Geologic Guide of the Hoodoo Valley Area

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Hoodoo Valley Field Trip
Coeur du Deluge Chapter
Ice Age Floods Institute
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INTRODUCTION
This field trip guide from Sandpoint, Idaho explores glaciation of the southern part of the Purcell Trench ice lobe and the northern route of glacial floods from the southern end of Lake Pend Oreille through the Hoodoo valley to the Pend Oreille River.

GEOLOGIC HISTORY
Northern Idaho has a rich geologic history, the incomplete record of which extends from 2.6 billion years ago to the present. The oldest known rocks, exposed near Priest River, Idaho, originated as sedimentary layers deposited in an ancient ocean. About 2.6 billion years ago, these deposits were intruded by granitic magmas and at some later point metamorphosed to form metasedimentary gneisses. The details of the subsequent billion years of geologic time are sketchy, but included granite magmatism west of present-day LaClede about 1.57 billion years ago. Our geologic record improves dramatically at 1.47 billion years when widespread deposition of the Belt Supergroup began, continued for at least 70 million years, and produced a tremendous thickness of sedimentary rock that contains remarkably well-preserved mudcracks, ripple marks, and algal mats. The Belt rocks are widely exposed east of Sandpoint. The Belt was deposited in a rifted basin; the lower strata (Prichard Formation) were deposited in deep water and mafic sills intruded the Prichard shortly during and shortly after deposition. The upper strata (Ravalli Group and above) were deposited in a shallow sea, perhaps similar to the Caspian Sea. The geologic record is again limited until about 800-600 million years ago when continental separation occurred and coarse sediments and volcanics of the Windermere Supergroup were deposited. An ice age has been documented at this time as well. Shortly after this in the Middle Cambrian, about 510 million years ago, sediments containing trilobites were laid down. Remnants of the Cambrian strata are preserved in down-faulted blocks near the southern part of Lake Pend Oreille.

Mountain building began in the Cretaceous (about 140 million years ago) as the entire region underwent compression. Rocks in the west were thrust up and over rocks to the east thickening the crust. Strata low in the geologic column were buried to great depths and metamorphosed. Erosion was extensive, and sediments were shed eastward into central Montana off the uplifted land mass. Granitic magmas intruded into the middle and upper parts of the earth’s crust and cooled slowly, forming batholiths. Most of the central and northern parts of the Selkirk Mountains are underlain by this Cretaceous granite, and isolated granitic bodies intruded east and south of Sandpoint. In the Eocene about 50 million years ago, compression gave way to ENE-WSW extension, which allowed localized areas of the crust such as the Selkirk Mountains to rise, and the overlying rock was removed by erosion. This extension brought high-grade metamorphic rocks such as the Hauser Lake gneiss to the surface in the footwall of large low-angle normal faults (detachment faults). The Eastern Newport fault is one such fault, characterized by relatively low-grade Prichard Formation in the upper plate (hanging wall) and high-grade Hauser Lake gneiss and granitic rocks in the lower plate (footwall). The high-grade gneiss is thought to be roughly the same age as the Prichard Formation, just at a higher metamorphic grade. During the same time, more magma intruded, which formed dikes in the area northwest of Hope and a granite pluton at Wrencoe. Basins developed, and conglomerate was deposited in the area north of Sandpoint. North-south trending extensional faulting in the Purcell Trench also occurred at this time. The youngest bedrock in the area is the Miocene Columbia River Basalt Group, which flowed north toward Sandpoint about 16 million years ago.
Basalt flows exposed just north of Athol are the Priest Rapids Member of the Wanapum Formation. More extensive valley basalt flows have presumably been stripped away by the Missoula Floods.

