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Application of synchrotron-based techniques for the study of calcium oxalate hydrates transformation

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Renal Nephrolithiasis is a clinical condition that implies the formation of microcrystals aggregates on the kidney. This disease affects up to 12% of the population with a recurrence rate around 50% [1]. Among the eleven types of kidney stones, 66% of the incidence is represented by calcium oxalate hydrates species: the dihydrate (weddellite, COD) and the monohydrate (whewellite, COM) [2]. The process which accounts for the transformation of COD into COM has been studied in mineral systems and in vitro. The formed stone after a total transformation (called TRA) is, chemically, COM, since it only contains one water molecule in its crystalline structure. TRA is difficult to differentiate from the stones nucleated as COM due to their high appearance, differentiation that is of great importance since both species are caused by different pathologies, so different treatment is needed to prevent recurrence. Therefore, the studies of this transformation process, as well as the stabilization of the dihydrated species, are important to understand the physiopathology, to propose an adequate treatment and, above all, to prevent recurrence.

The main objective is to fill in the knowledge gap regarding the crystalline conversion of calcium oxalate dihydrate, as well as the appropriate identification of the calcium oxalate monohydrate formation origin, in kidney stones. To accomplish this, different synchrotron radiation techniques have been applied (XAS, μFTIR and μXRD), since they allow to measure with a small spot size (microns) with a high spectral brightness (allowing a better signal to noise ratio): XAS measurements were performed to study the differences in the local coordination environment of calcium in both species [3]; SR- μFTIR was used to analyze the organic matter distribution, determining their role as promotors/inhibitors of COM and in the stabilization of COD crystals [4]; SR-μXRD was performed to evaluate the crystallographic textures differences between COM and TRA, correlating the results with the morpho-constitutional analysis applied for their classification [5].

In brief, these techniques have allowed us to differentiate between the calcium oxalate monohydrate species and to better understand the role of the organic matter on the transformation process.

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Primary authors: H.VALIDO, Iris (UAB); BOADA ROMERO, Roberto (UAB); RESINA-GALLEGO, Montserrat (UAB); FUENTES-CEBRIÁN, Victor (UAB); YOUSEF, Ibraheem (ALBA Synchrotron); VALLCORBA VALLS, Oriol (ALBA Synchrotron); VALIENTE, Manuel (Universitat Autònoma de Barcelona); LÓPEZ-MESAS, Montserrat (GTS-UAB)

Presenter: H.VALIDO, Iris (UAB)

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