# GEOSC 10 Unit 9 Virtual Fieldtrips

## Virtual Fieldtrip #1: Great Basin National Park and the Lehman Caves

Image 1: Great Basin Nationa Park’s Wheeler Peak, Nevada

Caption 1: Great Basin National Park’s Wheeler Peak, Nevada--Caves, Bristlecones, and the Age of the Earth Diagram from NOAA, photos from National Park Service (indicated) and by R. Alley

Image 2: Three pictures of cave formations, Lehman Cave, Great Basin National Park. First, Popcorn formation on column, second, helectites on column, and third, flowstone.

Image 3: Two pictures. 1. Shield formation in a cave. 2. Twisty stalactites (called helectites)

Caption 3: A shield (left) and hollow stalactites (soda straws; right). The National Park Service Web site doesn’t identify the cave pictured, but because shields are almost unique to Lehman Caves, and twisty stalactites (called helectites) are common there as well, these images are probably from Lehman.

Image 4: Two pictures of cave formations. 1. Soda straw. 2. Soda straws with helectites

Caption 4: Soda straw formation with drop of water on the end(left) and soda straw formations with helectites growing out of them (right). Again, these may be Lehman Caves, but the Park Service web site doesn’t say. Lehman is beautiful!

Image 5: Two pictures of dying bristlecone pines at Cedar Breaks National Monument, Utah

Caption 5: Bristlecone pines live fast and die young in “good” environments (wet and warm, with rich soils), but live long if barely prospering in cold, dry environments with impoverished soils. These are at Cedar Breaks National Monument, Utah.

Image 6: Two pictures. First, a closeup of the brislecone pines branches that look like a bottle brush. Second, the exposed roots of a bristlecone pine

Caption 6: The distinctive “bottle-brush” branches of the bristlecone pines (left, at Cedar Breaks) look like they are ready to clean test tubes in a lab. The rapid erosion at Bryce (right) leaves bristlecone roots exposed above the ground.

Image 7: Two pictures First, several Bristlecone pines, Mt. Evans, CO Second, a close up of a bristlecone trunk. One small section has bark, the rest is gone

Caption 7: Still more bristlecones, this time on Mt. Evans, Colorado. The tree shown at right is kept alive by a narrow strip of bark (yellow arrow), while most of the tree has had its bark sand-blasted away or otherwise removed (pink dashes). Tree-ring dating must be done under the living strip of bark.

Image 8: Diagram of cross-dating of tree rings

Catpion 8: Laboratory of Tree-Ring Research, The University of Arizona, NOAA Paleoclimatology Program Slide Set on Dendrochronology In this example of cross-dating in tree-ring research, the pattern of thick and thin rings in a core from a living tree (A) is matched to the pattern in a dead tree (B), then to wood in a native-American site, C, and then on to other, older wood samples (D-J).

Image 9: Long House cliff dwellings at Mesa Verde National Park

Caption 9: Construction was done mostly with stone and mud, but also with some wood, often hauled in from long distances. Tree-ring studies allow reconstruction of ages and of past climates.

Image 10: Three pictures. Two logs from Long House used for tree-ring research. One shows a plug removed for tree –ring research and replaced by modern wood. The third picture is of a museum specimen tree ring.

#### Virtual Fieldtrip #2: Grand Canyon National Park

Image 1: A view across the Grand Canyon

Image 2: Satellite-generated oblique view of the Grand Canyon looking across the South Rim village toward the North Rim village.

Image 3: USGS Landsat image of the Grand Canyon: At 277 miles long, 5 to 18 miles wide (average 10 miles wide), and about 5700 feet deep (just over a mile), Grand Canyon is not the longest, deepest, widest or steepest on Earth, but it may be the grandest for combining length, depth, width and steepness.

Image 4: National Park Service Historical Photo, rescue helicopter at the bottom of the grand canyon. National Park Service web site says: “Over 250 people are rescued from the Canyon each year. The difference between a great adventure in Grand Canyon and a trip to the hospital (or worse) is up to YOU - follow the rules of smart hiking and - DO NOT attempt to hike from the rim to the river and back in one day, especially during the months of May to September.”

Image 5: Three pictures of students at Silver Bridge, bottom of the Grand Canyon.

Image 6: Two pictures from Indian Gardens, Grand Canyon. First, a ground squirrel. Second, a mule deer in a feeding trough for the pack mules.

Image 7: California condors flying over the Grand Canyon. They have been reintroduced there successfully.

Image 8: Despite the dryness, the Canyon has many beautiful flowers including prickly pear, phlox, century plant and penstemon.

Image 9: Two pictures. Left, a view looking down onto the South Bright Angel Trail. Right, a student climbing up a steep part of the trail.

Image 10: close up of metamorphosed rocks abraded and polished by the Colorado River, Bright Angel Trail. Note that river-worn rocks look very different from glacier-worn rocks, but show clear evidence of erosion.

Image 11: Sunset at the Canyon.

