Map Compilations: Creating a Seamless Geologic Map for the State of West Virginia

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Abstract

In effort to create a seamless statewide geologic map, the West Virginia Geological and Economic Survey (WVGES) is building an Enterprise Dataset, an internal WVGES database that seamlessly synthesizes all available geologic data for the state. This work dovetails with the U.S. Geological Survey's goal of establishing a seamless nationwide geologic map. WVGES is mapping, organizing, and compiling 1:24,000 (24k) quadrangles by 1:100,000 (100k) sheets as part of an ongoing project for the U.S. GeoFramework Initiative of STATEMAP, a component of the National Cooperative Geologic Mapping Program. The goal is to have the geology of the state of West Virginia completely mapped at 24K scale. Presently, statewide geologic coverage exists as a combination of the 1:250,000 scale statewide geologic map published in 1968 and past and current 24K scale bedrock mapping of individual quadrangles. WVGES prioritizes bedrock mapping in areas of karst terrain, tourism, infrastructure development, and conservation, concentrated on the eastern state margin and New River Gorge area. While WVGES is organizing data by 1:100,000 sheets, the mapped geology retains 24K scale in the database. Presented are examples of this work in Silurian-Devonian bedrock units of the Elkins 100K sheet. Integrating different datasets resolves regional geology and provides a product useful for a broader range of studies. Important factors that improve resolution of geological maps include modern basemap data such as LiDAR and systematic edge-matching of mapped quadrangles. Edge-matching ensures congruence of geologic features across map boundaries. Overlays are created for digitized bedrock maps in ArcGIS to assess severity and offer solutions for mismatches. Minor mismatches include offset in features and solutions are drawn in the overlay. Geologic groups on one quadrangle may be split into formations on adjacent quadrangles mapped by different authors. Major mismatches are managed by supplementary data analysis or field work. Such issues correspond to structural complexity or inconsistencies in stratigraphic interpretation. Examination and resolution of these geological problems will greatly enhance quality of bedrock mapping, providing new and updated mapping for West Virginia.

BACKGROUND

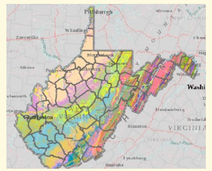
GOAL:

- **Compile 24K scale quadrangles into 100K scale map sheets** in order to resolve the regional geology and to provide a more useful digital map product applicable for a wider range of studies.

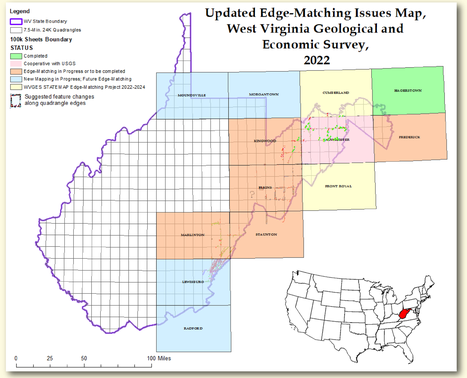
LONG-TERM GOALS:

- To have the state of West Virginia completely mapped at 24K scale.
- Implement GeMS Level 3 for both existing maps and all future mapping.
- Building the Enterprise Dataset, an internal WVGES database that includes all geologic data available for the state.
- Creating a seamless, high-resolution, statewide geologic map of West Virginia.
- Contribute towards the USGS's goal to have a seamless, nationwide geologic map by year 2030.

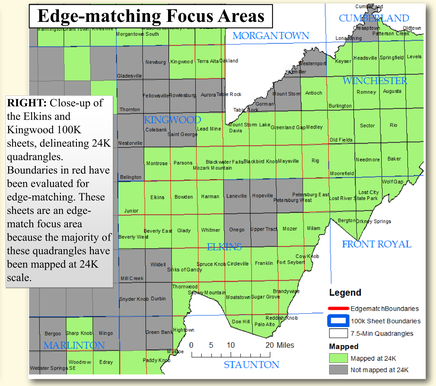
RIGHT: Statewide map of West Virginia showing the edge-matching status of 100K scale map sheets, with United States Map inset highlighting West Virginia in red. Edge-matching is concentrated mostly in the eastern portion of the state, coinciding with STATEMAP priority mapping areas.



