Seismological Constraints on Interactions between the Solid Earth and the Antarctic Ice Sheet

Professor Douglas A. Wiens

Department of Earth and Planetary Sciences
Washington University

The influence of the solid earth on the dynamics of ice sheets has crucial implications for climate change and sea-level rise. Projections of ice sheet retreat and sea level rise are heavily influenced by solid earth properties such as basal heat flow, bed properties, lithospheric thickness and mantle viscosity. Recently installed seismic networks in Antarctica and developments in technology allowing year-round unattended seismograph operation even in the coldest regions now allow us to use seismology to investigate these interactions. We use seismic velocity maps to constrain parameters important for ice sheet models such as heat flow and mantle viscosity. Results show low mantle seismic velocities associated with late Cenozoic rift systems and areas of high topography in West Antarctica. Inferred mantle viscosity in West Antarctica is much lower than assumed in recent glacial isostatic adjustment (GIA) models, and limits the GIA sensitivity to ice sheet mass changes within the last couple of centuries. Extremely high GPS uplift rates of greater than 40 mm/yr found in the Amundsen Sea coast region can only be fit with upper mantle viscosities of less than 10^{19} Pa s. Recent modeling suggests such low viscosities may cause rapid uplift during ice sheet retreat and stabilize the ice sheet by preventing marine transgressions.

Seismic data also provides important insights into the physics governing the movement of ice sheets. For example, co-located seismographs and GPS receivers deployed on the Whillans Ice Stream allow us to obtain very broadband records of ice velocity during the twice-daily stick-slip events. These records, combined with observations of far-field Rayleigh waves, reveal that the stick-slip motion is controlled by high friction regions located along the grounding line, in much the same way that “asperities” control slip during tectonic earthquakes.

29 May 2018

11:00 a.m.

Conference Room, 3/F, Mong Man Wai Building

EARTH SYSTEM SCIENCE PROGRAMME

Enquires: 3943 9624 essc@cuhk.edu.hk