Flathead River and Mission Range

©John Lambing

Montana Geology '03

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"A few days afterward we made an excursion to the Saleesh Lake, and beyond it, the Lake is a fine sheet of water about twenty [28] miles in length by three or four [6] miles in width, the haunt in all seasons of aquatic fowl, the country around, especially to the eastward and southward for many miles is very fine and will become a rich agricultural country for which its mild climate is very favorable, on the fine grounds many battles have been fought, the bones of the slain mark the places...it was from about the lake?? that most of our winter provisions came."

David Thompson Journals
1 March 1812

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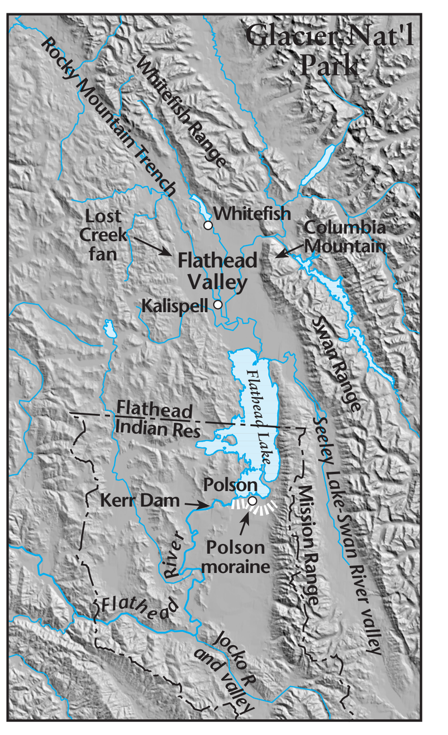
On the front: Tan beds of silt, clay, and gravel deposited in Glacial Lake Missoula border the Flathead River in the Mission valley downstream from Flathead Lake. Suspended silt particles, large enough to see with the unaided eye, contribute to the blue-green color of the water. Named for the mission of St. Ignatius founded in 1854, the Mission Range runs nearly north-south for more than 60 miles. The highest peak, McDonald Peak, located near the southern end of the range, is 9,820 feet (shown in the photo). Its faulted western margin accounts for the steep front. The cliffs east of the Flathead River in the calendar photo are about 25 miles southwest of Polson. They are composed of fine-grained sand and silt that were deposited in Glacial Lake Missoula and rise about 60–80 feet above the river then recede more gradually eastward to a height of about 200 feet above the river. The mountains are about 25 miles away.



Map of locations mentioned in text.

Prehistory and History

The trails used by early Native Americans became the pathways and roads of later generations and often ran parallel to, but at some distance from, the rivers. The rivers, themselves, were little used as transportation in this area. The principal route ran from the Tobacco Plains (on the U.S.–Canadian border eight miles north of Eureka, Montana) through the Flathead Valley, and Mission and Bitterroot valleys, and now is occupied by U.S. Highway 93. For thousands of years, this trail saw the passage of small family groups and small bands of traders exchanging native tobacco, furs, roots, and cedar wood for flint, obsidian, and buffalo robes.

1700s Early Mid-Century

The arrival of the horse in this area greatly changed the inhabitant's way of life. Trips that took weeks now could be made in days, and more domestic goods could be carried from camp to camp, allowing for the accumulation of more personal goods. Hunters ventured east of the mountains to hunt bison, sometimes bringing their entire extended families. The abundance of bison meat, carefully dried or preserved with berries and fat, helped reduce famine, especially in the winter. The horse also brought other peoples into the area, which caused shifts in alliances and hunting areas. Warfare, raids, and depredations became increasingly common. Native inhabitants resided in the area permanently or seasonally for thousands of years, commonly camping near streams and lakes because of the abundance of clean water, provisions of fish for food, and transportation. Members of the various Salish tribes who inhabited the valley were referred to as the "Flathead" in accounts as early as Lewis and Clark's 1805 journals (Moulton, 1988).

1800s to the Present

After British-Canadian fur trappers and traders began entering the valley in the early-1800s, the Flathead River and Flathead Lake became more heavily used for transportation of goods and people. The Flathead Indian Reservation was created in 1855; today, the Confederated Salish and Kootenai Tribes play an important role in managing the valley's water resources. Settlement in the upper valley rapidly expanded following the arrival of the Great Northern Railway in 1891, and steamboats operated regularly on Flathead Lake between the 1880s and the late 1920s as a main method of north-south transportation. The steamboats faded into history after the "eastside road" was completed in the late 1910s, and automobiles became more popular.

