Today:

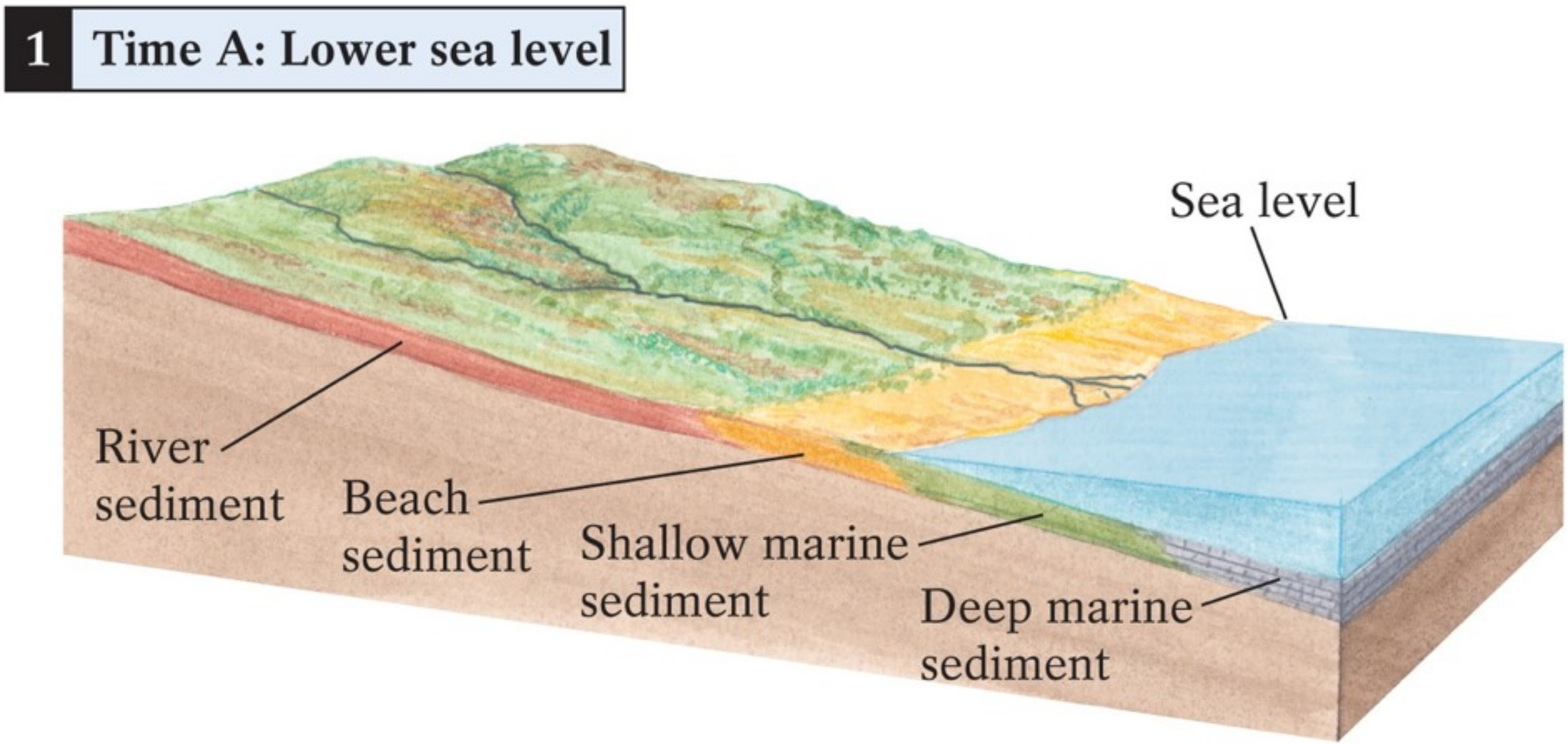
1) Discuss Extra Credit
2) Grand Canyon Talk
3) Google Earth Grand Canyon (Time Permitting)

Next Class:

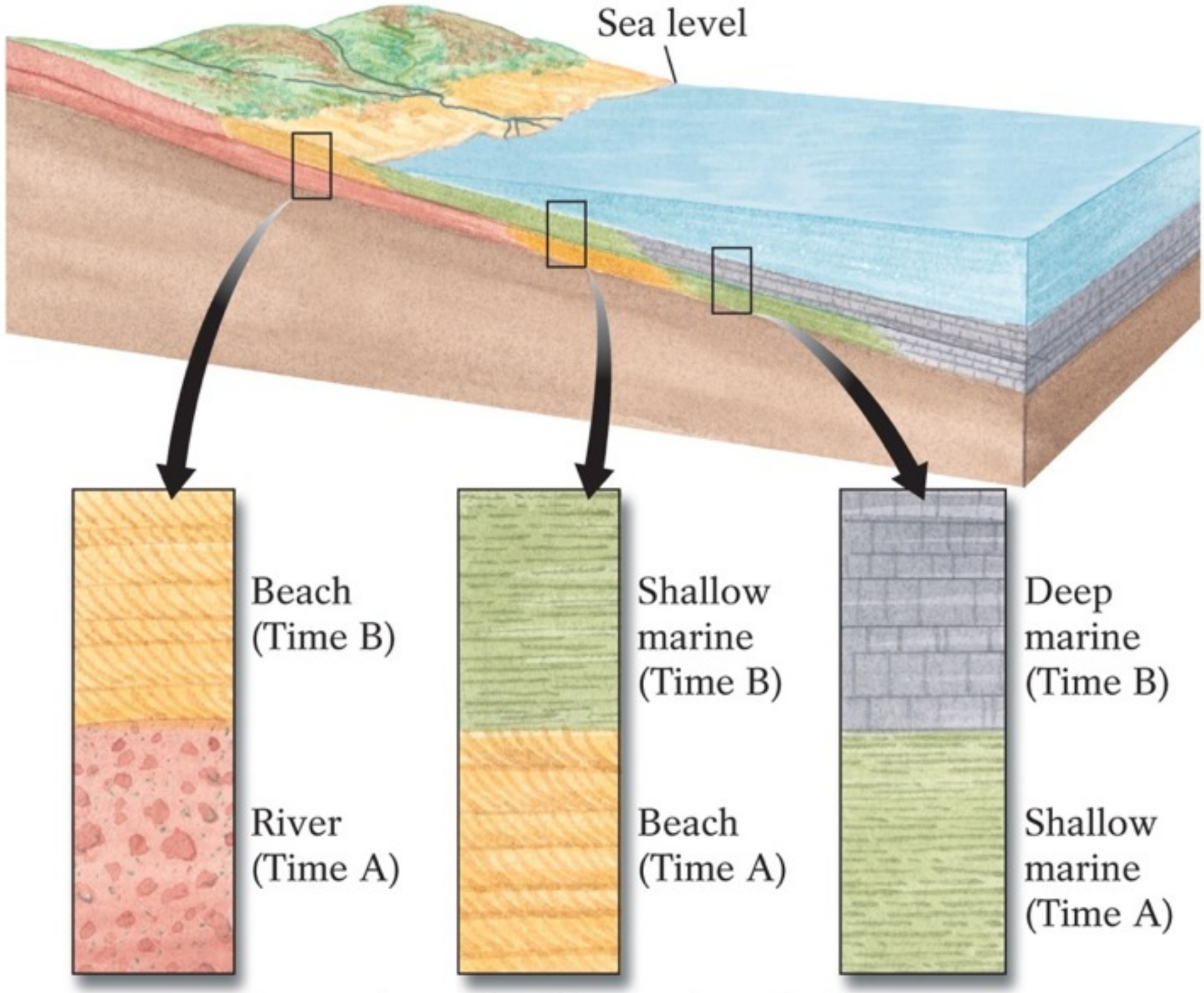
1) Quiz Chapter 8 Review / Chapter 17 Vocabulary
2) Lecture on Glaciers and Ice Ages

Sedimentary Facies

What happens when
Sea Level Rises or the land surface subsides?

