Principles of Historical Geology

Geology 331

Principles

- Principle of Superposition
- Principle of Original Horizontality
- Principle of Original Lateral Continuity
- Principle of Intrusive Relationships
- Principle of Cross-Cutting Relationships
- Principle of Fossil Succession – will discuss in Biostratigraphy Section

Principle of Superposition

In any undeformed sequence of sedimentary rocks, each bed is younger than the one below it and older than the one above it.

This is the basis of relative ages of all strata and their contained fossils.

Original Horizontality - Sediments usually form flat-lying deposits on the earth’s surface.

Original Horizontality - Sedimentary rocks are horizontal because the original sediments were horizontal.

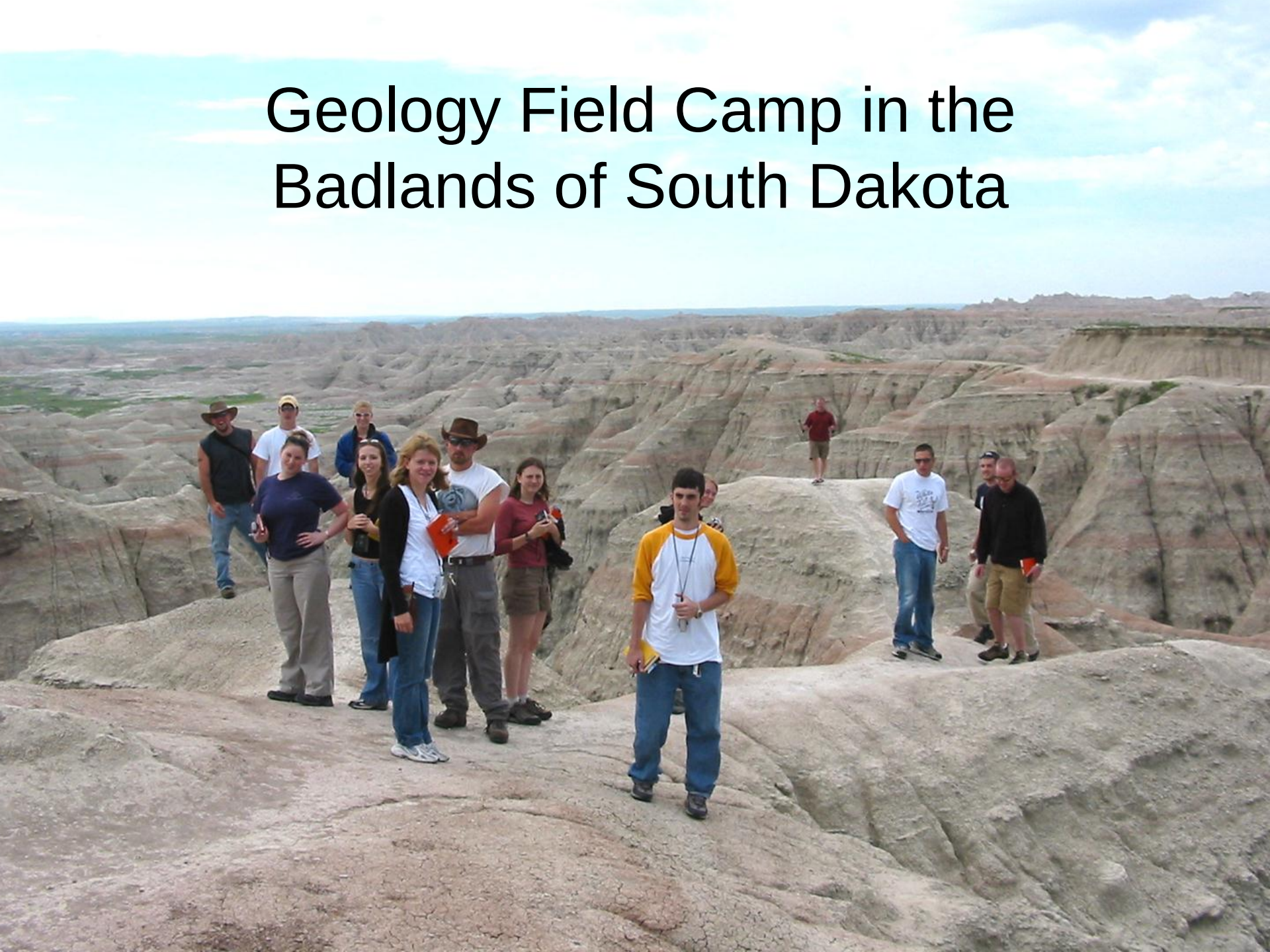
Original Horizontality – These layers were once horizontal. Why are they now tilted?

Principle of Original Lateral Continuity

- Strata originally extended in all directions until they thinned to zero at their edges of deposition.
- Thus, matching strata on opposite sides of a valley can be correlated.
- This principle is used to trace coal seams from one mountain to the next in West Virginia.

Original Lateral Continuity

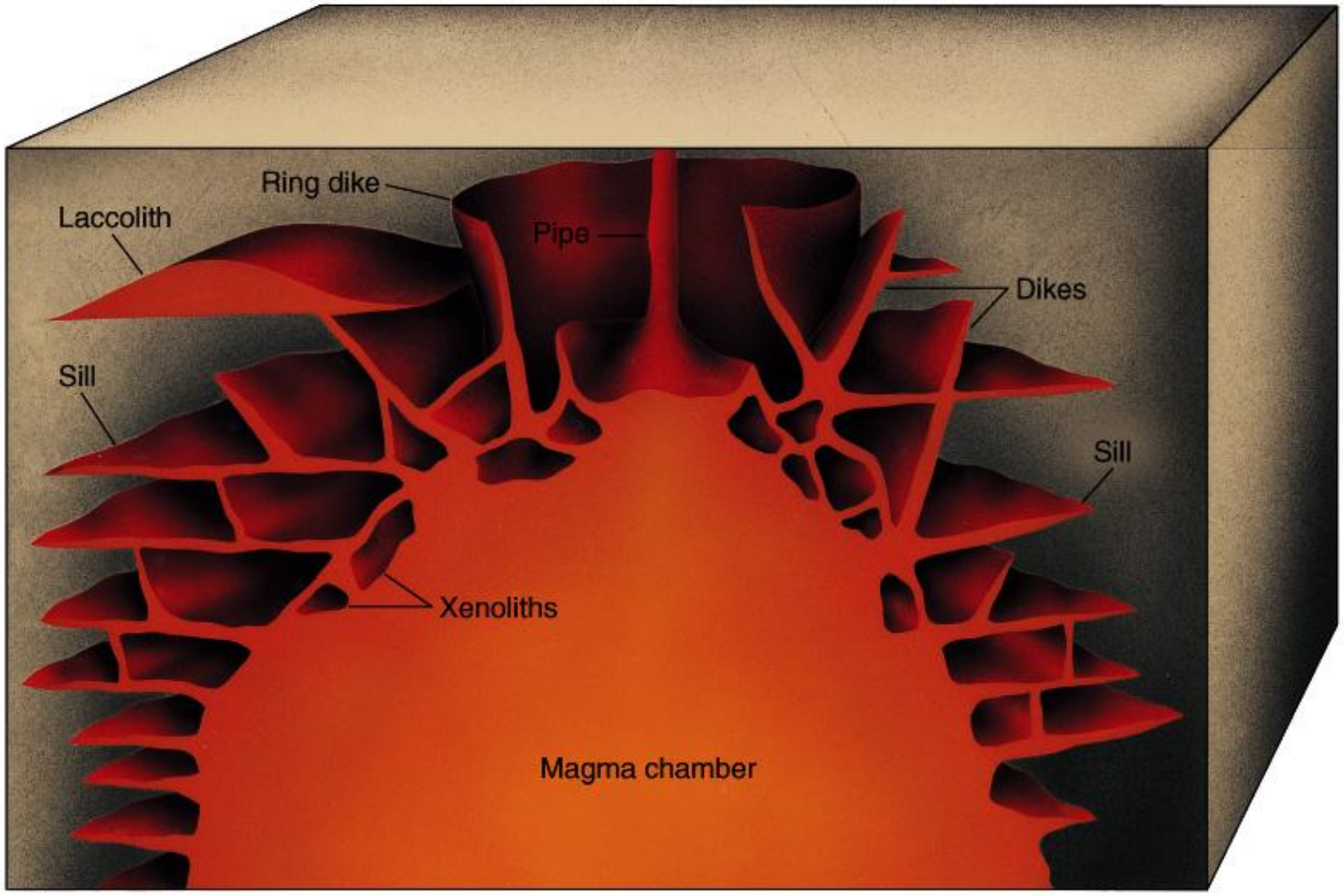
Geology Field Camp in the Badlands of South Dakota



Principle of Intrusive Relationships

- Invading igneous rock is always younger than the rock it intrudes.
- This is an indicator of relative ages.

