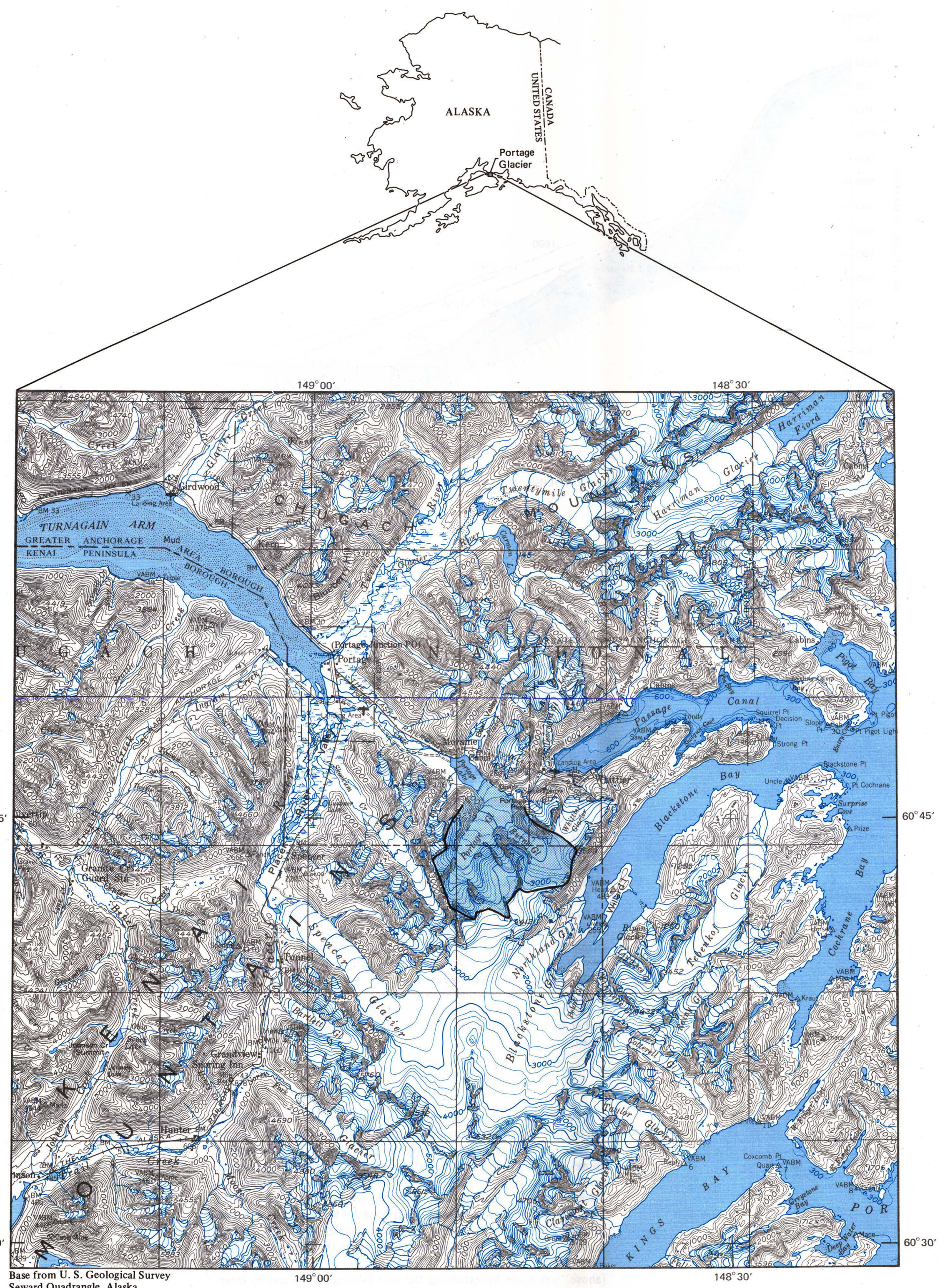
Prepared in cooperation with the
U.S. FOREST SERVICE