#### Virtual Fieldtrip #3: A Geologic Walk Out of the Grand Canyon—Climbing Time

Image 1: View into the Grand Canyon

Image 2: Rock units as seen from the south rim on the Bright Angel Trail. Starting from the bottom, is the GC Supergroup, Tapeats, Bright Angel, Muav, Temple Butte (Temple Butte is discontinuous (as is the Surprise Canyon, a recently discovered unit just above the Redwall), Fedwall, Supai, Hermit, Coconino, Toroweap, Kaibab. The Supai Group and the Grand Canyon Supergroup include several named layers.

Image 3: A rock formation above Bright Angel campground (just N. of the Colorado River up Bright Angel Creek near the bottom of the Canyon) shows sedimentary rocks of the Precambrian Grand Canyon Supergroup resting on the unconformity above metamorphosed rocks.

Image 4: Views of the N. side of the Colorado River from Bright Angel Trail, showing Zoroaster granite (pink) intruded into Vishnu Schist (dark) and heavily deformed, from the heart of an old mountain range.

Image 5: Rock formations that show a push-together fault. A fault can break rocks and break through to the Earth’s surface to raise mountains and lower valleys.  Then, if motion ceases on the fault, erosion can level the surface, and sediment can be deposited on top.  Such a situation can be found deep in the Grand Canyon, where a fault offsets Precambrian rocks, including the very old metamorphic rocks and, above them, the still-very-old sedimentary rocks of the Grand Canyon Supergroup, but the fault does not offset the younger, Paleozoic Tapeats Sandstone.

Image 6: The ‘Great Unconformity’ between Precambrian Grand Canyon Supergroup and Cambrian Tapeats Sandstone. Sometimes in faulting of the type seen in Death Valley, a fault on one side of a valley will experience more motion than the fault on the other side of the valley, so that rock layers in the valley are tilted.  Erosion may then remove the mountains, followed by deposition of new, horizontal layers of sediment on top.  The surface where the tilted layers meet the younger, horizontal layers is one type of unconformity, and a famous one in the Grand Canyon is called the “Great Unconformity”.  In the eastern Grand Canyon, the rocks beneath the Great Unconformity are part of the Grand Canyon Supergroup, from the Precambrian, whereas the rocks above are younger Tapeats Sandstone from the Cambrian.  Measuring the thickness of the tilted older layers shows that there are about two miles of sediment there—if you could tilt them back to horizontal, they would make a two-mile-high pile.

Image 7: East end of Grand Canyon National Park shows Precambrian rocks below the Great Unconformity and Paleozoic rocks above.

Image 8: Sedimentary layers in the Tapeats Sandstone. Cross-bedding (right) and ripple marks (seen edge-on above, yellow arrow) are among features shown. These are “normal” sediments, lacking signs of catastrophic or sudden deposition.

Image 9: small animal burrows shown in the Tapeats Sandstone and Supai Formation. Creatures hide in mud or crawl through mud looking for food, leaving tracks. Time clearly is required for this to happen. Burrows occur throughout the upper mile or so of the Canyon’s rocks.

Image 10: Two pictures of mud cracks in stone from the Grand Canyon. Mud cracks also are found in many, many layers of the Canyon, from many times when the sediment surface was stable long enough for cracks to form. Those to the right are in a block that fell from the Kaibab Limestone cliff, and those on the left are in the Bright Angel Shale, along the South Bright Angel Trail.

Image 11: Limestone fossils of trilobite tail and gastropods and an algae-mat. Shelly limestone from channel fill in basal Supai rocks, with trilobite tail (upper left) and some beautiful gastropods (snails). (right) Algal-mat (stromatolite) deposits, Chuar Group, Precambrian Grand Canyon Supergroup. Mats trapped mud, grew up through the mud, and trapped more.

Image 12: A rock formation. Bottom is a 100 ft high cliff of Hermit Shale (bottom of rock) with Coconino Sandstone on top. The Coconino sandstone has a fossil-sand-dune nature. In the middle of the picture and running vertically shows where sand fills a mud crack in the Hermit Shale. South Bright Angel Trail, Grand Canyon.

Image 13: Two pictures of fossil tracks, one in the Supai Formation and one in the Coconino Sandstone. Diverse fossil tracks have been found at many different levels in the Canyon.

Image 14: Still more fossil track ways from the Coconino fossil sand dunes in the Grand Canyon. Left: Lizard track way, National Park Service museum, South Rim. Right: fossil showing millipede tracks. Historical photo taken about 1920 of sample from Hermit Trail.

Image 15: Two pictures of fossil tracks in Coconino fossil sand dunes both of a lizard track way.

Image 16: Fern fossils from the Hermit Shale near the Kaibab Trail.

Image 17: Four fossils from Kaibab Limestone. Trilobite, Bright Angel Shale, fossil-bearing limestone, and nautiloid.

Image 18: The history of the Canyon did not end with the deposition of the Kaibab Limestone, which slants down to the north beneath Zion, and Zion’s rocks slant beneath Bryce… After the deposition, erosion of the Canyon has occurred (see the Enrichment in the text), and deformation has happened. Here, the South Bright Angel Trail crosses the Bright Angel Fault--the blue arrow points at the pulverized rocks of the nearly vertical fault zone.