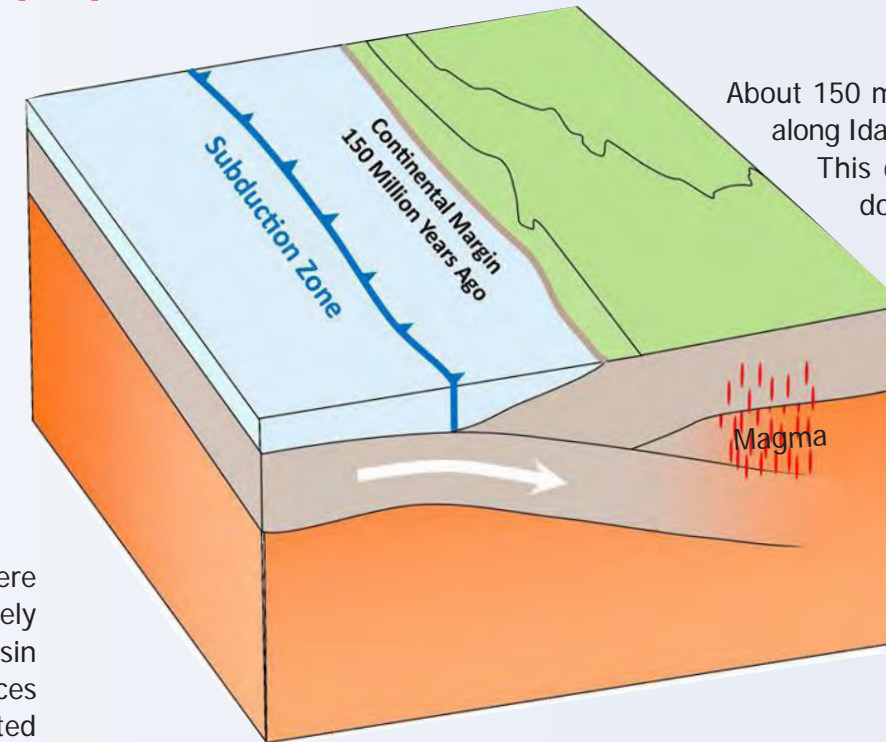


The geology of the Spokane Valley – Rathdrum Prairie area is the result of multiple geologic events that have occurred over hundreds of millions of years creating both our landscape and the aquifer of today. Understanding the geologic events of the past helps us better understand our environment and current issues. The geology of the area is complex and it has taken decades to piece the history together. Five significant geologic units compose most of the rock types found in the Spokane Valley – Rathdrum Prairie area. Brief descriptions of these units follow on the next pages. The color surrounding the description and abbreviation **match the color of the geologic units shown on the accompanying geologic map.**

DRAFT
3/31/2015

2. Kaniksu Batholith (Flir) - 50 to 100 millions years ago

Batholith Formation



About 150 million years ago, the continental margin was located along Idaho's western border, where two tectonic plates collided. This collision resulted in the western plate being forced down (subducted) and overridden by the eastern plate. As the western plate was subducted, the rock began to heat up as it reached greater depths, melting portions of the upper plate. The drawing shows what happened.

The melted material (magma) was lighter than the surrounding rock and rose up from deep within the earth. Instead of forming a volcano, it solidified near the earth's surface. The solidified body of rock is called a batholith.

The Kaniksu Batholith is located in northern Idaho and northeastern Washington, and is the northernmost formation of Idaho's many batholiths, which were formed about 70 to 80 million years ago.

Batholith Exposure

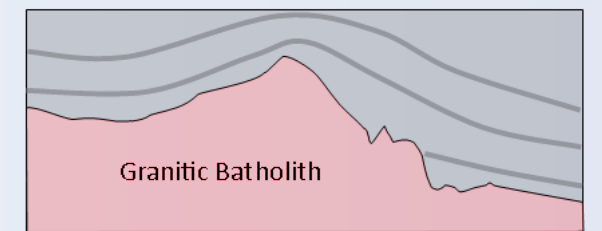
When the Kaniksu Batholith intruded upward, it forced the overlying Belt Supergroup rocks to the east and west. The Kaniksu Batholith split the Belt Supergroup rocks along the Purcell fault. In geology, a fault is where two rock bodies move past each other. Over time erosion of the overlying rock exposed the Kaniksu Batholith. The movement of the Belt Supergroup rocks to the east also formed a large trench between the two rock groups that eventually filled with gravels and sand forming the Rathdrum Prairie.

