

MAPPING DEFORMED PENNSYLVANIAN ROCKS IN THE DUNKARD BASIN, SOUTHWESTERN PENNSYLVANIA - USING GIGAPAN IMAGES

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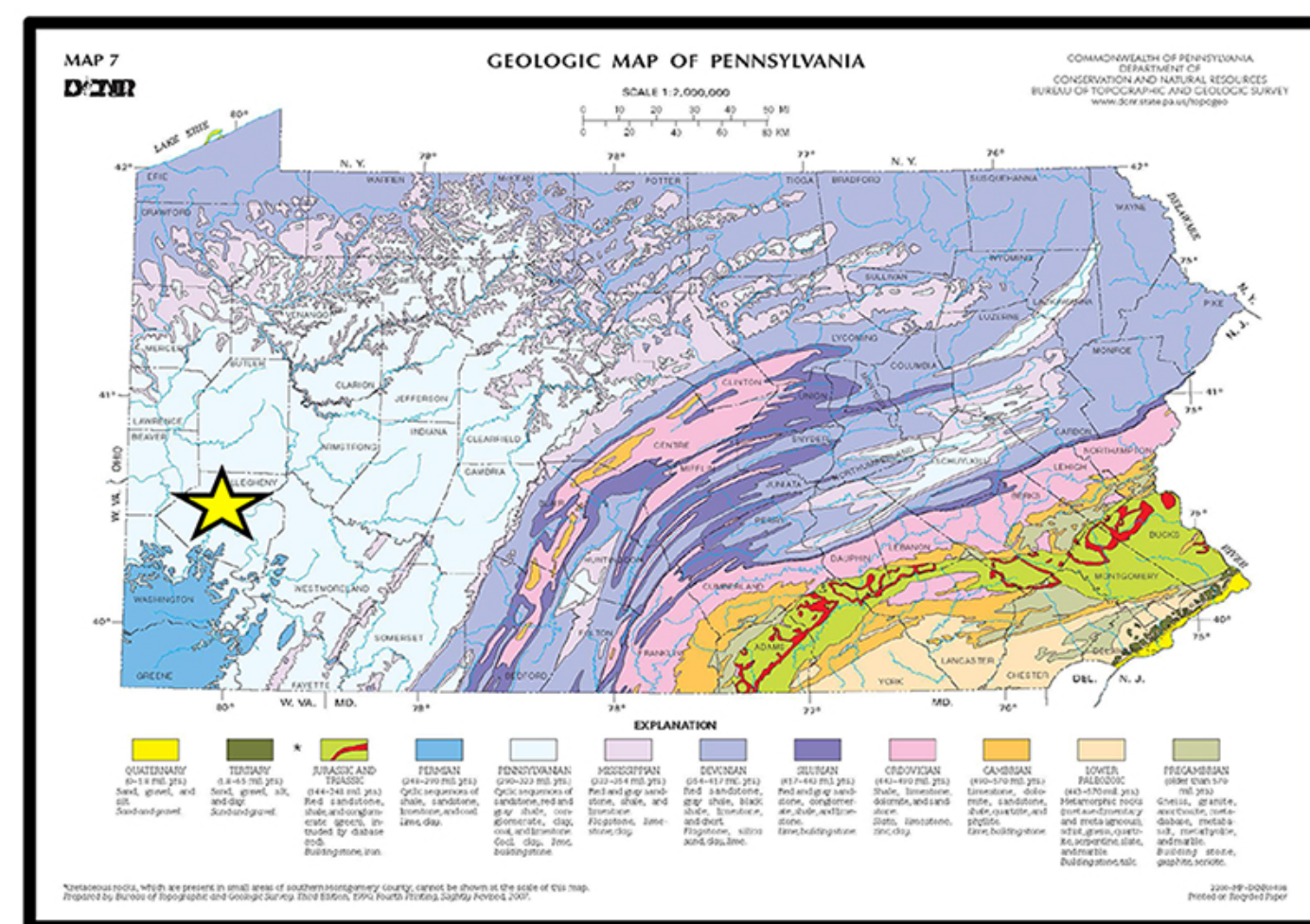
Abstract