Different types of intrusive igneous bodies



Igneous dikes in black, granite in pink

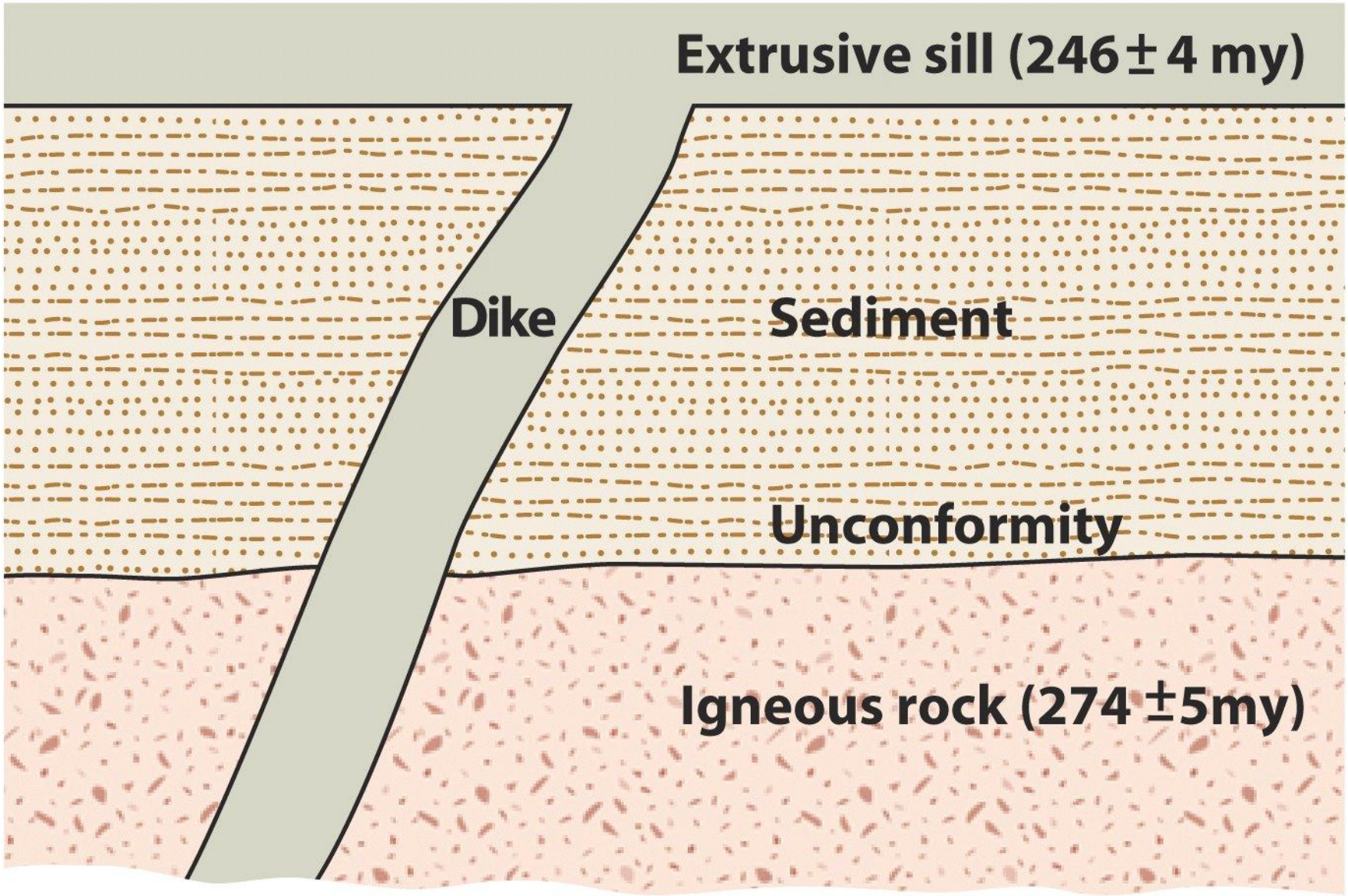


Figure 6-10
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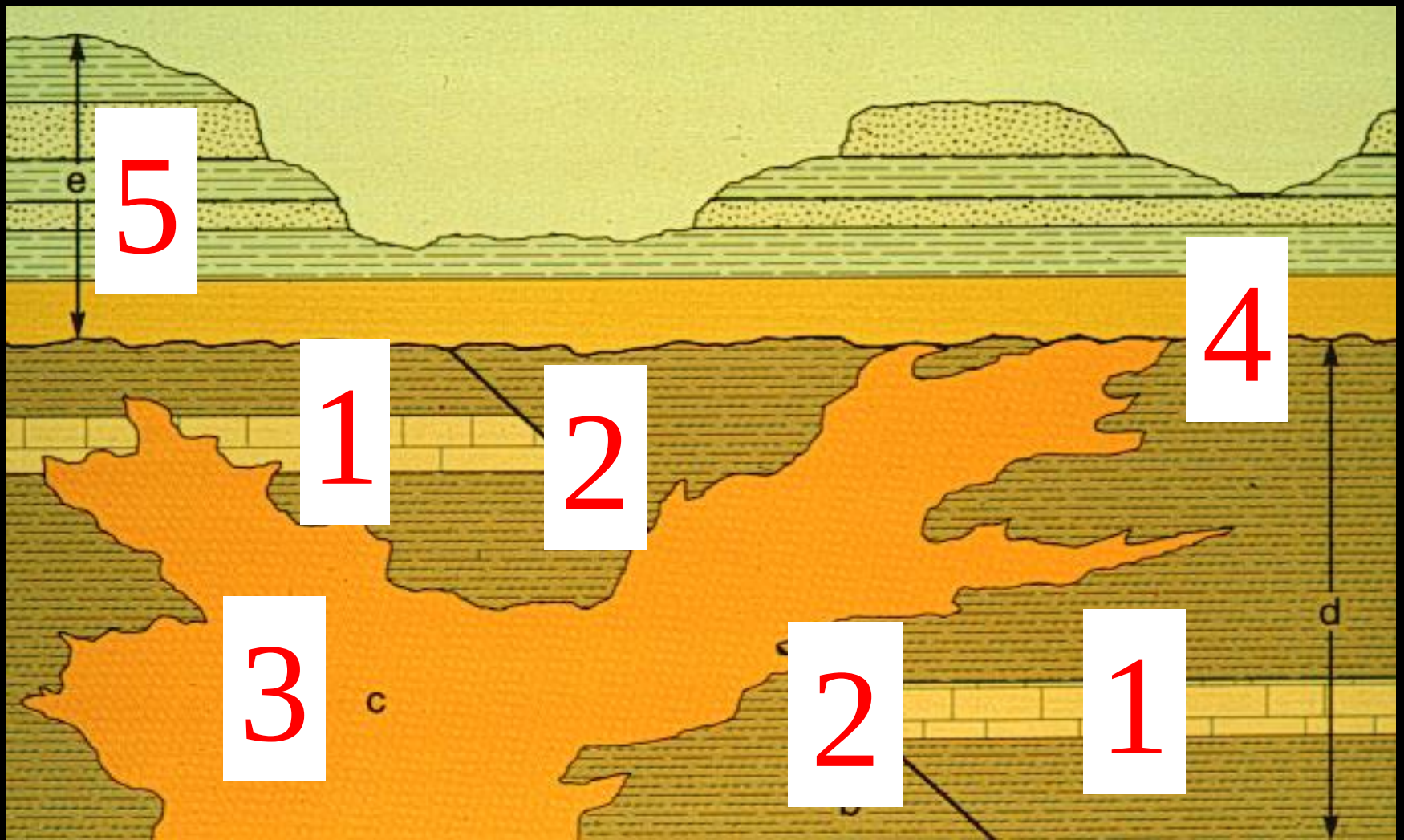
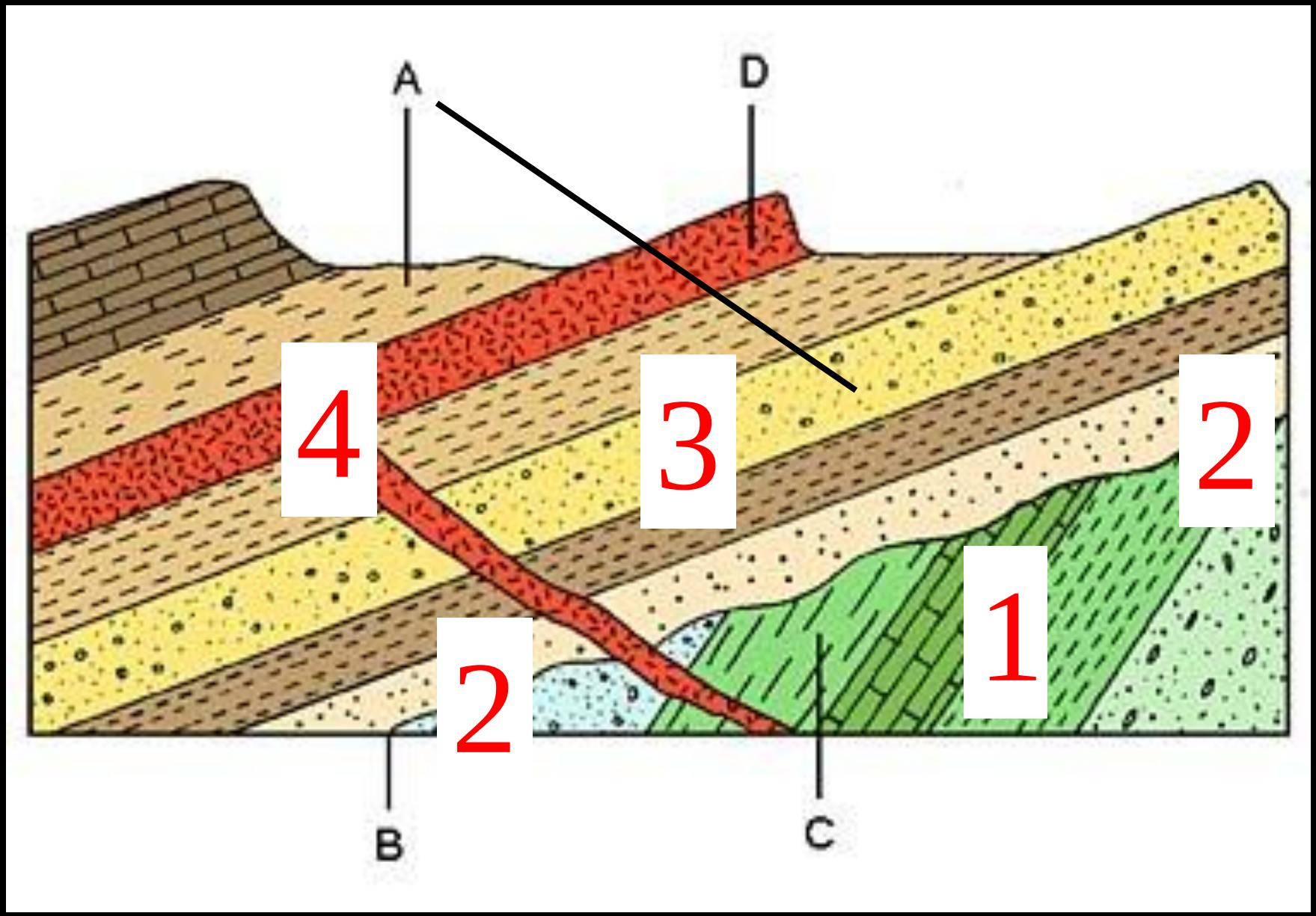
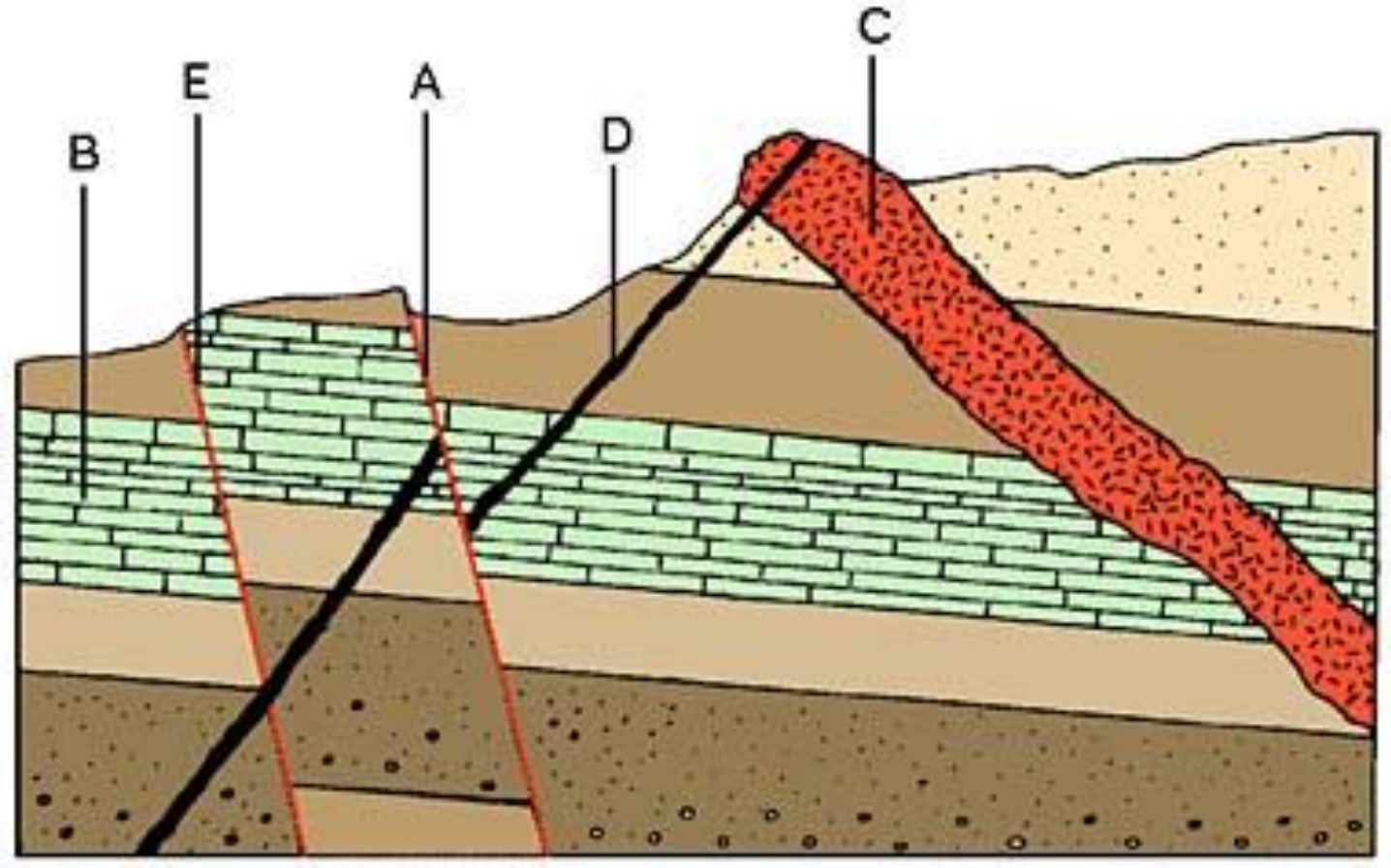
Can you interpret the sequence of geologic events using cross-cutting relationships and superposition?



