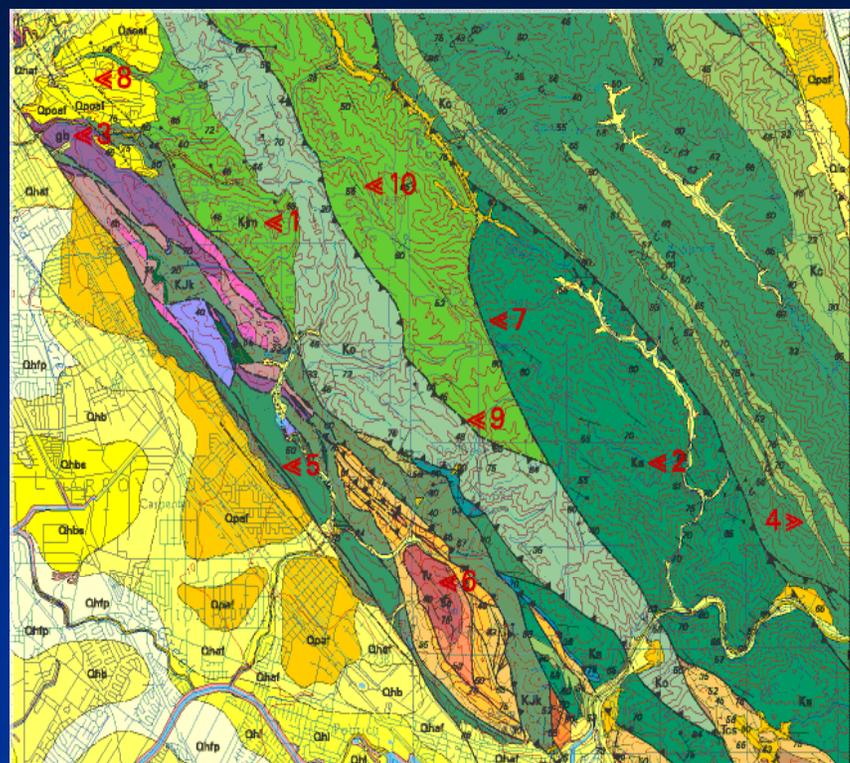
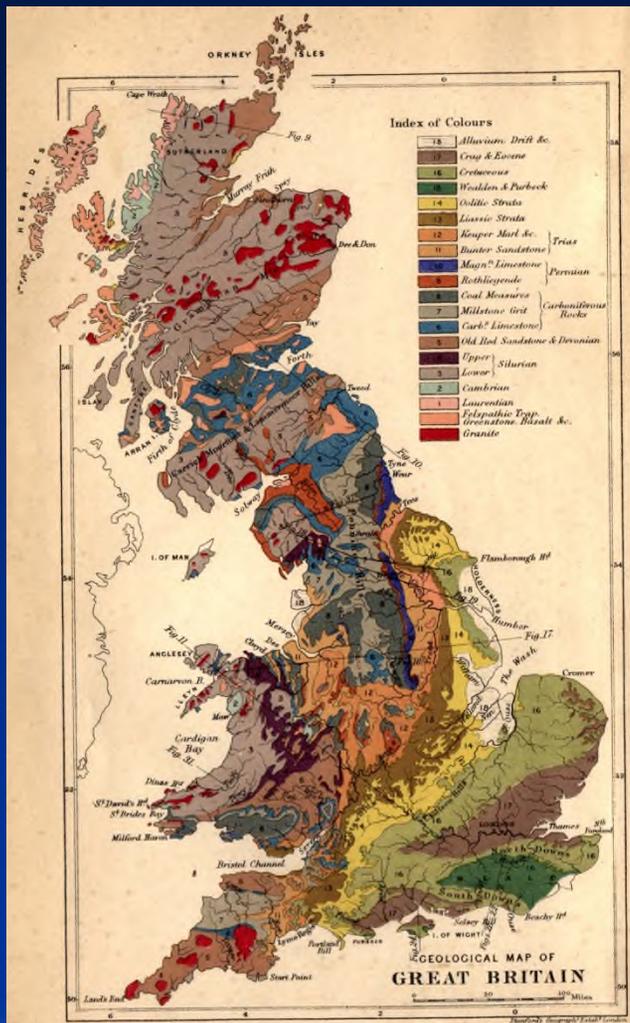


Geology Map Laboratory



Geology 101 Lab

Ray Rector: Instructor

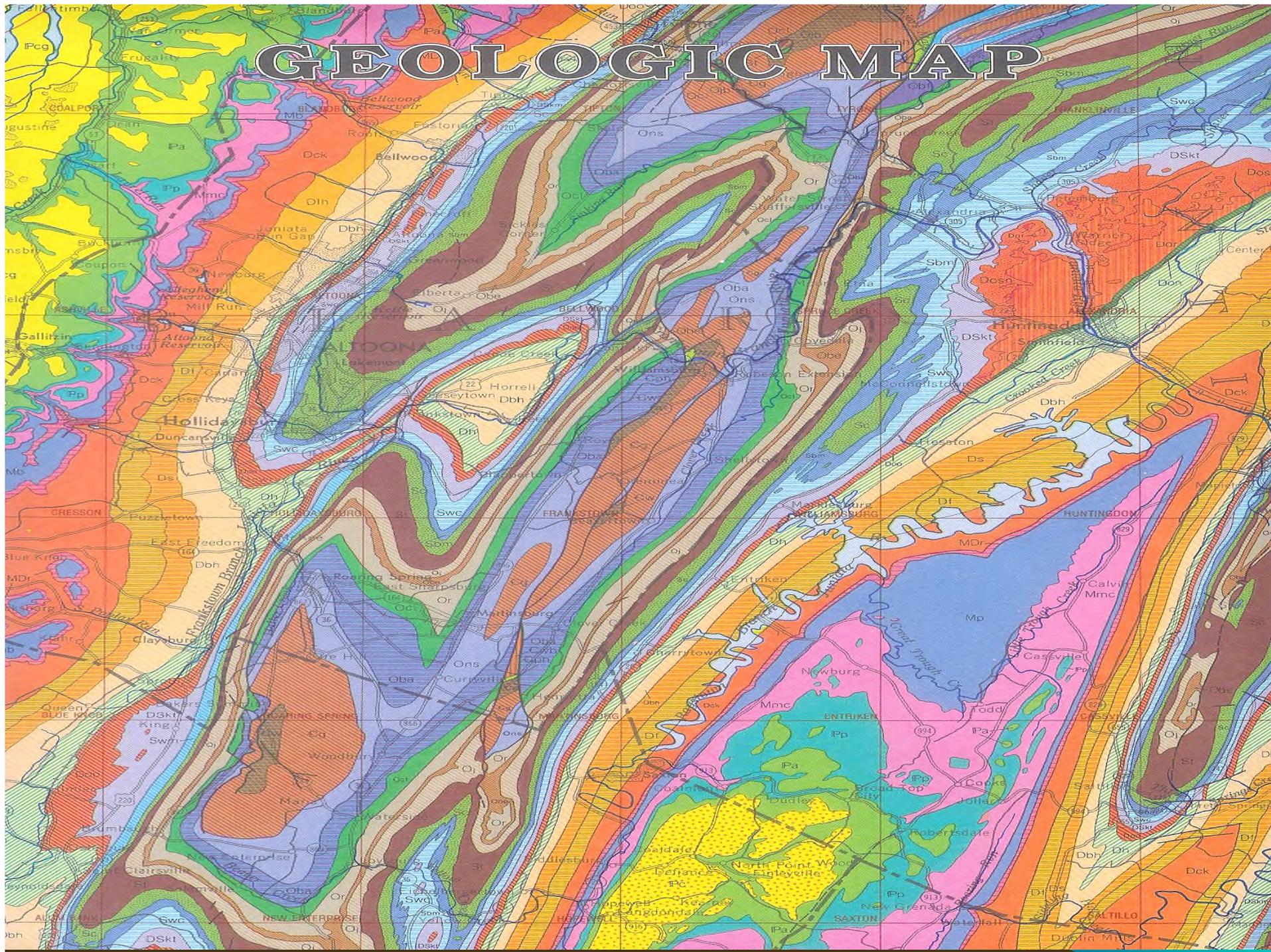
Geologic Map Learning Objectives

The student should understand and know:

- 1) The terminology and basic symbols of geology maps
- 2) How to read and understand a geology map legend
- 3) The general concepts and field methods used in making a geology map
- 4) How to successfully recognize structures on a geology map such as contacts, bedding orientation, folds and faults
- 5) How to reconstruct the geologic history of the mapped region based on the geologic map information.



GEOLOGIC MAP



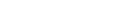
Use Rules of Structure To Interpret Geology Maps

- 1) Strike of beds is always parallel to the direction of the contacts.
- 2) Rock layers dip towards the youngest exposed rock layers.
- 3) Oldest rocks exposed in the center of eroded anticlines and domes.
- 4) Youngest rocks exposed in the center of eroded synclines and basins.
- 5) Horizontal folds form parallel sets of belt-like outcrop patterns.
- 6) Plunging synclines form "V" or "U" shaped, belt-like outcrop patterns.
 - ✓ Fold plunges toward *open* end of "U" pattern.
- 7) Plunging anticlines form "V" or "U" shaped, belt-like outcrop patterns.
 - ✓ Fold plunges toward *closed* end of "V" or "U" pattern.
- 8) Steeper the dip of the layer, the more narrow the width of its outcrop.
- 9) Hanging wall *moves up* relative to foot wall in reverse and thrust faults.
- 10) Hanging wall *moves down* relative to foot wall in normal faults.
- 11) Vertical slickenside grooving indicates dip-slip fault movement
- 12) Horizontal slickenside grooving indicates slip-slip fault movement

Geology Map Key or Legend

1) The map key lists and explains the geologic rock formations and the structural symbols

- ✓ Rock Names
- ✓ Rock Types
- ✓ Rock Ages
- ✓ Contacts
- ✓ Strike and Dip
- ✓ Faults and Folds

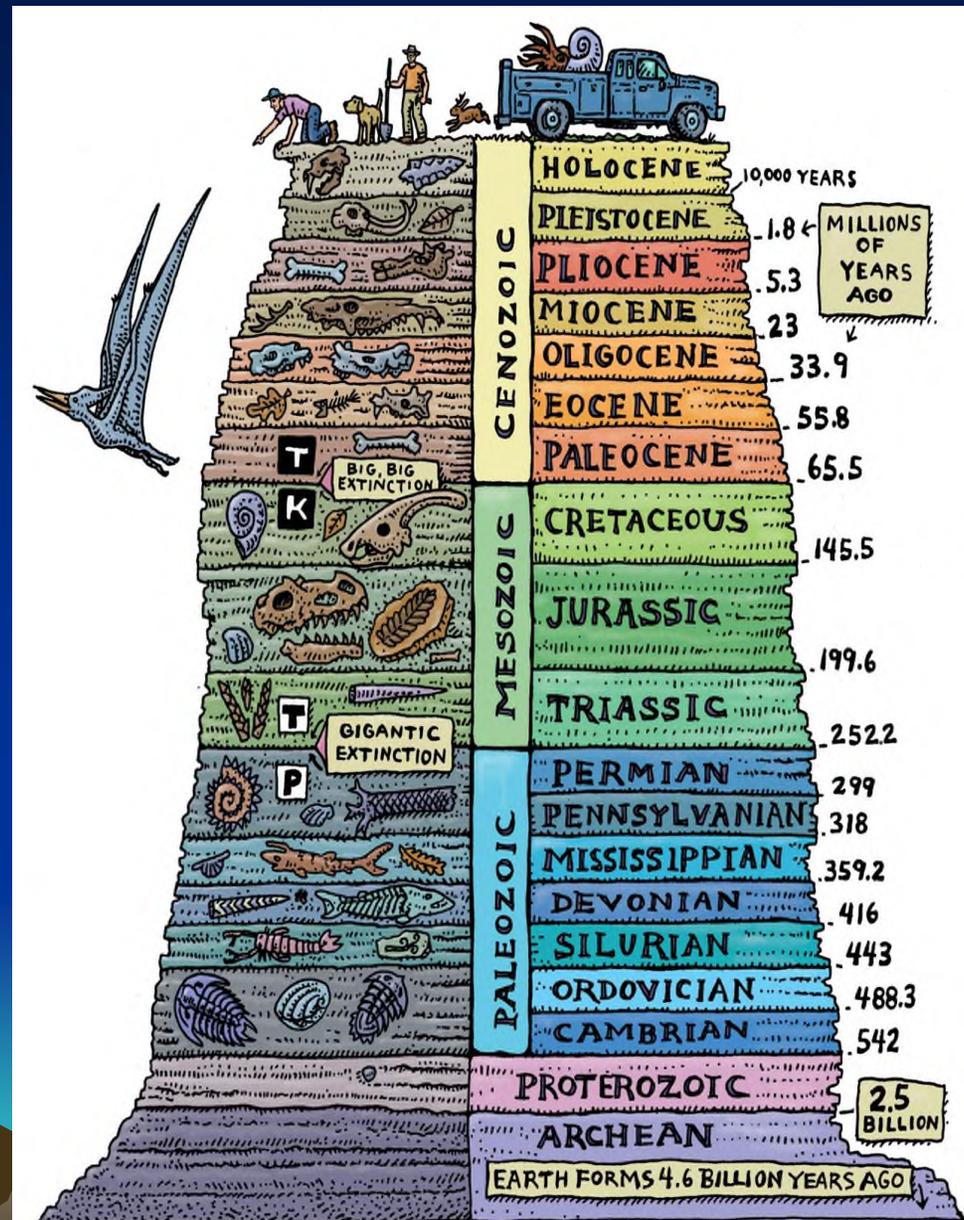
MAP KEY	
 af - Artificial Fill (Historic)	 Contact
 alf - Artificial Levee Fill (Historic)	 Contact, approximately located
 Qhaf - Alluvial Fan Deposits (Holocene)	 Contact, inferred
 Qhfp - Floodplain Deposits (Holocene)	 Contact, concealed
 Qhfb - Flood Basin Deposits (Holocene)	 Fault
 Qhbs - Salt Affected Flood Basin Deposits (Holocene)	 Fault, approximately located
 Qhl - Natural Levee Deposits (Holocene)	 Fault, inferred
 Qpaf - Alluvial Fan Deposits (Pleistocene)	 Fault, uncertain
 Qpof - Older Alluvial Fan Deposits (Pleistocene)	 Fault, concealed
 Tv - Unnamed volcanic rocks (Miocene)	 Fault, concealed and uncertain
 Tor - Orinda conglomerate (Miocene)	 Oblique fault with thrust or reverse component
 Tbr - Briones sandstone (Miocene)	 Oblique fault with thrust or reverse component, approximately located
 Tt - Tice shale (Miocene)	 Oblique fault with thrust or reverse component, inferred
 Tcs - Claremont shale (Miocene)	 Oblique fault with thrust or reverse component, uncertain
 Ts - Soberante sandstone (Miocene)	 Strike and dip of bedding
 Tsh - Unnamed shale and sandstone (Miocene)	 Strike and dip of overturned bedding
	 Strike and dip of vertical bedding

