



# YELLOWSTONE FOREVER

## **HYDROTHERMAL FEATURES AND EXPLOSION CRATERS #180801**

Start: 8/1/2018 at 7:00 p.m.

End: 8/5/2018 at 5:00 p.m.

Location: Old Faithful

Welcome to Yellowstone National Park. If you are a newcomer to the Yellowstone Forever Institute, you will be amazed at what awaits you during each day of exploration. We are glad that you are able to join us at Old Faithful, one of the park's most iconic locations. Our goal is to provide you with an enjoyable, high-quality educational experience and a safe and memorable visit to Yellowstone.

The following information is provided to help you prepare for your program. Please read it thoroughly and call us at 406.848.2400 or email [contact@yellowstone.org](mailto:contact@yellowstone.org) if you have any questions. We recommend all first time visitors seek general park information through the National Park Service at 307.344.2107 or [www.nps.gov/yell](http://www.nps.gov/yell).

### **Important Information Included in this Document:**

- Letter from Your Instructor
- What's Included
- How to Prepare for this Program
- Suggested Reading
- Yellowstone Forever Park Store Information
- Yellowstone Forever Supporter Information
- Code of Ethics
- Cancellation Policy
- Travel Information
- Supplemental Lodging Information

Welcome to the Yellowstone Forever Institute program, "Hydrothermal Processes Above the Yellowstone Magma Chamber: Large Features and Explosion Craters." As a visitor to Yellowstone National Park, you may know that the Yellowstone Caldera is one of the largest active volcanoes on Earth. What you may not know is that the Yellowstone Caldera hosts the largest hydrothermal system in the world and is larger than all other hydrothermal systems, combined. Yellowstone has over 10,000 hydrothermal features ranging from small fumaroles, hot springs, and mud pots to large geysers, thermal basins, and explosion craters.

In this five-day seminar, my goal is that you gain an appreciation for the scale of hydrothermal activity in Yellowstone, the critical influences of water and high topography, and better understand the complex processes that lead to the formation of one of the largest and not-well-understood potential geologic hazards in the park. We will meet the first evening at 7 p.m. in Yurt A near the Old Faithful Visitor Education Center. At that time, I will provide a general introduction to Yellowstone's volcanic history with a focus on its



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hydrothermal systems, especially the large hydrothermal explosion craters, the largest explosion craters in the world.

By the time the course is over, you should have a good feel for hydrothermal systems and processes, and a better understanding of large hydrothermal explosion events, their triggers, and their history in Yellowstone. Except for the evening lecture and optional hike, all class time will be spent, rain or shine, walking around in the outdoors and making observations. Good walking shoes will be required, as we could accumulate up to 12 miles in one day. This is an activity level 5 course.

*Lisa Morgan*, USGS  
Scientist emeritus, Yellowstone Volcano Observatory

## Program Itinerary

### Day 1

7:00 p.m. Orientation of class and the next two days in the field and an overview of the geologic evolution of the Yellowstone Caldera: Meet in Yurt A near the visitor center

Lunch and snacks are not provided so please make sure you bring a lunch, snacks, and adequate water for your needs during each day.

The locations listed below are planned stops but are subject to change depending on conditions in August.

### Day 2

7:15 a.m. Meet in front of the fireplace at the Old Faithful Lodge.

7:30 a.m. Depart for day. Today we will head east from Old Faithful and go over Craig's Pass. Today we will be visiting several very large hydrothermal explosion craters.

- We will stop at the Duck Lake overlook and look east into Duck Lake, which has about 20 m perched water table above Yellowstone Lake.
- Continue south and east. Turn left for West Thumb geyser basin. Turn right into the parking lot and park close to road. We will cross the road here and hike into Duck Lake hydrothermal explosion crater, which may have formed somewhere between 4-6,000 years ago.
- Dive north along the western margin of Yellowstone Lake. We will discuss an NSF (National Science Foundation) funded project, HD-YLake (Hydrothermal Dynamics of Yellowstone Lake) that I am part of and is currently active in the park. We will stop at Bridge Bay either this morning or later this afternoon to catch a look at the *RV-Annie* and the remotely operated submersible, *Yogi*.
- We will continue north to Fishing Bridge to look at a solid, 3D map of Yellowstone Lake and discuss its geology.



