INSTRUMENTAL OBSERVATIONS OF FROST CREEP AND SOLIFLUCTION IN A PERMAFROST ENVIRONMENT

A. L. Washburn, Professor of Geology, Yale University, New Haven, Connecticut.

ABSTRACT

The following conclusions are based on theodolite observations of lines of targets at Mesters Vig, Northeast Greenland (*). The lines were controlled by end points on bedrock, and target movement was measured with respect to the vertical plane through the end points. Most of the experimental sites were on stony loam. At these sites:

(1) Frost creep and gelifluction (solifluction associated with frozen ground) can be quantitatively distinguished from each other.

(2) The average magnitudes of frost creep and of gelifluction tend to be similar, but locally one or the other may predominate.

(3) On a slope of 11° to 15 1/2° the combined rate of movement by gelifluction and creep ranged from 0 cm/yr to 6 cm/yr.

(4) Moisture exerts a dominant influence on rate of movement for both frost creep and gelifluction, and is far more important than presence or absence of vegetation, as shown by the fact that the greatest movement is in the generally wettest sections of the experimental sites regardless of presence or absence of vegetation.

(5) In the wettest sections, the average rate of frost creep and gelifluction combined is probably roughly proportional to slope gradient.

(6) There appears to be a boundary condition, determined by moisture, above which gelifluction is active and below which it is negligible. The range of this condition approximates the range of the Atterberg liquid limit for mineral soil at a depth of 20-50 cm.

(7) Frost creep is almost entirely due to annual, rather than diurnal freeze-thaw cycles.

(8) A retrograde movement with respect to the vertical reference plan is common during summer and lessens downslope movement. This movement is mainly the result of desiccation and reflects a tendency of the thawed layer to settle back against the slope, as originally reported by Davison in 1889 (Geol. Mag., Decade 3, v. 6, p. 255-261). It seems probable that capillary pressure is an important factor in this movement.

The above conclusions reflect conditions at the experimental sites. However, at least (1), (4), and (8) are believed to be much more widely applicable. Also, it follows from (8) that creep due to wetting and drying in any environment is probably less per cycle of volume expansion and contraction than is commonly supposed, for, with a few notable exceptions, it seems to be generally assumed that such creep involves purely vertical settling.

(*) Cf. Geol. Soc. America Spec. Paper 68, p. 292.