Glaciation and geomorphology of Russell Creek valley, Park County, Wyoming

Dorothy Metcalf
Department of Geology, Whitman College, Walla Walla, WA 99362
Faculty Sponsor: Robert J. Carson, Whitman College

Nancy Adams
Department of Geology, Trinity University, 715 Stadium Dr. #108, San Antonio, TX 78212-7200
Faculty Sponsor: Diane Smith

Introduction

In the Pleistocene, the Yellowstone Ice Sheet covered the northwest corner of Wyoming (Pierce, 1979). One of its outlet glaciers flowed eastward along Clarks Fork of the Yellowstone River and into many smaller valleys in the area. One of these smaller valleys is Russell Creek Valley, which ice flowed into from six different directions (Figure 1). After the retreat of the ice, Russell Creek Valley continued to change due to fluvial, eolian, and mass wasting processes. The purpose of this project is to map the extent of the Clarks Fork Outlet Glacier in the vicinity of Russell Creek, as well as to map geomorphology and surficial deposits of the area.

Pleistocene Geology

Two distinct glaciations occurred in the Yellowstone area during the Pleistocene, the Bull Lake Glaciation and the Pinedale Glaciation. A study conducted on andesitic rocks in west Yellowstone attributed weathering rinds with a thickness >0.5 mm to the Bull Lake Glaciation and rinds with a thickness <0.5 mm to the Pinedale Glaciation (Colman and Pierce, 1981). The only possible evidence of Bull Lake Glaciation in Russell Valley is the 1.0 mm weathering rinds found on volcanics from moraine M1 and the terrace near Sugarloaf Mountain (Figure 1). For the most part, weathering rinds on volcanic clasts in Russell Creek valley are <0.1 mm thick, indicating that the landscape is a result of Pinedale Glaciation.

While the Clarks Fork outlet glacier of the Yellowstone Ice Sheet flowed east towards Dead Indian Hill, most of the ice continued northeast down Clarks Fork Canyon, but the remaining ice pushed up smaller creeks. Also, as the ice level rose, some lobes spilled over saddles into drainages. Russell Creek exemplifies both cases.

The ice reached an elevation of 2,730 m (8,960 ft.) along Cathedral Cliffs, six kilometers west of Russell Peak. The highest erratic found on the northwest ridge of Russell Peak is at an elevation of 2,709 m (8,889 ft.), which makes the ice thickness in the saddle west of Russell Peak 175 m (574 ft.). From this direction, most of the ice flowed into the East Fork of Painter Gulch, but some ice managed to flow into Russell Valley. The steep slope southeast of the ridge between the Natural Arch and Russell Peak resulted in an ice fall. Descending lines of erratics mark the extent of the tongue of ice referred to as the Natural Arch Lobe. The ice from this lobe retreated relatively quickly, leaving no terminal moraine.

At approximately the same time, ice spilled over the saddles between Russell Peak and Sugarloaf Mountain, forming the Bluebird, Waterhole, and North Lobes. Based on the maximum elevations of erratics found on the sides of Russell Peak and Sugarloaf Mountain, the maximum ice thickness in this vicinity was 213 m (700 ft.). The Bluebird and Waterhole Lobes were partly divided by two nunataks. These two lobes pushed as far south as the base of the peaks on the south side of the valley. Here they remained in equilibrium long enough to deposit moraines B, BW, and W. Kettles found at the southern extent of moraine BW indicate the former presence of stagnant ice.

At one time, all the meltwater from the ice lobes fed a lake which was blocked by the Main Lobe. Evidence of this lacustrine environment is the presence of ice-rafted erratics. The minimum elevation of this lake was 2,341 m (7,680 ft.) because a Flathead Sandstone erratic rests at this elevation. When the Main Lobe retreated far enough for the lake to drain, meltwater from the Waterhole Lobe scoured a channel with an anastomosing pattern.

At its maximum extent, the Clarks Fork outlet glacier flowed along the north side of Russell Peak. This ice limit can be traced by a line of erratics . An exact elevation is known because a dike remains standing two meters above the rest of the eroded surface, yet six meters to the north, erratics are found. If ice reached the dike, it would have pushed it over. Although a lobe of ice was unable to flow over this ridge, ice avalanches or rock falls carried meter-sized erratics over the ridge, where they are concentrated in gullies.

The North Lobe branched from the Waterhole Lobe and moved toward the southeast. The Main Lobe, actually in retreat, joined with this lobe. Their junction explains the shape of moraine M3. The distribution of moraines and erratics in the eastern end of Russell Valley indicates that if the N, S, and M Lobes were synchronous, the ice of these three glaciers merged.

