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## A study of heterogeneous equilibria in the saturated aqueous solutions of uranoarsenates and uranophosphates of alkaline and alkaline-earth elements

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Uranoarsenates and uranophosphates belong to a numerous difficult soluble compounds that can be formed by the ingress of various uranium-containing waste in the environment and can also be used as uranium-fixing matrices in technological processes. Research of the state of these compounds in aqueous solutions, of their hydrolytic stability and solubility, and of transformations of uranoarsenates and uranophosphates into other chemical compounds both in the solid phase and in a solution is important. In this work detailed research of the state of  $Mk(BvUO_6)_{k-1}nH_2O$  compounds (Bv-As,P; Mk-H<sup>+</sup>,Li<sup>+</sup>,Na<sup>+</sup>,K<sup>+</sup>,Rb<sup>+</sup>,Cs<sup>+</sup>,NH<sub>4</sub><sup>+</sup>,Mg<sup>2+</sup>,Sr<sup>2+</sup>,Ba<sup>2+</sup>) in aqueous solutions at 25°C within a wide range of acidity is presented. It has been found that behavior of all  $Mk(BvUO_6)_{k-1}nH_2O$  compounds in aqueous solutions obeys the general laws due to their structural and functional similarity. Acidity has the most essential effect on the chemical stability of uranium compounds under study. Composition and structure of the solid phase, ionic-molecular forms, and concentrations of U(VI), As(V), P(V) and Mk in equilibrium solutions depend on pH. In acidic medium (pH<2) difficult soluble acid with composition of  $HBvUO_6 \cdot 4H_2O$  is formed as a result of ionic exchange in the solid phase. In the case of the  $Mk(BvUO_6)_{k-1}nH_2O$  interaction with aqueous solutions of the alkaline elements hydroxides (pH>10) As(V) and P(V) are leached into the solution and insoluble uranates are formed. In the intermediate interval (2<pH<10) secondary solid phases are formed in quantities defined by acidity of the equilibrium solutions.  $(UO_2)_3(AsO_4)_2 \cdot 12H_2O$ ,  $(UO_2)_3(PO_4)_2 \cdot 8H_2O$  and  $UO_3 \cdot 2H_2O$  as synthetic analogues of the natural minerals should be mentioned among these phases. The solubility of all compounds with formulae  $Mk(BvUO_6)_{k-1}nH_2O$  has minimal value in neutral solutions ( $10^{-6}$ - $10^{-5}$ M) and sharply increases with addition of acid or base. The uranophosphates are characterized by higher chemical stability than uranoarsenates. The finer distinctions in behavior of  $Mk(AsUO_6)_{k-1}nH_2O$  and  $Mk(PUO_6)_{k-1}nH_2O$  are caused by the nature of the Mk elements, and they reveal themselves in conversions of the secondary phase formation reactions and in the acidity-base intervals of the primary solid phase existence. A physicochemical model characterizing quantitatively the equilibrium state in the heterogeneous systems under study is proposed for predicting the processes occurring when inorganic uranium compounds dissolve. Using the model it is possible to calculate the state diagrams of the solid phases and the equilibrium solutions over the phases. In addition, it is possible to evaluate various heterogeneous equilibria constants.

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