Kaniksu Batholith Rocks

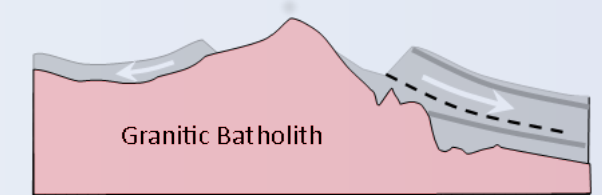
The upper crustal material is made up of many different types of minerals (rocks are made from one or more minerals) with different melting temperatures. Minerals with low melting temperatures melt first and separate from the larger rock mass. The minerals that melt first make up granitic-type rocks. Because it took millions of years for the magma to solidify back into rocks, it had time to form many different minerals as crystals that we can see when we look at the rocks.



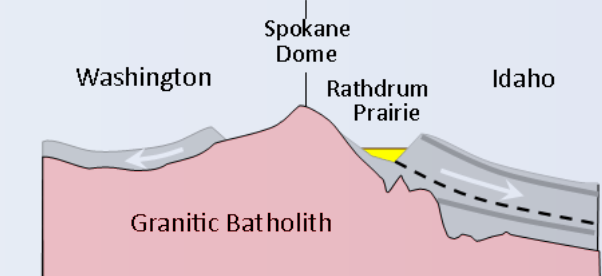
Deposition of Belt Supergroup



Intrusion of granitic batholith



Batholith emplacement displaces Belt Supergroup rocks to east and west



1. Belt supergroup (Bsg) - 1.1 to 1.4 billion years ago

What Are They?

Belt Supergroup rocks are composed of a thick sequence of sediments that were deposited in an ancient sea basin. The term "Supergroup" refers to an extremely thick sequence of rocks of the same kind, and Belt refers to the name of the basin that the sediments were deposited within. The basin was formed by geologic forces pulling the rock apart and creating a large, deep rift. The sediment was deposited deep under water forming thick accumulations. As the rift filled with sediment, it was also slowly sinking; a process geologists call "subsidence". The subsidence allowed even more sediment to accumulate in the rift. Eventually the rift started to fill and younger sediments were deposited in shallower water. The sediment consisted mostly of clay and silts, along with sands and calcium carbonate. The basin's great depth allowed sediment that is tens of thousands of feet thick to accumulate. The weight of all the overlying sediment eventually caused the sediment to metamorphose or turn into a type of rock called an argillite.



Fossil ripple marks

Window To An Ancient World

The Belt rocks were probably deposited much like what we see today with silts and sands from nearby land washing out into a shallow basin of water. Some of the sediments have ripple marks from wave action, indicating the sediments were deposited near the shoreline.

Fossils in the metamorphosed sediments of a type of blue-green algae are called stromatolites. Stromatolites are the oldest known fossils and formed layers or mats often shaped like domes. These fossilized domes are seen in some of the Belt Supergroup rocks. Stromatolites thrived in areas of warm shallow water and, like plants of today, needed sunlight and carbon dioxide to live. Stromatolites lived in large colonies, similar to current day coral reefs. Stromatolites currently exist in a few places in the world. They are found in small, isolated fresh-water lakes and shallow marine lagoons.