2) Each rock unit has a unique letter symbol and is color-coded

3) Map key is vital to understanding the accompanying geology map

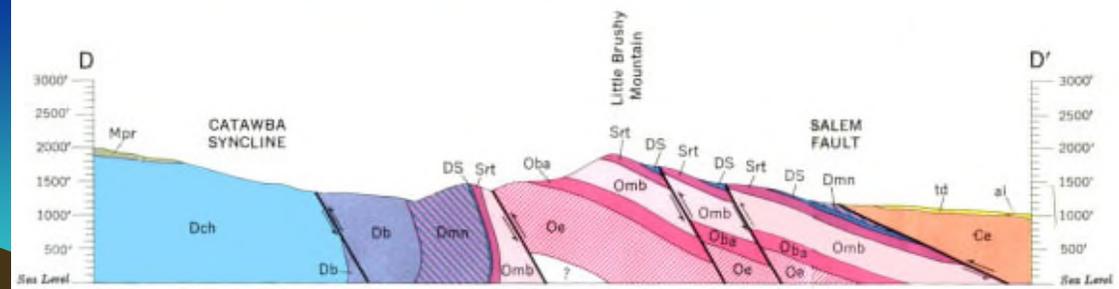
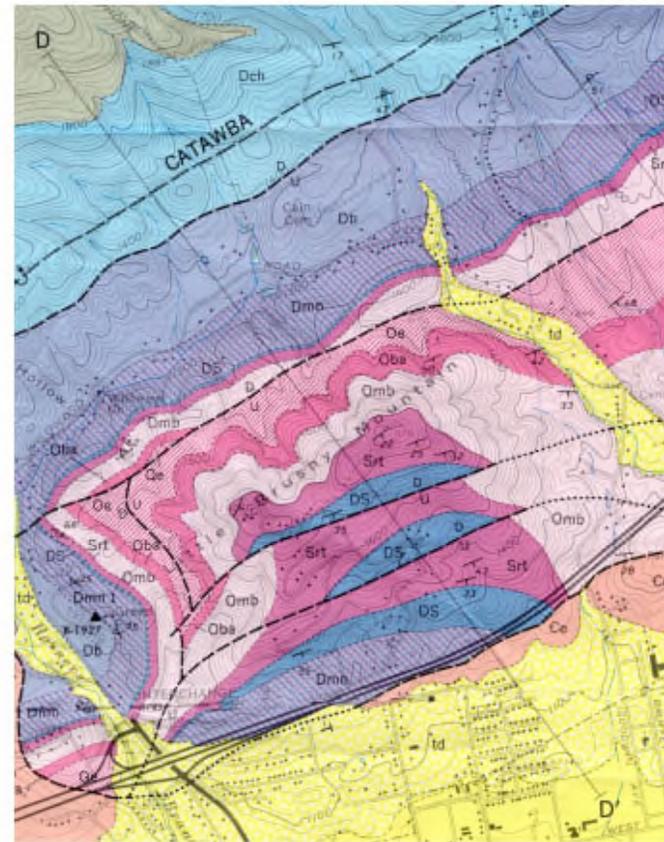
Rock Formations and Geologic Time

- 1) All rock formations on a geologic map have a specific assigned age
- 2) Rock formations are listed in an ordered sequence in a geologic map explanation according to age
- 3) The geologic ages of rock formations are assigned by geologic period
- 4) Geologic periods are further divided into lower (older), middle, and upper (younger)



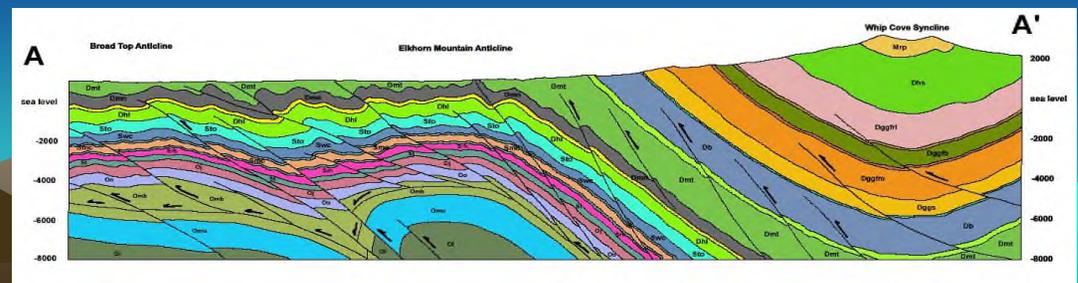
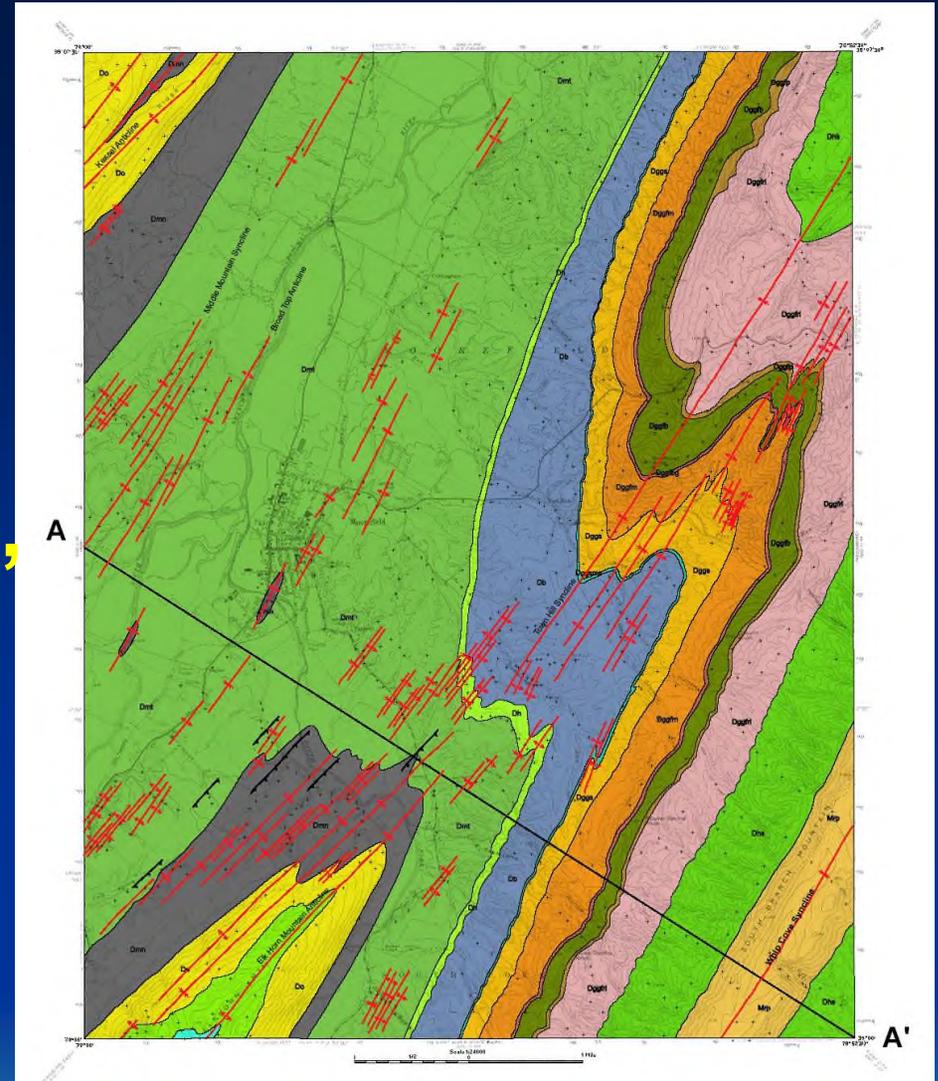
Geologic Map with Cross Section

