EFFECTS OF THE 1964 ALASKAN EARTHQUAKE ON GLACIERS AND RELATED FEATURES*

On 14 April 1964, less than three weeks after the most violent earthquake ever recorded on the North American Continent had shaken south-central Alaska, an Arctic Institute of North America field party began an aerial reconnaissance (Fig. 1) to determine how the initial shock and those that followed had affected the glaciers of the region. By 19 April the party had obtained oblique photographs in black-and-white and colour of many of the glaciers and associated features, but postponed further work until those obscured by fresh snow in the spring would be clearly visible. The second reconnaissance was thus carried out from 4 to 24 September.

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The apparent effects were photographed over a large area in part comprised of glaciers, glacial lakes and associated valley walls. Included were the collapsed cover of some ice-dammed lakes, unusually severe cracks in lake ice surfaces, traces of seiches along lake shores, ice shaken from glacier termini into lakes, and avalanches and landslides, some of the latter having spread entirely across the glaciers on which they fell. It was hoped that by comparing the 1964 spring and later summer photographs with those existing from earlier years an analysis of the visible effects of the 27 March earthquake and the associated aftershocks could be made.

It was surprising that there was so little obvious change. Few snow avalanches or snow slides in the glacier basins were observed and none appeared to have added enough substance to affect glacier regimen appreciably. With a few exceptions, hanging glaciers did not appear to have been affected and there was no unusual calving of

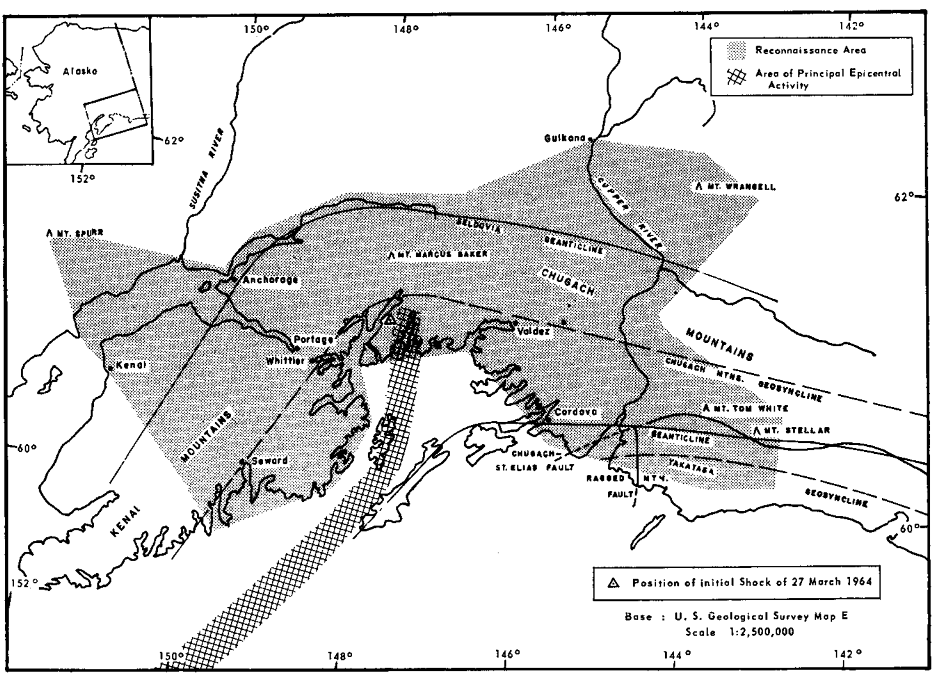

Fig. 1. South central Alaska.

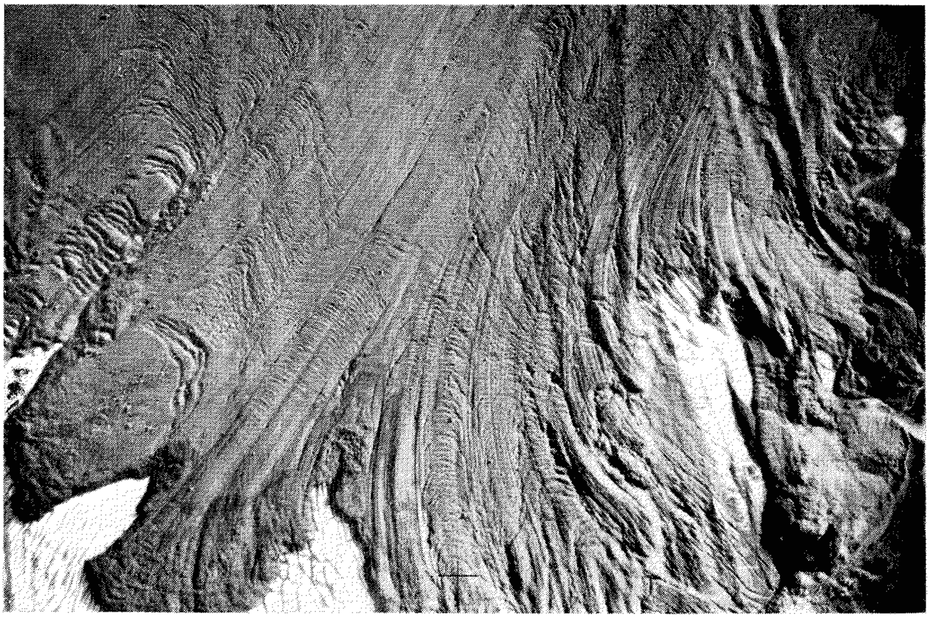

Fig. 2. Sherman Glacier. Vertical photograph from 3,000 m., 0900 hrs., 24 September 1964. The streaming flow lines, generally from upper right to lower left, are only one of the several complex textural forms apparent on the surface of the landslide. The boulders are as much as 15 m. in diameter.

glacier termini into tidewater. However, numerous avalanches of snow, ice and rock in varying proportions had been caused to fall from valley walls. Some of the landslides that had fallen on glaciers constituted one of the most conspicuous and impressive effects of the earthquake (Fig. 2).

