# The Ore Bin


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# THE WALLOWA "ICE CAP" OF NORTHEASTERN OREGON
## an exercise in the interpretation of glacial landforms

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## Introduction

The geology of the Wallowa Mountains was first mapped in 1938 (Ross) and 1941 (Smith and Allen). Since that time, little work has been done on the effects of the Pleistocene ice which mantled much of the Wallowa high country more than 15,000 years ago. From elevations above 8,000 feet, the ice flowed down the canyons, reaching as low as 3,000 feet on Pine Creek. It has been the custom to call this glacial cover an "ice cap," implying that a more or less continuous sheet of névé covered the central area of the mountains. Only one map showing the inferred maximum extent of the ice has been published (Crandell, 1965). The accompanying map (Figure 1) is a demonstration of what can tentatively be deduced from a geomorphic study of topography on maps which were not available in 1941. Undoubtedly field checks will revise the map in detail, but the large picture should remain valid.

## Procedures

Seven 15-minute and four $7\frac{1}{2}$-minute U.S. Geological Survey topographic quadrangle maps (see list at end of text) were used to determine the extent of the ice (Figure 1). These maps reveal many glacial landforms, both erosional and depositional (see Figure 2); the following can be easily recognized (definitions are adapted from Gary and others, 1972):

<u>Erosional landforms</u> (see accompanying photographs)

arête - a narrow, jagged, serrate mountaincrest, or a narrow, rocky, sharp-edged ridge or spur, commonly present above the snow line in glaciated mountains

bastion - a prominent mass of bedrock extending from the mouth of a glacial trough and projecting far out into the glacial valley

Above: Cirque and tarn; terminal moraine from "little ice age" about 4,000 years ago. Eagle Cap on skyline and arête to right. (Oregon Hwy. Div. photo)

Below: Ice Lake dammed by recessional moraine. Matterhorn Peak (upper left) and Sacajawea (upper right) are highest peaks in Wallowas. (Oregon Hwy. Div. photo)

cirque - a deep, steep-walled, flat- or gently-floored, half-bowl-like recess
or hollow commonly at the head of a glacial valley or saddle-shaped
depression in a ridge

col - a deep pass formed by the headward erosion of two cirques

hanging valley - a glacial valley whose mouth is at a relatively high level
on the steep side of a larger glacial valley

matterhorn - a high peak with prominent faces bounded by intersecting
walls of three or more cirques

tarn - a relatively small, steep-banked lake or pool occupying an ice-gouged
rock basin

U-shaped valley - a valley having a pronounced parabolic cross profile suggesting the form of a broad letter U, with steep parallel walls and a
broad, nearly flat floor; a glacial trough

Depositional landforms (see accompanying photographs)

moraine - a mound, ridge, or other distinct accumulation of unsorted,
unstratified glacial drift, predominantly till, deposited chiefly by
direct action of glacier ice in a variety of topographic landforms that
are independent of control by the surface on which the drift lies

lateral moraine - a low, ridge-like moraine deposited at or near the side
margin of a mountain glacier

recessional moraine - an end moraine built during a temporary but significant halt or pause in the final retreat of a glacier

terminal moraine - an end moraine, extending across a glacial valley as an
arcuate or crescentic ridge, that marks the farthest advance or maximum extent of a glacier

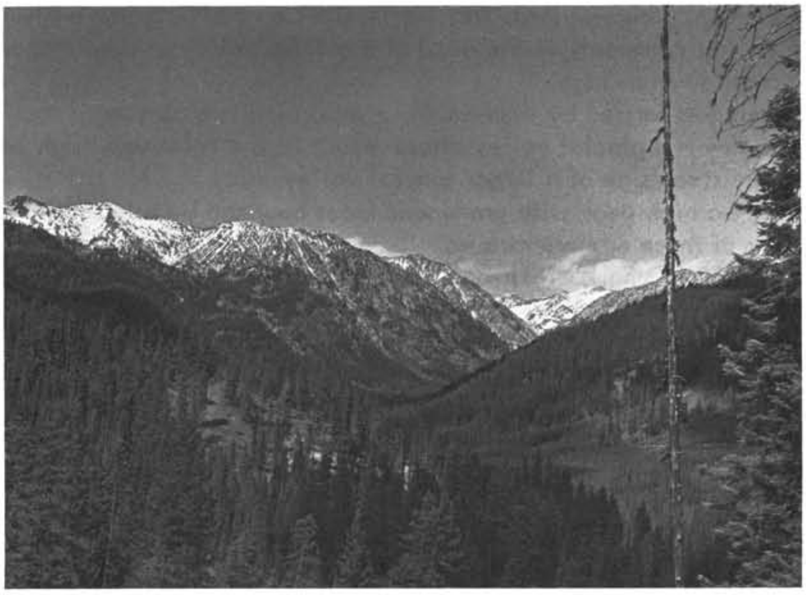
morainal lake - a glacial lake occupying a depression and dammed by a
terminal or recessional moraine

outwash - stratified detritus removed or "washed out" from a glacier by meltwater streams and deposited in front of or beyond the terminal moraine

In studying the topographic maps, the elevation of lateral moraines was particularly helpful in determining the extent of the ice in the valleys. Evidences of glacial extent, recognizable in the field but not on topographic maps, were noted by Smith and Allen (1941). These included the location of glacial erratics and the elevations of ice-scoured and polished surfaces (see photographs).

