Flint - Int. 3749

DEPARTMENT OF THE INTERIOR

INFORMATION SERVICE

GEOLOGICAL SURVEY

For Release To PM's, AUGUST 23, 1957

GLACIAL FEATURES AND SURFICIAL DEPOSITS OF THE MALASPINA DISTRICT, ALASKA

A map showing glacial features and surficial deposits of the Malaspina district on the south coast of Alaska has been released to the open files of the Geological Survey, the Department of the Interior announced today.

Field studies of the bedrock geology of the Malaspina district were made during portions of the 1947, 1953, and 1954 field seasons as part of the Geological Survey's program to investigate the petroleum possibilities of the Gulf of Alaska Tertiary province. In the present study aerial photographs were utilized for interpreting and plotting glacial features and surficial deposits.

The map on a scale of 1:96,000 shows the distribution and form of morainic debris, crevasses, vegetation cover, and other features on the surface of the glaciers. Surficial deposits are differentiated into twelve units according to inferred lithologic character, mode of origin, or relative age, and areas of bedrock are delineated. The recent history of glaciation and formation of surficial deposits in the Malaspina district and adjoining Icy Bay and Yakutat Bay is summarized in a brief text and two outline maps.

Copies of the report, entitled, "Glacial features and surficial deposits of the Malaspina district, Alaska" by George Plafker and Don J. Miller, have been placed on open file at the following Geological Survey offices: Library, Room 1033, General Services Administration Bldg., Washington, D. C.; Brooks Memorial Mines Bldg., College, Alaska; 117 Federal Bldg., Juneau, Alaska; 210 E. F. Glover Bldg., Anchorage, Alaska; Library, 4 Homewood Place, Menlo Park, Calif.; 468 New Customhouse, and Library, Denver Federal Center, Denver, Colo.; 1031 Bartlett Bldg., Los Angeles, Calif.; 724 Appraisers Bldg., San Francisco, Calif.; South 157 Howard St., Spokane, Wash.; Territorial Department of Mines, Territorial Bldg., Juneau, Alaska.

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P. N. 22577

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By

George Plafker and Bon J. Miller

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INTRODUCTION

The Malaspina district extends about 50 miles along the north shore of the Gulf of Alaska from Icy Bay and the Guyot Glacier on the west to Yakutat Bay and Disenchantment Bay on the east (see index map). The district includes a coastal lowland flanked on the north by a belt of rugged foothills, the higher ridges and peaks of which rise to altitudes of 4,000 to 6,000 feet. The southern front of the St. Elias Mountains rises abruptly at the northern margin of the foothills belt, about 30 miles from the coast, culminating in Mount St. Elias (18,008 ft.).

The Malaspina Glacier, the dominant feature of the Malaspina district, has long been regarded as the type example of the piedmont glacier. This huge ice sheet covers an area of about 840 square miles of the coastal lowland, rising gradually from an altitude of 100 feet or less at the outer margin to altitudes ranging from 1,000 feet to 2,000 feet at the southern margin of the foothills belt. The Malaspina Glacier is of special interest to glaciologists because its strikingly developed morainic banding offers clues to the nature of glacier movement. The processes of wastage and deposition at the stagnant margin of Malaspina Glacier can be compared with the mode of retreat of the former continental ice sheets; much can be learned here of the origin of the deposits formed along a stagnant ice margin.

Previous investigations

The results of early investigations of the glacial features and surficial deposits of the Malaspina district and the adjoining Yakutat Bay area are given in reports by Russell (1891, 1893), Tarr (1909), Tarr and Butler (1909) and Tarr and Martin (1914). Washburn (1935) described and illustrated the morainic banding on the surface of the Malaspina Glacier as seen from the air in 1933. Glaciological investigations carried out on the Malaspina Glacier and its principal tributary ice field, the Upper Seward Glacier, from 1949 to 1951 are described by Sharp (1951, 1951a, 1953, 1956, 1957), Bader (1951), and Allen and Smith (1953). Hartshorn (1952) studied proglacial and superglacial features at the southeastern margin of the Malaspina Glacier in 1951, and in 1956 examined and photographed the glacier margin from the air.

