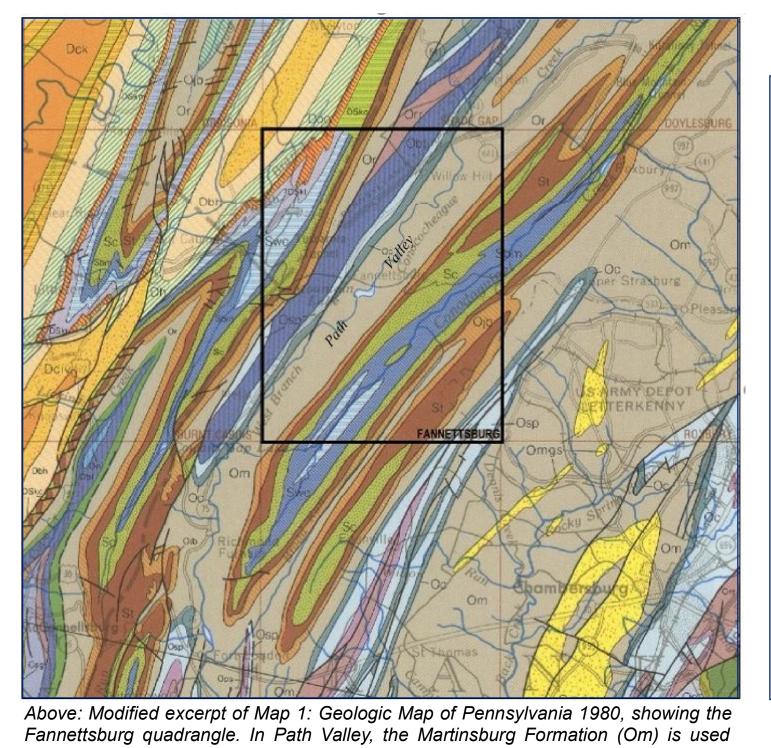
FACIES ASSOCIATION AND THE STRATIGRAPHIC RELATIONSHIP OF THE MARTINSBURG FORMATION AND THE REEDSVILLE FORMATION ALONG THE NORTHWESTERN EDGE OF THE GREAT VALLEY IN PENNSYLVANIA

ABSTRACT

The Reedsville and Martinsburg Formations are clastic units, primarily shale and siltstone, which occupy the same stratigraphic interval. They represent the Late Ordovician influx of clastic sediment over the Laurentian carbonate bank during the Taconic Orogeny. Along the western front of the Great Valley Section with the Blue Mountain and the Appalachian Mountain Sections of the Ridge and Valley Province, their character differs, due to differences in depositional environment. The Martinsburg Formation is primarily deep water turbidites, and pelagic marine life (e.g., graptolites) dominates the fauna. The Reedsville Formation consists primarily of contourites, tempestites, and sediments deposited by other shallow marine currents. The marine fauna is dominantly benthic invertebrates – brachiopods, bryozoans, crinoids, and trilobites. Despite these differences, the units in Pennsylvania are mapped essentially based on their location. The name Martinsburg is used for this interval in the Great Valley Section. The name Reedsville is used in the remainder of the Ridge and Valley physiographic province. No published geologic maps properly address the transition between the two units.

