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Inferring the viscous and elastic properties of a suture zone in Larsen C

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After the collapse of its neighbours, Larsen A and B, the Larsen C ice shelf is widely considered at risk of future climate-driven instability. Recent work has shown that the ice shelf is stabilized by soft melange in its suture zones, where adjacent flow units merge. Little is known about the mechanical properties of melange however, so that the quantification of its effect on the stability of Larsen C Ice Shelf has remained challenging.

To identify the structural and elastic properties of the Joerg Peninsula suture zone in Larsen C Ice Shelf, we integrate seismic reflection and ground-penetrating radar (GPR) geophysical measurements. GPR transects reveal the presence of a stiff layer of meteoric ice, trapped between the softer melange beneath and the firn layer above. Monte Carlo analysis reveals that the seismic velocity of this melange is noticeably reduced compared to meteoric ice. By applying Hashin-Shtrikman bounds on the elastic moduli of a two-phase mixture of ice and water to the velocities, we are able to derive the elastic properties of the melange. We ascertain, significantly, that the melange is softer than meteoric ice because it contains a substantial volume fraction of water.

The meteoric ice layer is buckling due to compressive lateral stresses. We suggest this process is analogous to fold buckling in sedimentary rocks. Using the ice flow model Elmer/Ice we are able to replicate this process, and thereby derive bounds on the rheological properties of the suture zone melange.