

### **Field trip to the Ft Niobrara National Wildlife Refuge near Valentine, NE**

This is a two-day lesson plan that could be incorporated into a unit on either sedimentary rocks or the geologic timescale. It allows the students to see and learn about five different stratigraphic units that are visible from the Ft. Niobrara National Wildlife Refuge near Valentine, NE.

#### **Learning Objectives:**

- 1) From an overlook on the Refuge, students will be able to point out the Rosebud Formation, Valentine Formation, the Cap Rock member of the Ash Hollow Formation, the Niobrara River alluvium terrace, and the Sand Hills.
- 2) Students will be able to describe the relative ages of these units.
- 3) Students will have practice at matching samples of rocks or sediment with the correct units.
- 4) Students will know how each unit was formed/deposited.
- 5) Students will be told about the climate, plants, and animals that existed here when each layer was forming.

#### **Concepts and Their Corresponding Vocabulary to Have Taught Prior to This Lesson:**

- 1) The Principle of Superposition
  - a. Relative age
  - b. Unconformity
  - c. Disconformity
- 2) How sedimentary rock forms
  - a. Weathering
  - b. Erosion
  - c. Deposition
  - d. Compaction
  - e. Cementation
  - f. Depositional environment
- 3) How sedimentary rocks are classified/identified
  - a. Gravel, sand, silt, clay
  - b. Sandstone vs. siltstone
- 4) Geologic Timescale
  - a. Era, period, epoch
  - b. Cenozoic Era
  - c. Tertiary Period and Quaternary Period

**Preparation:** Make arrangements a few weeks in advance for a field trip to the Ft. Niobrara National Wildlife Refuge. The person at the Refuge who was very helpful to me was Kathy McPeak. Arrange for a special permit for our group to go to the overlook.

**Day 1:**

- 1) Bell ringer activity: Put the students in groups of two. Give each group a notecard with one review topic on it. Give everyone a couple of minutes to prepare to present the answer to the question(s) on their card. (They can look in their book and/or notes.) Here is what the cards could say:
  - a. What is relative age? Describe the Principle of Superposition.
  - b. What is an unconformity? Specifically, what kind of unconformity is a disconformity?
  - c. Describe how clastic (or detrital) sedimentary rocks form. In your description, use the following words: weathering, erosion, deposition, compaction, cementation.
  - d. What is a depositional environment? How does it affect the type of sedimentary rock that forms?
  - e. What are the differences between gravel, sand, silt, and clay?
  - f. What is the difference between sandstone and siltstone? Describe how you could identify whether a rock is sandstone or whether it's siltstone.
  - g. Define these words: era, period, and epoch.
  - h. What era are we living in right now? When did it begin?
  - i. What period are we living in right now? When did it begin? What is the period before it called?
- 2) Have each group come to the front, and present the answer(s) the question(s) on their card. Here is what they should be:
  - a. Relative age is the age of something compare to something else (older or younger). The Principle of Superposition says that in undisturbed rock layers, the oldest rocks are on the bottom and the youngest rocks are on the top.
  - b. An unconformity is a gap in the rock sequence. A disconformity is a type of unconformity that records a time when the rock was exposed and eroded.
  - c. Clastic (or detrital) sedimentary rocks are made from clasts (or particles) or other rocks that have been weathered, then the clasts were eroded (or transported somewhere else) by an agent such as water. The particles were then deposited (set down). Over time the particles became compacted (pressed) and sometimes cemented (glued) together.
  - d. Depositional environment describes the type of environment that deposited the rock particles. It affects the size of the rock particles.
  - e. Gravel, sand, silt, and clay are clasts of different sizes. Gravel-sized particles are bigger than 2mm. Sand-sized particles are visible, but less than 2mm. Individual silt and clay grains are not visible to the naked eye. You differentiate between them by whether they feel gritty (silt) or smooth (clay).

- f. Sandstone is made of sand-sized particles. Siltstone is made of silt-sized particles. You identify a clastic sedimentary rock by looking at the grain size. For sandstone you would be able to see the individual grains, for siltstone, you wouldn't be able to see individual grains but they would feel gritty.
  - g. An era is the longest time division on the geologic timescale. A period is the second-longest (eras are divided into periods). An epoch is the division smaller than periods (periods are divided into epochs).
  - h. Right now we are living in the Cenozoic Era. It began about 65 million years ago.
  - i. We're living in the Quaternary Period right now. It began about 1.8 million years ago. The period before it was called the Tertiary Period.
- 3) Give each student a copy of the handout titled "Stratigraphic Units That Can Be Seen From Ft. Niobrara (Note-taking Pages)." This handout has several blanks that the students can fill in while they are listening to the PowerPoint lecture.
  - 4) Show the PowerPoint and lecture about the five different stratigraphic units that we will see. Have the students fill in the blanks on their handout as I lecture. (Before beginning, tell them that I will be starting at the BOTTOM of the BACK of the handout as I lecture because I will start with the earliest formation and move forward through time.)
  - 5) Show and go over the handout they will be using tomorrow titled "Interpreting the Sedimentary Rocks at..." Go over what each of these terms mean and what they indicate: sorting, sphericity, roundness, sediment maturity, lamination, graded bedding, and cross-bedding. Tell them they will be using this handout tomorrow to analyze and identify a few of the formations.
  - 6) Review what they should wear/bring for the field trip tomorrow:
    - a. Long pants (we'll be walking about 2 mi. through some grass)
    - b. A jacket (depending on the weather)
    - c. Hiking boots or athletic shoes that are comfortable and provide good protection
    - d. Sunscreen
    - e. Bug spray (depending upon time of year)
    - f. Lunch
    - g. Extra water
    - h. A pencil
    - i. Their note-taking handout from today
    - j. A daypack for carrying everything.