Interpolation of projected thicknesses of the ice, carefully checked by remnants of lateral moraines and medial moraine spurs at tributary valley mouths, permitted drawing appropriately spaced contour lines for the surface of the ice (Figure 1).

Below the firn area (zone of accretion), the thickness of the ice is inferred to have decreased gradually (in the zone of ablation) to the terminus. Rock steps and steeper stretches in the present valley profile were taken into



Above: U-shaped valley of Eagle Creek near Boulder Park. (Oregon Hwy. Div. photo)

Below: Bastions project into U-shaped valley of West Fork of Wallowa River. Small cirques and hanging valley on left. Sentinel Peak in distance is a "matterhorn."

consideration in estimating the thickness of the ice. Glacial cirque ice is mapped as being halfway up the cirque walls.

In a few instances, landslides may have been interpreted as névé fields or incipient cirques at lower elevations on the periphery of the area, and bastions may have been interpreted as moraines at glacial junctions.

## Conclusions

The so-called "ice cap" which fed the radiating glacial streams during the Pleistocene turns out to be multiple in nature. The Lake Basin ice field had a surface at least 8,500 feet above sea level; over the ridge to the west the Minam Lake ice field was a few hundred feet lower. The Aneroid Lake ice field and the several Imnaha ice fields were at about 8,400 feet elevation. Nunataks (isolated rock knobs projecting above the ice) are surprisingly rare; most of the high peaks appear to have been connected by narrow unglaciated ridges.

Thin ice fields covered much of the plateau surface south of the Imnaha valley, feeding glaciers down Lake and Clear Creeks. This area may have been more extensively covered by ice than is shown (Ross, 1938, p. 58).

The nine large glaciers (each more than 10 miles long) and their tributaries covered about 279 square miles (see Figure 1). Other isolated ice fields and glaciers added 58 square miles for a total of about 337 square miles covered by ice during the Pleistocene. This is a closer approximation than "200 square miles" or "500 square miles" - figures which have been bandied about for years - but it is a minimum figure, since thickness of the ice was conservatively estimated where definite evidence was lacking on the topographic maps.

In length, the Lostine glacier (22 miles) was slightly longer than the Minam (21 miles) and the Imnaha (20 miles). The other six major glaciers were from 12 to 13 miles in length.

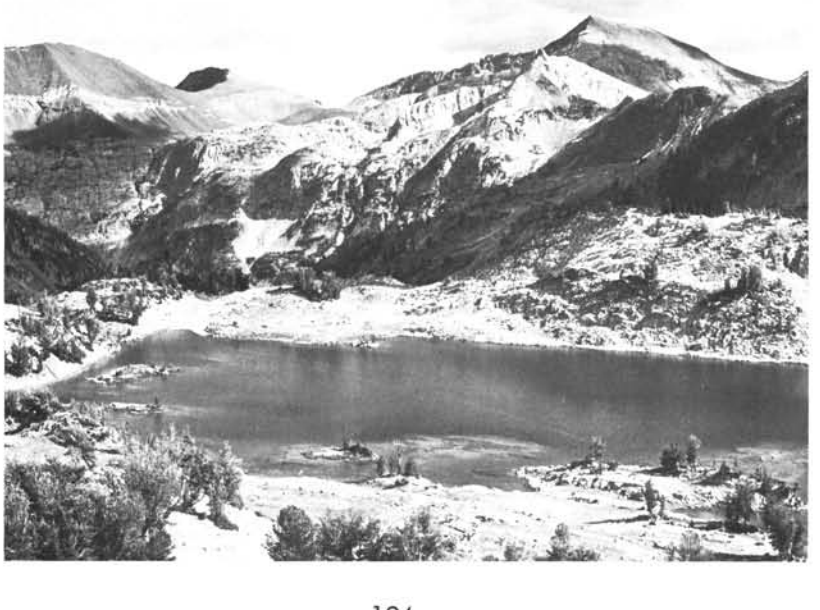
In area covered, the Minam glacier was the largest, with 67 square miles, followed by the Lostine (55) and the Imnaha (50). The Wallowa glacier covered 35 square miles. The other five major glaciers covered between 11 and 18 square miles each.