Present investigation

This report is an outgrowth of reconnaissance studies of the bedrock geology in the foothills belt of the Malaspina district, undertaken as part of a Geological Survey project to investigate the petroleum possibilities of the Gulf of Alaska Tertiary province (Plafker and Miller, 1957). The present study utilizing aerial photographs for interpreting and mapping glacial features and surficial deposits was undertaken with the dual objectives of (1) working out the Quaternary history of the Malaspina district, and (2) recording in detail the surface features of the Malaspina Glacier for the use of glaciologists studying glacier flow, wastage, and deposition.

A detailed planimetric map of the foothills belt was compiled from aerial photographs for use in the report on the bedrock geology of the Malaspina district. Plafker in 1955 and 1956 extended this map over the Malaspina Glacier to the coast, and plotted on it glacial features and surficial deposits as delineated on vertical aerial photographs. The photographs were taken by the U. S. Navy during the period June 30 to August 15, 1948, and have an average scale of about 1:35,000. On these photographs snow of the previous winter obscures some superglacial moraines that normally would be exposed at the time of minimum snow cover. This is true particularly of the lobe of relatively clear ice on the Malaspina Glacier south of the junction with the Seward Glacier, as a major part of this area is covered only by vertical photography taken on June 30.

The compilation of this map was conceived and planned by Plafker, and the work of interpreting and plotting the glacial features and surficial deposits from the aerial photographs was done almost entirely by him. The text was written by Miller. D. M. Hopkins gave helpful advice on questions of terminology and methods of presenting the data.

SUMMARY OF RECENT HISTORY OF GLACIATION AND DEPOSITION IN THE MALASPINA DISTRICT AND ADJOINING BAYS

I. Older glacier advance, culminating between 600 and 920 A.D. in Icy Bay and between 970 and 1290 A.D. in Yakutat Bay (fig. 1).

The maximum stand of the ice lobe that filled Yakutat Bay at the culmination of this advance is defined by the conspicuous end moraine along the southeast shore of Yakutat Bay, the low end moraine extending north from Point Manby, and the connecting submarine ridge which forms an arcuate shoal across the mouth of Yakutat Bay. The corresponding stand of the western margin of the Icy Bay lobe is defined by the conspicuous end moraine ridge extending north from Icy Cape. The seemingly anomalous inference that the front of the Malaspina Glacier between the Yakutat and Icy Bay lobes was not farther south than its present position is based on the following evidence: (1) the southeasterly direction of ice movement indicated by overridden moraine at the present margin of the Malaspina Glacier about 9 miles east of point Riou; (2) the southwesterly direction of ice movement and northward-trending ice front indicated by overridden ground moraine and end moraine, respectively, at the present margin of the Malaspina Glacier north of Point Manby.

A continuous or nearly continuous tidal front from the west side of Icy Bay to the east side of Yakutat Bay is inferred from the occurrence of marine shells in the end moraine extending north from Icy Cape, west of Icy Bay (Taliaferro, 1932, p. 761; Miller, field notes, 1947), and in till near the present margin of the Malaspina Glacier north of Point Manby (Russell, 1893, p. 63).

The dating of the culmination of the older advance between 600 and 1200 A.D. is based on the following radiocarbon age measurements made by the U. S. Geological Survey laboratory: wood in end moraine at Icy Cape (location A, fig. 1), collected in 1951 by Miller, age 1,200 ± 160 years (Meyer Rubin, lab. no. W-374, report dated April 16, 1956); wood in end moraine near Ocean Cape (location B, fig. 1), collected in 1956 by J. H. Hartshorn, age 830 ± 160 years (Meyer Rubin, lab. no. W-559, report dated June 11, 1957). Although an earlier, presumably Wisconsin, glaciation seems necessary to account for the enormous amount of glacial erosion that has taken place in the Yakutat Bay area (Tarr and Martin, 1914, p. 228-230) and Icy Bay, deposits that can be ascribed with certainty to such glaciation have not been found on the coastal lowland or at higher levels in the foothills belt.

