Celebrate Geologic Map Day!
Friday, October 15, 2021

Welcome to Geologic Map Day, a special event designed to promote awareness of geologic mapping and its vital importance to society. Geologic Map Day focuses the attention of students, teachers, and the general public on the creation, study, uses, and significance of geologic maps for education, science, business, and a variety of public policy concerns.

Organizing partners of Geologic Map Day are the U.S. Geological Survey, the Association of American State Geologists, the National Park Service, the Geological Society of America, NASA, and the American Geosciences Institute.

The event is celebrated on the Friday of Earth Science Week (**www.earthsciweek.org**), which is a public awareness campaign that reaches millions of people each year with educational resources, information, and activities promoting awareness of Earth science. Please join us!

GEOLOGIC MAP RESOURCES ONLINE

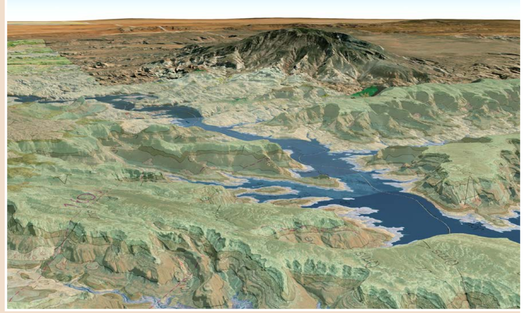
For guidance on these activities, as well as other resources, visit the Geologic Map Day webpage:

www.earthsciweek.org/geologicmap/

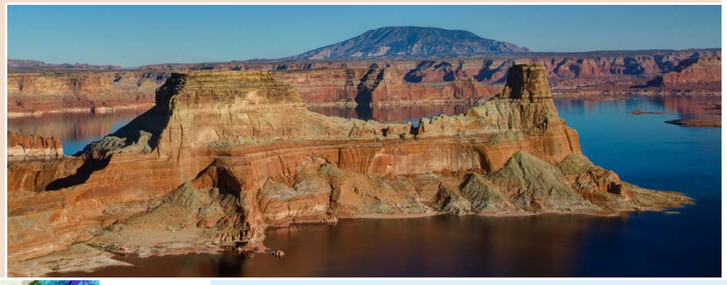
2: LOOKING BELOW EARTH'S SURFACE

The Utah Geologic Survey's interactive "Geologic Map Portal" (**https://bit.ly/21xGMD3**) allows you to see the geologic map on top of a 3-dimensional surface and topographic map. This is helpful for visualizing how the geology shown on the map appears in nature (image **d**). Geologists also make representations of what a slice through the Earth would look like, called a cross section. A cross section shows rock layers and the structures that contain them below the surface.

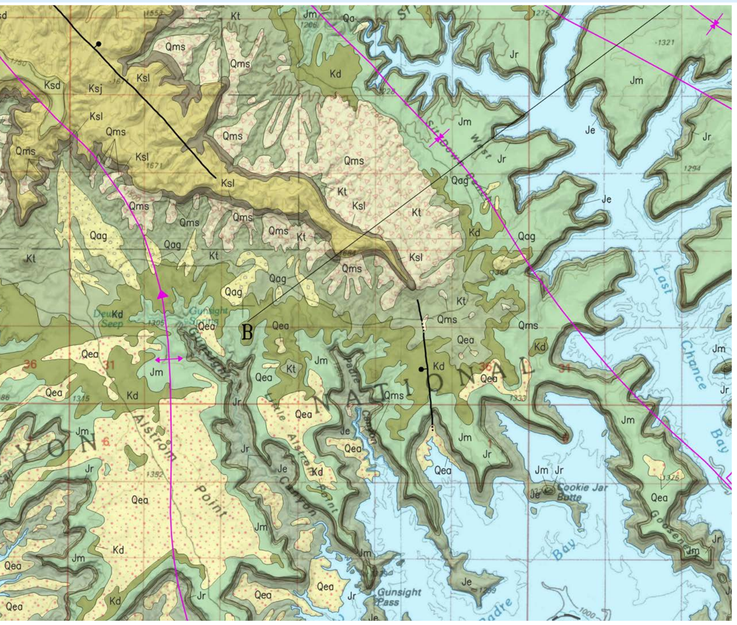
1. Practice using the interactive map portal to explore the geologic map. Zoom to Lake Powell. Roll your cursor over the controls in the gray bars on the right and on the left to see what each does. Use the "Go to a location" button on the right side to locate Gunsight Bay. Use the controls on the left to zoom in. Use the "Tilt view" button on the left to tilt the viewer to get a good 3D effect (you will need to be zoomed in so the "scale" reading at the bottom center of the map is about 1:40,000). Move from Gunsight Bay eastward to Last Chance Bay.
2. Examine the geology of Gunsight Butte shown in photo **e**. Try to identify the different rock layers. Record the number of layers you identified. Describe the orientation of these layers.
3. Look at the geologic map. How does the orientation of the layers on the west side of Last Chance Bay compare to the east side of Last Chance Bay?
4. Click on the "Tilt view" button until the view is straight down. Find the black line that runs diagonally across the northern part of Last Chance Bay. The ends of the line are labeled B at the southwest and B′ (pronounced "B prime") at the northeast. Find this line on the geologic map on the poster front. This line shows the location of the cross section. Examine the cross section shown on the front of the poster below the geologic map. How does the orientation of the layers compare to your ideas about the relationships among layers around Last Chance Bay?
5. Find Rock Creek on the map and the cross section. (Hint: Rock Creek flows southward into Rock Creek Bay.) Based on what you can observe on the map, what do you think is the impact of the creek on the landscape?
6. Find the words "anticline" and "syncline" on the cross section. Look up what they mean. How do they form?
7. If another cross section were oriented northwest-southeast cutting through Last Chance Bay (that is, perpendicular to the B-B′ cross section), how would its layers compare to the original B-B′ cross section?



