DEPENDENCE OF WATER CONTENT IN STRUCTURAL CHANNELS ON THE COMPOSITION OF FE-MG SOLID SOLUTIONS OF CORDIERITE

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This paper reports on an experimental study of the dependence of the water content in synthetic (Mg, Fe^{+2})-cordierites on the composition of the solid solutions at P_{H_2O}=200-250 MPa in the range T=600-700° C in conditions of iron-wustite oxygen buffer. Experiments lasting 10 days afforded monomineral cordierite powders. According to mass spectrometry data, the dependence of the water content on ferruginosity $F=Fe^{+2}/(Mg + Fe^{+2})$ has maxima in the region of the compositions with F=0.2-0.3 (fig.1). The observed dependence of the water content on ferruginosity in cordierites may be explained by the "dilution" effect. In the framework of synthetic (Mg, Fe^{+2})-cordierites, the paramagnetic Fe^{+2} ions are distributed anisotropically for samples with $0<F\leq0.2$; as a consequence, the water content increases with ferruginosity. The contribution of Fe^{+2} ions to the paramagnetic effects decreases oppositely with the degree of magnesium substitution at the octahedral sites of the framework because of their more orderly distribution in the lattice.

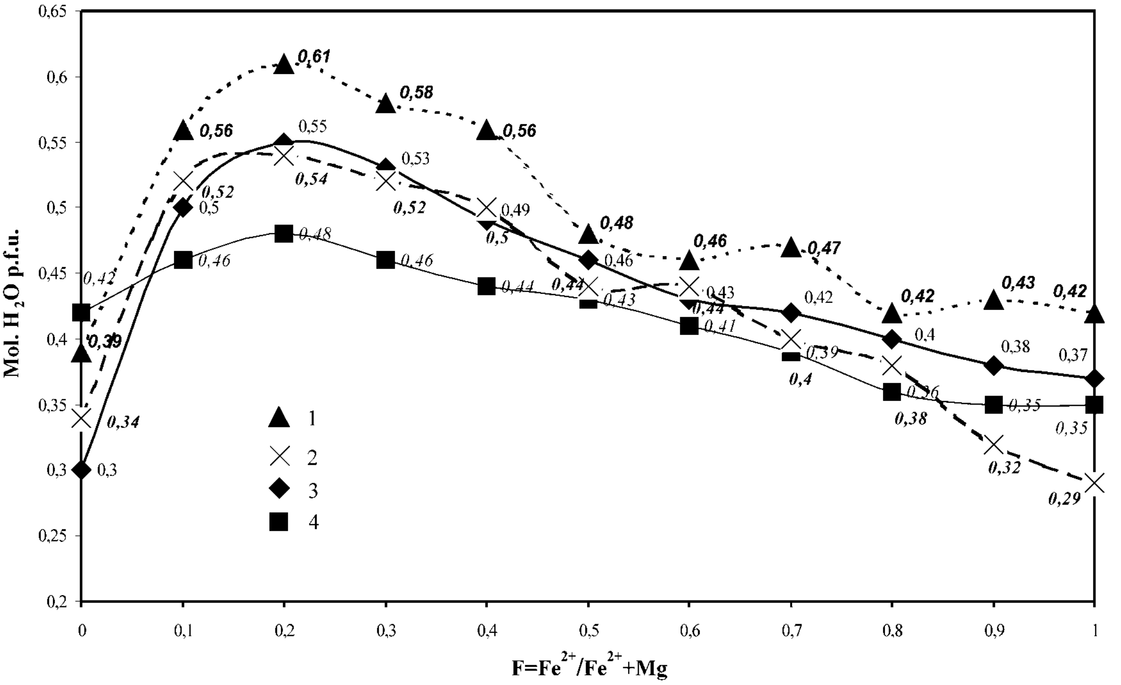

Fig. 1. Dependence of the water content in synthetic cordierites on their ferruginosity according to mass spectrometric data: 1 – series M (600 °C, 200 MPa); 2 - series N (650 °C, 250 MPa); 3 - series K (700 °C, 200 MPa); 4 - series L (650 °C, 200 MPa).