The passenger steamboat *Wasco* was one of many that transported people north and south across Flathead Lake (left); The community of Jessup was erected near the timber and flour mills supplied by water from the Jessup Mill Pond (right). The original dam impounding the pond is in the foreground of this photograph taken looking south. The enlarged pond today serves the Creston Fish Hatchery. Courtesy of The Northwest Montana Historical Society, Kalispell.

Geography of the Flathead Area

From headwaters in the high-alpine country near Glacier and Waterton Parks, the Flathead River flows through some of the most scenic areas in Montana including the Flathead Valley. The northern and southern parts of the Flathead Valley are separated by Flathead Lake, which with a surface area of 191 square miles, is the largest natural U.S. freshwater lake, excluding the Great Lakes. Striking vistas that include large free flowing rivers, cliff-forming glacial-lake deposits and sharply defined snow-capped peaks are found within the valley and enhance the valley's attractiveness to tourists and residents alike.

Water Resources of the Flathead Valley

As more people occupied the Flathead Valley and industrial development began, water resources continued to play a major role. In many places, such as at Jessup Mill near present-day Creston, streams were dammed to provide energy for timber processing and flour milling. Streams were used to transport timber and divert water to irrigate farm land. Large-scale, water-resource development included completion of the Kerr Dam in 1938, which raised the level of Flathead Lake by about 10 feet, and completion of Hungry Horse Dam on the South Fork of the Flathead River in 1953, which provided electricity for industry in the northwest United States. The abundant fishery supported by the Flathead River and its tributaries, as well as the many other lakes, has always been important in the region for sustenance and sport.

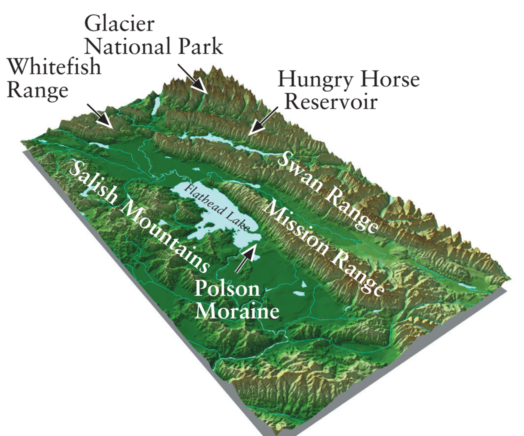
The scenic beauty of the Flathead River and Flathead Lake and easy access to outdoor amenities have helped attract people, making the Flathead Valley one of the fastest growing areas in Montana, with a 26 percent increase in population between 1990 and 2000. Although the river and lake may help attract the new residents, it is the hidden ground-water resource that has supported the surging population. Ground water, concealed beneath the land surface in shallow and deep aquifers, supplies more than 90 percent of the residents and is also an important source of irrigation water.

Recognizing the important role ground water plays in the region, scientists from the Montana Bureau of Mines and Geology's Ground-Water Characterization Program, in cooperation with local agencies, conservation districts, and the Confederated Salish and Kootenai Tribes, recently completed an assessment of the ground-water resources of the Flathead Lake area.

Hydrogeology of the Flathead Valley

The mountain ranges and intermontane valleys that characterize the region began forming tens of millions of years ago. The Flathead Valley is at the southern end of a northwest southeast–trending system of valleys in Montana and British Columbia. The valleys initially formed 45–50 million years ago as the Earth's crust was stretched northeast-southwest, creating faults along which the mountain ranges were uplifted and the valleys were down dropped. The oldest rocks exposed belong to the Belt Supergroup, a 50,000-foot-thick sequence of 1.4 billion-year-old sedimentary rocks that form the mountain cores and also underlie the valley-fill materials. In the Flathead Valley several thousand feet of mostly unconsolidated sediment overlies the bedrock. The upper several hundred feet of valley fill contain the most important aquifers.