What is the sequence of events?



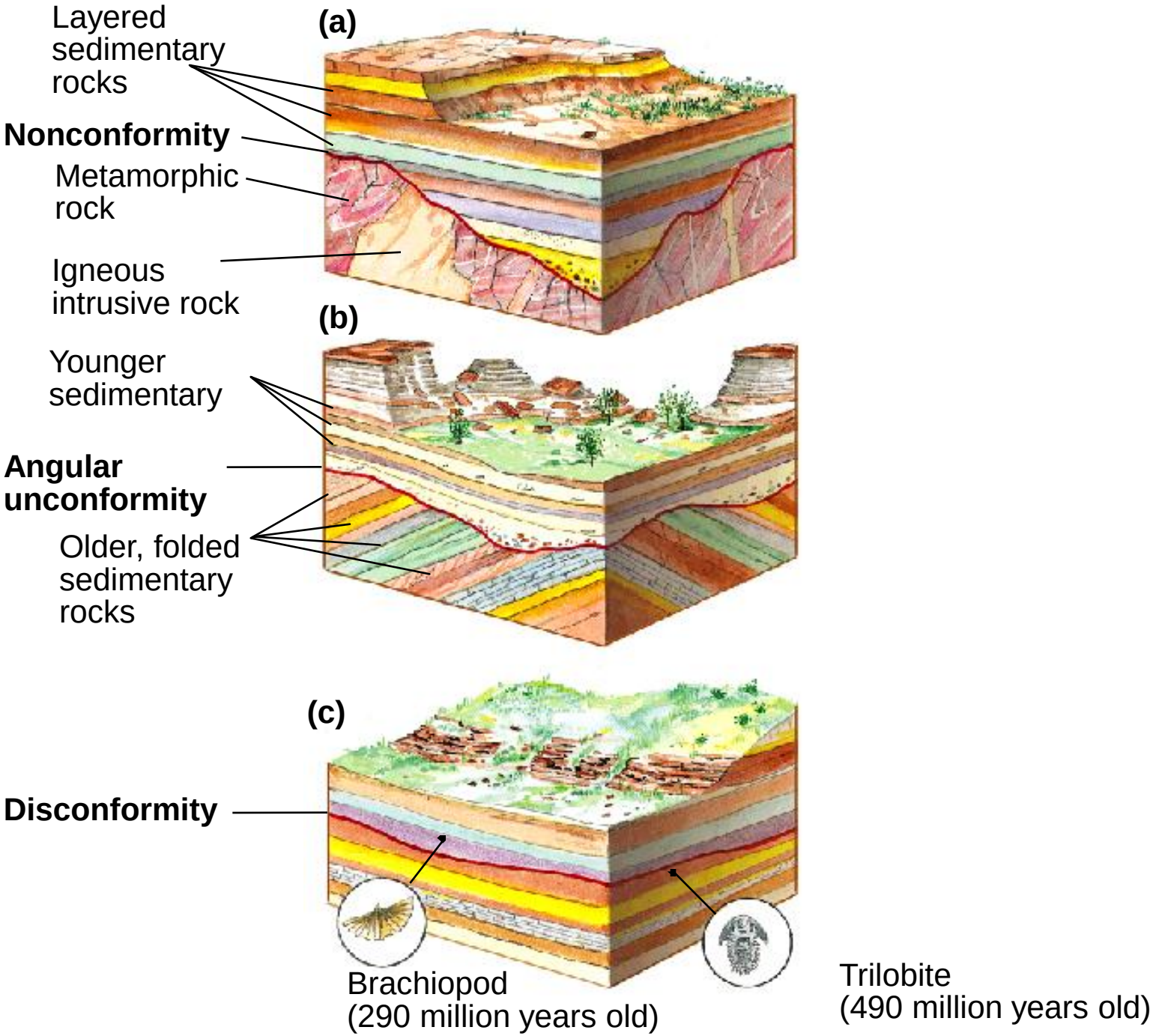
What is the sequence of events?



The Meaning of Unconformities

Unconformities

- Unconformities represent major gaps of time.
- They are the result of periods of erosion or non-deposition.
- They help us to understand the great age of the earth.


(a)
Layered sedimentary rocks
Nonconformity
Metamorphic rock
Igneous intrusive rock
(b)
Younger sedimentary
Angular unconformity
Older, folded sedimentary rocks
(c)
Disconformity
Brachiopod (290 million years old)
Trilobite (490 million years old)

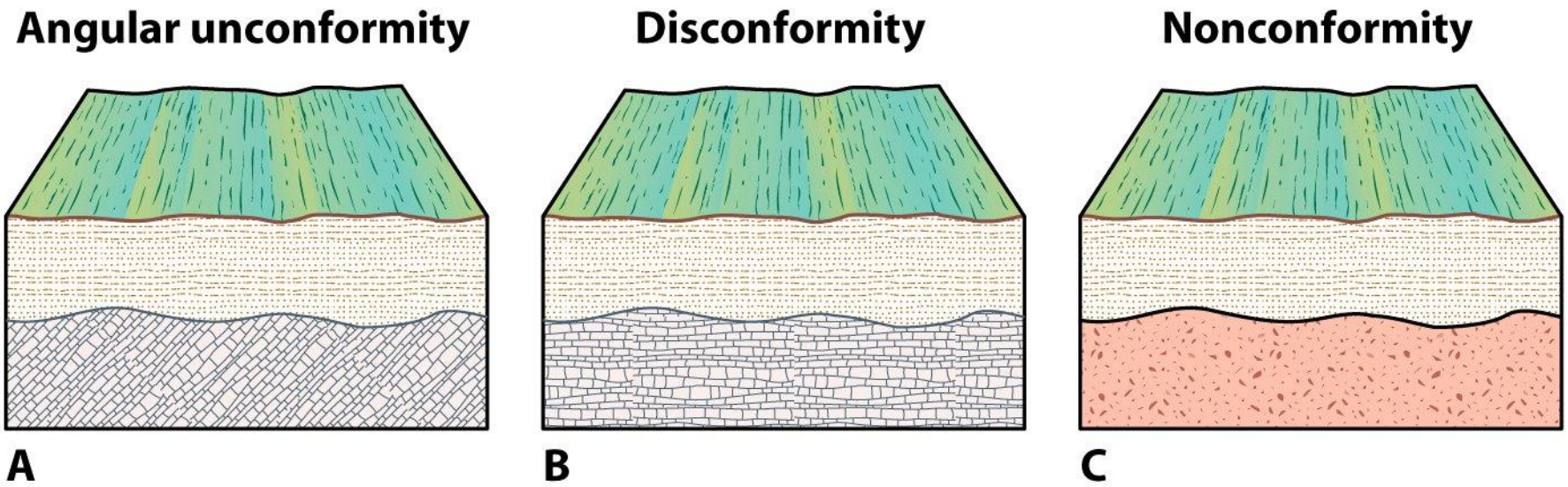


Figure 1-23
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Angular Unconformity

- Recognized by tilted or deformed sedimentary rocks below flat-lying sedimentary rocks.