- 1) A geologic cross section depicts a scale-balanced side profile of a specific transect across a geology map
- 2) The cross section includes rock formations and structural elements
- 3) Geology depicted in a cross section is an interpretation based on map view field data



Geologic Map with Cross Section

Moorefield Quadrangle, Hardy County, West Virginia



Geologic Map Explanation

Series	Stage	Stratigraphic Units	Description	
Mississippian	Osagean	Pococoo Group Rockwell and Purslane Formations, Undifferentiated (Mrp)	Pococoo Group (Rockwell and Purslane Formations, Undifferentiated, 700-900 ft.) Light gray to dark gray, medium-grained, quartz sandstone with minor conglomerates; iron stained sandstone in lower part. Upper part consists of light gray to white quartz sandstone with minor quartz pebble conglomerate zones.	
	Kinderhook			
Devonian	Famennian	Hampshire Formation (Dhs)	Hampshire Formation (2300-2800 ft.) Non-marine, fine-grained, red and reddish gray sandstone and shale with minor tan and light green shale and sandstone beds present; unfossiliferous, except for rare terrestrial plant fossils such as <i>Archaeopteris</i> . Formation thins to west side of Town Hill syncline.	
	Frasnian	Greenland Gap Group Foreknobs Formation	Red Lick Member (Dggfl)	Foreknobs Formation, Red Lick Member (1400-1550 ft.) Very fine- to fine-grained sandstone with interbedded brownish gray to red shale, siltstone, occasional conglomerates, and marine fossils. Upper contact placed at last occurrence of marine fossils. Prominent quartz and mudstone conglomerate at approximate contact with Hampshire Formation. Formation is thickest on west limb of Whip Cove syncline.
			Pound Member (Dggfp)	Foreknobs Formation, Pound Member (65-220 ft.) Massive, coarse to medium-grained light gray to white sandstone. Planar wedge-shaped cross beds and conglomeratic zones are common. Formation thins to the north and east in the quadrangle. Serves as a ridge-forming unit.
			Blizzard Member (Dggfb)	Foreknobs Formation, Blizzard Member (625-670 ft.) Gray interbedded thin- to medium-bedded sandstone and siltstone with some shale. Thickness tends to be constant throughout the quadrangle. Tends to form topographic low between the ridge-forming Pound and Elsey Gap members.
			Briery Gap Member (Dggbg)	Foreknobs Formation, Briery Gap Member (60-130 ft.) Massive, medium- to coarse-grained light gray to white sandstone. Rippled, planar wedge-shaped cross beds and conglomeratic zones are common. Formation thins to the north and east in the quadrangle. Serves as a ridge-forming unit.
			Mallow Member (Dggfm)	Foreknobs Formation, Mallow Member (1250-1400 ft.) Medium-gray siltstones, thin-bedded fine- to medium-grained sandstone, alternating with shale. Lowest strata consist of 25-30 ft. interval of mainly siltstones and fine- to medium-grained sandstones, which serves as contact with underlying Schert Formation. Formation thins to the north and east in the quadrangle. Lowermost Mallow unit serves as a low ridge-former.
	Schert Formation (Dggs)	Schert Formation (775-900 ft.) Mainly siltstone and shale, with some fine-grained sandstone, all light olive gray. Siltstones may reach 2-2.5 feet in thickness. Siltstones and sandstones less abundant than in overlying Mallow Member. Basal member is Minnehaha Springs.		
		Minnehaha Springs Member (Dggsms)	Schert Formation, Minnehaha Springs Member (25-30 ft.) Lowest member of the Schert Formation. Sequence of olive gray coarse siltstone at the base of the Schert. Serves as boundary between underlying Brallier Formation and Greenland Gap Group. Locally may form a slight topographic high.	
	Brallier Formation (Db)	Brallier Formation (1450-1600 ft.) Medium dark gray shales, interbedded with thin-bedded siltstones, most commonly not exceeding 4-8 inches in thickness. Back Creek Siltstone Member 100-125 feet above base is 25-30' sequence of thick siltstones, with some sandstones. Not present north of Moorefield. Upper contact with Schert Formation at Minnehaha Springs Member.		
		Harrell Shale (Dh)	Harrell Shale (250-300 ft.) Dark gray, thinly laminated platy weathering shale. Lower member is the Burket, a black shale sequence which is atop the Pokejoy Limestone Member of the Marhantango. Upper contact of formation is gradational and placed at first siltstone of the Brallier Formation.	
Mahantango Formation (Dmt)		Mahantango Formation (1600-1800 ft.) Dark Gray siltstone and non fossiliferous shale, minor fine-grained sandstone; spheroidal weathering common. Upper contact placed at top of Pokejoy Limestone below the Burket Member of the Harrell Shale.		
Eifemian (Emf)	Marcellus-Needmore Shales (Dmm)	Marcellus-Needmore Shales (500-600 ft.) Black to dark gray, marine fossiliferous shale of the Marcellus overlies medium to dark gray and greenish gray to brownish black shale of the Needmore, 25-30 ft. thick argillaceous limestone (i.e. Pussell Member) in middle of Marcellus; dark gray limestone nodules and beds near base of Needmore.		
	Siegöe (Do)	Oriskany Sandstone (100-140 ft.) White to light gray, medium to coarse-grained, quartz sandstone with quartz conglomeratic zones; crossbedded; abundant marine fossils (brachiopods); carbonate and silica cement.		
Silurian	Gedinian (Dgh)	Helderberg Group (400-500 ft.) Massive-bedded, coarse-grained, gray limestone; abundant marine fossils; dark and light colored chert layers in upper one-third; minor karst development; lower part is Silurian.		
	Pridolite (Sto)	Tonoloway Limestone (400-500 ft.) Fine-grained, laminated, gray argillaceous marine limestone; minor shale layers; mudrocks common on bedding surfaces; fossiliferous.		

