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https://www.westernriver.com/grand-canyon-vacation/map

This exercise will guide you in a virtual tour of the Grand Canyon as shot by the Geoscience Dept. of Arizona State University. It was shot using a 360 degree camera, so you can navigate in a full circle using your mouse, also up and down. We will only be exploring a fraction of what is available. Feel free to do more exploring on your own, especially if you have never had the privilege of exploring the real thing. The trip will be explored in the reverse order from that followed by the actual participants.

Go to: http://vft.asu.edu/

Choose the Grand Canyon Icon at the bottom of the screen.

Click the *Explore this VFT* button.

Navigate to the *UnGuided Exploration* and click *Explore this VFTi.*

Click the *camera icon* by the words "Canyon Walls". Click on the Video Icon to activate the following short video links and use the information you learn to answer the associated questions.

Rock Layers

1. Which general principle of geology does Dr. Semken describe:
   _____Superposition

Tapeats Sandstone

2. *What are the names of the three formations described?* _____
   Tapeats SS,
   Bright Angel Shale,
   Muav Limestone.
3. *When these rocks were deposited when the ocean was transgressing or regressing?*
   _____ *Transgressing*
4. What does that word in question 3 mean? _____
   Sea level rising, advancing over land

Redwall Limestone

5. During the deposition of Redwall was this area dry land or below sea level? _____
   below sea level

Supai Group

6. The Supai group was deposited in a location between what two types of environments?
   _____ ***land and sea***

Hermit Formation

7. What is rock type (specifically, not metamorphic, igneous or sedimentary)? _____ shale
8. Why does the Hermit Formation form slopes? _____ because it is soft

Coconino Sandstone

9. The Coconino Sandstone was deposited in what type of environment? _____
   Desert

Toroweap

10. The Toroweap was deposited in a setting that was transitioning from _____Dry land to __marine_____
11. What is the type of rocks we have been looking at? Sedimentary? Igneous? or Metamorphic?

_____Sedimentary

12. How can you tell? _ layers/stratification or rock names

Click *Media* Tab to close.

There are two *video icons* labelled "On the River" and "360 River Float" to the right of the beach camp on the river. Fun to watch if you like rafting or have never rafted and are curious.

Click on the pulsating green arrow labelled "Mile 60 Rapids". This will take you to an overhanging ledge of rocks and another pulsating green arrow labelled, "Mile 62 Colorado River Confluence". Click on that arrow. Click on the *camera icon* labelled, "confluence", then click on the *video icon* to activate the videos. Watch them and answer the following questions.

13. What does "confluence" mean?

    _____

    Two rivers joining

14. Name the two rivers involved:

    _____ Little Colorado &

    _____ the Colorado

15. Explain the unusual color of one of the rivers, what causes it (be specific)?

CO2 SCATTERS LIGHT CaCO3 coats the bottom making it more reflective, precipitating out of the water

16. There is a flow indicator in the river (looks like a yellow buoy). In what cardinal direction is the river flowing? _____ west

If you swing your view to the right you will see a yellow video icon labelled, "Hydrology and Mineral Deposits". Watch the videos and answer the questions associated with each.

Clasts

17. What is a clast? _____

    Pieces of rock material carried by the river

    Average incision rate

18. What does "incision rate" mean?

    _____

    cutting down

Travertine and the hydrology of the Grand Canyon.

19. What type of sedimentary rock is travertine (organic, clastic, precipitate)? _____

    precipitate

20. Why? __Formed by $CaCO_3$ precipitating out of the water as it degasses CO_2

Click on the green arrow labelled, "Mile 60, sixty miles rapids". Click on the Video Icon, "The Tapeats sandstone and the Cambrian" and watch the related videos to answer the following questions.

Tapeats sandstone

21. During the Cambrian what was happening worldwide? _____

    an explosion of life

22. The Tapeats sandstone was deposited approximately how many million years ago?

    _____ 520-540

Marine transgression

23. What would be the first type of sediment deposited during a transgression?

    _____ sand

24. In what direction was the shoreline migrating during this Cambrian transgression?

    _____ east

Cambrian explosion

25. Give an example of an animal that left fossil traces in the Tapeats sandstone.

    _____ worms or trilobites

Sedimentary structures

26. The cross-beds represent what type of depositional environment. _____

    Beach (OR Dune)

27. Dr. Karlstrom described alternating layers of sandstone and mudstone. Do the mudstones represent deeper or shallower water? _____

    Deeper

Cross-bedding

28. The crossbedding represents the migration of what type of sedimentological structure?

    _____ dune

29. In what directions was the structure migrating? From left to right or right to left?

    _____ left to right

Deepening ocean

30. The following sequence of sediments were deposited in this area: Sands, muds and lime muds. These sediments became what three rocks (Put your answers in the order from youngest to oldest.