Angular unconformity

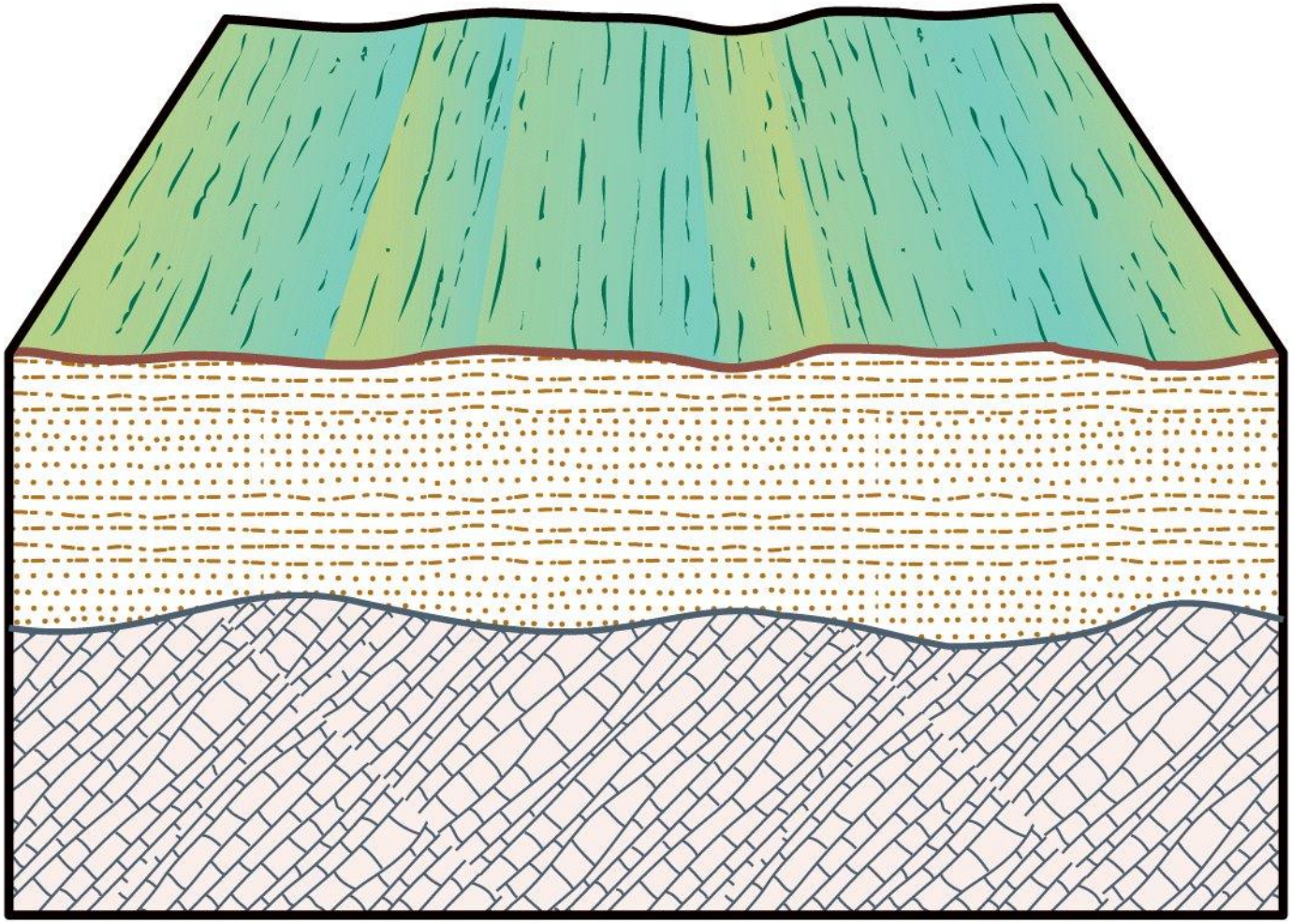

Figure 1-23a
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Disconformity

- The unconformity is an erosion surface within a sequence of flat-lying sedimentary rocks.

Disconformity

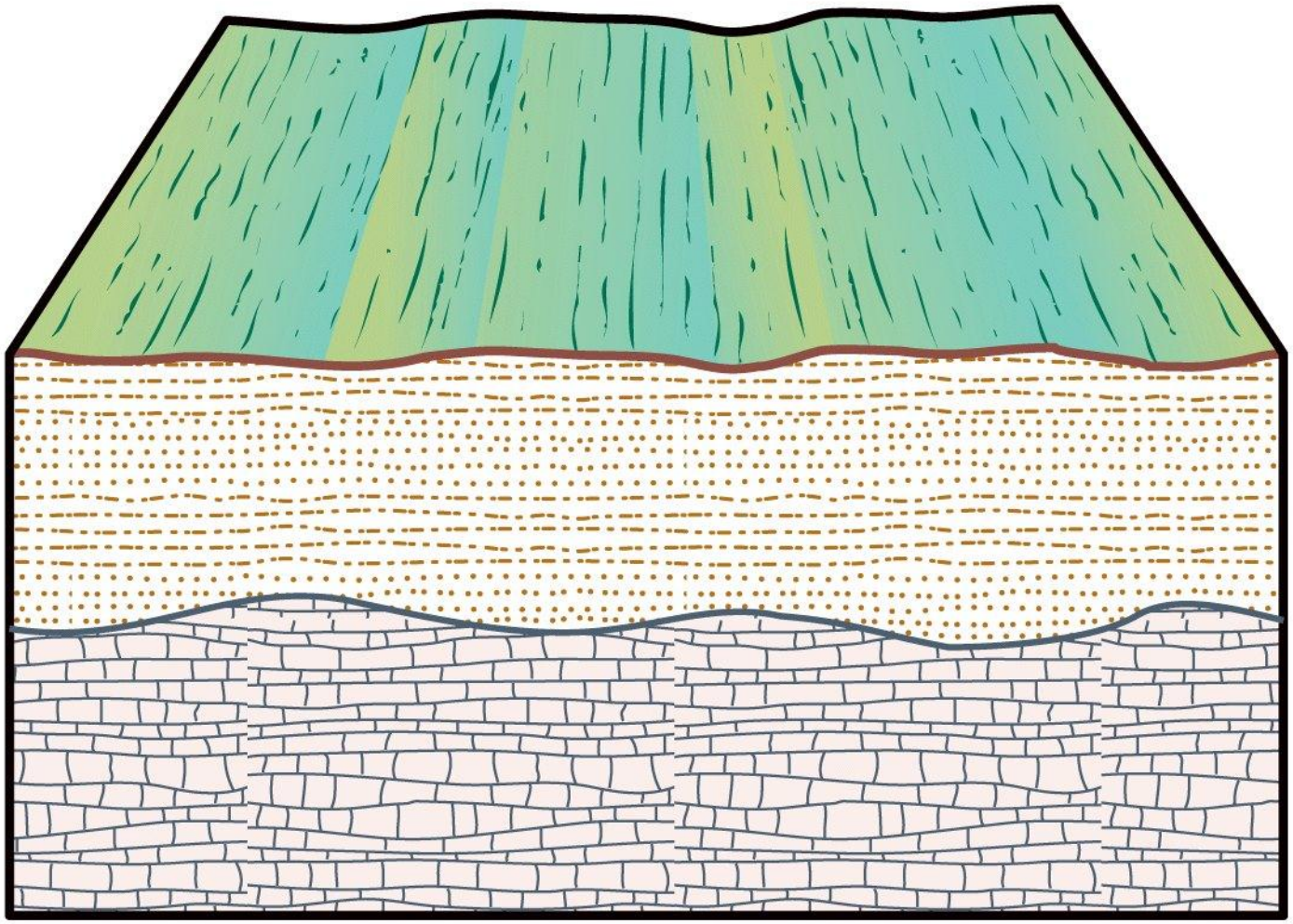

Figure 1-23b
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Nonconformity

- Recognized by sedimentary rocks resting on an eroded surface of igneous or metamorphic rocks.

