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The effect of mechanochemical treatments of sepiolite with CsCl on the calcination products

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摘要

Abstract

Calcination of sepiolite and of two sepiolite/CsCl mixtures, unground and air-ground was investigated by thermo-XRD-analysis. At 200 °C sepiolite, neat, mixed or air-ground with CsCl lost interparticle and zeolitic water. The framework of sepiolite persisted during the dehydration but became defected, mainly in the air-ground mixture, less in the unground mixture and little in the neat clay. At 500 °C, with the loss of bound water, the neat clay was folded and transformed into sepiolite anhydride. In sepiolite/CsCl mixtures the dehydrated variety persisted but the degree of crystal-imperfection increased in the air-ground mixture more than in the unground mixture. At 700 °C the neat clay remained crystallized, but the CsCl mixtures became amorphous. Some crystalline dehydrated sepiolite or sepiolite anhydride persisted in the unground and air-ground CsCl mixtures, respectively. At 850 °C, the neat clay crystallized into protoenstatite with some enstatite and clinoenstatite. The amorphous fraction of sepiolite in the unground sepiolite/CsCl mixtures crystallized into pollucite and forsterite and the crystalline fraction was transformed into enstatite, protoenstatite, and clinoenstatite. In the air-ground mixture, the amorphous phase was transformed into pollucite with some forsterite and the crystalline fraction into enstatite.

Keywords

Cesium chloride, Clinoenstatite, Enstatite, Forsterite, Mechanochemistry of sepiolite, Pollucite, Protoenstatite, Thermo-XRD-analysis

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The effect of mechanochemical treatments of sepiolite with CsCl on the calcination products

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Abstract Calcination of sepiolite and of two sepiolite/CsCl mixtures, unground and air-ground was investigated by thermo-XRD-analysis. At 200 °C sepiolite, neat, mixed or air-ground with CsCl lost interparticle and zeolitic water. The framework of sepiolite persisted during the dehydration but became defected, mainly in the air-ground mixture, less in the unground mixture and little in the neat clay. At 500 °C, with the loss of bound water, the neat clay was folded and transformed into sepiolite anhydride. In sepiolite/CsCl mixtures the dehydrated variety persisted but the degree of crystal-imperfection increased in the air-ground mixture more than in the unground mixture. At 700 °C the neat clay remained crystallized, but the CsCl mixtures became amorphous. Some crystalline dehydrated sepiolite or sepiolite anhydride persisted in the unground and air-ground CsCl mixtures, respectively. At 850 °C, the neat clay crystallized into protoenstatite with some enstatite and clinoenstatite. The amorphous fraction of sepiolite in the unground sepiolite/CsCl mixtures crystallized into pollucite and forsterite and the crystalline fraction was transformed into enstatite, protoenstatite, and clinoenstatite. In the air-ground mixture, the amorphous phase was transformed into pollucite with some forsterite and the crystalline fraction into enstatite.

Keywords Cesium chloride · Clinoenstatite · Enstatite · Forsterite · Mechanochemistry of sepiolite · Pollucite · Protocastite · Thermo-XRD-analysis

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Introduction

The use of different earths (e.g. fuller earths) for cleaning clothes or for pharmaceutical and medical purposes as well as for cosmetic purposes is known from ancient times [1]. From recent geological surveys, it is known that the clay fraction of most earths mentioned by Greek historians or quoted in Egyptian medical papyri or Sumerian lists is calcium montmorillonite. However, in many of these earths sepiolite or palygorskite is the principal clay fraction. For these applications, the earth was ground and in many cases also thermally treated. In order to provide special properties to the clay, different inorganic or organic additives were ground together with the earth.

Mechanochemical interactions of clay minerals with alkali halides were widely investigated in our laboratory (see e.g. [2–13]). Cesium is unique among the alkalis. Due to its large size the polarizing power and hydration abilities are weak. Cs⁺ breaks water structure, enriching the system with monomeric water molecules. Recently, our attention has been focused on the mechanochemical reactions of sepiolite with several alkali halides and it has been found that the effect of CsCl differed from that of the other salts.

Most clay minerals have a layer structure [14, 15] and during mechanochemical treatments with alkali halides they delaminate [3–9]. Sepiolite and palygorskite are unique. In their structure, there is a repeated inversion of the tetrahedral-octahedral-tetrahedral (TOT) layer. As a result of this inversion, they have intraparticle tunnels and interparticle channels [16]. The two minerals differ in the frequency of inversion, sepiolite having wider tunnels.

Grinding and thermal treatments of sepiolite are applied in different industries [17]. Calcination of sepiolite has been widely investigated, and most investigators claim that clinoenstatite is the principal thermal product [18].



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