

**2008 GEOLOGY DEPARTMENT SPRING FIELD TRIP**  
**51-360-301: 2 CREDITS**

***Volcanology of Cenozoic Volcanic Centers in Idaho, Wyoming, and Montana:  
Devil's Tower National Monument, Craters of the Moon National Monument,  
and Yellowstone National Park***

- Instructors: Dr. George Hudak Office: Harrington 211  
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- Time: Spring Interim, 2008: May 19 – June 4, 2008
- Text: Guidebook to the Volcanology of Cenozoic Volcanic Centers in Idaho, Wyoming and Montana: Craters of the Moon National Monument and Yellowstone National Park (Hudak, 2008)
- Map: Geology of Craters of the Moon National Monument and the Geological Map of Yellowstone National Park (both will be provided)
- Other Supplies: Field book (hard-back, waterproof), No. 3 pencils, colored pencils, calculator, protractor, compass (available from Department)
- Grading: Grades will be based on: a) evaluation of your field notebooks; b) evaluation of your guidebook exercises; and c) your overall performance on the trip. Evaluations will be conducted by Dr. Hudak and his teaching assistants. You will be instructed on how to keep a good field notebook in a meeting prior to our departure for the trip.
- Pre-Trip Meetings: An organizational meeting will be held February 24 at in Harrington 217 at 4 p.m. in Harrington 217. Subsequent meetings will be announced via e-mail and on the bulletin boards throughout Harrington Hall.
- Transportation: All transportation will be by University vehicles, in caravan.
- Course Objectives: Your objectives for this course should, at a minimum, include the following:
- To learn how to make and record geological observations in the field and to systematically record them in notes and on a map;
  - To learn how to interpret field observations in terms of the origins of rocks, structures, landforms, and groundwater and the geological history that they represent;
  - To accomplish the above objectives via written geological field book and completed guidebook exercises (including small geological maps, geological sketches, and geological problem sets)
  - To gain an understanding of the volcanological, hydrogeological, and tectonic processes which have led to the formation of the Craters of the Moon volcanic center and the Yellowstone Caldera and its included hydrogeological systems.
  - To understand the physical and chemical differences between mafic and felsic volcanic centers.
  - To gain an appreciation for the beauty and fragility of these two unique and geologically significant natural settings.