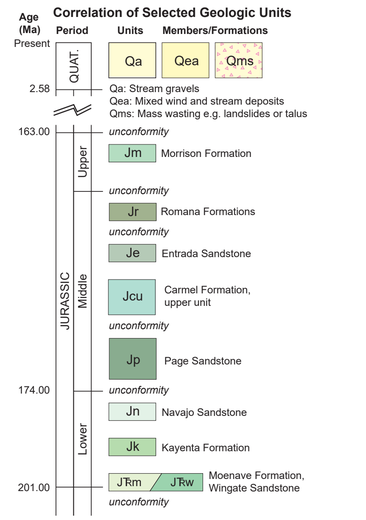
d. This image from Utah's interactive geologic map viewer shows the digital geologic map laid on top of a 3-dimensional landscape. Giving each layer its own color makes it easier to see their configuration around the lake.



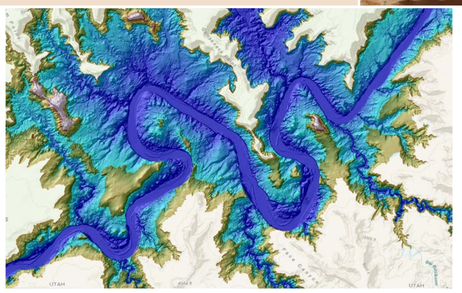
e. The iconic Gunsight Butte exposes several sandstone formations and towers nearly 1,000 feet above Lake Powell.



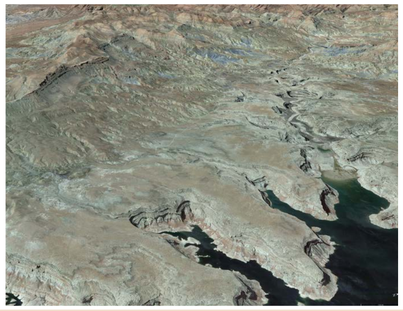
a. Part of the geologic map provides a bird's-eye view of the geology around Last Chance Bay. Several of the same layers can be seen in the photograph (b) of the area.



c. Rocks with unique features are arranged according to their ages. An *unconformity* is a gap in the record where there are no rocks of a particular age. This correlation shows only the rock units that are useful for the activities. To see the full correlation and rock descriptions, including rocks of Cretaceous and Triassic ages, go to "Plate 2" at: https://bit.ly/21xGMD2.

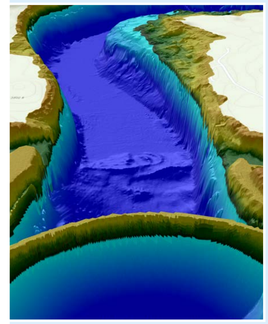


h. This image is from a special kind of model that combines digital data of surface and riverbed elevation. Zooming in gives a unique impression of the lake bed and flooded natural canyon. A color scale indicates several elevations shown on the image.



g. Google Earth™ image (looking west) showing a large escarpment, deposits, and channels to the west of Last Chance Bay. This image contains plenty of evidence of active processes.