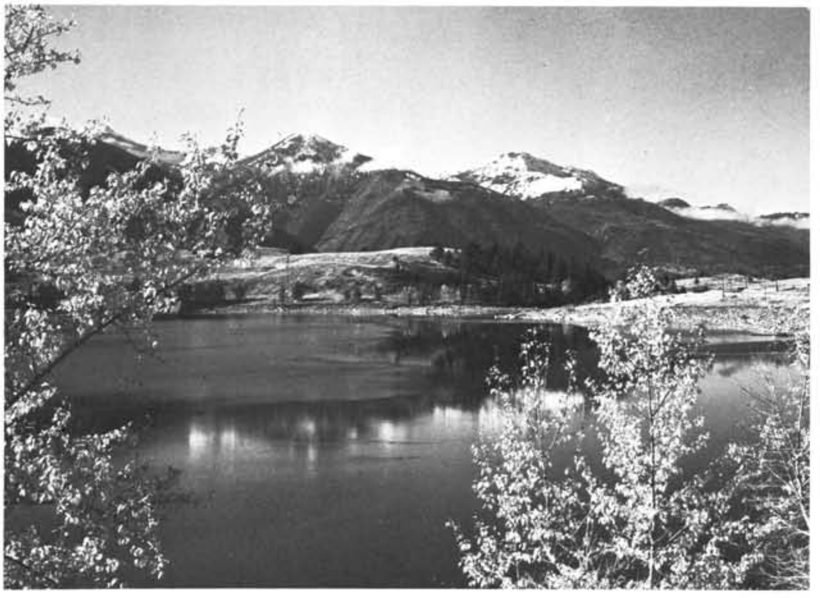
In elevation reached by the lower ends of the glaciers, the Lostine came down to 3,380 feet above sea level; the Minam was a close second at 3,600 feet. The six other major glaciers reached between 4,000 and 4,200 feet. The Pine Creek glacier apparently reached to 2,960 feet at some time (pre-Frazier) during the Pleistocene (Crandell, 1965).

In thickness of ice, without field-checking, the maximum seems to have been about 2,500 feet in the upper Lostine and Minam glaciers. The Wallowa was thickest at its junction with the East Fork, about 1,500 feet. The Hurricane was less than 1,000 feet thick throughout.

Above: Moccasin Lake, a tarn lake in upper Wallowa River drainage. Eagle Cap on left.

Below: Glacier Lake, a tarn at head of West Fork of Wallowa River. Cusick Mountain in upper right. Three cols on skyline. (Oregon Hwy. Div. photo)





Above: Terminal moraine of Wallowa River glacier dammed river to form Wallowa Lake. (Oregon Hwy. Div. photo)

Below: Lateral and terminal moraines hem in Wallowa Lake. U-shaped valley of West Fork of Wallowa River in upper left and many cirque basins on skyline. (U.S. Forest Service photo)