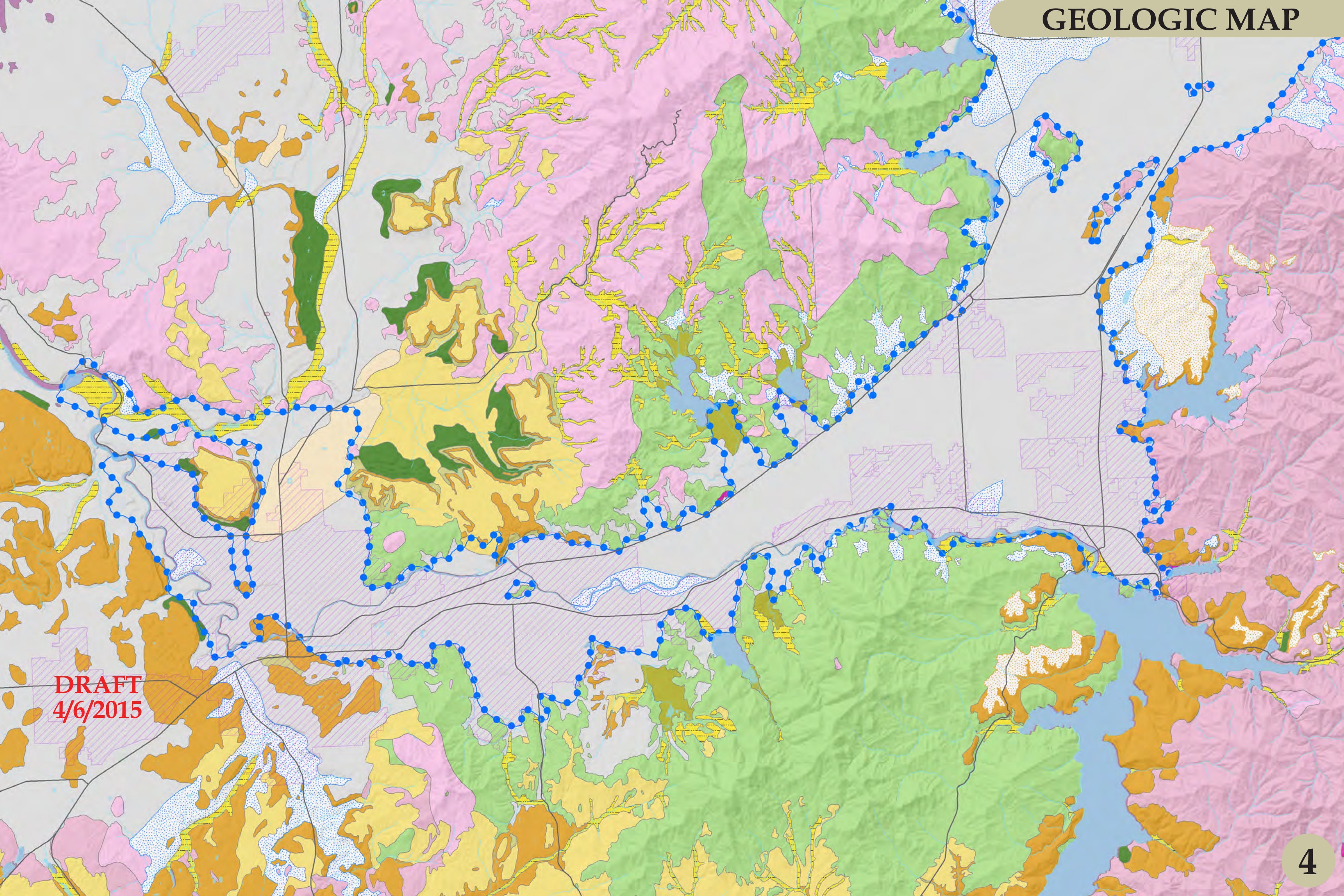
Fossil stromatolites



Kaniksu rock on Mount Spokane



Living stromatolites in Australia



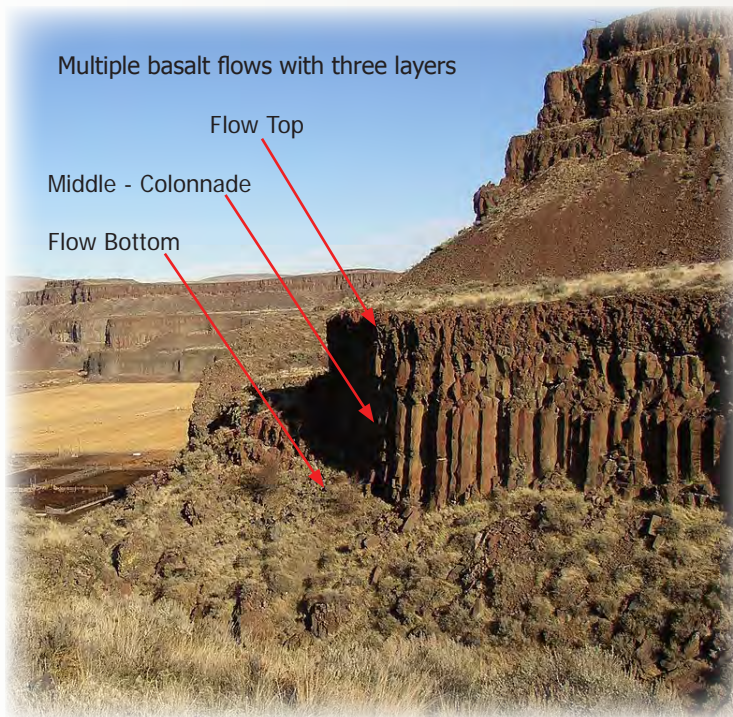
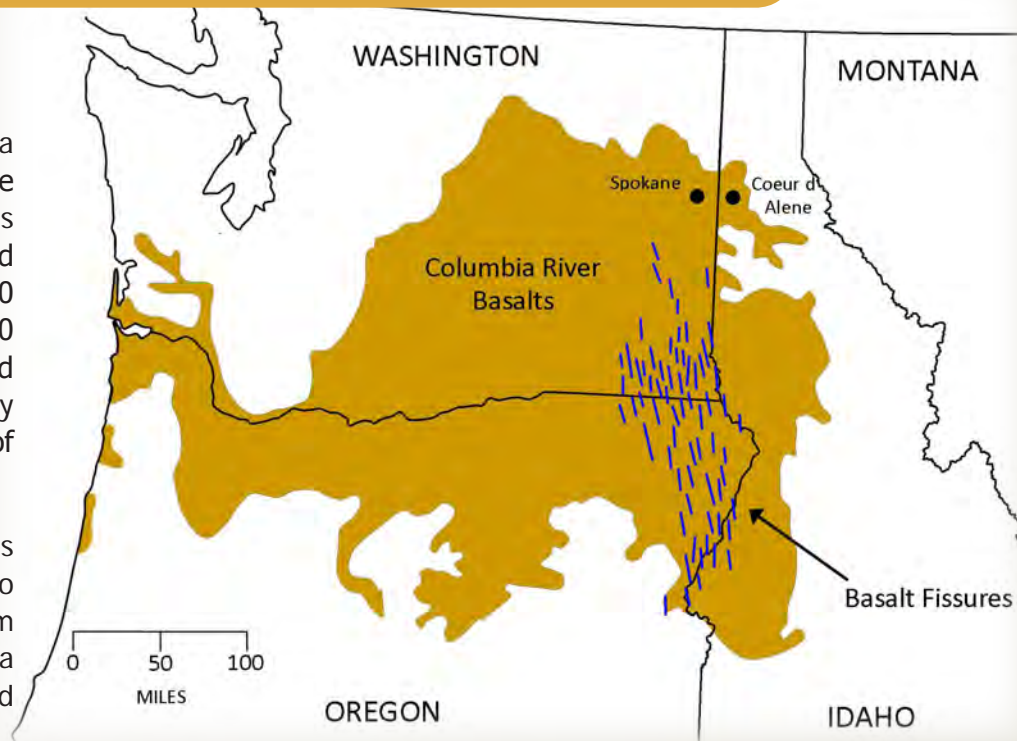
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3. Columbia River Flood Basalts (Crb) - 10 to 17 million years ago

Lava Flows

About 10 to 17 million years ago, as many as 270 lava flows erupted from basalt fissures located near the Idaho, Oregon, and Washington borders. The eruptions did not form volcanos because the lava was very fluid and acted like floods. It is estimated that almost 42,000 cubic miles of lava flowed out over an area of 63,200 square miles. The individual lava flows were estimated to be about 150 feet high and moved at approximately 3 miles per hour. Sometimes there were hundreds of thousands of years between the lava flows.

In the central area of Washington near the Tri-Cities the cooled and hardened lava, called basalt, is up to 10,000 feet thick. The Spokane Valley – Rathdrum Prairie (SVRP) aquifer is at the edge of the Columbia River Flood Basalts and many of the mountains around the SVRP aquifer stick out above the basalts.



Three Basalt Forms From Each Lava Flow

The basalt has three appearances depending on where it was in the flow when it hardened: flow top, middle section, and flow bottom.

- The upper part of the basalt flow (flow top) cooled and hardened quickly in contact with the atmosphere so it developed many small air bubbles. Basalt with many small air bubbles is called vesicular basalt.
- The middle section of a basalt flow took a long time to cool and solidify. As the basalt cooled, it shrank and developed cracks. The cracks started near the top where it cooled first and then spread downward making long columns. Each individual basalt column is called a colonnade.
- The flow bottom was in contact with the top of the previous older basalt flow. Generally the top of the previous flow was exposed to the elements and weathered into soil and smaller bits of basalt. When the new lava flowed over the top of the older basalt, it picked up and incorporated large amounts of the rock debris. Basalt with bits of rock is called a breccia.