RM/JB 04/03

Units listed below do not outcrop	
	Will's Creek (300-375 ft.)
	Bloomsburg (25-40 ft.)
	McKenzie Formation (300-325 ft.)
	Keefe Sandstone (20-30 ft.)
	Rose Hill Formation (400-450 ft.)
	Tuscarora Sandstone (150-250 ft.)
Ordovician System	
	Juniata Formation (300-400 ft.)
	Oswego Formation (350-450 ft.)
	Martinsburg Formation (1,500-2000 ft.)
	Middle Ordovician
	Lower Ordovician

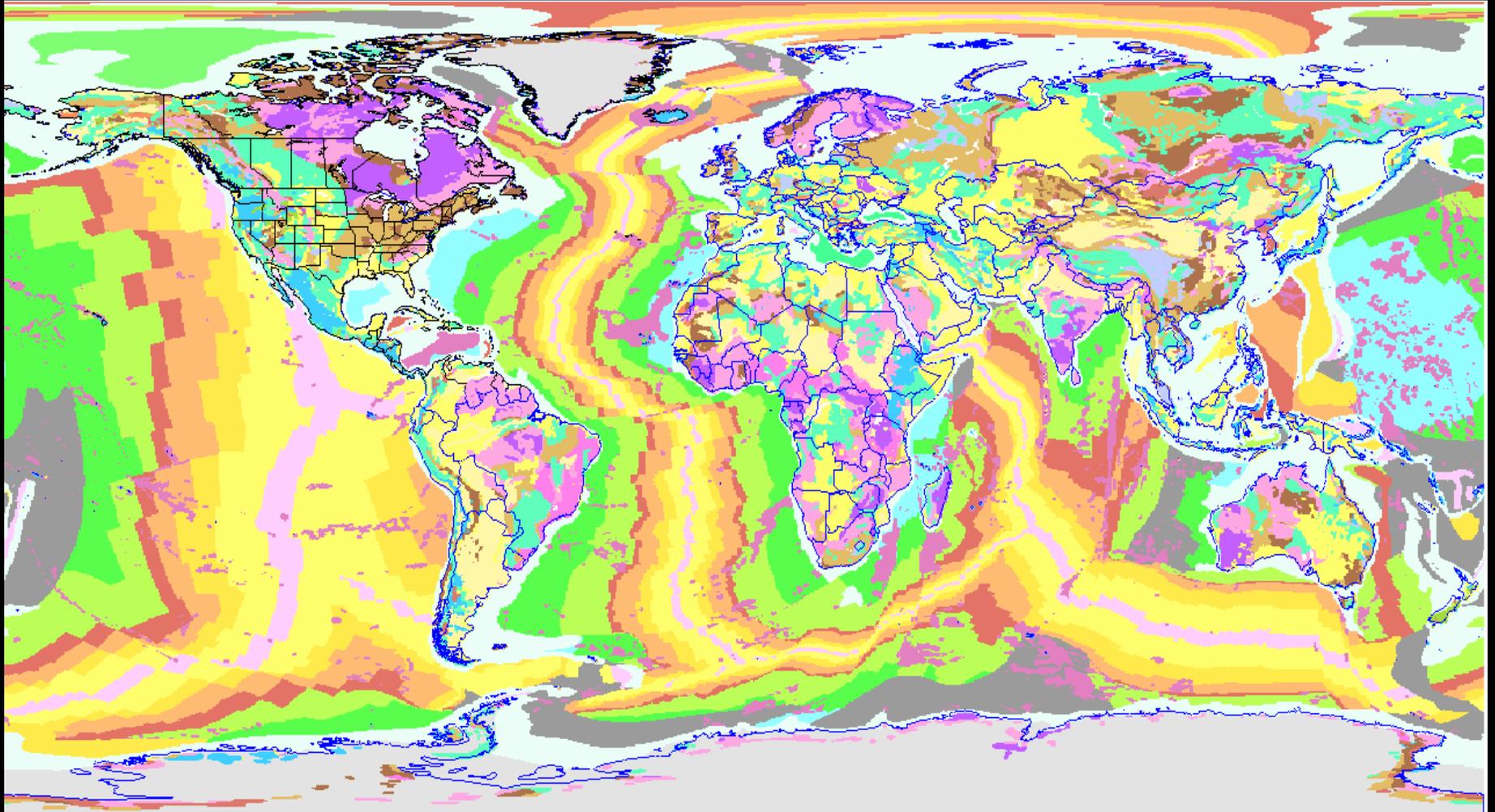
Explanation of Symbols	
	Anticline
	Syncline
	Overturned Anticline
	Overturned Syncline
	Reverse Fault (teeth on upper plate)
	Bedding Orientation Observation

Moorefield Quadrangle, Hardy County, West Virginia

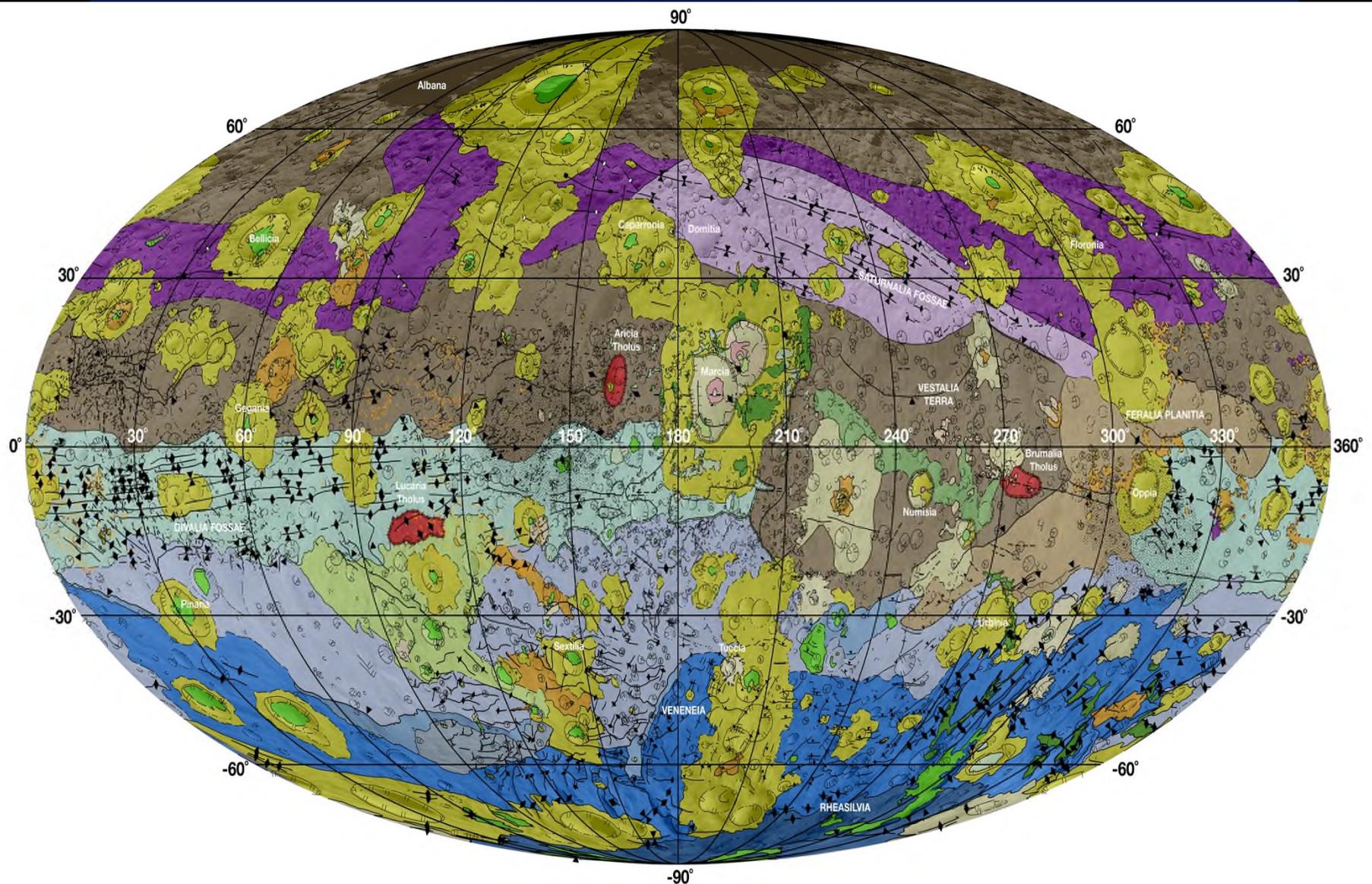
Use Rules of Structure To Interpret Geology Maps