## Tentative Generalized Itinerary and Emergency Contact Numbers

<b>Date</b>	<b>Time</b>	<b>Location</b>
<b>May 19</b>	2:30pm	Harrington Hall – Organize gear and pack vans for trip
<b>May 20</b>	5:30 am 8:00 pm	LEAVE: Geology Department, University of Wisconsin Oshkosh ARRIVE: Badlands National Park Camp Location: Cedar Pass Group Campground (605-433-5235) <u>Objectives:</u> Drive from the Geology Department to Badlands National Monument. <u>Itinerary:</u> Travel will be via State Highway 21 and Interstate Highways 90/94. Lunch at approximately noon; dinner at approximately 6:00 pm <u>Activities:</u> No major activities planned other than driving and setting up camp
<b>May 21</b>	7:00 am 1:00 pm	LEAVE: Badlands National Park (after touring Badlands) ARRIVE: Devil’s Tower National Monument Camp Location: Devil’s Tower N. M. Belle Fourche Campground (307-467-5283) <u>Objectives:</u> Brief tour of the Badlands, 3-4 hour drive to Devil’s Tower. <u>Itinerary:</u> Travel will be via Interstate Highway 90 and Wyoming Highways 14 and 24. We will have lunch when we arrive at Devil’s Tower. We will then set up camp in early afternoon prior to doing our field exercise. <u>Activities:</u> We will take a brief tour of Badlands National Monument, occasionally stopping to describe the geology and take photographs. We may do a short field exercise (measuring sections) in the afternoon just outside of Devil’s Tower National Monument.
<b>May 22</b>	7:00 am 7:00 pm	LEAVE: Devil’s Tower National Monument ARRIVE: West Yellowstone, MT Camp Location: Yellowstone Grizzly RV Park (406-646-4466) <u>Objectives:</u> Drive from Devil’s Tower National Monument to West Yellowstone (MT). <u>Itinerary:</u> We will travel via Interstate Highway 90 and Wyoming State Highways 343/14/14-16. We will have lunch at approximately noon, and should arrive in West Yellowstone, Idaho by about 7 pm (via a drive through Yellowstone Park). After setting up camp we will have a group dinner at a local restaurant in West Yellowstone. <u>Activities:</u> No major activities other than driving and setting up camp.
<b>May 23</b>	7:30 am 3:00 pm	LEAVE: West Yellowstone, MT ARRIVE: Craters of the Moon National Monument, ID Camp Location: Craters of the Moon National Monument (208-527-3257) <u>Objectives:</u> Drive from West Yellowstone to Idaho Falls via Idaho Highway 20. Shop for three days worth of food in Idaho Falls. Drive to Craters of the Moon National Monument via Idaho Highways 20 and 26/93. Set up camp at Craters of the Moon and take a hike through several volcanoes in the park. There will be a short volcanology lecture following dinner at the camp. <u>Itinerary:</u> We will then travel south to Idaho Falls via Idaho State Highway 20. We will stop in Idaho Falls to pick up food for 3 days. We will have lunch at a park in Idaho Falls. We will proceed west from Idaho Falls on State Highway 20 to Arco, stopping along the way to observe the East Butte and Middle Butte volcanic features, as well as the Axial Volcanic Zone associated with the Snake River Plain. We will proceed south from Arco on State Highway 20/26/93 to Craters of the Moon National Monument, where we will camp. <u>Activities:</u> AM: 1) Break camp in West Yellowstone and drive to Idaho Falls; 2) shop for food in Idaho Falls: PM: 1) Eat lunch in Idaho Falls; 2) Observe Cenozoic volcanic features of the Snake River Plain, including East Butte, Middle Butte, and the Axial Volcanic Zone, which are all associated with Snake River Plain volcanism; 3) set up camp at Craters of the Moon National Monument; 4) Hike around Craters of the Moon National Monument; 5) Group volcanology lecture in the evening.

**May 24**

7:00 am LEAVE: Craters of the Moon National Monument  
6:00 pm ARRIVE: Craters of the Moon National Monument  
Camp Location: Craters of the Moon National Monument (208-527-3257)

Objectives: 1) Observe, sketch, photograph and discuss the genesis of the volcanic features of Craters of the Moon National Monument; 2) determine the best location within the park to perform the following day's mapping exercise (dictated by access, snow conditions, park regulations, conversations with park officials).

Itinerary: We will spend the whole day touring Craters of the Moon National Monument, observing, sketching, photographing, and discussing the various volcanic features that are present. We will break camp between 7:00 and 8:00 am. In the morning we will meet with a Craters of the Moon Geologist who will give us some insight into the volcanic activity that took place in the region. Lunch will be eaten in the field at approximately noon. We will arrive back at camp approximately 6:00 pm.

Activities: 1) Overview stop to describe the geological environment at Craters of the Moon, and geological processes associated with basaltic and andesitic volcanism; 2) develop individual skills observing, sketching, describing, and photographing geological features.

**May 25**

7:00 am LEAVE: Craters of the Moon National Monument  
6:00 pm ARRIVE: Craters of the Moon National Monument  
Camp Location: Craters of the Moon National Monument (208-527-3257)

Objectives: 1) Develop geological mapping skills by working in small groups; 2) learn to decipher the geological history and geological processes that occurred during an eruption at Craters of the Moon by performing detailed mapping and identifying and interpreting various spatial relationships between various types of rocks and lava flow features.

Itinerary: We will spend the whole day in the field mapping volcanic features in Craters of the Moon National Monument. We will break camp at approximately 8:00 am. Lunch will be packed prior to leaving camp and will be eaten in the field. We will arrive back at camp approximately 6:00 pm.

Activities: Geological mapping will be done in small groups (4 to 6 students per group) and will be done on digitally enhanced (scaled to show more detail) USGS topographic maps. Mapping will take place from mid-morning until mid-afternoon. During the later part of the afternoon, we will assemble all of the maps from the area and put together a composite map based on each group's individual mapping. We will then discuss the results of our day's work, and discuss some of the problems encountered while mapping and while putting together maps made by different people.

