

Repeating Ruptures at David Glacier Modified by Tidal Influences

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We report on a pattern of repeating earthquakes originating from the base of David Glacier as it flows through the Transantarctic Mountains. The seismic events (with moment magnitude $M_w=1.8$) recurred regularly (approximately every 20 minutes) over a period of 275 days during 2002 and 2003. Before and after this 275-day period, the interval between events was random and irregular. The events are likely caused by an asperity beneath David Glacier that regularly releases stress accumulated by the flow of the glacier. We suggest that the change in seismic behavior is due to changes over time in debris concentration of the basal ice as relatively cleaner or dirtier ice is advected over the bedrock asperity. This results in the rheology of the ice-asperity contact also changing over time, leading to the observed seismicity patterns.

The location of the asperity resulting in the observed seismicity is approximately 55 km from the grounding line. David Glacier goes afloat and becomes the prominent Drygalski Ice tongue in the Ross Sea. The ice tongue is subject to the strong diurnal ocean tide. During the times of regular recurrence of seismicity, the inter-event time is approximately 22 minutes. Both the inter-event spacing and the magnitude of the events changes slowly over time, and are related to tidal amplitudes. There is a lag between the tidal amplitude maxima and the inter-event spacing maxima, and that phase lag is also related to the dominant tidal periods.

During periods of high tide the mean inter-event time is longest, which likely results from backpressure of the tides end loading the glacier. It is theorized that the added backpressure causes a decrease in flow velocity resulting in less displacement at the asperity as well as a longer healing period at the ice-rock interface. This increased healing results in a stronger ice-bed interface at the time of slip, which leads to higher magnitude events.