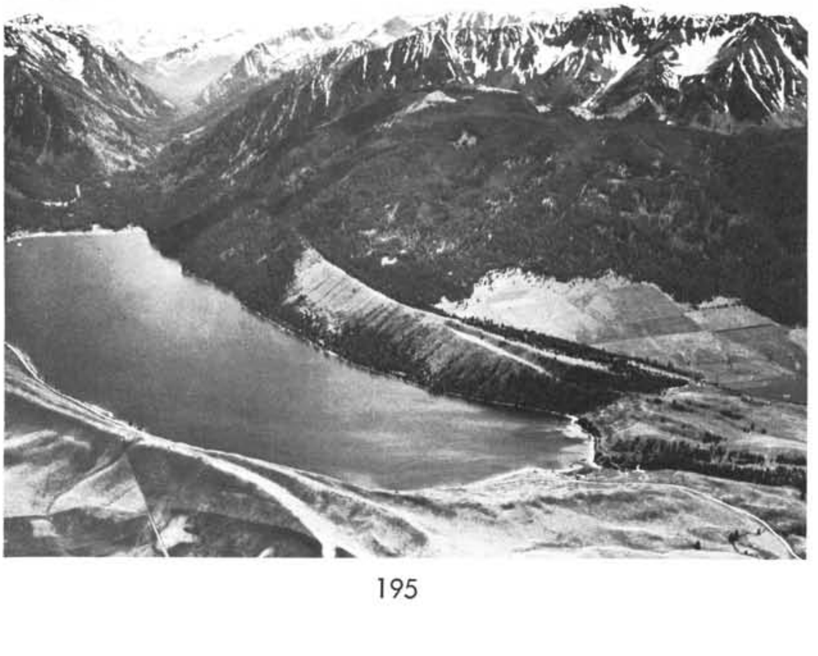


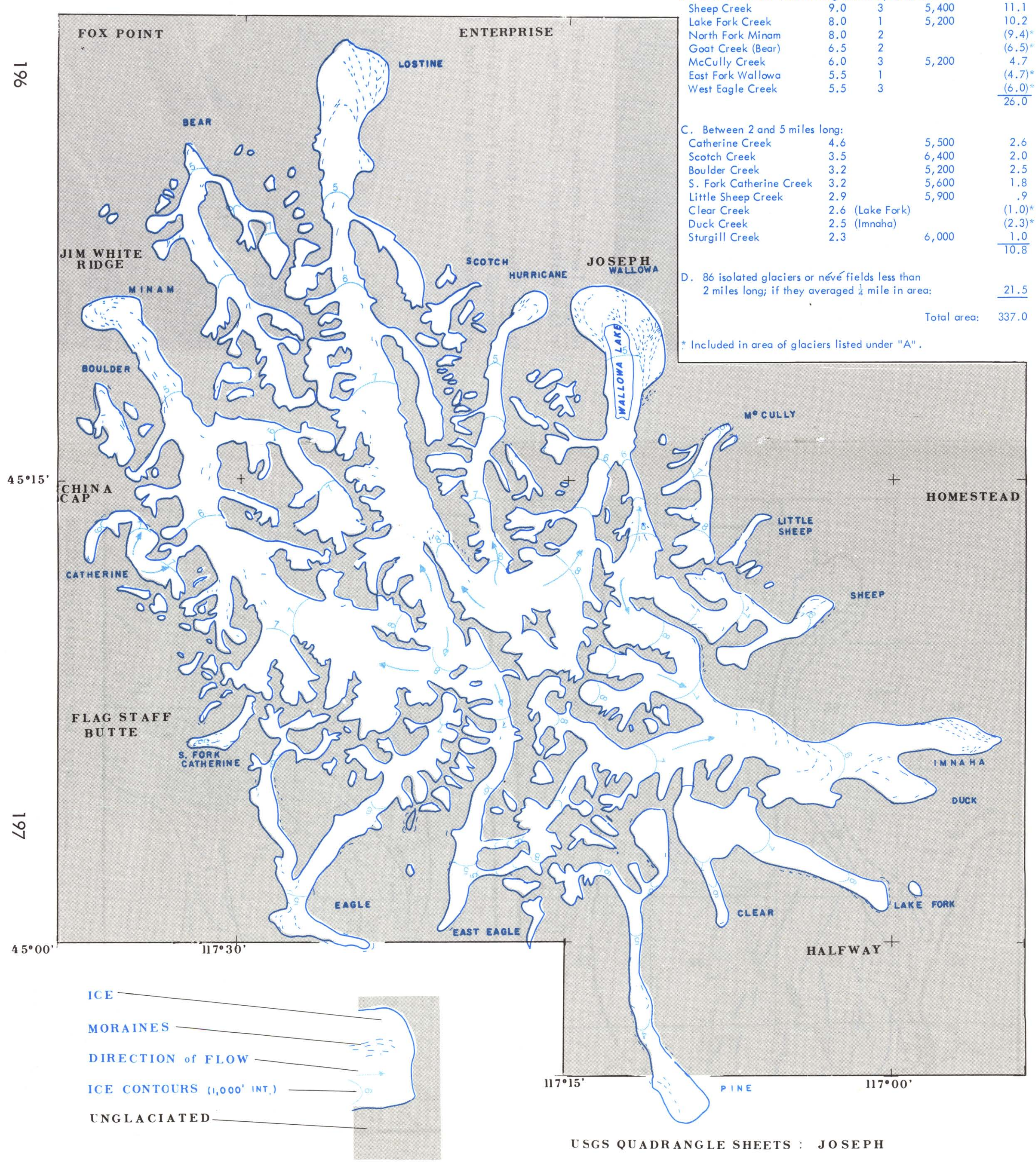
FIGURE 1

# EXTENT of PLEISTOCENE GLACIERS in the WALLOWA MOUNTAINS, OREGON

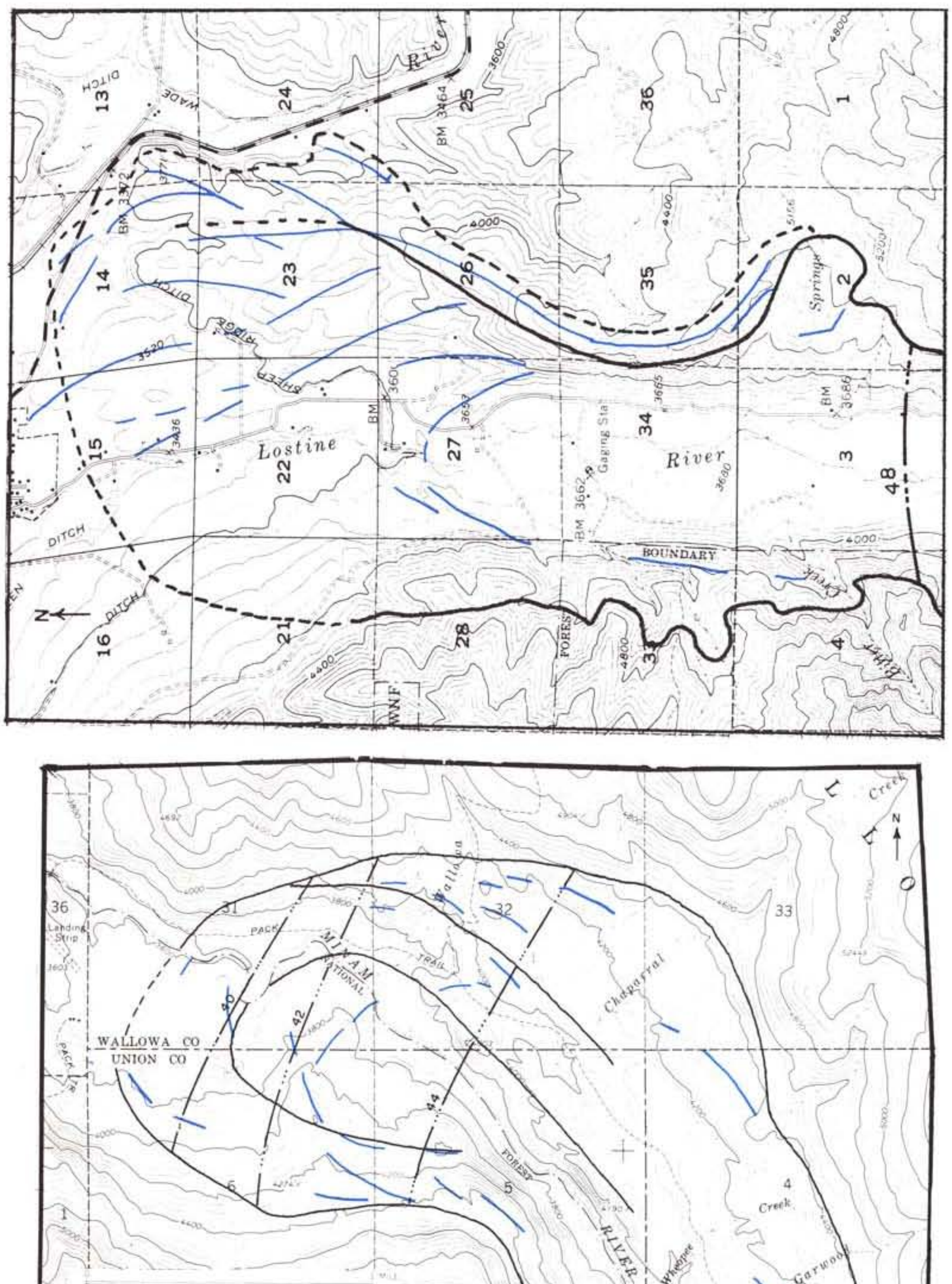
SUMMARY OF DATA ON WALLOWA GLACIERS

| Name | Length (miles) | No. of major branches | Elevation at lower end (feet) | Area of ice (sq. miles) |
|---|---|---|---|---|
| A. Glaciers more than 10 miles long: | | | | |
| Lostine River | 22 | 4 | 3,380 | 55.0 |
| Minam River | 21 | 5 | 3,600 | 67.5 |
| Imnaha River | 20 | 5 | 4,200 | 50.5 |
| Wallowa River | 13 | 2 | 4,200 | 35.4 |
| Hurricane Creek | 13 | 1 | 4,200 | 11.5 |
| East Eagle Creek | 13 | 1 | 4,100 | 12.2 |
| Eagle Creek | 13 | 1 | 4,000 | 18.5 |
| Bear Creek | 12 | 2 | 4,200 | 15.5 |
| Pine Creek | 12.6 | 2 | 2,690 | 12.6 |
| | | | | 278.7 |
| B. Between 5 and 9 miles long (tributary or isolated): | | | | |