Each basalt flow covered the previous one and developed similar appearances. You can see all three basalt forms when the full height of the flow is exposed.

Latah Formation

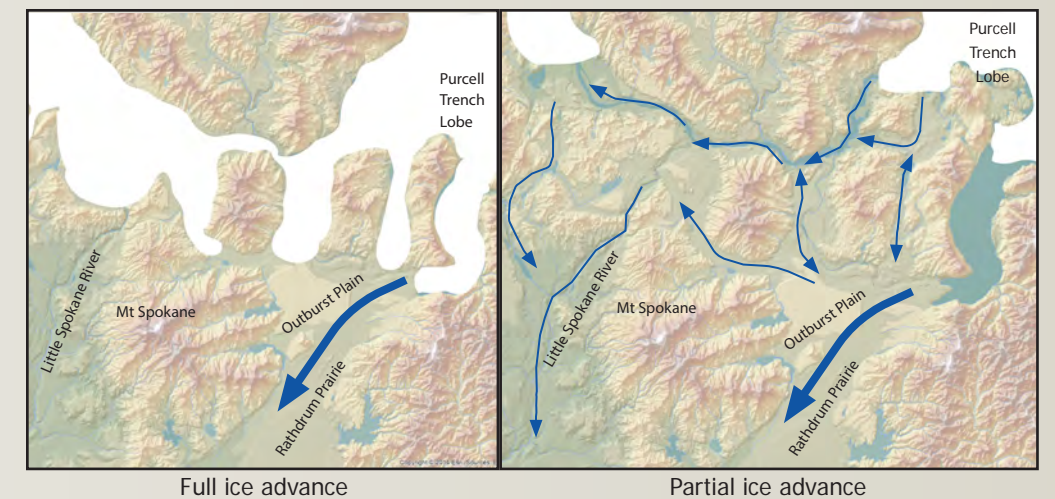
In northern Idaho and eastern Washington, the flood basalts filled the valleys, blocking streams and rivers creating ponds and lakes. These ponds and lakes filled with silt and fine-grained sediments that later formed siltstone and are called the Latah Formation. Many types of fossils including plants, mollusks, and fish can be found in these sediments.



Different Paths

Sometimes the Purcell Trench Lobe extended to the southern end of Lake Pend Oreille. When the ice dam broke, the only path available to the floods was south over the Rathdrum Prairie. See the map at right.

