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OPEN FILE MAP 84-632 SHEET 1 of 3
MARINE GEOLOGY ATLAS
GLACIER BAY, ALASKA

MAP OF MARINE GEOLOGY OF UPPER MUIR AND WACHUSETT INLETS, GLACIER BAY, ALASKA: SEDIMENT DISTRIBUTION AND THICKNESS, BATHYMETRY, AND INTERPRETED SEISMIC PROFILES

by

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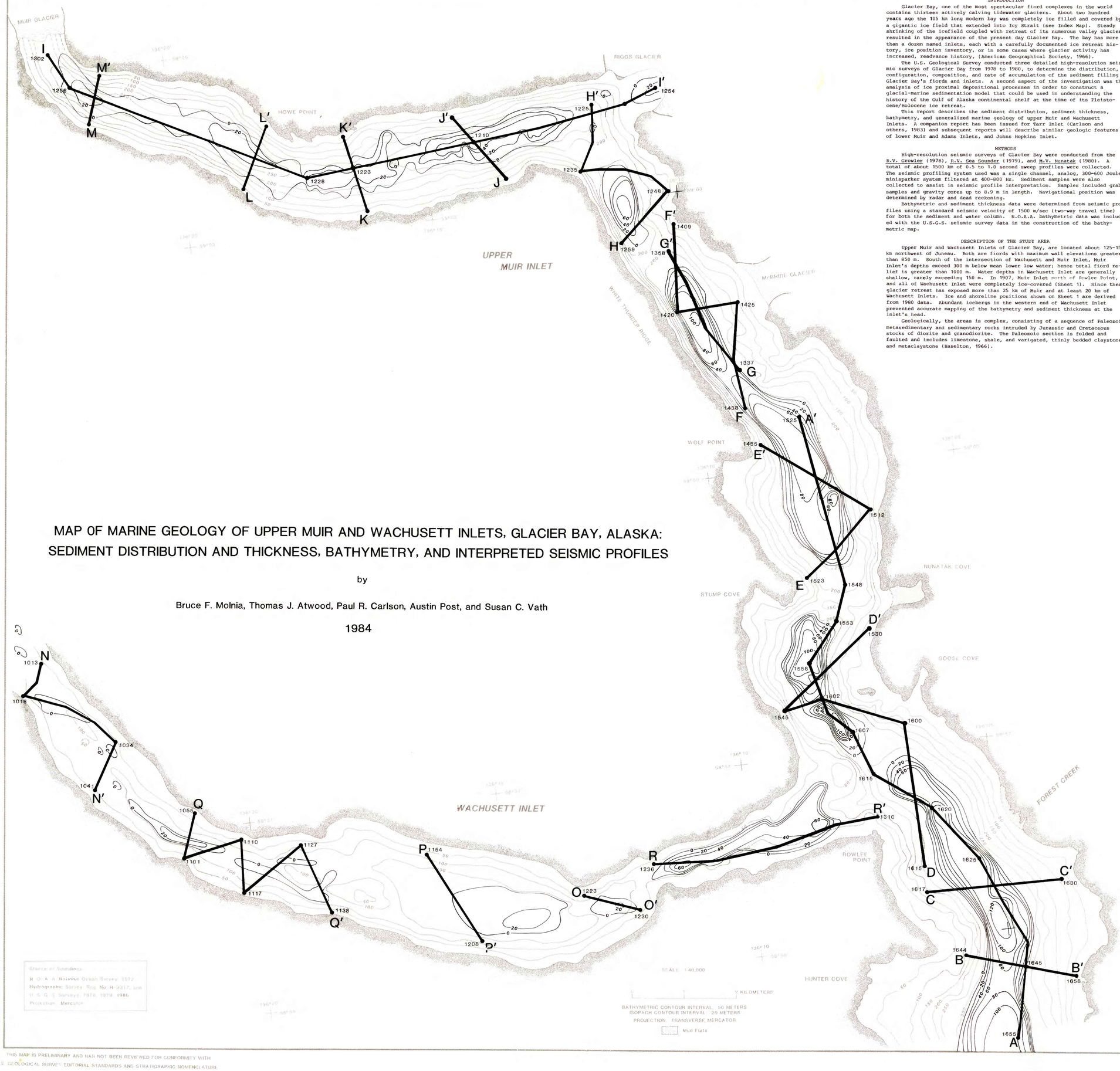


INTRODUCTION

Glacier Bay, one of the most spectacular fiord complexes in the world contains thirteen actively calving tidewater glaciers. About two hundred years ago the 105 km long modern bay was completely ice filled and covered by a gigantic ice field that extended into Icy Strait (see Index Map). Steady shrinking of the icefield coupled with retreat of its numerous valley glaciers resulted in the appearance of the present day Glacier Bay. The bay has more than a dozen named inlets, each with a carefully documented ice retreat history, ice position inventory, or in some cases where glacier activity has increased, readvance history, (American Geographical Society, 1966).

