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Subglacial hydrology as a control on ice stream shear margin locations THIBAUT PEROL, JAMES R. RICE, Harvard University, JOHN D. PLATT, Carnegie Institution for Science, JENNY SUCKALE, Stanford University — Ice streams are fast-flowing bands of ice separated from the nearly stagnant ice in the adjacent ridge by zones of highly localized deformation known as shear margins. However, it is presently unclear what mechanisms can control the location of shear margins. Within the shear margin, the transition from a slipping bed beneath the ice stream to a locked bed beneath the ridge concentrates stresses. We show that subglacial hydrology can select the shear margin location by strengthening the till within the margin. Our study uses a two-dimensional thermo-mechanical model in a cross-section perpendicular to the direction of flow. We show that the intense straining at the shear margins can generate large temperate regions within the deforming ice. Assuming that the melt generated in the temperate ice collects in a drainage channel at the base, we show that the channel locally decreases the pore pressure in the till. For a Coulomb-plastic rheology, this depressed pore pressure leads to a basal strength substantially higher than that inferred under the majority of the stream. Our results show that the additional basal resistance produced by the channel can reduce the stresses concentrated on the locked bed. Matching the model to surface velocity data at Whillans ice stream margin, we show that a stable shear margin occurs when the slipping-to-locked bed transition is less than 500 m away from a channel operating at an effective pressure of 200 kPa if the basal hydraulic transmissivity is equivalent to that of a water-film 0.2 mm thick.

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