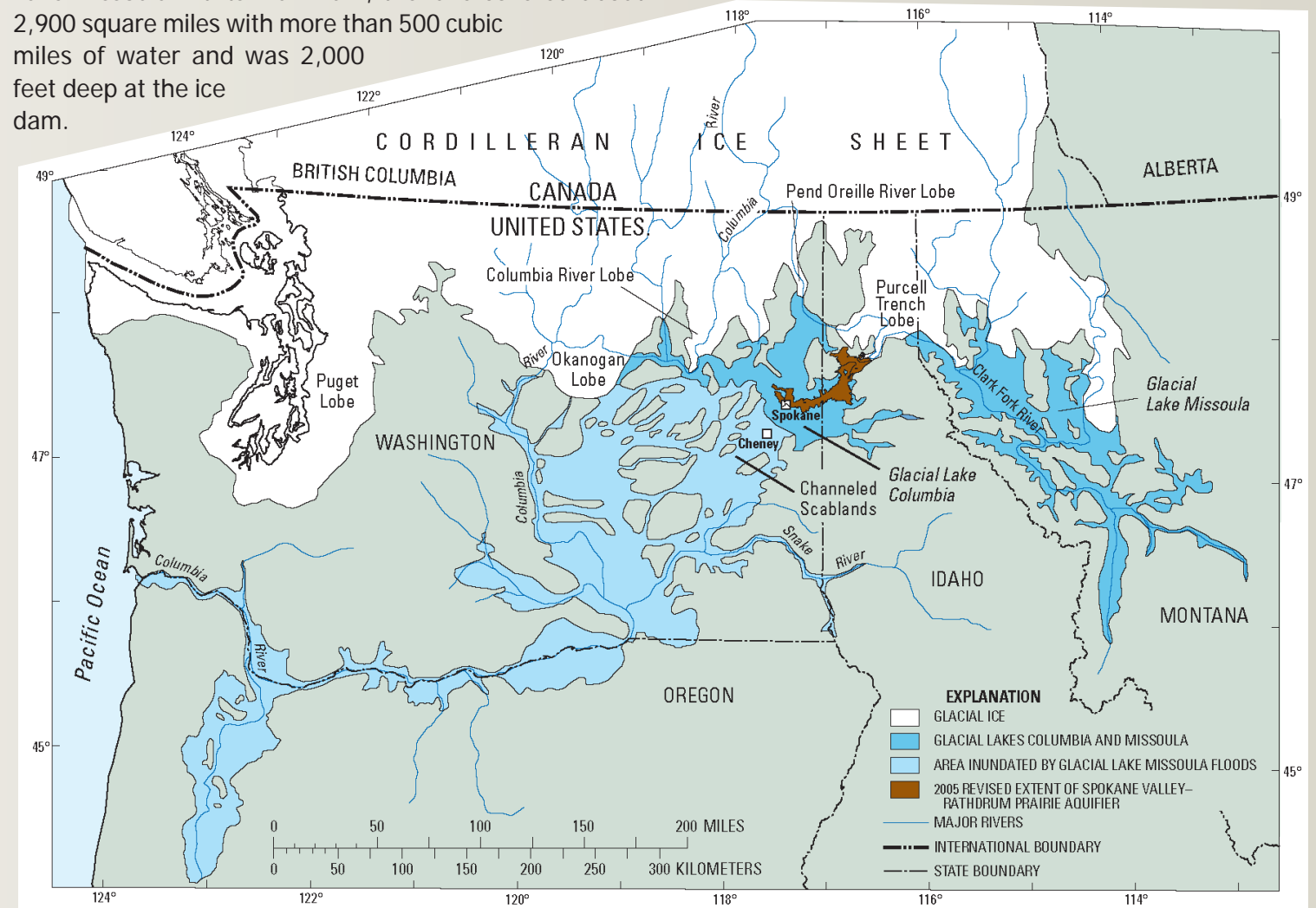
When the Purcell Trench Lobe did not extend as far, the floods had several possible paths besides the Rathdrum Prairie. Some of the water flowed through routes that led to the Little Spokane River valley. See the map at far right.



4. Glacial Lake Missoula Flood Deposits (Fg) - 15 to 100 thousand years ago

The cooling climate during the Pleistocene Epoch, or Ice Age, caused sheets of ice to advance south several times from current day Canada. The uneven leading edges of the Cordilleran ice sheet are called lobes. There were two main lobes in the area. The Purcell Trench Lobe flowed far enough south to sometimes block the Clark Fork River and the Okanogan Lobe flowed far enough south to block the Columbia River.

The Purcell Trench lobe of ice reached south to completely cover the area of present day Lake Pend Oreille during the last glacial advance, 13,000 to 18,000 years ago. This glacier blocked the Clark Fork drainage forming Glacial Lake Missoula. At its maximum, the lake covered about 2,900 square miles with more than 500 cubic miles of water and was 2,000 feet deep at the ice dam.