Nonconformity

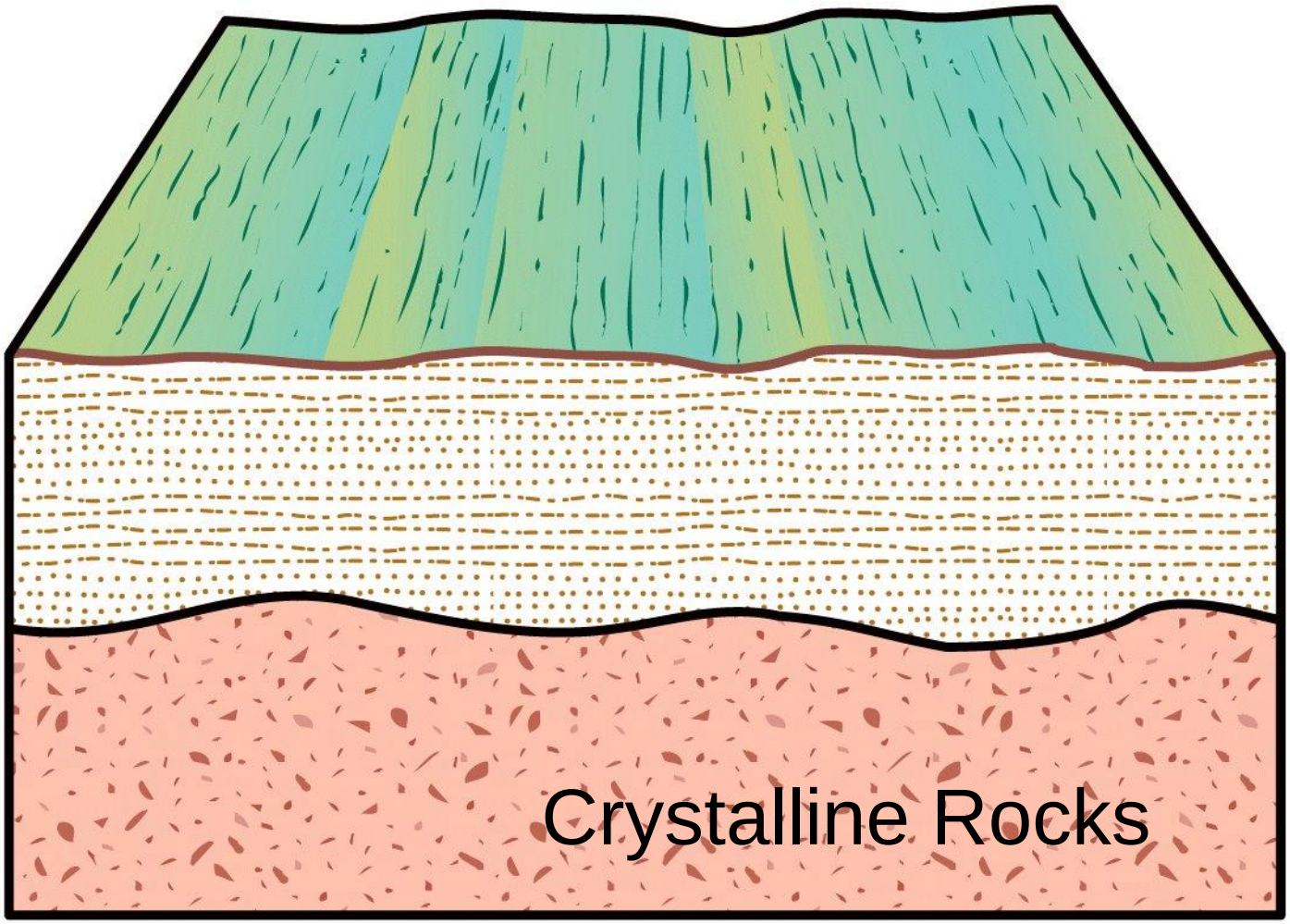

Figure 1-23c
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James Hutton, 18th Century founder of Geology

Siccar Point, Scotland, where Hutton discovered the meaning of unconformities.

Siccar Point, Scotland, where Hutton discovered the meaning of unconformities.

Figure 14-23
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Siccar Point, Scotland, June 2004

