	?	Reviewed	Validation		37341 300	[3DFDF03-999F-4ED5-9528-8867D7638AF6]		228	Feature/Row matches	Distrib	Severity: 2
14	?	Reviewed	Validation								Creation date: 3/2/2026 9:10:59 PM
											Creator: AMSTEINLEITNER



Migration to GeMS Database

- Finally, USGS QC tool is run



shatoolik_surficial_gems.gdb-ValidationErrors.html

Database path:

This file written by `GeMS_ValidateDatabase.py`, version of 02/19/2025

Tue Apr 14 12:10:37 2026

DO NOT RENAME THIS FILE. IT MUST RESIDE IN THE SAME FOLDER AS shatoolik_surficial_gems.gdb-Validation.html

Color Codes

Orange are tables, feature classes, or feature datasets in the geodatabase

Blue are fields in a table

Green are values in a field

Level 2 errors

2.4 MapUnits missing from DMU. Only one reference to each missing unit is cited

MapUnitPolys, **MapUnit**, **MzPrc**

2.7 Duplicated terms in Glossary

landslide and mass wasting, generic

landslide and mass wasting, other

Level 3 errors

3.3 GeMS fields that are missing values (NULL values in critical NoNulls fields)

DescriptionOfMapUnits, **ParagraphStyle**

A shorter list of validation errors



Questions?