II. Older recession, beginning before 1400 A.D. and ending about 1700 A.D.

Retreat of the ice lobes in Icy Bay and Yakutat Bay to positions near to or upvalley from the present tidal fronts of the glaciers discharging into the heads of these bays is inferred from (1) the presence of well-preserved wood, including parts of the trunks of trees as much as 4 inches in diameter, at the south margin of the Guyot Glacier a mile above the present front and about 4 miles northeast of the present forest margin (Miller and Plafker, field notes, 1953); (2) the evidence of former forest growth extending up to or beyond the present limits of the glaciers on Russell Fiord, Disenchantment Bay, and along the outer margin of the foothills west of the head of Yakutat Bay (Tarr, 1909, p. 126, 130-131, 138-139). The legend of the Yakutat natives that a large bay formerly extended to the foot of Mount St. Elias (Topham, 1889, p. 350; also cited by Tarr and Martin, 1914, p. 47) may also be an indication of the extent of recession in Icy Bay during this interval.

Retreat of the southeastern margin of the Malaspina Glacier to a position at least two miles north of the present front is indicated by remnants of interglacial forests found at two localities about 5 miles north of Point Manby (Sharp, 1956, and personal communication, July 3, 1956).

According to recent studies made by the U. S. Forest Service, the forest growing on the outwash apron at the outer margin of the end moraine near Yakutat is a relatively pure even-aged spruce stand with an average age of nearly 550 years (H. E. Andersen, personal communication, 1957). The oldest of 27 spruce trees on which an accurate age count was obtained in 1953 was then 553 years old (J. W. Kinney, personal communication, 1957). This indicates that recession of the Yakutat Bay lobe began before 1400 A.D., assuming that the outwash apron did not become stabilized and suitable for forest growth until after the recession had begun. The rate of reforestation since the latest advance in approximately comparable situations around the present stagnant margins of the Bering and Malaspina Glaciers indicates that the spruce forest probably did not become established on the outwash apron near Yakutat for at least 50 years after the tidal ice front began to retreat into Yakutat Bay.

Formation of the present coastal plain bordering the Malaspina Glacier began with the recession following the older glacier advance, in part by deglaciation of end and ground moraines, in part by constructional processes of glacial streams, waves, and wind, and possibly in part by uplift of the land relative to sea level. The elongate ridges just east of Cape Riou, thought to be dunes, the compound spit 8 miles east of Point Riou, and the beach ridge southeast of Ocean Cape possibly were formed entirely during the interval between the older and younger glacier advances.

III. Younger glacier advance culminating after 1700 A.D. and before 1791 A.D.

The maximum stand of the Yakutat-Disenchantment Bay lobe during the younger advance possibly is indicated by a submarine ridge near Blizhni Point, which was thought by Gilbert (1904, p. 49, 51, fig. 27) to be a moraine. Support for this interpretation is found in the southwesterly direction of ice movement indicated by overridden moraine and a possible end moraine just north of Blizhni Point, and also in the lateral moraines which can be seen on aerial photographs of the mountain front west of Bancas Point, in the vicinity of the Black and Galiano Glaciers. These lateral moraines, which are not shown on the map, decrease in altitude westward. The charts and accounts of Malaspina, Vancouver, and Tebenkof indicate that the ice front was at or just north of Haenke Island in Disenchantment Bay from 1791 to 1823 (Russell, 1891, p. 64-67, 97-98; Tarr and Martin, 1914, p. 108-109).