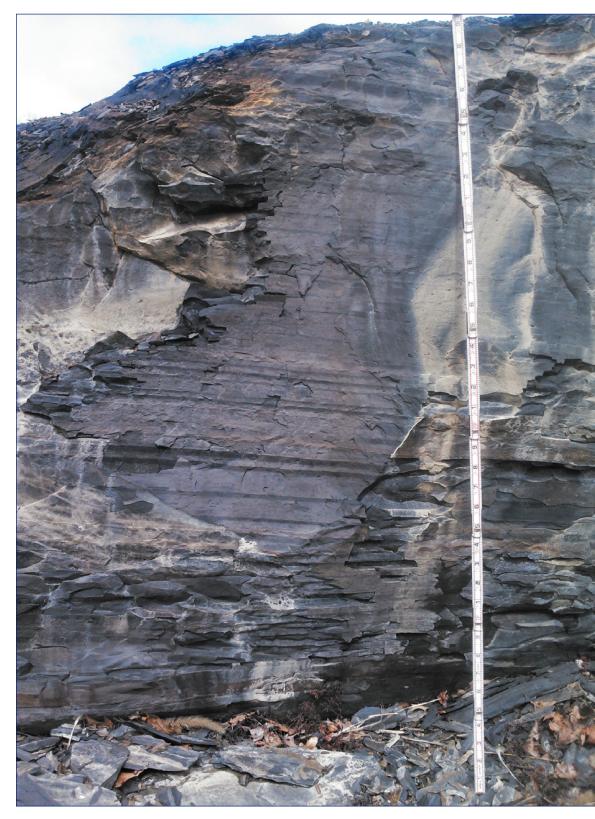
Lehman (1989) first used the name Reedsville for rocks on the Great Valley side in Swatara Gap, Lebanon County, that had previously been mapped as upper Martinsburg Formation, based on the lithologic characteristics described above. Mapping by Ganis and Blackmer (2010) in Lebanon and Dauphin Counties confirmed this interpretation. They also found a time gap between the units, with the youngest Martinsburg in the C. americanus graptolite zone, and the Reedsville in the C. spiniferus zone. Geologic mapping and coring by Bierly farther to the southwest in Franklin County found a similar sequence of Martinsburg overlain by Reedsville. These occurrences indicate that the Reedsville extends at least into the northwestern edge of the Great Valley. It may have been even more extensive to the south and east prior to removal by erosion. Although we know that the deep-water Martinsburg facies thins dramatically across the Blue Mountain/Appalachian Mountain front, further mapping is necessary to determine its extent north and west of the Great Valley Section.



A Mapping Problem: Reedsville Formation vs. Martinsburg Formation

No geologic maps published by the Pennsylvania Geological Survey have attempted to map the transitional nature of the Reedsville and Martinsburg Formations. Naming of these formations in Pennsylvania has been separated by physiographic section, with the Martinsburg unit being used the Great Valley section, and the Reedsville unit being used in the remainder of the Ridge and Valley province.

This "physiographic mapping" breaks down in Path Valley, Franklin County where the Horse Valley and North Mountain synclines plunge, allowing Path Valley (Appalachian Mountain Section) to merge with the Cumberland Valley (Great Valley Section). Therefore, the name of the Ordovician shales in Path Valley has "flip-flopped" over time depending on the preference of the mapper.