LOCATION OF PORTAGE GLACIER



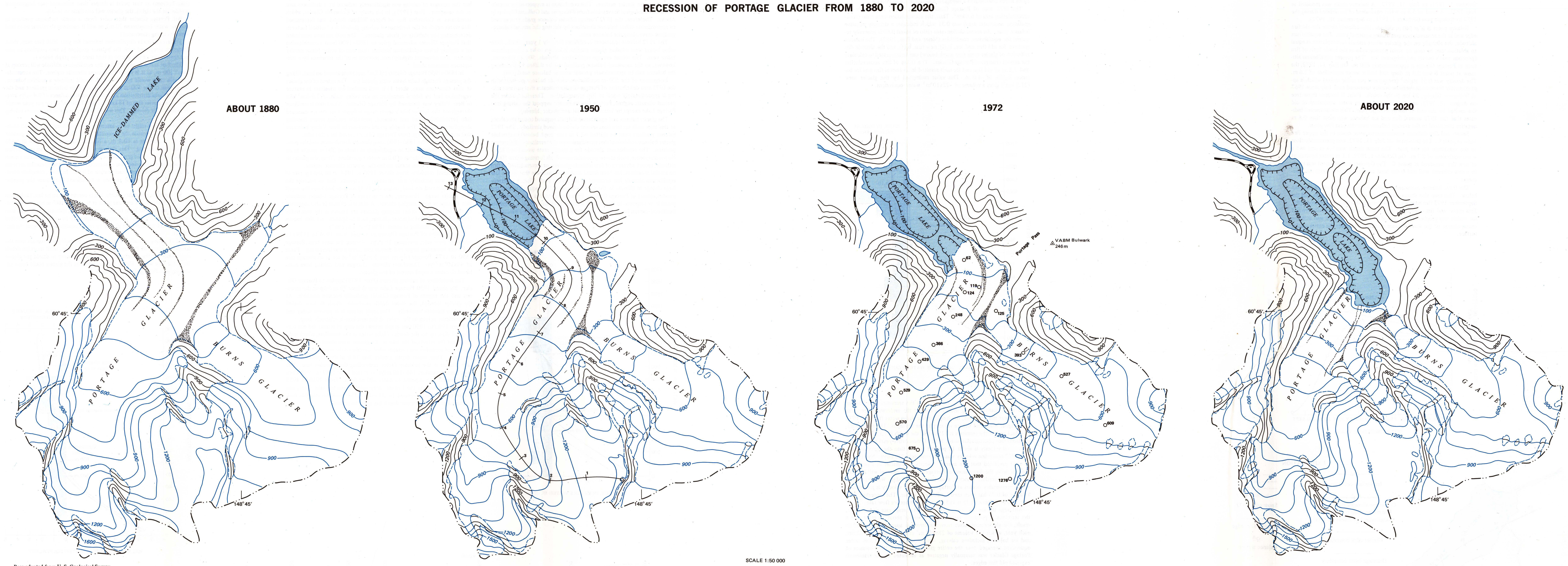
Base from U. S. Geological Survey Seward Quadrangle, Alaska, 1:250,000, 1969

SCALE 1:250 000

5 0 5 10 15 20 25 KILOMETERS

CONTOUR INTERVAL 200 FEET
DATUM IS MEAN SEA LEVEL

RECESSION OF PORTAGE GLACIER FROM 1880 TO 2020



Base adapted from U.S. Geological Survey Seward Quadrangle, Alaska, (C-5, D-5) 1:63,360, 1951

SCALE 1:50 000

1 .5 0 1 2 KILOMETERS

CONTOUR INTERVAL 100 METERS
DATUM IS PRE-1964 EARTHQUAKE MEAN SEA LEVEL

EXPLANATION

- Ice surface contours (300)
- Bedrock surface contours (300)
- Bathymetric contours (100)
- Centerline showing distance in kilometers used to construct longitudinal profiles (see text)
- Glacier edge boundary
- Drainage basin boundary
- Medial moraine
- Altitude measurement points-July 11, 1972 altitude is shown in meters (1276)

INTRODUCTION

For centuries, Portage Glacier and Portage Pass have at times served as a surface transportation route between Passage Canal in Prince William Sound and Turnagain Arm of Cook Inlet. During this time Portage Glacier has advanced and retreated strongly, presenting travelers with an ever-changing challenge. For some time prior to 1800 the glacier did not block the route through Portage Pass. The glacier then advanced strongly until about 1880, at which time Portage Pass and the Portage Lake basin were occupied by the glacier. Since 1914 the glacier has receded markedly, leaving Portage Lake in the glacial depression. The surface route is no longer easily travelled because the lower part of the glacier is highly crevassed, the ice margins are broken, and the exposed glacially scoured bedrock walls are steep. The lake is not easily navigable because of numerous icebergs.

At present, the glacier is a visitor attraction of Chugach National Forest. The glacier terminus is viewed from the northwest end of Portage Lake. Continued retreat of Portage Glacier could eliminate the present view of the spectacular calving ice front. This atlas presents an analysis of the history and trends of Portage Glacier, and the data are used to predict possible future changes in the glacier. Sheet 2 of this atlas contains a technical discussion of the general conclusions on Sheet 1.

