DEPARTMENT OF THE INTERIOR
UNITED STATES GEOLOGICAL SURVEY

HYDROLOGIC INVESTIGATIONS
ATLAS HA-559 (SHEET 1 OF 3)

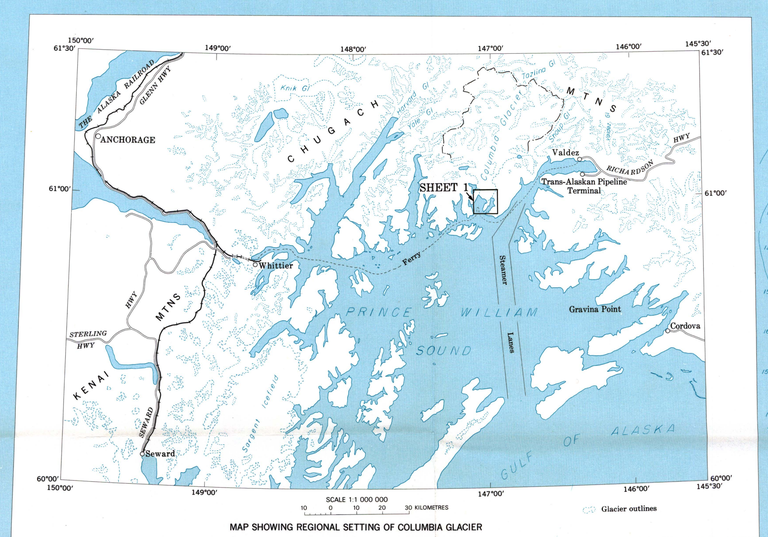
PRELIMINARY HYDROGRAPHY AND HISTORIC TERMINAL CHANGES OF COLUMBIA GLACIER, ALASKA

By
Austin Post

1975

MAP OF PRELIMINARY HYDROGRAPHIC SURVEY OF COLUMBIA GLACIER TERMINUS

MAP SHOWING REGIONAL SETTING OF COLUMBIA GLACIER



VARIATIONS AND STABILITY OF COLUMBIA GLACIER

Nearly all glaciers in Alaska and other parts of the world which end in the oceans (here called tidal[1] glaciers) have experienced very large scale asynchronous advances and retreats which are not directly related to climate. Changes in snowline altitude and glacier width as a glacier advances or retreats can create instabilities which may continue long after the triggering mechanism has dissipated (Mercer, 1961).

Independent studies of tidal glaciers by the author and by Hoppe (1959) and Groswald (1974, p. 73) have disclosed that another very critical factor in the stability of these glaciers is the water depth at the glacier's terminus. Instability results when a tidal glacier retreats even a short distance into a deep basin from a stable position on a terminal shoal. The glacier may then retreat many kilometres per year as innumerable icebergs, some of immense size, break away from the glacier.

Since first mapped in 1794 by Vancouver (1798), nine Alaskan tidal glaciers have made large-scale drastic retreats, including the 100-km retreat of ice in Glacier Bay, which is probably the greatest retreat in historic time in the world. Columbia Glacier, 1,100 km² in area and the largest glacier in Prince William Sound, is now the only tidal glacier remaining on the North American Continent which is still in an extended Neoglacial position.

The terminus of Columbia Glacier has been in a state of near equilibrium since first mapped. Even under these conditions icebergs occasionally drift into the shipping lanes in northern Prince William Sound and the approaches to Port Valdez, southern terminal of the new trans-Alaskan pipeline (U.S. Coast and Geodetic Survey, 1964, p. 32, 41). Drastic retreat of the glacier would vastly increase iceberg hazards to shipping, especially to large, unwieldly vessels such as oil tankers. Thus it is important to know if Columbia Glacier is in a situation where drastic retreat is possible. Also the dynamic condition of the glacier needs to be determined so that its future stability may be predicted. This atlas pertains to the first of these questions.

The data reported here resulted from a first-of-its-kind hydrographic survey made of a tidal glacier by use of a specially equipped mother ship and an unmanned, instrumented launch which could be run by radio control directly to the glacier's hazardous tidal cliff. Positions of both vessels were determined by theodolite intersection from shore and by sextant angles and radar ranging from shipboard.

These surveys show that Columbia Glacier, as was anticipated, ends on a shoal judged to be a terminal moraine, which extends completely across Columbia Bay. Water depths on this bar, where measured in this preliminary examination, ranged from less than 2 to about 30 m. Soundings by skiff (1973) in a large terminal embayment on the west side of the glacier and radar soundings (1974) of the ice thickness obtained at various points on the glacier's surface disclose that the shoals at the terminus do not continue far under the ice. For at least 30 km up the glacier from the terminus much of the bottom is far below the sea, and ice depths as great as 700 m below sea level were recorded.

The data on the following sheets show that for more than 70 years Columbia Glacier's terminus has been virtually stable, with frequent temporary advances being balanced by retreats of the same magnitude. This stability is in marked contrast to other glaciers in the area, most of which have thinned and retreated during this interval, the only other notable exceptions being tidal glaciers which have previously made large-scale drastic retreats and which are currently advancing. Columbia Glacier's extended position and advances in recent decades over areas not glaciated for more than 9,000 years (J. H. Mercer, written commun., 1975) are anomalous. Very large embayments which form some years in the glacier's terminus cliff may present a serious hazard to the glacier's continued stability. Drastic retreat with associated increased iceberg discharge could occur within a few years should the glacier retreat from the shoals. These fluctuations at the terminus and changes in thickness in other parts of the glacier are being carefully monitored in order to predict the glacier's future stability.

[1]Not necessarily having a floating terminus.

Triangulation by U. S. Geological Survey 1974.

Topography modified U. S. Geological Survey 1:63,360 quadrangles Cordova D-8, Seward D-1, Valdez A-8, and Anchorage A-1.

Hydrography from 1973 and 1974 surveys by U. S. Geological Survey with chartered University of Alaska Research Ship Acona and radio-controlled launch Firefish.

Surveyed in cooperation with the National Oceanic and Atmospheric Administration

198 Soundings positioned by theodolite and sextant surveys, corrected for tide.

74 Soundings positioned by radar or dead reckoning, not corrected for tide.

PA POSITION APPROXIMATE
PD POSITION DOUBTFUL
ED EXISTENCE DOUBTFUL

2.4 When less then 10 metres, soundings are in metres and tenths.

SCALE 1: 10 000
½ 0 ½ 1 MILE
.5 0 5 1 KILOMETRE
CONTOUR INTERVAL ON LAND 30 METRES
HEIGHTS AND DEPTHS IN METRES
DATUM IS MEAN SEA LEVEL

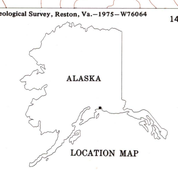
Photographic station and name or number, those without center dot indicate approximate locations.
△ 1974 triangulation station and name.
□ Grab sample site, position approximate.

Shorelines are approximate mean high tide from NASA 19,800 metres altitude and aerial photographs, May 1974

Dotted lines furthest from shore indicate approximate shoreline at extreme low tide. Shorelines, shoals, and off-shore rocks not field checked.

Lines with dates show glacier terminus on that date; July 1974 line is dashed where terminus lie on land.

C-14 wood sample dated 9,330 ±160 years before present, collected at base of 2 metres of peat (Mercer, written communication, 1975)



LOCATION MAP

Interior—Geological Survey, Reston, Va.—1975—W76064

For sale by U.S. Geological Survey, Fairbanks, Alaska 99701; Denver, Colo. 80225; or Reston, Va. 22092, price $1.75 per set