scale and pointing in the direction of dip. GPS Coordinates



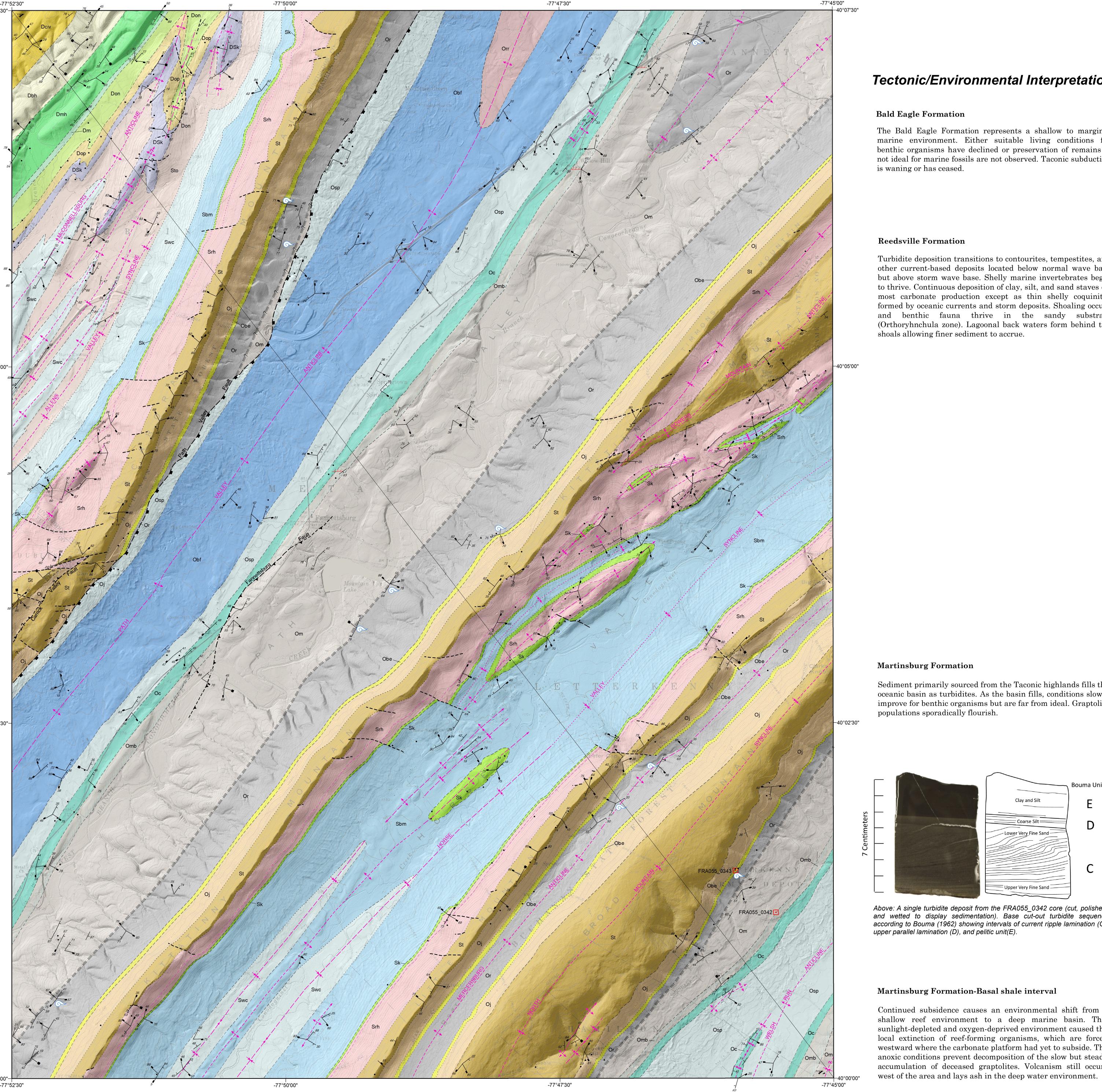
Geologic Mapping of the Fannetttsburg Quadrangle

