Laser Raman microspectrometry of metamorphic quartz:

A simple and effective method for comparison of metamorphic pressures

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ABSTRACT

Laser Raman microspectrometry method was applied to metamorphic quartz in quartz-eclogite, epidote-amphibolite and amphibolite facies rocks to discuss the quantitative correlation between the Raman shift and metamorphic pressure. Quartz crystals sealed in garnet and other crystals have higher Raman shift than those in the matrix. Furthermore the quartz inclusions show the Raman shift specific to the individual host crystals in eclogites (garnet ? kyanite > omphacite ? epidote). These observations imply that the residual pressures retained by quartz inclusions depend on elastic parameters of the host crystals as discussed by previous researchers. The Raman shift of quartz inclusion in garnet systematically increases with increasing metamorphic pressure in the ascending order from amphibolite, through epidote-amphibolite, to quartz-eclogite facies. Calibrations based on the experimental works suggest that the measured frequency shifts signify residual pressures of 0.1, 0.3-0.4 and 0.7-0.8 GPa for these three groups of metamorphic rocks, respectively. Normal stresses (internal pressures) of quartz inclusions in garnet numerically simulated adopting an elastic model and inferred pressure-temperature conditions at peak metamorphic stage are compatible with the residual pressures estimated based on the Raman frequency shifts. Laser Raman microspectroscopic analysis of quartz is a simple and effective method for (1) comparison of pressure conditions in metamorphic rocks formed under various P-T conditions, and (2) detection of higher-pressure signature in metamorphic rocks extensively recrystallized during the subsequent exhumation and hydration stage.