Panoramic images of an outcrop produced with a GigaPan robotic camera mount and Canon EOS 60D camera are used to enhance the quality of structural analysis of deformed Pennsylvanian rocks that crop out along a 250 meter-long railroad cut in southwestern PA. Clastic rocks of the lower Casselman Formation of the Conemaugh Group record tilted beds, listric normal faults, a reactivated angular unconformity and small-scale asymmetric folds. These structures are not typical of the general flat-lying rocks that characterize this region of the Appalachian Plateau and suggest at least three episodes of sliding and extension along detachment faults. The lowest exposed units, tilted 30 - 40° degrees to the south, comprise decimeter-scale alternating shale and lithic-quartz arenite beds. Locally developed within the tilted blocks are small-scale, tight asymmetric detachment folds that record southward transport. A prominent angular unconformity separates the tilted blocks from overlying, sub-horizontal, medium to thick-bedded cross-stratified quartz arenite. Listric normal faults that presumably underlie the tilted section do not cut the unconformity. The basal unit above the unconformity varies from 10's of centimeters to about a meter and comprises fractured beds of foliated siltstone and fine-sandstone, disrupted coal beds and rounded cobbles. The deformation recorded within this unit suggests reactivation of the erosional surface during detachment of the overlying sandstone. Above the unconformity, clastic dikes cut thin, discontinuous coal seams, recording the injection of fluid-rich sandstone. Conjugate shear fractures record brittle deformation of semi-lithified beds. A late north-dipping listric normal fault that records about one meter of displacement cuts both the angular unconformity and overlying quartz arenite. Although rocks of the Dunkard Basin rarely show the complex structures recorded at this outcrop, we suggest that the normal faults and detachments record transport into the Appalachian Basin penecontemporaneous with accumulation of the Casselman Formation.

Methodology

Images of select sections of the western portion of the outcrop were captured using a Canon EOS 60D camera mounted on a GigaPan EPIC Pro robotic mount. Images were stitched together using GigaPan Stitch software and any necessary adjustments to contrast and color saturation were made in Adobe Bridge CS6. Geologic structures were mapped on Adobe Illustrator CS6. A panorama of the western portion of the railroad cut was produced using Adobe Photoshop (Rak et al., 2013).

Location



Stratigraphic Column of Conemaugh Group

GROUP	FORMATION	GENERALIZED GEOLOGIC SECTION	INDIVIDUAL BEDS OR MEMBERS				
Monongahela	Pittsburgh		Pittsburgh coal				
			Upper Pittsburgh limestone Lower Pittsburgh limestone				
Conemaugh	Casselman		Cornellville sandstone Clarkburg coal Morgantown sandstone Wallerburg coal Birmingham shale Duganese coal				
			Glenshaw		Ames Limestone Pittsburgh red beds Bakersown coal Upper Saltsburg sandstone Woods Run limestone Nashine limestone Lower Saltsburg sandstone Pine Creek limestone Buffalo sandstone		
					Allegheny		Brush Creek limestone Upper Mahoning sandstone Mahoning coal Lower Mahoning sandstone Upper Freeport coal

