

## Jackson Hole glacial geology field trip, July 7, 2018 Field Trip

July 7, 2018 Field Trip led by Ken and Jennifer Pierce

Pleistocene glaciations were fundamental in shaping the landscapes of Jackson Hole and the Teton Range. The next-to-last glaciation (Bull Lake, ~150,000 years ago) filled all Jackson Hole with south-flowing ice and streamlined East and West Gros Ventre Buttes. The last glaciation (Pinedale, ~20,000-14,000 years ago) scoured the Teton Range and piled glacial moraines at the foot of the Range. But more importantly, large glaciers invaded Jackson Hole along the southern margin of the Greater Yellowstone Glacial System (GYGS). About 20,000 years ago, glaciers advanced from the High Absaroka Range advanced into Jackson Hole and deposited thick glacial outwash gravel on Antelope Flats. Glacial scour excavated four basins, including a basin 600 feet deep basin beneath the Jackson Lake Dam. About 15,000-16,000 years ago, an icecap from the Yellowstone Plateau glaciers advanced into Jackson Hole, excavated Jackson Lake, and built a large glacial outwash fan that includes Baseline Flats, then receded towards Jackson Lake and deposited the Potholes, South Landing, and Cow Lake fans in the just deglaciated area.

The easterly flow of atmospheric moisture through the lowland conduit of the Snake River Plain explains the south westerly orographic precipitation buildup for the GYGS and the concomitant precipitation shadow developed in the lee of this migrating glacial buildup.

A 55 page report by Ken Pierce and others (2018 ) titled "Pleistocene Glaciation of the Jackson Hole area, Wyoming" is electronically available at <https://doi.org/10.3133/pp1835> .

*Led by Ken Pierce for Jackson Hole Geologists and staff of Grand Teton National Park.*

We will gather in the at the public parking lot on the northeast corner of North Cache and Gill Street- one block north of the Town Square. We will consolidate into as few autos as possible. The mileages are based on the distance from one stop to the next.

Please bring a packed lunch, water, hat, and rain parka. And please use the rest rooms in the public building. If possible, make sure that one person in a car has a Seasonal NPS Pass or a Golden Age NPS Passport

Stop 1. We will gather in this parking lot for a short discussion of the Bull Lake glaciation. The Bull Lake glaciation that filled all of Jackson Hole about 150,000 years ago. The upper limit of Bull lake deposits is 7,800 feet at the top of Snow King Ski area and terminated 7 miles south of here. This glacier flowed into Jackson Hole from the north and was part of the Greater Yellowstone Glacial System of Bull Lake age. In Jackson Hole on the south side of the GYGS, the Bull Lake extended 30 miles beyond the Pinedale; on the southeast side of the GYGS in the Ashton, Idaho area the Bull Lake extended 14.3 miles beyond the Pinedale, and on the west side of the GYGS in the West Yellowstone, Montana area, the Bull

Lake extended 13.7 miles beyond the Pinedale. However, on the north and east sides of the GYGS, the Pinedale glaciation overrode and extended beyond the Bull Lake glaciation.

Head north on U.S. 187 (north Cache Street); 0.9-4 miles- on the left East Gros Ventre Butte that was glacially streamlined by south flowing Bull Lake glacier and on the right the aptly named Flat Creek dammed by the Cache Creek alluvial fan on which the town of Jackson is built; 4-6.2 miles- climb up onto the loess-mantled Bull Lake terrace deposited by the Gros Ventre River; 6.2 miles- Gros Ventre River bridge; 6.2 -7.8 miles- Pinedale terrace-fan of Gros Ventre River; 7.8-10.3 miles- Pinedale 3 floods of Snake River across Pinedale 2 terrace that extends to the east to a gently curving, fluvial-flood-terrace scarp (not fault scarp) that undercuts an earlier Pinedale loess- mantled terrace (with no buried soil) of the Gros Ventre River (see Pierce and others, 2018, Figure 13); road to Jackson Hole Airport at 8.6 miles; 10.3-13 miles- Blacktail Butte on the right that was overtopped by thick Bull Lake ice, there is no fault scarp along the west edge of the butte; 12.1 miles- inner road to Moose; 14.3 17.3 miles- climb up to Pinedale 2 terrace gravel on west margin of Antelope Flats to Stop 2.

Stop 2. Teton Point turnout (see Pierce and Good, 1992, Stop 1-2). Here we are on the feather edge of Pinedale 2 outwash from north-north west in the Spaulding Bay area of Jackson Lake and which here buries Pinedale 1 outwash that that heads to the northeast and forms most of Antelope Flats fan. Half a mile east of here, the Pinedale 2 outwash locally undercuts and produces a scarp in Pinedale1 outwash. The inset terrace we call the flood flume and is of Pinedale 3 age Three lobes advanced into Jackson Hole from the Greater Yellowstone Glacial System (GYGS): (1) the Buffalo Fork lobe from the High Absaroka Range,(2) the Pacific Creek lobe from the Two Ocean Plateau and beyond, and (3) the Snake River lobe from the southern Yellowstone Plateau. GYGS first culminating first with the Buffalo Fork lobe from the high Absaroka Range and progressing to the Snake River lobe from the Yellowstone Plateau.

Continue north on U.S. 187 for 2.8 miles (4.5 km) and turn right on gravel road and park cars on edge of road beyond sharp right turn at 0.3 miles .