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- We will continue east and park at the parking area for the 2900-year-old Indian Pond hydrothermal explosion crater. We will discuss the large number of large hydrothermal explosion craters in this area and in the lake in addition to large hydrothermal domes. We will hike out to Storm Point and then hike out onto Mary Bay to look at the deposits from the explosions.

5:30-6:00 p.m. Return to Old Faithful.

Return to Old Faithful. Dinner is on your own. For those interested, meet at 8 p.m. at fireplace in Old Faithful Lodge and we will walk around Geyser Hill and parts of Upper Geyser Basin (optional).

## Day 3

7:15 a.m. Meet at in front of the fireplace at the Old Faithful Lodge.

7:30 a.m. Depart for day.

Today we will head west and north from Old Faithful and head for Norris geyser basin, one of the hottest and most active thermal basins in Yellowstone and home to Steamboat Geyser, which boasts the currently tallest geyser active in the world (~300 feet, ~92 m).

- Stop at Midway Geyser Basin. We will walk around Excelsior crater, which erupted initially as a large hydrothermal explosion crater in 1898, as well as Grand Prismatic hot springs, the third largest hot spring on earth and the largest one in North America.
- Park in the parking area outside of the Norris parking north of the intersection and on the east side of the road. Hike into Norris geyser basin through the woods coming into Porcelain Basin.
- Hike over to Porkchop Geyser, a small hydrothermal explosion crater that formed in September 1989.
- Drive south along the topographic margin of the Yellowstone caldera where exposures of the Lava Creek Tuff are thick and mostly outside of the margin and large post-caldera rhyolitic lava flows fill the caldera.
- Drive to Fountain Flats road and park. We will hike through the Pocket Basin hydrothermal explosion crater and look at features in the crater and along the Firehole River. Walk down to Ojo Caliente hot springs and out to Sentinel Hot Springs.
- Drive farther south to Biscuit Basin where we will look at Black Diamond Geyser, a geyser that has been erupting hot mud with some rocks in recent years.

6:00 p.m. Return to Old Faithful. Dinner is on your own.

## Day 4

7:15 am Meet at in front of the fireplace at the Old Faithful Lodge.

7:30 a.m. Depart.

Our third day will be spent first looking at the interconnected hydrothermal fractures exposed in the walls of Yellowstone Canyon.



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- Drive east from Old Faithful over Craig's Pass. Drive north along the west side of Yellowstone Lake. Turn right at Fishing Bridge and head east to parking for Pelican Valley and Turbid Lake. We will hike to Turbid Lake (about 9 miles round trip) and discuss its formation about 10,300 years ago.
- Return to vehicle and drive west past Fishing Bridge. We will drive north along the Yellowstone River and north along the Hayden Valley. Drive to Artist Point. Here we will have a short hike and look at the hydrothermally altered rocks exposed in the canyon.

6:00 p.m. Return to Old Faithful. Dinner is on your own.

## **Day 5.**

7:15 am Meet at in front of the fireplace at the Old Faithful Lodge.

7:30 a.m. Depart for day.

Today we will drive west from Old Faithful to Lower Geyser Basin and Twin Buttes.

Park at Fairy Falls trailhead. This will be approximately a 10-mile hike.

- Hike to Fairy Falls. On the way, we will hike up to the platform overlooking Grand Prismatic. Continue hike to Fairy Falls and continue to Spray Geyser and Imperial Geyser.
- Hike up to the top of Twin Buttes where a large hydrothermal explosion crater with several smaller ponds is located in ice-contact deposits.
- Return to Old Faithful.

## **What's Included:**

Your tuition includes daily outings and transportation during your program. It does not include transportation to the park, park entrance fees, meals, or lodging. Gratuities are not included in the price of programming. If you would like to recognize exceptional service by a Yellowstone Forever Institute staff member, tips are appreciated. Donations to support Yellowstone Forever educational programs are also appropriate and will be used to improve and expand opportunities for people to make deep connections to Yellowstone.

