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Kinetics of phase transformation and Love numbers

Y. Krien and **L. Fleitout** (ENS-CNRS Paris)
laboratoire de Géologie, ENS (fleitout@geologie.ens.fr, 33144322200)

The time scale necessary for the completion of a phase transformation after imposing a pressure variation in the mantle is unknown: it may range from a few hours to a million year.

Various mechanisms affect the kinetics of phase transitions: the volume variation can only be accomodated if the matter in the surrounding mantle has time to deform. This may delay phase transformations which occur over a short pressure range. Diffusion may also retard phase transformations, in particular those affecting the pyroxene and its high-pressure phases.

Love numbers are usually computed using the 'short-term' elastic mechanical properties deduced from seismology, assuming that the mantle material stays in the same phase. If this is not true, the Love numbers characterising the radial displacement and the geoid may be affected by 10% for harmonics between 10 and 50. The strongest effects concern the tangential displacements. A phase shift is also expected for periodic loadings with the appropriate frequency.

It seems presently difficult to detect potential phase change effects in the mantle response to the annual loads revealed by Grace. On the other hand, the ratio gravity over vertical displacement associated with the post-glacial rebond (GRACE data plus GPS vertical motions) may bring some constraints on the kinetics of phase transitions.