

The Editor,  
*The Journal of Glaciology*

SIR, *Internal Moraines and Rock Glaciers*\*

On reading J. G. McCall's important study of a cirque glacier (*Journal of Glaciology*, Vol. 2, No. 12, 1952, p. 122), I think that what he calls "the sole," a debris-laden layer 30 cm. thick, is really the deep moraine. It seems well established that internal moraines are really debris-laden layers (Robert P. Sharp, *Journal of Glaciology*, Vol. 1, No. 4, 1948, p. 182).

Most of the glaciers in the Juncal group (Andes of Santiago), have debris-laden layers extending upwards from the bottom for over a quarter, a half, or even more of the thickness of the glacier. The study of the Juncal Sur Glacier shows that it is neither a layer of dead ice, nor a glacier on which another one is superimposed. This glacier advanced in 1949, flowing over four cliffs 600 m. high in total, and causing a jumble of seracs. The debris-laden ice appears on the higher cliff, on both sides of the system of seracs, and around the small "piedmont glacier" formed at the foot of the cliffs. On the higher cliff it constitutes one-third of the thickness of the glacier.

I should be very glad to know whether analogous phenomena have been observed in other countries. In the references which I have found (W. H. Ward, *Journal of Glaciology*, Vol. 2, No. 11, 1952, p. 11, for instance), the author spoke of clean and active ice slipping over dirty and dead ice. Was there no evidence that the two layers had moved together at some time?

I suppose that in this region, where glaciers have rarely completely laid bare a friable rock (porphyrite), the fragments become incorporated in the glacier ice over a considerable depth and flow with it. It is only in the alpine type of glacier, with a strong flow which has swept a hard bed bare, that this deep layer has almost disappeared.

In an overflow of the Olivares Beta Glacier to the west (Ventisquero Colgante del Cerro Negro), now motionless, the debris-laden stratum extends downwards from the top, at an altitude of 4600 m. The clean layer has retreated from about 3400 m. to about 4100 m. during the past 30 years. In its place lies a glacier, wholly covered with detritus, coming from the melting of part of the deep moraine. From a distance this masked glacier resembles a typical "rock glacier," of which many are found in the area. Although in varying stages of development, they all seem to have the same origin.

The debris is disposed in corrugated planes, almost parallel to the ground, and seems to have been caught up from the ground. (In a wholly covered glacier, the Mono Verde West Rock Glacier, I was able to examine the earth, which filled a slip plane, in detail.) The fact that McCall did not discover any rock flour in the debris can be explained by Boyé's theory that corries are broken up in periglacial conditions. Rock flour comes next, from the rubbing of the debris-laden ice on the bed rock.

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\* Professor R. F. Flint describes a rock glacier as follows:

In form it resembles a small valley glacier; its distal area is marked by transverse concentric ridges, and it heads in a cirque. It consists of ragged, angular nonsorted rock fragments, many of them very coarse, derived from the walls of the cirque. In some rock glaciers interstitial ice is present as a cement between the rock fragments.—*Ed.*

SIR, *The terms "Névé" and "Firn"*

I see that in Mr. M. M. Miller's letter in the November 1952 issue of the *Journal*, page 150, the definition of firn suggested by the Committee on Snow Classification of the International Association of Scientific Hydrology is as follows:

"old snow which has outlasted one summer at least (transformed into a dense heavy material as a result of frequent melting and freezing)."

If the words in brackets are to be considered part of the definition this will be a mistake. It may be true that in the Alps and most mountain regions firn is formed from snow in this way, but the greater part of the firn of the world, i.e. in the interior of polar ice caps, has never been subject to melting and freezing but is transformed "into a dense heavy material" by pressure and recrystallization only. It seems to me, therefore, that the suggested definition will lead to confusion. I would either omit the