EXPLANATION

- Red beds
- Limestone
- Sandstone
- Shale and siltstone
- Coal

Rocks exposed at Bakerstown Station railroad cut

Shultz and Harper, 2001

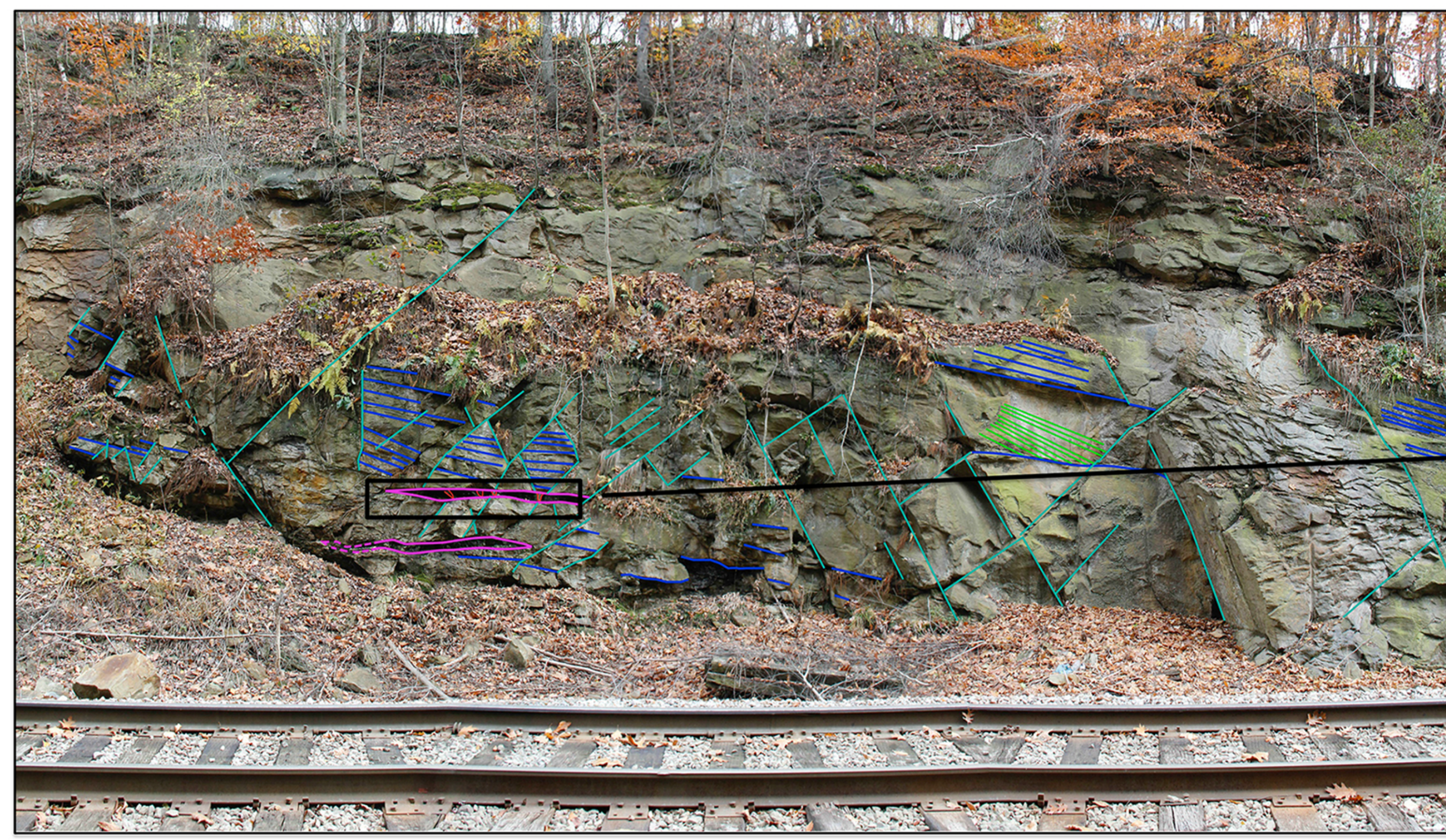
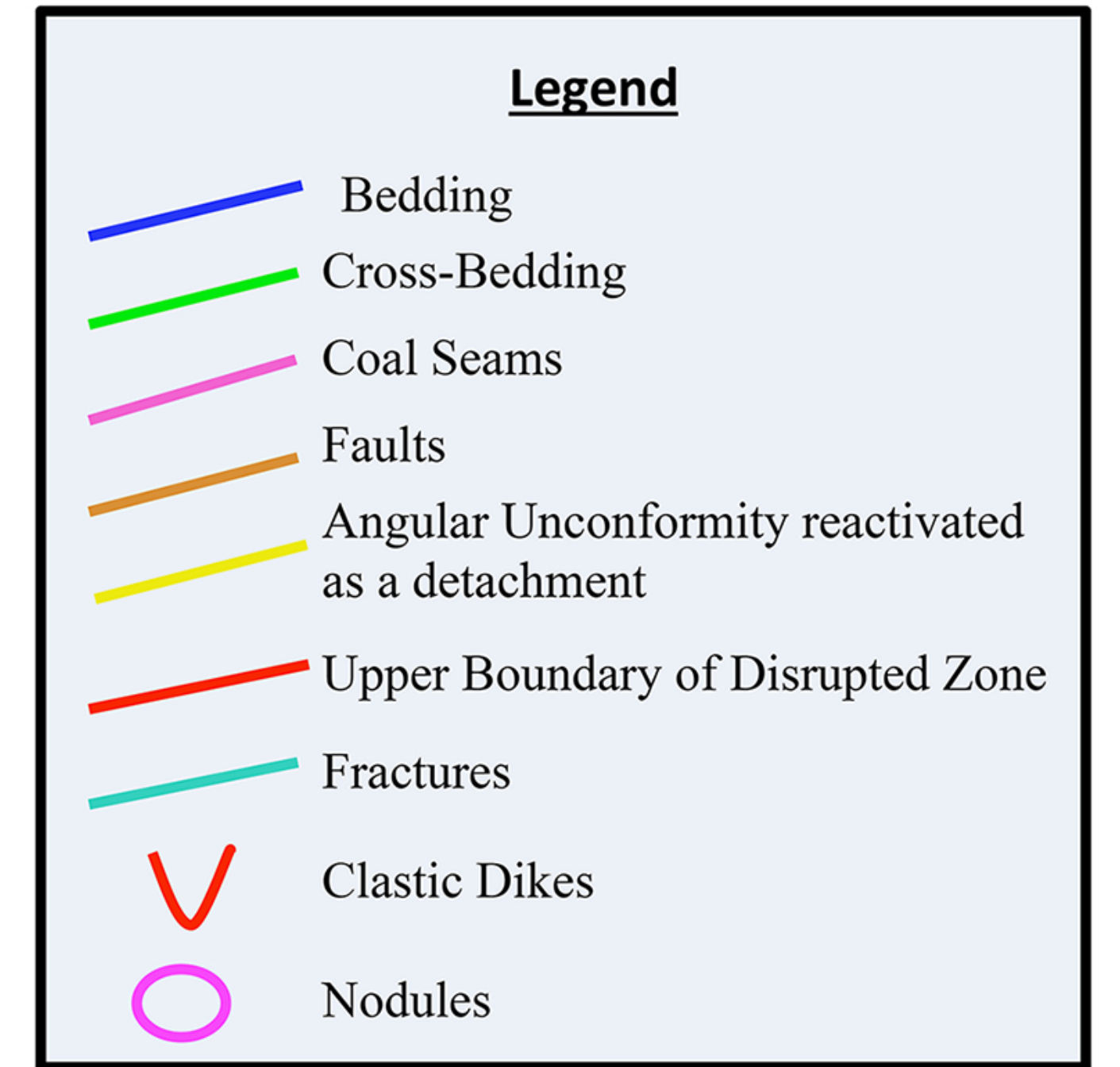