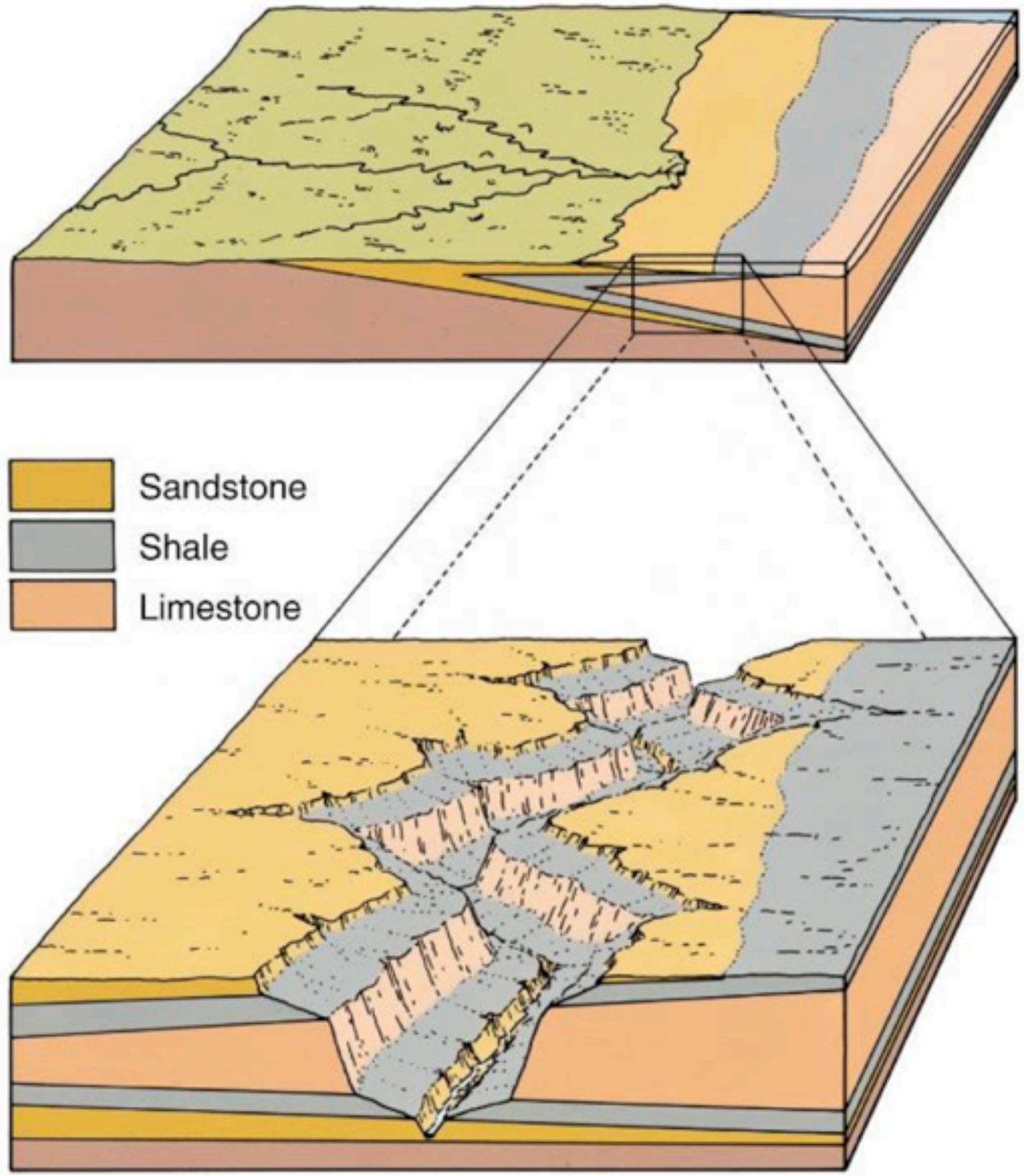


2 Time B: Higher sea level



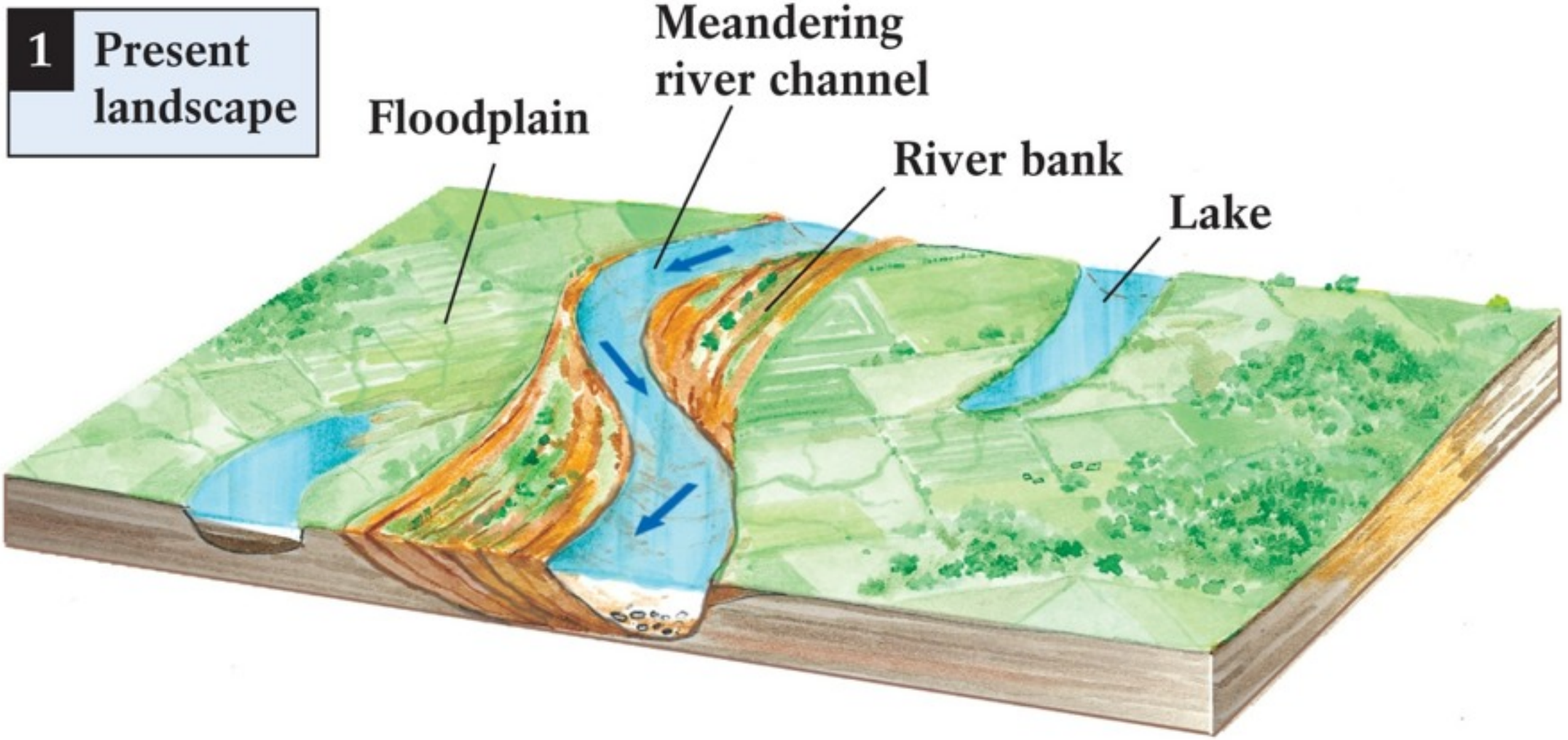
Comparison of sediments deposited

Transgression and Regression
Sedimentary facies

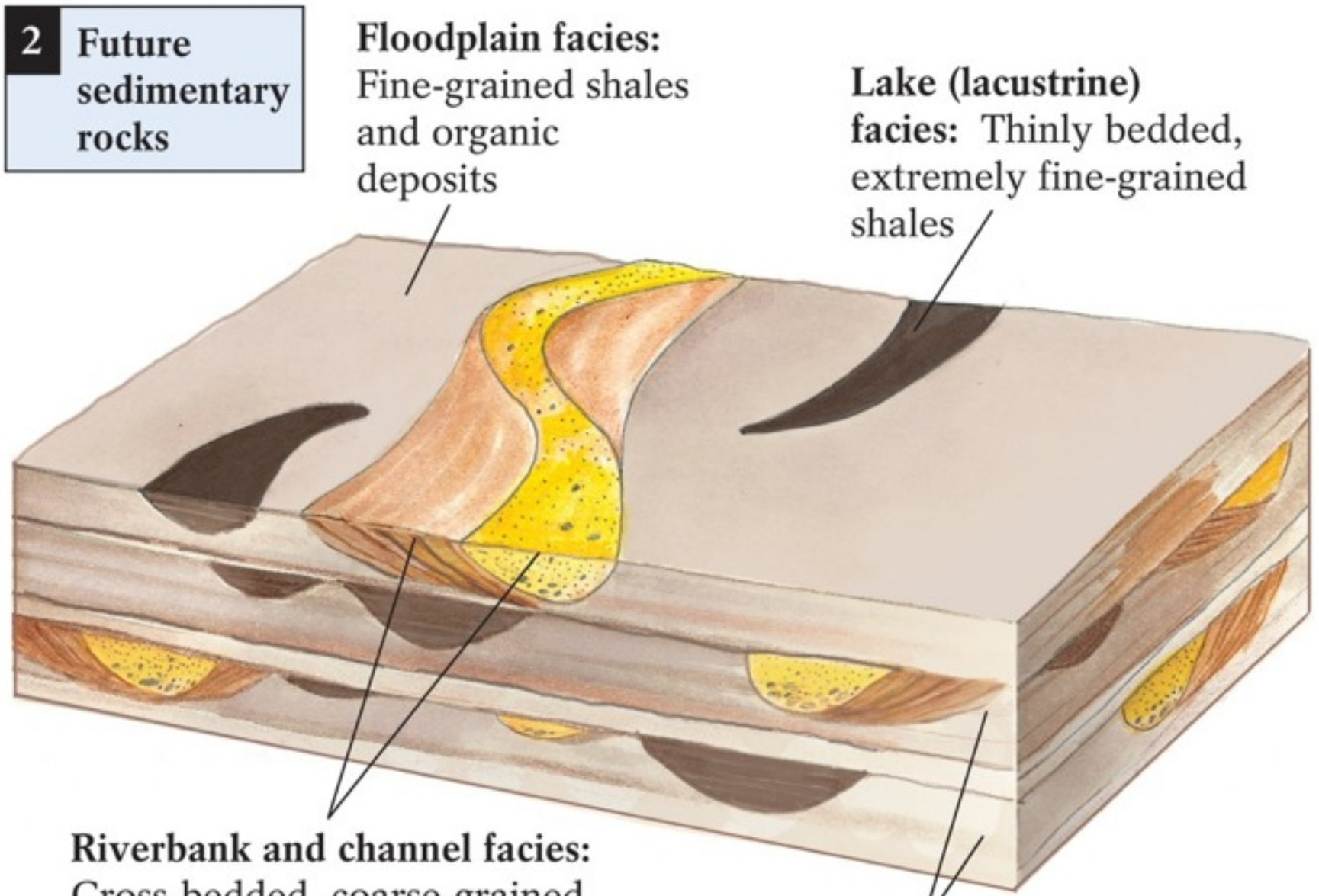


Animation

Sedimentary Facies



Sedimentary Facies



Sedimentary Facies

How do we know about the evolution of the Grand Canyon region from 500-250 Ma?

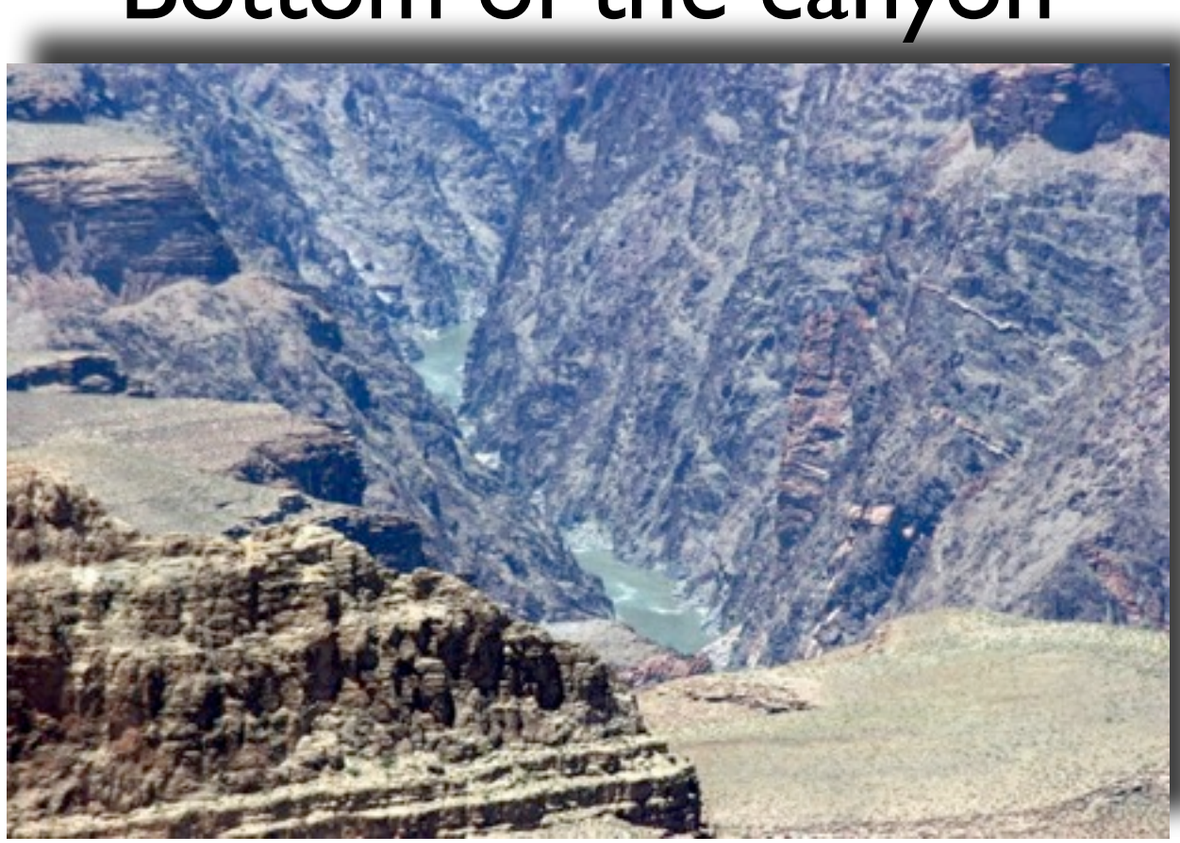
What is the Evidence?

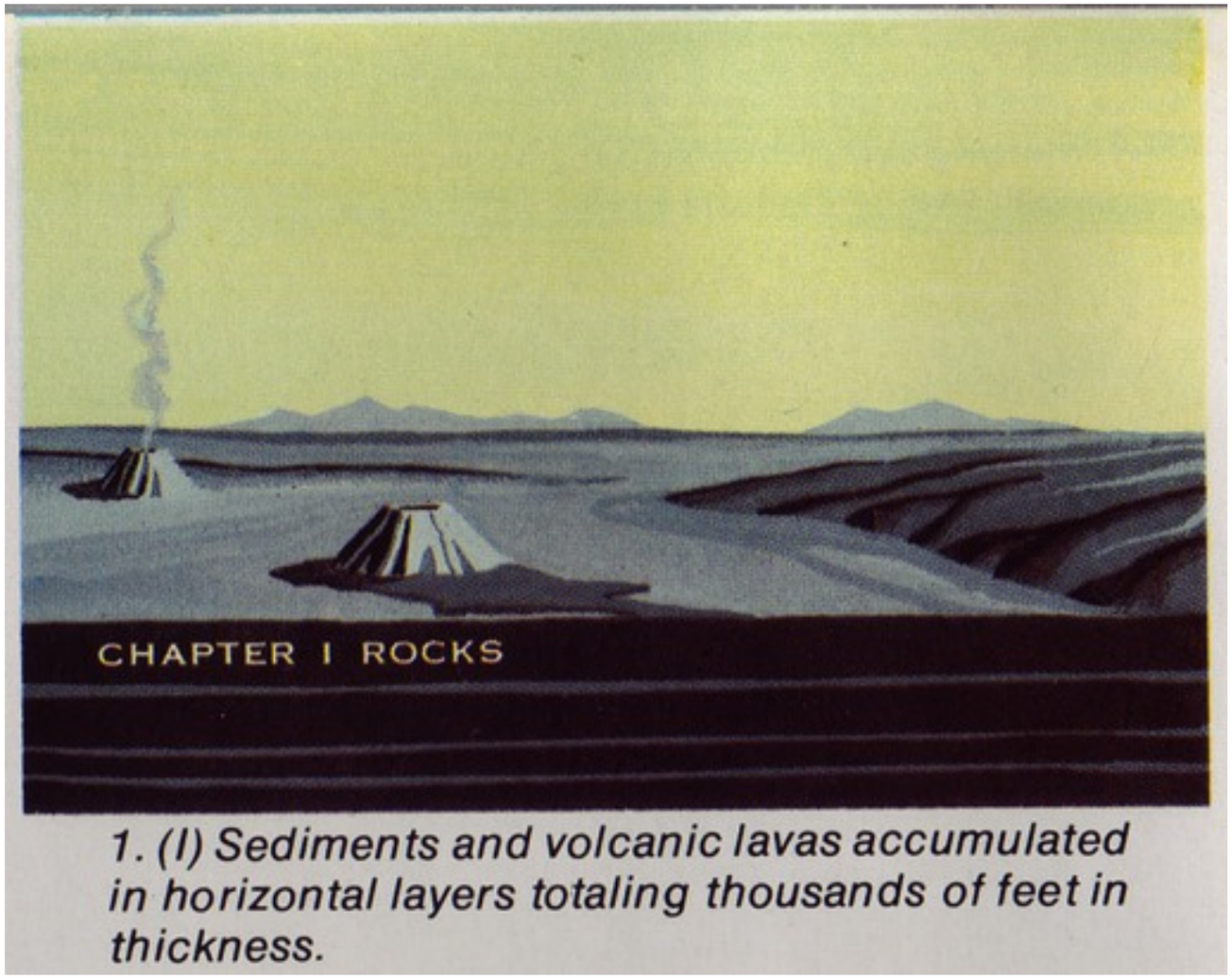
Depositional Environments: Case Study

The Canyon from 60 miles above

>1.7 Billion years ago Vishnu Sediments and Volcanic Sediments accumulate in shallow sea

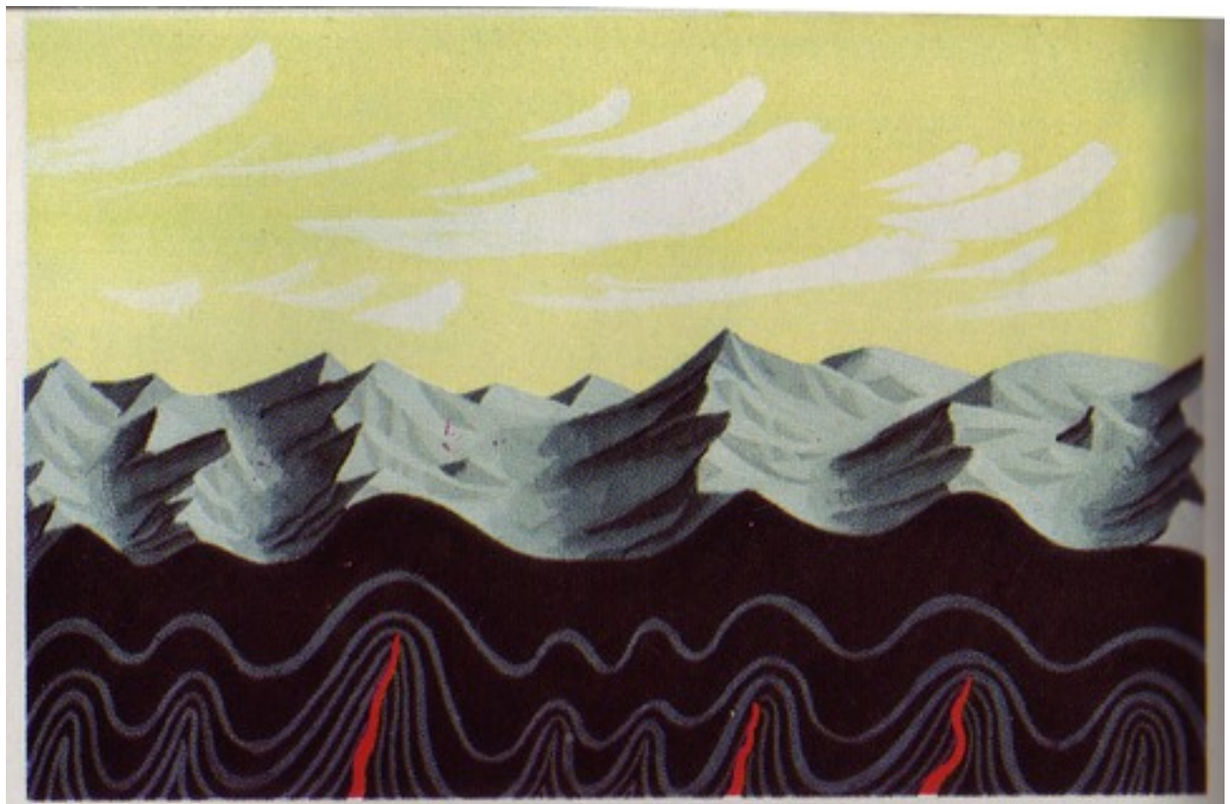
Bottom of the canyon





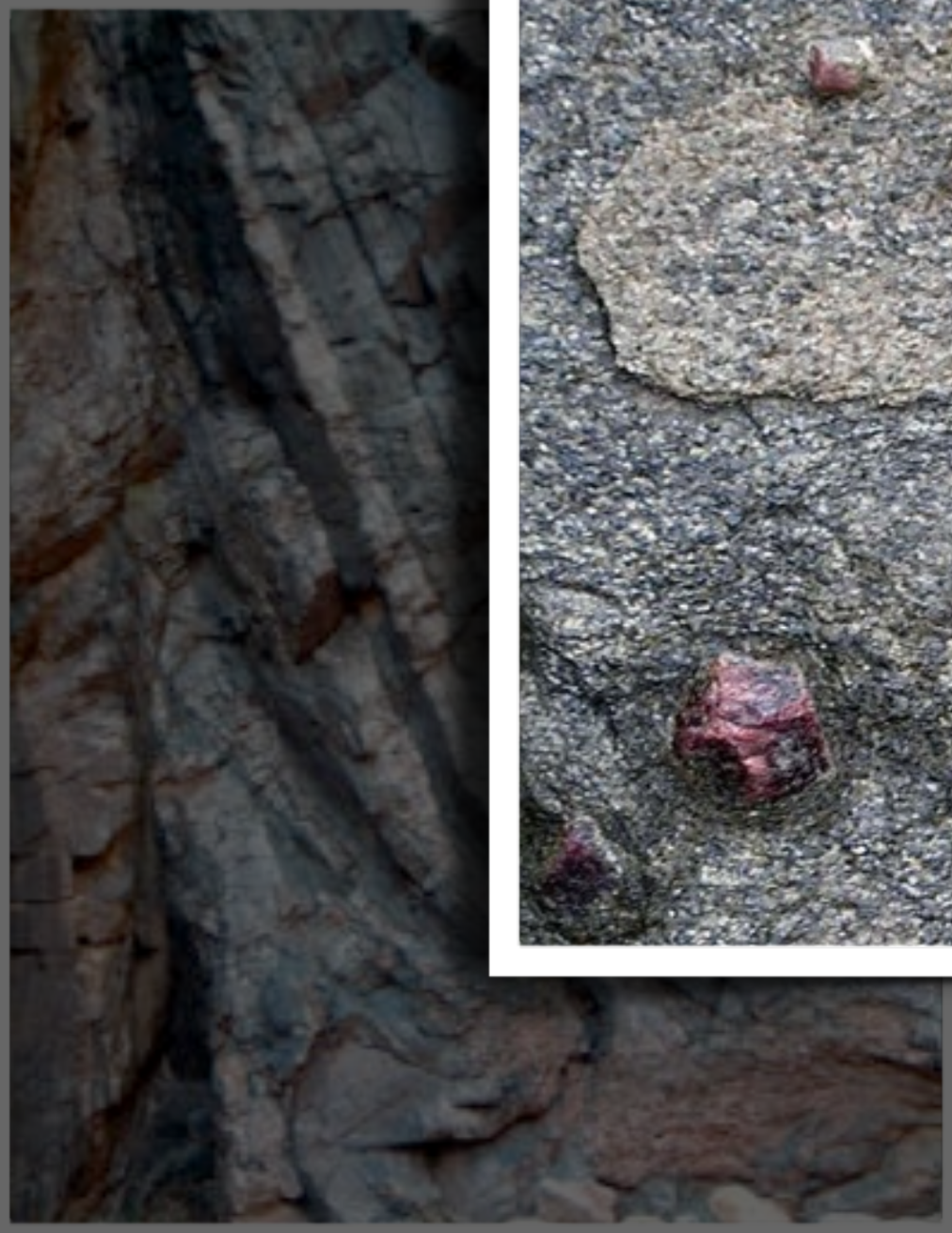
1. (I) Sediments and volcanic lavas accumulated in horizontal layers totaling thousands of feet in thickness.

