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Tidal motion found to influence Antarctic sub-glacial seismicity

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Image: National Science Foundation

(Phys.org) -- An American team of researchers has concluded that a period of rapid-succession small earthquakes in Antarctica over a several month span back in 2002-2003 was likely due to a glacier passing over some rough terrain and its periodic nature likely came about because of the impact of ocean tides. The team has published a paper describing their observations and conclusions in the journal *Nature Geoscience*.

There are a lot of seismic sensors in Antarctica, continuously monitoring the continent and its movements. Scientists have found over the years that glaciers tend to produce small earthquakes as they move over rocky protrusions. Such activity is generally random and irregular and for that reason a series of small earthquakes occurring beneath David Glacier roughly every twenty five minutes, for several months, stood out.

The researchers note that small earthquakes that occur due to glacial movement generally come about as a result of stick-slip action. The glacier encounters an obstacle that causes part of it to slow or stop until the momentum of its mass is enough to overcome the obstacle, at which point it suddenly lurches forward, causing the ground to shake a little bit. Normally such actions occur without any discernible pattern. With David Glacier however, the stick-slip shaking, recorded by the Transantarctic Mountains Seismic Experiment array under the glacier in East Antarctica (which drains into the Ross Sea) was so predictably periodic that it warranted further research.

The team identified 20,000 small earthquakes during the time frame, all coming within about 25 minutes of each other. By comparing the seismic data with other glacier slip-stick recordings, they confirmed that the shaking was due to the glacier moving over something below, rather than conditions beneath the surface of the land mass. Then they noted that the periodicity of the earthquakes matched up with ocean tides, which made sense, because scientists already know that glaciers tend to slow a very small amount during high tide (because of buoyancy) and speed up at low tide. That they say, accounts for the regularity of the earthquake activity during the time period under study.

The researchers say their findings indicate that tidal activity likely plays a role in other glacial areas as well and suggest that it might play an additional unknown role as global warming causes a rise in sea levels around the world.

More information: Motion of an Antarctic glacier by repeated tidally modulated earthquakes, *Nature Geoscience* (2012) doi:10.1038/ngeo1555

Abstract

Between debris-laden glacial ice and bedrock, basal seismicity can develop that yields information about bed properties1, stress distribution, outburst flooding, and crevassing and calving. Basal seismicity in response to glacial motion is linked to variations in both stress and lubrication of bedrock by water and till. Here we analyse data from the Transantarctic Mountains Seismic Experiment array in 2002–2003 to investigate seismic behaviour at David Glacier, a large outlet glacier that drains 4% of East Antarctica's ice sheet into the Ross Sea. We identify about 20,000 seismic events that are larger in magnitude and duration than typical for glacial sources and repeat at regular intervals of about 25 min. These events are consistent with stick–slip behaviour of debris-laden ice moving over a single obstacle of rough bedrock, modulated by relatively small stress changes from the ocean tides. In the years before and after the interval of repeating events, seismic events with irregular and generally longer intervals were detected at the same location, and are consistent with combined stick–slip and continuous sliding of the subglacial interface. We suggest that the observed transitions in seismicity patterns capture the dynamic behaviour of the ice stream, and that—despite lower ice-flow velocities—sliding in the stick–slip regime enhances subglacial erosion.