## **Continuing Education Credit**

Many of our Field Seminars are recognized by universities across the country. We are happy to provide a letter of completion and supporting documentation that you can submit to the institution of your choice to request approval for university credit or CEUs.

## **Lodging Option**

Rooms will be held until 30 days prior to the program in the Old Faithful area for students attending this program for an additional charge. To make your reservation, please call 866.439.7375 and give them the Yellowstone Forever Institute program name.

## **How to Prepare for this Program:**



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## How fit do you need to be?

This program is an activity level 5 and students enrolled in this program are expected to be active participants. Be prepared for brisk, aerobic, destination-oriented hiking up to 12 miles a day. You should be physically conditioned to do these hikes comfortably and keep pace with the rest of the group. Elevation changes up to 2000 feet on dirt trails or off-trail. Loose rock, uneven footing, steep hillside traverses, and stream crossings are possible. Good coordination is required. We recommend you begin an exercise program right away if you have not already done so. Participants residing at lower elevations may want to arrive a day early to adjust to the altitude. To learn more about how specific medical conditions can be affected by Yellowstone's environment and our activities, please visit [www.Yellowstone.org/experience/health-information/](http://www.Yellowstone.org/experience/health-information/)

## General Clothing and Equipment List

Much of your time will be spent outdoors and all programs are held rain, snow, or shine. You should be prepared for a variety of mountain weather conditions and temperatures. Appropriate clothing, equipment, and footwear are very important. Spring, summer, and fall temperatures can range from below freezing in the mornings to 85 degrees Fahrenheit in the afternoons. The layered use of garments for protection against the wind, sun, and temperature extremes should guide your clothing choices. Loose-fitting layers allow you to maintain a comfortable and dry body as outside temperatures change, and as your own body temperature and moisture output changes with different levels of exertion. Some colder-weather items may not be needed in July or August, but please keep in mind that Yellowstone's weather is unpredictable.

## Equipment:

Yellowstone Forever field staff assigned to your program will be carrying a first aid kit, bear spray, and emergency communication device.

- Daypack**, with enough capacity to carry extra clothes, water, lunch, camera, binoculars, field guides, etc.
- Water bottle**, one-quart is the minimum recommended. Camelback or similar hydration systems work well in summer but can freeze in winter.
- Sunglasses**
- Sunscreen/lip protector**, sun at high altitude can burn unprotected skin quickly.
- Camera, binoculars**
- Notebook/pencil**
- Pocket hand and foot warmers**, recommended November through May.
- Flashlight/Headlamp**, a small light for walking to and from your cabin in the evenings and mornings.
- Alarm**, so you're on time for the day's activities.

## Summer Clothing:

- Insulating underwear**, capilene, polypropylene, or similar wicking fabric.
- Midweight insulating layer**, light, 200-weight synthetic fleece or wool shirt/pullover.
- Heavyweight insulating layer**, wool, down, or heavy-weight fleece jacket, for less-active times.



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- Waterproof and windproof outer layer**, lightweight and breathable. Jackets and pants are recommended.
- Short sleeved shirt**, cotton okay in summer, but synthetic wicking shirts are ideal.
- Pants**, synthetic hiking pants, lightweight pile/fleece pants or tights or similar. Jeans are not recommended.
- Hats**, both a brimmed sun hat and an insulating hat for cool weather.
- Gloves**, lightweight glove liners and a pair of wool/fleece gloves or mittens.
- Socks**, light wool or synthetic liner sock with heavier wool or synthetic outer sock. The inner-outer sock combination helps prevent blistering, wicks moisture and reduces friction. Cotton socks do not wick moisture and are not recommended.
- Hiking boots**, that provide stability, traction, and comfort. Unless you've consistently hiked in athletic shoes, bring boots that provide ankle support.
- Off-duty shoes**, sandals, athletic shoes, or other leisure footwear.