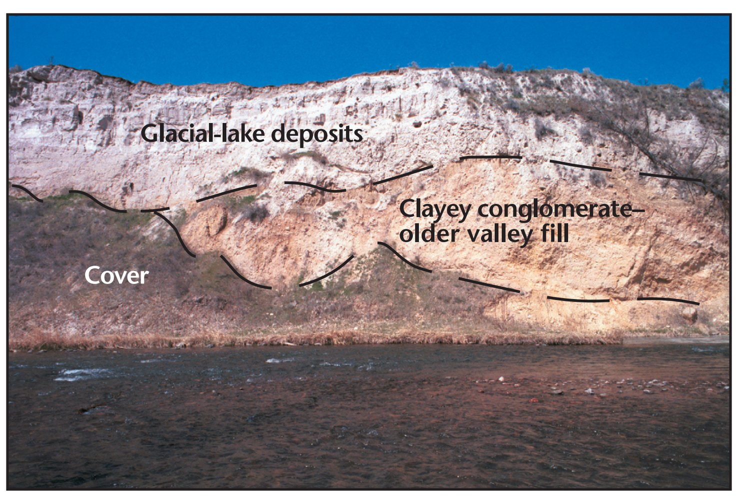
Glacial ice pushed southward through the Flathead Valley during several glacial episodes. Its most recent advance is marked by the Polson Moraine, an arcuate ridge of boulders, gravel, sand, silt, and clay pushed and carried by the glacial ice. Glacial ice sliding over rock and sediment produced great quantities of silt-sized sediment, aptly referred to as rock flour because of its similarity in texture to common flour. The silt accumulated in ice-marginal lakes and streams and in compacted mixtures of silt and gravel deposited directly by ice, called till. The glacial ice changed the topography by relocating rivers and abrading the valley margins and then depositing the fragmented material as till. Rivers and meltwater carried abundant coarse boulders, cobbles, and finer sand and silt. When these streams emptied into a glacial lake, clayey and gravelly sediment accumulated across large areas. West-flowing valley glaciers also spilled from drainages in the Mission Range, creating smaller moraines along the east side of the valley. Not only did glacial ice directly change the topography, huge



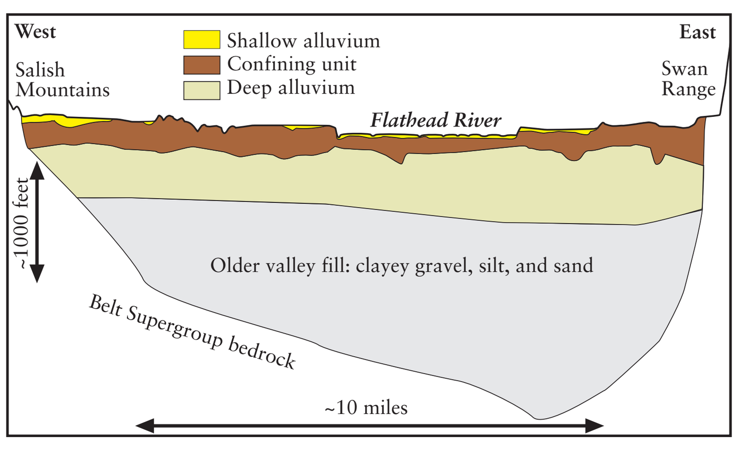
Present: The Flathead Valley is the largest intermontane valley in northwestern Montana, stretching north-south from the Whitefish Range to the Jocko Hills.

15,000 years ago: At the peak of the last glaciation, glacial ice extended south from Canada and north from the Seeley Lake Swan River valley area into the Flathead Valley. The toe of the Flathead Lobe was periodically flooded by the immense Glacial Lake Missoula, which was created when a glacier dammed the Clark Fork River near the Idaho-Montana border.

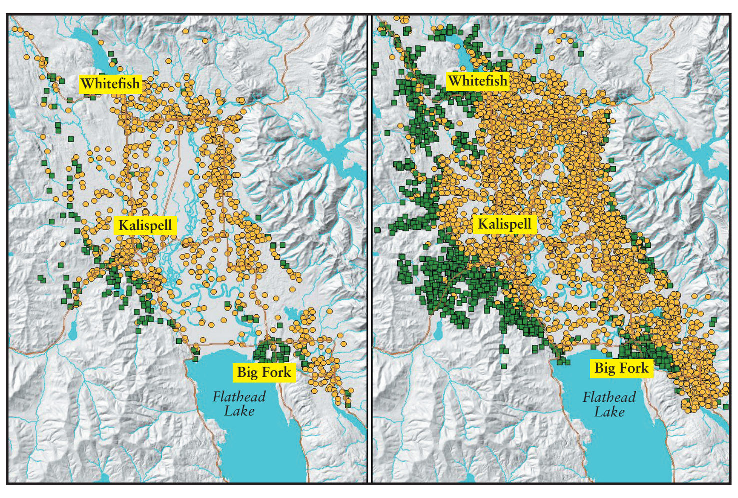
The Polson Moraine, the prominent hills that border the southern end of Flathead Lake, was built up by deposition at the toe of the Flathead Lobe as it stood at its farthest south position during the last glacial period.