**May 26**

7:00 am LEAVE: Craters of the Moon National Monument  
6:00 pm ARRIVE: West Yellowstone, MT  
Camp Location: Yellowstone Grizzly RV Park (406-646-4466)

Objectives: 1) Continue to develop our understanding of the volcanic events associated with Snake River Plain volcanism by observing the volcanic features present at the North Robbers Lava Field, the South Robbers Lava Field, the Cerro Grande Lava Field, and the Axial Volcanic Zone; 2) gain a further understanding of the temporal relationships, spatial relationships, and volcanic deposits formed during the formation of the 2 million year old Island Park Caldera complex; 3) discuss the movement of the Yellowstone Hot Spot over the last 2 million years; and 4) weather permitting, get an opportunity to take photographs of the west side of the Teton Mountain Range.

Itinerary: We will pack up camp and leave Craters of the Moon National Monument between 7:00 and 8:00 am. We will proceed north to Arco on State Highways 20/26/93, then turn east and observe Big Southern Butte, Cedar Butte, Table Legs Butte, and Taber Butte as we make our way southeast along State Highway 26 to Blackfoot. We will proceed north from Blackfoot on Highway 15 to Idaho Falls. We will eat lunch at approximately noon. We will continue north from Idaho Falls on Highway 15 to the Three Tetons historical marker located approximately 2 miles north of Ashton, Idaho. We will then make several short stops to observe the volcanic deposits and volcanic landforms along Highway 15 between Ashton and West Yellowstone, MT. These will include unwelded and densely welded Mesa Falls Tuff, the Island Park Rhyolite, views of the Henry's Fork and Big Bend Ridge

Calderas, and views of the Yellowstone Plateau and the Madison Range. We should arrive in West Yellowstone approximately 6:00 pm, where we will set up camp at Yellowstone Grizzly RV Park. We will have a group dinner at a local restaurant in West Yellowstone after camp is set up.

Activities:

AM: Observe the various volcanic features present at Big Southern Butte, Cedar Butte, Table Legs Butte, and Taber Butte.

PM: 1) Stop and take photographs of the western side of the Teton Mountains; b) stop in several locations to look at different textures within the Mesa Falls Tuff, formed during the formation of the 2 million year old Island Park Caldera; 3) stop to look at an outcrop of the Island Park Rhyolite, a post-Island Park Caldera (1.2 million year old) lava flow; 4) view the Henry's Fork and Big Bend Ridge Calderas; 5) view the Yellowstone Plateau and the Madison Mountain Range.

**May 27**

7:00 am LEAVE: West Yellowstone, MT

6:00 pm ARRIVE: Madison Campground, Yellowstone Park

Camp Location: Madison Campground, Group Site C (307-344-2253)

Objectives: 1) Observe and interpret the tilted Paleozoic and Mesozoic rocks at Devil's slide 2) view and interpret processes associated with active landslides within Gardiner, MT.; 3) Park orientation and tour of the Mammoth Hot Springs area.

Itinerary: We will break camp at 7:00 am and drive north out of Yellowstone National Park into Gardiner, Mt. We will proceed north to observe the "Devil's Slide". We will return to Gardiner to observe the geomorphology of active landslides near the gate to Yellowstone Park. We will then proceed to Mammoth Hot Spring for a discussion with YNP staff at 2:00 pm. We will have a tour of the Mammoth Hot Spring area with YNP staff. Following the tour you will have time to visit Mammoth Hot Spring on your own (2-3 hours). We will meet at approximately 5:00 pm and proceed to the Madison Campground. After registering, we will set up camp and cook dinner. A short lecture on the volcanic history of Yellowstone Park will follow dinner.

Activities

AM: We will drive north through Gardiner, MT and observe several geological features exposed in roadcuts along State Highway 89. We will then return to Gardiner, and observe the active landslides located to the west of the city. We will re-enter Yellowstone National Park and stop for lunch at the Mammoth Visitors Center.

PM: We will take a brief tour of, the Mammoth Visitors Center. We will meet with YNP staff for a guided tour of the Mammoth Hot Spring complex. Following the tour, we will hike from the upper terraces down to the lower terraces of the complex. During this hike, we will occasionally stop to sketch or photograph some of the unique features of this travertine hot spring complex. We will go to the Madison Campground for dinner and a good nights rest.