    _____ limestone
    _____ shale
    _____ sandstone

Click the green arrow labelled, "Mile 50 The Granaries and Nankoweap Canyon". Upon arriving, pan to the right until you see the video icon labelled, "Canyon Overview". Click on this and answer the questions associated with the relevant videos.

Paleozoic Sedimentary Layers

31. How many millions of years are represented here, from the top of the canyon to the bottom? _____ 250

Three main rock types

32. What are the three main rock types?

_____ _____ _____

Igneous, metamorphic, sedimentary

A sense of time

33. When did people last live in the Grand Canyon? _____ 1000 years ago
34. What is the name of the geologic time period during which fish evolved? _____

Devonian

35. Which is younger, the rocks in the canyon or the canyon itself? _____ canyon
36. If you hadn't watched the video you could have figured out the answer to the preceding question by using what basic geologic principle? _____

    Cross-cutting

Click on the *Mile 32 Vassey's Paradise* arrow. If you turn to the right you will find the video icon labelled, "Karst, limestone and marine organisms", on the backpack of one of the geology students who is standing near the left edge of the group by a student in a blue jacket. Click on the icon to see the following topics and answer the related questions.

Karst

37. What is karst?

_____

Process that forms underground passages

Redwall limestone and karst

38. What is the field method that we learned during mineral identification for determining whether a rock has CaCO3 (calcium carbonate) in it?

_____ fizzes in HCl

39. Describe the process by which holes are formed in limestone as described by Professor Semken (BE THOROUGH – 4pts)? _____ Water + CO_2 = acid, creates holes in limestone P. Semken describes it a bit differently, be lenient

Marine organisms

40. Dr. Semken points out evidence of multicellular organisms in rocks that are what geologic age? _____ Devonian
41. When was the Devonian? (google it) _____ 419-358 mya

Ancient stream channels

42. Dr. Semken describes how a __ Stream Channel_____ was carved into Cambrian-aged rocks during the Devonian.
43. The stream deposited sediments which lithified and are now called the ____ Temple Butte _____ Formation.

Click on the pulsating green arrows labelled, "Mile 13 Ledge" and then "Mile 0 Lee's Ferry. This is the famous spot where the water discharge was measured, that gave Herbert Hoover the data he used to divide up the Colorado River water between the upper and lower basins.

If you look back in the direction from which we came you will find a video icon labelled, "Trace Fossils and Dating". Watch the videos and answer the associated questions.

Trace Fossils

44. What type of trace fossil is shown here? _____ burrows

Sedimentary layers, a time trip

45. Dr. Semken is describing what basic geologic principle? _____ Superposition

A little to the left of the boats there is a camera icon labelled, "Pre-trip prep". Click on that and watch the videos and answer the associated questions.

Moenkopi Formation

46. The Moenkopi consists of what two rocks? _____

    Mudstone, SS

47. What sedimentary structure in the Moenkopi tells us that the mud went through wet and dry periods? _____ mudcracks

Shinarump conglomerate

48. The Shinarump conglomerate was deposited in what type of depositional environment?

    _____ stream/river

Navajo Bridges

49. The Kaibab Limestone was formed in what depositional environment? _____ sea

50. (Extra Credit) How do you explain how the Kaibab Limestone which is at the bottom of the canyon, at river level, in this video, can be at the top of the canyon, on the rim, further downstream? (You may have to really think about this one.)

    Loss of elevation as the river cuts down into the rock

    _____

Coconino Sandstone

51. What type of depositional environment was the Coconino Sandstone deposited in?

    _____ Desert

52. What is the word that means "wind-blown"? _____ eolian

53. Is the Coconino older or younger than the Kaibab? _____ older

54. What geologic principle gives you the answer to the previous question?

    _____ Superposition