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Field observations of subglacial processes beneath an Antarctic polythermal glacier

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This paper reports observations and measurements of ice structure and deformation made in two tunnels excavated into the margin of Taylor Glacier. The excavations reveal a complex, rapidly deforming 4.5 m-thick basal ice sequence. Measurements conducted over a year demonstrate that about 55% of glacier surface velocity can be attributed to deformation within the debris-rich basal ice. Strain measurements show that the highest strain rates occur in ice with the highest debris concentrations (26% by volume) and the lowest strain rates occur in clean ice that has a meteoric origin and very low debris concentrations (<0.02%). Deformation within the basal ice sequence is achieved by folding which results in shortening of the debris-bearing ice followed by attenuation of the folds due to the progressive simple shear which generates predominantly laminar structures. Displacement measurements, together with the occurrence of cavities and slickenslides, suggest that 15% of glacier motion is achieved by sliding at structural discontinuities within the basal zone even though the basal temperature is -18°C. The combination of high debris concentrations and high strain rates in the debris-bearing ice means that material transported in the basal ice is exposed to a high rates of abrasion which produces heavily striated and facetted clasts typical of temperate glaciers even though the bed is cold. The volume of sediment carried in the basal zone is sufficient to produce a till thickness of 0.6 to 0.72 m which is similar to loads carried by many temperate glaciers.