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Relative strength of the pyrope-majorite solid solution and the flow-law of majorite containing garnets.

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Even though the garnet phase is the second most abundant phase in the upper-mantle and transition-zone, no previous studies have directly measured the effect of majorite content on the strength of garnet under mantle conditions. Here we report the results of constant strain-rate and stress-relaxation experiments on garnets in the pyrope–majorite solid solution which constrain the strength of majoritic containing garnets relative to pyrope as a function of majorite content and temperature. We find that at temperatures below $650\,^{\circ}$C both pure pyrope and majoritic garnets have the same strength. Conversely, above $650\,^{\circ}$C we find that majoritic garnets are initially stronger than pure pyrope but weaken with increasing temperature and majorite content and with significant majorite contents are weaker than pyrope above approximately $800\,^{\circ}$C. We develop a flow law for the entire pyrope–majorite solid solution as a function of temperature and majorite content.

From our experimental results it is necessary that majorite is the weak phase in the transition-zone. Furthermore, the relative-weakness of majorite garnet, which dominates the mineralogy of the subducted MORB layer at transition-zone depths, further promotes thermal run-away processes as the causal mechanism for deep-focus Earthquakes.