

(3) Under the same conditions of wire diameter and load, the velocity only showed a difference of a factor or two in spite of changes in thermal conductivity of the wire by more than a thousand times. These small differences of velocity when compared to thermal conductivity may be explained by the surface roughness, flexibility of the wire, and other physical properties of the interface.

(4) A thin wire moved faster than a thick wire even if the same pressure was applied. Under constant load, the velocity decreased as  $R^{-n}$  where  $R$  is the radius of the wire and  $n$  takes a value between 1.3 and 2.

These four effects suggest strongly that plastic deformation is responsible as they cannot be understood by the classical theory of regelation. However other observations show that we cannot completely give up the classical theory.

(5) Many cracks occurred in the ice in front of the wire and then filled by melt water, and melt water moved upwards around the wire in places. If dyes were dropped on the top surface of ice, coloured water diffused to the rear of the wire. These observations give fine evidence of the existence of melt water.

(6) Different weights were hung on each end of the wire and the weight difference at which the wire started to slide horizontally was determined. Friction coefficients of  $c$ . 0.001 for nylon and 0.01 for copper were obtained. The coefficient for silk string, however, was extremely high so that the string could not move even though string showed regelative movement as compared to nylon.

It may be concluded that part of the regelation occurred by plastic deformation although the classical theory cannot be completely abandoned as a mechanism of regelation.

## GLACIER-BED LANDFORMS OF THE PRAIRIE REGION OF NORTH AMERICA

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**ABSTRACT.** Two major types of terrain that formed at or near the bed of Pleistocene continental ice sheets are widespread throughout the prairie region of Canada and the United States. These are (1) glacial-thrust blocks and source depressions and (2) streamlined terrain.

Glacial-thrust terrain formed where the glacier was frozen to the substrate and where elevated pore-water pressure decreased the shear strength of the substrate to a value less than that applied by the glacier. The marginal zone of ice sheets consisted of a frozen-bed zone, no more than 2 to 3 km wide in places, within which glacial-thrust blocks are large and angular. Up-glacier from this zone, the thrust blocks are generally smaller and smoothed. Streamlined terrain begins 2 to 3 km behind known ice-margin positions and extends tens of kilometres up-glacier. Streamlined terrain formed in two ways: (1) erosion of the substrate as a consequence of basal sliding in the sub-marginal thawed-bed zone and (2) erosional smoothing accompanied by emplacement of till in the lee of thrust blocks where they were deposited and subsequently exposed to thawed-bed conditions as a result of further advance of the glacier.

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## EROSION OF GROOVES BY SUBGLACIAL MELT-WATER STREAMS

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**ABSTRACT.** The shape of the former Laurentide ice sheet in what is now northern Ohio and southern Ontario is calculated and the subglacial hydrological potential field computed. Subglacial water flow is found to be concentrated over high points in the bed, such as what is now Kelleys Island in Lake Erie. Some  $10^{10}$  litres of subglacial melt water per year passed over Kelleys Island.

It is argued that the "glacial" grooves on Kelleys Island are subglacial melt-water channels. Assuming that the subglacial melt water attained saturation with respect to  $\text{CaCO}_3$  in passing over the limestone of Kelleys Island, the material formerly occupying the grooves could have been dissolved in  $10^2$  years. This is a much shorter time than glacier occupancy and the assumption of chemical equilibrium is not critical.

The features on Kelleys Island are fluted valleys about 6 m across and each flute is about 0.1 m in width. Each flute represents a subglacial channel but only one or two of these channels operated at any one time. Blockages, perhaps caused by basal debris, caused the rivers to make minor course changes and in many instances it is possible to determine the order of channel occupancy. The channels were striated after abandonment by water when moving basal debris or debris-laden ice occupied the channels. From the Gauckler-Manning formula and the potential gradient obtained from the ice-sheet model the river velocity is calculated to be about  $4 \text{ m s}^{-1}$ , in rough agreement with the water flux calculated earlier.

The grooves support the concept that subglacial water flows in "Nye" channels, and raise the suggestion that subglacial erosion by solution is of widespread importance.

## DISCUSSION

C. R. BENTLEY: In producing the surface elevations for your reconstructed ice sheet you have apparently integrated the expression for  $dE/dl$  down-stream so that there is no up-stream expression of Kelleys Island. If you approached from down-stream instead you would, I