FORMER EXTENT AND RECENT VARIATIONS OF PORTAGE GLACIER

A collection of early observations of Portage Pass is presented in Tarr and Martin (1914, p. 363-367). Lieutenant Joseph Whidbey, member of George Vancouver's voyage of discovery to the North Pacific and around the world, viewed Portage Pass on June 7, 1794, from the head of Passage Canal. Vancouver recorded Whidbey's observations that "the valley has a tolerably even surface," and was "nearly destitute of any vegetable productions," and was "equally passable in all directions" (p. 364). Lieutenant Whidbey also noted that the pass was free of snow. Russians and Indians were known at that time to have traversed the pass. Vancouver also reported that Lieutenant James Johnstone encountered Indians who "with their canoes, had crossed the isthmus" (p. 364). In 1794, the then unnamed Portage Lake was probably larger than it is today.

In 1880 Ivan Petroff wrote in the *Tenth Census of the United States* (Tarr and Martin, 1914, p. 364) that a "glacial formation forms the portage route between Chugatch Bay [an old name for Prince William Sound] and Cook Inlet." Petroff, Mendenhall, Learnard, and Castner (referred to by Tarr and Martin, 1914) reported that Portage Glacier was fed by snowfields from the north and the south. The only possible ice sources from the north are glaciers in Bear Valley. However, strandlines in Bear Valley indicate that a glacier-dammed lake separated the Bear Valley glaciers from Portage Glacier. Soldiers and 1898 gold rush prospectors used the pass by climbing over Portage Glacier. From 1880 to 1909 a number of observers noted that Portage Glacier flowed west to a gravel outwash plain and that a distributary arm flowed northeast through Portage Pass to within approximately 1 km of the head of Passage Canal (Tarr and Martin, 1914). The ice surface was 300-330 m above sea level in Portage Pass (Mendenhall, 1900, p. 301). Therefore, Portage Glacier advanced approximately 5 km from 1794 to 1880-1900. The low rocky debris mounds immediately west of Portage Lake are the terminal moraine left by the advance which culminated between 1890 and 1900 (Viereck, 1967).

The major retreat of the glacier's terminus since 1914 has been documented in published reports (Barnes, 1943; Schmidt, 1961) and since 1950 with aerial photography by the U.S. Geological Survey.

Present-day Portage Lake began to form about 1914. Between 1914 and 1939 the glacier terminus retreated slowly, at an average rate of 16 m/yr. From 1939 to 1950, the average rate of retreat increased to 145 m/yr and from 1950 to 1972, the rate of retreat was 32 m/yr. A small advance occurred in 1974, but it was not accompanied by thickening of the lower ice stream. This pulse did not continue in 1975.

The first topographic map of the Portage Glacier basin was made in 1952 by the U.S. Geological Survey from vertical aerial photographs taken in the summer of 1950. The Geological Survey 1:63,360 scale topographic maps, Seward (C-5 and D-5), Alaska, were modified for this report to the nearest metric equivalent map with a scale of 1:50,000 and a 100-m contour interval. The 1972 topography of Portage Glacier was drawn using the 1972 aerial photographs and altitude measurements made at 15 points on the glacier. Altitudes were measured on July 11, 1972, by aneroid barometer surveying techniques referenced to benchmark VABM Bulwark in Portage Pass and are not corrected for the 1964 earthquake land level subsidence of 1.8 m (Plafker, 1969, pl. 2). Altimeter accuracy is ±3 m and location accuracy ±100 m. Glacier edge positions were mapped from oblique aerial photographs taken in 1972.

Changes in the glacier from 1950 to 1972 are apparent if the maps for those years are compared. Since 1950 the glacier terminus has continued to recede and has thinned 100-120 m in the present terminus area. The ice in the 1972 terminus area had thinned more than 200 m between 1880-1900 and 1972. Less thinning has taken place at higher altitudes on the glacier; no significant change in thickness has occurred since 1950 above 800 m altitude.

Other notable changes have resulted from the thinning. The lower glacier area was narrower in 1972 than in 1950. The medial moraines, rock-debris stripes on the glacier, have shifted in an eastward direction. This shift indicates that the flow of ice from Burns Glacier has decreased rapidly during the past several decades. When Portage Glacier advanced prior to 1880, Burns Glacier probably became a weak tributary and thickened in response to the damming effect of Portage Glacier. As Portage Glacier thinned after 1900, the ice previously stored in the Burns valley discharged, producing a relatively wide ice stream. This discharge of ice ended in 1970. Since then Burns Glacier has become stagnant in the vicinity of its confluence with Portage Glacier.

A large glacier-dammed lake formed in Bear Valley when Portage Glacier was at its maximum extent. This lake was probably unstable and repeated failure of the ice dam probably caused severe flooding of the Portage Creek valley. In 1950, a small glacier-dammed lake at the northeastern margin of the glacier near Portage Pass was periodically filling and emptying into Portage Lake. The lake continued to break out annually until 1970. After 1970 the receding glacier no longer formed an ice dam. Shorelines of both recent lakes are still visible.

