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Seismic Constraints on the Mantle Viscosity Structure beneath Antarctica

Douglas Wiens (1), David Heeszel (2), Richard Aster (3), Andrew Nyblade (4), and Terry Wilson (5)

(1) Washington University in St Louis, Earth and Planetary Sciences, Saint Louis, United States (doug@wustl.edu), (2) US Nuclear Regulatory Commission, Washington, DC 20555, USA, (3) Department of Geosciences, Colorado State University, Fort Collins, Colorado 80523, USA, (4) Department of Geosciences, Pennsylvania State University, University Park, Pennsylvania 16802, USA, (5) Byrd Polar Research Center and School of Earth Sciences, The Ohio State University, Columbus, Ohio 43210, USA

Lateral variations in upper mantle viscosity structure can have first order effects on glacial isostatic adjustment. These variations are expected to be particularly large for the Antarctic continent because of the stark geological contrast between ancient cratonic and recent tectonically active terrains in East and West Antarctica, respectively. A large misfit between observed and predicted GPS rates for West Antarctica probably results in part from the use of a laterally uniform viscosity structure. Although not linked by a simple relationship, mantle seismic velocities can provide important constraints on mantle viscosity structure, as they are both largely controlled by temperature and water content. Recent higher resolution seismic models for the Antarctic mantle, derived from data acquired by new seismic stations deployed in the AGAP/GAMSEIS and ANET/POLENET projects, offer the opportunity to use the seismic velocity structure to place new constraints on the viscosity of the Antarctic upper mantle.

We use an Antarctic shear wave velocity model derived from array analysis of Rayleigh wave phase velocities [*Heeszel et al,* in prep] and examine a variety of methodologies for relating seismic, thermal and rheological parameters to compute a suite of viscosity models for the Antarctic mantle. A wide variety of viscosity structures can be derived using various assumptions, but they share several robust common elements. There is a viscosity contrast of at least two orders of magnitude between East and West Antarctica at depths of 80-250 km, reflecting the boundary between cold cratonic lithosphere in East Antarctica and warm upper mantle in West Antarctica. The region beneath the Ellsworth-Whitmore Mtns and extending to the Pensacola Mtns. shows intermediate viscosity between the extremes of East and West Antarctica. There are also significant variations between different parts of West Antarctica, with the lowest viscosity occurring beneath the Marie Byrd Land (MBL). The MBL Dome and adjacent coastal areas show extremely low viscosity ($\sim 10^{18}$Pa-s) for most parameterizations, suggesting that low mantle viscosity may produce a very rapid response to ice mass loss in this region.