Geophysical Research Abstracts, Vol. 8, 01087, 2006
SRef-ID: 1607-7962/gra/EGU06-A-01087

Deformation of subglacial sediment by ploughing: implications for glacier dynamics

M. Rousselot[1], U.H. Fischer[2]

[1] Versuchsanstalt für Wasserbau, Hydrologie und Glaziologie, Eidgenössische Technische Hochschule, ETH-Zentrum, CH-8092 Zürich, Switzerland
[2] Antarctic Climate and Ecosystems Cooperative Research Center and Australian Antarctic division, GPO Box 252-80, Hobart, Tasmania 7001, Australia
marie.rousselot@ethz.ch

For soft-bedded glaciers, deformation of the substrate can contribute considerably to the overall motion of the glacier. Depending on the amount of basal shear stress transmitted across the ice–bed interface, deforming beds may be involved in ice flow instabilities such as glacier surging or fast ice streaming. The hydromechanical factors that control the basal shear stress resisting the flow of soft-bedded glaciers are however poorly understood. In particular, the process known as ploughing, where clasts that protrude into the glacier sole are dragged through the upper layer of the sediment, remains largely unexplored.

A new laboratory device of large dimensions was developed and constructed to study under realistic subglacial conditions the factors that control the shear stress resisting the motion of ploughing clasts at the base of a glacier. In this device, an instrumented tip is dragged at different velocities through water saturated glacial sediment subject to different normal effective stresses. Results of ploughing experiments that where performed using sediment from Unteraargletscher, Switzerland, show that pore pressures above and below the hydrostatic level develop around the tip and that their absolute magnitude increases with the ploughing velocity. The shear stress on the tip is independent of the velocity but scales with the applied normal effective stress, indicating that the sediment behaves as a Coulomb plastic material. The results, when compared to those of other studies of clast ploughing, suggest that significant sediment weakening in front of ploughing clasts may depend on the relative magnitudes of excess pore pressure generated by sediment compression and pore pressure below the hydro-

static due to dilatant shearing. For typical glacier velocities and sizes of ploughing clasts, these magnitudes are governed by the diffusivity and the density of the sediment, respectively. Therefore, depending on the dominant pore pressure response of the deforming sediment, clast ploughing may have the potential to either trigger ice flow instabilities or stabilize glacier motion.