**May 28**

7:30 am LEAVE: Madison Campground, Yellowstone Park

6:30 pm ARRIVE: Madison Campground, Yellowstone Park

Camp Location: Madison Campground, Group Site C (307-344-2253)

Objectives: 1) Develop an understanding of the pre-caldera geological history of Yellowstone Park; 2) observe, discuss, and interpret some of the modern surficial processes in Yellowstone Park (e.g. landslides and debris flows); 3) develop skills in making field observations.

Itinerary: We will leave Madison Campground around 7:30 am and drive to the Boiling River Parking lot approximately 2 miles north of Mammoth. After a one- to two-hour long geological exercise, we will drive to Tower Junction, making two short geological stops along the way. We will proceed through the Lamar River Valley and make several short stops along the way. We will eat lunch at approximately noon after a short uphill hike to Trout Lake. We will return to Tower, making geological stops along the way. We will then complete a short sketching project at the Calcite Springs Overlook. We will return to the Madison Campground at approximately 6:30 pm

### Activities

AM: 1) Rock examination and description exercise at the Boiling River parking area; 2) observations of Huckleberry Ridge Tuff and Absaroka Volcanics at Undine Falls parking lot; 3) observe and photograph Eocene petrified trees near Tower; 4) observe Soda Butte, the northeastern-most hot spring associated with the Yellowstone geothermal system; and 5) hike approximately 1.2 miles to Trout Lake, where we will have lunch.

PM: 1) Observe hydrothermally altered sediments along the banks of the Lamar River; 2) sketch basalt / sediment contact from Calcite Springs overlook; 3) sketch basalt / sediment contact at Overhanging Cliff parking lot; 4) discuss the age(s) of the basalts and their contact relationships with the sediments.

## **May 29**

7:00 am LEAVE: Madison Campground, Yellowstone Park

7:00 pm ARRIVE: Madison Campground, Yellowstone Park

Camp Location: Madison Campground, Group Site C (307-344-2253)

Objectives: 1) To gain an overall appreciation of the variety of hydrothermal features present in Yellowstone National Park by observing geothermal activity at several geyser basins; 2) to observe, sketch, photograph, and interpret various types of geothermal features within the park; and 3) to see at least two eruptions of Old Faithful Geyser.

Itinerary: We will break camp at 7:00 am. We will spend the day observing the hydrothermal features in the Upper, Midway, and Lower Geyser Basins. We will eat lunch in the field at Midway Geyser Basin at about noon. During the afternoon you will have approximately four hours to explore the Upper Geyser Basin and Old Faithful. We will pack up the vans at approximately 6:00 pm and return to Madison Campground for the evening.

### Activities:

AM: 1) Observe Porcupine Hills and discuss the results (and scientific importance) of the Y-13 drill hole; 2) tour of the Fountain Paint Pots hydrothermal features; 3) observe various hydrothermal features in the Lower Geyser Basin; 4) examine Grand Prismatic Spring and relatively fresh flow-banded, spherulitic rhyolite lava flows within the Midway Geyser Basin; 5) Lunch at Grand Prismatic Spring area.

PM: 1) Observe, sketch, photograph, interpret, and discuss the variety of hydrothermal features that are present at Upper Geyser Basin / Old Faithful; 2) observe and photograph at least two eruptions of Old Faithful Geyser; 3) hike along the margin of, and observe, the Mallard Lake rhyolite lava dome. There will be an optional hike to see several of the hydrothermal features present on the Mallard Lake dome.

## **May 30**

7:00 am LEAVE: Madison Campground, Yellowstone Park

7:00 pm ARRIVE: Bridge Bay Campground, Yellowstone Park

Camp Location: Bay Bridge Campground, Group Site F (307-344-2253)

Objectives: 1) Obtain a better understanding of the volcanological processes responsible for the wide variety of volcanic rocks that will be observed; 2) gain an understanding of the differences between hot springs and fumaroles; 3) gain an appreciation for the process of hydrothermal alteration; 4) observe and think about the magnitude of geological events associated with the collapse of a caldera complex.

