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RENEWED ACTIVITY OF MULDROW GLACIER, ALASKA, AFTER THE 1956 SURGE

By A. E. Harrison

(Department of Electrical Engineering, University of Washington, Seattle, Washington 98105, U.S.A.)

Abstract. Recovery of the Muldrow Glacier in the area below the lower Muldrow ice fall is progressing at a rapid rate. About one-third of the lost ice thickness at the base of the ice fall has been replaced during the 10 years since the surge. The ice velocity in this region is apparently quite rapid, but quickly decreases down-stream and is barely detectable at McGonagall Pass, 6.5 km from the base of the ice fall. Muldrow Glacier still offers an excellent opportunity to study the recovery from a surge, and the flow of a normal wave into stagnant ice.

Résumé. *Regain d'activité du Muldrow Glacier, Alaska, après la crue de 1956.* La reconstitution du Muldrow Glacier, dans le secteur en aval de la plus basse zône de séracs est en progression rapide. Environ un tiers de l'épaisseur de glace perdue au pied de la zône de séracs a été récupérée au cours des 10 années depuis la crue. La vitesse de la glace dans cette région est apparemment très grande, mais elle décroît rapidement vers l'aval et est à peine sensible au McGonagall Pass, à 6,5 km après le pied des séracs. Le Muldrow Glacier offre encore une bonne occasion d'étudier la reprise d'un glacier après une crue, et l'écoulement d'une onde normale dans la glace stagnante.

Zusammenfassung. *Neuerliche Aktivität des Muldrow Glacier, Alaska, nach dem Ausbruch von 1956.* Die Erholung der Muldrow Glacier im Gebiet unterhalb des unteren Muldrow-Eisfalles schreitet sehr rasch voran. Ungefähr ein Drittel des Eisdickenverlustes am Fuss des Eisfalles wurde während der 10 Jahre seit dem Ausbruch wieder ersetzt. Die Eisgeschwindigkeit in diesem Gebiet ist offensichtlich recht gross, nimmt gletscherabwärts aber schnell ab und ist am McGonagall Pass, 6.5 km vom Fuss des Eisfalles entfernt, kaum noch wahrnehmbar. Der Muldrow Glacier bietet noch immer eine ausgezeichnete Gelegenheit, die Erholung von einem Ausbruch und den Übergang einer normalen Welle in stagnierendes Eis zu untersuchen.

Stagnation of glaciers following a surge has been reported by a number of observers. (Sheldon, 1930; Moffit, 1942; Post, 1960; Dolgushin and others, 1963; Harrison, 1964.) The descriptions of stagnation by Tarr and Martin (1914) are classical and the advances by Alaskan glaciers they observed between 1906 and 1910 are now known to have been surges, (Post, 1965; Harrison, 1966) although Tarr and Martin considered and rejected that explanation. Whether the ice in a stagnant glacier is virtually motionless, or merely moving quite slowly, has not yet been determined. The portion of the Muldrow Glacier below the zone recovering from the 1956 surge offers an excellent opportunity to verify this point.

During the recovery period following a surge, when the ice reservoir is being re-filled, it is anticipated that the ice would at first be stagnant, then be re-activated, with the zone of renewed motion moving down the glacier. Observations by an expedition to McGonagall Pass (Fig. 1), to determine whether the ice at that point had moved since 1957, led to the conclusion that the boot-shaped debris pattern opposite the Pass in Figure 2 was still motionless, with a possible error of 18 m (Harrison, 1967). However, the ice thickness at Gunsight Pass had increased an estimated 30 m and there was some indication that ice flow had reached a point midway between Gunsight and McGonagall Passes.

More recent data, based on photogrammetric comparison of 1967 photography by Austin Post of the U.S. Geological Survey with pictures taken for the I.G.Y. in 1957 by the U.S. Navy, indicate that the two surface-debris patterns at point A in Figure 2 have moved 48 m since 1957 with a possible error of ± 6 m. The location of the boot-shaped debris pattern was difficult to define accurately but it had apparently moved about the same amount during the same interval. This inability to define the position of the boot pattern may explain why its movement was not detected by visual observations in 1966. It is not known whether the movement at these two locations has occurred only during the last few years, or whether the ice has moved slowly throughout the entire 10 year period.

A movement of 150 m was estimated at point B, 3.7 km from McGonagall Pass. This point is in the area where renewed ice flow was suspected in 1966. The movement at point C, 4.2 km from McGonagall Pass, was about 500 m. Debris patterns in the 1967 photographs had been noticeably compressed compared with the 1957 photographs. Measurements at Gunsight Pass could not be made because Post's stereo coverage did not extend to this region of the glacier.