4: PROCESSES BELOW THE WATER



Geologic maps and Google Earth™ images provide images that are snapshots of the times they were made. Weathering, erosion, and deposition continue to break down and build up Earth's surface. In this activity you will explore the channel of the Colorado River that is submerged by Lake Powell and look for evidence of change.

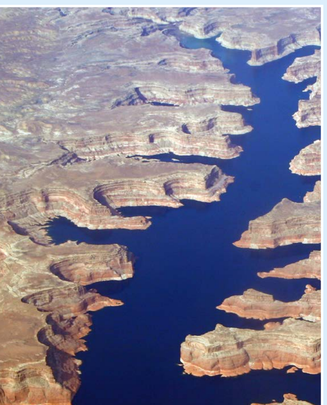
i. A digital elevation model shows Glen Canyon Dam and submerged landforms on the upstream riverbed.

1. Go to the Coastal National Elevation Database (CoNED) (**https://bit.ly/21xGMD4**) and open the "CoNED Project Viewer" to view the topobathymetric maps there. These maps show the topography (land elevation) and bathymetry (water depth) of the areas. Zoom into Lake Powell. Use the online "Legend" or the color "Key to selected elevations" to identify the former channel of the Colorado River. What color is used to indicate the river channel?
2. Go to the "3D Topobathymetric Digital Elevation Model for Lake Powell Storage Capacity Assessment" on the CoNED website (**https://bit.ly/21xGMD5**). In the "Overview" tab, scroll down to the video of the three-dimensional (3D) view of Lake Powell (image **h**).
3. Watch the video once all the way through. At the beginning of the video, notice where the road crosses the lake. That is where the dam is located.
4. Restart the video and look at the landform on the channel floor immediately upstream (behind) of the dam (image **i**). How could it have formed?
5. Continue watching the video and identify features of erosion and deposition in the former channel. These submerged deposits are not shown on the geologic map.
6. If the erosion and deposition features in the channel were to be shown, what rock unit label would you give them? Write a short description that you could use for these rock units.
7. Research how deposition can cause problems for dams. In what ways can geologic maps be tools for solving the problems caused by deposition?

We hope you enjoyed using this unique geologic map and related tools. This is just one of thousands of maps in the USGS National Geologic Map Database. The catalogue can be searched by location and themes, including geology, geophysics, marine, resources, hazards, and more. Find your local geologic map and explore the Earth system beneath your feet! Visit **https://bit.ly/21xGMD6** or **https://ngmdb.usgs.gov/ngm-bin/ngm_compsearch.pl**

1: DIFFERENT TIMES, DIFFERENT ENVIRONMENTS

Geologic maps show the locations of various kinds of rocks at the surface. In places where rivers have eroded the surface, deeper layers become exposed. The opposite occurs when lake levels rise; rocks along the shore are covered by water. Geologic clues in each layer can be used to tell a story of Earth's history. Differences between one layer and the next reveal changes in the Earth system. Let's explore part of the Smoky Mountain 30′ x 60′ Quadrangle map. This poster shows a portion of that map. The entire map can be found at the National Geologic Map Database (**https://bit.ly/21xGMD1**) or from the Utah Geological Survey (**https://bit.ly/21xGMD2**).



1. Choose one of the smaller coves in Last Chance Bay (see map **a**). Can you identify the same layers shown on photo **b** on the geologic map?
2. Find a point above the cove on the green colored layer with the rock unit label **Jm**. Imagine you are walking to the lake on the map from the place where you see the **Jm** label. Which other rock unit layers would you pass? Can you tell which is the oldest layer and which is the youngest layer? Explain your reasoning.
3. Use the "Correlation of Selected Geologic Units" (see figure **c**) to find the ages of the rock layers you passed through.
4. Go to the online map. On the second page "Plate 2" of the online map, read the detailed "Description of Geologic Units" to find out about **Jm** and the neighboring units. Make a hypothesis about how these rocks formed. Research about the geologic history of this period in North America.
5. If the lake level dropped, what do you think the map would look like? (For a clue, look along the shoreline at the southeast corner of the Smoky Mountain Quadrangle map where there are additional layers exposed at the surface.) Are the additional layers younger or older than those at the edge of the lake? Explain.
6. Use the "Correlation of Selected Geologic Units" to find the ages of the rocks that would be exposed if the water level dropped. Find out about the past environment.

b. A photo of the steep-sided coves on Last Chance Bay showing several different sandstone formations.

