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ラマン二酸化炭素密度計を用いた圧力推定

Pressure estimation using Raman CO2 densimeter

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Density of CO_2-rich fluid inclusion in crustal and mantle rocks can be regarded as an indicator of the original pressure condition if it is assumed that the mass of fluid is conserved within the mineral capsule. CO_2Raman densimeter using a wavenumber interval of Fermi diad bands (delta value) is applicable to such geological samples. However, there are spectroscopic and geological problems for an accurate and precise estimation for the original conditions.

Recent studies evaluate these errors using natural samples and provide the methods of correction. Uncertainties in wavenumber calibration, possibly up to 0.5 cm^{-1}, can be corrected by a daily use of density standards whose delta values are calibrated for the curve of the CO_2densimeter applied. The extent of density modification during the exhumation or uplifting is probably related to the cooling rate and the stiffness of the host mineral. Small carbonate minerals are observed at the wall of CO_2-filled cavities in tectonically exhumed rocks and xenoliths in dikes. They were formed by reactions between the fluids and the host minerals. A decrease of density due to such reactions can be roughly estimated by thermodynamic calculation if the volume ratio of a carbonate grain in a cavity is known. Plastic deformation of the host minerals may have a significant effect on the CO_2density in slowly cooled samples. This is expected to cause a size-dependent density variation that might be only detectable using Raman spectroscopy with a high wavenumber resolution and a small analytical volume. If the correction for this process is needed, we have to solve an elast-plastic spherical problem as a function of time. These effects are considered to be minor and almost negligible in mafic and ultramafic xenoliths in erupted rocks.

Comparison with pressure-temperature estimation based on mineral chemistry is carried out using xenoliths in a basaltic dike. Raman CO_2densimeter gives pressure estimation 1.5-2 kbar lower than the petrological estimation of 8 kbar for a spl and pl-bearing peridotite. The discrepancy implies existence of additional factors reducing CO_2density in minerals, such as a change of the fluid composition, faceting of a cavity, and hidden effects of plastic deformation.

キーワード:ラマン分光法,二酸化炭素,流体包有物,密度標準,補正

Keywords: Raman spectroscopy, CO2, fluid inclusion, density standard, correction