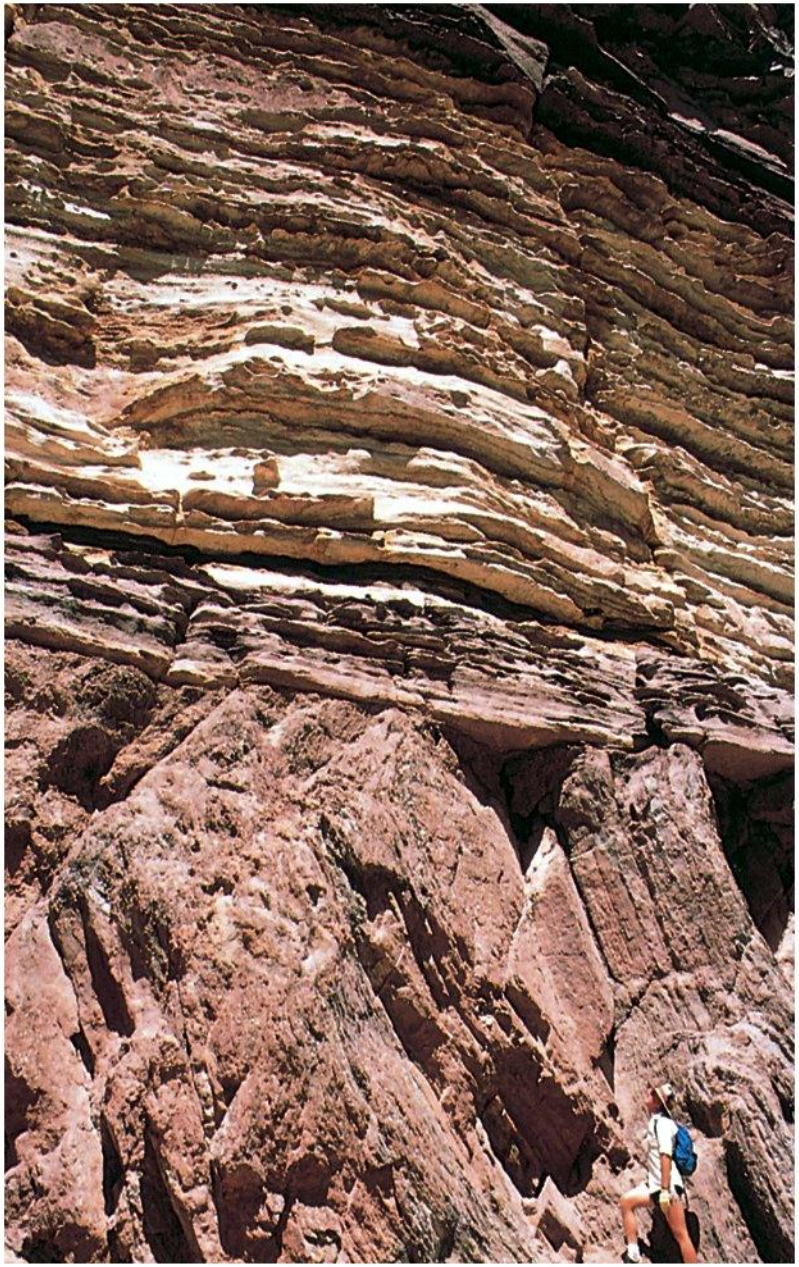

Figure 1-22
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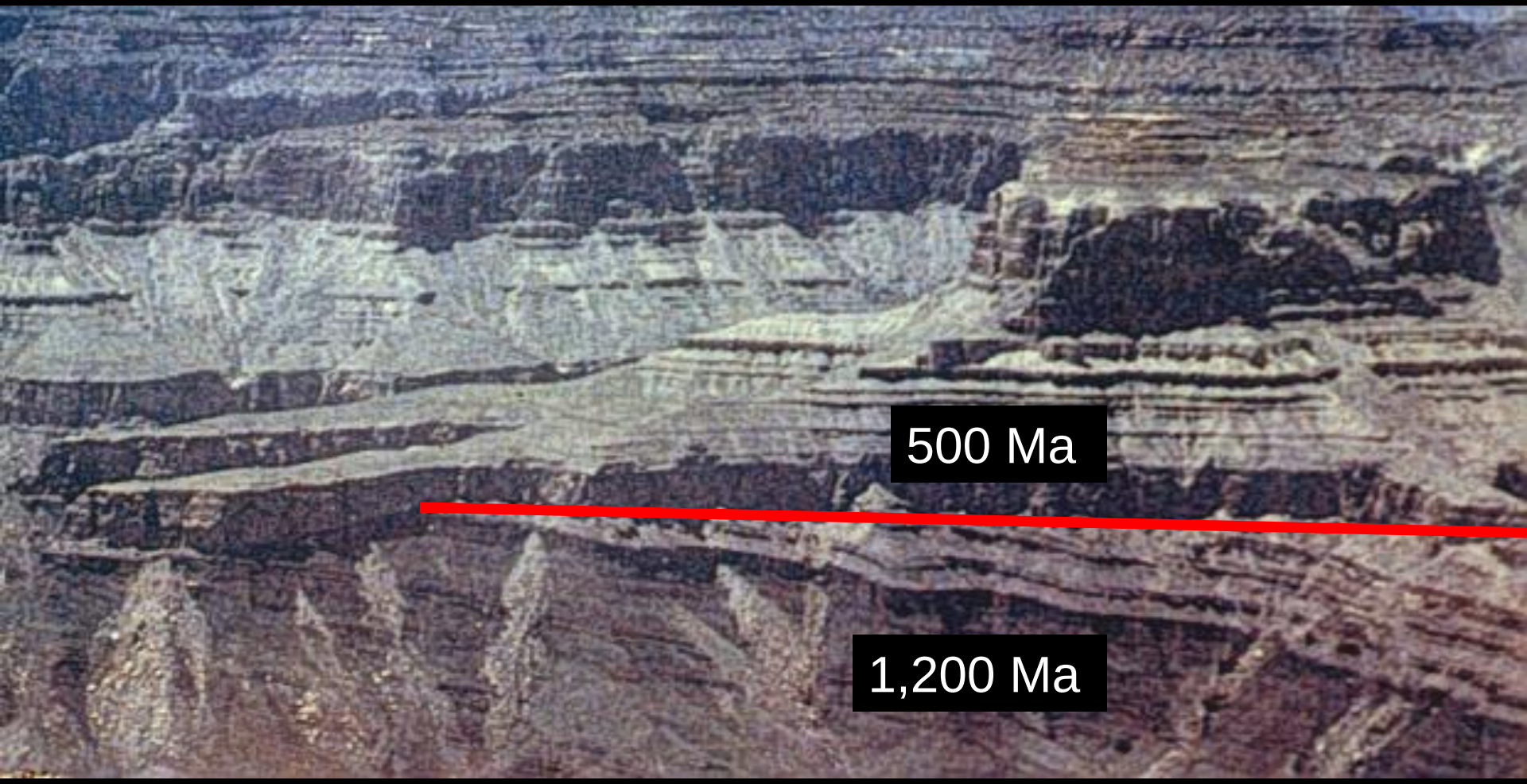
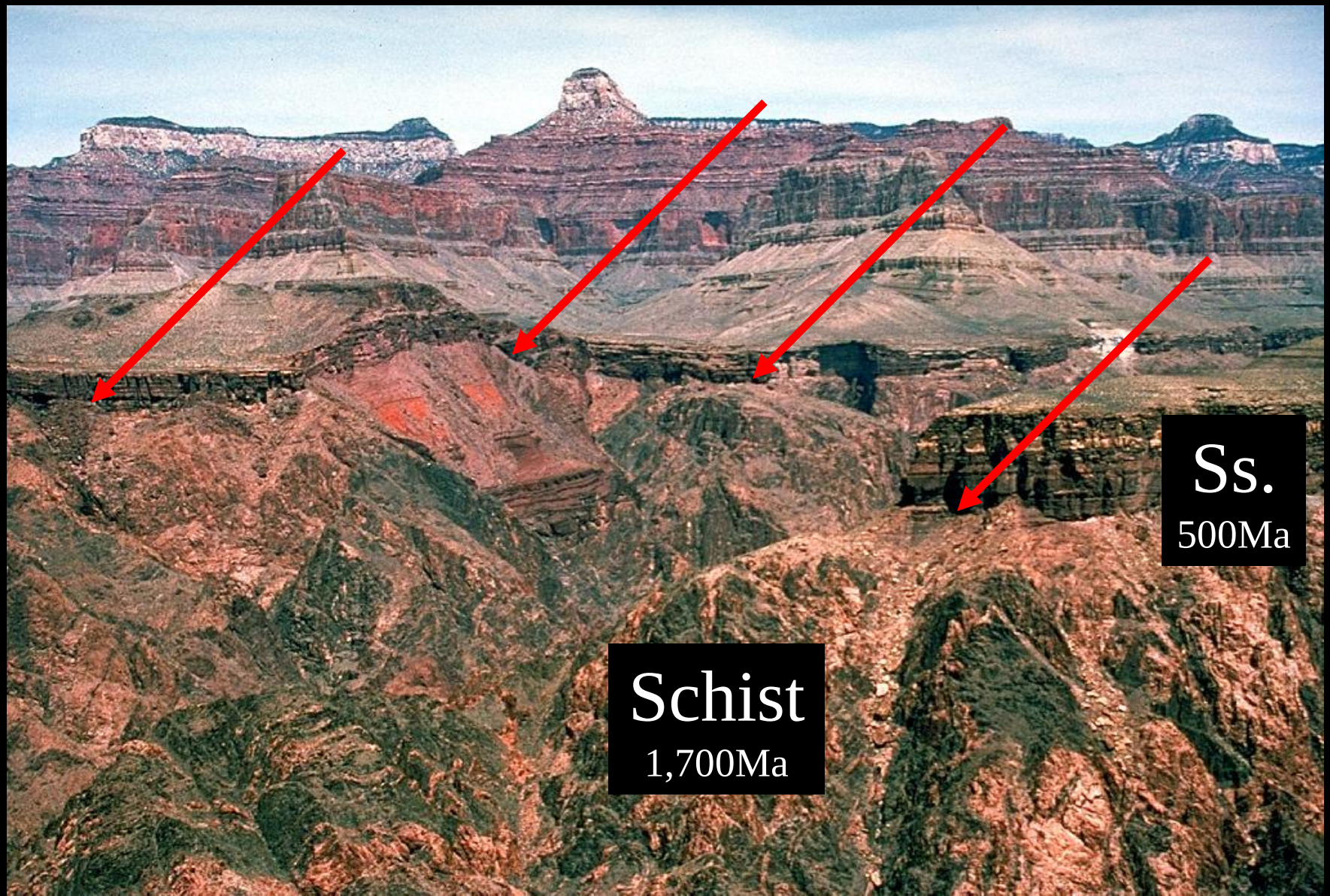
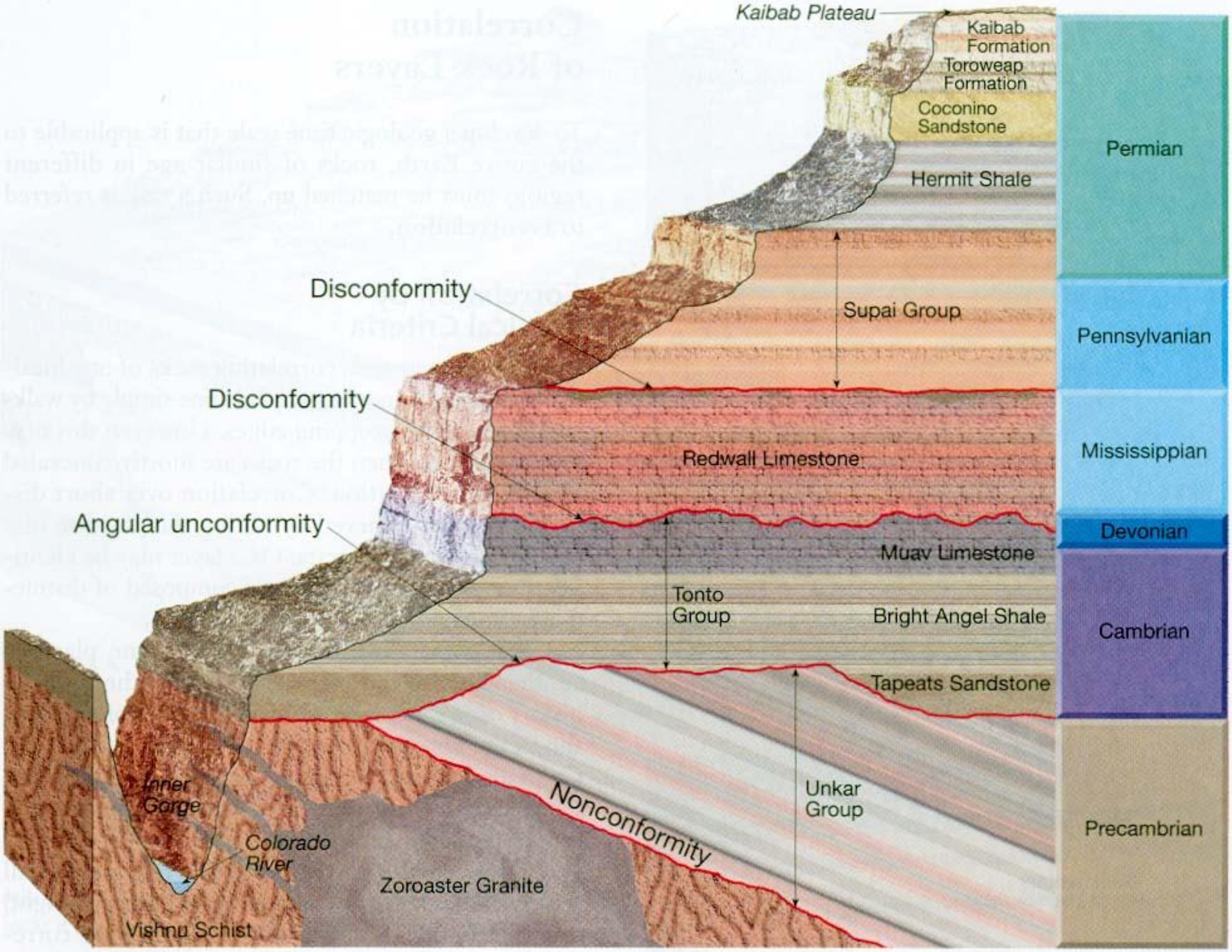
Angular Unconformity in the Grand Canyon between Proterozoic and Cambrian Rocks

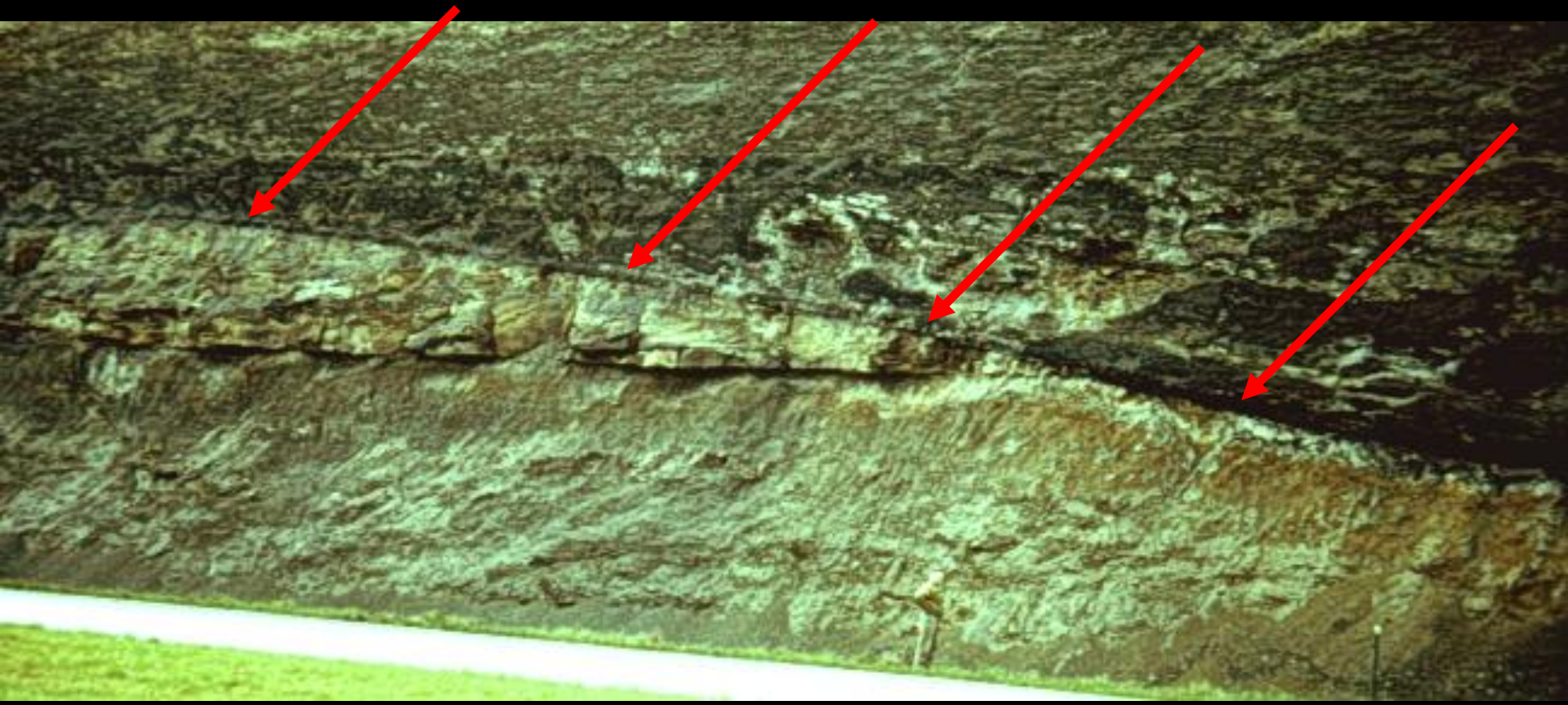


Nonconformity between schist and sandstone in the Grand Canyon




Kaibab Plateau
Kaibab Formation
Toroweap Formation
Coconino Sandstone
Hermit Shale
Permian
Disconformity
Supai Group
Pennsylvanian
Disconformity
Redwall Limestone
Mississippian
Angular unconformity
Devonian
Muav Limestone
Tonto Group
Bright Angel Shale
Cambrian
Tapeats Sandstone
Inner Gorge
Colorado River
Nonconformity
Unkar Group
Precambrian
Zoroaster Granite
Vishnu Schist