The maximum stand of the Icy Bay lobe is defined by conspicuous end moraines on the east and west shores of Icy Bay and by the connecting submarine ridge which forms an arcuate shoal across the mouth of the bay. A position at or near the maximum stand is recorded in the maps and accounts of several expeditions to this region between 1886 and 1907 (Seton-Karr, 1887; Libbey, 1886, p. 292-293; Topham, 1889, p. 350-351, map; Russell, 1893, p. 12-17, p. 64; Tarr and Martin, 1914, p. 50-51), and possibly also in the records of the exploration of this coast by the Vancouver expedition in 1794. The charts and

accounts of Vancouver (1798, p. 204, charts), Belcher (1843, p. 79-80), and Tebenkof (1852; chart reproduced in Tarr and Martin, 1914, p. 46) show a shallow bay which has been assumed by Tarr and Martin, Taliaferro (1932, p. 764, 766), and others to have been located in the position of the outer part of the present Icy Bay and has been cited as evidence of a less advanced position of the Icy Bay lobe from 1794 until some time after 1837. The writers, however, agree with the interpretation of Russell (1893, p. 13) that the Icy Bay of the early explorers was in the position of the former outlet of the Yahtse River east of the present Icy Bay, and we infer from this that the ice had advanced to the mouth of the present Icy Bay before 1794. This interpretation of the position of the Icy Bay shown on the charts of Vancouver and Tebenkof is supported by the shape of the bay and its position relative to the Sitkagi Bluffs, Point Manby, and Mount St. Elias. Moreover, Tebenkof's chart shows a sounding of 30 feet near the head of the bay, whereas the depth at a corresponding position in the present Icy Bay ranges from 100 to 300 feet.

The maximum stand of the Malaspina Glacier during the younger advance is defined by an end moraine with which the glacier is still in contact around much of its margin. The glacier may have extended a short distance into the sea at the present position of the Sitkagi Bluffs. According to Sharp (1956, and personal communication, July 3, 1956) trees growing in ablation debris at the outer margin, and a radiocarbon date of less than 300 years on wood from the interglacial forest overridden by the glacier together fix the culmination of the last advance at 200 ± 50 years ago. The Icy Bay and Yakutat lobes presumably advanced to their maximum positions about the same time.

IV. Younger recession beginning before 1791 A.D. in Yakutat Bay and about 1904 A.D. in Icy Bay, and continuing to the present.

The observations of the Malaspina and Vancouver expeditions (Russell, 1891, p. 62-68) show that recession of the Yakutat-Disenchantment Bay lobe began some time before 1791, if the submarine ridge near Blizhni Point represents the maximum stand during the younger advance. The record of the general recession of the glaciers in the vicinity of Yakutat Bay up to 1913 and of their minor readvance in response to the Yakutat Bay earthquake of 1899 has been summarized by Tarr and Martin (1914). On the present map the combined front of the Lucia and Atrevida Glaciers is shown nearer the coast than on the reconnaissance map of the Yakutat district made in 1905 and 1906 (Tarr and Butler, 1909, pl. 37), but this is probably due to difference of interpretation in locating the glacier front in stagnant ice covered by ablation debris and vegetation. The fronts of the other glaciers at or near the west shore of Disenchantment Bay are at about the same relative positions on the 1905-1906 map and the present map.

Retreat of the tidal front of the Icy Bay lobe into the present Icy Bay began probably in 1904, and certainly no later than 1909 (Maddren, 1914, p. 151; Tarr and Martin, 1914, p. 50-51). The ice front was about 7 miles from the mouth of the bay in 1913 (Maddren, 1914, pl. 4) and in 1922 (U. S. Coast and Geodetic Survey Chart 8457), and about 12 miles from the mouth of the bay in 1948 (present map). Vertical photographs taken on June 30 and on September 12, 1948 show changes in the position of the ice front amounting to as much as 0.3 mile (see map). From the relative positions of minor irregularities on the medial moraine of the Guyot Glacier on these two sets of photographs, the average rate of movement of the ice near the front of the glacier was calculated at about 67 feet per day.

Stagnation of the marginal part of the Malaspina Glacier probably began concurrently with or shortly after beginning of recession of the Yakutat-Disenchantment Bay lobe. The englacial pits shown on the map are believed to indicate the approximate extent of stagnant ice in 1948: a marginal zone ranging in width from less than half a mile to about six miles and comprising about one-fourth of the total area of the Malaspina Glacier. In recent years parts of the southeastern margin of the Malaspina have retreated as much as 3 miles, and large lakes have formed between the ice front and the end moraine.