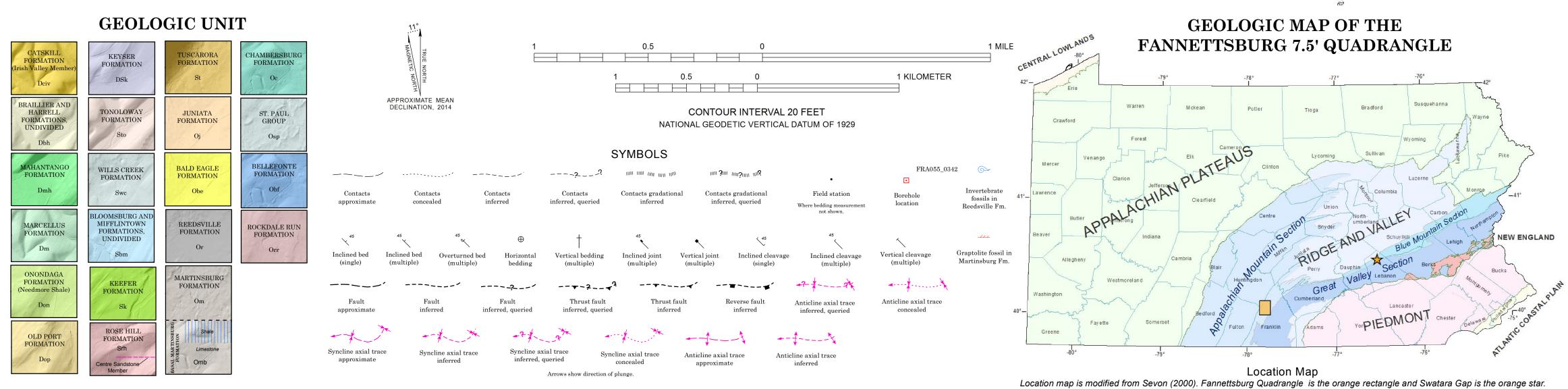
One of the main goals of mapping the Fannettsburg 7.5' Quadrangle, was to determine the stratigraphic relationship and extent of the Reedsville and Martinsburg Formations. Mapping revealed a sequence interbedded carbonates and shale indicating rapid drowning, followed by "black" deep marine shale directly above the Chambersburg Limestone. These strata are lithostratigraphically comparable to that of the Coburn and Antes Formations north and west of the quadrangle, which traditionally underlie the Reedsville Formation. However, a thick (>1000 feet) interval of fining upward sequences (FUS) of dominantly silt-shale and clay-shale above the "black shale" is more diagnostic of the Martinsburg Formation in the Cumberland Valley (Great Valley Section). This interval represents distal turbidites, commonly displaying a truncated sequence of Bouma units D and E, and less commonly bearing crosslaminated very fine grained sandstone representing Bouma unit C.

In the upper several hundred feet of the shale interval, the simple FUS breaks down to a more complex interbedded sequence of shale, siltstones, and very fine sandstone. This interval becomes more silty, and marine invertebrate fossil lags appear. At some localities, articulated crinoid columns suggest short-distance or in-situ deposition. This is diagnostic of shallow-water deposition and represents the Reedsville Formation.

A 300.5-foot core capturing the upper extent of the Ordovician shales shows that the fossiliferous facies is present, extending the Reedsville Formation at least into the western edge of the Great Valley.

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horvhnchula zone) Lagoonal back waters form behind th

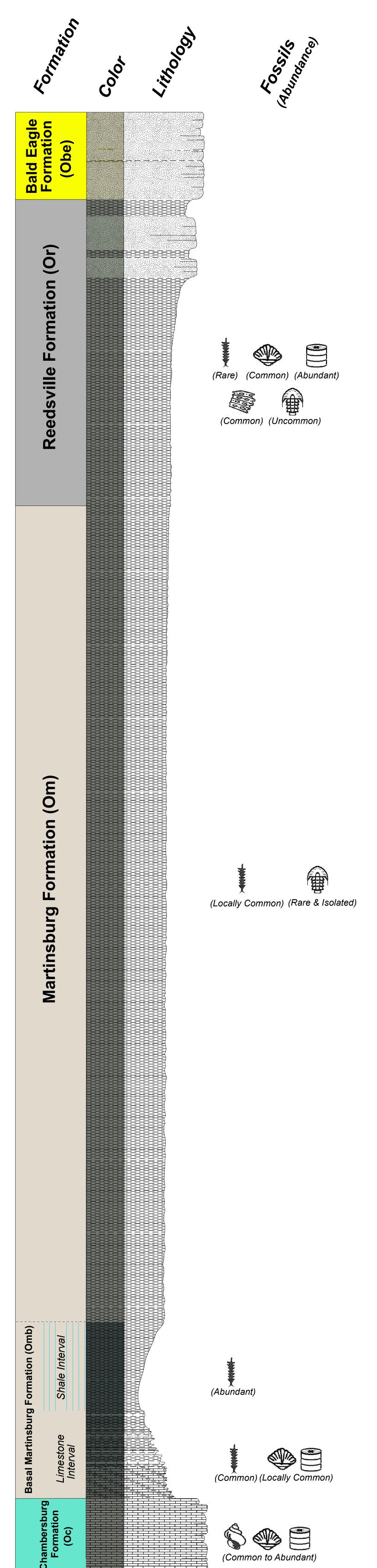
unlight-depleted and oxygen-deprived environment caused the local extinction of reef-forming organisms, which are forced stward where the carbonate platform had yet to subside. Th anoxic conditions prevent decomposition of the slow but steady accumulation of deceased graptolites. Volcanism still occurs