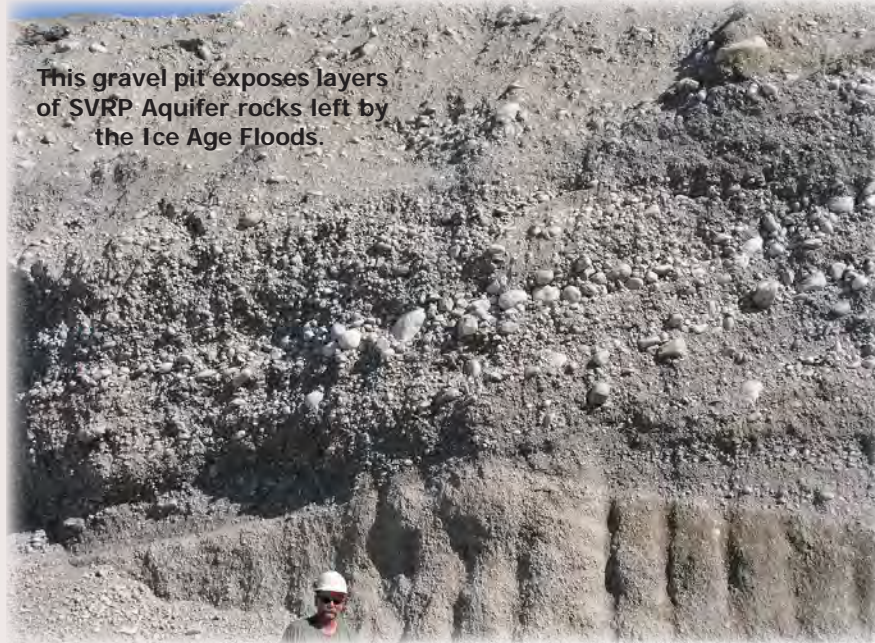
Exploding Ice

The water behind the ice dam exerted great force on the ice dam and forced its way into the ice. Eventually the ice dam failed and released a great volume of water all at once, creating enormous floods. Ice dams reformed and exploded at least 40 times. These types of glacial floods are called jokulhalups, an Icelandic term meaning "glacial run".

How The Ice Age Floods Created The Spokane Valley - Rathdrum Prairie Aquifer

The water in the Spokane Valley -Rathdrum Prairie (SVRP) area during the floods reached depths of about 450 feet and flowed with peak velocities of 60 miles per hour. The flow rates may have reached one billion cubic feet per second—more than the flow of all the rivers in the world. Large amounts of ice, cobbles, sand, and gravel were carried along with the water. The larger gravel, cobbles, and boulders were deposited and the smaller silt and sand were carried away. These rocks are now part of the SVRP aquifer.

Glacial Lake Columbia covered the Rathdrum Prairie and Spokane Valley almost to the front of the ice dam during some of the floods. When the lake was present, it slowed down the water so some silt and sand were deposited along with the gravel, cobbles, and boulders.



This gravel pit exposes layers of SVRP Aquifer rocks left by the Ice Age Floods.



Wave-cut strandlines near Perma, Montana record former high-water lines, or shorelines of Glacial Lake Missoula.

Repeated Ice Age Floods

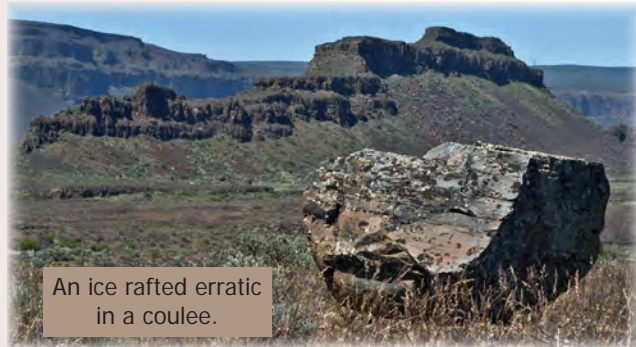
After a flood event ended, the ice lobe slowly moved southward, blocking the Clark Fork River once again. Eventually, this dam would also fail, resulting in another flood. This repeated flooding deposited large amounts of mainly gravel and cobbles in the Spokane Valley – Rathdrum Prairie area and eventually blocked the tributary valleys, forming Lakes Coeur d'Alene, Hayden, Pend Oreille, Spirit, Twin, Hauser, Liberty and Newman.

Ice Age Floods Beyond The SVRP Aquifer

The catastrophic floods from Lake Missoula rapidly flowed into Glacial Lake Columbia displacing enormous amounts of water forming geologic features called "coulees." Coulees are generally long with steep sides caused by the rapid erosion and down cutting from the large amounts of water flowing through them. The water that spilled out into the coulees to the west and over low points to the south flowed in enormous sheets across central Washington. The large amounts of water deformed the landscape giving the area the name "scablands."

Large pieces of ice with boulders floated many miles in the flood. The boulders were deposited as the ice melted leaving behind unusual rocks called "erratics".

The flood water finally spilled into the present day Columbia River Gorge and on to the Pacific Ocean.



An ice rafted erratic in a coulee.

Did you know?

- The ice dam was over 2,000 feet tall.
- Glacial Lake Missoula was as big as Lake Erie and Lake Ontario combined.
- The floodwaters speed may have peaked at about 60 mph.