~1.7 Billion years ago Vishnu Sediments metamorphosed to form Vishnu Schist



2. (I) Rock layers were folded and metamorphosed as a mountain range formed. Molten material invaded from below.

~1.7 Billion years ago Vishnu Sediments metamorphosed to form Vishnu Schist



s were folded and meta-
untain range formed. Molten
om below.

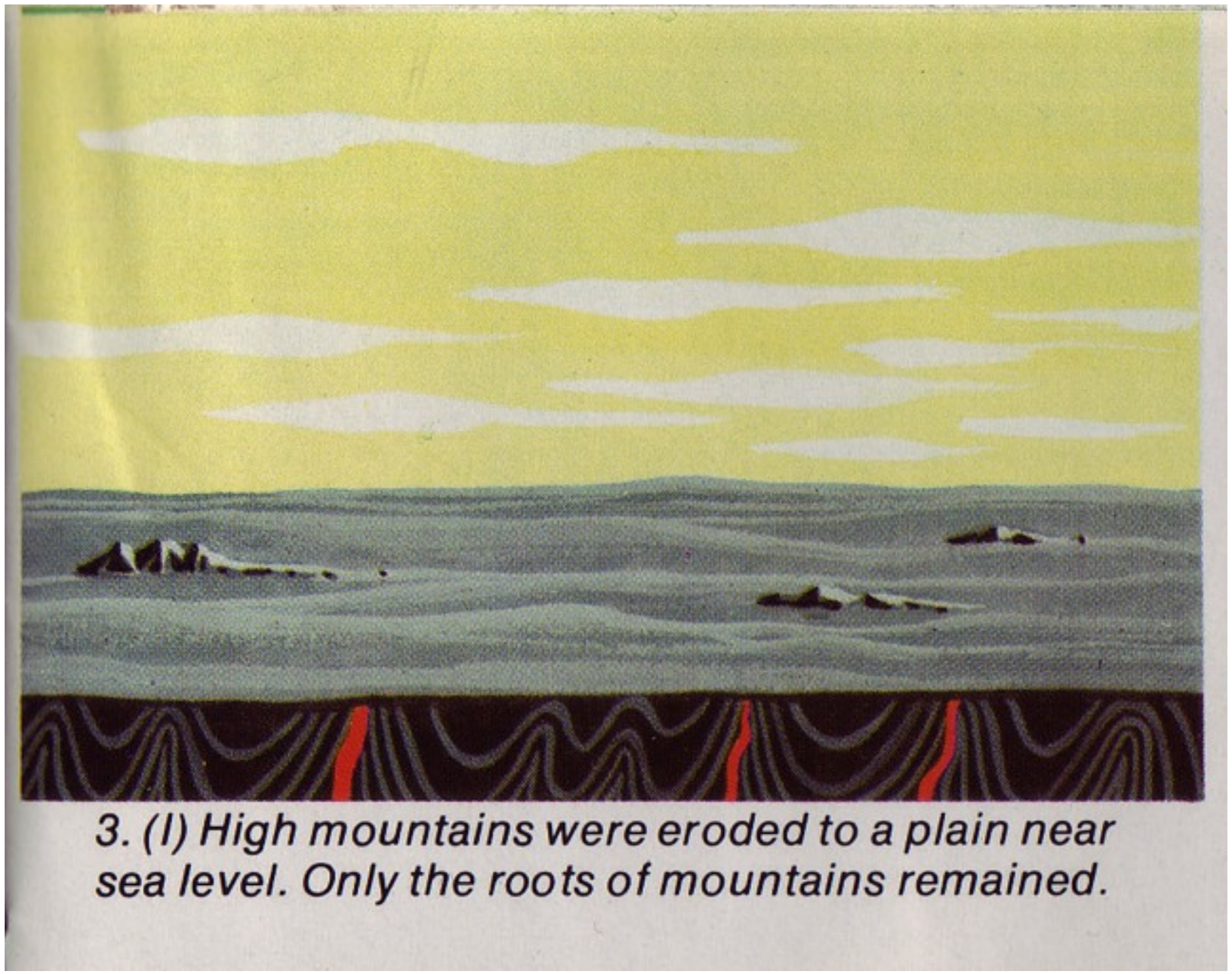
Garnets suggest depth of >10 km

~1.6 Billion years ago Vishnu schist is intruded by Zoroaster Granite

2. (I) Rock layers were folded and meta-morphosed as a mountain range formed. Molten material invaded from below.

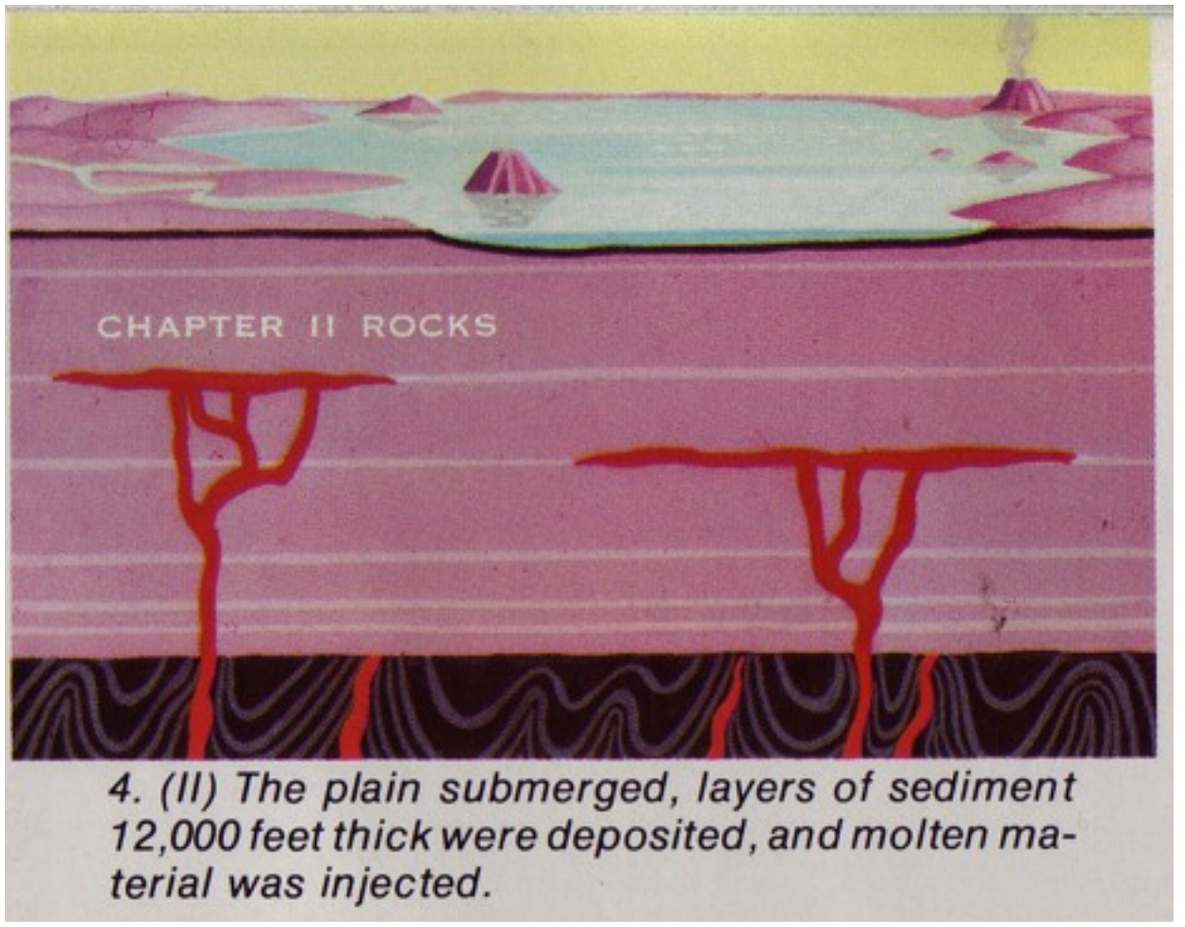
Activation of subduction to the west

<1.6 Billion years ago Mountains are washed away exposing Vishnu metamorphic Mt. core



3. (I) High mountains were eroded to a plain near sea level. Only the roots of mountains remained.

1200-800 Million years ago greater than 3km of shallow marine and volcanic rocks are laid down

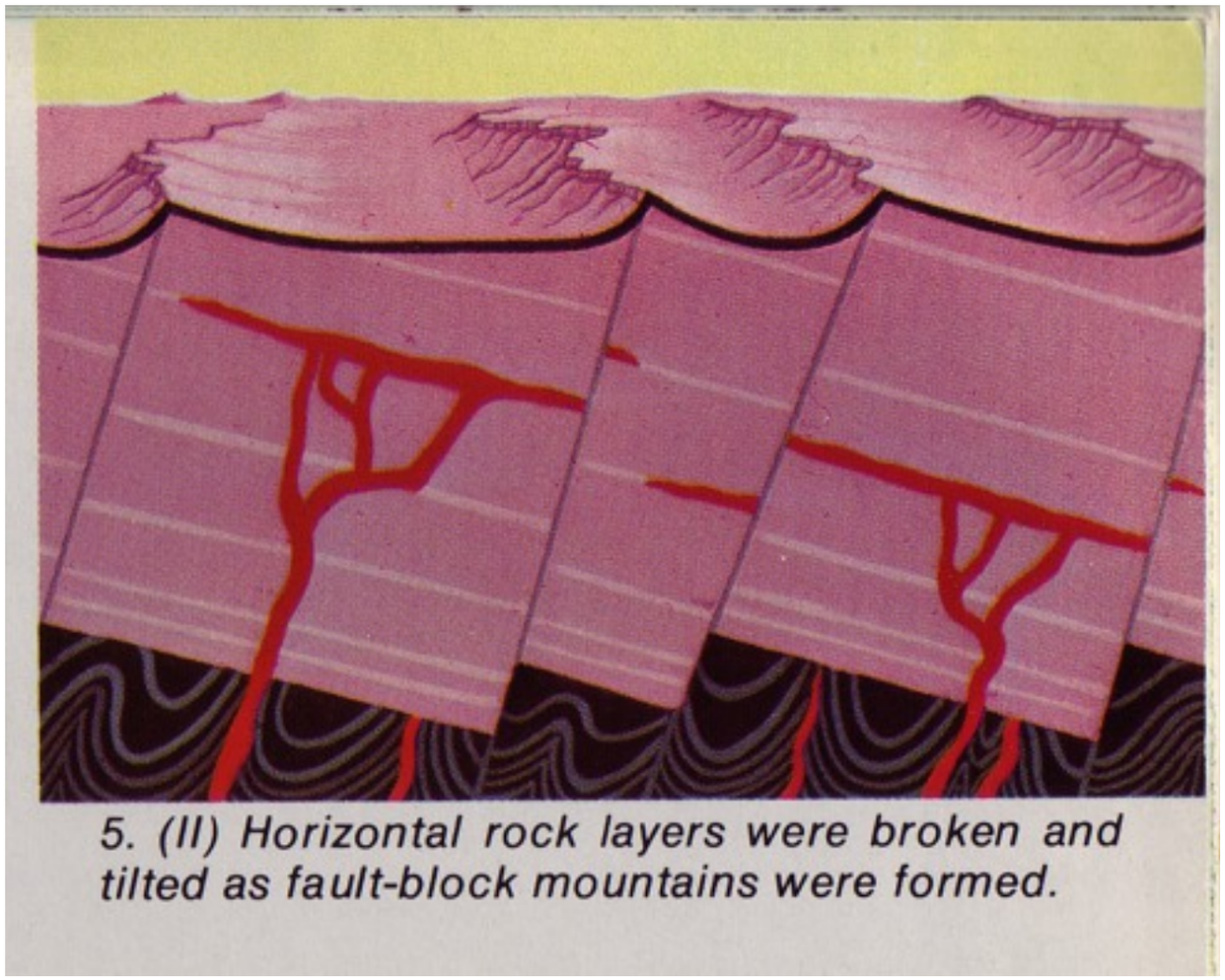


4. (II) The plain submerged, layers of sediment 12,000 feet thick were deposited, and molten material was injected.

Grand Canyon Supergroup

<800 Million years ago North America and the Grand Canyon Supergroup experiences continental extension

Basin and Range Province
Nevada and Utah

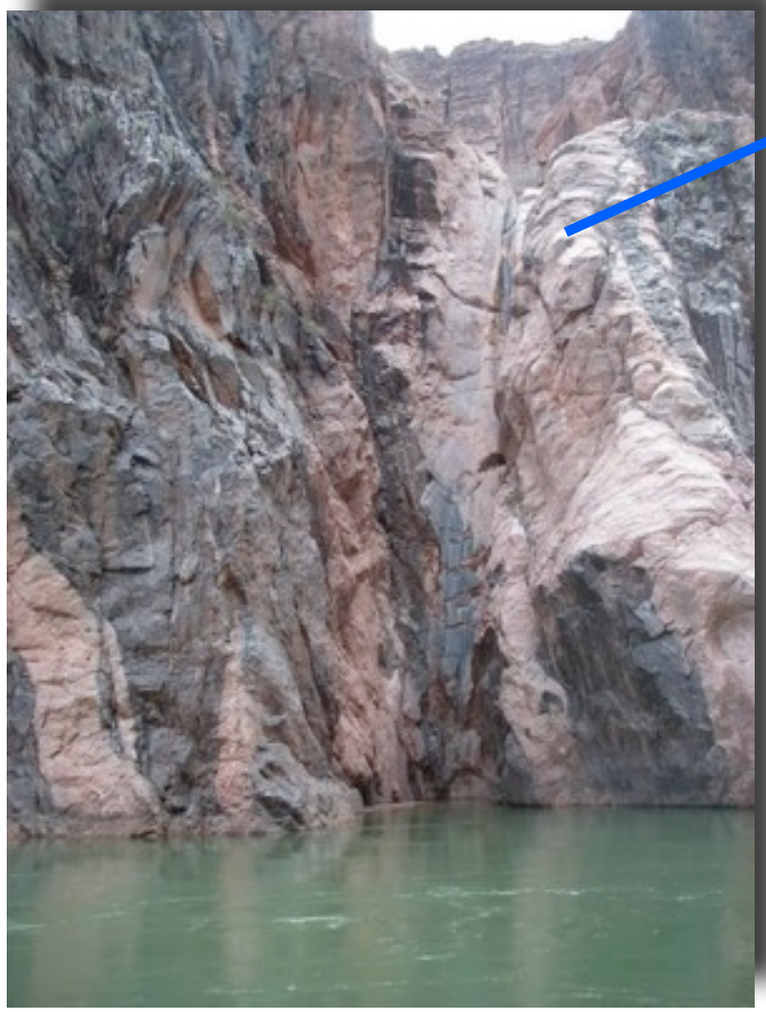


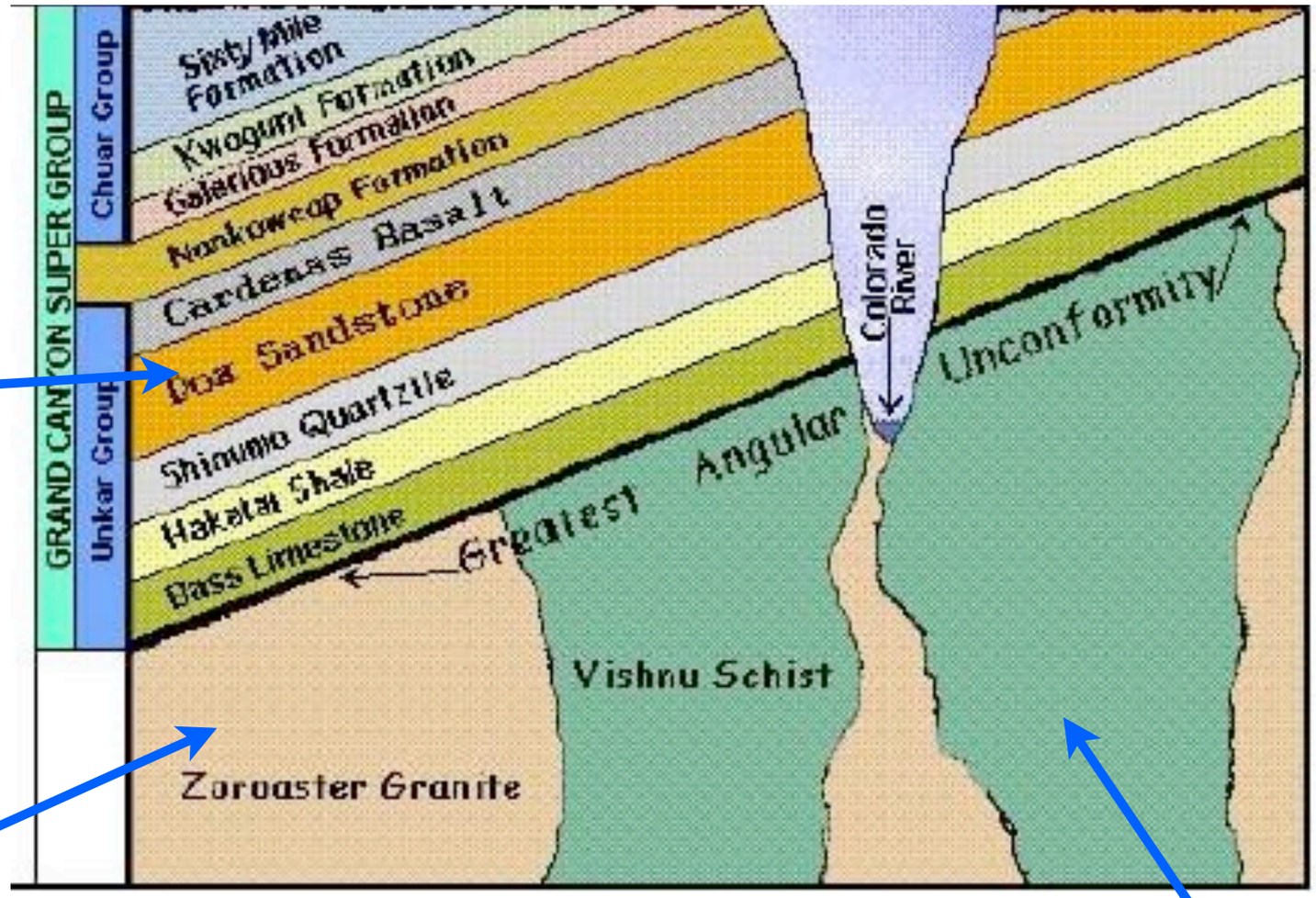
5. (II) Horizontal rock layers were broken and tilted as fault-block mountains were formed.

