EARTHQUAKE-INDUCED CHANGES IN ALASKAN GLACIERS

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Abstract. The earthquake of 27 March 1964 in Alaska created a great number of rock avalanches which discharged onto the glaciers from the surrounding mountains. The ice falls became much more broken up than normal but the remainder of the surface of the glaciers was largely unchanged except for more open crevasses than before the earthquake.

Résumé. *Variations des glaciers de l'Alaska dues aux tremblements de terre.* Le tremblement de terre du 27 mars 1964 en Alaska a créé un grand nombre d'avalanches de roches descendant sur les glaciers des montagnes environnantes. Les chutes de séracs ont été plus crevassées que d'ordinaire, mais la surface des glaciers était largement inchangée sauf plus crevassée qu'avant le tremblement de terre.

Zusammenfassung. *Veränderungen an Gletschern in Alaska, verursacht durch Erdbeben.* Das Erdbeben in Alaska vom 27 März 1964 löste eine grosse Zahl von Felslawinen aus, die von den umgebenden Bergen auf die Gletscher niedergingen. Die Zerrissenheit der Eisbrüche nahm beträchtlich zu; doch blieb die übrige Gletscheroberfläche weitgehend unverändert, mit Ausnahme des Auftretens von mehr offenen Spalten als vor dem Erdbeben.

The epicenter of the great Alaskan earthquake of 27 March 1964 occurred near Columbia, Yale and Meares Glaciers. The only expeditions to penetrate the region at the head of these glaciers in the heart of the Chugach Mountains were led by the author in 1955 and 1957 (Nielsen, 1955, 1957, 1963). This region was visited again after the earthquake on 8 June 1964 to observe what effect the earthquake may have had on the glaciers. In general the results were not as spectacular as had been expected but some definite changes were observed which appear to be significant, some of which are not discussed in other reports (Christensen and Bolt, 1964; Field and others, 1964; Grantz and others, 1964).

The most striking thing observed was the large number of rock avalanches onto the glaciers and the lack of snow on the mountain sides along the glaciers. Although spring was late in arriving in Alaska in 1964, and the snow line on the glacier surfaces was about what was expected or actually at lower altitudes than expected from previous observations for 8 June, there was much less snow on the mountains than had been observed even a month later in early July of 1955, 1957 and 1959. Apparently much of the snow along with great quantities of rock were shaken off the mountains by the earthquake. This effect is illustrated by two photographs (Figs. 1 and 2) of the head of Valdez Glacier taken in late June 1959 and 8 June 1964. After the earthquake, Mount Cashman and the other peaks on the north side of the glacier (right side of the photographs) were nearly bare of snow, while the glacier surface itself was covered with many rock avalanches. The same phenomenon was observed on Columbia, Tazlina and other glaciers near the epicenter of the earthquake.

As expected, many of the snow bridges over the giant crevasses of upper Columbia Glacier and elsewhere had fallen into the crevasses. This was especially noticeable about 25 miles (40 km.) north-east of the epicenter in the middle of Columbia Glacier, where it is broken up by a series of both transverse and longitudinal crevasses. In 1955 and 1957 the crevasses were largely covered, with only occasional holes and open crevasses. After the earthquake, many of the crevasses were no longer bridged and the rectangular block-like pattern of the crevasses was evident. These great crevasses were often 10–50 ft. (3–15 m.) across and many hundreds of yards long.

Next to the tremendous number of rock avalanches seen, the most striking change found on the glaciers themselves was the modification of the ice falls. After the earthquake, the ice

Fig. 1. Looking west up the upper 8 miles (12·8 km.) of Valdez Glacier about 25 June 1959. Mount Cashman is the last peak on the right at the head of the glacier. The peaks rise about 2,500 ft. (765 m.) above the glacier

had a powdery ground-up appearance. Even on moderate slopes the ice was all broken up and resembled the ice at the base of ice cliffs where falling blocks of ice have been thoroughly disintegrated as they fell. The earthquake must have created violent motions among the ice blocks of the ice falls; while in the uncrevassed or unbroken areas of the glaciers, the earth movements were not enough to produce noticeable changes. Apparently a smooth unbroken section of a glacier is capable of absorbing tremendous mechanical shocks without breaking up to any extent, but the weak and crevassed sections become even more broken up by the mechanical motions of the earth beneath them. Of course, it is possible in some cases that the ice falls occur across fault lines where the mechanical agitation could be especially severe.

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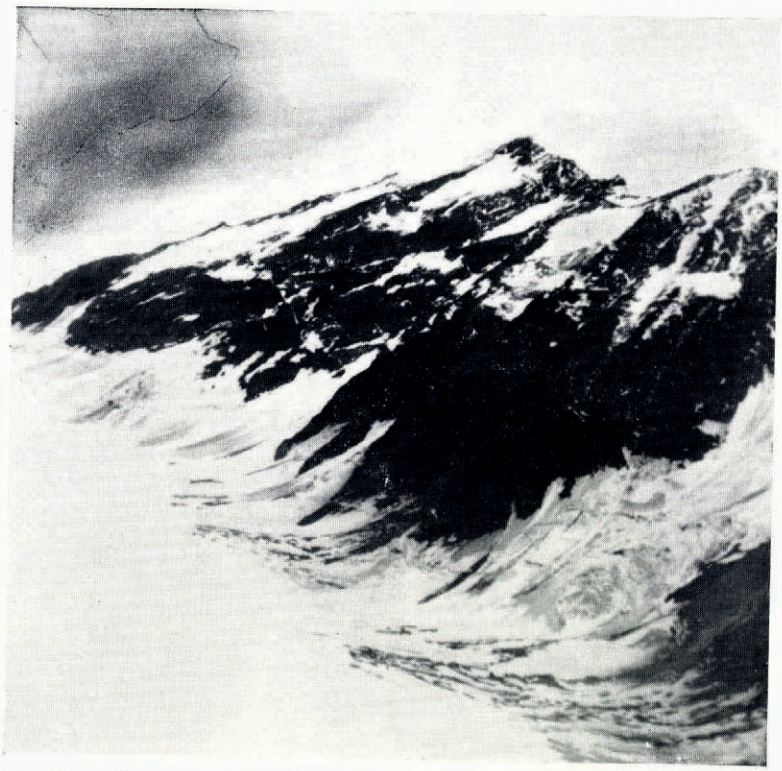

Fig. 2. View of upper Valdez Glacier as seen from the air on 8 June 1964 after the earthquake. Note the large number of rock avalanches that have fallen from the peaks onto the glacier. Mount Cashman is the peak at the head of the glacier on the right

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