Itinerary: We will eat breakfast, pack up, and break camp by approximately 7:00 am. From the Bridge Bay Campground we will drive north to Canyon, west towards Norris Junction, and then north toward Mammoth, stopping along the way to look at a variety of volcanic rocks, hydrothermal and fumarolic features, as well as several geological structures associated with “basin and range” style tectonics. We will eat lunch at the parking area on Firehole Canyon Drive. After a one- to two-hour geological exercise, we will head north to Norris Geyser Basin, and spend the rest of the afternoon at the site of the highest concentration of hydrothermal features on earth. We will leave Norris at 6:00 pm and return to Bay Bridge Campground by around 7:00 pm.

### Activities:

AM: 1) Stop at Golden Gate to observe the outstanding outcrops of Huckleberry Ridge Tuff; 2) observe and discuss “basin and range” tectonics at a brief stop at Swan Lake Flat; 3) observe, sketch,

photograph, and discuss the volcanic features at Sheepeater Cliffs; 4) observe, photograph, and discuss the genesis of Obsidian Cliff; 5) observe, photograph, smell, and discuss the differences between fumaroles and hot springs, as well as talk about hydrothermal alteration and the formation of epithermal gold ore deposits at Roaring Mountain.

PM: 1) Virginia Cascades field exercise (if area is open); 2) Observe Beryl Spring; 3) Observe, sketch, photograph, and discuss the volcanic features present in a one-mile long traverse along Firehole Canyon Drive; 4) observe, photograph, smell, and discuss the wide variety of hydrothermal features in Norris Geyser Basin.

## May 31

7:00 am LEAVE: Bridge Bay Campground, Yellowstone Park

7:00 pm ARRIVE: Bridge Bay Campground, Yellowstone Park

Camp Location: Bridge Bay Campground Group Site F (307-344-2253)

Objectives: 1) See more of the variety of hydrothermal features in Yellowstone Park by visiting the West Thumb hydrothermal field; 4) observe hydrothermal alteration associated with a hydrothermal crater at Steamboat point.

Itinerary: We will eat breakfast and leave camp at 7:00 am. We will travel to West Thumb Geyser basin. We will tour and do some sketching exercises during 2-3 hours at the West Thumb Geyser Basin. We will eat lunch about noon. We will drive east to Steamboat Point to observe hydrothermal alteration exposed during the formation of a hydrothermal crater. We will then travel approximately five miles east, out of the caldera complex, and look at Absaroka lahar deposits. We will return to Bridge Bay Campground at approximately 6:00 pm.

### Activities

AM: 1) West Thumb Geyser Basin tour and exercises.

PM: 1) observe, sketch, perform mineral identification, and discuss the hydrothermal alteration minerals and the genesis of Mary's Bay (Yellowstone Lake); 2) observe and smell the active geothermal venting at Steamboat Point; and 3) observe and sketch some of the lahar deposits associated with the Absaroka volcanics.

## June 1

7:00 am LEAVE: Bridge Bay Campground, Yellowstone Park

6:00 pm ARRIVE: Bridge Bay Campground, Yellowstone Park

Camp Location: Bridge Bay Campground, Group Site F (307-344-2253)

Objectives: 1) Observe extremely acid hydrothermal systems at Mud Volcano, and discuss the genesis of the extreme acidity within the hydrothermal fluids present at this geothermal site; 2) observe, photograph, and discuss the genesis of the Grand Canyon of Yellowstone Park.

Itinerary: We will break camp between 7:00 and 8:00 am. Our first stop will be the Mud Volcano hydrothermal field to observe extremely acid hydrothermal activity. We will then make several stops along the Grand Canyon of the Yellowstone. We will eat lunch at approximately noon. Following lunch, if weather and ground conditions permit, we will take a short (1-2 mile) hike along the rim of the Grand Canyon of the Yellowstone. We will stop at Canyon Village to observe the exhibits there, as well as to buy souvenirs. We will then make our way back to the Bridge Bay campsite, arriving at approximately 6:00 pm.