Martinsburg Formation-Basal limestone interva

Encroachment of a subduction zone intiates the subsidence he Laurentian carbonate bank and represents the beginning of the Taconic orogeny. Volcanic ash and sporadic surges of fine siliclastic material cover the carbonate bank. Benthic (graptolites) begin to thrive under these conditions

Chambersburg Formation

This is the youngest formation in the quadrangle to represen the stable Laurentian carbonate bank. A diversity of benthic organisms thrive under these conditions



Upper 50 to 80 feet is very fine grained to fine-grained sandst pasal contact of the Reedsville Formation is gradational and fined by the absence of shelly marine fossil horizons. It is likely that e Reedsville and Martinsburg Formations interfinger. The Reedsvill ormation is estimated to be at least 375 to 475 feet thick but could be

Nove: Fossils observed in the field during mapping of the Fannettsburg quadrangle left: graptolites, Orthograptus quadrimucronatus; right: glabella of trilobite. Triarthus sp.

The lower basal Martinsburg is interbedded medium-dark-gray to dark gray micritic to fine-crystalline limestone and dark-gray to grayish-black alcareous shale, transitioning downward to crystalline limestone terbedded with highly cleaved argillaceous limestone. Bed thicknesse ange from less than 0.1 foot to 1.4 feet thick. Crystalline limestone enerally become thicker and more abundant towards the base of the nation. Laminations and very sparse graptolites were observed in the nents were observed in the crystalline limestone. At least four light bentonite beds were identified through this calcareou nterval, ranging from 0.05 to 2.1 feet thick. Bentonites commonly ntain slickensided calcite shards and may have a very thin bed of dark gray shale directly above. The calcareous interval ranges from oproximately 105 to 275 feet thick.



