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Investigation of crystal anisotropy using seismic data from Kohnen Station, Antarctica

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The flow behavior of glaciers and ice sheets is influenced by a preferred orientation of the anisotropic ice crystals. Knowledge about crystal anisotropy is mainly provided by crystal orientation fabric (COF) data from ice cores. To gain a broader understanding about the distribution of crystal anisotropy in ice sheets and glaciers we use seismic measurements. Two effects are important: (i) sudden changes in crystal orientation fabric (COF) lead to englacial reflections and (ii) the anisotropic fabric induces an angle dependency on the seismic velocities and, thus, also recorded traveltimes. For comparisons of ice core data and seismic results we connect COF data with the elasticity tensor and, thus, determine seismic velocities and reflection coefficients for cone and girdle fabrics from ice-core data.

In the Antarctic field season 2012 we carried out a vertical seismic profiling (VSP) survey within the borehole of the EDML ice core and a seismic wideangle survey close to Kohnen Station, Antarctica. From the VSP survey we derive interval velocities and compare these velocities to the theoretically calculated velocities from COF ice-core data. The overall velocity trend derived from the ice-core data is well reflected in the VSP velocities. It shows, that the choice of the monocrystal elasticity tensor for the calculation of velocities from ice-core data is important for a good fit with the VSP velocities. For comparison of seismic data with radar and ice-core data we use stacked traces of the wideangle survey. Thus, we are able to identify COF induced reflections in both the seismic and radar data sets.