

Temperature Measurements at the Historic Old Faithful Pub, Yellowstone National Park



Figure 1. Panoramic view of the historic Old Faithful Pub located near the Old Faithful Inn. Notice the currently inactive geyser and its cone on the left of the photograph and the sloping land surface extending from the geyser cone towards the pub. The sloping land surface is the siliceous sinter apron associated with flowing hydrothermal water. On 22 July 2009, the temperature at 20 inches depth in the inactive geyser was 186 °F (85.5 °C). Photograph taken on 26 June 2009, view to the north.

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INTRODUCTION

Herb Dawson and Mary Murphy of Yellowstone's Concessions Management Division provided Yellowstone National Park Geology Program personnel with final plans for preservation of the historic Old Faithful Pub in June 2009. The plans described the excavation of the entire area under the pub structure (about 6,000 square ft (560 square m)) from one to 4 ft in depth (0.3 to 1.2 m), and excavations for curbing, water lines, and sewer lines.

Because the construction area is occurring within an active thermal area, YNP Geology Program personnel undertook a reconnaissance of subsurface temperatures on 22 July 2009. The purpose of the reconnaissance was to gather data for delineation of hydrothermal activity at the construction site. The data and this report can be used to 1) protect the thermal resource of the Old Faithful area, 2) define safety protocols for workers at the construction site, and 3) aid the design of a building that will be minimally impacted by ongoing hydrothermal activity.

LOCATION OF STUDY AREA AND GEOLOGY

The historic Old Faithful Pub is located about 400 ft (122 m) to the southwest of the Old Faithful Inn (see Figure 2). The pub is on thermal ground associated with the Myriad Thermal Group.

Previous geologic mapping (Christiansen and Blank, 1974; Waldrop, 1975; and Muffler and others, 1982) shows the geologic setting of the Upper Geyser Basin and the Old Faithful hydrothermal area. Christiansen and Blank's (1974) bedrock map shows sediments and silica-rich sinter between the lava flows of the Mallard Lake Dome (Mallard Lake rhyolite flow) and the Madison Plateau (Summit Lake rhyolite flow). Christiansen and Blank (1974) and more detailed mapping by Muffler and Others (1982) show the location of the historic pub within the sinter plain (Figure 3). Waldrop's (1975) geologic mapping emphasizes the various types of sediments in the Upper Geyser Basin and Old Faithful area. He describes (1) the obsidian-rich sands eroded from nearby lava flows, (2) the hydrothermally deposited silica-rich white to light gray sinter, and (3) various glacial and late glacial sediments. Muffler and others (1982) provides a detailed geologic map of the Upper Geyser Basin. Their detailed map clearly shows the location of the historic Old Faithful pub on silica-rich white to light-gray sinter in the Myriad Group.

In the Upper Geyser Basin, a red clay layer exists in the Old Faithful developed area. Red clay forms when hydrothermal waters interact with obsidian-rich sands. This red clay layer forms a barrier to boiling temperature steam and water flow. Excavation into this red clay layer can result in the release of boiling-temperature fluids. Due to the importance of the red clay layer, Yellowstone Park personnel sited the new Old Faithful Visitor Center away from areas with a red clay layer. Additionally, while assessing potential hydrocarbon plumes at the lower gas station, Wyoming Department of Environmental Quality personnel terminated drilling when they encountered the red clay layer.

