

Glaciation of the Elkhorn Mountains, northeastern Oregon

Emily Geraghty

Department of Geology, Whitman College, Walla Walla, WA 99362

Faculty sponsor: Robert J. Carson, Whitman College

INTRODUCTION

Reconnaissance mapping of 21 glaciated valleys in the Elkhorn Mountains of northeastern Oregon revealed limits and relative ages for two alpine glacial events. Evidence for possible Pinedale (10,000-30,000 years ago) and Bull Lake (150,000-200,000 years ago) glaciations was observed. Old (Bull Lake?) drift is characterized by orange grus-rich soils, rotten granitic clasts at a depth of 1 to 2 meters, and, where present, basalt clasts with significant weathering rinds. These areas which were glaciated by Bull Lake ice exhibit bedrock tors which rise about 1-2 m above the ground surface. These tors have had time to develop from the end of the Bull Lake glaciation because they have not been eroded by Pinedale ice. Late Pleistocene (Pinedale?) drift is characterized by grayish tan sandy soils with fresh clasts. Some areas covered by Pinedale ice exhibit scoured bedrock surfaces. Tors in nearby unglaciated areas may be 2-4 m high.

The purpose of this project was to determine the ice limits for each of the Elkhorn valleys, map the extent of the two glaciations (Fig. 1), and determine the length and area of each glacier (Table 1). This investigation greatly refines the work by Bentley (1974), and expands southward the research by Bevis (1995). The glacial limits proposed here are based in part on the geologic maps by Pardee (1941), Brooks (1982), Ferns and others (1982, 1987), and Thurber and Carson (1990). In addition, surficial maps by Bilderback and Morriss (see their two papers, this volume) were used.

VALLEY GLACIAL HISTORY

NORTH- AND EAST-FACING VALLEYS:

Grande Ronde: The Grande Ronde Valley was occupied by the westernmost glacier that originated from the Anthony Lakes cirque complex. A somewhat indistinct glacial limit for this valley is six kilometers downvalley from Grande Ronde Lake. This limit is one of an older glacial event (possibly Bull Lake) indicated by the lack of freshly scoured surfaces. Little ice flowed out of Anthony Lakes cirque into the Grande Ronde valley during the last glacial maximum (Pinedale?).

Anthony Creek: The Anthony Creek Valley is the most prominent glacial trough. Evidence suggests that a large valley glacier flowed from the north out of the Anthony Lakes cirque and turned east. Distance from cirque headwall to terminus is 12 kilometers. Recessional moraines are found throughout the valley--the two uppermost dam Anthony and Mud Lakes and the lowest and largest occurs slightly upvalley from the terminus. Prominent lateral moraines are evidence of the last glacial maximum (Pinedale?) and extend to the terminus. Bull Lake? moraines lie slightly outside of these prominent Pinedale moraines. Their proximity indicates that both glaciations had almost identical extents. Glacial Lake Indian formed at the glacier's terminus by the blocking of Indian Creek.

Antone Creek: This glacier formed from ice fed from Antone Creek cirque and the eastern portion of the Anthony Lakes cirque complex. The maximum extent lies 12 kilometers downvalley from Antone Creek cirque. Here, the terminal moraine connects with broad lateral moraines probably from the older glacial event. Upvalley approximately 3 kilometers, lie more moraines, probably a result of the younger glacial event.

Dutch Flat Creek: This glacier began in the Dutch Flat cirque and flowed east. The Bull Lake and Pinedale glaciers extended to similar lengths. A rounded bedrock saddle indicates that the upper part of the glacier may have extended over the range and combined with the North Fork John Day River Glacier Complex. Both Pinedale and Bull Lake terminal moraines remain.

Lawrence Creek: Lawrence Creek is one of the 10 valleys with unknown age of glaciation. The ice at the head of Lawrence Creek extended approximately 1 km and did not combine with the neighboring glaciers of Dutch Flat or North Powder (Bentley, 1974).

North Powder River: Approximately nine cirques are at the top of this large former ice complex. The glacier flowed east before turning north toward its confluence with the Dutch Flat Creek glacier. The ice limits for both ages of glaciation are similar, but the area of ice was the largest of the range in Pinedale time (27.3 km²). There is a complex of two Bull Lake plus three Pinedale moraines at the range front.

Rock Creek: The Rock Creek glacier originated from the cirque at the base of Rock Creek Butte and flowed northwest before turning northeast at the confluence with the North Fork of Rock Creek. Pinedale and Bull Lake ice

limits differ here—the Pinedale terminus does not reach the range front, whereas the Bull Lake limit reaches as far as 16 km downvalley. Pinedale lateral moraines hug the valley sides, while Bull Lake lateral moraines are very large features reaching down to the range front.

Willow Creek: This glacier of unknown age flowed northeasterly but not far enough downvalley to intersect the Rock Creek glacier (Bentley, 1974).

Pine Creek: The Pine Creek glacier was generated in three small cirques flanking Rock Creek Butte to the east. The glacier moved northeasterly and terminated with Pinedale moraines before the confluence with the North Fork of Pine Creek. A Bull Lake moraine lies on the North Fork but other Bull Lake evidence was not found in the main channel of Pine Creek.

Goodrich Creek: The Goodrich glacier originated from a large cirque at the base of Elkhorn Peak and moved to the northeast. A moraine- and human-dammed lake presently sits within the cirque, and further downvalley remnants of a moraine complex is apparent. Pinedale and Bull Lake ice limits differ in this valley; glaciers did not reach the range front. An extinct talus-fed rock glacier is evident on the north-facing valley side of Goodrich Creek valley.