The U.S. Geological Survey conducted three detailed high-resolution seismic surveys of Glacier Bay from 1978 to 1980, to determine the distribution, configuration, composition, and rate of accumulation of the sediment filling Glacier Bay's fiords and inlets. A second aspect of the investigation was the analysis of ice proximal depositional processes in order to construct a glacial-marine sedimentation model that could be used in understanding the history of the Gulf of Alaska continental shelf at the time of its Pleistocene/Holocene ice retreat.

This report describes the sediment distribution, sediment thickness, bathymetry, and generalized marine geology of upper Muir and Wachusett Inlets. A companion report has been issued for Tarr Inlet (Carlson and others, 1983) and subsequent reports will describe similar geologic features of lower Muir and Adams Inlets, and Johns Hopkins Inlet.

METHODS

High-resolution seismic surveys of Glacier Bay were conducted from the R.V. Growler (1978), R.V. Sea Sounder (1979), and M.V. Nunatak (1980). A total of about 1500 km of 0.5 to 1.0 second sweep profiles were collected. The seismic profiling system used was a single channel, analog, 300-600 Joule minisparker system filtered at 400-800 Hz. Sediment samples were also collected to assist in seismic profile interpretation. Samples included grab samples and gravity cores up to 8.9 m in length. Navigational position was determined by radar and dead reckoning.

Bathymetric and sediment thickness data were determined from seismic profiles using a standard seismic velocity of 1500 m/sec (two-way travel time) for both the sediment and water column. N.O.A.A. bathymetric data was included with the U.S.G.S. seismic survey data in the construction of the bathymetric map.

DESCRIPTION OF THE STUDY AREA

Upper Muir and Wachusett Inlets of Glacier Bay, are located about 125-150 km northwest of Juneau. Both are fiords with maximum wall elevations greater than 850 m. South of the intersection of Wachusett and Muir Inlet, Muir Inlet's depths exceed 300 m below mean lower low water; hence total fiord relief is greater than 1000 m. Water depths in Wachusett Inlet are generally shallow, rarely exceeding 150 m. In 1907, Muir Inlet north of Rowlee Point, and all of Wachusett Inlet were completely ice-covered (Sheet 1). Since then glacier retreat has exposed more than 25 km of Muir and at least 20 km of Wachusett Inlets. Ice and shoreline positions shown on Sheet 1 are derived from 1980 data. Abundant icebergs in the western end of Wachusett Inlet prevented accurate mapping of the bathymetry and sediment thickness at the inlet's head.

Geologically, the areas is complex, consisting of a sequence of Paleozoic metasedimentary and sedimentary rocks intruded by Jurassic and Cretaceous stocks of diorite and granodiorite. The Paleozoic section is folded and faulted and includes limestone, shale, and varigated, thinly bedded claystone and metaclaystone (Haselton, 1966).

GLACIAL HISTORY

The Fairweather Range and the Gulf of Alaska continental shelf, both to the west of Glacier Bay, have a long glacial record that may extend as far back in time as the early or middle Miocene (Plafker and Addicott, 1976; Molnia and Sangrey, 1979). A similar long glacial record probably applies to Glacier Bay although no stratigraphic evidence for pre-Holocene glacial events has been found.