In 1923, Professor J Harlen Bretz of the University of Chicago began publishing a series of papers explaining the origin of the Channeled Scabland in eastern Washington. He attributed this system of dry channels, coulees, and cataracts to an episode of flooding on a scale larger than geologists had ever recognized. Prominent geologists disputed his hypothesis, and the resulting controversy is one of the most famous in geologic literature. Bretz’s ideas for such large-scale flooding were viewed as a challenge to the uniformitarian principles then ruling the science of geology. J.T. Pardee of the U.S. Geological Survey first studied glacial Lake Missoula in 1910 but it was until the early 1940s before he presented evidence for rapid drainage of the large ice-dammed lake. He estimated the lake contained 500 cubic miles of water and drained at a rate of 9.46 cubic miles an hour. Pardee’s explanation of unusual currents and flood features in the lake basin provided Bretz with the long-awaited source for flooding in the Channeled Scabland. Recently geologists’ attention has mostly focused on the recognition of evidence for multiple floods and timing of the ice age events. Features created by the ice age floods can be observed in an area covering 16,000 square miles in Montana, Idaho, Washington, and Oregon. A National Ice Age Floods Geologic Trail has been established by Congress highlighting these features.

EARLY EXPLORATION

Between 1808 and 1812, North West Company fur agent and surveyor David Thompson traveled through these ice and flood features as he established the first circle of trade houses in what his company called “The Columbia District.” Thompson’s distinctive maps clearly show that the trails Kootenai and Salish people showed him follow geologic features across the landscape. In spring 1808, Thompson and his crew canoed down the Kootenai River to an encampment near modern Bonners Ferry. From there Kootenai people led him north to Kootenay Lake, following the path of the Purcell Lobe as it retreated in the last ice age. Although the trader wanted to push south to Lake Pend Oreille, his guides told him that spring flooding had rendered the trail impassable. In the fall of 1809 the Kootenai led him south into the Pend Oreille Country. He established his Kullyspel House at the Clark Fork Delta, which during the Pleistocene would have been beneath the ice dam that backed up Lake Missoula. Thompson wintered in Saleesh House, about 70 miles upstream on the Clark Fork at the modern town of Thompson Falls, Montana. In spring 1810, he dispatched clerk Jaco Finlay to build Spokane House, a full hundred miles across a divide and downstream on the Spokane River. Over the winter of 1811-12, Thompson visited Flathead Lake and the area around Missoula Montana. On his maps, mountains rendered with the “caterpillar” method of the time define the outline of glacial Lake Missoula above the Clark Fork, Flathead, and Bitterroot Rivers. The tribal trail he called the “Skeetshoo Road” leading from Kullyspel to Spokane House follows ice age flood channels across Rathdrum Prairie between the Pend Oreille and Spokane drainages. At least two other major tribal trails on his maps, “the Kullyspel Road” and the “Shawpatin-Pilloossees Road” trace flood channels from the Pend Oreille all the way to the Snake River. For more complete historical information see Nisbet (2005, 2007).
FIELD TRIP GUIDE

LONG BRIDGE STOP
The present US 95 bridge is the fourth generation of structures built here. The first was a wooden bridge on cedar pilings, completed in 1910, nearly two miles long. It was regarded as the World’s longest wood bridge and was replaced in the 1930’s by a second wooden structure that was still regarded as the record. In 1956 a concrete structure replaced the wood span. However, with time road salt deteriorated the concrete and rusted the steel reinforcement. The latest bridge was designed for expansion to four lanes (Conley, 1982).

Figure 1. Aerial View of Sandpoint, Byway, Schweitzer, and Long Bridge (Idaho Transportation Department).

The railroad causeway east of the Long Bridge is one of several lake and river crossings to Sandpoint. Throughout its history, Sandpoint has been an important regional and international train junction known as the “Funnel.” The Great Northern, Northern Pacific, Spokane International, Union Pacific, Burlington Northern, and Montana Rail have played important roles in the regional economy and commerce.

