

EGU22-11602

<https://doi.org/10.5194/egusphere-egu22-11602>

EGU General Assembly 2022

© Author(s) 2022. This work is distributed under the Creative Commons Attribution 4.0 License.



Thermal degradation of biological carbonates

Pedro Álvarez-Lloret, Adriana Torres-Mansilla, and Luis Monasterio-Guillot

Dept. of Geology, University of Oviedo, 33005, Oviedo (pedroalvarez@uniovi.es)

The study of mineral decarbonation mechanisms is of great interest for its application to various geological and industrial processes. Biomineralization is a phenomenon by which living organisms are able to produce mineral phases, the most abundant of which are calcium carbonates and phosphates. Among the more abundant polymorphs of calcium carbonate are calcite and aragonite, being the most thermodynamically stable structures under biological environments (Weiner & Addadi, 1997). In general, mineral phases formed by biologically controlled mineralisation processes have lower crystallinity characteristics than their geological analogues. In the current communication, the thermal degradation of biogenic calcium carbonates is comparatively studied with their respective ones of geological origin. During the transformation, chemical and microstructural alterations occur from the original polymorphs of biogenic calcite (eggshell; *Gallus gallus*) and aragonite (mollusc shell; *Ruditapes philippinarum*) to the final calcium oxide mineral phase. The samples were gradually heated from room temperature to 1100°C in order to remove the water content and organic matter components contained in the biogenic phases and to induce progressive mineral decarbonation. The kinetics of these compositional transformations were analysed by means of differential scanning calorimetry (DSC). Different analytical techniques, such as attenuated total reflectance infrared spectroscopy (ATR-FTIR), X-ray diffraction (XRD) and scanning electron microscopy (SEM), were used for the chemical and structural characterisation of the mineral transformation of these phases. During thermal degradation, changes are observed in the molecular composition of these biogenic phases related to the distortion of the carbonate group and its association with the organic components. Furthermore, the mineral decarbonation process of calcium carbonates involves different structural transformation mechanisms that depend on the modification of unit cell parameters, thermal expansion coefficients and microstructural reorganisation (Rodríguez-Navarro et al., 2009). Accordingly, CaCO₃ crystalline structures are transformed from the original calcite and aragonite phases to the cubic structure of lime, with a calcite-aragonite transformation prior to decarbonation explained by the reorientation of the CO₃ group towards Ca and by changes in the packing of the Ca atoms, followed by the increase of the unit cell volume (Antao & Hassan, 2010). The results show some significant differences during mineral transformation depending on their geological or biological origin. The characterization of this mineral decarbonation process has important implications in natural and industrial processes (i.e., cement production, CO₂ capture).

- Weiner, S.; Addadi, L. (1997) Design strategies in mineralized biological materials. *Journal of Materials Chemistry*, 7(5), 689-702.

- Rodriguez-Navarro, C.; Ruiz-Agudo, E.; Luque, A.; Rodriguez-Navarro, A.B.; Ortega-Huertas, M. (2009) Thermal decomposition of calcite: mechanisms of formation and textural evolution of CaO nanocrystals. *American Mineralogist* 94, 578–593.
- Antao, S. M., Hassan, I. (2010) Temperature Dependence of the Structural Parameters in the Transformation of Aragonite to Calcite, as Determined from in Situ Synchrotron Powder X-Ray-Diffraction Data. *Canadian Mineralogist* 48, 1225– 1236.