**Day 2:**

- 1) Drive to the Refuge via Hwy. 12. Turn south on the road to Berry Bridge. Stop when we get to the road cut exposing the Valentine Formation. (Don't give away the formation name yet.) Give each student a packet containing three stapled-together copies of the handout titled "Interpreting the Sedimentary Rocks at..." and also a sheet for their final drawing. Have the students fill in the blank on the first one to say "the road to Berry Bridge." Have everyone get out of the bus (with their pencils and handouts) and take a look at the road cut. Have students get

- up close and analyze the grain size, sorting, sphericity, roundness, and sediment maturity.
- 2) Once everyone has had a chance to analyze the rock, discuss their findings. Discuss whether there are any physical features that would indicate depositional environment. Ask them if they know which formation we are seeing. Discuss that fact that this is the Valentine Formation. A big clue is how easily the sandstone crumbles. Most of it is unconsolidated or semiconsolidated sandstone. Review the fact that this was deposited by a river 14-12 mya.
  - 3) Get back in the bus and continue to head south. Go across the Berry Bridge and take the back road to the Refuge Headquarters. Stop at the Headquarters for a brief bathroom break and to see their museum. In the museum, point out the fossil display.
  - 4) Get back in the bus and head toward the Refuge's main entrance. Stop and park the bus at the canoe launch area. Remind them to bring along their handouts and a pencil. Get out and walk across the Refuge's road. There is a hill with exposed Rosebud Formation rock. (Don't give away the formation name yet.)
  - 5) Have the students fill in the blank on the top of their second sheet to say "the Refuge's main entrance." Have students get up close and analyze the grain size, sorting, sphericity, roundness, and sediment maturity.
  - 6) Once everyone has had a chance to analyze the rock, discuss their findings. Discuss whether there are any physical features that would indicate depositional environment. Ask them if they know which formation we are seeing. Discuss the fact that this is the Rosebud Formation. It is a pinkish-tan siltstone. It was deposited by a river with low energy currents on a wide, flat floodplain about 28-23 mya. Few fossils have been found in this formation.
  - 7) Get back in the bus. Get back on Hwy. 12, by turning right and heading up the hill. At the top of the hill, there is a place where the bus can pull off of the highway. Get out and walk to a locked gate. (Refuge personnel will have to let us in the gate.) Walk along a two-track road to the south for about one mile to get to the overlook.
  - 8) At the first overlook point, have students notice the boundary between the Rosebud and Valentine formations on the opposite (south) side of the river. You can see numerous springs and seeps at the unconformity between the two formations. Have the students think about why the water comes out there.
  - 9) Walk to the east. Eventually we will reach an outcrop of the Cap Rock Member of the Ash Hollow Formation. (Don't give away the formation name yet.) Have the students fill in the blank on the top of their third sheet to say "the overlook." Have students get up close and analyze the grain size, sorting, sphericity, roundness, and sediment maturity.
  - 10) Once everyone has had a chance to analyze the rock, discuss their findings. Ask them if they know which formation we are seeing. Discuss the fact that this is the Cap Rock Member of the Ash Hollow Formation. It is a well-hardened, porous sandstone. It was deposited by a river, but it also has some layers within it that are wind-blown volcanic ash. It formed about 12-9 mya.
  - 11) Continue walking to the east until you reach an overlook point. This overlook point provides an excellent view of all 5 stratigraphic units at once. The bottom-

- most layer along the river is the Rosebud Formation. Above it is the Valentine Formation. We will be standing on the Cap Rock Member of the Ash Hollow Formation. The flat terrace across the river is the Niobrara River alluvium terrace (formed about 20,000 years ago by the ancestral Niobrara River). And in the distance to the south the Sand Hills can be seen. (We will be driving through the Sand Hills on our trip back to Ainsworth on Hwy. 20.) The Sand Hills are a wind-deposited formation, about 15,000 years old.
- 12) Have the students sit down and spend at least ten minutes drawing what they see. Their drawing must include all five stratigraphic units. Each unit must be labeled with four things: its name, a number (1-5) indicating relative age (1 = first, 5 = last), a brief description of it, and how it formed. (This drawing will be their assessment for this field trip. They can turn it in immediately, or wait until tomorrow if they want to add to it.)
  - 13) Walk to the bus and head home.

Please see other attachments that go with this lesson plan:

- 1) Stratigraphic Units That Can Be Seen From Ft. Niobrara (Note-taking Pages)
- 2) Stratigraphic Units at Ft. Niobrara PowerPoint
- 3) Stratigraphic Units That Can Be Seen From Ft. Niobrara (Lecture Notes/Note-taking Key)
- 4) Handout titled "Interpreting the Sedimentary Rocks at..."
- 5) Page 4 of field trip packet (Drawing page)

**Source:**

Voorhies, M.R. (1987) "Late Cenozoic stratigraphy and geomorphology, Fort Niobrara, Nebraska." *Geological Society of America Centennial Field Guide*. Available at: <http://www.gsjournals.org/perlserv/?request=get-abstract&doi=10.1130%2F0-8137-5403-8.1>