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Ice stream basal seismicity reveal basal conditions: Siple Coast, West Antarctica

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Measurements of local and regional earthquakes made on the Siple Coast of West Antarctica (ice streams B, D, and E; now know as Whillans, Bindschadler, and MacAyeal, respectively) have been analyzed for rates, locations, and size. We find that seismicity associated with the flow of glaciers and ice streams is widely variable. In addition, the seismicity associated with a single glacier or ice stream is spatially variable. Finally, the seismicity at a location is temporally variable. As we have measured both seismicity and flow speed concurrently, we can correlate slip events (for ice stream B) or flow speed variations (for ice streams D & E) with basal seismicity.

For ice stream B, which moves by episodic stick-slip that appears to be controlled by the frictional properties of the basal zone (see papers by Winberry et al.; Bindschadler et al., this conference), the seismicity is strongly correlated to the slip events. Each slip event is associated with or causes elevated seismicity, but there is significant variability in the transfer function relating slip and seismicity. As we have established, the slip events are strongly associated with the phase of the tide (slips at high tide and on the falling tide), and here we show that the bursts of seismicity are at the same times. However, the magnitude of the seismicity burst is controlled by the slope of the spring-neap tidal cycle. During the transition from neap to spring tide, each slip event is associated with a burst of seismicity. During the spring to neap transition, the slip events are nearly aseismic. This startling asymmetry in the response of the ice stream is discussed and alternative hypotheses examined.

For ice streams D & E, the seismicity peaks during the falling tide (when the flow speed peaks), but there the similarity between the two ice streams ends. The events on ice stream D are areally more-widely distributed than the events on ice stream E. We attribute the difference in seismicity patterns to the frictional properties of the beds of the ice streams, with ice stream E having more concentrated “sticky spots” than the relatively more smooth ice stream D.