| Sheep Creek | 9.0 | 3 | 5,400 | 11.1 |
| Lake Fork Creek | 8.0 | 1 | 5,200 | 10.2 |
| North Fork Minam | 8.0 | 2 | | (9.4)* |
| Goat Creek (Bear) | 6.5 | 2 | | (6.5)* |
| McCully Creek | 6.0 | 3 | 5,200 | 4.7 |
| East Fork Wallowa | 5.5 | 1 | | (4.7)* |
| West Eagle Creek | 5.5 | 3 | | (6.0)* |
| | | | | 26.0 |
| C. Between 2 and 5 miles long: | | | | |
| Catherine Creek | 4.6 | | 5,500 | 2.6 |
| Scotch Creek | 3.5 | | 6,400 | 2.0 |
| Boulder Creek | 3.2 | | 5,200 | 2.5 |
| S. Fork Catherine Creek | 3.2 | | 5,600 | 1.8 |
| Little Sheep Creek | 2.9 | | 5,900 | .9 |
| Clear Creek | 2.6 | (Lake Fork) | | (1.0)* |
| Duck Creek | 2.5 | (Imnaha) | | (2.3)* |
| Sturgill Creek | 2.3 | | 6,000 | 1.0 |
| | | | | 10.8 |
| D. 86 isolated glaciers or névé fields less than 2 miles long; if they averaged ¼ mile in area: | | | | 21.5 |
| | | | Total area: | 337.0 |

* Included in area of glaciers listed under "A".