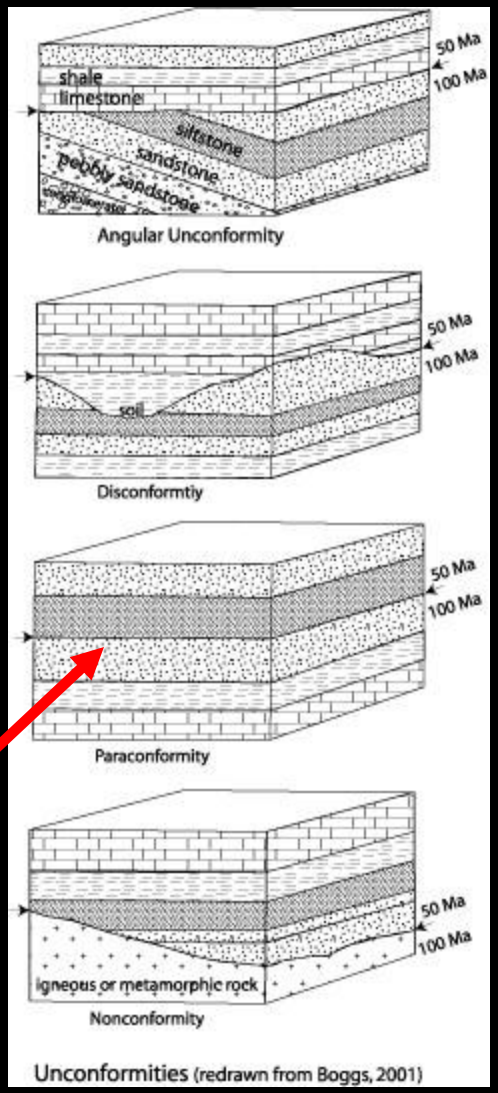
Disconformity within Pennsylvanian age rocks, West Virginia. The disconformity shows an older topography.



Several disconformities within Pennsylvanian age rocks along Rt. 19, West Virginia.

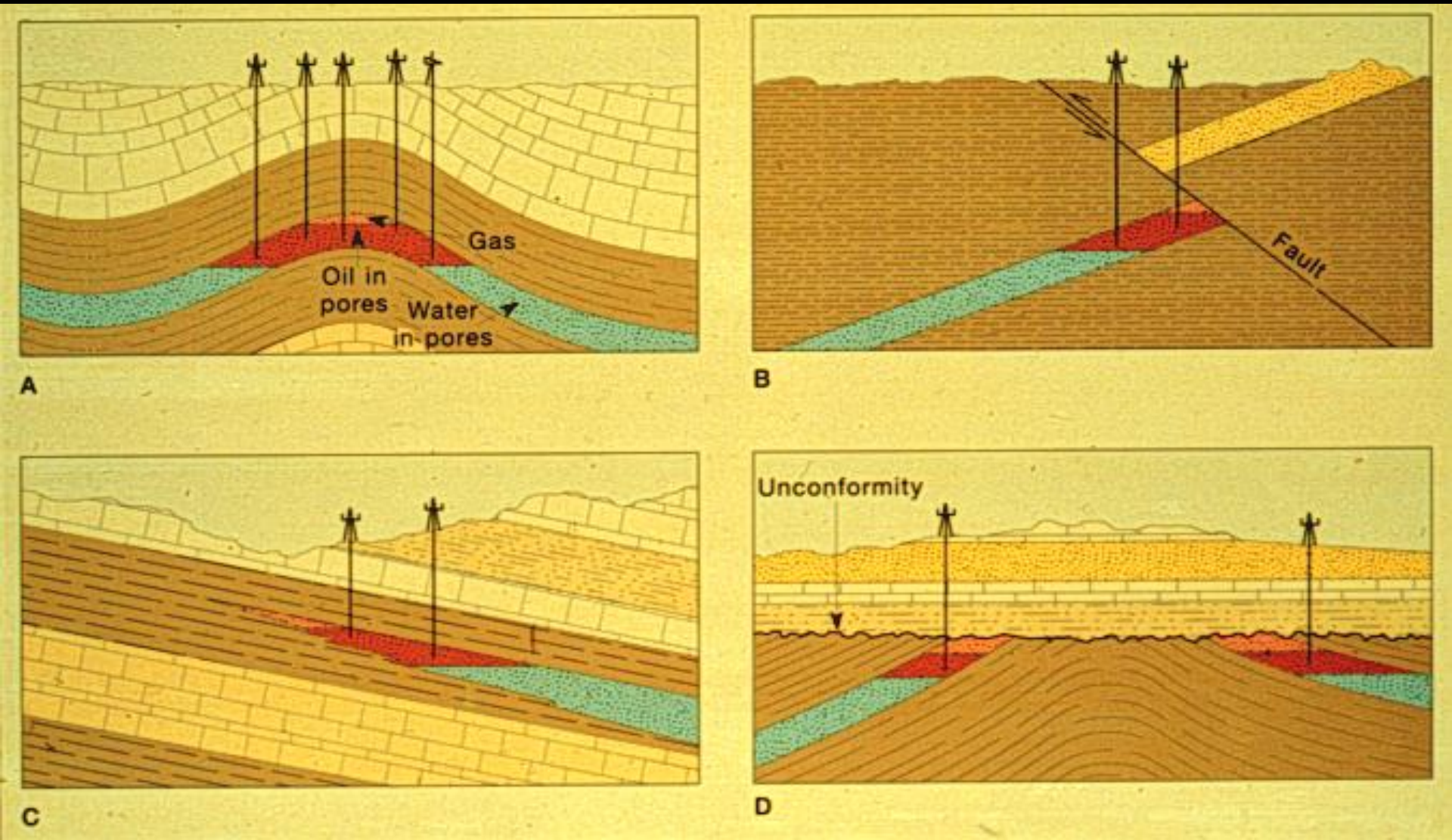
Paraconformity

- Para means “near”, as in nearly conformable
- An unconformity with no obvious erosion surface.
- There is a distinct gap in the fossil record.

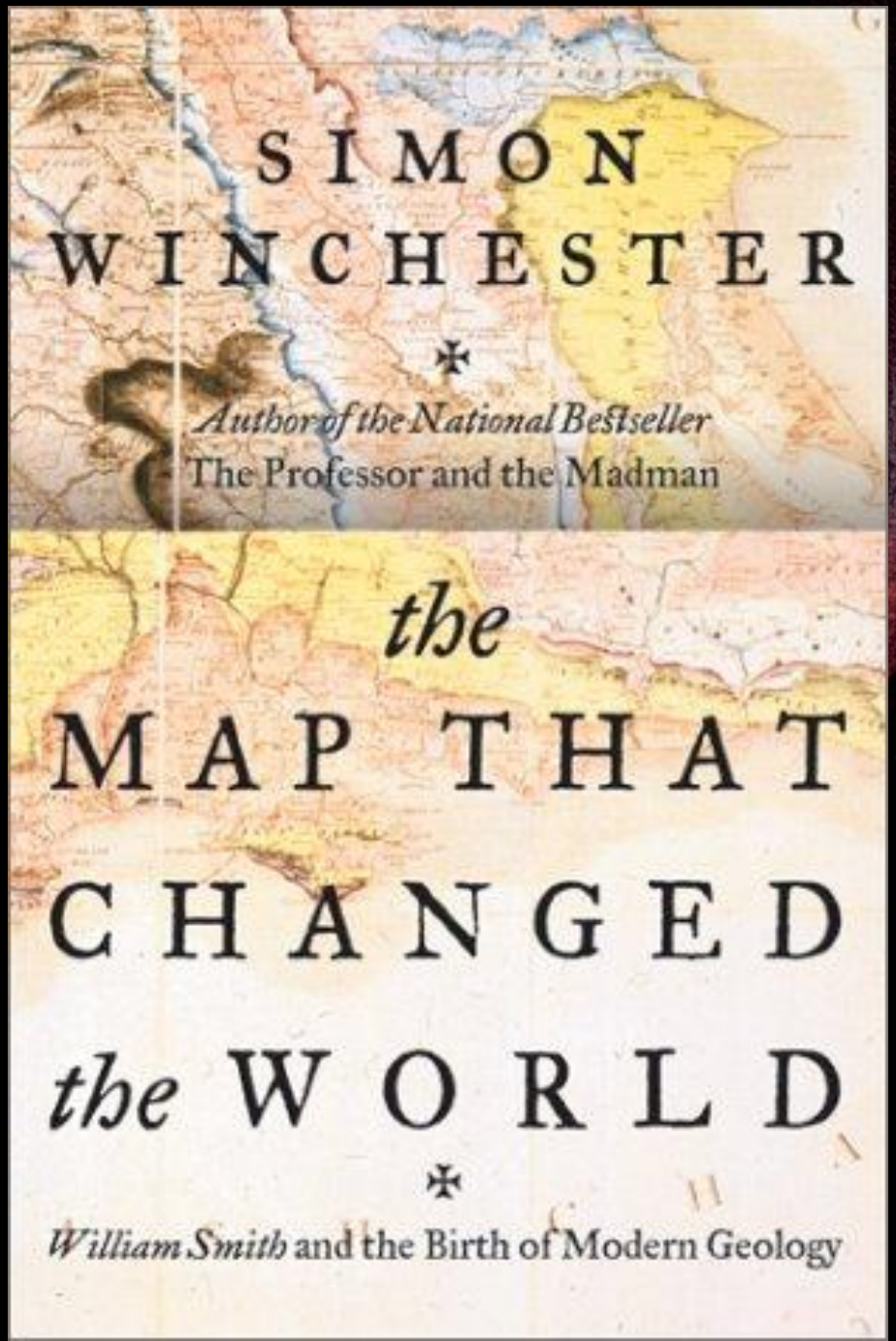


Unconformities (redrawn from Boggs, 2001)