Figure 3: Eastern portion of outcrop shows cross-bedded sandstone structurally above the unconformity. Outcrop records discontinuous coal beds, conjugate fractures, and clastic dikes in the coal beds.



Figure 4 : Dikes of sandstone cutting coal bed.



Discussion

Pennsylvanian clastic rocks that comprise the lower Casselman Formation of the Conemaugh Group record tilted beds, listric normal faults, an unconformity reactivated as a detachment, conjugate fractures and clastic dikes. Such structures are not typical of the general flat-lying rocks that characterize the Appalachian plateau west of the folds of the Valley and Ridge Province. The extensional structures record west-directed transport of semi-lithified beds into the Appalachian Basin following uplift.

Structures at this outcrop record multiple episodes of deformation:

- Foliated beds at the base of a thin (<10m), tilted, section that locally record asymmetric detachment fold indicate detachment and probable movement along listric normal faults (Fig. 2 and inset B)
- Cross-stratified quartz sandstone overlying the tilted section shows conjugate fractures, rarely filled with sand, and sandstone dikes cutting beds of coal indicating deformation of semi-lithified sediment (Figs. 3 and 4).
- The base of the unconformable layers is marked by a disrupted unit of variable thickness comprised of fractured siltstone, fine sandstone, and small discontinuous stringers of coal and rounded cobbles (Figs.1 and 2). Locally, fine sandstone at the top of the footwall is foliated (Fig. 2A). The deformation recorded within this unit suggests reactivation(s) of the unconformity during detachment of the overlying sandstone
- A younger listric normal fault with about 1 meter of displacement cuts the unconformity, disrupted unit, and overlying cross-stratified quartz arenite (Fig. 1).

Structures that record deformation of semi-lithified beds are widespread at the base of the Morgantown Sandstone of lower Casselman in the Dunkard basin of southwestern PA.

