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Toasting the Jelly Sandwich: The effect of shear heating on lithospheric strength.

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When a material (eg. a rock) deforms by viscous or brittle processes it produces heat. Most geologists acknowledge this on an outcrop scale (eg. as frictional melts) but only rarely are this heat incorporated into geodynamic models. In this presentation we show by parallel analytical and numeric solutions that shear heating is one of the main heat sources in a deforming lithosphere. Balancing the energy (calculation frictional heating) will, in many cases complete reverse the conclusions drawn for models where this heat source is neglected. For example, deformation of strong rocks will rapidly produce so much heat that these rocks thermally weaken and thus no longer play the role the model prescribes. Using dynamic models where heat is produced, diffused and fed into rheological properties we have tested simple models of lithospheric strength, and arrives at the conclusion that models including shear heating can produce geotherms, heat flow and strength data that compares to observations on the earth. As a test of these numeric models we use a gravitational force balance of orogens, which is completely free of rock rheology assumptions (e.g. Jelly Sandwich (strong upper mantle) versus the Crème´Brulee´ (strong lower crust) lithosphere). This assumption-neutral-solution also demonstrates that the integrated orogenic shear heat production is on the order of 0.05 W/m2, which at least compares to the radiogenic heating in the same rock-column. Frictional heating thus represent a major control of the distribution of magmatism, the depth and magnitude of seismisity, pressure in the deep earth, surface and subsurface topography as well as partially controlling and driving plate tectonics.