Supergroup rocks tilted during extensional deformation

<800- 550 Much of the Grand Canyon Supergroup is washed to the sea. Only a few erosional remnants are preserved to tell their story!

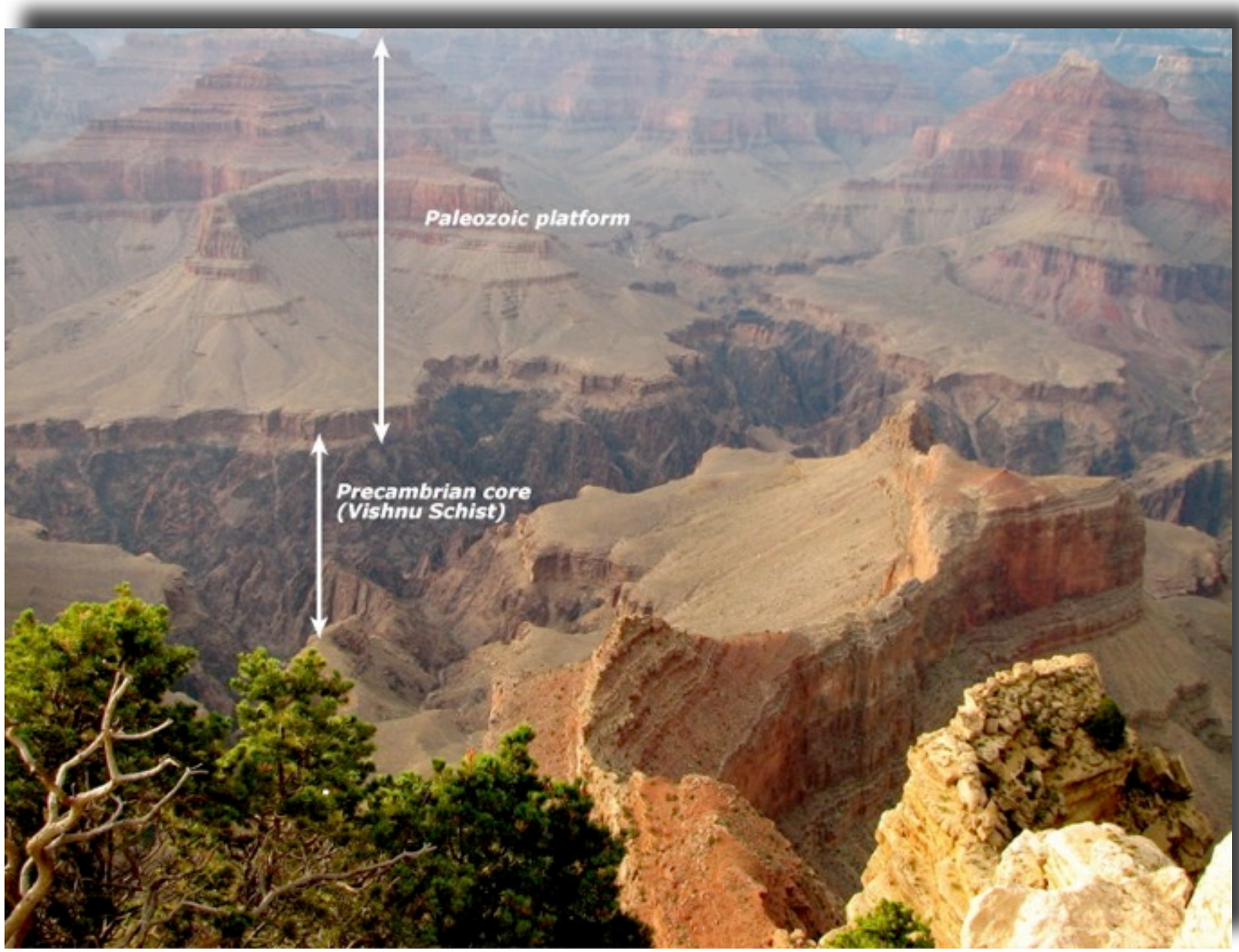
6. (II) The mountains were eroded to a plain. Only wedge-shaped remnants forming ridges were left.



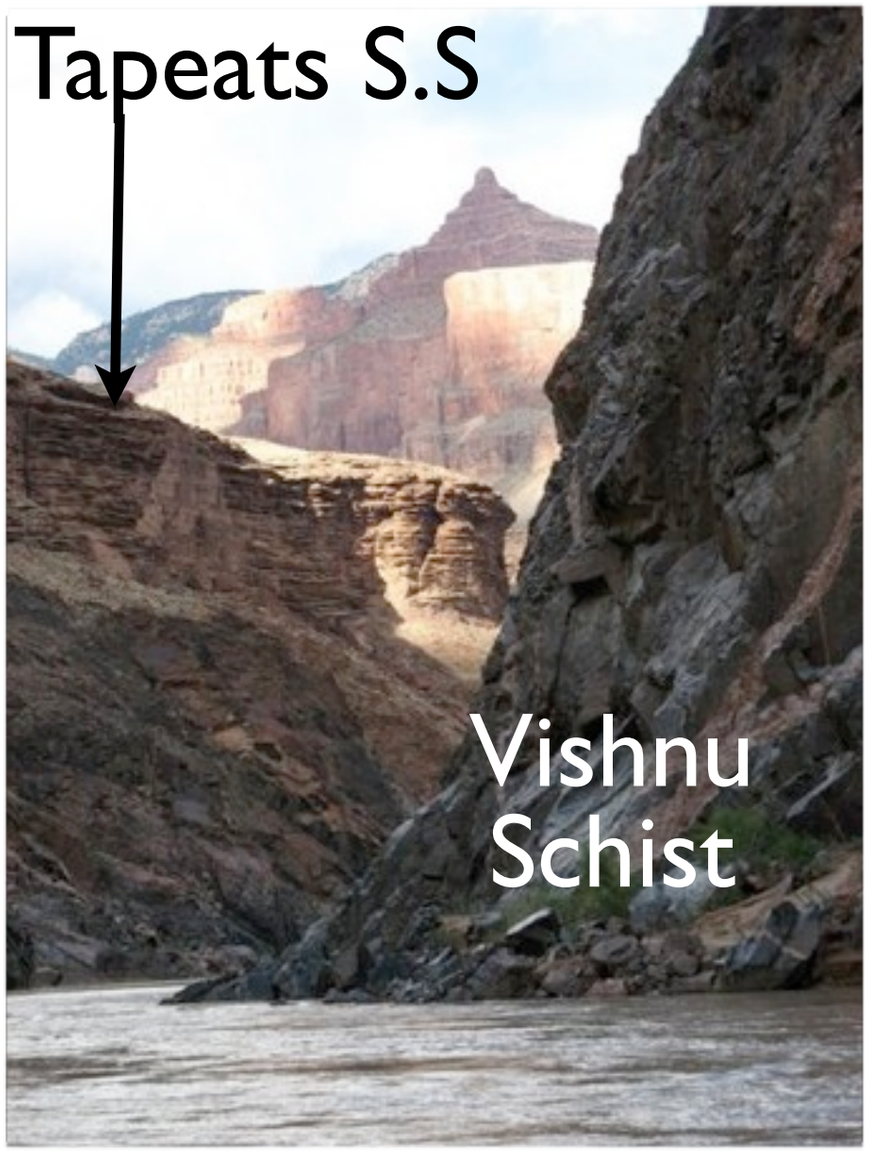


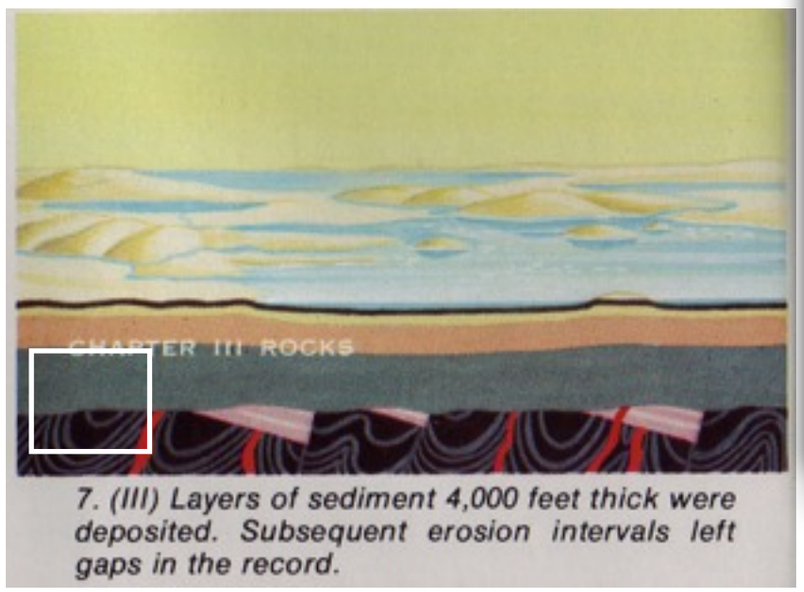
Proterozoic Stratigraphic Column

The nonconformity between these two groups of rocks represents a loss of 1.5 Billion years of geologic time



Beginning approximately 550 Million years ago shallow sea covers North America beginning with deposition of the Cambrian Tapeats Sandstone



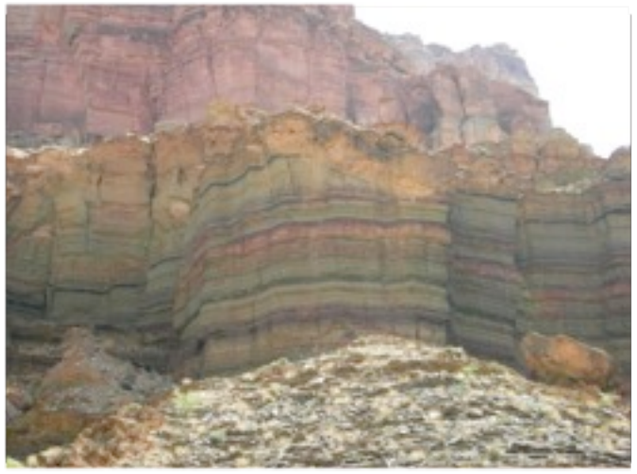


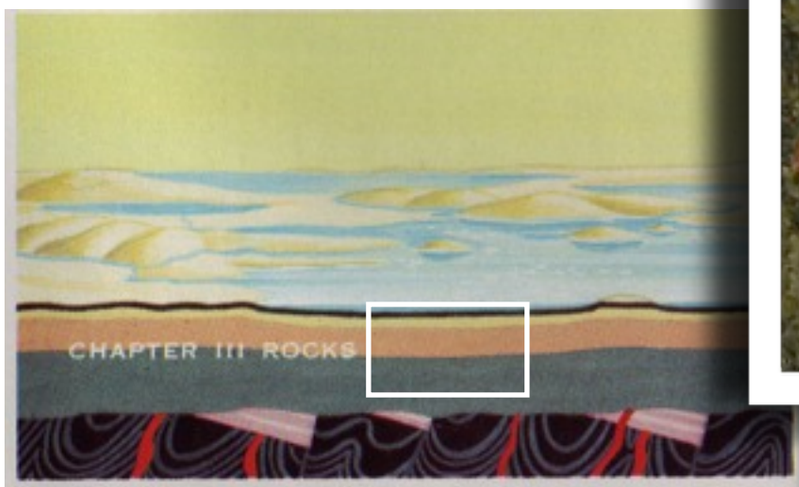
7. (III) Layers of sediment 4,000 feet thick were deposited. Subsequent erosion intervals left gaps in the record.

20

What is relative sea level doing?

~520-500 Million years ago Bright Angel Shale and Muav Limestone accumulate (abundant sea life)





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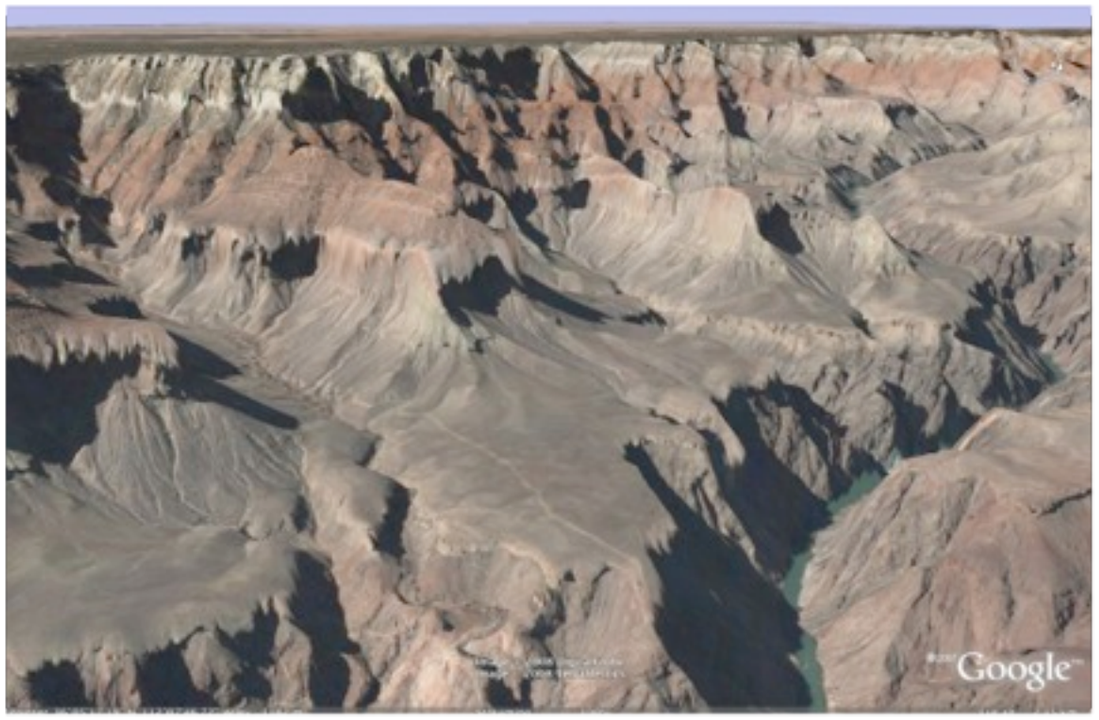