Location Map of the Old Faithful Historic Pub

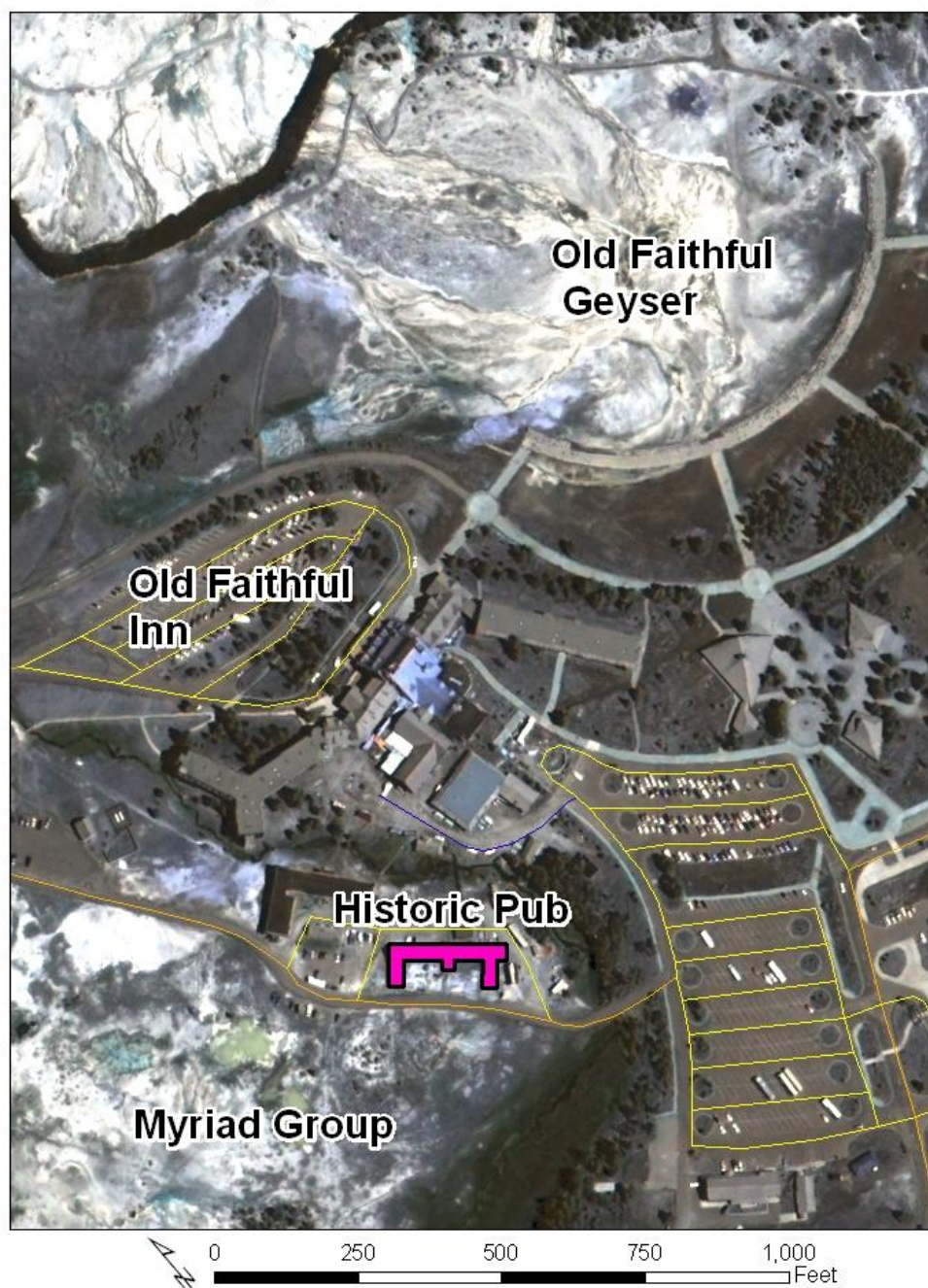


Figure 2. Map showing location of the historic Old Faithful Pub (hot pink) and roads (yellow). The Pub is southwest of the Old Faithful Inn along a service road that connects the lower gas station and Delaware North store with a parking lot northeast of the Old Faithful Ranger Station. Base map is a Quickbird satellite image taken 11 August 2006. Road layer (connector and special purpose roads) from the Yellowstone Spatial Analysis Center.