Stop 3. Pinedale 1c moraine and deep kettle (see Pierce and others, 2018, Figures 22, 23). Walk adjacent to deep kettle to Pinedale 1c moraines. The Pinedale 1a is only represented by kettles in outwash 2.3 miles south of here, whereas the Pinedale 1b is represented by moraines supporting scattered trees 1.5 miles south of here, and the Pinedale 1c here by moraines nearly buried by outwash as indicated on the north side of the moraine by a steep drop off that represents a mold of a high glacier front. The southern margin of the Greater Yellowstone Glacial System (GYGS) is outwash dominated with thick outwash almost burying the glacial moraines. Two factors may be involved: abundant supply of quartzite cobbles from poorly consolidated Cretaceous and early Tertiary conglomerates and isostatic depression lessening the gradient of outgoing streams from the GYGS.

Turn vehicles around, return paved highway, turn right and go 0.2 miles to left turn into Snake River Overlook.

Stop 4. Snake River Overlook (see Pierce and others, 2018, Figures 20, 29). Glacial outwash here defines the three subdivisions of the Pinedale glaciation: Pinedale 1 forming Antelope flats east of here that has a very subdued channel pattern, Pinedale 2 forming Baseline Flats across the Snake River from here at about the same altitude but with a clearly expressed channel pattern and younger than that at the Snake River Overlook (**not** the same age across the Snake River as some have concluded), and Pinedale 3 outwash east of the forested Burned Ridge that forms "The Potholes" so named for its abundant kettles. Because of this extensive outwash, the Pinedale glacial sequence is better understood by the outwash relationships than by the outwash dominated moraines.

Continue north on U.S. 191 and drop down to the Pinedale 2 bench past Hedrick Pond on the right, to lake deltas rich in ash eroded from the recycled Teewinott Formation near Triangle X Ranch, past Spread Creek and the Spread Creek hill with not a fault scarp on its south side, and just after the buffalo Fork bridge turn left on U.S. 287 and proceed at entrance gate for inner road of Grand Teton National Park. If we continued east on U.S. 287, we would be within Pinedale 1 Buffalo Fork lobe for 26 miles to an ice divide above Togowotee Pass, and we would cross a postulated Pinedale 2 moraine 17 miles at Togowotee Mountain Lodge. Starting at GTNP Entrance Gate, 0.6 miles- Pacific Creek bridge; 3.9 miles road to left down Pinedale lake barrier bar at an altitude of 6,800 feet on the east side of Oxbow Bend; 5.6 miles- road junction and continue on U.S 287; 6.1 miles- Willow Flats Overlook.

We will have a rest stop at Jackson Lake Lodge.

Stop 6. Willow Flats Overlook and Lunch Stop. Walk out to viewpoint. As diagramed in Pierce and others (2018, Figure 6) the 8-10 Ma Teewinot Fm. dips 22° west, the 4.45 Ma Kilgore Tuff also dips 22° west on Signal Mountain, and the 2.06 Ma Huckleberry Tuff dips 11° west on Signal Mountain. These dips and the emplacement of the Kilgore Tuff from its eruption site west of the Teton Range indicates the Teton Range is younger than 4.5 Ma.

On a bench above and across the upper end of Jackson Lake, the upper limit of the Pinedale 2 Snake River lobe was at an altitude of 8,600 feet. Farther north on Huckleberry Ridge the upper limit of the Snake River lobe was at an altitude 9,000 feet. In Pinedale 2 and 3 times, Jackson Lake was excavated, and east Jackson Lake, ice-scoured topography indicates south-south west glacial flow. Near this stop between Christian Pond and Emma Matilda Lake, a two-sided kame terrace requires that the Pacific Creek lobe was along the east side of this kame terrace and the Snake River lobe was on the west side of this kame terrace. Similar two-sided kame terraces occur at the west end of Two Ocean Lake.

Turn back on U.S. 187 and at 0.6 miles turn right on inner road; 1.1 miles cross Jackson Lake dam; 2.7 miles- continue past road to Signal Mountain Lodge; 3.8 miles- continue past road to Signal Mountain; 4.0-4.7 miles- the head of the South Landing channelway; 7.6 miles- low point on the head of the Potholes channelway. The head of the Spaulding Bay channelway is about from 7.7 to 8.1 miles but the roads have been relocated from the maps I have.

Stop 7. We will park either (1) near  $15.5 \pm 0.5$  ka type Pinedale 2 moraines or (2) the Mountain View Turnout along the new road about half a mile down the Pinedale 2a outwash from the type Pinedale 2 moraines. The outer Jenny Lake moraines have a cosmogenic age of  $15.2 \pm 0.7$  ka and are mostly buried by Pinedale 2 outwash and are therefore clearly older than the Pinedale 2 moraines. Although the Pinedale 2 moraines are younger than the outer Jenny Lake moraines the cosmogenic age is slightly older, but well within the error limits. We knew Pinedale 2 outwash straphically quite young but only when we discovered a short segment of Pinedale 2 moraines with large granitic boulders good for cosmogenic dating did we replicate a surprisingly young age for the Pinedale2 terminal moraines deposited by the Snake River lobe from the Yellowstone Plateau icecap.

Stop 8. Jenny Lake and inner Jenny Lake moraines with a cosmogenic age of  $14.4 \pm 0.8$  ka. Cores from the bottom of Jenny Lake indicate that "sediment accumulation began centuries before 13.8 ka" based on radiocarbon dating (Larsen and others, 1016, p. 70). Following deposition of the inner Jenny Lake moraines, upvalley recession was rapid, as revealed by glacial boulders on the bedrock threshold of Lake Solitude near the valley head that date to  $12.9 \pm 0.7$  ka.

Enjoy the view across Jenny Lake and eventually return to Jackson.