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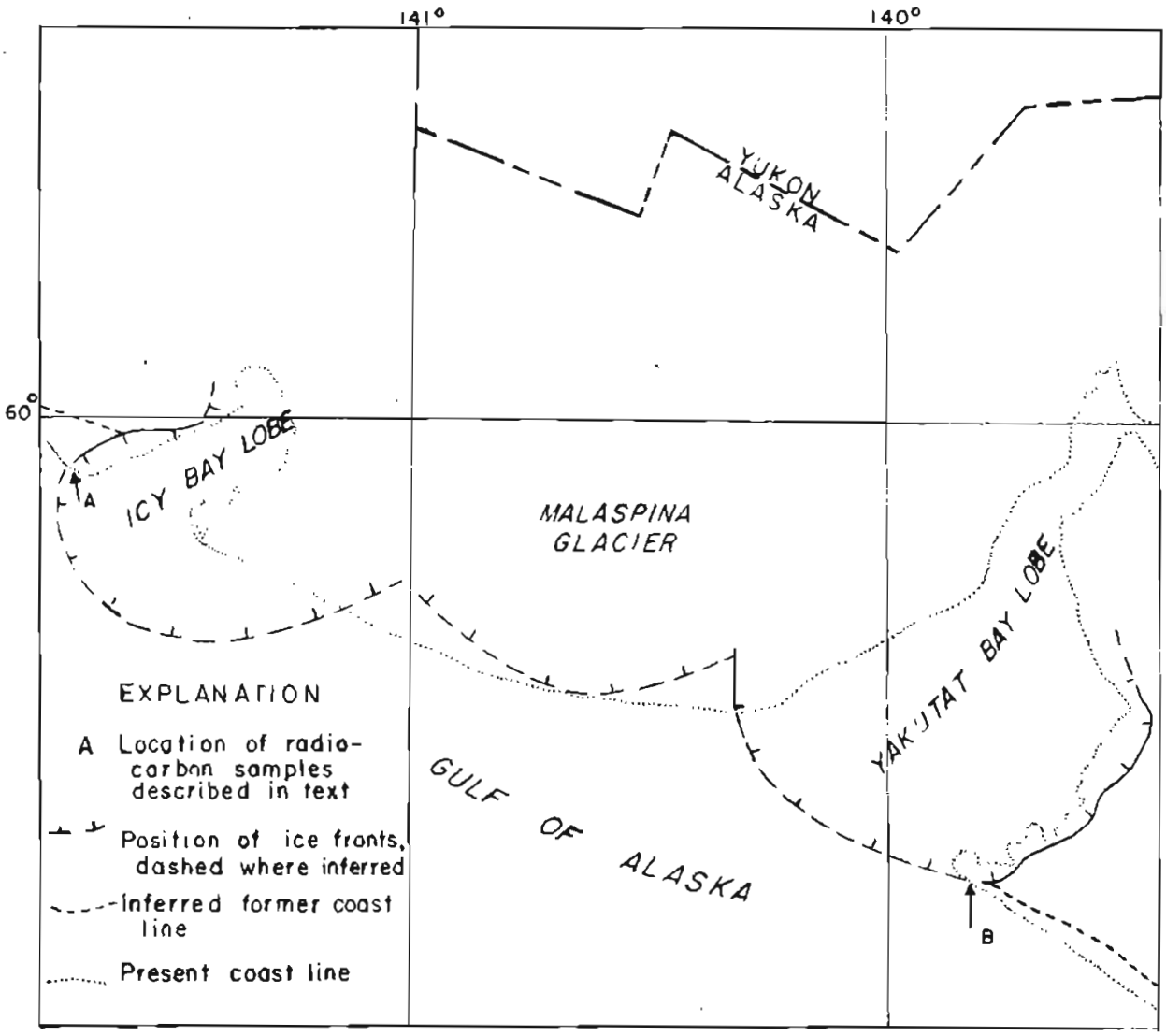