During the last ice age, the Purcell Trench Lobe (Figure 2) of the Cordilleran ice sheet advanced from Canada into the Idaho Panhandle, blocked the mouth of the Clark Fork River and formed Lake Missoula. At maximum extent this glacial lake was up to 2,000 feet deep and covered 3,000 square miles of western Montana. Catastrophic failures of the Clark Fork ice dam released 500 cubic miles of water at a rate 10 times the combined flow of all the present-day rivers on earth. The torrent of water and ice thundered across the states of Idaho, Washington, and Oregon at speeds more than 65 miles per hour to the Pacific Ocean. The enormous energy of the flood water carved the land into canyons and cataracts, excavated more than 50 cubic miles of soil and rock, piled boulders in huge gravel bars, and drowned entire valleys in beds of sediment. The southward flow at the ice front repeatedly blocked the Clark Fork River, refilled Lake Missoula, and resulted in multiple flood events.

The Cordilleran late Wisconsin ice was north of the Canadian border as late as 17,500 BP and the maximum in the Purcell Trench was reached about 15,000 BP (Clague et al. 1980).
Waitt (1985) interprets $^{14}$C evidence to show that Glacial Lake Missoula existed only between about 17,200 and 11,000 years ago. The Purcell Trench was free of Cordilleran ice when two closely spaced Glacier Peak eruptions deposited ash about 11,200 years ago (Carrara et al. 1996). Latest glacial alpine moraines formed by valley glaciers in the Selkirk and Cabinet Ranges occupy the tributary valleys of the Purcell Trench. These deposits must post-date retreat of the Cordilleran ice lobe and are evidence for a late alpine glacial advance. A radiocarbon date of 9,510 ± 110 BP (Mack and others, 1978) from a peat bog within the glacial limit on the west slope of the Selkirk Mountains may provide a limiting date on the last alpine ice in the Priest Lake area.

Boulders deposited near the last glacial maximum of the Purcell Trench ice lobe and post-flood recessional moraines were sampled for cosmogenic surface exposure dating. Cosmogenic 10Be surface exposure ages (mean weighted) constrain the glacial maximum ice limit near the Clark Fork ice dam at 14.1 ± 0.6 ka (Breckenridge and Phillips, 2010). Kame deposits near the United States-Canada border constrain the ice recession (10Be range) from 13.3 to 7.7 ka (W. Phillips, written comm., 2011). In Washington, glacial lobes dammed the Columbia River and its tributary drainages forming Pleistocene Lake Columbia (Richmond, et al. 1965, Waitt and Thorson, 1983) with a water level up to 2400 feet above sea level. Lake Columbia covered the Rathdrum Prairie. The modern-day outlet of Lake Pend Oreille is the Pend Oreille River at the northwest arm of the lake and flows to Washington and north into British Columbia.

![Figure 2. Map of Cordilleran ice margin (modified after Richmond, 1986). Glacial Lake Missoula, and major flood outburst routes. BRL: Bull River Lobe; CL: Colville Lobe; FL: Flathead Lobe; PTL: Purcell Trench Lobe; PRL: Priest River Lobe; TRL: Thompson River Lobe. Glacial Lake Missoula: cross-hatched area. Arrows show major flood outburst routes.](image-url)
In September 1809, David Thompson and a voyageur named Joseph Beaulieu, guided by “a Kullyspel lad,” rode horses around the north end of Lake Pend Oreille to the river. Thompson described a “sandy point” near City Beach at modern Sandpoint, then continued to the outlet of the river near Dover. When he canoed across the lake in a Kalispel canoe in April 1810, Thompson put up at the “point of Sand.” When he canoed the route again in June 1811, he set a course by “the Rock below the Sandy Point” (Nisbet, 2005). The rock feature is now known as Tank Hill and is composed of granitic bedrock scoured by ice age glaciation and floods.
The Sagle area is mostly underlain by till rather than flood deposits. Well logs mostly show blue clay and glacial till (DeSmet, 1983). Part of the ice remained intact here while most of the late glacial floods passed through the Lake Pend Oreille basin. Therefore the deposits in the Cocolalla valley were not subjected to extensive flood scour by the last flood events. Ice contact deposits mostly cover the floor of the valley. The bedrock along the valley margins and in the mountains were strongly scoured by ice.