Evidence For The Ice Age Floods

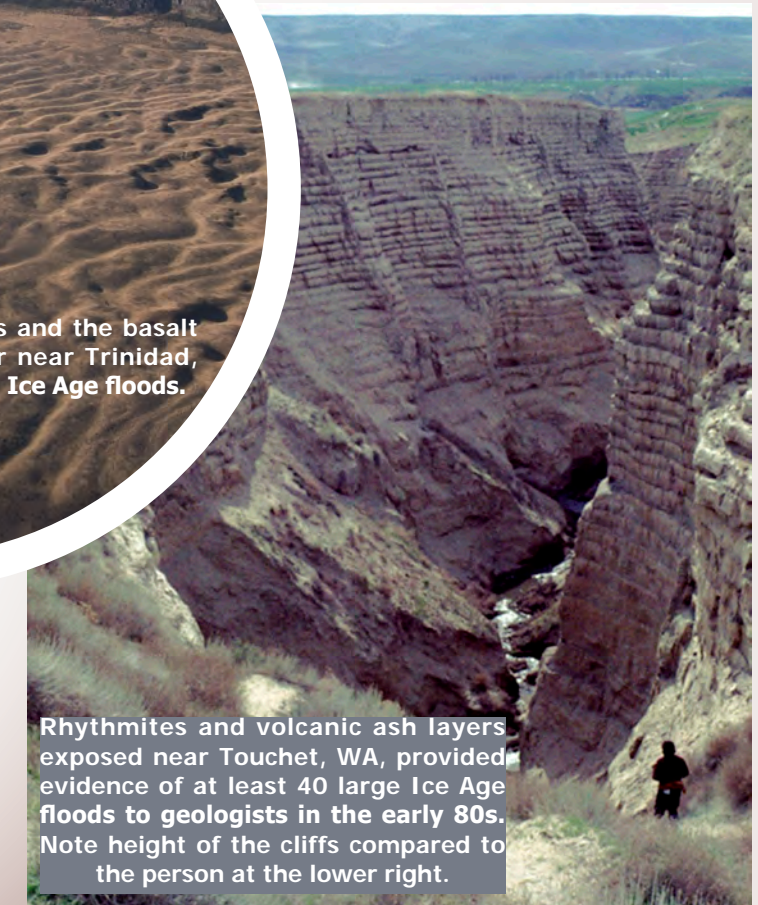
The evidence for Glacial Lake Missoula comes from shoreline features called wave-cut strandlines on many hillsides in Montana.

Giant ripples marks on Camas Prairie in Montana and on the West Bar in Washington as well as large coulees are evidence of large amounts of water flowing rapidly.

Sediment layers with large rocks on the bottom and clay on the top, called rhythmites, found in many places along the flood's path are the evidence for repeated Ice Age floods. Some rhythmites are found along the lower part of Hangman Creek. The exposed rhythmites near Touchet, Washington, have at least 40 layers.



The West Bar with ripple marks and the basalt cliffs along the Columbia River near Trinidad, Washington are evidence of the Ice Age floods.



Rhythmites and volcanic ash layers exposed near Touchet, WA, provided evidence of at least 40 large Ice Age floods to geologists in the early 80s. Note height of the cliffs compared to the person at the lower right.

GEOLOGISTS UNRAVEL THE MYSTERY OF THE ICE AGE FLOODS AND GLACIAL LAKE MISSOULA

J Harlen Bretz (1881-1981) was a University of Chicago professor who studied the channelled scablands of eastern Washington. His 1923 theory proposed the scablands resulted from a catastrophic ice age glacial flood, an idea that was not accepted until the 1950s because he did not know the source of the flood.



Joseph T. Pardee (1871-1960) was a US Geological Survey geologist who theorized the wave-cut strandlines above Missoula and other features in western Montana came from a large lake that emptied rapidly. In 1940 he reported the lake emptied to the west and was the source of Bretz's catastrophic flood.

5. Unconsolidated Deposits (Ucd) - Present to 1.6 million years ago

These deposits represent all unconsolidated deposits that have been accumulated through wind, water, or as a result of landslides. These include the Palouse wind blown-sediments that extend from the Central Washington to the Pullman-Moscow area north to some of the upland areas surrounding Spokane. About a million years ago a warm dry climate existed and significant winds from the southwest carried silt from the central Washington area. The source of the fine silt was the fine material that flowed with older catastrophic floods and settled in what is now the channelled scablands. These wind blown silts are also called "loess" deposits, derived from the German word for loose.