ABOVE: The Statewide 1968 1:250,000 scale Geologic Map of West Virginia, revised for GeMS.



Edge-matching Focus Areas



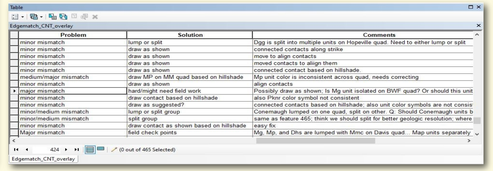
RIGHT: Close-up of the Elkins and Kingwood 100K sheets, delineating 24K quadrangles. Boundaries in red have been evaluated for edge-matching. These sheets are an edge-match focus area because the majority of these quadrangles have been mapped at 24K scale.

Edge-matching: A Fundamental Approach for Compiling Maps

Edge-matching is a systematic method designed to **identify** and **resolve** geological mismatches between adjacent 24K scale quadrangles. 24K scale quadrangles are compiled into 100K scale sheets, which are then assessed for any geological errors or mismatches that exist along mapped boundaries. Major contrasts in mapping may exist between adjacent 24K scale quadrangles, which may reflect differences in mapping scale, geologic interpretations, mapping technologies, stratigraphic nomenclature, map symbology, and more.

Mismatches are identified and organized into **three different overlays**; **1) geologic unit contacts, 2) structural axes, and 3) faults.** The overlays are used to identify and annotate observed mismatches (See table below).

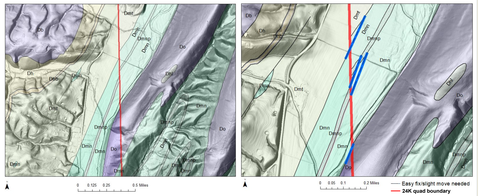
In each overlay, the identified **mismatches** are ranked as **minor**, **medium**, or **major** based on the complexity of the geological problem.



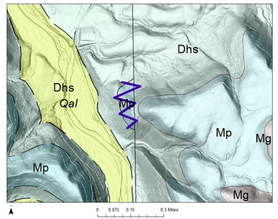
LEFT: Attribute table for the geologic **contacts edge-match overlay.** Suggested solutions for correcting each problem are described in the attribute table, and may be drawn in the overlay for minor mismatches.

Minor Mismatches

Problems classified as **Minor Mismatches** are considered to have easy or immediate fixes. Regardless of how small the error may be, it is important to track any and all changes.

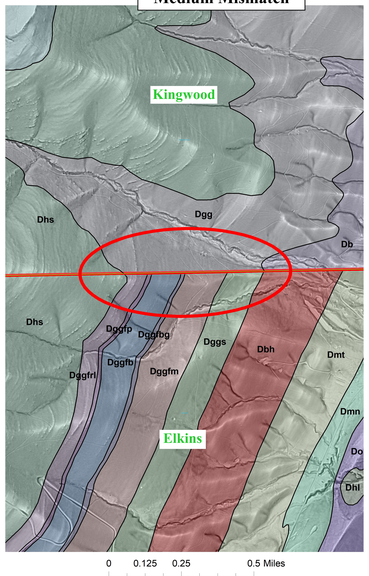


Mismatch Example 1: Misalignment of map unit contacts across quadrangle boundary. There is a slight offset in the Devonian shale unit contacts. A suggested fix is proposed by drawing in the **Edgematch_Contact_Overlay** (blue lines). This example is from the Kingwood 100K sheet.



Mismatch Example 2: A mismatch between the Hampshire (Dhs) and Price (Mp) Formations along a 24K quadrangle boundary (Elkins 100K). In the absence of field data and no evidence on the LiDAR, the most simple suggested solution is to delete the isolated Mp polygon.

Medium Mismatch

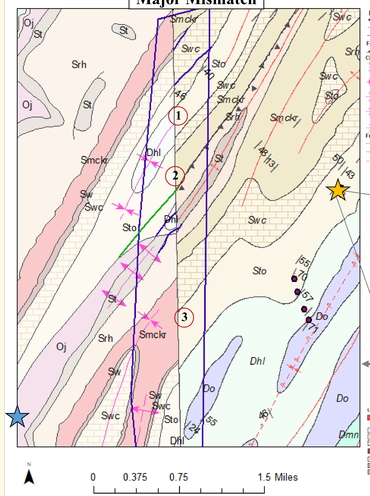


Mismatch Example 3: A geologic group is mapped on one quadrangle, but is differentiated into its respective formations/ members on an adjacent quadrangle. The Greenland Gap Group is mapped together on the top quadrangle, but split into Formations and Formal Members on the bottom quadrangle.