USGS QUADRANGLE SHEETS : JOSEPH



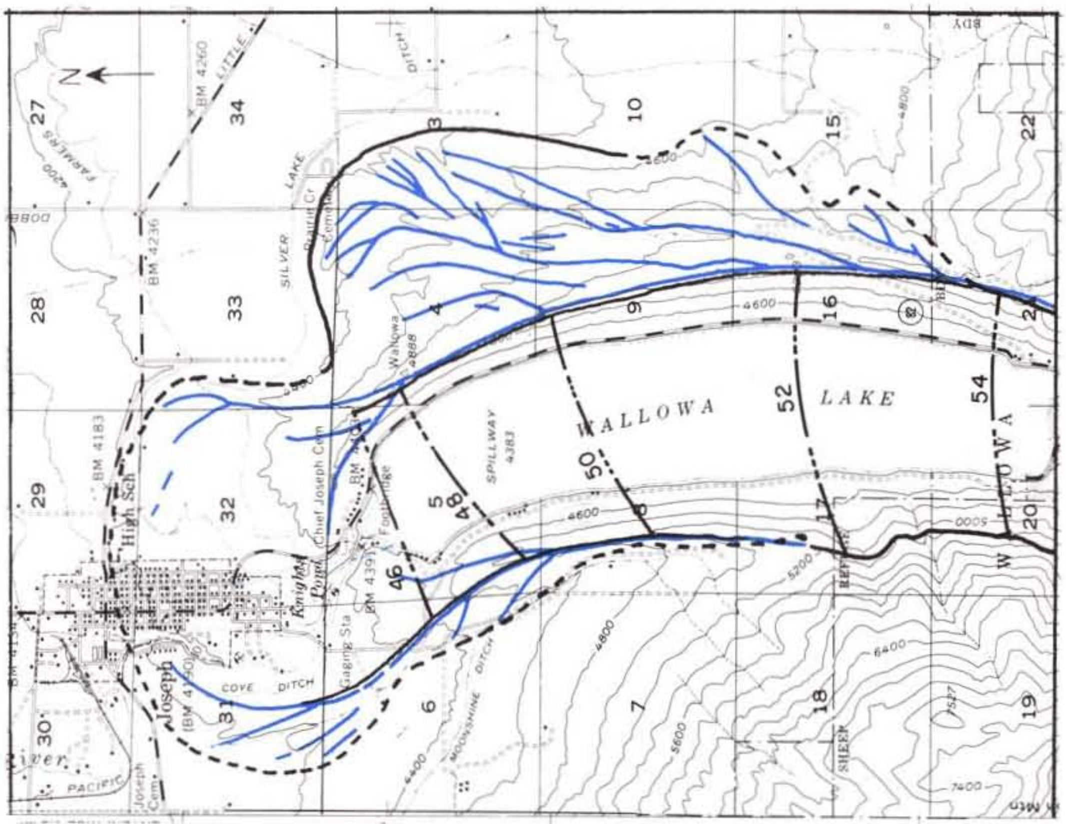

SCALE

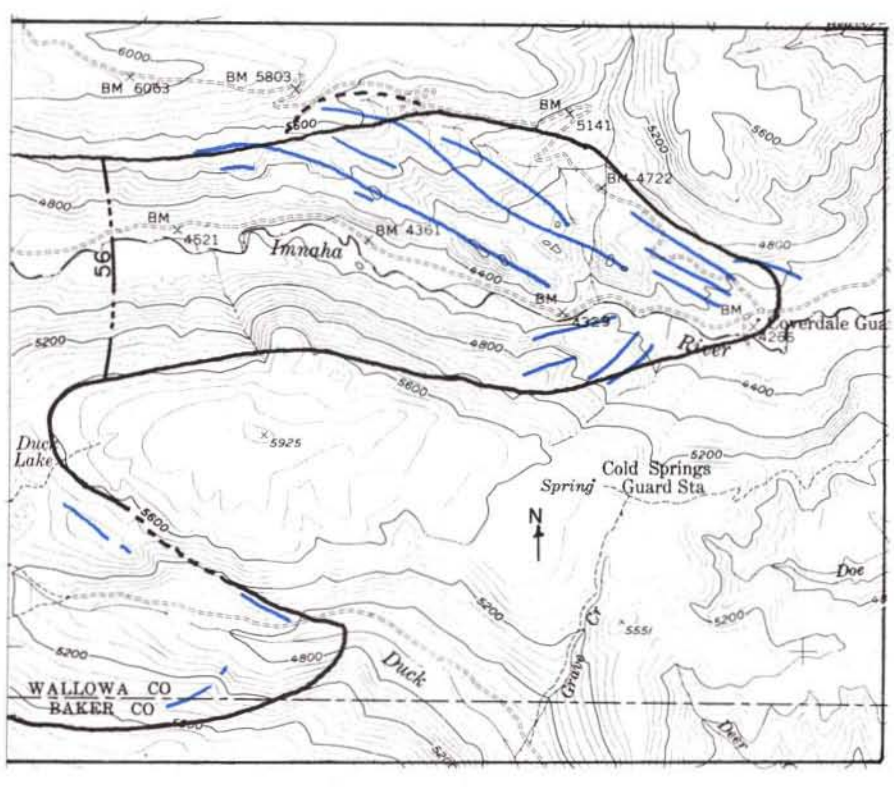
0 — 1 MILE
EXCEPT AS NOTED

PROX. MAX. BOUNDRY of GLACIER

*MORAINES*

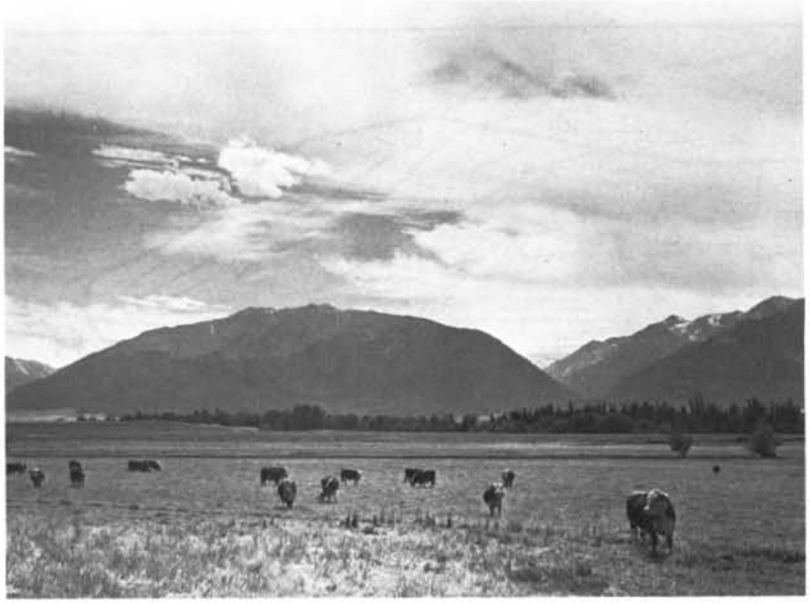
**FIGURE 2**


WALLOWA
LAKE
SPILLWAY
Joseph
High Sch
Chief Joseph Cem
COVE DITCH
MOONSHINE DITCH
SILVER LAKE
BM 4236
BM 4183
BM 4260

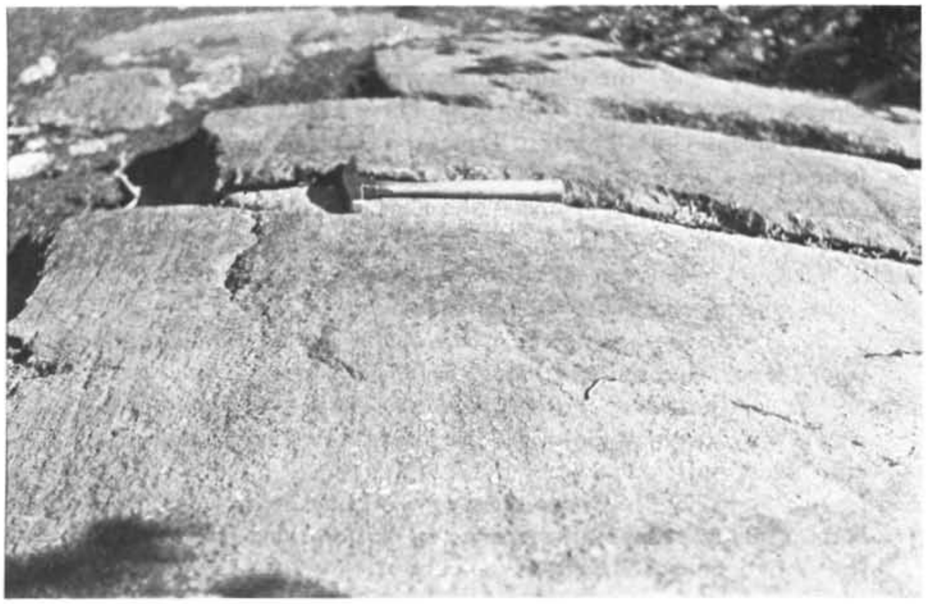


BM 6063
BM 5803
BM 5141
BM 4722
BM 4521
BM 4361
Imnaha
River
Coverdale Gua
Duck Lake
5925
Cold Springs Guard Sta
Spring
Doe
Duck
Gray Cr
5551
WALLOWA CO
BAKER CO

The Frazier glaciation, the latest major advance of alpine glaciers in the Wallowas, ended about 15,000 years ago. Since that time, climatic fluctuations have caused small glacial advances, such as the "little ice age" about 4,000 years ago, which left terminal moraines high in the major glacial valleys.