Of primary interest, however, is the most recent Pleistocene and Holocene glacial history of Muir and Wachusett Inlets. McKenzie and Goldthwait (1971) state that late Wisconsin glacier ice extending more than 1028 m above present sea level and probably within a few hundred meters of 1680 m above sea level, reached southward to Icy Strait and westward to the Pacific Ocean. The exact date of retreat of this advance is unknown but radiocarbon (^{14}C) dates on a spruce cone from the Forest Creek Formation (11,170 ±225 yr B.P.) and wood from peat in Adams Inlet (10,940 ±135 yr B.P.) suggest that prior to 11,000 yr B.P. glaciers in the Muir Inlet area had retreated at least as far as their present positions. An outcrop of Muir Till at Forest Creek has been interpreted (Haselton, 1966) to show that Muir Glacier may have readvanced after 10,400 yr B.P. McKenzie and Goldthwait (1971) discount the 10,400 yr. B.P. advance and present a series of alternative interpretions of the outcrop. By 7,500 yr B.P. Hypsithermal warm climate was well established and a wedge of outwash gravel and sand filled much of upper Glacier Bay to elevations of up to 120 m above present-day sea level (Goldthwait, 1963). At the time of deposition the land surface may have been depressed as much as 96 m with respect to present sea level. The volume of this outwash gravel and sand would be about 60 km^3 (Goldthwait, 1963). Subsequent ice advance (Little Ice Age), beginning as early as 2950 yr. B.P., again filled Glacier Bay and eroded and pushed much of the hypsithermal gravel out of the upper inlets and into lower Glacier Bay or even further south into Icy Strait (Goldthwait, 1963). Retreat of Little Ice Age glaciers began about 1650 AD to 1750 AD (200-300 yr B.P.) and is still continuing in Muir Inlet.

Sediment in Glacier Bay fiords consists primarily of post-Little Ice Age glacial-marine deposits and outwash. Additionally, older Hypsithermal gravels, Little Ice Age basal till, and moraines of a variety of ice advances and retreats are present. Interpreted seismic profiles (sheets 2 and 3) indicate numerous units that may represent older pre-Little Ice Age and Little Ice Age deposits. Identifications of these geologic units are based strictly on morphology and stratigraphic relationships as we have been unable to obtain suitable material for dating.

SEDIMENT THICKNESS AND SEDIMENT ACCUMULATION RATES

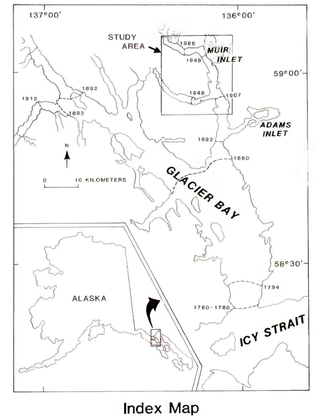
Upper Muir Inlet has eight mid-fiord basins that have sediment accumulations of greater than 60 m, and a number of other areas including basins adjacent to Muir and Riggs Glaciers, with thinner sediment fills. Wachusett Inlet has only minor sediment accumulations in its upper end and one fiord mouth basin where over 60 m of sediment have accumulated.

Sedimentation rates in Wachusett Inlet are generally very low and rarely as much as 1 m/yr. In Muir Inlet, however, many areas have sedimentation rates that exceed 3 m/yr (see profiles I-I' - M-M'). Molnia and others (1979) have described a 4.5 m/yr maximum sedimentation rate in the area between profiles H-H' and J-J'. The area immediately adjacent to Muir Glacier (profile M-M') has the maximum sedimentation rate observed in Glacier Bay. Here approximately 20 m of sediment have accumulated in about two years. This maximum sedimentation rate may be a function of basin geometry, or perhaps sedimentation is highest immediately adjacent to the ice margin and decreases in an exponential relationship with an increase in the distance to the ice margin and time. In any case, sedimentation rates at the 1978 terminus position have recently exceeded 9 m/yr. With time, the sediment column undergoes compaction and dewatering, thus leaving a thinner sediment mass than initally observed.

INTERPRETATION OF SEISMIC PROFILES

Eighteen interpreted seismic profiles (labled A-A' through R-R') are included on Sheets 2 and 3 of this report. Profiles are marked to display depth, intersections with other profile lines, times that correspond to start and end of lines and minor positional corrections, and course changes. Small reference letters (i.e. "(a)") are also shown. These are explained in detail in the description that accompanies each profile.

All profiles have vertical exaggeration of approximately 10x. All lines were collected at ship speeds of between 3.5 and 5.0 knots (approximately 6.5-9.3 km/hr). Speed variations on individual profiles were the result of wind, surface currents, and ice bergs that had to be avoided. By convention, all profile lines displayed on Sheets 2 and 3 have either west or north to their left sides. The horizontal distance scale of sheets 2 and 3 corresponds to a speed of 4 knots. This single scale is arbitrarily used for all profiles.



Index Map

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