NUMERICAL MODELLING OF ICEBERG CALVING AND IMPLICATIONS IN SEISMIC WAVES GENERATED

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Glacial earthquakes is a class of seismic events of magnitude up to 5, occurring primarily in Greenland, in the margins of large marine-terminated glaciers with near-grounded termini. They are caused by calving of cubic-kilometer scale unstable icebergs which penetrate the full-glacier thickness and, driven by the buoyancy forces, capsize against the calving front. These phenomena produce seismic energy including surface waves for $\sim$2 min, with dominant energy between 10-150 s of period whose seismogenic source is compatible with the contact force exerted on the terminus by the iceberg while it capsizes. During the capsize of the iceberg which can last typically for 5 min, the normal force applied to the calving front causes a reverse motion of the elastically compressed glacier terminus within a 500 m radius area. Once the contact is released, a terminus rebound is measured and the glacier terminus flows for few hours.

To simulate capsize events, we use a finite element model with special boundary conditions to model fluid-structure interaction (fluid pressure depending on depth, pressure and skin drags). A 2D plane strain formulation in linear elasticity is used. Contact and frictional forces are measured on the terminus and compared with laboratory experiments. We show the influence of geometric factors on the force history, amplitude and duration at the laboratory and field scales. Finally, the force inverted from seismic data is used to constrain the model and invert geometric and physical parameters as the iceberg dimensions, the local water depth, the calving front orientation or the ice-bedrock friction.
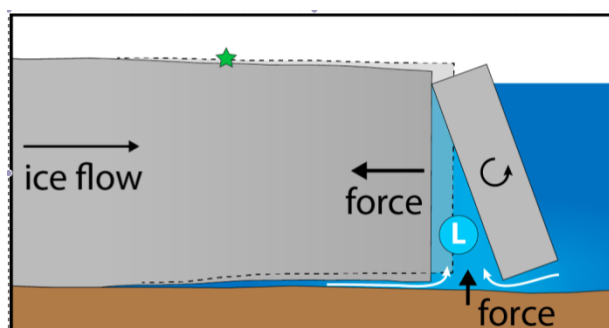
Figure 1. Cartoon of the calving sequence phenomena responsible for the generation of seismic waves. Glacier deflection caused by capsizing iceberg shown relative to initial position (dotted line). Acceleration of iceberg to right exerts a force in the upglacier direction (left), leading to reverse motion of the terminus. Reduced pressure behind the iceberg (âĂIJLâĂİ) draws water from beneath the glacier and from the proglacial fjord, pulling the floating portion of the glacier downward and exerting an upward force on the solid Earth. From Murray et al., 2015 [1].

References

[1] Murray, T., M. Nettles, N. Selmes, L. Cathles, J. Burton, T. James, S. Edwards, I. Martin, T. O'Farrell, R. Aspey, et al. (2015), *Reverse glacier motion during iceberg calving and the cause of glacial earthquakes*, Science, 349(6245), 305-308.S