Under the insulating layer of firn, the line of zero rock temperature will be somewhat higher—possibly at 3100 m. From here, downhill, the increasing thickness of the firn layer and the heat of the Earth will have the effect that a fluid-plastic deep-lying layer is very easily possible. From 3100 m., uphill, the ice remains rigid and adheres firmly to the cold rock. At the surface, however, a downhill movement of 35 m. per annum was measured. This movement is a consequence of the increasing thickening of the granular substance of the firn on an inclined base, and also of the withdrawal of ice on the downhill side where the plastic deep-lying layer moves on.

If similar soundings could be made much lower down on the Jungfraufirn instead of in the neighbourhood of the Joch, the results would certainly be different. The measurements of Haefeli and Kasser [4] on the middle of the Aletsch Glacier and in galleries in other glaciers, have confirmed the existence of plastic ice layers.

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DEFORMATION OF A VERTICAL BORE HOLE IN A PIEDMONT GLACIER

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The well-conceived and nicely executed British plans for measurement of velocity distribution along a vertical profile in the Jungfraufirn [1, 2] provided inspiration and guidance for a similar experiment in the Malaspina Glacier, Alaska. A repetition of the earlier experiment seemed desirable because it was not entirely certain that the Jungfraufirn provides the best conditions for extrusion flow,[3, 4] the concept it was desired to test. The Malaspina Glacier appears to offer conditions ideally suited for extrusion flow. It is a piedmont glacier, a sheet of ice with gentle surface slope, covering more than 1000 square miles on the flat coastal plain of southern Alaska. From seismic reflections, the glacier's floor is known to slope northward toward the mountains in opposition to the southward flow of ice.

In the summer of 1951 a vertical hole approximately 5 cm. in diameter was bored to a depth of 305 meters near the center of the glacier by an electrically heated hot-point. Boring stopped at this point because the hot-point ceased to function. The glacier at this point is 595 meters thick, its surface slopes southward at 6·6 meters per kilometer, and its floor, 183 meters below sea level, slopes gently northward. The bore hole was cased with aluminum pipe, 3·5 cm. inner diameter and 4 cm. outer diameter.

Orientation of the pipe was determined by a small-diameter inclinometer, kindly loaned free of charge by the Parsons Survey Company of South Gate, California. This instrument gave reproducible measurements of inclinations accurate to 0° 05′, and of bearing accurate to 2° or 3°. Readings were made at 15-meter intervals. Curve A (Fig. 1, p. 183) shows the initial orientation of the pipe, projected on to a vertical plane bearing S. 25° E., the direction of flow as inferred from structures in the glacier. A resurvey 3½ weeks later showed no perceptible deformation.