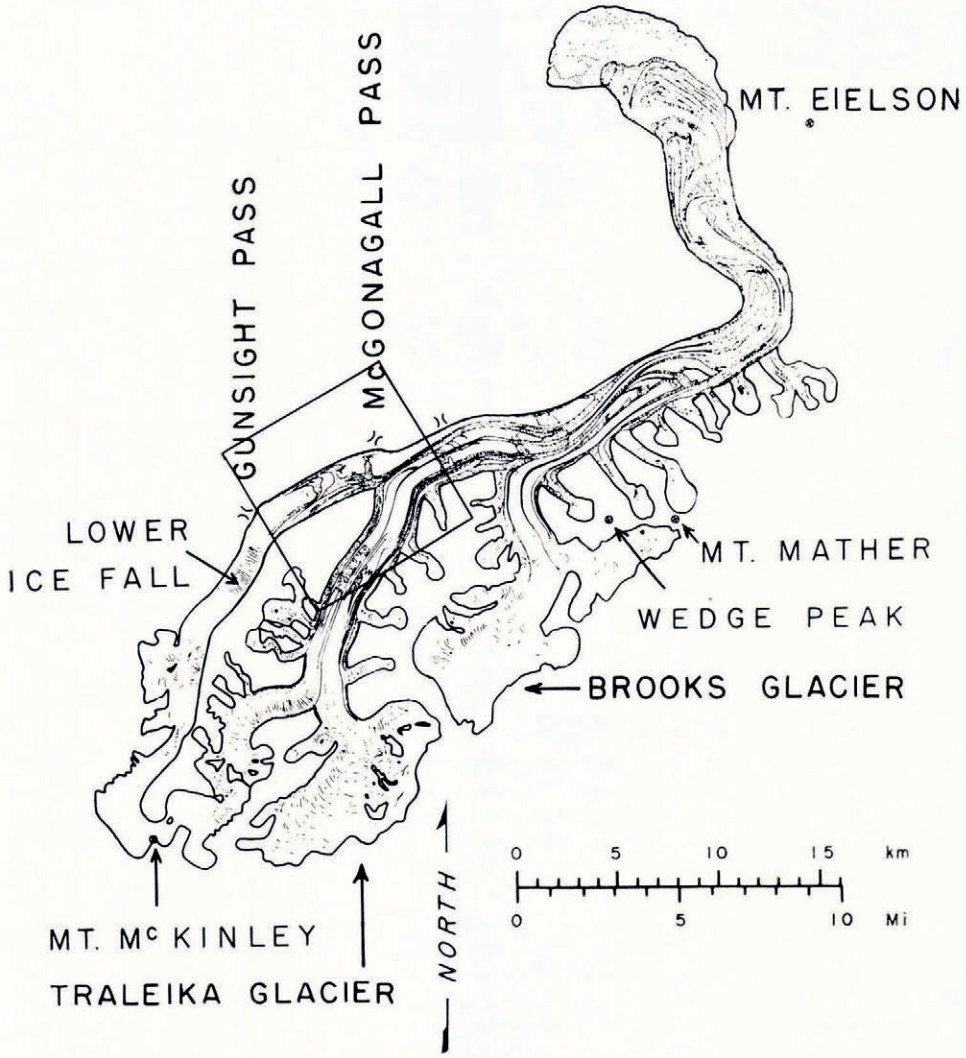

Fig. 1. Map of Muldrow Glacier, Alaska, showing area included in photograph in Figure 2.

The movement decreases rapidly down-stream because the velocity gradient is negative and motion begins later due to the time lag in the arrival of the wave advancing through the ice. This behavior is to be expected during the recovery period following a surge. The movement is probably much greater than 50 m/year at Gunsight Pass, where the ice level has risen about 30 m since 1957. This increase in thickness at the Pass corresponds to the replacement of a third of the ice removed during the surge.

Evaluation of the other 1967 photographs to determine whether the ice in the 39 km of Muldrow Glacier below McGonagall Pass is still stagnant would be highly desirable. Movement in the vicinity of the tributary from Mt Mather should be checked. This program would also provide quantitative data on the mobility of stagnant ice, or prove that movement is too small to be detected. Continued study of the entire Muldrow Glacier system will provide valuable information on ice flow. High-altitude stereo coverage of Muldrow Glacier should be repeated, including the Brooks Glacier, Traleika Glacier and the

Muldrow Fork above Gunsight Pass, in order to record conditions during this stage of the recovery period. Repetition of stereo photography after intervals of a few years would provide invaluable information on the progress of a normal wave moving into stagnant or less active ice.

Fig. 2. Aerial photograph of McGonagall Pass and vicinity on 5 September 1957, showing debris patterns used in measuring movement of Muldrow Glacier (U.S. Navy photograph for I.G.Y.).

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