Lithologic Descripitio

Bald Eagle Formatio

ckness is calculated between 90 and 180 feet

eedsville Formatio



Martinsburg Formation-Basal shale interval

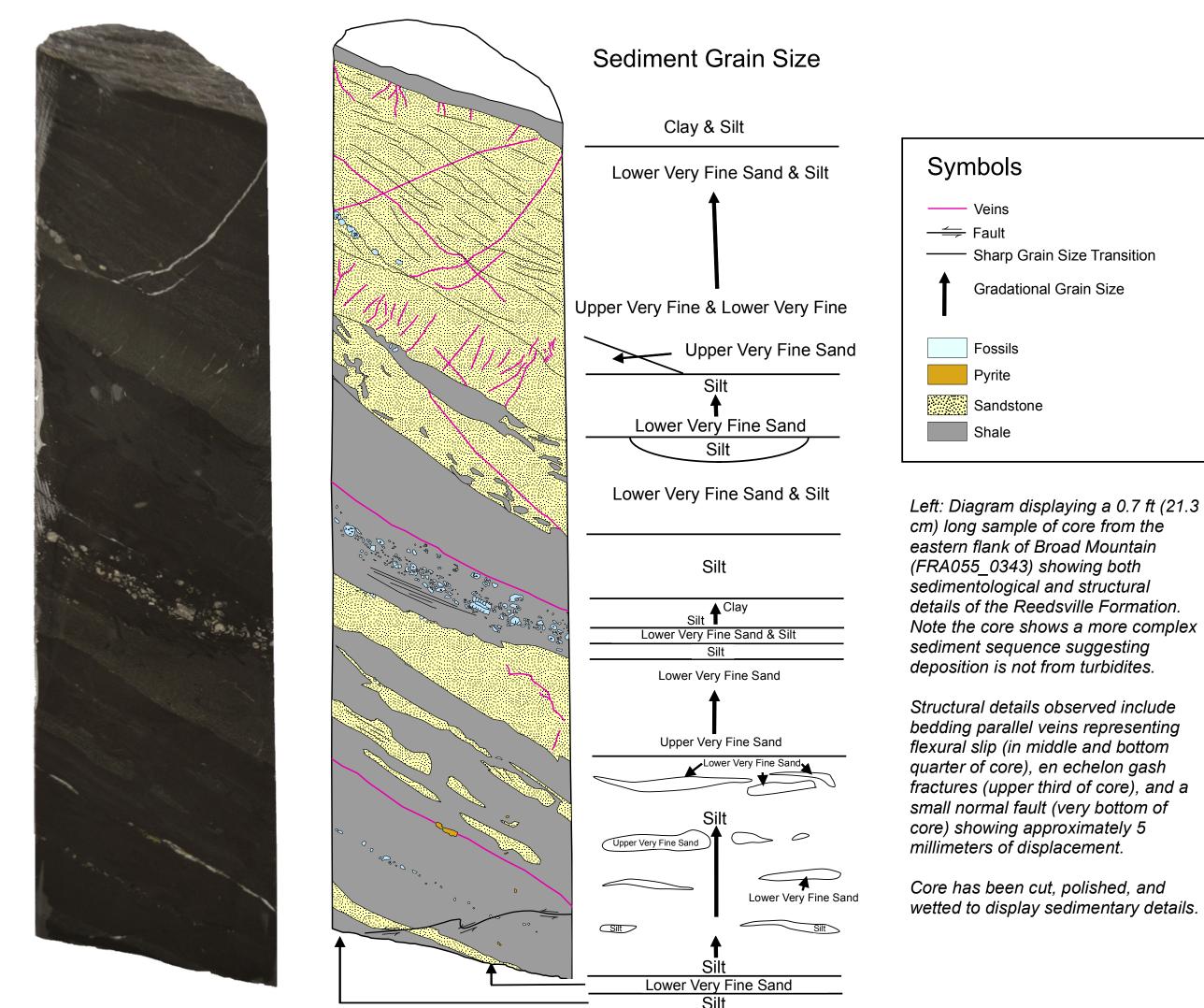
The lower approximately 20% of the formation consists of dark-gray to lack shale and limestone. here referred to collectively as "basal Aartinsburg." The upper 90 to 120 feet of the basal Martinsburg is dark grav to black carbonaceous shale, commonly containing graptolites Corynoides calicularis (most abundant), Orthographi Orthograptus pageanus, Dicellograptus sp., *idoclimacograptus sp.*, and *Diplacinthograptus caudatus*. Surface posures tend to be non-calcareous, whereas fresh rock in cores is at east in part calcareous. Beds are generally less than 0.25-inch thick. although beds up to 0.5-inch thick have been observed.

