

Hydroxyl in omphacites and omphacitic clinopyroxenes of upper mantle to lower crustal origin beneath the Siberian platform

MONIKA KOCH-MÜLLER,^{1,*} STANISLAV S. MATSYUK,² AND RICHARD WIRTH¹

¹GeoForschungsZentrum Potsdam Telegrafenberg 14473 Potsdam

²Institute of Geochemistry, Mineralogy and Ore Formation, Ukrainian Academy of Science, Pr. Palladina 34, Kiev-252 142

ABSTRACT

A series of clinopyroxenes from the lower crust and upper mantle beneath the Siberian platform was investigated by Fourier-transform infrared (FTIR) spectroscopy and transmission electron microscopy (TEM). The IR spectra of all our samples exhibit three groups of absorption bands at (1) 3445–3465, (2) 3500–3540, and (3) 3600–3624 cm^{-1} . Using synchrotron IR radiation, which utilizes a spot size of only $5 \times 5 \mu\text{m}$, we realized that the intensities of the absorption bands, mostly those of group 3, showed extreme variation within one crystal. TEM as well as polarized and high-pressure IR spectroscopy indicated that the OH groups that cause the bands of group 3 were not intrinsic but due to nm-sized inclusions of sheet silicates.

The intensities and peak positions of the bands of group 2 correlate with the amount of tetrahedral Al^{3+} indicating that the charge-deficient substitution of Al for Si is responsible for the bands of group 2. The intensities and peak positions of the bands of group 1 correlate with the concentration of vacancies at M2 indicating that the cation vacancies at M2 control the incorporation of hydroxyl responsible for the bands of group 1. The bands of groups 1 and 2 are caused by the same type of OH dipole, however, occurring in different structural environments.

The concentration of the structurally bound water of the omphacitic clinopyroxene is in the range from 31 to 514 ppm H_2O (by weight). Surprisingly, the lowest concentration was found in clinopyroxene, that comes from the highest pressure region, i.e., the diamond-bearing eclogite xenoliths of the Mir kimberlite pipe. The highest values were obtained in omphacites of the lower-pressure grospsydites of the Zagadochnaya kimberlite pipe and in omphacitic clinopyroxene of the lower pressure granulites of the Udachnaya kimberlite pipe, respectively. The low water content of clinopyroxene from the high-pressure region seems to be controlled by low water activity during crystallization. However, hydrogen loss during the uplift cannot be ruled out.