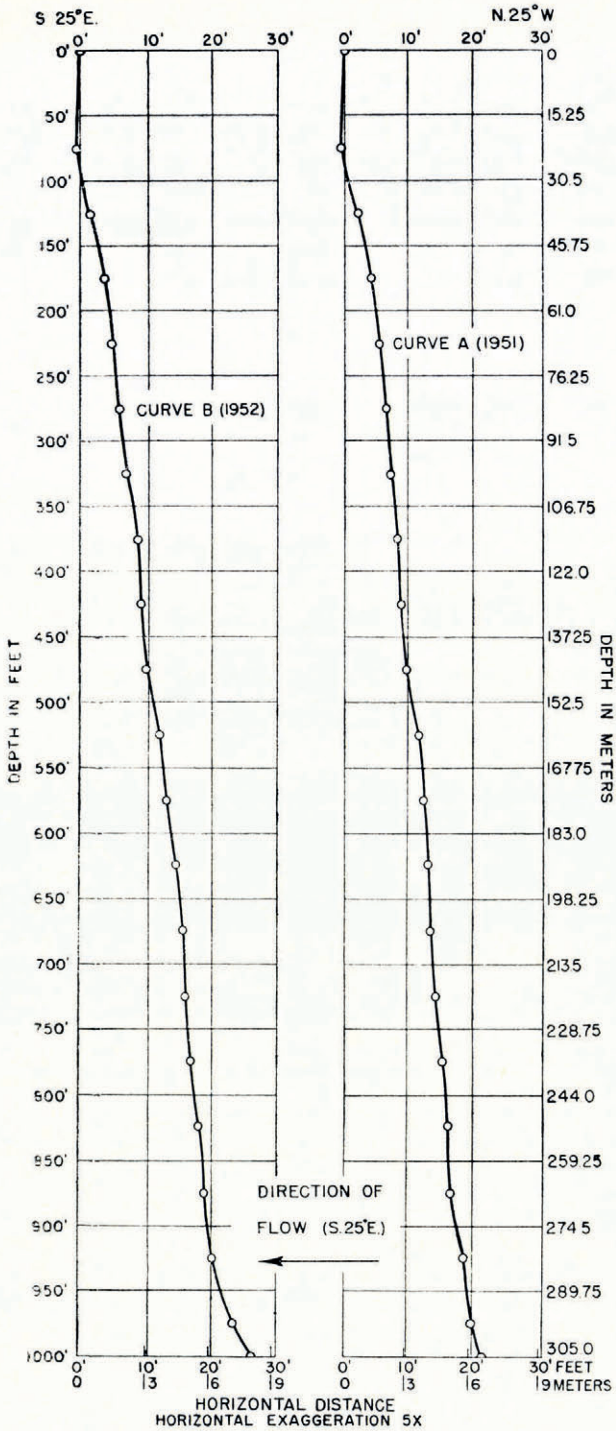

Fig. 1

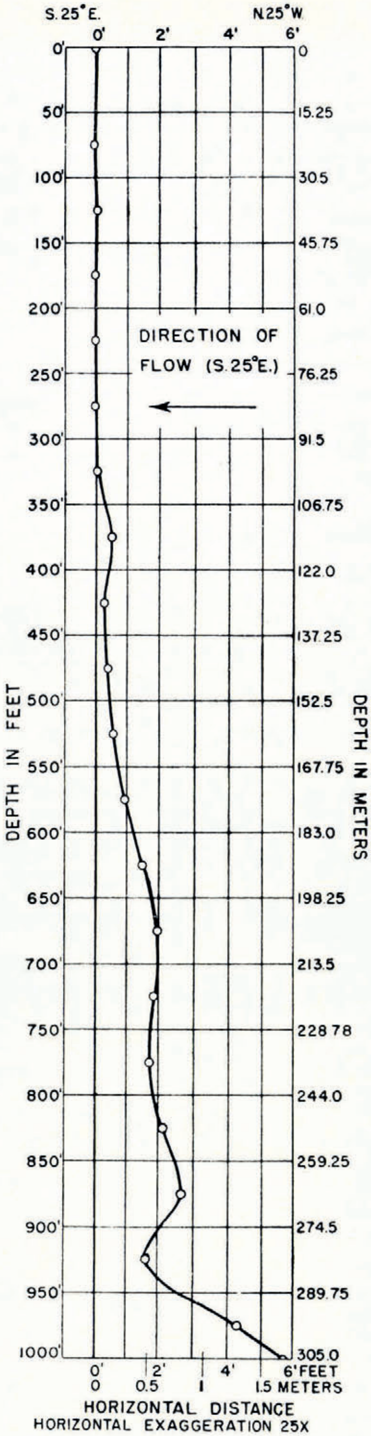

Fig. 2

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Orientation of the pipe one year later, in August 1952, is shown by Curve B (Fig. 1). Deformation during this interval is more easily seen if plotted against a straight vertical line (Fig. 2). During the first year no perceptible differential flow occurred in the uppermost 90 meters of the glacier. Below that depth flowage was slight but at a relatively uniform rate except for some irregularity and a small acceleration below 275 meters. Total differential flow between the top and bottom of the 305-meter pipe was only 1·75 meters. The absolute amount of flow is not known, for the test site is too far from fixed triangulation points to permit such a measurement.

The deformation is, as yet, too slight to permit firm conclusions as to the mode of flow in this sheet of ice, and further observations of the pipe will have to be made in subsequent years. The results to date do not support the concept of extrusion flow. Deformation of the pipe suggests that flowage occurs more readily at depth than close to the surface, as might be expected, but the surface ice appears to be carried along by the flowing ice beneath in a manner contrary to the mechanism of extrusion flow.

The possibility of extrusion flow below the depth of the bore hole cannot be wholly eliminated, because of the small magnitude of differential flowage recorded so far, but it seems unlikely because extrusion flowage would entail a reversal in direction of the present source.

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THE ANTARCTIC PACK ICE IN WINTER

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Abstract. A summary of the winter conditions at the edge of the pack ice around Antarctica, as observed on 16 occasions by the R.R.S. *Discovery II* between 1932 and 1951, is followed by a more detailed account of each visit. The state of the ice on the northern fringe of the pack is noted especially with reference to the various stages in the formation of pack ice. Detailed reference is also made on each occasion to the meteorological conditions obtaining not only during the ship's stay on the ice edge but for 2 or 3 days beforehand. Despite the limited number of observations possible it would appear that the state or condition of the ice edge, at any one point in winter, is largely dependent on local weather conditions, and it is suggested that, basically, the condition of the ice edge falls into three or, possibly four main categories.

Attention is drawn to the possible relationship between the sea surface temperature and the condition of the ice on the fringe of the pack but it is considered probable that the surface temperature has a greater effect on the distribution of pack ice generally, rather than on the state of the ice edge locally.

Zusammenfassung. Einer Zusammenfassung der Winterzustände am Rande des Packeises um die Antarktis herum, wie sie bei 16 Gelegenheiten von den R.R.S. *Discovery II* zwischen 1932 und 1951 beobachtet wurden, folgt ein ausführlicherer Bericht jedes einzelnen Besuches. Bei jeder Gelegenheit wird auch eingehend auf die meteorologischen Bedingungen hingewiesen, die nicht nur während sich das Schiff um die Eisränder aufhielt erhalten wurden, sondern auch für 2 oder 3 Tage vorher. Trotzdem nur eine begrenzte Anzahl von Beobachtungen möglich war, scheint es, dass die Beschaffenheit des Eisrandes zu jeder Zeit im Winter hauptsächlich von lokalen Wetterbedingungen abhängt, und es wird vorgeschlagen, dass die Beschaffenheit des Eisrandes grundlegend in drei oder möglicherweise vier Hauptkategorien zerfällt.

Es wird auf das mögliche Verhältnis zwischen der Temperatur der Seeoberfläche und der Beschaffenheit des Eises am Rande des Packeises aufmerksam gemacht, aber es wird als wahrscheinlich angenommen, dass die Oberflächentemperatur eher einen grösseren Einfluss auf die Verteilung des Packeises im grossen und ganzen hat als auf die Beschaffenheit des Eisrandes lokal.