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SPECIAL COLLECTION: APATITE: A COMMON MINERAL, UNCOMMONLY VERSATILE

REVIEW

A mineralogical view of apatitic biomaterials

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ABSTRACT

Biomaterials are synthetic compounds and composites that replace or assist missing or damaged tissue or organs. This review paper addresses Ca phosphate biomaterials that are used as aids to or substitutes for bones and teeth. The viewpoint taken is that of mineralogists and geochemists interested in (carbonated) hydroxylapatite, its range of compositions, the conditions under which it can be synthesized, and how it is used as a biomaterial either alone or in a composite. Somewhat counter-intuitively, the goal of most medical or materials science researchers in this field is to emulate the properties of bone and tooth, rather than the hierarchically complex materials themselves. The absence of a directive to mimic biological reality has permitted the development of a remarkable range of approaches to apatite synthesis and post-synthesis processing. Multiple means of synthesis are described from low-temperature aqueous precipitation, sol-gel processes, and mechanosynthesis to high-temperature solid-state reactions and sintering up to 1000 °C. The application of multiple analytical techniques to characterize these apatitic, frequently nanocrystalline materials is discussed. An online supplement[1] details the specific physical and chemical forms in which synthetic apatite and related Ca phosphate phases are used in biomaterials. The implications from this overview are the enhanced recognition of the structurally and chemically accommodating nature of the apatite phase, insight into the effects of synthesis techniques on the specific properties of minerals (specifically apatite), and the importance of surface chemistry of apatite nanocrystals. The wide range of synthesis techniques, types of analytical characterization, and applications to human health associated with apatite are a non-geological demonstration of the power of mineralogy.

Keywords: Apatite, Ca phosphate, biomaterial, synthesis, bone, hydroxylapatite, Review article