Algoma Lake is located in an ice-marginal drainage. Core samples collected from the lake contain Mazama ash (~6,700 BP) at a depth of 1.2 m and an older unidentified ash at 2.7 m (Breckenridge, written comm.).
Figure 5. Kame moraines are prominent features on the east side of the Sagle-Cocolalla valley (Burmester and others, 2007).

Figure 6. The Dufort area is the location of an ice stagnation deposit and recessional moraine. The narrow bedrock valley here constricted the ice. Excavations for the US 95 railroad overpass exposed ice contact deposits (southward advances) overlain by glacial outwash and lake deposits (northward retreats).
COCOLALLA LAKE STOP

Cocolalla Lake is bounded by a recessional moraine on the south. Ice from the Lake Pend Oreille basin passed across the divide into this valley. Ice flowed west through gaps between Little Blacktail, Blacktail, and Three Sisters. The head of Cocolalla Creek is in an ice gap between Little Blacktail and Blacktail mountains. The creek follows a circuitous path through Cocolalla and Round lakes, Hoodoo channel, and to the Pend Oreille River.

Figure 7. Part of the Sandpoint 30’ x 60’ Geologic Map (Lewis and others, 2008).
A well-developed end moraine marks the topography just south of Careywood. The upper height of ice flowing through the gap between Huckleberry Mountain and Long Mountain to the west was at least 3800 feet elevation, and the ice limit on Little Blacktail Mountain to the east was as high as 4000 feet elevation.

BAYVIEW STOP - LAKE PENDE OREILLE
Bayview, Idaho was originally established as a logging town in 1891 and later was the processing site for lime mined here and at Lakeview across Lake Pend Oreille until 1936 (Conley, 1982). The source was the Lakeview Limestone of Cambrian age. The community is now a recreation destination and the site of the Acoustic Research Detachment, US Navy.

Lake Pend Oreille is the largest lake in Idaho and is located about 50 miles south of the British Columbia border in the Purcell Trench. The lake level is 2062 ft above sea level, with the surrounding terrain as high as 6002 ft. The maximum depth of the lake is an impressive 1150 ft, the deepest lake, by far, in the region (5th deepest in the US). The location of the lake is probably related to an old river valley controlled by faults. Lake Pend Oreille basin was carved repeatedly by a lobe of Pleistocene ice, scoured by ice age floods and filled with glacial outwash and flood deposits. The lake is dammed at the south end by thick glacial and flood deposits underlying Farragut State Park. Data from seismic reflection surveys performed on the lake show distinct sub-bottom reflections. These surveys were conducted by the United States Navy primarily for geotechnical studies of the lake-bottom surface. The seismic reflection surveys show that the bedrock lake basin has been glacially overdeepened to a depth more than 500 ft below present-day sea level. The seismic sections are interpreted to show a record of subglacial erosion, Missoula Flood deposition, and a post-flood glacial readvance (Breckenridge and Sprenke, 1997).

Figure 8. Aerial view of the southern end of Lake Pend Oreille. Looking west down the main path of megaflooding. Rathdrum Mountain and Mount Spokane in the distance. Large water towers in Farragut State Park are visible in the center.
Seismic studies of the bedrock morphology and sedimentary facies of inland linear valleys, such as the Okanagan and Kalamalka valleys in British Columbia, have revealed bedrock erosion to depths well below sea level and subsequent rapid infilling by sediment (Gilbert 1975, Fulton and Smith 1978, Mullins and others, 1990, Eyles and others, 1990, Desloges and Gilbert 1991, Gilbert and Desloges 1992). These valleys, which are similar to the Lake Pend Oreille basin, contain substantial sediment thicknesses and owe their locations to structural lineaments and their morphology to large-scale glacial erosion beneath Cordilleran ice sheets. Shaw and others (1999), proposed that flood releases beneath the British Columbia Ice Sheet were a contributing source of scabland flooding in Washington. These are all elongate, deep valleys, controlled by pre-existing fluvial channels, preferentially carved along pre-existing structural features at the southern margins of the Cordilleran Ice Sheet.

