Crystal chemistry and synthesis of biological carbonated apatites and apatite-protein nanocomposites

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The main aims of the present long-term research are to reveal the regularities of complicate ion- substitutions in carbonated apatites, to study the nanocomposite structure of biological hard tissues and to develop suitable synthesis methods of analogues of biological apatites and apatite-protein nanocomposites.

Experimental section

Objects of the research are physiogenic and pathogenic apatite - albuminous composites formed in the human body, fossils and also synthetic apatites received by different methods. The study of biological and synthetic materials has been carried out by methods of powder and single-crystal X-ray diffraction; NMR, EPR, IR and KR spectroscopy; SE and TE microscopy and by various chemical techniques.

Discussion of Results

The biological apatites are characterized by variable non-stoichiometry composition that caused by ion-substitutions at all crystallographic sites. If Ca deficit is mainly related to the incorporation of CO_3^{2-} ions of the B types, the direct correlation between CO_3^{2-}content and number of vacancies at Ca-sites is distinguished. The Ca deficit mainly due to a deficit of (OH^-, F^-)- ions resulted in the incorporation of water into channels of the crystal structure. Apatite of teeth, renal, salivary stones and dental calculi is water containing nonstoichiometric carbonate OH-apatite with Ca^{2+} and OH^- ion deficiencies. Owing to the variations in the unit cell parameters ion replacements in apatites of pathogenic origin are more intense in comparison with physiogenic dental enamel apatites. The albid tissue of Late Devon conodonts yields a diffraction pattern characteristic of a single crystal. This apatite – protein biological composite is nanostructured material (biological mesocrystal). The atomic structure of biological apatite from albid tissue is very close to that of stoichiometric apatite-(CaF). The synthesized carbonated apatites of B type , for which the Ca deficit is mainly due to the incorporation of water, are close to the apatites-(CaOH) formed in the human body. Biomimetic apatite (CaF) - gelatin composites are analogous of substances of tooth tissue of some modern fishes.

The work was supported by RFBR project13-05-90432 Ukr_f _a.