## Required Reading

- Brantley, S. R., Lowenstern, J. B., Christiansen, R. L., Smith, R. B., Heasler, H., Waite, G., and Wicks, C., 2004, "Tracking Changes in Yellowstone's Restless Volcanic System." U.S. Geological Survey Fact Sheet 100-03. <http://pubs.usgs.gov/fs/fs100-03/>
- Lowenstern, J. B., Christiansen, R. L., Smith, R. B., Morgan, L. A., Heasler, H., 2005. "Steam Explosions, Earthquakes, and Volcanic Eruptions — What's in Yellowstone's Future?" U.S. Geological Survey Fact Sheet 2005-3024. <http://pubs.usgs.gov/fs/2005/3024/>
- Yellowstone Volcano Observatory Website (<http://volcanoes.usgs.gov/yvo>). Please read some of the articles on the front page, some of the archived articles, and the FAQs. We will likely be making changes over the next month, so keep an eye out for anything new!

## Suggested reading

- Morgan, Lisa A., Shanks, W.C. Pat, and Pierce, Kenneth L., 2009. "Hydrothermal processes above a large magma chamber: Large hydrothermal systems and hydrothermal explosions in Yellowstone National Park" Geological Society of America Special Paper 459, 95 pgs.
- Good, John M., and Pierce, Kenneth L., 1996, *Interpreting the Landscapes of Grand Teton and Yellowstone National Parks - Recent and Ongoing Geology.*, 58 p. doi:ISBN-10: 0931895456, available at Yellowstone Forever stores in the park.
- Christiansen, R. L., 2001, "The Quaternary and Pliocene Yellowstone Plateau volcanic field of Wyoming, Idaho, and Montana" U.S. Geological Survey Professional Paper: 729-G, 145 p., 3 plates, scale 1:125,000. This is the ultimate word on Yellowstone's volcanic geology. Available through the Yellowstone Forever Park Store or a **large** online version can be downloaded from: <http://geopubs.wr.usgs.gov/prof-paper/pp729g/>
- Morgan, L.A., Shanks, WCP, Lowenstern, JB, Farrell, JE, and Robinson, J, 2017, Geologic field trip guide to the Volcanic and Hydrothermal Landscape of the Yellowstone Plateau: U.S. Geological Survey Scientific Investigations Report 2017-5022-P.



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- Hurwitz, S., and Lowenstern, J.B., 2014, Dynamics of the Yellowstone hydrothermal system, *Reviews in Geophysics*, v, 51, doi:10.1002/2014RG000452.

## Park Stores

Our Park Stores feature more than 900 books, maps, and videos to help you plan your visit, along with a wide selection of shirts, hats, and other logo items to remind you of your visit to Yellowstone. Yellowstone Forever supporters receive a 15 percent discount on merchandise online or at any of our 11 locations in and around Yellowstone. Proceeds directly support Yellowstone. Visit: [Shop.Yellowstone.org](http://Shop.Yellowstone.org)

## Supporter Program

Yellowstone Forever Supporters directly fund priority park programs and projects. Supporters also provide scholarships for teachers and help expand programming for underserved youth. Benefits include a subscription to our magazine *Yellowstone Quarterly*, early registration and discounts for Yellowstone Forever Institute programs, and discounts on retail purchases throughout Yellowstone (exclusions apply). If you are not yet a supporter of Yellowstone Forever, an introductory subscription (one year) to our magazine *Yellowstone Quarterly* is included with your tuition. For more information, visit: [Yellowstone.org/donate](http://Yellowstone.org/donate)

## Code of Ethics

The Yellowstone Forever Institute is committed to demonstrating a high standard of appropriate and ethical behavior in Yellowstone. As a participant in a Yellowstone Forever Institute program, we ask you to adhere to the following Code of Ethics. In addition to the ethics highlighted below, the Institute abides by all National Park Service rules and regulations. We also practice Leave No Trace guidelines for traveling responsibly in the wilderness.

**Observing wildlife:** We will do our best to have as little impact on wildlife as possible. Animals will be observed from a distance, using high-powered spotting scopes to help keep our presence from affecting their behavior. Participants should not expect to get close-up photographs of wildlife. The Yellowstone Forever Institute will adhere to National Park Service regulations by keeping a minimum distance of 25 yards from bison, elk, bighorn sheep, deer, moose, coyotes and nesting birds and 100 yards from bears and wolves. We will not entice wildlife with food, animal calls or any actions that change their behavior.