- 1) Strike of beds is always parallel to the direction of the contacts.
- 2) Rock layers dip towards the youngest exposed rock layers.
- 3) Oldest rocks exposed in the center of eroded anticlines and domes.
- 4) Youngest rocks exposed in the center of eroded synclines and basins.
- 5) Horizontal folds form parallel sets of belt-like outcrop patterns.
- 6) Plunging synclines form "V" or "U" shaped, belt-like outcrop patterns.
 - ✓ Fold plunges toward *open* end of "U" pattern.
- 7) Plunging anticlines form "V" or "U" shaped, belt-like outcrop patterns.
 - ✓ Fold plunges toward *closed* end of "V" or "U" pattern.
- 8) Steeper the dip of the layer, the more narrow the width of its outcrop.
- 9) Hanging wall *moves up* relative to foot wall in reverse and thrust faults.
- 10) Hanging wall *moves down* relative to foot wall in normal faults.
- 11) Vertical slickenside grooving indicates dip-slip fault movement
- 12) Horizontal slickenside grooving indicates slip-slip fault movement

Geologic Map of Earth



Geologic Map of Mars



Geologic Map of North America



U.S. DEPARTMENT OF THE INTERIOR
U.S. GEOLOGICAL SURVEY



Geological Survey of Canada
Géologie géologique du Canada



Geology of the Pacific Rim
Géologie de la Région Pacifique



Scale: 1:500,000
1:100,000
1:50,000
1:25,000

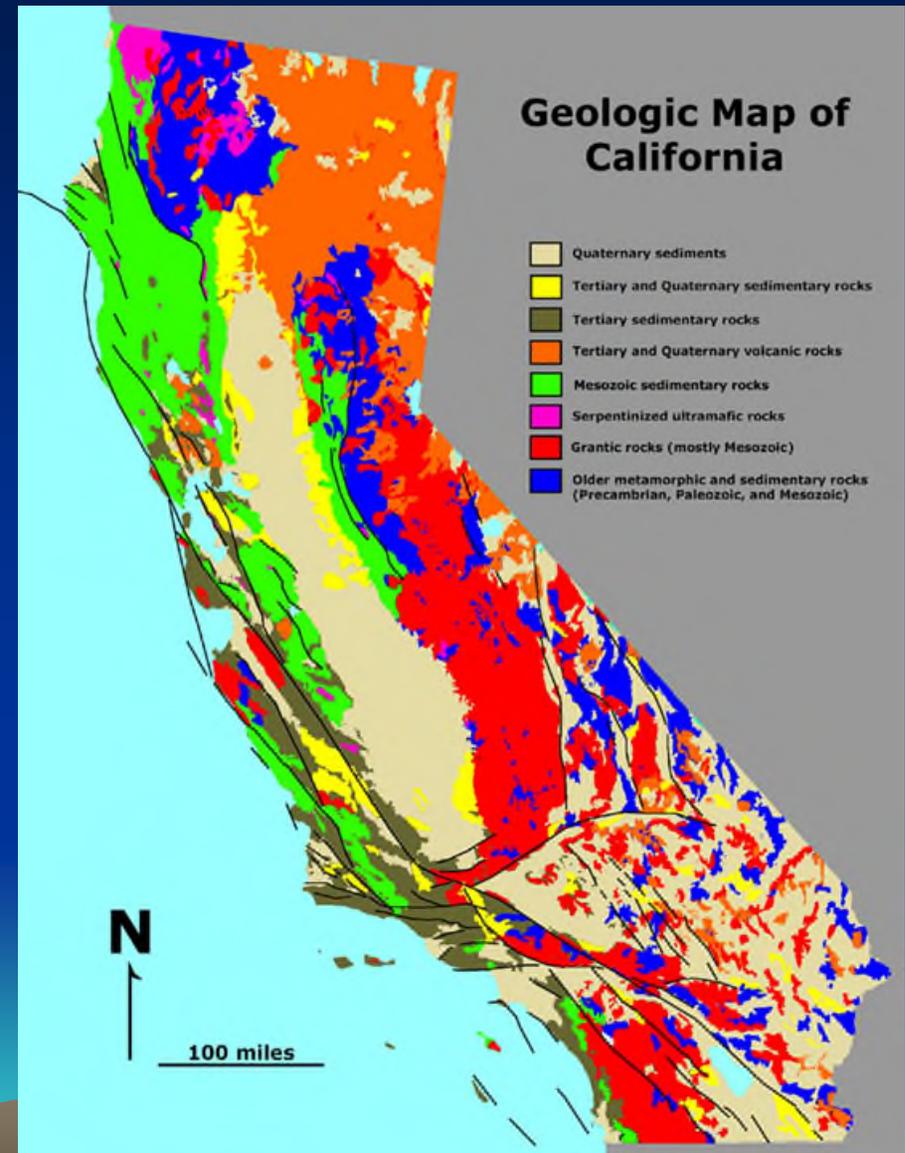
Projection: Lambert Conformal Conic
Reference: Canadian datum of 1983
Projection: North American datum of 1983

Usefulness of Geology Maps

1) Geology maps have many vital uses:

- ✓ Mineral Prospecting
- ✓ Engineering
- ✓ Earthquakes
- ✓ Historical geology
- ✓ Landform studies
- ✓ Soil development
- ✓ Biological studies

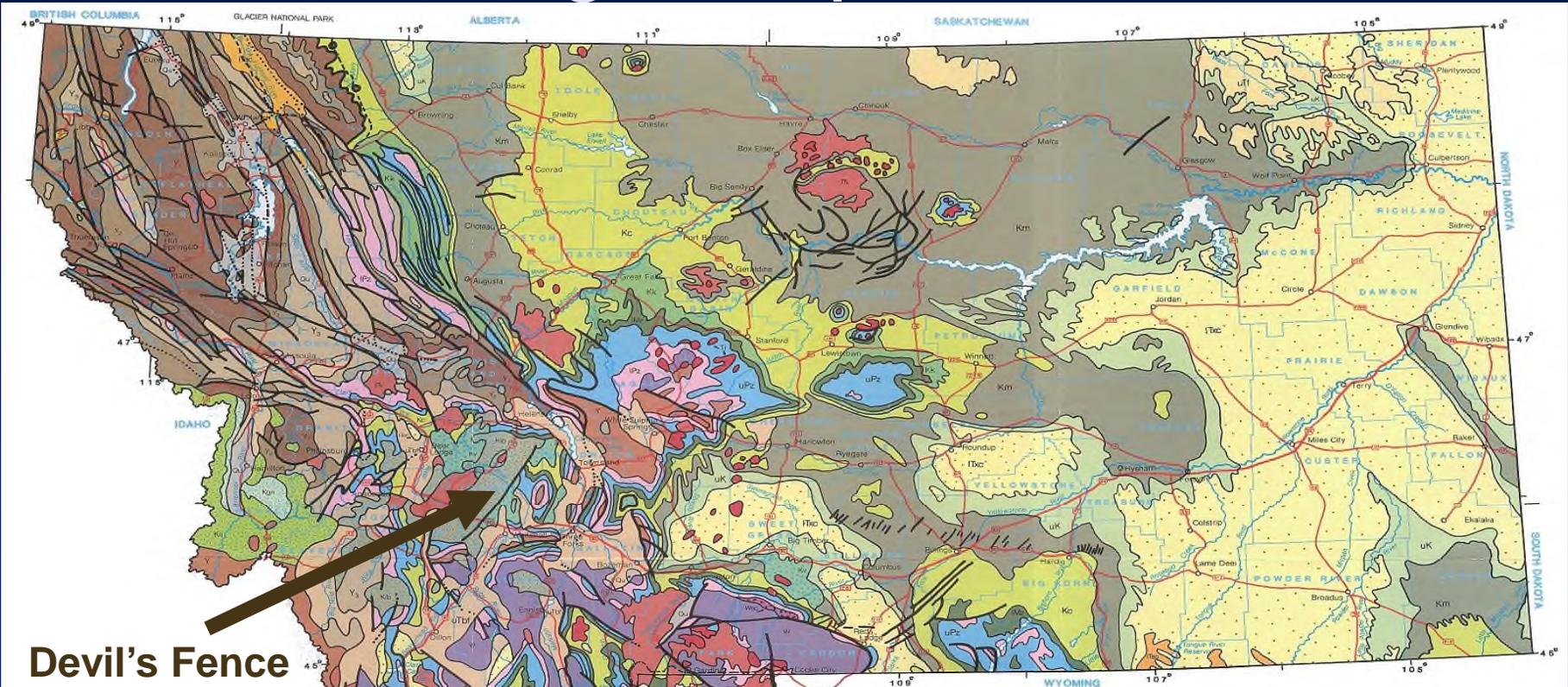
2) Geology maps are even useful when buying a home. Why?