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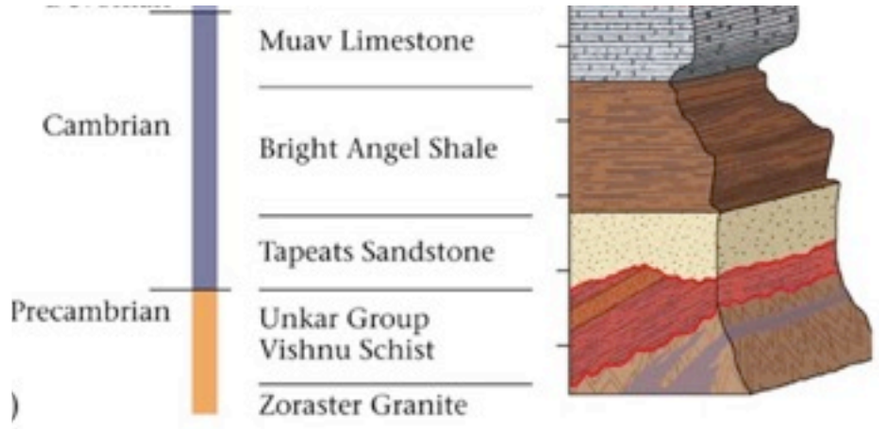
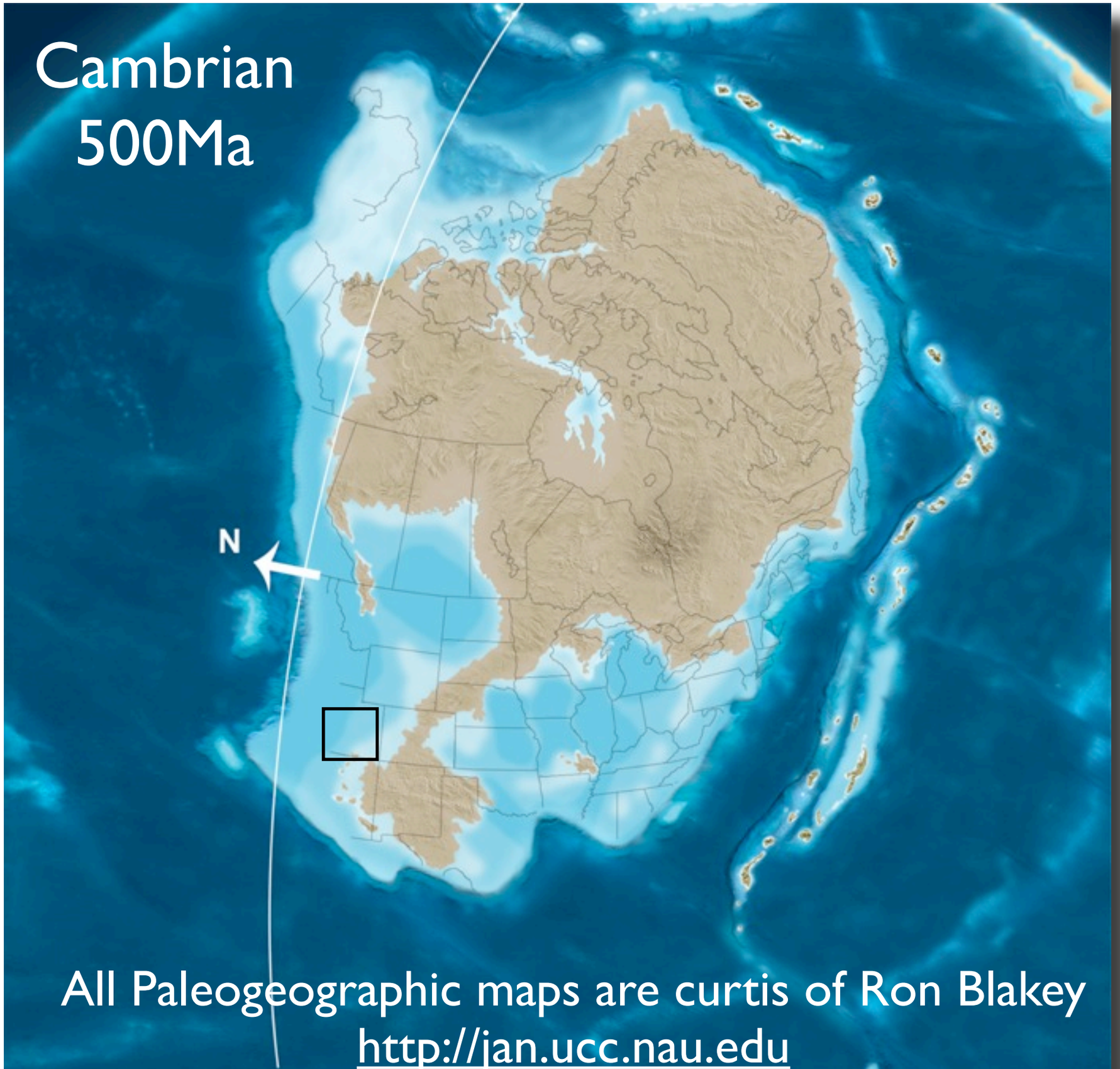
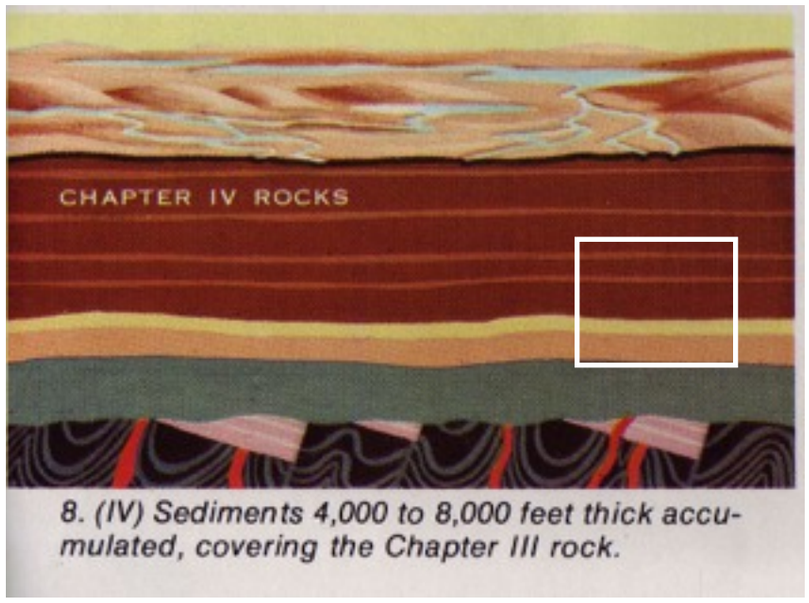


Paleogeography of NAM

Passive Margin Sedimentation



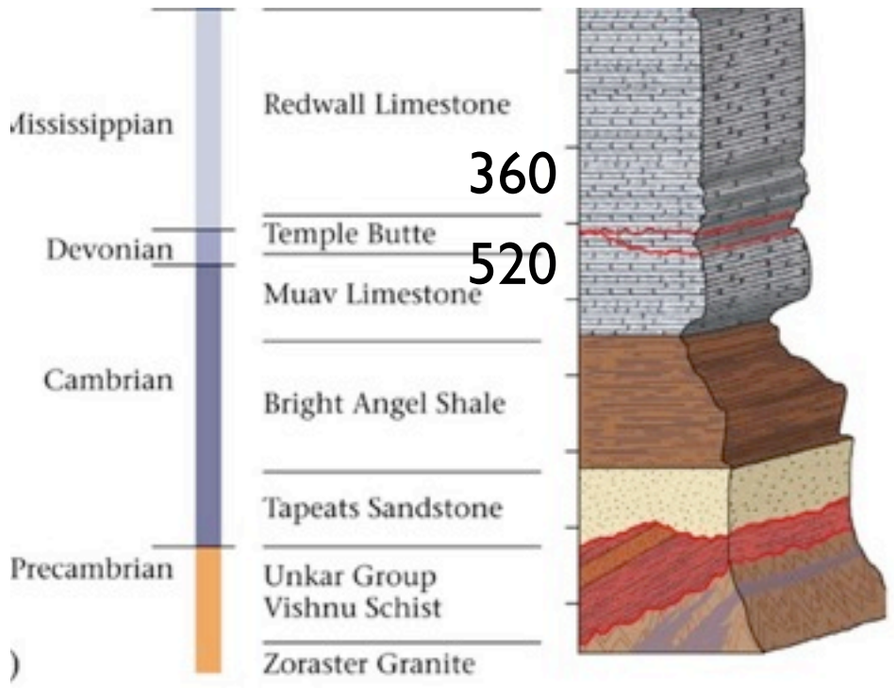
~355 Million years ago deposition of the Redwall Limestone



8. (IV) Sediments 4,000 to 8,000 feet thick accumulated, covering the Chapter III rock.

What happened between 500 and 355 Ma?

What did relative sea level do?



Paleogeography of NAM

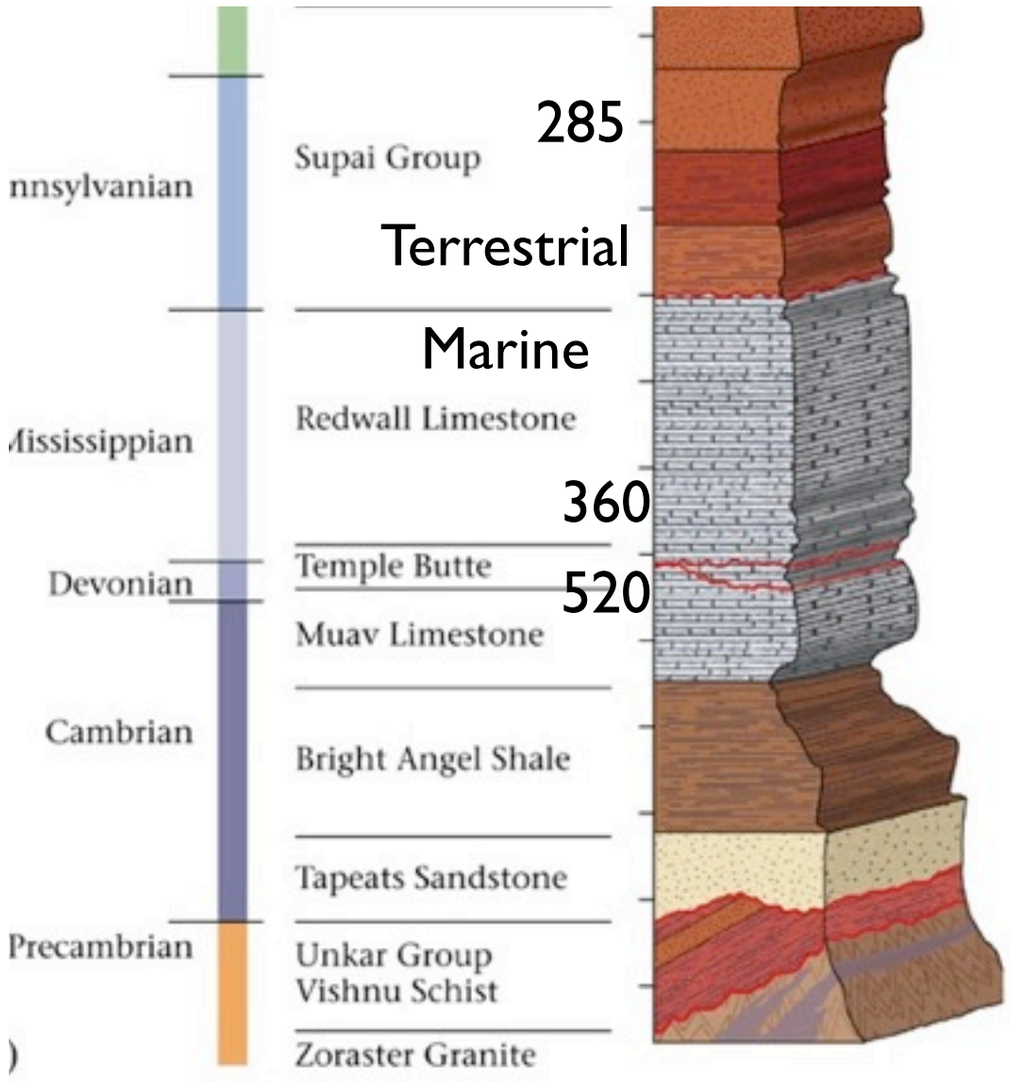
Uplift and erosion as island arc approaches the trench

Paleogeography of NAM

Relaxation and subsidence following accretion of the arc to NAM. Deposition of the Redwall limestone in shallow continental sea

~320 Million years ago Deposition of the Supai Group. Swampy terrestrial Rocks

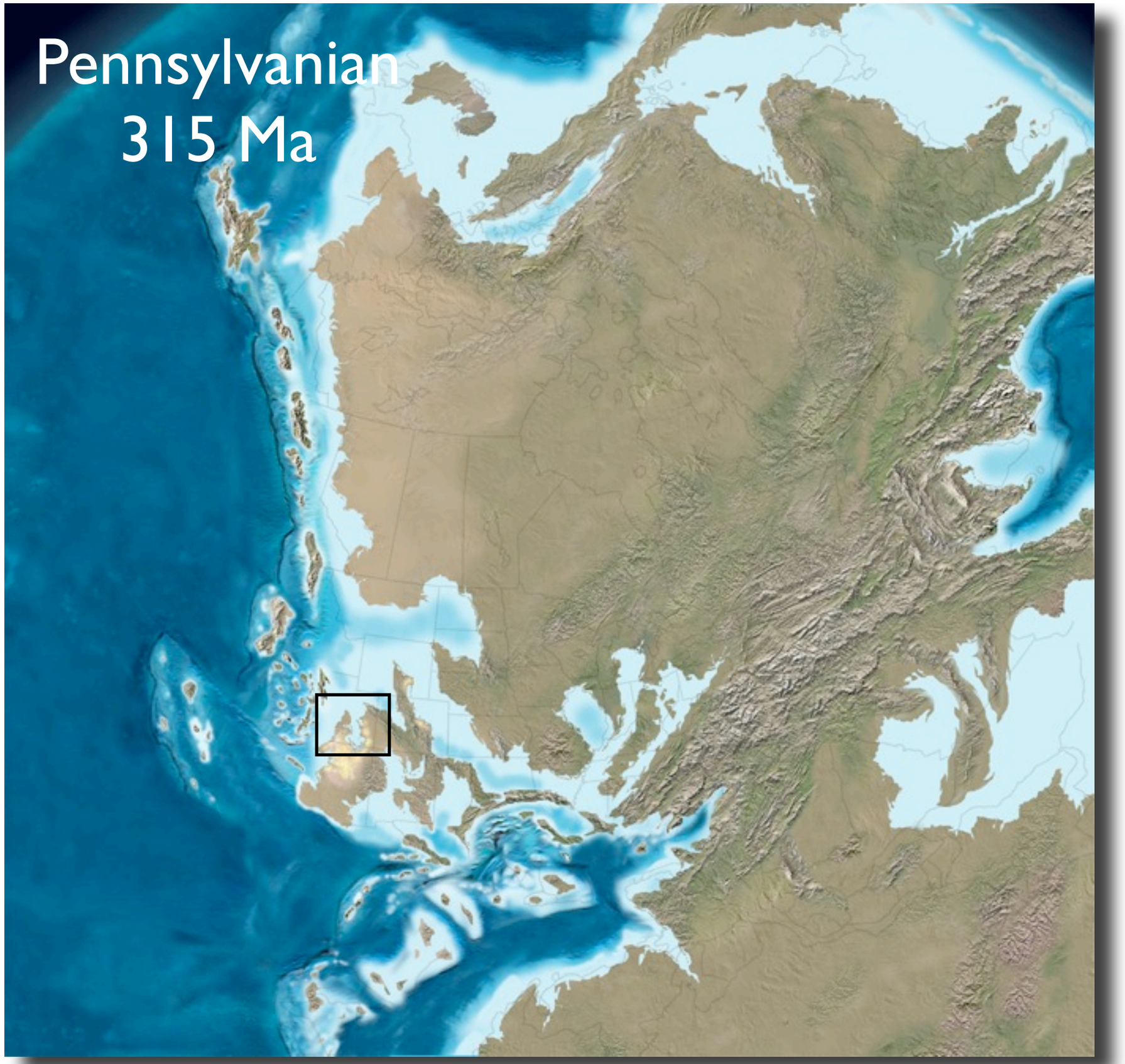
Redwall limestone cliff former



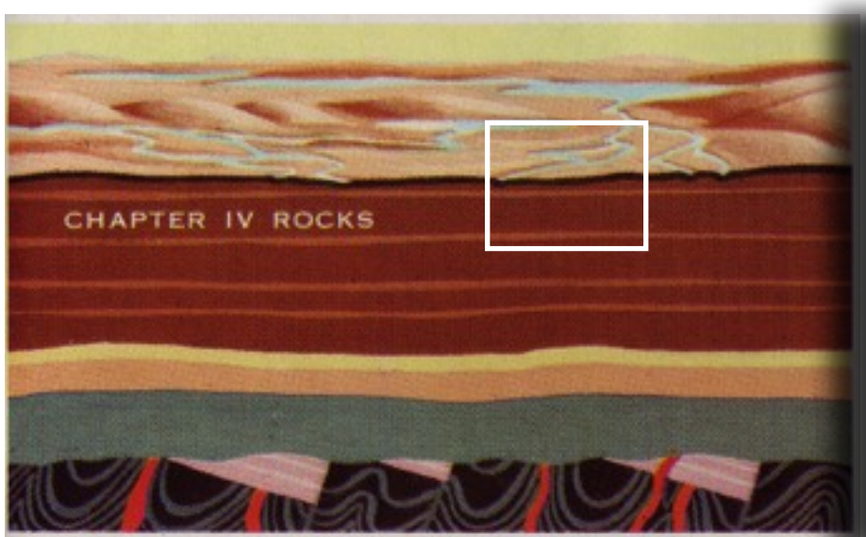
What did relative sea level do?