**FARRAGUT STATE PARK**

Farragut State Park occupies the original site of the Farragut Naval Training Base. The base was active from 1942 to 1946 and was the second largest in the United States. The camp trained nearly 300,000 WW II sailors in 15 months and was decommissioned in 1946 (Conley, 1982). The 1964 a federal and state of Idaho exchange converted the land to Farragut State Park. A fee is required per vehicle for day use off of State Highway 54.

Farragut State Park is located at the “breakout” of Glacial Lake Missoula floods. Failure of the ice dam in the Clark Fork valley fractured and broke apart the 20-mile-long tongue of ice occupying the Lake Pend Oreille basin and a torrent of water and ice burst from the south end of the lake. Churning flood waters flowed 2000 ft deep across Farragut State Park.

The park includes many geologic features left by glaciation and megafloods accessible by road, trails and water. Information and materials are available at the Farragut State Park Visitor Center. Farragut State Park provides an outdoor museum for visitors to observe and study some of the most spectacular ice age features on earth and find clues about the geologic history. Some of the activities you might want to include in your park visit are:

**Figures 9a and 9b.** Identify ice age landforms on the park model at the visitor’s center.
Figures 9c and 9d. Visit Jökulhlaup Point

Jökulhlaup (yo-kull-loup) is an Icelandic term meaning huge glacial meltwater flood, which must include water flowing from underneath the ice. The process includes the breakdown of an ice dam.

This peninsula is a result of natural forces including jökulhlaups of the Ice Age floods.

On older maps, this area has been marked Solitaire Point, then Leiburg Point, then Blackwell Point. This turnout was once called MacDonald Viewpoint.
**Figure 9e.** Study a topographic map of the park.

**Figure 9f.** Explore Buttonhook Bay: Farragut State Park looking north toward Hoodoo channel, the flood path to the Pend Oreille River.
Hoodoo channel, an abandoned outlet of Lake Pend Oreille provided a pathway for late-glacial meltwater and for the last outbursts from Glacial Lake Missoula. The channel is marked with a number of closed depressions, probably the result of melting icebergs. One of the largest of these features and was used as a natural amphitheater for the Navy Base. Several origins for these features have been proposed, including kettles, potholes, and sub glacial meltwater.
Figure 9i. View the rockslide of Bernard Point and the cliffs that were scoured by ice and flood water over 2000 feet above the lake level. The bedrock cliffs on Bernard Peak (to the southeast) are middle Belt carbonate (Wallace Formation). The lower part of Bernard Peak is Cretaceous granodiorite. The cliffs on Cape Horn Peak (to northeast) are Cambrian Gold Creek Quartzite downfaulted against the Burke Formation of the Belt Supergroup.

Figure 9j. Discover large flood erratics of the “breakout” area carried by ice and water.
Figure 9k. Examine the beach for exotic rocks left by the ice age floods

Figure 9l. Major breakout point was from the end of the Lake Pend Oreille basin shown here. Nearly all of the water escaping from Lake Missoula passed through this field of view. Discharge estimates range from 14 to 21 million cubic meters per second.
PEND OREILLE CITY SIGN PULLOUT

The main path of the flood outbursts from the Pend Oreille Lake basin can be followed across the trench and south toward Coeur d’Alene and west to Spokane. Another main flood path was to the north down the Hoodoo and Blanchard valleys to the Pend Oreille River and Little Spokane River via Newport, Washington. The water scoured as high as 3450 feet on Round Mountain. Flood bars filled the side valleys of the Prairie and formed Spirit, Twin, Hayden, Fernan, Newman, Liberty and Coeur d’Alene lakes. The trim line of flood-water erosion on the bedrock south of Post Falls is above 2600 feet in elevation. That is a depth of 400 feet across the prairie between Rathdrum and Post Falls and 250 feet above Ross Point. Multiple episodes of flood erosion and deposition have left a complicated record in the Rathdrum gravels. Ross Point is a remnant of one of the oldest floods that has been dissected by later and mostly smaller floods. It is likely that the evidence for even older floods and ice advances have been removed by the latest flood events.