Bedrock Geology of the Old Faithful Area

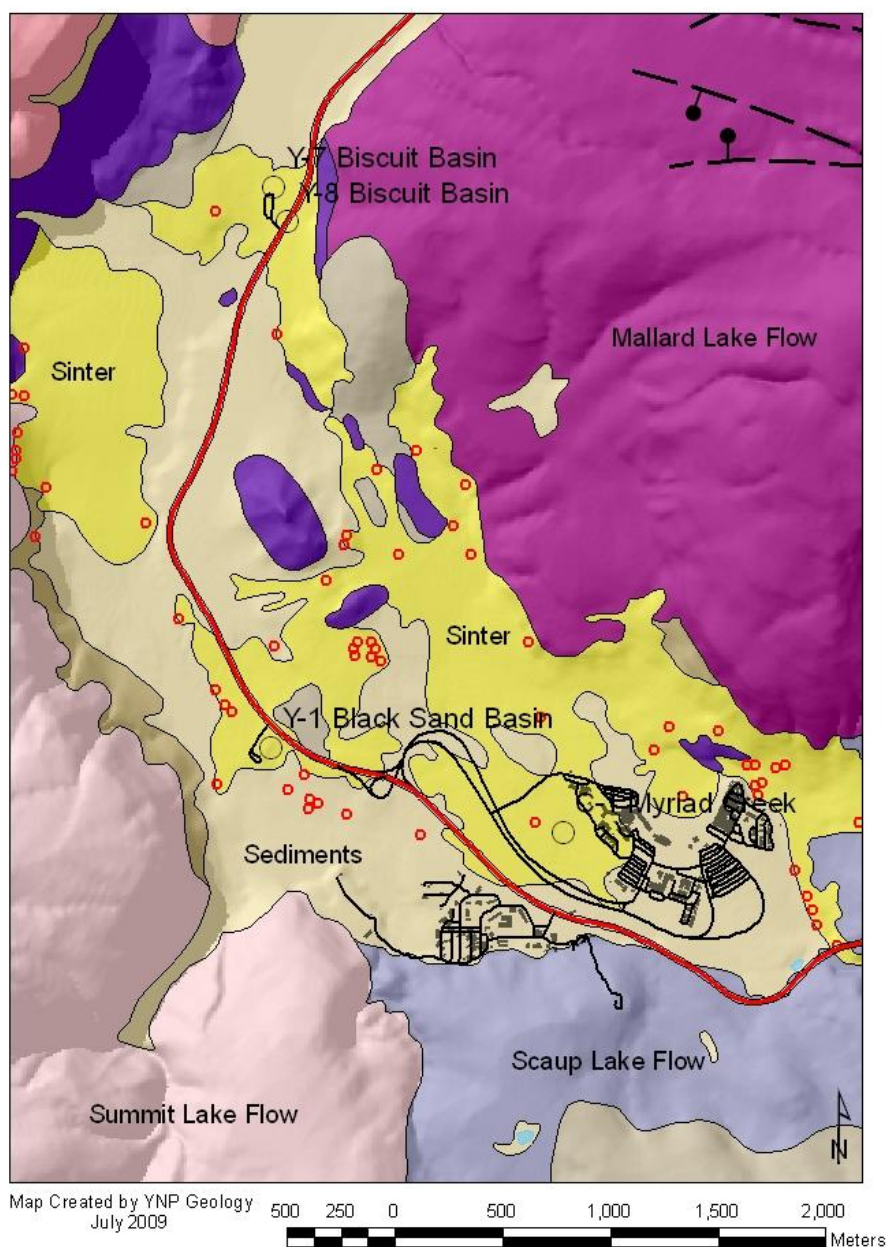


Figure 3. Map showing the bedrock geology of the Old Faithful area draped over topography (modified from Christiansen and Blank, 1974). Notice the lava flows (Mallard Lake (hot pink), Summit Lake (light pink) and Scaup Lake (lilac)) surrounding the Upper Geyser Basin. Sediments (tan) and sinter (yellow) are between the lava flows. An old lava flow (purple) crops out in the Upper Geyser Basin. The thick red line is the main road and the black lines are other roads in the Old Faithful area. Red circles are hydrothermal features.

METHODOLOGY

YNP Geology Program personnel measured subsurface temperatures in the construction area on 22 July 2009. A type K thermocouple plugged into the Oakton Acorn Series meter measured temperatures with accuracy of $\pm 2.7^{\circ}\text{F}$ ($\pm 1.5^{\circ}\text{C}$).