Mill Creeks: Both forks of Mill Creek were glaciated by ice of unknown age. Each glacier extended only slightly to the east (Bentley, 1974).

Marble Creek: This glacier was fed by ice from 3 small cirques. Till of unknown age extends downvalley to a marble quarry. A moraine-dammed lake of Pinedale age lies within one cirque. Striated boulders of greenstone were found in this valley.

SOUTH-FACING VALLEYS:

Lake Creek: The Lake Creek glacier is of unknown age and was fed by two cirques. These two cirques generated ice which flowed southeast before veering south. The limits extend approximately 2.8 km downvalley. Presently, two lakes sit within the cirques.

Cracker Creek: The Cracker Creek glacier was fed by two cirques. The ice moved south approximately 6 km. The age of the ice is unknown, and little evidence is apparent for any moraines.

Fruit Creek and Silver Creek: There are two cirques at the heads of both Fruit and Silver Creeks. Valley glaciers of unknown age moved south, combined for a short distance, and then split before terminating.

McCully Fork: This glacier originated from two cirques, one of which sits on the south flank of Mt. Ireland. The ice of unknown age headed south and terminated approximately 6 km downvalley.

NORTH FORK OF JOHN DAY RIVER GLACIER COMPLEX:

North Fork John Day River: The North Fork John Day glacier was fed by the ice of two small cirques. The ice traveled north where it then moved westward after converging with ice from Crawfish Creek. Bull Lake ice reached a distance of 17.5 km. In Bull Lake time, the main glacier was also being fed by ice from the Baldy Creek glacier to the south. At the Bull Lake terminus, two ice-dammed lakes (Glacial Lakes Trail Creek and Crane Flat) formed from streams which were blocked and diverted. The area of this glacier (including the ice from the tributaries of Crawfish and Baldy Creeks) totaled 118.3 square km, which makes it by far the most extensive glacier in the range at any time. In comparison, Pinedale extent was minimal. The smaller cirques atop the range contributed to the main glacier during Bull Lake time; however, they show little evidence for any Pinedale contribution. In Pinedale time, the ice extended downvalley but did not reach far enough to merge with the ice from the other cirques.

Crawfish Creek: A rounded saddle between the heads of Crawfish and Dutch Flat Creeks cirques suggests that the glaciers on the east and west sides of the range combined here. The Crawfish Creek ice moved west before turning south to meet with the North Fork ice. Bull Lake ice reached the main channel of the North Fork of the John Day and helped contribute to the voluminous John Day glacier. Pinedale ice was less extensive and stopped before the confluence of the two rivers.

Baldy Creek: The ice for this glacier was fed by two cirques, one of which sits at the base of Mt. Ireland. The ice moved north toward the North Fork of the John Day River, where it contributed to the voluminous glacier in Bull Lake time. Pinedale ice was less extensive and stopped before the confluence of the two creeks.

CONCLUSIONS

Twelve valley glaciers existed on the northeast side of the range crest; those along Antone, Dutch Flat, and Rock Creeks and North Powder River advanced to the range front, with little distance between moraines of the two glaciations. In contrast, the valley glacier advancing north along the Grande Ronde River and the ice complex along the west-flowing North Fork of John Day River were quite extensive during the older glaciation, but apparently extended only a short distance beyond the cirques in the latest glaciation. The age of glaciation is unknown in 10 valleys in the southern part of the range. There is a great difference in extent of Bull Lake vs. Pinedale glaciers on the east vs. the west sides of the range. The possible causes include differential topography, precipitation,

temperature, wind, and insulation. Bull Lake ice was more extensive than Pinedale or unknown age ice (Table 1). In fact, known Pinedale ice covered only about half of the area covered by Bull Lake ice.

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Table 1: Glacial Dimensions

	Pinedale		Bull Lake		Unknown Age	
	Length (km)	Area (km ²)	Length (km)	Area (km ²)	Length (km)	Area (km ²)
1:Marble Cr	--	--	--	--	3.0	2.6
2:Mill Cr	--	--	--	--	3.0	1.3
3:Mill Cr (N)	--	--	--	--	2.0	0.4
4:Goodrich Cr	2.5	1.3	3.2	1.9	--	--
5a:Pine Cr	5.8	3.8	--	--	--	--
5b:N.Fork Pine Cr	--	--	2.2	2.1	--	--
6:Willow Cr	--	--	--	--	3.2	2.7
7:Rock Cr	13.0	14.1	16.0	21.1	--	--
8:N. Powder R	15.0	27.3	15.8	33.3	--	--
9:Lawrence Cr	--	--	--	--	1.0	0.1
10:Dutch Flat	11.8	16.6	12.4	22.7	--	--
11:Antone Cr	10.0	15.9	12.5	24.3	--	--
12:Anthony Cr	12.0	17.9	13.0	21.8	--	--
13:Grande Ronde	6.0	7.7	10.5	23.0	--	--
14:Crawfish Cr	6.1	6.4	--	--	--	--
15:N.Fork John Day	3.2	4.4	17.5	118.3	--	--
16:Baldy Cr	6.2	6.4	--	--	--	--
17:McCully Fork	--	--	--	--	6.0	8.7
18:Silver Cr	--	--	--	--	9.0	9.0
19:Fruit Cr	--	--	--	--	6.5	5.1
20:Cracker Cr	--	--	--	--	6.0	4.7
21:Lake Cr	--	--	--	--	2.8	1.0
Total		121.8		268.5		35.6

Figure 1: Eikhorn Range Ice Limits for Pinedale and Bull Lake Glaciations