In 1972, three subglacial lakes existed immediately below the Burns Glacier terminus. The roof of one subglacial lake collapsed in 1972; a second collapsed in 1973. Evidence for these water bodies appears on the glacier surface as areas of concentric crevasses which formed as the enclosed water pressure fluctuated (see photograph this sheet).

PORTAGE GLACIER IN THE FUTURE

Portage Glacier will probably continue to retreat and thin until the ice no longer terminates in deep water. The ice-balance data, calculations, and the data base used to predict continued retreat are described on sheet 2 of this report.

The Portage Lake trench probably extends to Burns Glacier. A crevassed knob in Portage Glacier south of the Burns Glacier-Portage Lake depression may reflect the first location behind the present terminus where the valley floor is near the present level of Portage Lake. This may become the southeast shore of Portage Lake, should the glacier retreat to that point. At the average rate of retreat since 1914, the terminus of Portage Glacier would recede to the projected southeast shore of Portage Lake by the year 2020. This position of the shore area may be inaccurate and the rate of retreat could change, which would alter the time at which the glacier will reach the shore.

A map and retouched photograph on this sheet incorporating the assumed conditions in the longitudinal profile postulated for year 2020 show how the glacier might appear. Portage Glacier may terminate against part of the terminus of Burns Glacier. The western part of the ice front could have an imposing 50-m-high ice face which would be highly crevassed as ice moves into the lake. Calving on such a high face would be spectacular even though a smaller volume of ice would be calving than at present. The glacier terminus will probably retreat out of view from the present U.S. Forest Service visitor facility. Portage Pass and Portage Lake would then become a more easily traversed surface route. If the ice-filled valley is deeper than presently estimated, Portage Glacier may recede even farther than indicated by the year 2020.

A detailed analysis of the glaciological data, possible causes of variations, and predictions for Portage Glacier are on sheet 2 of this atlas.

PORTAGE GLACIER APRIL 5, 1972

Snow accumulates on Portage Glacier from September through June. Iceberg drifting was impeded during the winter by lake ice. A pressure ridge in the winter lake ice, lakeward of the concentrated berg area, was caused by the glacier's winter motion. The areas of greatest crevassing and wave ogives, areas with repeated large waves in the glacier surface below icefalls on the three main tributaries of Portage Glacier, are labeled in this photograph. Storms in the Gulf of Alaska cause strong easterly winds in the Portage Glacier area. These winds produce the large snow cornices on ridges and dune patterns on the lake ice. (U.S. Geological Survey photograph 72M2-20, view to southeast.)

PORTAGE GLACIER JULY 21, 1972

Annual ogives, a series of dark patches near the glacier centerline, are visible on the lower glacier below the snow edge. These ogives are a continuation of those visible in the April 5, 1972, photograph. The ogives indicate that the annual centerline flow rate in this area of the glacier is approximately 220 m/yr. An area of concentric crevasses (indicated by arrow) in the Burns Glacier ice below its confluence with Portage Glacier is the roof of a subglacial ice-dammed lake which alternately fills and empties. Outbursts from this reservoir flow beneath the glacier to Portage Lake. The snowline had retreated to an altitude of 400 m on Portage Glacier by this date. The sheared ice margin indicates that Portage Glacier is very active. (U.S. Geological Survey photograph 72M4-91, view to southeast.)

PORTAGE GLACIER SEPTEMBER 10, 1972

Icebergs in Portage Lake had been blown to the west end of the lake when this photograph was taken. The collapse area in the Burns Glacier ice is the site of the subglacial lake which had a thin ice roof in July 1972. More extensive ice collapses on the grounded terminus of the main branch reveal a former subglacial conduit. The conduit may have served as a drainageway for the lake shown on the 1950 map and the recently active subglacial lake in the Burns Glacier ice. Old firn edges exposed on both Portage and Burns Glaciers indicate the recent average equilibrium altitude. (U.S. Geological Survey photograph 72R6-58, view to southeast.)

PREDICTION YEAR 2020

Retouched photograph — By approximately year 2020, Portage Glacier may appear like this.

☆Interior—Geological Survey, Reston, VA.—1977—W77062

RECONNAISSANCE HYDROLOGY OF PORTAGE GLACIER BASIN, ALASKA

By
L. R. Mayo, Chester Zenone, and D. C. Trabant

1977

For sale by Alaska Distribution Section, U.S. Geological Survey, 310 First Avenue, Fairbanks, AK 99701, and Branch of Distribution, U.S. Geological Survey, Box 25286, Federal Center, Denver, CO 80225