Data collected include temperature and distance from the building. Personnel measured temperatures at depths of 10 inches (25 cm), 20 inches (50 cm), and 30 inches (75 cm). One team member drove a $\frac{1}{2}$ inch (1.3 cm) diameter, 4-foot (1.2 m) long steel rod into the ground to allow temperature measurements. At three sites, the ground was too hard to drive the steel rod to 30 inches (75 cm) depth. At two sites, the ground was soft enough that the temperature sensor could be pushed by hand to 30 inches (75 cm) depth without the use of the steel rod. Geology personnel recorded temperatures, depth of measurements, red clay on the temperature probe, distance from the building, and ease of penetration into sediments or sinter in a field notebook. On a plan of the historic pub, Geology staff also sketched the approximate field locations of temperature measurements and their distance from the building.

A mobile mapping unit recorded accurate digital locations of the temperature sites. The mobile mapping system consists of a Trimble ProXH global positioning system (GPS) receiver with a Zephyr antenna and Allegro CX handheld field computer. After collecting temperature data, geology staff corrected the field locations using Trimble's GPS Pathfinder Office software and the Slough Creek Plate Boundary Observatory (PBO 720) precision GPS station. The accuracy of the corrected points generally varies from ± 5.9 inches to 7.9 inches (± 15 cm to 20 cm). Locations were also taken with a meter tape using building corners and walls as reference points. All temperature locations are 1.6 to 3.3 ft (0.5 to 1.0 m) outside the building walls.

RESULTS

Temperature measurements are consistent with an active thermal area. Figures 4, 5, 6 and 7 show the results of the temperature survey. Temperatures are above normal in the entire study area, except along the southeastern portion of Myriad Creek (Figure 5).

At several sites, field observations indicate ongoing and past hydrothermal activity. The silica-rich sinter apron from a nearby geyser cone was too hard to penetrate with a steel rod at one site (Figure 5, Temperature 109°F site). A puff of vapor and a sulfur smell occurred when Geology personnel placed the temperature probe into a 30 in (75 cm) hole (Figure 6, temperature 130°F site). Then, the temperature probe suddenly dropped 8 in (20 cm). At the sites of temperatures (127°F and 128°F), the temperature probe had red clay on its tip (Figure 6). Also, personnel pushed the temperature probe from 20 to 30 in (50 to 75 cm) by hand at these sites.

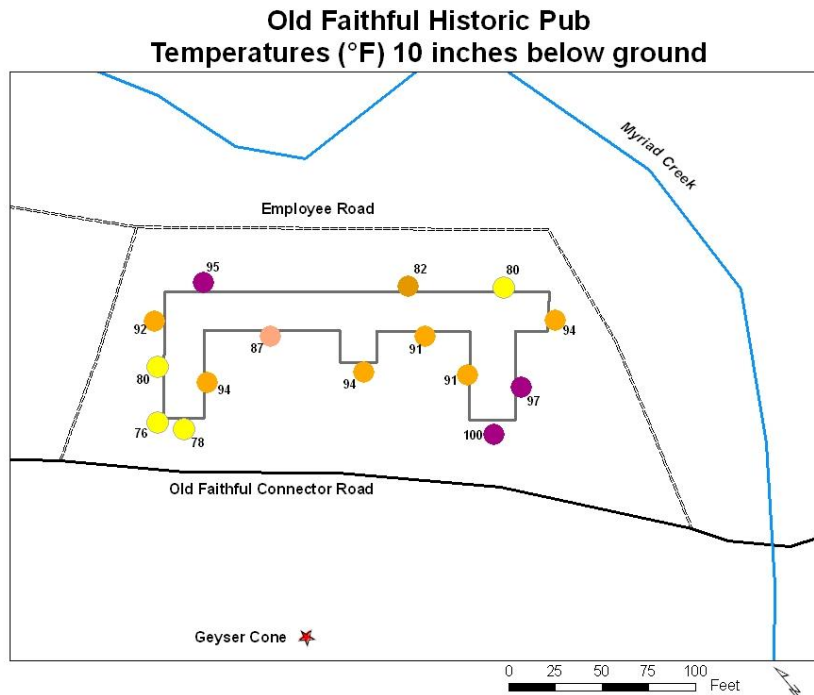


Figure 4. Map of the historic pub showing temperature measurements (in degrees Fahrenheit) at 10 inches (25 cm) depth.