Pinkish white silt deposited in Glacial Lake Missoula is near the land surface throughout the area south of the Polson Moraine. The semi-consolidated gravelly clay below the silt in this river bank along the Jocko River is 30–40 million years old and accumulated during initial down dropping of the valley.



This east west–oriented cross section shows the relative positions of bedrock and basin-fill material in the Flathead Valley north of Flathead Lake.



Wells drilled into the deep alluvium (orange dots) and bedrock (green squares) before 1975 (left) and by the end of 2001 (right) depict increasing density of development and expansion of drilling around the perimeter of the valley, showing the residential development of foothill areas.

The Flathead Valley looking northwest from Columbia Mountain towards Whitefish Lake and the southern end of the Whitefish Range.

Acknowledgements

The Northwest Montana Historical Society, Kalispell, Montana, graciously made their photograph collections available.

Credits

Front photo by John Lambing. Text photos were taken by Larry Smith unless noted otherwise. Text was written by Larry Smith, John LaFave, Bob Bergantino, and Tom Patton, MBMG.

Location

lakes formed from meltwater along ice-dammed rivers. During several glacial advances between about 15,000 and 30,000 years ago, water draining from most of western Montana was dammed near the Idaho-Montana border by glacial ice, creating temporary stands of a large glacial lake, referred to as Glacial Lake Missoula. Glacial Lake Missoula waters backed up from the south to meet glacial ice at the Polson Moraine.

Another glacial lake (ancestral Flathead Lake) formed in front of the Flathead Lobe as the glacial period ended and the glacier retreated northward. Ancestral Flathead Lake extended, at its maximum, between the Whitefish Range on the north and the Polson Moraine on the south. The lake level was lowered as stream water cut downward through the Polson Moraine near present-day Kerr Dam. The present-day Flathead Lake is a remnant of the former, much larger ancestral Flathead Lake.

Till deposited by the Flathead Lobe and glacial-lake sediment (laminated beds of silt and clay) deposited in the ancestral Flathead Lake occurs widely throughout the Flathead Valley north of the Polson Moraine and separate thin stream-deposited sand and gravel (the shallow alluvium, generally within 50 feet of the land surface) from the deep alluvium. The deep alluvium is stream sediment that was deposited prior to, and eventually buried by, the till and lake sediment and is generally found at depths greater than 100 feet.

Ground-Water Resources

The main aquifers in the Flathead Valley north of Flathead Lake are the shallow alluvium and the deep alluvium. The shallow alluvium is important in limited areas of the valley but is potentially susceptible to contamination, more prone to drought, and is not being developed as commonly as the deep alluvium. The deep alluvium generally produces large amounts of ground water wherever it is penetrated by wells. Bedrock underlying and surrounding the valley is also utilized as an aquifer but is typically permeable to water only where fractured. Where the deep alluvium and bedrock are greater than 100 feet below land surface and produce water to wells, they are called the deep aquifers.

The Deep Aquifer

The deep aquifer north of Flathead Lake is a truly exceptional resource. It is productive, and well yields in excess of 100 gallons per minute are common. The water is of excellent quality, with typically very low concentrations of naturally dissolved minerals. The aquifer is well protected in most places from surface contamination by low-permeability layers of silt and clay (sediment through which ground-water passes very slowly). The aquifer is widespread beneath the entire valley north of the lake. In some places, however, the water circulation and quality have been impacted by development and the increasing demands that are being placed on the aquifer.

The distribution of water wells reflects the population growth in the valley; between 1975 and 2000, there was a five-fold increase in the number of wells completed in the aquifer. As residential development has moved from the center of the valley to the valley perimeter, the fractured bedrock also has become heavily used.

The fractured bedrock in the mountains surrounding the valley supplies ground water to, or recharges, the deep aquifer. Most of the precipitation in the mountains falls during the winter months, and recharge occurs primarily during spring runoff. Fractures in the bedrock facilitate transfer of ground water from mountains into the deep aquifer. Ground-water flow is away from the mountains toward the Flathead River in the center of the valley and south toward Flathead Lake. Beneath the glacial-lake and till sediment, ground water occurs under pressure (in that the sediment are beneath a confining layer of low permeability). Pressures are great enough in some areas that ground water will flow from some wells at land surface.

