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Raman spectroscopic study of garnet inclusions in diamonds from the mantle transition zone

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ABSTRACT

Raman spectra of syngenetic majoritic garnets were obtained from the Brazilian Sao-Luiz diamond suite. These garnets have a low majoritic content (<50%). Spectra were collected from (1) inclusions embedded in the diamonds and (2) inclusions extracted from the diamonds. From the latter, a clear relationship exists between the Raman spectra and the chemical analysis. All the majoritic garnets (Si > 3) have a characteristic signature in the frequency region of the SiO_4-SiO_6 stretching vibrations. This vibration gives a broad peak between 800 and 900 cm^{-1} just before an intense band (900–930 cm^{-1}) classically assigned to Si-O stretching vibrations of the SiO4 tetrahedra in all known garnets. This broad band is also present in non-majoritic garnets (Si = 3) that result from the transformation, within the diamonds, of majoritic garnets into low-pressure garnet + pyroxene intergrowths. We show that the presence of significant TiO_2 content in these normal garnets leads to Raman spectra mimicking those of majoritic garnets. The occurrence of a broad shoulder between 800 and 900 cm^{-1} as well as broad bands near 960 and 1030 cm^{-1} in the Raman spectra are no longer diagnostic features indicative of a majoritic garnet when the TiO_2 content of the garnets is high (>1 wt%) as is the case for the Sao Luiz diamonds. The full width at half maximum (FWHM) of the strong Raman mode near 910 cm^{-1} is the only reliable signature that discriminates Si = 3 from Si > 3 garnets. The frequency of the diamond Raman mode used as an in-situ piezometer shows that the actual pressure of the garnet inclusions is between 0.5 and 0.8 GPa.