Black Rapids Glacier, Alaska—Near the Trans-Alaska Pipeline—Unexpected Behavior for a Surge-type Glacier

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Black Rapids Glacier, a surge-type glacier in the Alaska Range, most recently surged in 1937 and is currently in its quiescent phase. During several surges prior to 1937, ice crossed the Delta River and created glacier-dammed lakes, flooding areas of the Delta River valley in which the Richardson Highway and the Trans-Alaska Pipeline are presently located. Another surge is possible within the next several decades. The U.S. Geological Survey and University of Alaska Fairbanks started a monitoring program in 1970 as hazard reconnaissance research for the pipeline. Ice velocity, changes in ice thickness, and surface mass balance are measured at three to ten sites.

The behavior of Black Rapids Glacier during its quiescent phase is significantly different from that of Variegated Glacier, the only other well-studied surge-type glacier in Alaska. The ice speed at Variegated Glacier steadily increased during the 10 year period of observation prior to its 1983 surge. At Black Rapids Glacier, the ice speed has displayed fluctuations which were previously unexpected for a surge-type glacier—the annual speed increasing and decreasing by as much as 44% of the 18 year mean. The glacier was observed to be speeding up from 1979 to 1987, then slowed down from 1987 to 1991. Velocity measurements in the 1992 season again show the velocity increasing.

The internal shear stress, as estimated from the ice thickness and surface slope, did not change enough to account for the large velocity changes in terms of increased ice deformation. The velocity changes must be due to basal motion. We consider two possibilities: either changes in the basal boundary conditions—perhaps changes in the hydraulic or mechanical properties at the bed of the glacier—control the complex velocity fluctuations, or the bed of the glacier is composed of a material that is highly sensitive to changes in stress. That is, a small change in stress at the bed results in a large change in the strain rate and, hence, the ice velocity component attributable to basal motion.

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