Effects of Ground-Water Development on Water Levels

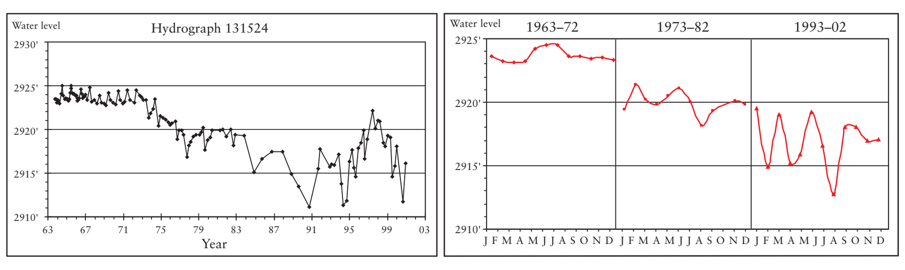
Ground-water levels in the deep aquifer respond to seasonal runoff, to climate fluctuations, and to pumping from wells. Prior to extensive development of the deep aquifer, water levels fluctuated in a seasonal runoff pattern. During the 1970s, the number of high-capacity irrigation wells withdrawing ground water from the deep aquifer was greatly increased. The irrigation development resulted in water being removed from aquifer storage and caused water-level declines as the ground-water system developed a new equilibrium. This occurs in the middle of the valley where the deep aquifer is buried beneath low-permeability units and where there are more high-capacity wells.

Although the long-term data indicate the aquifer does not seem in danger of depletion, seasonal pumpage now controls the timing and magnitude of water-level fluctuations over a large area. Given the confined nature of the aquifer, this sensitivity to use indicates a potential for interference among wells and warrants continued monitoring.

Water Quality

Water quality may be characterized by the type and concentrations of its naturally dissolved minerals. Ground water in the deep aquifer has a consistent chemical makeup and is of good quality for drinking and other uses. Calcium, magnesium, and bicarbonate are the primary ions in solution, and the water is typically low in dissolved solids (less than 400 milligrams per liter [mg/L]); there is no discernable chemical difference between the water from the deep alluvium and the water from bedrock.

Nitrate, an essential nutrient at low concentrations but potentially toxic at elevated concentrations, has not been detected above the health standard of 10 mg/L in the deep aquifer; concentrations are generally lower than 1.5 mg/L. A few samples collected northwest of Kalispell contained nitrate in concentrations greater than 1.5 mg/L, suggesting that contamination of the deep aquifer in that area may be occurring. This Lost Creek fan area is a location where a thick accumulation of shallow alluvium was deposited on top of the deep alluvium by glacial meltwater, and the protective layer of glacial lake deposited silt and clay may be absent. The deep aquifer may be vulnerable to contamination from surface sources here and in similar areas.



Effects of increasing usage of ground water in the valley can be inferred from this long-term hydrograph and a graph of average monthly water levels for the periods 1963–72, 1973–82, and 1993–2001. Between 1963 and 1972 water levels fluctuated in a consistent seasonal runoff pattern with no increasing or decreasing trend; annual fluctuations were generally less than 2 feet. Between 1973 and 1982, the pattern changed; water levels dropped sharply in the late summer; recovery occurred sporadically in winter and spring; and the magnitude of the annual fluctuation doubled to 4 feet per year. Well-log and water-rights records indicate that many high-capacity irrigation wells were installed during this time period. Since 1993, data show that the pumping response has become more pronounced, with annual fluctuations of nearly 8 feet. The increase in water levels during 1996–97 corresponds to a period of above-average precipitation and runoff.

References and Further Reading

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Montana Bureau of Mines and Geology

Montana Tech of The University of Montana

Scope and Organization

The Montana Bureau of Mines and Geology (MBMG) was established in 1919 as a public service agency and research entity for the State of Montana to conduct and publish investigations of Montana geology, including mineral and fuel resources, geologic mapping, and ground-water quantity and quality. In accordance with the enabling act MBMG conducts research and provides information but has no regulatory function.

MBMG is organized into five divisions: Administrative, Analytical, GIS/ Computer Services, Information Services, and Research. Most staff work within the Research Division. The director of MBMG holds the position of State Geologist.

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