Moraine on Thorp Creek, tributary of Hurricane Creek, is a prominent topographic feature. "Ballet dancer" is Warren D. Smith, noted Oregon geologist, deceased.



Outwash from Wallowa glaciers formed broad plains of sand and gravel at foot of mountains near Joseph. (Oregon Hwy. Div. photo)



Above: Striated, ice-scoured rock surface exposed in Lostine Canyon. Note geologic pick for scale.

Below: Erratic boulders of granodiorite perched on limestone bedrock near Marble Point, 2,500 feet above Lostine River, indicate elevation of glacial ice.

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Crandell, D. R., 1965, The glacial history of western Washington and Oregon, in Wright, H. E., Jr., and Fry, D. G. (eds.), The Quaternary of the United States: Princeton Univ. Press, p. 349-350 (map after Lowell, 1940).

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Stovall, J. C., 1929, Pleistocene geology and physiography of the Wallowa Mountains, with special reference to Wallowa and Hurricane Canyons: Univ. Oregon master's thesis, unpub.


### Topographic Quadrangle Maps

| 15-minute | | 7½-minute |
|---|---|---|
| Enterprise | Homestead | Fox Point |
| Joseph | Sparta | Jim White Ridge |
| Eagle Cap | Halfway | China Cap |
| Cornucopia | | Flagstaff Butte |

* * * * *

## MOUNT RAINIER HISTORY DESCRIBED

"Quaternary Stratigraphy and Extent of Glaciation in the Mount Rainier Region, Washington," by D. R. Crandell and R. D. Miller, is a recent publication by the U.S, Geological Survey and designated Professional Paper 847. The 59-page report includes a geologic map of the region and a topographic map of Mount Rainier National Park. According to the authors, a nearly continuous ice cap once mantled the Cascade Range, with ice extending down the Cowlitz River about 120 km (193 miles). Today each of the five major river valleys contains glacial deposits of repeated glaciations, and drift from at least two ancient glaciations has been recognized.

Professional Paper 847 is for sale by U.S.G.S. Branch of Distribution, 1200 S. Eads St., Arlington, VA 22202. The price is $1.60.

* * * * *

## POTENTIAL GEOTHERMAL LAND WITHDRAWN FROM MINERAL EXPLORATION

A recent news release from the U.S. Department of the Interior, Bureau of Land Management, announces that 31,114.7 acres (approximately 50 square miles) of land in Malheur County centering around Jordan Craters has been established as a "Research Natural Area." According to the news release, the arrangement will "aid BLM in managing and protecting the area to insure preservation of the total environment." Not stated in the release was the fact that this action also withdraws the land from mineral entry.

As noted in the October 1975 ORE BIN, about two-thirds of all public lands are now completely or partially withdrawn from mining activities. Here is another instance of a tract of land essentially reserved for ecological study, a single-use purpose which is contrary to the multiple-use concept espoused for many years by the Federal government.

The Jordan Craters lie within a large area of relatively young volcanic rocks, one of the most promising regions for future geothermal development. Even though the Jordan Craters Research Natural Area of approximately 31,000 acres is only a small part of the total volcanic field, its withdrawal has a negative effect on mineral exploration activities in the surrounding territory; past experience has shown that companies looking for geothermal or mineral resources always give a wide berth to public lands withdrawn "to insure preservation of the total environment."

Every public land withdrawal is justified in the eyes of the Federal agency responsible for managing it, and in most instances, the area involved for any one withdrawal is comparatively small. But as has been clearly pointed out by Bennethum and Lee in the October 1975 ORE BIN, the cumulative effect of withdrawals is tremendous. To quote from these authors: "We think some attention will have to be paid to the trend toward accelerated withdrawals because it seriously erodes the long-range mineral position of the country. It affects our economy, our ability to protect jobs, and it is forcing American industry to look elsewhere for minerals. It makes us vulnerable to mineral cartels like the OPEC oil cartel."

--- R. E. Corcoran

* * * * *

## INTERIOR DEPARTMENT POSTS FILLED

Thomas S. Kleppe, former U.S. Representative from North Dakota, was made Secretary of the Interior on October 9, 1975, succeeding Stanley K. Hathaway, who resigned in July. On November 20, 1975, the Senate confirmed the nomination of D. Kent Frizzell to be Under-Secretary of the Interior. Frizzell, a Kansan who has been solicitor of the Interior Department, fills a post that has been vacant since May 1.

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