Paleogeography of NAM

Shallow Swamp in interior sea way. Supai Group



~290 Million years ago Deposition of the Hermit shale by terrestrial streams streams Group.



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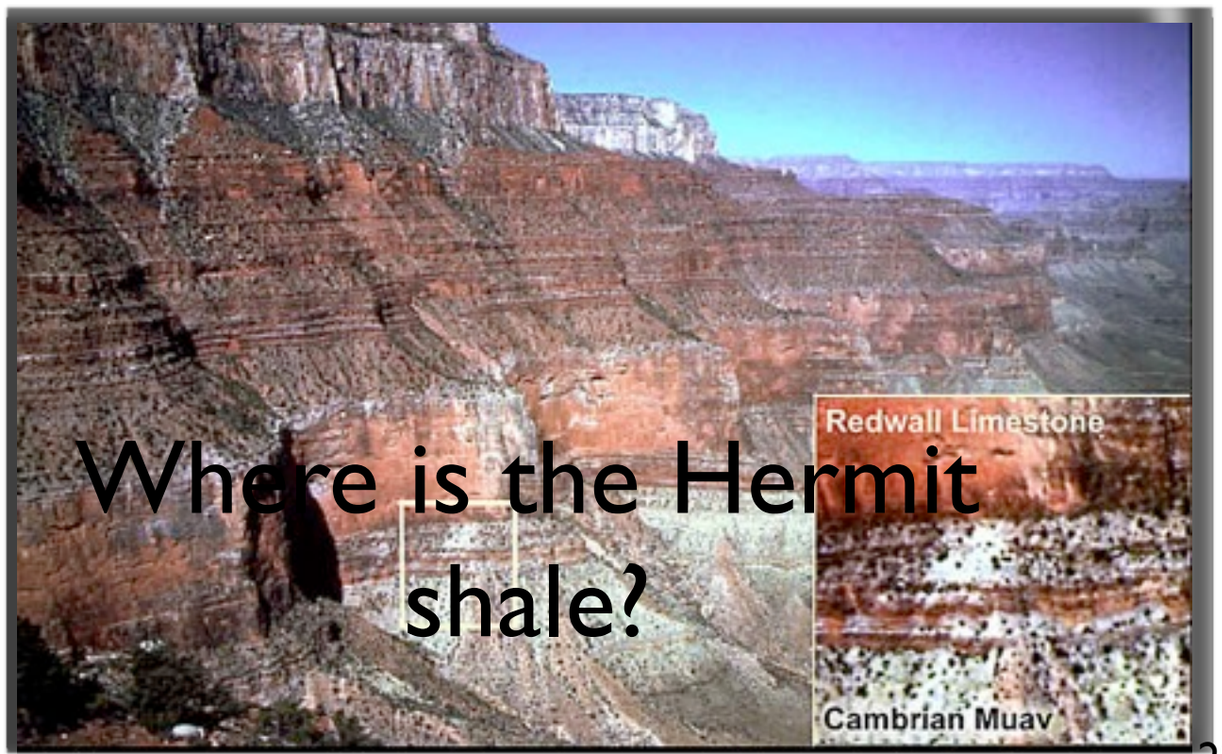
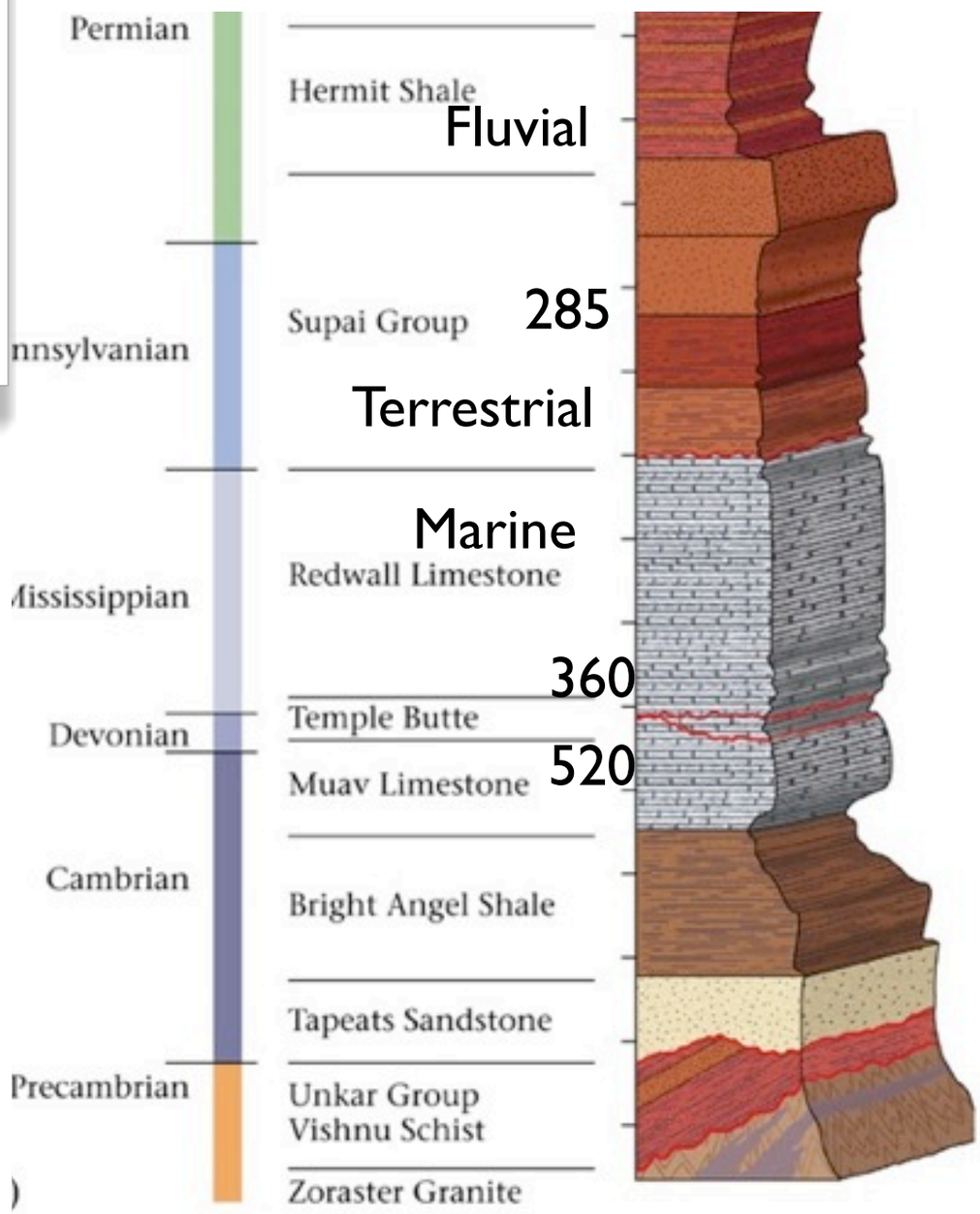


Where is the Hermit shale?

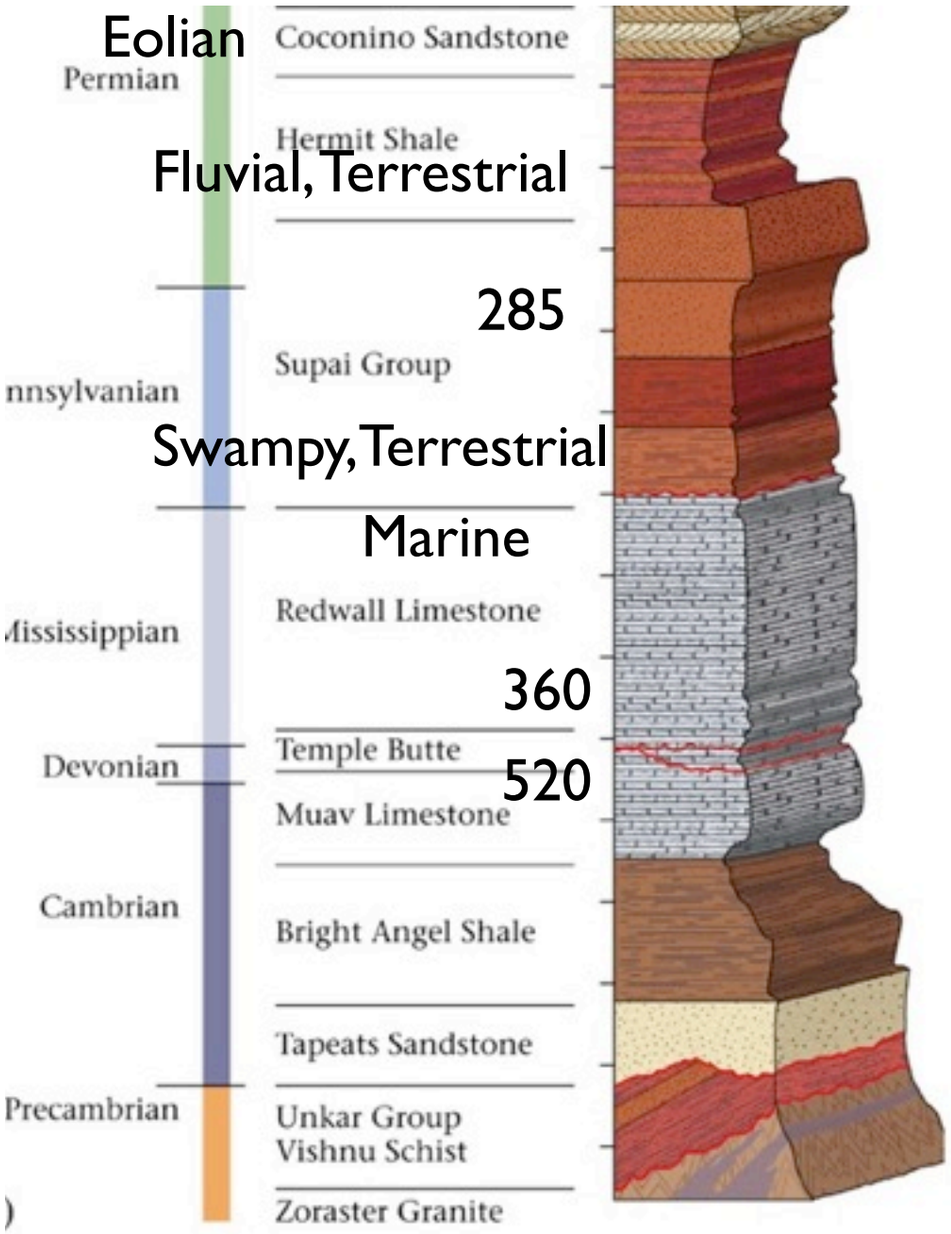
28



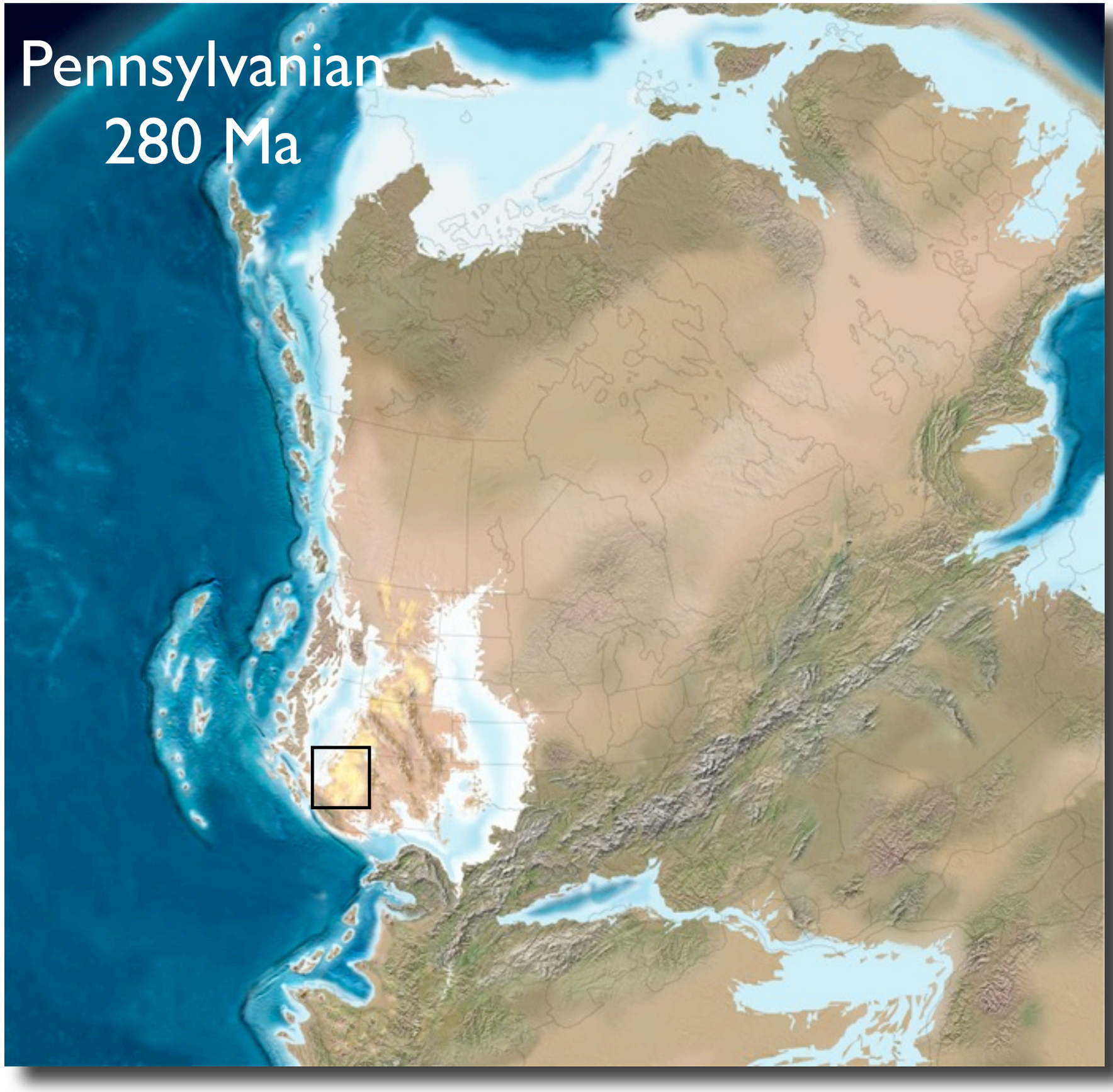
~280 Million Years ago the Coconino Sandstone covers the Hermit shale by eolian sand

Eolian, Terrestrial

Where is the Coconino sandstone?