The shown mismatch is located on the Kingwood-Elkins 100K boundary.

Legend
Edgematch_Kingwood_CNT_overlay
WV 100K Boundary
Top Quad:
Mp - Price Formation
Dhs - Hampshire Formation
Dgg - Greenland Gap Group
Db - Brallier Formation
Bottom Quad:
Dhs - Hampshire Fm
Dggfrl - Foreknobs Fm, Red Lick Member
Dggfp - Foreknobs Fm, Pound Member
Dggfb - Foreknobs Fm, Blizzard Member
Dggfbg - Foreknobs Fm, Briery Gap Member
Dggfm - Foreknobs Fm, Mallow Member
Dggs - Scherr Fm
Dbh - Brallier - Harrell Fm, Undifferentiated
Dmt - Mahantango Fm
Dmn - Marcellus - Needmore Sh, Undifferentiated
Do - Oriskany SS
Dhl - Helderberg Group

Major Mismatch



Mismatch Example 4: Major unit differences between two 24K quadrangles on the Elkins 100K sheet. Major differences include: **(1)** the Helderberg Group (Dhl) on the left quad and not on the right quad; **(2)** a discontinuous fault;
(3) significant differences in stratigraphy, between the Tonoloway Limestone (Sto), the Wills Creek Limestone (Swc), and undifferentiated Silurian Limestones.

Problem-solving techniques for medium and major mismatches

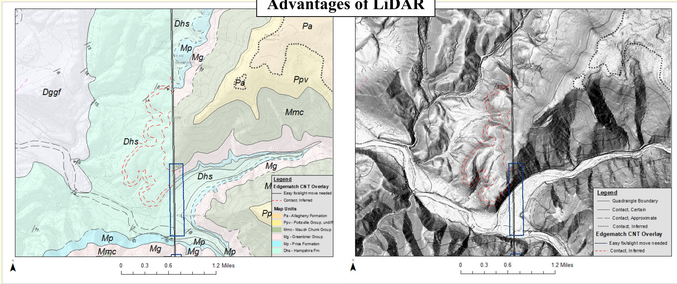
Medium and **major** mismatches do not have obvious solutions and require more thought. Fixing these problems may involve re-evaluating geology based on available data (i.e field points, LiDAR, etc), talking to the person/people who mapped the area in question for clarification (if possible), and in severe cases, field checking and/or collecting additional field data in the problem area.

Field Checking Data

Photo corresponds to yellow star on Mismatch 5. Initially mapped as the Tonoloway Limestone, geologists interpreted this unit as the Wills Creek Limestone during a field check.

LEFT: A fault propagation fold in the Ordovician Juniata Formation, observed during an edge-matching field check to resolve mismatches in the Elkins 100K sheet (blue star on Mismatch 5). This well-known Juniata outcrop falls just southeast of a major mismatched area, where geologists were attempting to resolve discrepancies in mapped units further complicated by a fault zone.

Advantages of LiDAR



Mismatch Example 5: A unit contact mismatch area ranked as **medium/major.** The recent release of full-coverage LiDAR Imagery for the state of West Virginia has been a significant help in correcting placement of map unit contacts, structural axes, and fault lines. Resistant, ridge-forming units can be traced using LiDAR. Truncation and offset of units relating to faults is also visible in LiDAR. In recent mapping, LiDAR has been helpful for differentiating the Greenbrier Group because units like the Union Limestone contain abundant sinkholes, visible in the LiDAR.

Edge-matching Across State Boundaries

The WVGES is working with the USGS, neighboring state geological surveys of Maryland, Pennsylvania, and Virginia, to map seamless geology across state boundaries. We are collectively working towards sharing data across agencies to allow edge-matching in real-time. Standardizing stratigraphic nomenclature for the northern Appalachian region and having open communication of map data between agencies facilitated through in-person meetings and ArcGIS Online are just a few collaborative approaches we have taken.