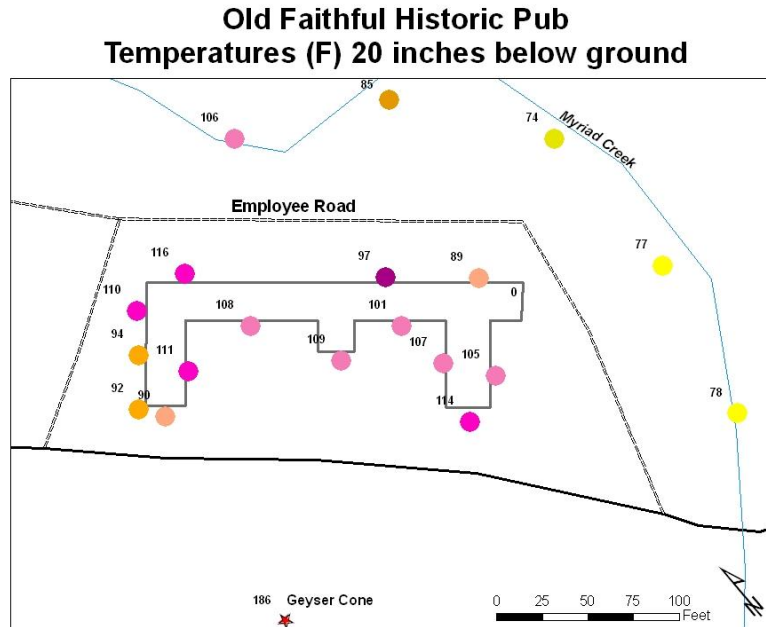


Figure 5. Map of the historic pub showing temperature measurements (in degrees Fahrenheit) at 20 inches (50 cm) depth. It was too hard to hammer the steel rod beyond 20 inches (50 cm) at the site of the 109 °F (43.0 °C) temperature.

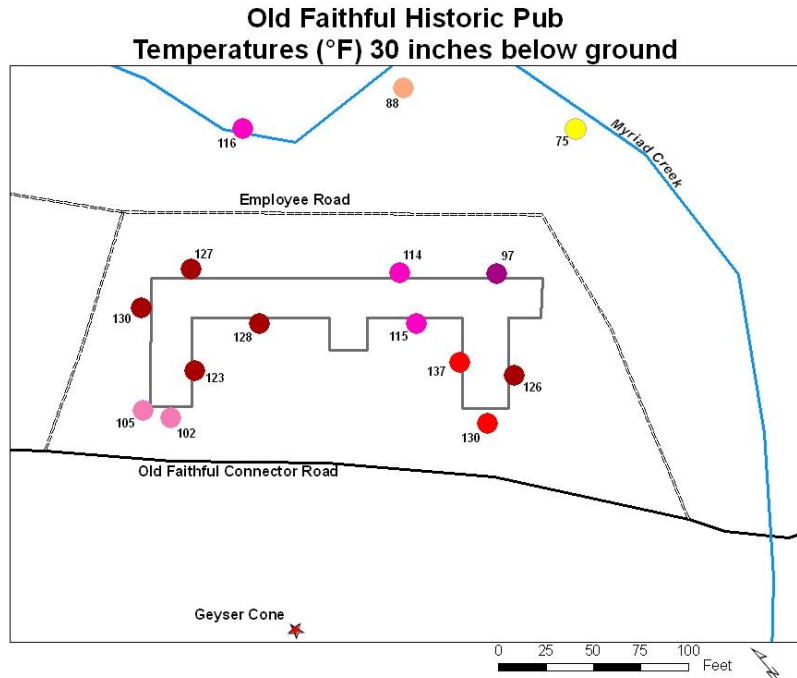


Figure 6. Map of the historic pub showing temperature measurements (in degrees Fahrenheit) at 30 inches (75 cm) depth. At the sites of temperatures 127 °F (53.0 °C) and 128 °F (53.5 °C), the temperature probe had red clay on its tip. Also, personnel pushed the temperature probe from 20 to 30 in (50 to 75cm) by hand at these sites.