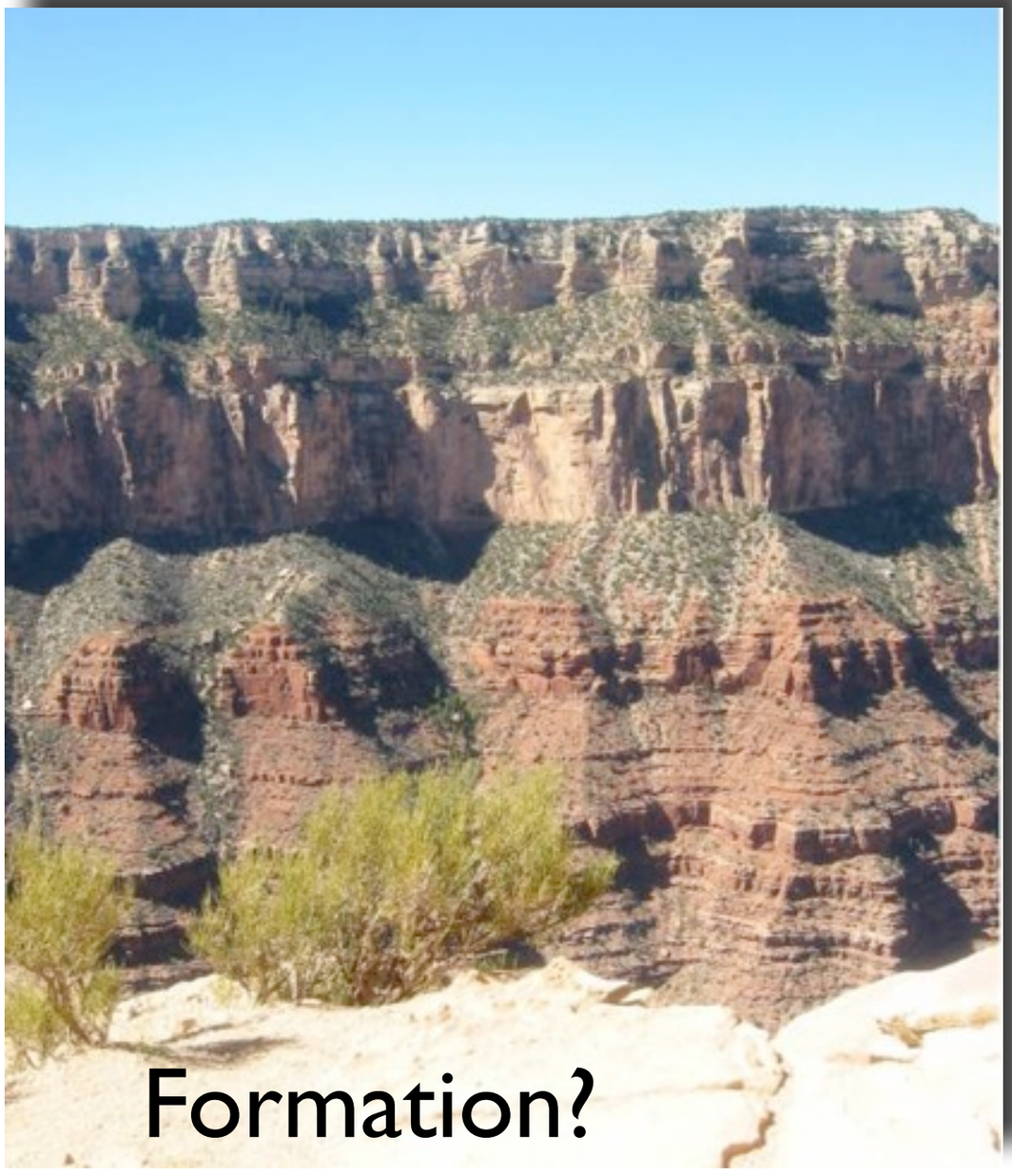


Paleogeography of NAM



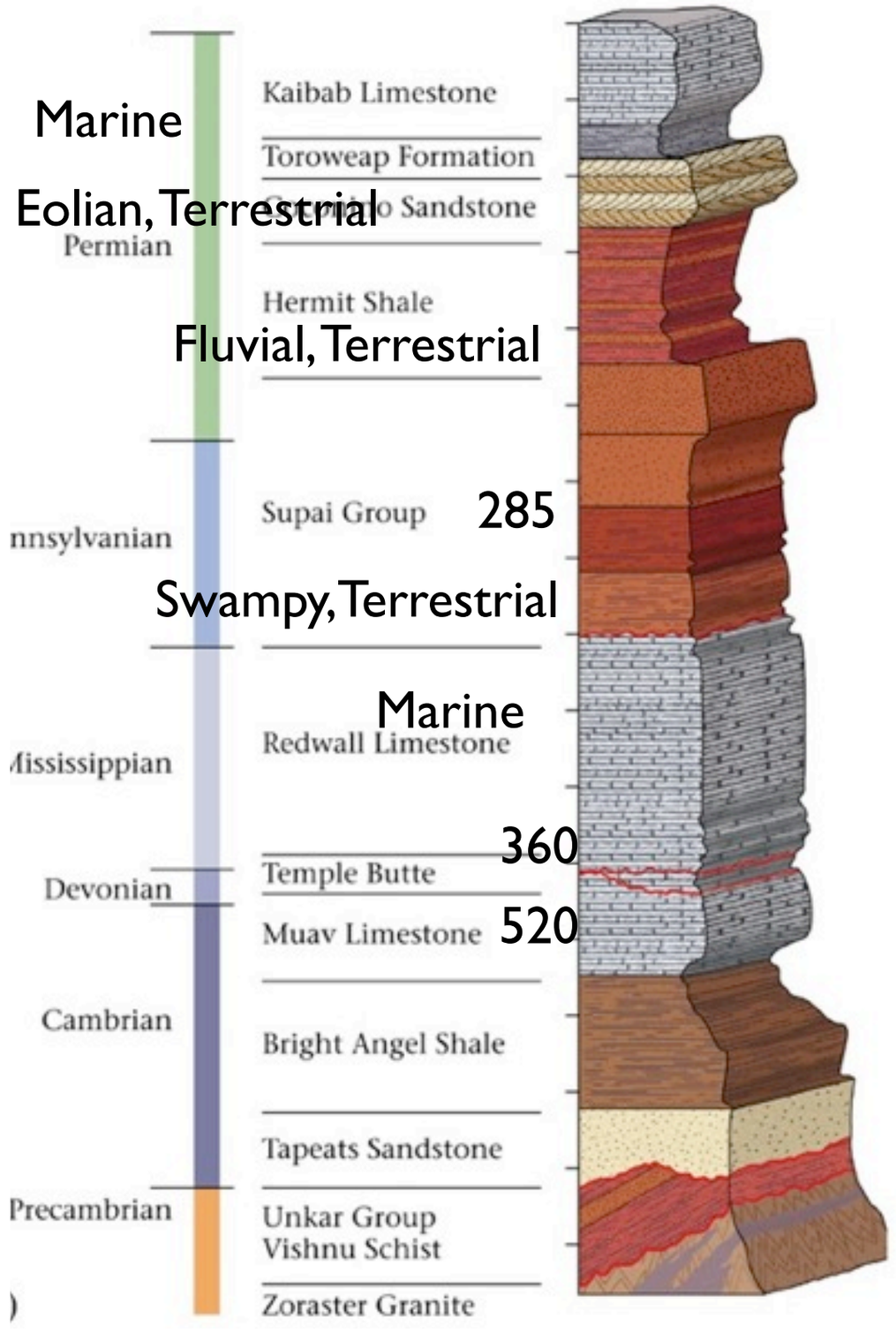
Shallow seaway and continental erg. Deposition of Sand dunes of Coconino

~260 Million Years ago deposition of the Toroweap limestones and shale, and Kaibab limestone

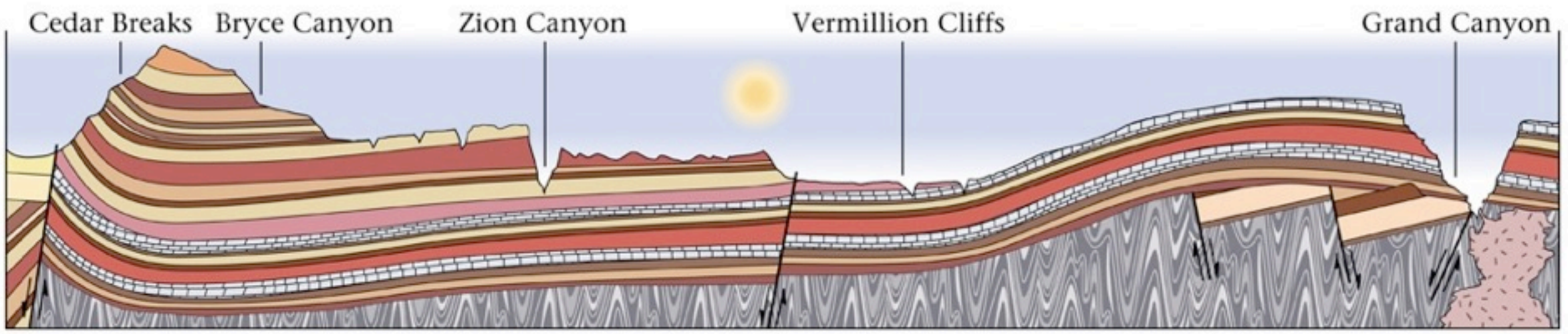


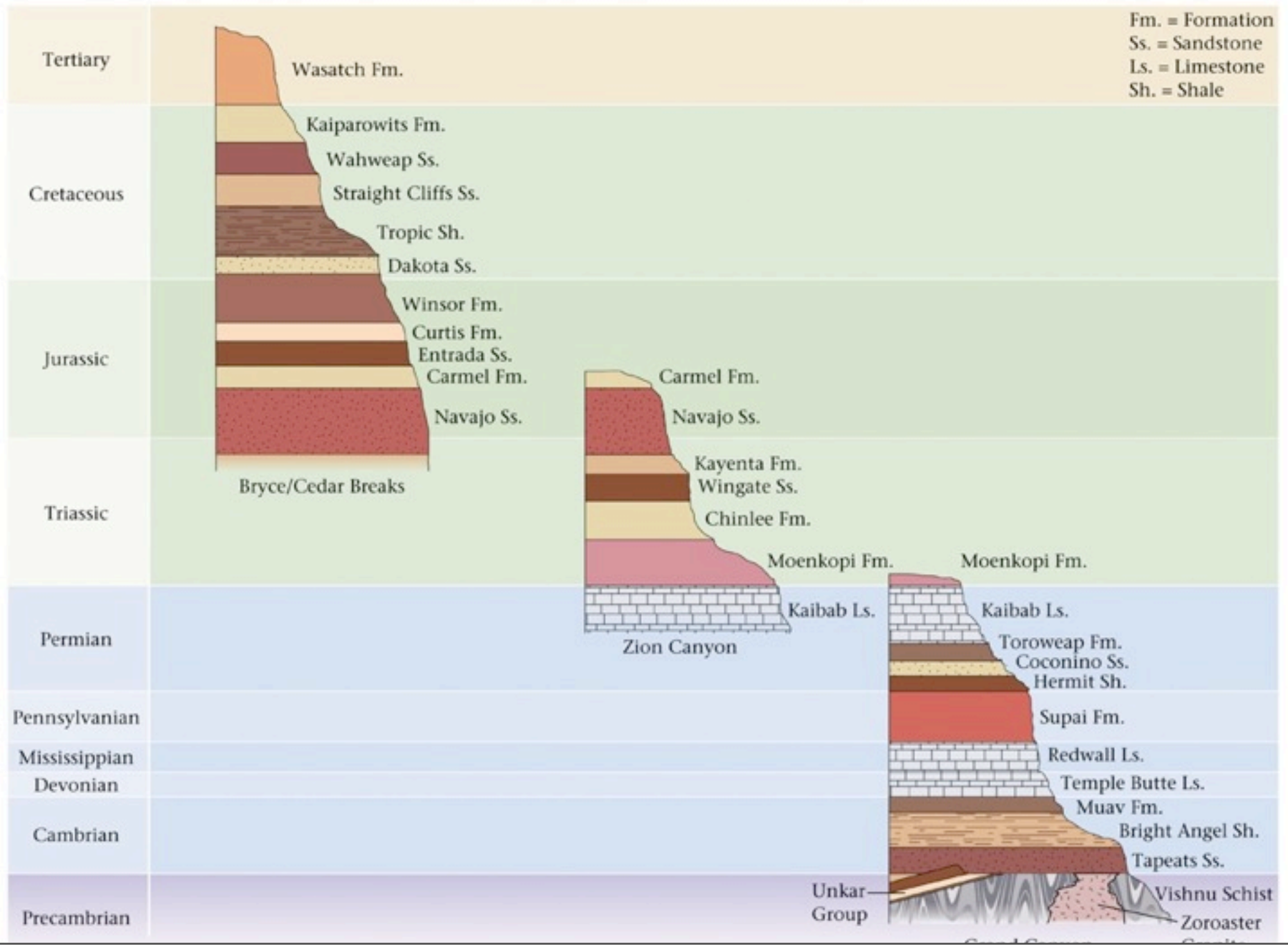
Formation?

What did relative sea level do?



Paleogeography of NAM


Cedar Breaks
Bryce Canyon
Zion Canyon
Vermillion Cliffs
Grand Canyon


Tertiary
Cretaceous
Jurassic
Triassic
Permian
Pennsylvanian
Mississippian
Devonian
Cambrian
Precambrian
Wasatch Fm.
Kaiparowits Fm.
Wahweap Ss.
Straight Cliffs Ss.
Tropic Sh.
Dakota Ss.
Winsor Fm.
Curtis Fm.
Entrada Ss.
Carmel Fm.
Navajo Ss.
Bryce/Cedar Breaks
Carmel Fm.
Navajo Ss.
Kayenta Fm.
Wingate Ss.
Chinlee Fm.
Moenkopi Fm.
Kaibab Ls.
Zion Canyon
Moenkopi Fm.
Kaibab Ls.
Toroweap Fm.
Coconino Ss.
Hermit Sh.
Supai Fm.
Redwall Ls.
Temple Butte Ls.
Muav Fm.
Bright Angel Sh.
Tapeats Ss.
Unkar Group
Vishnu Schist
Zoroaster
Fm. = Formation
Ss. = Sandstone
Ls. = Limestone
Sh. = Shale
0
30
km

In the past 50 Million Years 4000-8000 ft of Mesozoic strata are removed. In the past 5 million years (?) the canyon has been cut

100 ka local basaltic volcanism erupts on the rim, locally and damning the Colorado River

Lava Falls

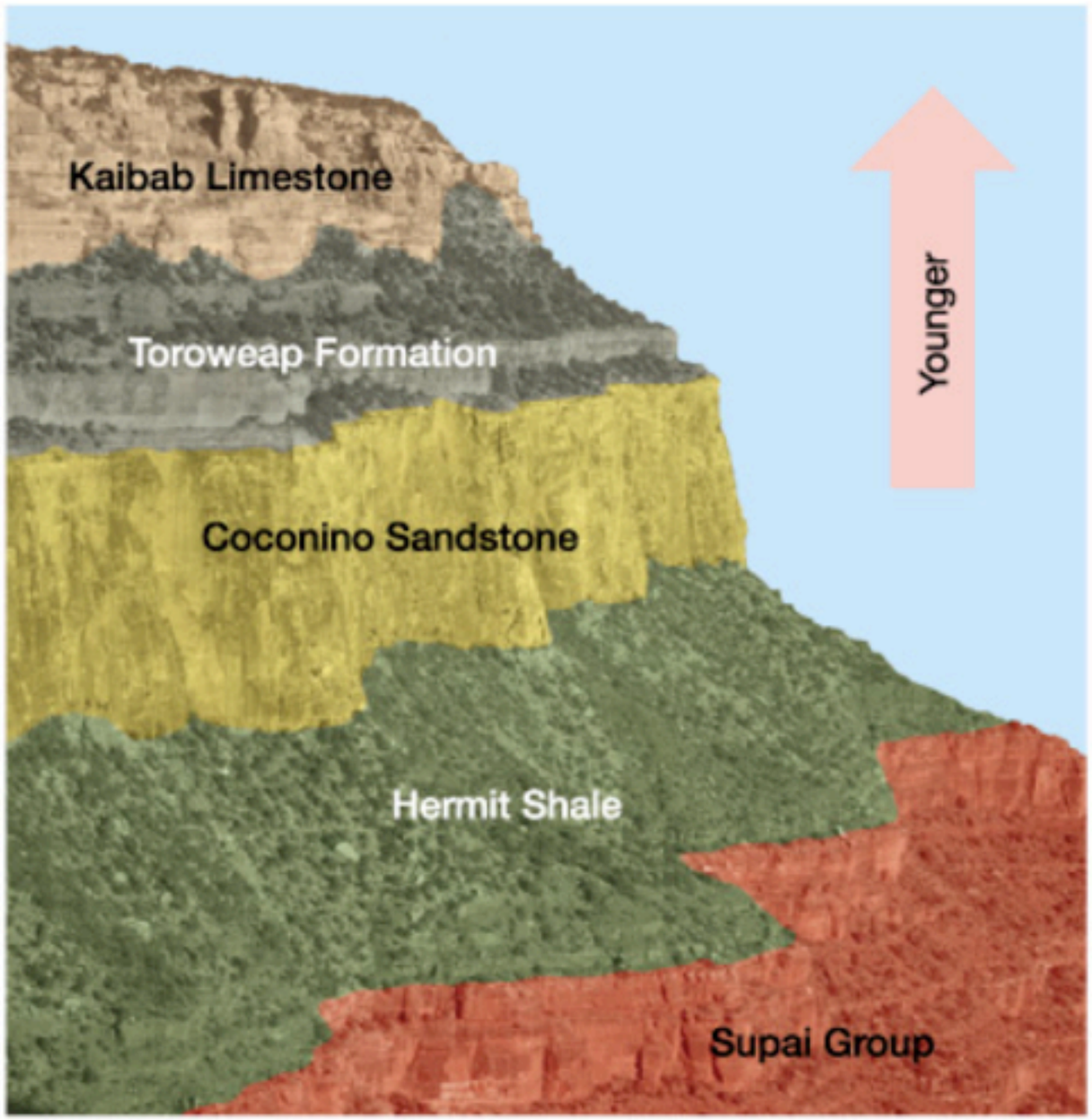
Differential Erosion

A.