**Leave what you find:** It is illegal to remove natural or cultural artifacts (plants, animals, bones, rocks, etc.) from Yellowstone. Yellowstone Forever Institute instructors have permission from the National Park Service to manipulate plants, rocks, bones, etc. for educational purposes and will return them to their natural positions and locations.

**General etiquette:** Yellowstone Forever Institute groups will be considerate of other visitors and respect the quality of their experience. Voices and vehicle sounds carry great distances and affect both wildlife and people—remaining silent or very quiet while watching wildlife lets the sounds of Yellowstone (including wolf howls) prevail.



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**Roads and vehicles:** Expect wildlife on the road, and drive at or below the posted park speed limits. When stopping to observe wildlife or other park features, the Yellowstone Forever Institute will move vehicles entirely off the road. If there is no safe pullout available, we will drive to the next safe place and walk back to observe the wildlife. We will not stop in the middle of the road, and should a traffic jam develop as a result of our activities, we will cease the activity.

**Properly dispose of waste:** We will pack out all trash, leftover food and litter. Your instructor will discuss techniques for properly disposing of human waste in the field.

**Traveling lightly:** When hiking or walking in Yellowstone, we will use existing trails and boardwalks. We will follow appropriate techniques when walking off-trail. Walking around muddy or wet places in the trail increases erosion and negatively affects the resource; proper equipment is essential to hiking ethically. Participants should come adequately prepared with the equipment listed for their course and should expect to walk through mud, snow or puddles in the trail.

*Thank you for helping us set a good example in Yellowstone!*

## **Field Seminar Cancellation and Refund Policy**

If you cancel within seven calendar days of your registration date, your payment is refundable less a \$50 per person per course processing fee. Under most circumstances, if you cancel on the eighth calendar day or after, from the date of registration, 100% of registration payments will be forfeited. If lodging is cancelled after the eighth calendar day from the date of registration, 100% of lodging payments will be forfeited. Applicable taxes will be refunded in the event of program or lodging cancellations. We reserve the right to cancel a course up to 30 days before the first class day. If we cancel, you will receive a full refund of your payment. We urge you to take out accident, baggage, and trip cancellation insurance through a travel agent or website such as [TravelGuard.com](https://www.travelguard.com). Travel insurance can help protect you against financial loss if you must cancel or interrupt your trip.





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## Yellowstone Map **YELLOWSTONE FOREVER**



POINT TO POINT DISTANCE		Miles/Kilometers
North Entrance to Mammoth Hot Springs	5 mi/8 km	
Mammoth Hot Springs to Norris	21 mi/34 km	
Norris to Canyon	12 mi/19 km	
Norris to Madison	14 mi/23 km	
Madison to West Entrance	14 mi/23 km	
Madison to Old Faithful	16 mi/26 km	
Old Faithful to West Thumb	17 mi/27 km	
West Thumb to South Entrance	22 mi/35 km	
West Thumb to Bridge Bay	21 mi/34 km	
Fishing Bridge to East Entrance	27 mi/43 km	
Fishing Bridge to Canyon	16 mi/26 km	
Canyon to Tower Falls	19 mi/31 km	
Roosevelt to Northeast Entrance	29 mi/47 km	
Roosevelt to Lamar Buffalo Ranch	11 mi/17 km	
Roosevelt to Mammoth Hot Springs	18 mi/29 km	

ELEVATIONS		feet / meters
North Entrance	5314 / 1620	
West Entrance	6667 / 2032	
South Entrance	6886 / 2099	
East Entrance	6951 / 2119	
Mammoth Hot Springs	6239 / 1902	
Old Faithful	7365 / 2254	
Grant Village	7733 / 2357	
Lake	7784 / 2373	
Canyon	7734 / 2357	
Roosevelt	6270 / 1911	



**OPEN ROADS**

**YF FACILITIES**

**ENTRANCE GATES**

**COMMON POINTS OF INTEREST**

1 mile (mi) = 1.609344 kilometers (km)