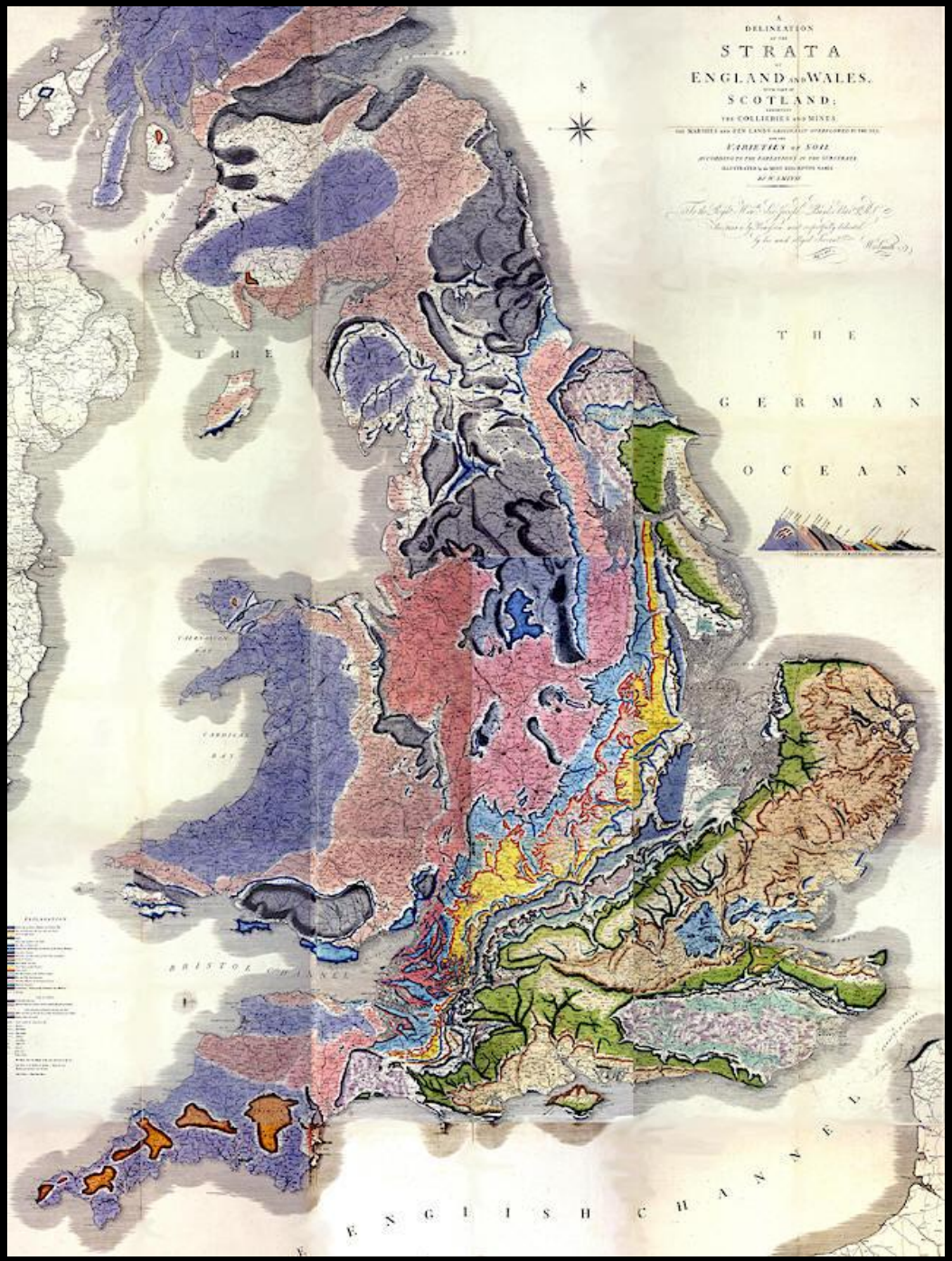
Application of the Principles of Historical Geology. Examples for finding petroleum.



William Smith, the first 19th Century geologist to understand stratigraphy and make correlations.


SIMON
WINCHESTER
Author of the National Bestseller
The Professor and the Madman
the
MAP THAT
CHANGED
the WORLD
William Smith and the Birth of Modern Geology

William Smith's Geologic Map of England and Wales



William Smith's Geologic Map of part of England

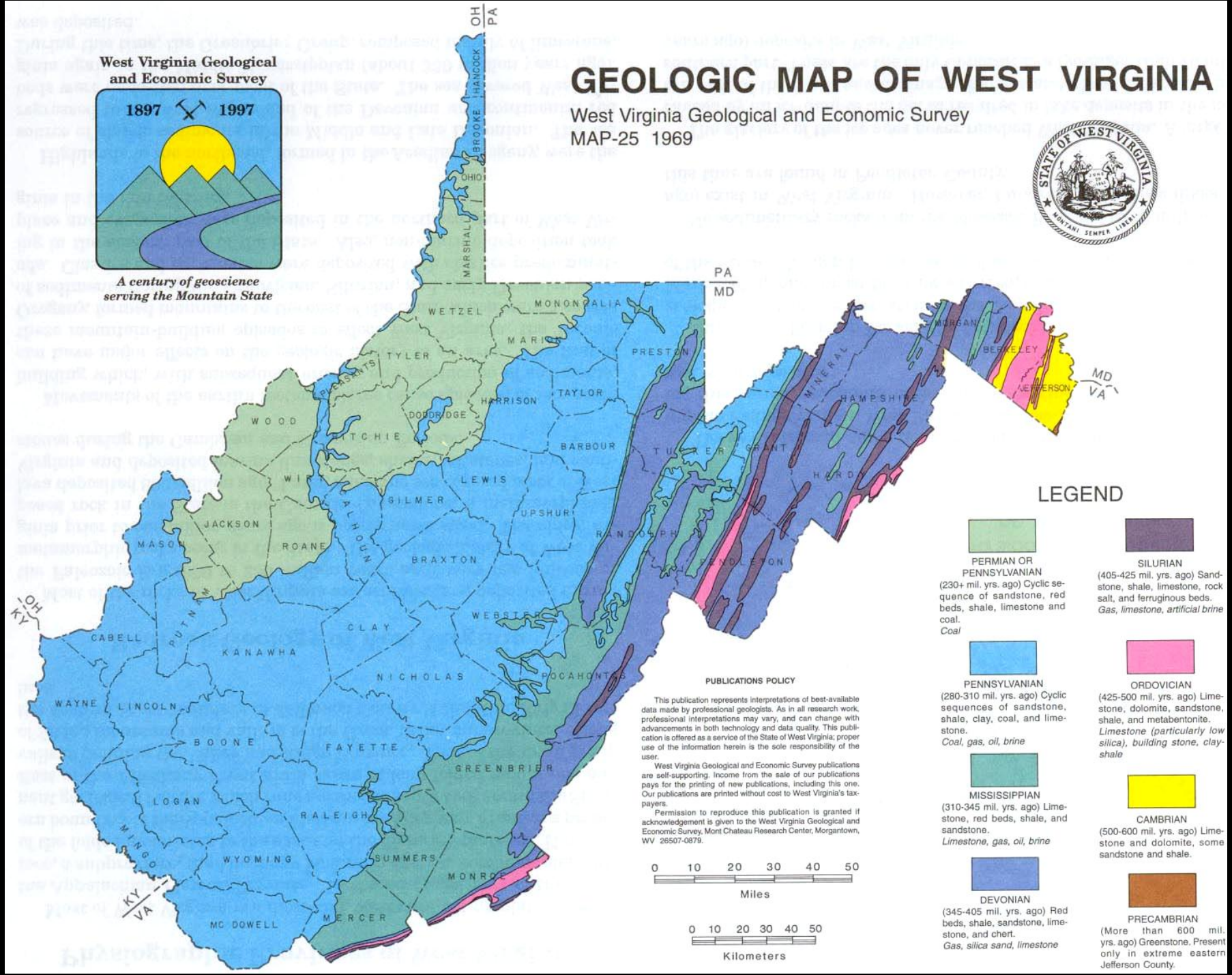
West Virginia Geological and Economic Survey

1897 1997

A century of geoscience serving the Mountain State

GEOLOGIC MAP OF WEST VIRGINIA

West Virginia Geological and Economic Survey
MAP-25 1969



LEGEND

PERMIAN OR PENNSYLVANIAN
(230+ mil. yrs. ago) Cyclic sequence of sandstone, red beds, shale, limestone and coal.
Coal

PENNSYLVANIAN
(280-310 mil. yrs. ago) Cyclic sequences of sandstone, shale, clay, coal, and limestone.
Coal, gas, oil, brine

MISSISSIPPIAN
(310-345 mil. yrs. ago) Limestone, red beds, shale, and sandstone.
Limestone, gas, oil, brine

DEVONIAN
(345-405 mil. yrs. ago) Red beds, shale, sandstone, limestone, and chert.
Gas, silica sand, limestone

SILURIAN
(405-425 mil. yrs. ago) Sandstone, shale, limestone, rock salt, and ferruginous beds.
Gas, limestone, artificial brine

ORDOVICIAN
(425-500 mil. yrs. ago) Limestone, dolomite, sandstone, shale, and metabentonite.
Limestone (particularly low silica), building stone, clay-shale

CAMBRIAN
(500-600 mil. yrs. ago) Limestone and dolomite, some sandstone and shale.

PRECAMBRIAN
(More than 600 mil. yrs. ago) Greenstone. Present only in extreme eastern Jefferson County.

0 10 20 30 40 50
Miles

0 10 20 30 40 50
Kilometers

THE DATA IS IN THE STRATA