Geologic Map of Montana

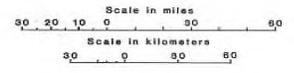


Geologic Map of Montana



Devil's Fence Area

GEOLOGICAL MAP of MONTANA and Yellowstone National Park



KEY
 Fault, sense of motion not indicated
 Contact

CONTINENTAL AND MARINE DEPOSITS

- Quaternary, extensive**
Stream, glacial, and lake deposits
- Tertiary, Flaxville gravel**
Gravel and sand with some silt, volcanic ash, and marl
- Tertiary, basin fill**
Oligocene through Pliocene basin fill composed of a heterogeneous mixture of gravel, sand, silt, and clay deposited by streams and in lakes
- Eocene, continental deposits**
Includes fine to coarse-grained clastic rocks
- Paleocene, continental deposits**
Including stream-deposited sediments of coal-bearing Fort Union Fm. In the east, Willow Creek Fm. in the north central, and Beaverhead conglomerate in the southwest

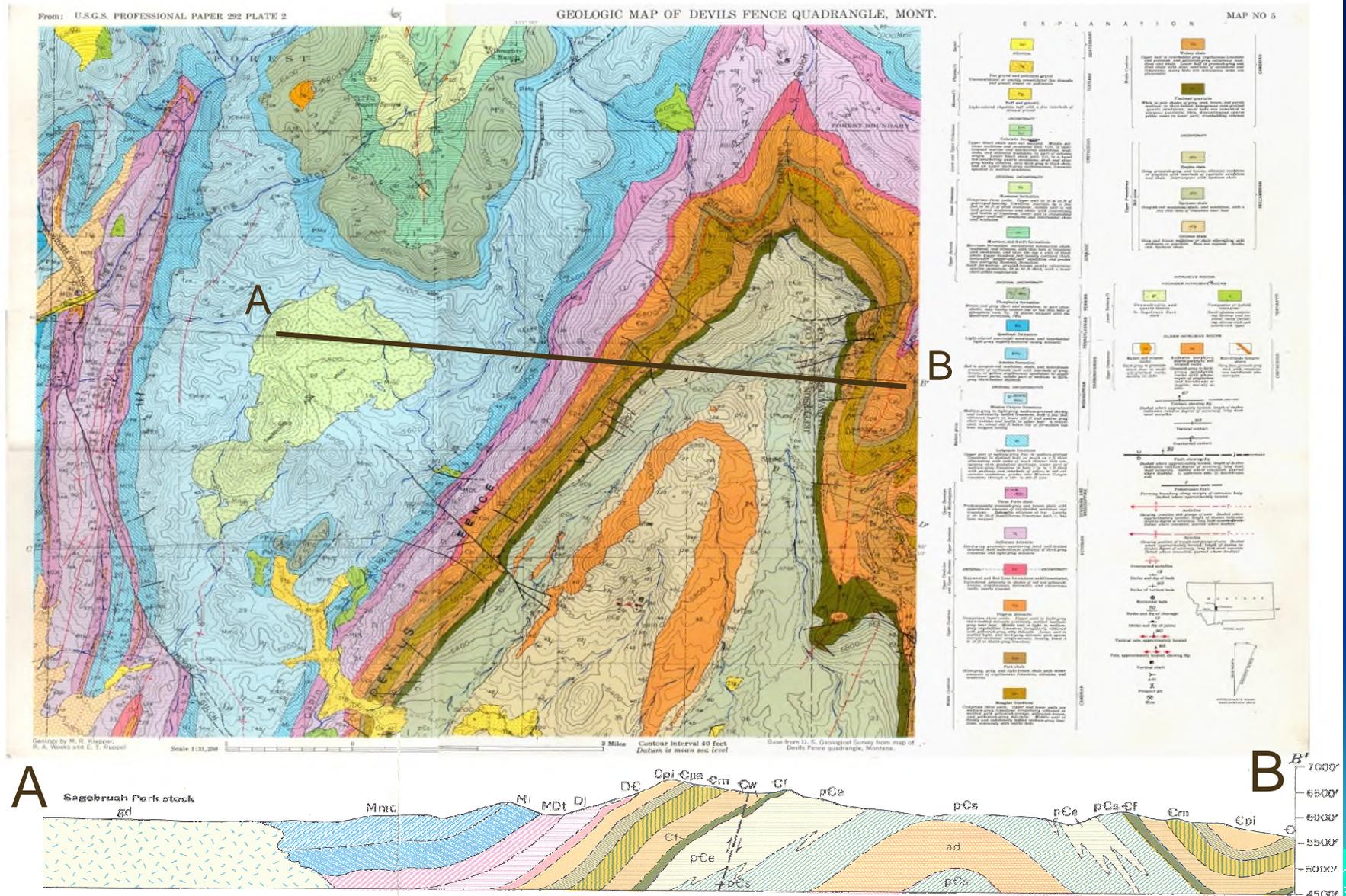
- Upper Cretaceous, undifferentiated**
Hell Creek sandstone and shale, St. Mary River mudstone, and volcanoclastic Livingston Gp. in south-central Montana
- Montana Group**
Bearpaw shale, Judith River sandstone, altstone, and shale, Claggett shale, Eagle sandstone, and Telegraph Creek sandy shale. Includes Fox Hills sandstone and Pierre shale in the extreme east
- Colorado Group**
Includes mainly shale of the Niobrara, Belle Fourche, Mowry, and Thermopsis Formations
- Kootenai Formation**
Conglomerate, sandstone, shale, and mudstone
- Lower Mesozoic**
Includes calcareous fossiliferous sandstone, shale, and limestone of the Ellis Group in the central and south central, and the Dinwoody and Thayne Formations in the southwest as well as the Morrison shale, sandstone, and marl in the west

