Viscous relaxation of mineral Inclusions and its implications for reaction overstepping calculations in metamorphic rocks

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Over the recent years, Raman elastic barometry has been developed as an additional method to calculate metamorphic conditions in natural systems. A major advantage of Raman elastic barometry is that it does not depend on thermodynamic databases and classic geobarometry methods but relies on mechanical calculations. As a consequence, Raman elastic barometry offers an independent method for estimating the pressure conditions that prevailed at the time of entrapment of minerals during growth of their hosts.

The difference between the pressure calculated using elastic geobarometry and that calculated by phase equilibria methods has recently been employed to estimate the extent of metamorphic reaction overstepping in natural systems. Quantification of the latter however implicitly assumes that the rheology of the inclusion-host system is perfectly elastic. This assumption may not hold at high temperatures, where viscous creep of minerals takes place.

The amount of viscous relaxation of a host-inclusion system is a path-dependent quantity which mostly depends on the temperature-time (T-t) path followed. Here, we present examples of visco-elastic relaxation of mineral inclusions and calculate the apparent reaction overstepping which results by assuming that the mechanical system is purely elastic. Our modelling shows that host-inclusion systems that experienced large peak temperatures for long periods of time will retain inclusion residual pressures that cannot be simply related to the growth of their hosts and should therefore not be used for reaction overstepping calculations.