Multiple Modes of Refreezing Meltwater beneath Ice Sheets

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Meltwater can influence ice flow by lubricating the base or by freezing-on new warm ice that changes ice sheet strength. In East Antarctica water in subglacial networks along the valleys of the Gamburtsev Mountains refreezes along the high ridge producing large bodies of basal ice. Basal ice units thicken along flow and deflect the overlying stratigraphy upward up to 1000m. In Antarctica, basal units are characterized by a upper reflector and often emerge from the bright, water-filled ice sheet bed. Basal freeze-on in the Dome A region must have persisted in the same locations through the last glacial-interglacial transition to produce the 60km long features. While the surface accumulation, surface slope and bed morphology vary on the north and south of Dome A, a quarter of the ice sheet base consists of ice freeze-on from the bottom. Similar structures are present within the Greenland Ice Sheet. In Antarctica, refrozen ice has been sampled over Lake Vostok and imaged downstream of Lake Vostok, over Lake Concordia, close to Dome C and on both sides of Dome A. In Greenland, both surface and basal meltwater refreeze to the bottom of the ice sheet producing distinct ice units up to 1100m thick. In Greenland it is clear the units consist of a core of refrozen water commonly surrounded by 100's of meters of heavily deformed ice. Beneath Petermann Glacier, Greenland refrozen ice units coincide with the onset of fast flow and continue downstream where they correspond to locations of rapid melting of the floating ice tongue. Refreezing can modify the temperature structure and rheology of an ice sheet influencing both deformation and discharge of ice into the global oceans. The basal freeze-on modifies the fundamental structure of ice sheets, thickening the ice column from the base. Inclusion of these basal processes is essential to produce robust predictions of future ice sheet change and to accurately predict the location of the oldest ice.

Free Falling