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Spectroscopic study of mimetite-vanadinite solid solution series - preliminary results

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Mimetite $Pb_5(AsO_4)_3Cl$ and vanadinite $Pb_5(VO_4)_3Cl$ are minerals from the Pb-apatites family which belong to the apatite supergroup. Most often they crystalize under hypergenic conditions, in oxidation zones of Pb ore deposits, where they form paragenesis with pyromorphite $Pb_5(PO_4)_3Cl$. These minerals are used in the techniques of soils reclamation. Their crystal structure allows substituting of metal cations as well as of anionic complexes. Natural mimetite often contains admixture of phosphates and/or vanadates. Similarly, vanadinite contains admixtures of phosphates and/or arsenates.

Among the lead apatites, properties of the minerals from pyromorphite-mimetite solid solution series are well known, while the knowledge about the mimetite-vanadinite series is incomplete. The aim of this research was synthesis and spectroscopic characterization of mimetite-vanadinite solid solution series.

Mimetite, vanadinite and their solid solution were synthesized from aqueous solutions by dropwise mixing of $Pb(NO_3)_2$, Na_3VO_4, $Na_2HAsO_4 \bullet 7H_2O$ and NaCl at 25 ºC and pH = 3.5. Products of the syntheses were analyzed by X-Ray diffraction (XRD), Infrared absorption spectroscopy (FTIR) and Raman spectroscopy.

The precipitates formed in the syntheses were identified by the XRD method as mimetite, vanadinite and their solid solutions. Other crystalline phases were not present in synthetic precipitates within the detection limit of XRD.

In the Mid-IR spectra of mimetite-vanadinite solid solutions series, bands characteristic for vibrations of As-O bonds of the AsO_4 tetrahedra and vibrations of V-O bonds of the VO_4 tetrahedra were observed. The band corresponding to stretching $\nu_3$vibrations of AsO_4 and VO_4 occured in the range 700-900 cm^{-1}. In the Raman spectra, bands which are characteristic for vibrations of As-O bonds of the AsO_4 tetrahedra and vibrations of V-O bonds of the VO_4 tetrahedra were also observed. The bands attributed to vibrations in the AsO_4 tetrahedra appeared at 880-740 cm^{-1}, 460-280 cm^{-1} and 220-120 cm^{-1}. The bands attributed to vibrations in the VO_4 tetrahedra appeared in the ranges 830-820 cm^{-1} and 380-280 cm^{-1}. Analysis of Mid-IR spectra and Raman spectra allowed to observe correlation between changes in the position of the vibrational modes and the chemical compositions of the studied samples.

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