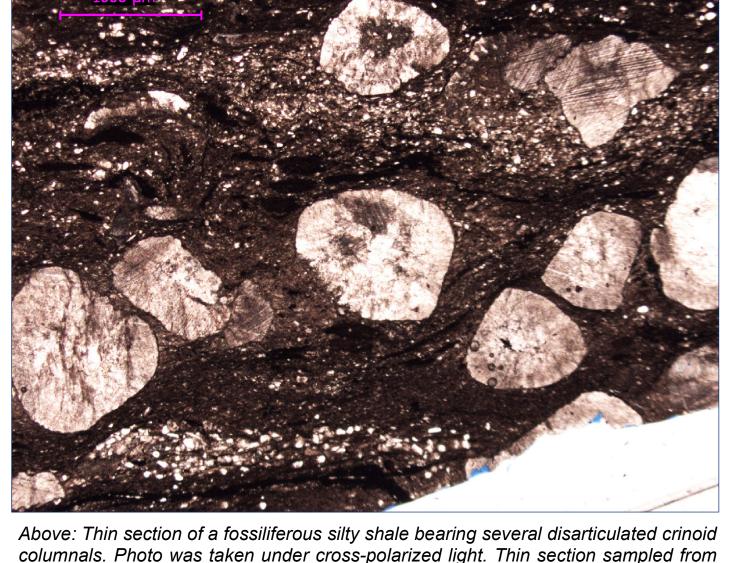
Aartinsburg Formation-Basal limestone interval

The basal contact is at the base of the lowest argillaceous imestone/calcareous shale. Total formation thickness is estimated to be between 1,130 and 1,760 feet

Chambersburg Formation

Medium-dark-gray to dark-gray micritic or biomicritic limestone. Ir upper portions of the formation, the micritic limestones are riddled with undulatory beds and inclusions of argillaceous limestone. Fossils are commonly disarticulated and fragmented crinoid and brachiopods remains. Sparite and biosparite beds are rare. Light-olive-gray dismicrite (birds-eye vaughanite) are rare. Bentonites similar to those described in the basal Martinsburg are present. Beds range from 0.6 to 6.0 feet thick and are dominantly 1.0 to 3.5 feet thick. Formation thickness was calculated between 325 and 510 feet.







Conclusions

statewide revisions in the nomenclature are necessary to correctly resolve the stratigraphic relationship of the Martinsburg and Reedsville Formations. Ulrich (1911) abandoned the Martinsburg Formation and replaced it with the Reedsville Formation in northcentral Pennsylvania. Later mapping extended the Reedsville Formation at the expense of the Martinsburg Formation throughout the rest of the state except, in the Great Valley Section. This mapping replacement ignores there are two unique facies. The Reedsville Formation represents the shallow marine environment and the Martinsburg Formation represents the sedimentation within the deep basin (turbidites) close to the Taconic subduction zone. Mapping by facies may be more appropriate if both formation names are to be retained. This would extend the Reedsville Formation to the western edge of the Great Valley with the Martinsburg Formation underling the Reedsville.

Alternatively the term Reedsville could be abandoned and the Martinsburg Formation could be reintroduced to include both facies, particularly as Martinsburg-type facies are present in north-central Pennsylvania above the Antes Formation. However, further stratigraphic complications appear in the transition from carbonate platform to clastic basin at the base of the sequence, where "basal Martinsburg" is used in the Great Valley and Salona, Coburn, and Antes Formations are used in the remainder of the Ridge and Valley. Pending further investigation, use of the names Martinsburg and Reedsville as presented herein is suggested.

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References

Bouma, A. H., 1962, Sedimentology of some flysch deposits, a graphic approach to facies interpretation, Elsevier Publishing Company, p.48 to 57. Ganis, R. G. and Blackmer, G. C., 2010, Preliminary Geologic Map of the Great Valley in Dauphin and Lebanon Counties, Pennsylvania.

ehman, D. and Pope, P. K., 1989, Upper Ordovician tempestites from Swatara Gap, Pennsylvania: depositional processes affecting the sediments and paleoecology of the fossil faunas, Palaios, Society for Sedimentary Geology, Vol. 4, p. 553-564.

Sevon, W. D., 2000, Physiographic provinces of Pennsylvania (4th ed.): Pennsylvania Geological Survey, 4th ser., Map 13, scale 1:2,000,000

Ulrich, E. O., 1911, Revisions of the Paleozoic systems, Geol. Soc. America Bull., v. 22, p.321-329 and p. 552-553.