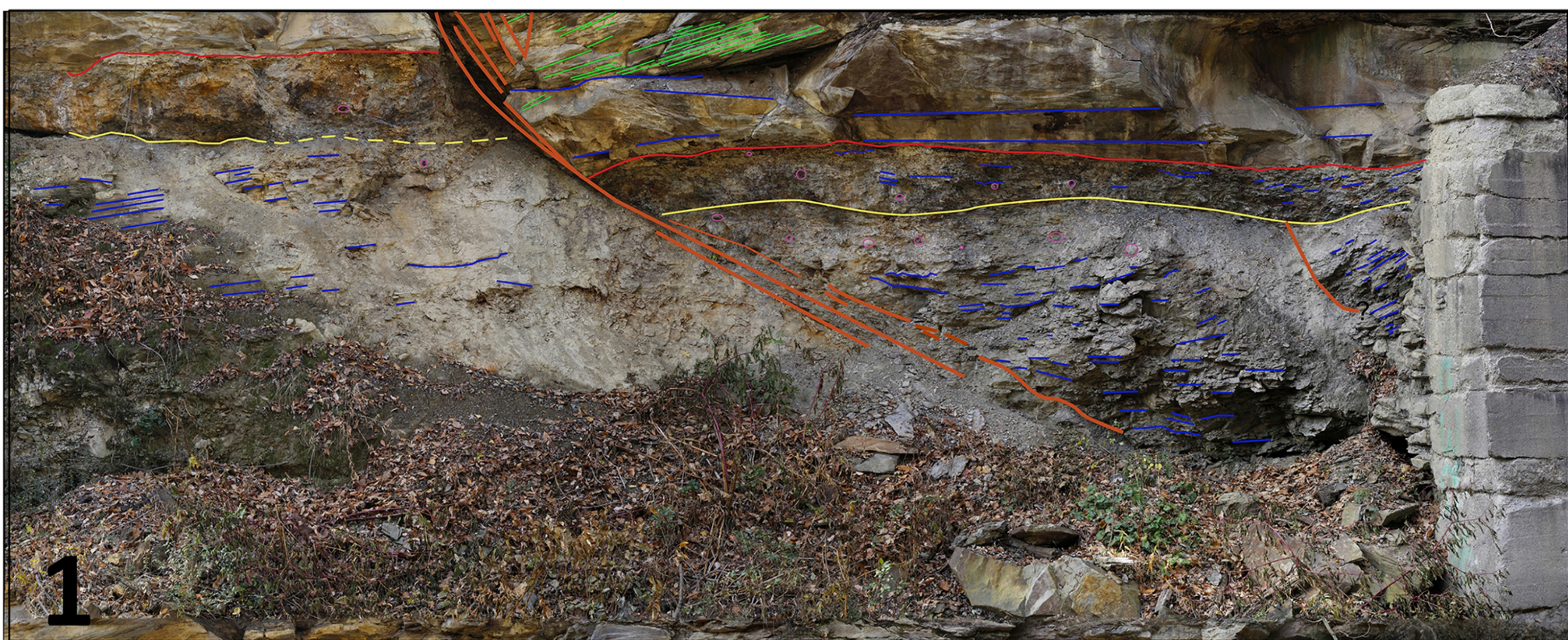


Figure 1: GigaPan image of the southern portion of western outcrop displaying cross-stratified sandstone, cobble-sized nodules, the disrupted zone above the reactivated angular unconformity, a early normal fault cut by the unconformity and the later listric normal fault that cuts the disrupted zone and unconformity.



Figure 2: GigaPan image of the northern portion of western outcrop displaying the reactivated angular unconformity separating highly tilted beds below from subhorizontal beds above. Inset photo A shows contact between tilted foliated sandstone below unconformity and sandstone beds above unconformity. Inset photograph B shows asymmetric fold in foliated sandstone.



Panorama of the western outcrop (Rak et al., 2013).

References

- Rak, A., Campbell, P. A., and Anderson, T. H., 2013, Evidence for multi-stage deformation within Pennsylvanian rocks in the Dunkard Basin, Southwestern Pennsylvania, from Geological Society of America Northeastern Section, May 2013.
- Shultz, C. H. and Harper, J. A., 2000, Stop 8, Bakerstown Station railroad cut, in Harper, J. A., ed., Pittsburgh at the millennium – the impact of geoscience on a changing metropolitan area: Annual Field Conference of Pennsylvania Geologists, 55th, Pittsburgh, Pa., Guidebook, p. 125-130.
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