Most early workers considered the deposits and landforms in the Spokane Valley and eastern Washington as glacial in origin. Features like those impounding Liberty Lake, Newman Lake, Coeur d’Alene Lake, and Twin Lakes were interpreted as lateral moraines or glacial outwash. Even Bretz did not recognize these features as flood in origin. Most geologists now consider the deposits in the valley to be of flood origin, but it is not known how much of the fill represents reworked till, glacial outwash, or older sediments. In any case, the gravels are an important sole-source aquifer and important aggregate resource for the region. The suite of rock types contains clasts derived from the basin of Glacial Lake Missoula in Montana as well as from the Purcell Trench in Idaho and British Columbia. The most common clasts are from granitic, Precambrian Belt Super group metasedimentary, and mafic rocks. Intact basalt columns are derived locally from the Columbia River basalt rimrock nearby but were quickly broken in flood transport. Large scale foreset beds tens of feet thick are common. The high energy clast-supported gravels are matrix-poor (boxwork) and have high porosity.

CaCO₃ content and bulk density of samples taken from the cemented gravel unit were determined in the laboratory. Measured CaCO₃ content within the gravel unit is variable and averages ~10% by weight. This openwork fabric results in the remarkable water capacity of the Rathdrum Prairie–Spokane aquifer that serves nearly 400,000 people in the two state area. The hydrology of the aquifer is not well understood. In some reaches the Spokane River recharges the aquifer while in others the aquifer discharges to the river. Little subsurface stratigraphy has been documented, mainly because most wells have been so productive there has been no incentive to study the stratigraphy. Gravity studies of the Rathdrum Prairie and Spokane Valley indicate the bedrock may be as much as 1000 feet deep at Highway 41 (Adema, Sprenke, and Breckenridge, 1998).

Several clusters of giant boulders are located along Highway 41 between Spirit Lake and Twin Lakes. The boulders are mostly a granodiorite similar to an outcrop near Bayview. The rock type plus the fact that geophysical surveys of the immediate area reveal an ancestral valley, shows the boulders are not outcrop but have been transported. The largest boulder measures 49 by 40 feet and weighs over 1600 tons (Jim Browne, written comm.). Their size seems anomalously large even for catastrophic floods. Perhaps they were deposited by a tremendous base surge or were rafted by a great berg of the disintegrated ice lobe.
ATHOL FLOOD BAR

Figure 10. The railroad north of Athol cuts through the center of a giant gravel bar deposited by floods bursting from the end of Lake Pend Oreille. The huge boulders at the bottom of the cut were excavated to accommodate widening of the track. Note size of boulders and equipment.

RAILROAD CROSSING STOP
US-95 and the railroad embankments now replace old wooden trestles that crossed the channel near here, the abandoned outlet channel from Lake Pend Oreille. Trenches for natural gas pipelines from Canada exposed several feet of Mazama Ash in the floor of Hoodoo Channel but core from the small lake (?) depression in the channel in the just south of US-95 measures over 30 feet of Mazama. Cores have encountered peat and organic sediments in the paleochannel.

Figure 11. The northern path of flooding from the Glacial Lake Missoula outbursts is more complex than the Rathdrum Prairie Route (Lewis and others, 2002).
Steeply dipping foresets of flood and outwash gravels in this pit exhibit two directions of transport. Flood gravels from Lake Pend Oreille dip north and outwash from ice in the Sagle-Cocolalla valley dip south (Figure 11). Glacial striae on granite along the railway are evidence of a minimum southern advance.

**KELSO LAKE STOP**
Granite of the Kelso Pluton (88 Ma) is exposed. The rock is granite porphyry, jointed and readily quarried.