Activities: 1) Tour the Mud Volcano hydrothermal field, and discuss the genesis of the extremely acid hydrothermal fluids in this geothermal area; 2) observe and smell Sulphur Cauldron, one of the most acid hot springs in Yellowstone Park; 3) make several stops on the north side of the Grand Canyon of the Yellowstone, including Brink of the Lower Falls, Lookout Point, and Inspiration Point; 4) make several stops on the south side of the Grand Canyon of the Yellowstone including Upper Falls Viewpoint and Artist Point; and 5) weather and ground conditions permitting, take a short hike (2-3 miles) on the south rim of the Grand Canyon of the Yellowstone.

**June 2**

7:00 am LEAVE: Bridge Bay Campground, Yellowstone Park  
 8:00 pm ARRIVE: Devil's Tower KAO Campground

Camp Location: Devil's Tower KAO Campground (307-467-5395)

Objectives: 1) Observe and discuss the destruction associated with the 1959 Madison Canyon earthquake and landslide; 2) visit the Hebgen Lake Visitors Center; 3) Start our return trip to Oshkosh by leaving Hebgen Lake and driving north on State Highway 191 to Bozeman, MT. From there we'll take Interstate 90 East to Devil's Tower National Monument, WY, where we'll be camping.

Itinerary: We will travel to Hebgen Lake Visitors Center via the Yellowstone roads and Montana State Highway 287. We will plan to have lunch either at the visitor's center or somewhere in the area and to start our return trip to Oshkosh by 1pm.

Activities: 1) We will make several stops on our way to the Hebgen Lake Visitors Center, discussing various aspects of the 1959 earthquake (e.g. see the fault scarp, tour buildings destroyed by the earthquake, look at deformation in the roadway caused by the earthquake, discuss landslide processes associated with the earthquake); 2) Drive north to Bozeman, MT, then east through Montana and Wyoming arriving at Devil's Tower KAO Campground (WY) by around 8:00 in the evening.

**June 3**

7:00 am LEAVE: Devil's Tower KAO Campground, WY  
 8:00 pm ARRIVE: Blue Mounds State Park, Luverne, MN

Camp Location: Blue Mounds State Park Group Camp Site (507-283-1307)

Objectives: Continue to travel east towards Oshkosh.

Itinerary: We will pack up the vans and leave the Big Horn Mountains Campground by no later than 7:00 am. We will drive east on I-90, stopping at Wall Drug for some short but sweet last minute souvenir shopping. From Wall, we'll continue on I-90 East until we reach the exit for Luverne, Minnesota (exit 12). We will turn north on State Highway 75 and proceed to Blue Mounds State Park, where we will be camping for the evening. Anticipate arriving at Blue Mounds State Park between 8:00 and 9:00 in the evening

Activities: 1) Pack up camp, load vans, and hit the road by 7:00 am; 2) drive across Wyoming and South Dakota, stopping briefly at Wall Drug; 3) set up camp at Blue Mounds State Park for the evening, anticipate arriving at the park by around 8:00 pm.

**June 4**

7:00 am LEAVE: Blue Mounds State Park  
 4:00 pm ARRIVE: Geology Department, University of Wisconsin Oshkosh

Clean bus, clean and store equipment, turn in field notebooks, end of course

Objectives: 1) Break camp for the final time; 2) return to Oshkosh; 3) clean and store all field equipment for future trips; and 4) turn in field notebooks for final grading.

Itinerary: We will break camp and be on the road by 7:00 am. We will travel south on Minnesota State Highway 75 to Interstate 90, where we will turn left and travel east across Minnesota to Tomah, Wisconsin. We may eat lunch at a fast food restaurant along the highway, depending on how the group feels. In Tomah, we will join State Highway 21 and drive east until we arrive in Oshkosh (should be sometime mid-afternoon). Once we arrive at the Geology Department, we will clean the vans and the field equipment, store the field equipment, return the vans to Fleet Vehicles, and turn in field notebooks for grading.

Activities: 1) Break camp at 7:00 am; 2) travel east across Minnesota and Wisconsin to Oshkosh; 3) clean field equipment and vans; 4) return field equipment and vans to the appropriate locations; and 5) turn in field notebooks for final grading.

*Any of the emergency numbers listed for the campgrounds should work if you should need to be contacted. You may also be contacted during emergencies by calling the Geology Department cellular phone at 920-420-7820. We will have this phone with us at all times during our excursion.*