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OBSERVATIONS OF INNER MORAINES NEAR THE TERMINUS OF McCALL GLACIER IN ARCTIC ALASKA AND LABORATORY EXPERIMENTS ON THE MECHANISM OF PICKING UP MORAINES INTO A GLACIER BODY

(Abstract only)

by

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ABSTRACT

A number of moraine-covered ice hills 1 to 2 m in height, 3 to 5 m in major axis, and 2 to 3 m in minor axis (referred to as moraine-hills for convenience) were found sporadically on the ice surface near the terminal margin of the lobe of McCall Glacier, a subpolar glacier in Arctic Alaska, during our observations made in the summers and early falls of 1971 and 1972. The thickness of a moraine layer covering an ice hill was of the order of 0.3 to 0.5 m; the moraine was mostly composed of sand and silt with a small amount of rounded pebbles.

More than ten conformal arc-shaped thrust faults, convex down-glacier, with an interval from 20 to 30 m were also found on the ice surface, 150 to 300 m away from the terminus of the glacier. It was noted that these thrust faults were associated with the moraine-hills; hence, all the moraine-hills found in the area were located along the thrust faults. This strongly suggests that these moraines had been transported by shear action along thrust planes in the ice body from the bed to the upper surface of the glacier.

Crossing the thrust faults, a supraglacial stream 3 to 5 m in depth had formed, in which melt water from the ablation area was flowing. On the vertical wall of the stream, a large number of inclined dense dirt layers were observed along shear planes; they were parallel to one another and from 50 to 100 mm apart. Blocks of dirt ice samples were cut out from the wall of the stream so that the fine structure and texture of the dirt ice could be investigated in detail; the inner moraines contained in them were also collected for microscopic examinations. The results showed that the moraines were mostly composed of sand and silt. It is, therefore, most unlikely that such fine particles were formed by scraping of rocks from the glacier bed, because rounded sand and silt are usually formed by grinding action in a turbulent stream flow. Hence, it may be assumed that they have been formed in a subglacial stream.

Meanwhile, an ice tunnel was found extending deep into the glacier from the terminus along the bed of the glacier, in which a subglacial stream was running. The water flow of the stream decreases markedly with the onset of winter, giving access to the inside of the tunnel, so a reconnaissance was made inside the tunnel near the entrance in the autumn of 1971. Deposits on the bed of the glacier and the stream were examined, and it was found that large amounts of sand and silt existed among rounded-shaped rocks on the greatly smoothed surface of the bed. The sand and silt must be the origin of the inner moraines found along the thrust planes and of the moraine layers covering the ice hills on the glacier surface.

There has been much argument by earlier workers about the mechanism of formation of inner moraines near the edge of a cold ice cap. Theories and models such as a shear hypothesis (Chamberlin and Salisbury 1904: chapter 5) and a freezing model (Weertman 1961) have been proposed, but no definite conclusion has been reached.

A series of simulation experiments were conducted in a cold laboratory in order to study the mechanism of formation of inner moraines in a glacier. To simulate a glacier, ice was confined between two parallel solid planes inclined at a small angle, the top surface being smooth and the bottom surface irregular with various protuberances. A small amount of sand was placed at the interface between the bottom surface and the ice, and pressure was applied to the ice along the inclination perpendicular to the parallel line of the two planes. Movements of sand particles accompanying the ice flow over the uneven bottom surface were observed at 0°C under a microscope; 16 mm time-lapse motion pictures were also taken for observation of detailed processes in which sand particles were picked up into the body of ice and inner moraine layers were formed. The observations disclosed that sand particles were carried into the body of the ice at the top of a protuberance to form moraine layers and were further transported obliquely upward by shear action along shear planes.

REFERENCES

Chamberlin T C , Salisbury R D 1904 *Geology. Vol 1. Second ed. revised.* New York, Henry Holt

Weertman J 1961 Mechanism for the formation of inner moraines found near the edge of cold ice caps and ice sheets. *Journal of Glaciology* 3(30): 965-978