

Optimization of synthesis conditions of pyromorphite-vanadinite and mimetite-vanadinite solid solution series

Urszula Janicka, Tomasz Bajda, Justyna Topolska, Maciej Manecki

AGH University of Science and Technology, Faculty of Geology, Geophysics and Environmental Protection; al. Mickiewicza 30, 30-059 Krakow, Poland; e-mail: ujanicka@agh.edu.pl

© 2014 Authors. This is an open access publication, which can be used, distributed and reproduced in any medium according to the Creative Commons CC-BY 4.0 License requiring that the original work has been properly cited.

Minerals: pyromorphite $Pb_5(PO_4)_3Cl$, mimetite $Pb_5(AsO_4)_3Cl$ and vanadinite $Pb_5(VO_4)_3Cl$ belong to the apatite supergroup. Commonly they form in hypergenic conditions. They are best known from the oxidation zones of lead ore deposits. Natural pyromorphite usually contains admixture of arsenates or vanadates, whereas mimetite or vanadinite contain admixtures of phosphates. Solid solutions of the pyromorphite-mimetite series are well known, while the knowledge about anionic substitutions in vanadinite is incomplete. Therefore, the aim of this study was to find optimal conditions for the synthesis of pyromorphite-vanadinite and mimetite-vanadinite solid solution series. This research will allow to check the range of possible anionic substitutions, formation conditions such as pH, temperature and in, turn, to obtain better knowledge about the properties of these minerals.

Pyromorphite, mimetite, vanadinite and pyromorphite-vanadinite and mimetite-vanadinite solid solutions series were synthesized from aqueous solutions. Solutions containing Pb^{2+} , PO_4^{3-} , AsO_4^{3-} , VO_3^- , VO_4^{3-} and Cl^- ions in stoichiometric molar proportions were dropwise mixing. This method of synthesis allows controlling the stoichiometry of the chemical composition of synthetic precipitates. Synthesis reactions were carried out at various pH and at different temperatures (range

from 25°C to 85°C). After the synthesis, suspensions were left for two weeks for aging. Then the suspensions were filtered using a Büchner funnel. The precipitates were washed with double-distilled water and acetone, and then dried. Synthetic precipitates were analyzed using various analytical techniques including X-Ray diffraction (XRD), Scanning electron microscopy coupled with Energy Dispersive Spectroscopy (SEM/EDS), Infrared absorption spectroscopy (FTIR) and Raman spectroscopy.

Results of XRD, SEM/EDS, FTIR and Raman spectroscopy analyzes of studied samples showed that temperature 25°C and pH = 3.5 are optimal conditions to synthesize pyromorphite-vanadinite and mimetite-vanadinite solid solution series. Chervetite $Pb_2V_2O_7$ was formed together with studied phases at lower pH values (1.7, 2.2), or higher temperatures (75°C, 85°C). At pH = 11.5, minerals with hydroxyl groups were formed. It has been observed that the formation of pyromorphite-vanadinite and mimetite-vanadinite solid solution series mainly depends on the pH values. The temperature is less important.

The project was financed with resources of the National Science Centre, Poland, granted based on decision no. DEC-2013/09/N/ST10/00677.