3: SURFACE PROCESSES

Part A: Younger Deposits

Active erosion wears away surface rocks while deposition piles loose sediments on top of existing surfaces. Over time loose sediments may be compacted and cemented, which forms sedimentary rocks. Younger rocks and sediments are also shown on the geologic map. Let's look for evidence of young rocks and active deposition using the map and other tools.

1. In Google Earth™ go to Alstrom Point. Set the view to the north and to 3D. Zoom into the large area called The Sand Hills, which is south of Alstrom Point (shown in image **f**).
2. Explore the area from different angles. Look for shapes and patterns on the surface. Look for clues around the edges of the layer and how it rests on the layer below.
3. Find the same layer on the geologic map. Write down the two- or three-letter rock unit label for this layer.
4. Return to Google Earth™ and look for a layer to the north of Alstrom Point that appears to be similar.
5. Confirm that the layer is similar using the rock unit labels. How far is this similar layer from the lake?
6. Use the "Description of Geologic Units" on the online map (on Plate 2) to find information about the layer. Compare this to your ideas about how the layer formed.
7. In Google Earth™, zoom out so you can see the northern part of Arizona. Can you find the same layer? How does this observation change your ideas about how the layer formed?

f. Google Earth™ image of Alstrom Point and desert landforms to the south.

Part B: Landslides

Over long periods of time, weathering breaks down rocks into sediments. Through the process of erosion, those sediments are transported by air, water, ice, and gravity.

1. On the geologic map, go to the northern area of Last Chance Bay and look to the west. Examine the large deposit labeled **Qms** near the shore.
2. On Google Earth™ find the same area (image **g**). Print this view. Trace the edge of the **Qms** deposit shown on the geologic map (figure **a**) onto your printed image.
3. On Google Earth™ make observations of the highest and lowest parts of the deposit. (Hint: The elevation of the point under the cursor is shown in the lower right.)
4. Move to the south end of the landslide where the rocks appear to be a lilac color (look on the lower right of the Google Earth™ image and move so the "Camera" position is about 37°0′40″N and 111°19′50″W). Zoom in and out to make observations of the surface. What evidence can you find that the landslide is being eroded?
5. On Google Earth™ find the creek flowing into the northwest canyon of Last Chance Bay. Describe the deposit at the mouth of the creek. How do you think it formed?
6. Find this same deposit on the geologic map. Record its label. Use the "Correlation of Selected Geologic Units" (figure **b**) on the back of the poster or the online geologic map find the age of the deposit. Relate the age to your claim.
7. On the geologic map, follow the creek upstream. Also find it in Google Earth™. Find other deposits labeled **Qms** near the creek. How might the deposit at the mouth of the creek relate to mass wasting?

NGSS Connections for Activities

Disciplinary Core Ideas
- Earth's systems: **1**, **2**, **3**, **4**
- Earth and human activity: **1**, **2**, **3**, **4**

Crosscutting Concepts
- Patterns: **1**, **2**, **3**, **4**
- Structure and function: **1**
- Scale, proportion, quantity: **2**
- Cause and effect: **3**
- Stability and change: **4**

Science and Engineering Practices
- Planning and carrying out investigations: **1**
- Analyzing and interpreting data: **1**
- Developing and using models: **2**, **3**, **4**
- Obtaining, evaluating, and communicating information: **2**
- Engaging in argument from evidence: **3**
- Asking questions and defining problems: **4**

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Front maps and back figures a and c: Doelling, H.H., and Willis, G.C., 2008, Geologic map of the Smoky Mountain 30′ x 60′ quadrangle, Kane and San Juan Counties, Utah, and Coconino County, Arizona. Utah Geological Survey Map 213DM, scale 1:100,000. Front photo of Glen Canyon Dam: © Michael Collier. Back figures: b: Doc Searls (CC by 2.0); d: Interactive Geologic Map Portal, Utah Geological Survey; e: NPS/Brent & Dawn Davis; f and g: © Google Earth™; h and i: Dean Tyler, USGS Earth Resources Observation & Science Center. Data Citation: Poppenga, S.K., Danielson, J.J., and Tyler, D.J., 2020, One Meter Topobathymetric Digital Elevation Model for Lake Powell, Arizona-Utah, 1947-2018: U.S. Geological Survey data release, https://doi.org/10.5066/P9XX0J1Y. Magnifier: The Noun Project.

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