Geophysical Research Abstracts
Vol. 18, EGU2016-8413-1, 2016
EGU General Assembly 2016

Synthesis and solubility of Pb-Ca and P-As hydroxylapatite solid solutions

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The objective of the study are three solid solution series:

- HPY hydroxylpyromorphite $Pb_5(PO_4)_3OH$ – HAP hydroxylapatite $Ca_5(PO_4)_3OH$

- HAP hydroxylapatite $Ca_5(PO_4)_3OH$ – JBM johnbaumite $Ca_5(AsO_4)_3OH$

- JBM johnbaumite $Ca_5(AsO_4)_3OH$ – HMI hydroxylmimetite $Pb_5(AsO_4)_3OH$

The phases were synthesized from aqueous solutions at high pH (over 8) at ambient temperature by dropwise mixing of chemical reagents: $Pb(NO_3)_2$, $Ca(NO_3)_2 4H_2O$, $(NH_4)H_2PO_4$, and $Na_2AsHO_4 7H_2O$. The products of all syntheses are crystalline, monomineral fine powders (crystal size less than 1 μm). Their chemical composition is close to theoretical. Systematic shift of XRD peaks and FTIR or Raman bands is observed within the solid solution series.

Dissolution experiments were run at 5^{o}C, 25^{o}C, 45^{o}C, and 65^{o}C. An aliquot of 0.5g of each phase was dissolved in 250 mL of 0.05M NH_4NO_3 (pH between 3 and 5) for about 3 months. In all cases dissolution resulted in increase of pH by about 1. The systems were considered in equilibrium when three consecutive samplings (ca. two weeks apart) resulted in similar concentrations (within 3 standard deviations).

The dissolution of all phases in question is incongruent. The amount of precipitating secondary phases was too small for identification. The results of HPY – HAP dissolution experiments are inconclusive due to strongly incongruent dissolution. This is partially in contrary to recent report by Zhu et al. (2015). Systematic increase of solubility is observed in HAP – JBM series. Also, the solubility of these phases increases with the increase of temperature. This is more pronounced for HAP than for JBM. Systematic increase of solubility is also observed in HMI – JBM series.

This work is partially funded by AGH research grant no 11.11.140.319 and partially by Polish NCN grant No 2014/01/M/ST10/00355.

Zhu,Y., Zhu, Z., Zhao, X., Liang, Y., Huang, Y., 2015. Characterization, dissolution, and solubility of lead hydroxypyromorphite $Pb_5(PO_4)_3OH$ at 25–45^{o}C. Journal of Chemistry, vol. 2015, article ID 269387