Intermediate depth earthquakes due to grain size assisted thermal runaway: What are the odds?

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Intermediate-depth earthquakes are ubiquitous events that occur at depths between 50-300 km. Due to the pressure and temperature conditions at these depths, conventional brittle failure is unlikely and alternative rupture mechanisms have to be invoked. Among others, thermal runaway has been proposed as a potential candidate for intermediate-depth earthquake generation. However, this mechanism requires relatively high stresses that might be difficult to attain in the Earth.

A recently developed model that couples shear heating and grain size evolution has shown that the stresses needed for thermal runaway might be significantly reduced if grain size evolution of a two-phase material is taken into account. The odds of this mechanism being an important mechanism in the nucleation of intermediate-depth earthquakes are thus increased through the feedback between grain size evolution and shear heating.

Here we apply this model to the 2013 Wind River earthquake in the western US. Results indicate that for high background strain rates, grain size assisted thermal runaway is indeed a feasible mechanism that could have generated this earthquake. Furthermore, we speculate on possible settings where such high strain rates occur and present 2D models of grain size assisted thermal runaway.

Keywords: intermediate-depth earthquakes, thermal runaway, grain size evolution