Figure 1. Position of ice fronts and coast line at culmination of older advance

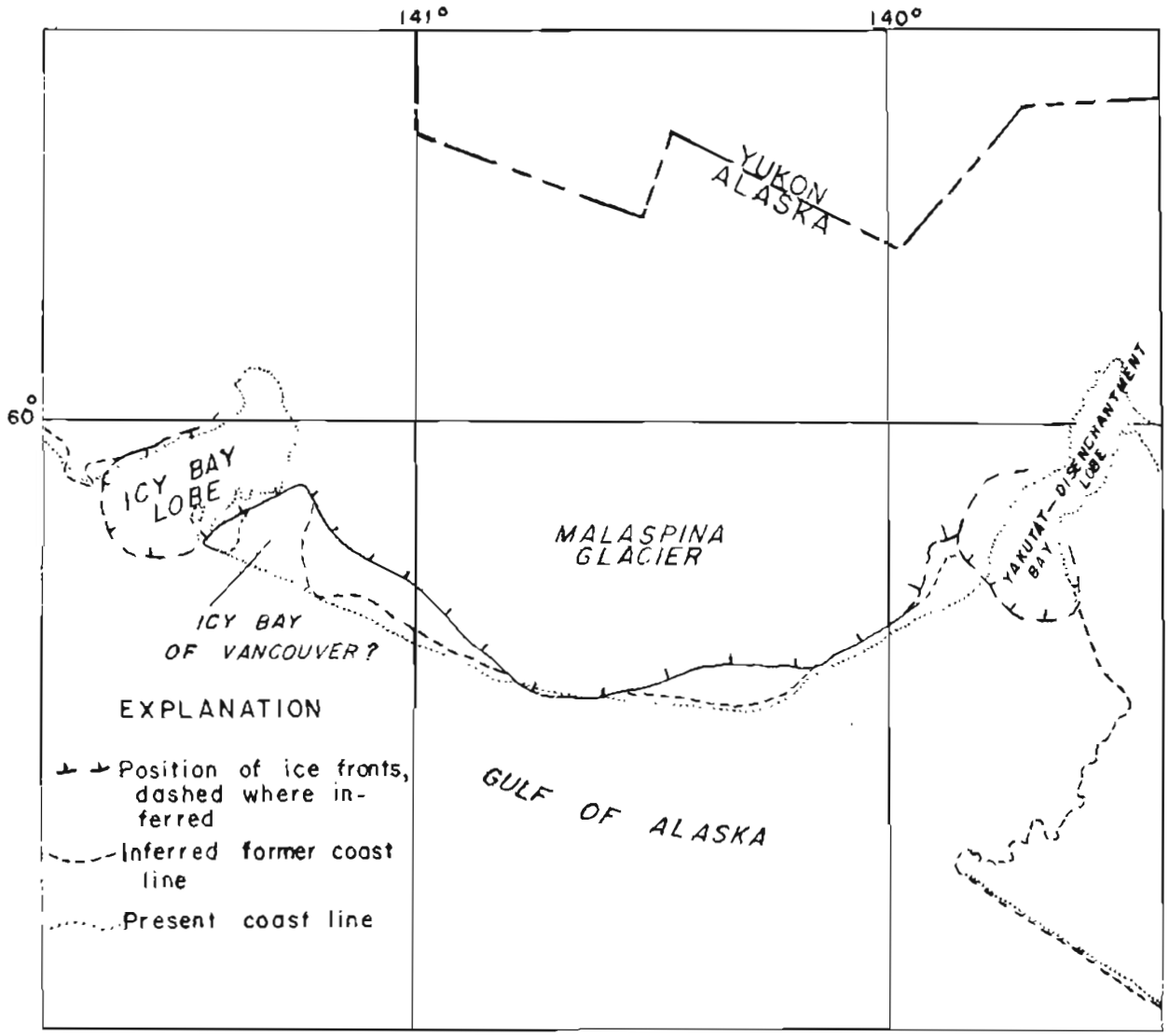

Figure 2. Position of ice fronts and coast line at culmination of younger advance