**BASALT OUTCROPS AND BOULDERS STOP**
Along and north of the road are exposures of Columbia River Basalt the youngest bedrock in the Purcell Trench. These outcrops of the Priest Rapids Member (about 14.5 Ma) are the northernmost recognized outcrops of the Columbia River Basalts in the area. They post date the Grande Ronde Basalt (15.5 Ma) that forms the rimrock south of Athol along US 95.
The south part of Hoodoo Channel contains a series of gravel deposits not formed as flat river or outwash terraces but successively lower low-sinuosity huge channels and nested whaleback bars.

Figures 14a and 14b. Shaded relief maps of Hoodoo Channel. The great flood bar that dams Spirit Lake is the highest of the sequence and exhibits dramatic giant current ripples. The current directions of the Spirit Lake ripple field show flows both southward down the Rathdrum Prairie and northward through the Hoodoo and Blanchard valleys. These massive flood deposits may bury any ice contact deposits.
HOODOO LAKE
A distributary of ice flowed south from the Pend Oreille River into Hoodoo Valley. Hoodoo Mountain (5119 ft elev.) to the west and Long Mountain (4568 ft elev.) to the east were glaciated and contain moraines and discontinuous till deposits. Large gravel bars formed around Horn Mountain (Figure 14b) at the confluence of Hoodoo Valley and the Pend Oreille River. David Thompson traveled through the Hoodoo Valley on the Skeetshoo road from Spokane House to Sinyakwateen [sp.] crossing. He traveled this route several times (Nisbet, 2005; Elliott, 1918). Of geologic interest are his journal entries noting the disappearance into the ground of the drainage from “Fish Lake” (now Twin Lakes), the high bank forming the drainage divide between the Skeetshoo (Spokane) and Kullyspel (Pend Oreille) drainages (Figure 4), and the high bank (terrace) above the Lake (Hoodoo).

LONG MOUNTAIN VIEW
Drive up USFS 2697 for views of the channel and bar sequences in Hoodoo Valley.

SENEACQUOTEEN BOAT RAMP STOP
This is the location of the Seneacquoteen Ferry across the Pend Oreille River. The town of Laclede is at the other side of the ferry directly across the river.

Figure 15. View of Laclede from Seneacquoteen boat ramp.

A tongue of ice from the Purcell Trench Lobe flowed west from the Sandpoint area and down the Pend Oreille River Valley. The terminus of this western tongue like the eastern one in the Clark Fork valley was transient but mainly located between the mouth of the Priest River and Laclede. This tongue of ice blocked the mouth of the Priest River and formed a glacial lake in the southern Priest River valley. The northern Priest River valley was glaciated by ice from Canada and joined on the east by valley glaciers from the Selkirk Range. Moraines and glacial scour demonstrate that at maximum thickness the Purcell Trench Lobe flowed through Happy Fork Gap (3760 ft elev.) into the Priest River basin.
Pendant flood bars deposited in the lee of the bedrock has been removed for construction materials. Crossbedded gravels are exposed evidence that some late floods traveled down the Pend Oreille River from the Sandpoint area. The scoured bedrock and talus deposits are now being quarried for construction materials.

**Figure 16.** Part of Geologic Map of the Sandpoint 30' x 60' quadrangle (Lewis and others, 2002).

**ROUND LAKE STATE PARK**
Round Lake is located in a glacial meltwater channel that drained from ice in the Dufort area. As the ice margin retreated northward, meltwater and proglacial lakes in the Cocolalla valley would have established the route of present-day Cocolalla Creek (Figure 7). The origin of the Round Lake depression may include kettles, potholes, and sub-glacial meltwater formed by changes in flood channel configuration.


Breckenridge, R.M., and Lewis, R.S., 2005, Field Trip to the Clark Fork ice dam and Missoula Floods outburst area, Idaho: Ice Age Floods Institute, 17 p.


Lewis, R.S., R.F., Burmester, R.M. Breckenridge, M.D. McFadden, J.D. Kauffman, 2002, Geologic Map of the Coeur d'Alene 30 x 60 Minute Quadrangle, Idaho. Idaho Geological Survey Geologic Map 33, 1:100,000 scale.


Location Map of Field Guide Stops