Based on the experimentally verified procedure for using diffuse reflection IR spectroscopy for identification and localization of H_2O molecules in the channels of (Mg, Fe^{+2})-cordierites it was shown that some H_2O molecules (H_2O-II) have an orientation with the vector $\overrightarrow{H-H}$ perpendicular to the C axis of the crystal (fig. 2, 3). Previously, it was traditionally maintained that the appearance of H_2O-II is due to the orientational effect of alkaline ions.

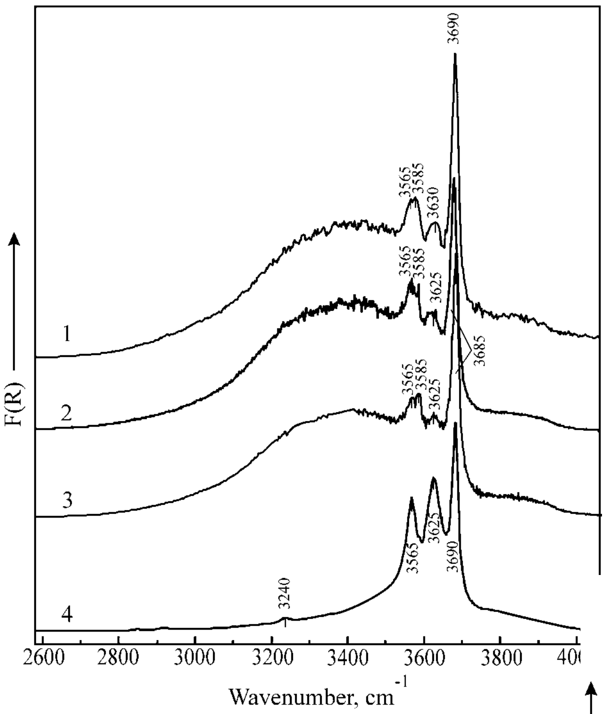

Fig. 2. IR diffuse reflection spectra of cordierite powders in the region of stretching OH-vibrations. Synthetic alkaline-free samples with ferruginosity: 1) 0.00, 2) 0.50, 3) 1.00. Natural Z-cordierite with Na content of 0.07 p.f.u. and ferruginosity 0.30 from the epidote-amphibolite facies (Southern Chui complex, Altai Mountains).

It seems that the orienting effect on the dipole of H_2O-II in (Mg, Fe^{+2})-cordierites is produced by the active proton (H-Bronsted) centers of the framework bonded to the bridging oxygens of the lattice Al-O(H)-Si [2-6]. The role analogous to that of Na^+ is possibly played by other positively charged centers lying in the channels of the structure or at adjacent framework sites.

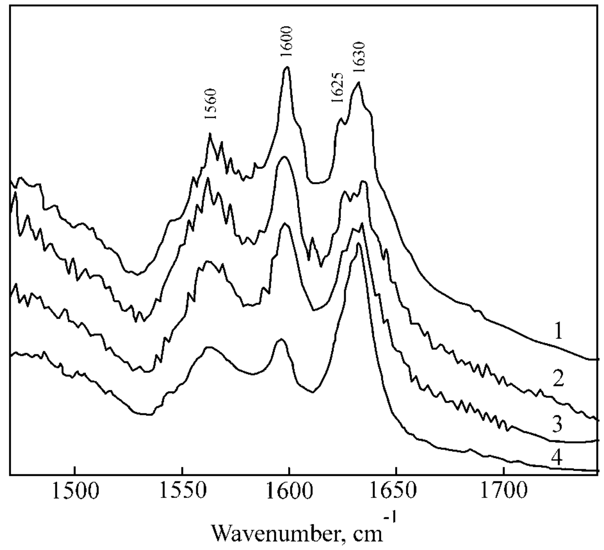

Fig. 3. IR diffuse reflection spectrum of cordierite powders in the region of the deformation OH-vibrations. 1, 2, 3 – synthetic alkaline-free samples with ferruginosity 0.00, 0.50, 1.00, respectively; 4 - natural sodium-containing Z-cordierite with ferruginosity 0.30.

The results of our experimental studies of a wide range of synthesized ferrous cordierites indicate that water concentration in cordierites depends not only on the partial pressure of water and formation temperature, but also on their ferruginosity. This must be taken into account in solving the inverse problem - reconstructing the water pressure regime in cordierite-containing metamorphic complexes using mineralogical methods.

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