T43B-0681: Inferring Crustal Viscosity from Seismic Wavespeeds: Applications to the Rheologic Structure of the Himalayas

Thursday, 14 December 2017
13:40 - 18:00
New Orleans Ernest N. Morial Convention Center - Poster Hall D-F

We constrain the viscosity of the lower crust through a joint inversion of seismic P-wave (V_p) and S-wave (V_s) velocities. Previous research has demonstrated robust relationships between seismic velocity and crustal composition, as well as between the composition and viscosity of the lower crust. Here we extend these analyses, showing seismic velocity can be used as a robust indicator of crustal viscosity. First, we use the Gibbs free energy minimization routine Perple_X to calculate equilibrium mineral assemblages for a global compilation of crustal rocks at various pressures and temperatures. Second, we use a rheological mixing model that combines single-phase flow laws for major crust-forming minerals to calculate bulk viscosity from the predicted mineral assemblages incorporating the effects of strain rate, temperature, pressure, and water activity. We apply our method to regional seismic and heat flow data across East Asia in order to separate the relative variations in mid-crustal viscosity associated with composition and temperature. In some regions, temperature variations are the dominant influence on viscosity; e.g., we predict a 3 order of magnitude increase in viscosity between the low heat flow Sichuan Basin and higher heat flow surrounding regions. These viscosity variations are consistent with those previously inferred to produce the different topographic gradients in these areas [1]. However in constant heat flow regions, compositional variations exert the primary influence on viscosity; e.g., the North China Craton and the Yangtze Craton are predicted to have compositionally-controlled viscosities ranging from 10^{22}–10^{23} Pa×s. Finally, the regional V_p/V_s ratios in the Tibetan Plateau cannot be explained by thermal and/or compositional variations alone, possibly indicating the presence of melt, which would lead to additional viscosity reductions.

[1] Clark & Royden, Geology, 2000.

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