Kinetic modeling of the coesite-quartz transition in an elastic field and its implication for the exhumation of ultrahigh-pressure metamorphic rocks

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A kinetic model of the coesite-quartz transition under an elastic field was examined. This model is applied to discuss the possible exhumation path of ultrahigh-pressure metamorphic rocks. By incorporating the model of transition kinetics into a three-shelled composite sphere model in linear elasticity, the internal stresses in coesite, quartz, and garnet shells were calculated for given external pressure (P)-temperature (T) paths. The occurrence of rupture provides a constraint on the temperature and the amount of quartz inverted from coesite at the rupture for each P-T path. Comparison of calculated results and the natural occurrence of coesite inclusion from the Dora Maira Massif, containing ~27% quartz at the rupture, enable us to constrain the possible exhumation path and possible transition kinetics. A steep decompression path with slow transition kinetics is most favorable, which is consistent with the estimated P-T path during exhumation for most UHP metamorphic rocks.