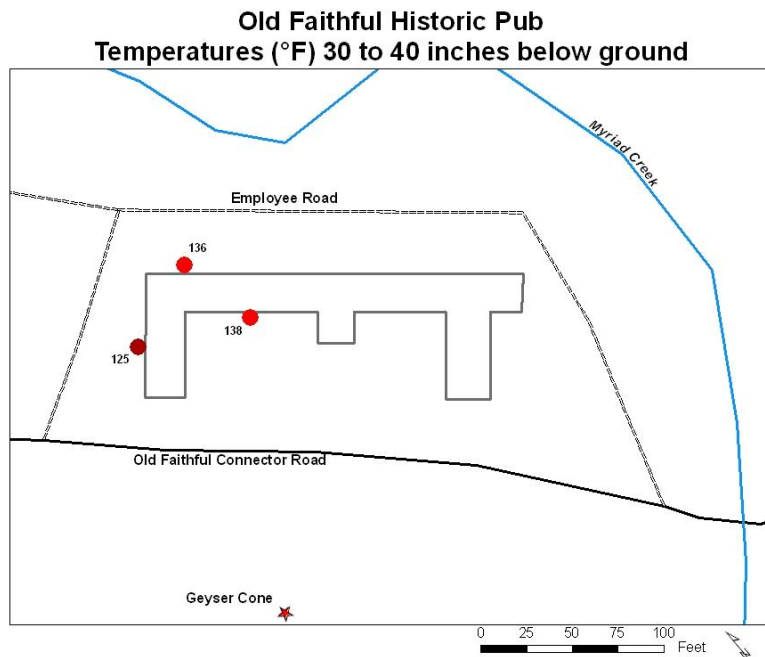


Figure 7. Map of the historic pub showing temperature measurements (in degrees Fahrenheit) at depths greater than 30 inches (75 cm) depth. The depth for the 125 °F (51.5 °C) was 37 inches (95 cm), for 138 °F (59.1 °C) was 39 inches (1.0 m), and for 136 °F (58.0 °C) was 35 inches (90 cm).

DISCUSSION

Previous construction of a water line along the Old Faithful Connector Road (Figure 5) provides evidence of this active hydrothermal area. The construction of this water line resulted in the cessation of Round Geyser either immediately or soon after construction around 1980 (Personal Communication, Jennifer Whipple, 2009). A fire hydrant associated with this water line ejected steam when opened.

CONCLUSION

The high temperatures (137 °F (58.5 °C)) at shallow depths (30 inches (75 cm)) are consistent with the historic Old Faithful Pub being in an active thermal area. A significant increase of temperature with depth, the high temperature (186 °F (85.5 °C)) in the nearby geyser cone and the presence of heat-altered red clay provide additional support for this conclusion.

REFERENCES CITED

- Christiansen, R.L., and Blank, Jr., H.R., 1974, Geologic Map of the Old Faithful Quadrangle: U.S. Geological Survey Geologic Quadrangle Map GQ1189, Scale 1:62,500.
- Muffler, L.J.P., White, D.E., Beeson, M.H., and Truesdell, A.H., 1982, Geologic Map of the Upper Geyser Basin, Yellowstone National Park, Wyoming: U.S. Geological Survey Miscellaneous Investigations Map I-1371, Scale 1:4,800.
- Waldrop, H.A., 1975, Surficial Geologic Map of the Old Faithful Quadrangle: U.S. Geological Survey Miscellaneous Geologic Investigations Map I-649, Scale 1:62,500.