- Mississippian, Pennsylvanian, Permian**
Includes Madison limestone, Big Snowy dolomite and limestone, and Quadrant sandstone
- Devonian and Cambrian**
Consists of Three Forks shale, Jefferson limestone, Pilgrim and Meagher limestone, Park and Wolsey shale, and Flathead sandstone
- Upper Belt-Massoula and Pegan Groups**
Chiefly red, maroon, and purple argillites and impure quartzite and limestone
- Middle Belt-Wallace, Siyeh, Helena Fms.**
Heterogeneous Wallace Fm. including argillite, limestone, sandstone, shale, and quartzite; Siyeh and Helena limestones
- Lower Belt-Ravalli and Prichard Fms.**
Ravalli Fm. includes siliceous and sandy quartzite, argillite, and shale; Prichard Fm. consists of banded slate with interbedded sandstone
- Undivided Belt Supergroup**

VOLCANIC, PLUTONIC, AND METAMORPHIC ROCKS

- Quaternary, rhyolitic volcanic rocks**
Volcanic rocks, mostly felsic Yellowstone flows and associated pyroclastic deposits
- Tertiary, intrusives**
Mostly granitic to intermediate composition, some alkaline especially in north-central Montana
- Lower Tertiary, volcanic rocks**
Flows and associated pyroclastic deposits; latite, andesite, with some rhyolite and basalt and associated intrusive dikes and necks
- Younger Cretaceous, granitic rocks**
Boulder Batholith and related rocks; predominantly quartz monzonite
- Cretaceous, volcanic rocks**
Mafic to intermediate composition lava flows, ash flows, and other pyroclastic rocks with interbedded sedimentary rocks including Elkhorn Mountains volcanic rocks
- Older Cretaceous, volcanic rocks**
Idaho Batholith and associated masses; monzonite and granodiorite
- Border Zone of Idaho Batholith**
Metasedimentary rocks of Belt age intruded by granitic rocks
- Stillwater Complex**
Layered mafic-ultramafic intrusive complex, includes anorthosite; associated with hornfels aureole
- Archean, undifferentiated**
High-grade metamorphic rocks derived from igneous and sedimentary parent rocks. Lithologies include quartz-feldspathic gneiss, granulite, amphibolite, quartzite, and marble

Geologic Maps – Devil's Fence Quad



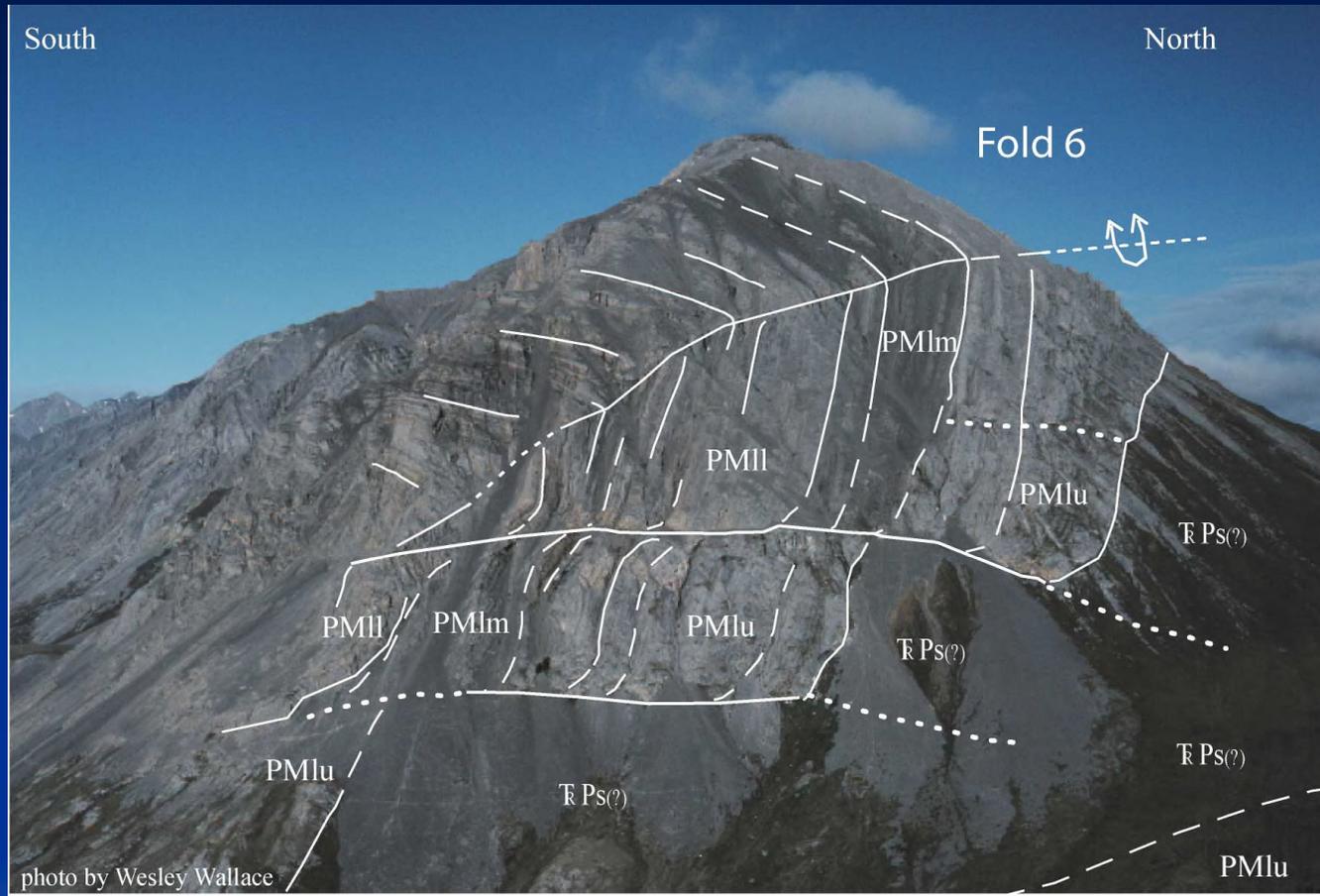
Devil's Fence Topographic Feature



Use Rules of Structure To Interpret Geology Maps

- 1) Strike of beds is always parallel to the direction of the contacts.
- 2) Rock layers dip towards the youngest exposed rock layers.
- 3) Oldest rocks exposed in the center of eroded anticlines and domes.
- 4) Youngest rocks exposed in the center of eroded synclines and basins.
- 5) Horizontal folds form parallel sets of belt-like outcrop patterns.
- 6) Plunging synclines form "V" or "U" shaped, belt-like outcrop patterns.
 - ✓ Fold plunges toward *open* end of "U" pattern.
- 7) Plunging anticlines form "V" or "U" shaped, belt-like outcrop patterns.
 - ✓ Fold plunges toward *closed* end of "V" or "U" pattern.
- 8) Steeper the dip of the layer, the more narrow the width of its outcrop.
- 9) Hanging wall *moves up* relative to foot wall in reverse and thrust faults.
- 10) Hanging wall *moves down* relative to foot wall in normal faults.
- 11) Vertical slickenside grooving indicates dip-slip fault movement
- 12) Horizontal slickenside grooving indicates slip-slip fault movement

Geology Map Web References



<http://www.nature.nps.gov/geology/usgsnps/gmap/gmap1.html#unique>

<http://www.globalchange.umich.edu/Ben/ES/earthstructure.htm>

<http://www.winona.edu/geology/MRW/maps.htm>

<http://www.nps.gov/archive/yell/slidefile/scenics/outsideynp/Page.htm>