From the photographs there appears to have been more activity of glacier fronts terminating in lakes than those terminating in tidewater. The evidence, however, is not conclusive because there are no earlier spring descriptions or photographs to compare with the observations and impressions of April 1964. The same difficulty arises when an attempt is made to examine the effects of ice-dammed lakes: there is not enough descriptive information or photographic coverage prior to the earthquake to permit comparisons leading to definite conclusions.

A very small amount of shattering and calving was apparent at the front of glaciers terminating in tidewater. This must be considered unusual since after earthquakes of comparable violence in 1899 and 1958 the bays and inlets near the epicenters were reported[1] to be filled with bergs and floes, even to the extent of preventing navigation of steamships into Muir Inlet for six years after the 1899 shock.

Of all the ice-dammed lakes observed, the one in the southwestern embayment of Columbia Glacier showed more evidence of having drained as a consequence of earthquake shaking than any other. The fact that there was no pronounced shoreline visible, which would be expected if draining were recent, may be explained by recent snow accumulation in the area. The lake on the western margin of the terminal lobe of Skilak Glacier did display a prominent shoreline which can be explained by the fact that the western side of the Kenai Peninsula receives less than one fourth of the precipitation that falls near

Columbia Glacier and Bay.

Although the few snow avalanches or slides seen in the Kenai or Chugach mountains are not considered extensive enough to have altered glacier regimen, nine landslides are believed to have been large enough to do so. All nine lie on or near a line normal to the principal line of epicentral activity and nearly parallel to the Chugach-St. Elias fault. Closer examination of them is needed, however, and long term studies are necessary to provide significant information on the changes that are now taking place and will continue to take place. There may have been subtle changes not yet apparent, such as kinematic waves in the glaciers, and these may not be detected for years.

The first to speculate upon the effects of earthquakes on glaciers were Professors R. S. Tarr and Lawrence Martin[2] who hypothesized on the results of great quantities of snow, ice and rock being added to the accumulation areas of glaciers. Their "Theory of earthquake avalanche supply"[3] was based on the series of spasmodic glacier surges and advances in the Yakutat Bay area beginning in 1906 which they attributed to the Alaskan earthquakes of September 1899. Prior to these earthquakes the glaciers were considered to be mostly in a state of recession. After field studies conducted from 1906 to 1913 Tarr and Martin were satisfied that each glacier advance was a response to earthquake shaking. They theorized that avalanches caused by the shaking resulted in abnormal accumulation in the upper glacier basins which generated waves travelling down the glaciers. The waves caused crevassing and later abrupt and spasmodic advances of termini. Hidden Glacier, northeast of Yakutat advanced about three kilometers between 1906 and 1909. In that time it covered a photographic site near the 1905 front with an estimated 335 m. of ice. Studies undertaken as a result of the 1964 earthquake may in the next few years test the Tarr and Martin theory.

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Election of Fellows

At the meeting of the Board of Governors on 12 December 1964 the following were elected Fellows of the Institute:

Spencer Apollonio, M.Sc. Specialist in arctic marine plankton productivity and ecology; organizer and leader of Devon Island Expedition, 1960-63.

Roger J. E. Brown, Ph.D. Specialist in distribution and properties of permafrost related to building in northern areas, National Research Council, Canada.

Charles J. Eagan, Ph.D. Physiologist and biophysicist, Arctic Aeromedical Laboratory, Alaska.

Arthur Fernald, Ph.D. Glacial geologist and geomorphologist, Alaska Terrain and Permafrost Section, U.S. Geological Survey.

Louis-Edmond Hamelin, Ph.D. Professor and specialist in glacial and periglacial geomorphology; Director, Centre d'Etudes Nordiques, Université Laval, Canada.

C. R. Harington, M.Sc. Zoologist, studying the polar bear for Canadian Wildlife Service; has also made studies of musk oxen and other arctic animals.

William N. Irving, Ph.D. Arctic archaeologist; head of the Western Canada Section of the Archaeology Division, National Museum of Canada.

Olav H. Løken, Ph.D. Physical Geographer, specialist in glacial geomorphology; Geographical Branch, Canada.

Richmond W. Longley, M.A. Geography Department, University of Alberta; Meteorologist in charge of the meteorological station at Resolute 1956-58; general responsibility for the other four joint Arctic Meteorological stations.

Michael Marsden, M.A., M.Sc. Assistant Professor, Dept. of Geography, Sir George Williams University, Montreal; Director, Montreal Office of the Arctic Institute 1958-1964.

Mark F. Meier, Ph.D. Glaciologist; vice-president, International Commission of Snow and Ice, in charge of glaciological research, Water Resources Division, U.S. Geological Survey.