An outwash plain that formed in front of the North Lobe provides some timing for the events in this area. Because the outwash plain aggrades against moraine M4, the Main Lobe was in equilibrium here at the time of the outwash from NL. Then, when too much water built up behind moraine M4, and after the Main Lobe retreated further, a cut was made through the northeast end of moraine M4, draining the area.

The advance of the Sugarloaf Lobe may have involved several collisions. The least complicated hypothesis is that the lobe barely advanced, never joined the North or Main Lobe, and remained in equilibrium long enough to leave terminal moraine SL. However, several possible combinations of junctions exist between the Sugarloaf, North, and Main Lobes. Timing is the main variable in each case.

The Main Lobe advanced as far west as M1. As it receded, it deposited moraines M2, M3, and M4. While this lobe and the previously mentioned lobes were entering Russell Valley, Clarks Fork ice continued to move eastward. It plucked limestone blocks from Antelope Mountain and removed shale above the Pilgrim Limestone; the glacier smoothed the Pilgrim Limestone, creating glacial pavement. Also, the Clarks Fork ice striated the Flathead Sandstone and Precambrian rocks and created roche moutonnees from pre-existing granitic hills on the floor of Clarks Fork Valley.

During retreat of Clarks Fork ice, many lateral moraines were deposited. These parallel ridges are found east of Antelope Mountain, with the exception of a ridge found south of the highway. Till covers most of the area. At least one ice marginal meltwater channel was eroded; its location was controlled by fractures in the granitic rocks.

Holocene Geology

After the Pinedale Glaciation, it is likely that the valley lacked significant vegetation. Wind deflated the area, removing the silt and clay from the till deposits. Later, as vegetation began to grow, the silt particles caught in the plants, and loess integrated itself into the soils of the area. In one drainage to the south, Sunlight Valley, Erb's evidence of dunes supports this theory (Erb, 1995).

The fluvial systems of the area re-established their drainage channels. Russell Creek cut a channel near where the Bluebird and Waterhole Lobes had terminated, and across the four moraines of the Main Lobe. An intermittent stream between Sugarloaf Mountain and Peak 2,617 m (8,588 ft.) cut through the outwash in that area, leaving terraces.

Other tributaries of Russell Creek originated on the steep slopes of the surrounding ridges and mountains. As the water drained from these areas it brought down significant amounts of sediments that accumulated as alluvial fans at the base of these mountains and ridges.

As Russell Creek cut through moraine M4, the shales below the Pilgrim Limestone lost their lateral support. Thus, the shale, limestone, and till began slumping, sliding, and flowing southeastward. In the middle of this mass wasting complex, where the dirt road makes several switchbacks, parallel ridges with sag ponds exist. Loess in the soil and the presence of caliche suggest that this is an ancient mass wasting event. However, renewed activity, evidenced by a fresher scarp and slide area, is located in the northeast area of this complex.

Three more recent earthflows are found along Russell Creek. Their headwall scarps are easily visible. The actual occurrence of one of these earthflows can be dated by an old road and pipe that are covered by the mass wasting materials. In fact, Russell Creek moved southward because this event blocked it.

Although much of Russell Creek continues to cut through till and bedrock, in parts of the upper valley, the creek meanders, forming a floodplain. As the knickpoint has migrated westward, alluvial terraces have formed, and the toes of some alluvial fans have been eroded.

Conclusion

In the Pleistocene, several lobes of the Clarks Fork outlet glacier penetrated Russell Valley. Also, during this time, a lake occupied the valley floor. After the retreat of the lobes in Russell Creek valley, the Clarks Fork outlet glacier continued to deposit lateral moraines, and its meltwater carved channels. In the Holocene, fluvial and mass wasting processes dominated. The creek re-established its drainage, cutting through moraines and outwash in some areas, while meandering and forming a floodplain elsewhere. Alluvial fans formed at the base of tributaries coming from the steep slopes around the valley. With the removal of lateral support and the incompetency of the Cambrian shales, some slopes underwent mass wasting.

References Cited

Colman, S. M., and Pierce, K. L., 1981, Weathering rinds on andesitic and basaltic stones as a Quaternary age indicator, western United States: U.S. Geol. Survey Prof. Paper 1210, 56 p.

Erb, Nelson, 1995, Geomorphology and glacial history of Sunlight Basin, Park County, Wyoming: The Eighth Keck Research Symposium in Geology, Pomona College, Claremont College, California, p.101-104.

Parsons, W.H., 1939, Glacial geology of the Sunlight area, Park County, Wyoming: J. Geology, v.47, p.737-748.

Pierce, K. L., 1979, History and dynamics of glaciation in the northern Yellowstone National Park area: U.S. Geol. Survey Professional Paper 729-F, 90 p.

Surficial deposits and geomorphology of Russell Creek Valley, Wyoming

Figure 1