B.

Differential Erosion

A.



B.

Know **T**he **C**anyon's **H**istory **S**tudy **R**ock **M**ade **B**y **T**ime

Know **T**he **C**anyon's **H**istory **S**tudy **R**ock **M**ade **B**y **T**ime

Top

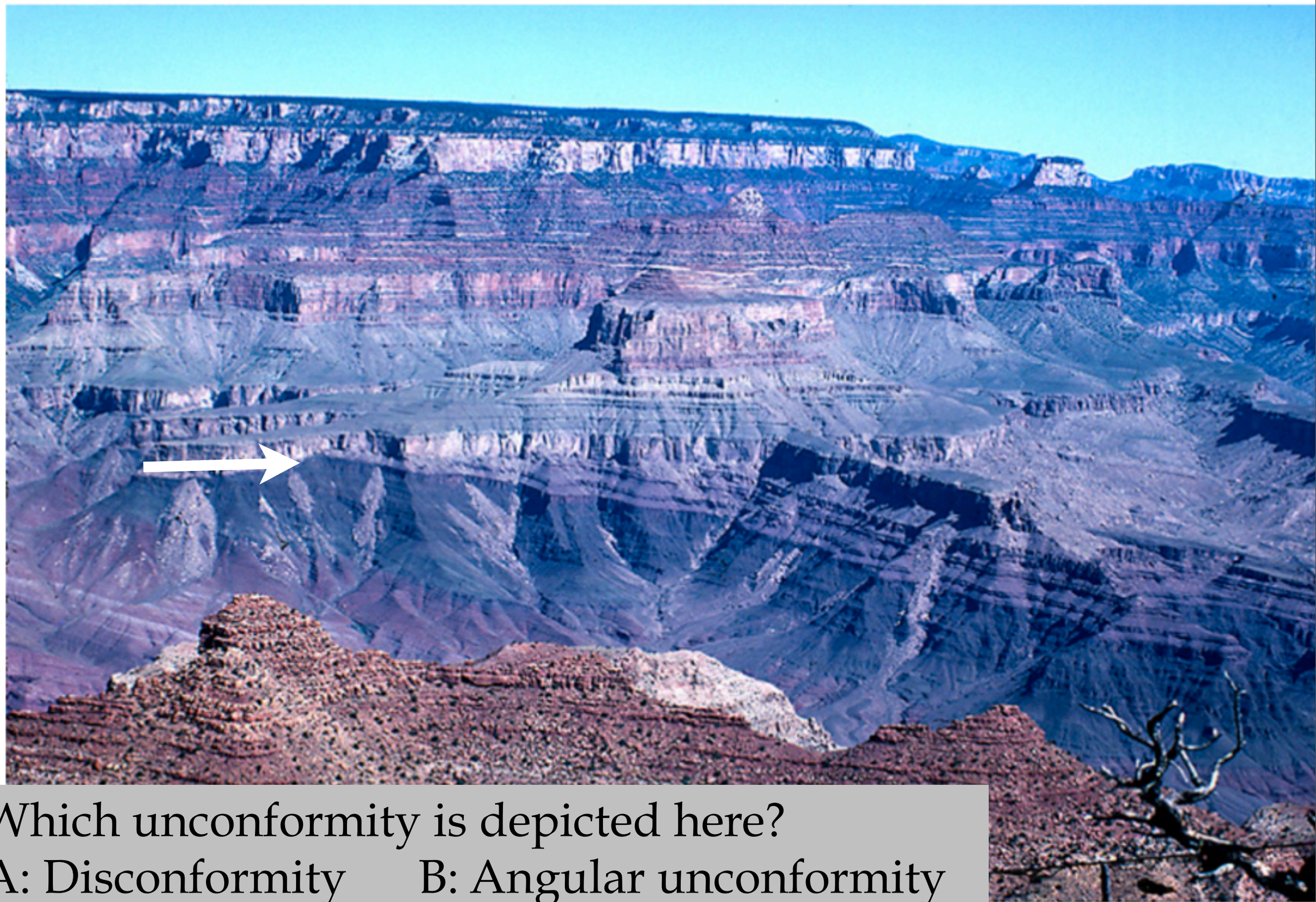
Kaibab Limestone
Toroweap Sandy Shale
Coconino Sandstone
Hermit Shale
Supai Group (Sandstone and Shale)
Redwall Limestone
Muav Limestone
Bright Angel Shale
Tapeats Sandstone

Bottom of Cambrian Section

Vishnu Schist

Differential Erosion

Differential Erosion



Which unconformity is depicted here?

A: Disconformity B: Angular unconformity

C: Nonconformity

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Vishnu Schist

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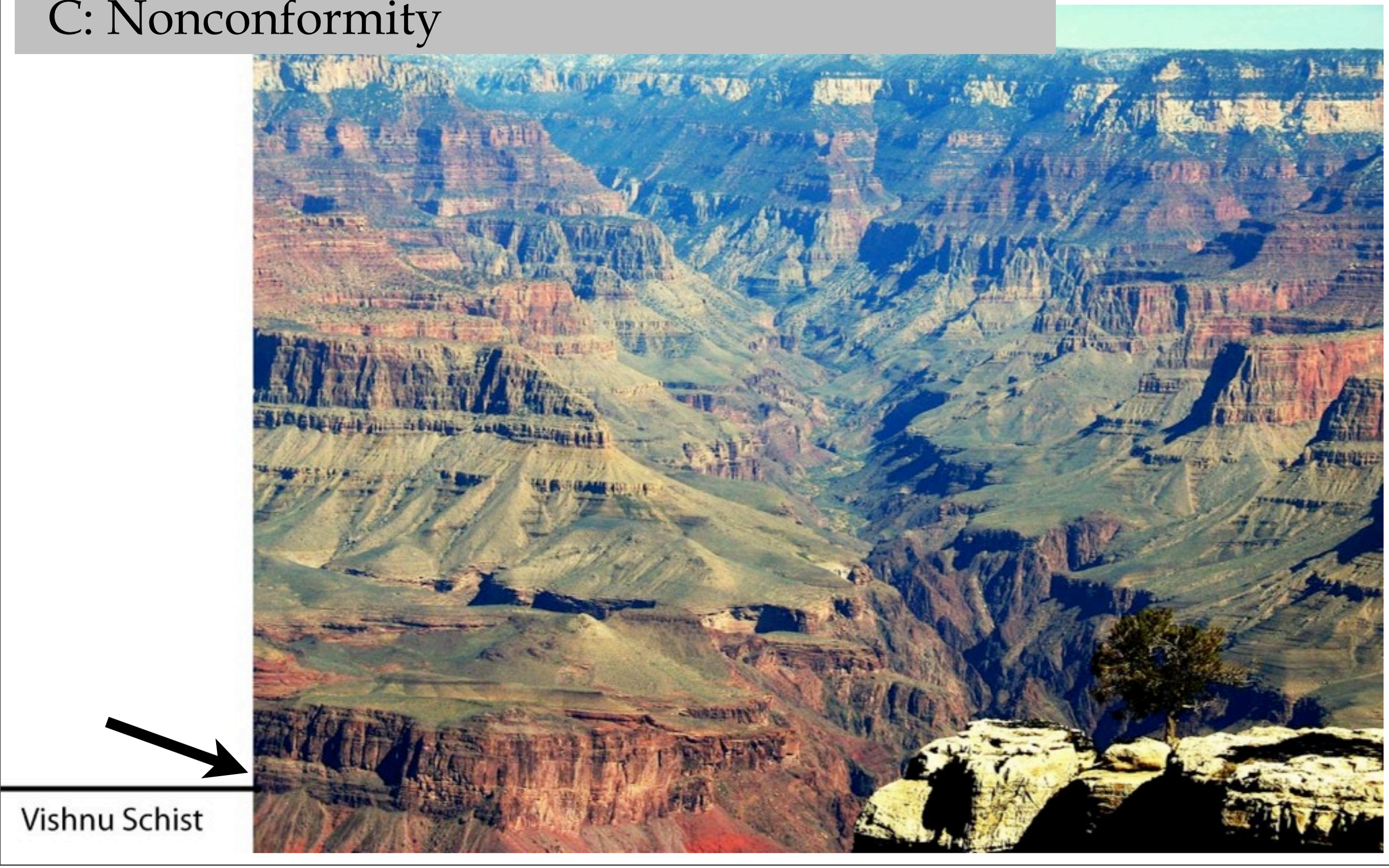


The photograph below shows a section of the Grand Canyon stratigraphy discussed last week. How many distinct compositional layers (e.g., sandstone, limestone, shale, conglomerate) of sedimentary rock overlie the prominent cliff that composes most of this photograph?

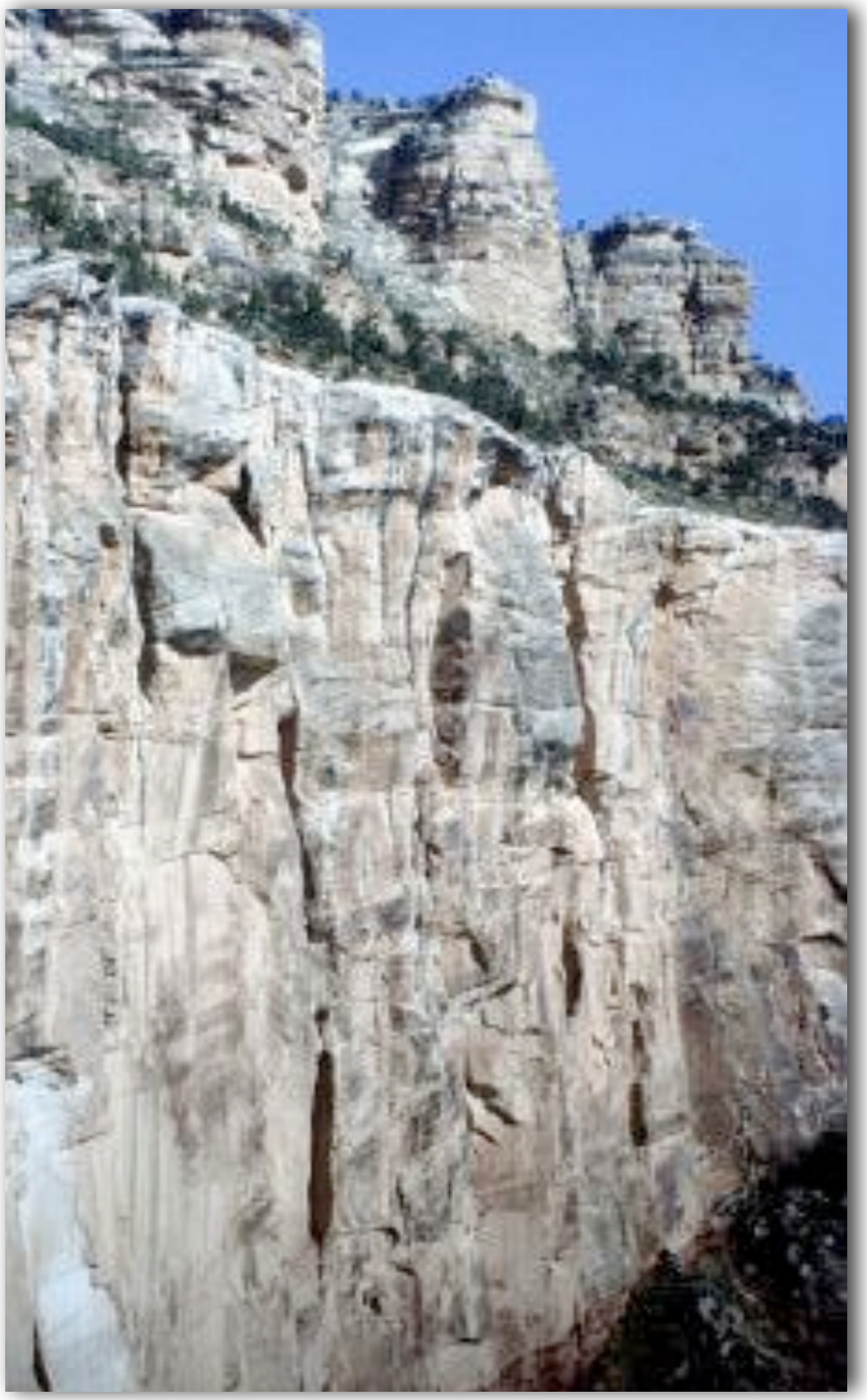
(A) 1

(B) 2

(C) 3

(D) 4

(E) Can't be determined from this photograph



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(B) 2

(C) 3

(D) 4

(E) Can't be determined from this photograph

This photograph shows the upper three sedimentary formations of the Grand Canyon. Which of the following is <u>not true</u>.

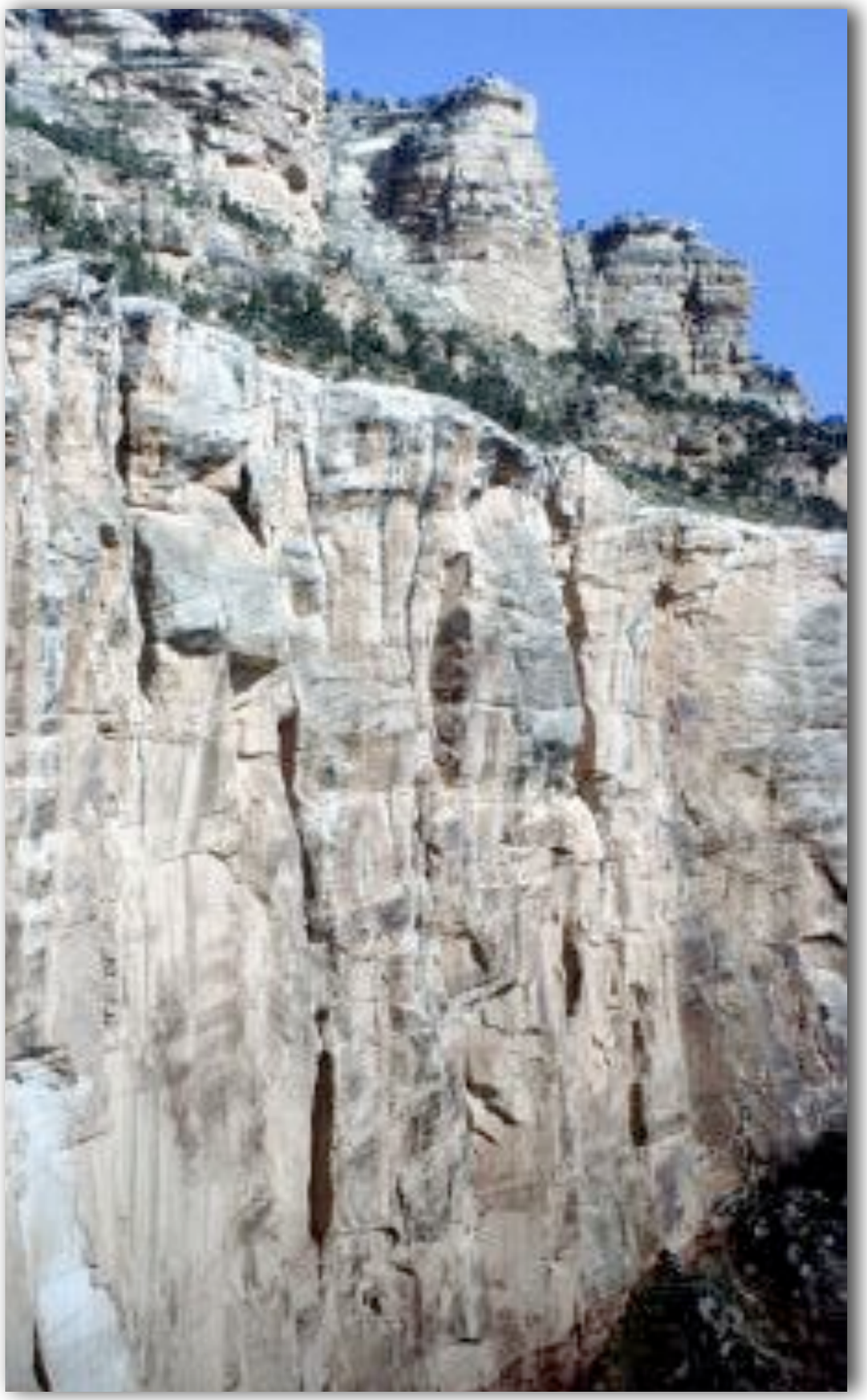
(A)The lower prominent cliff at the base is likely composed of Sandstone or limestone.

(B)The middle formation is likely composed of Sandstone or limestone.

(C) The upper formation is likely composed of Sandstone or limestone.

(D) Both A and B

(E) Both B and C



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