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Investigation of organic matter entrapped during calcite growth by a multi-method approach

E. Chalmin (1), Y. Perrette (1), B. Fanget (1), and R. Drysdale (2)

(1) Université de Savoie, EDYTEM, Le Bourget du Lac Cedex, France (emilie.chalmin-aljanabi@univ-savoie.fr), (2) Department of Resource Managment and Geography, University of Melbourne, Parkville 3010 VIC, Australia

Organic matter (OM) entrapped in calcite is regularly used for environmental studies; however, incorporation mechanisms and types of interaction remain poorly understood. This study used a new methodology to investigate interactions between OM and the calcite matrix during crystallization processes using humic acid entrapment. A multi-method approach confirmed that OM is both adsorbed onto the calcite surface and incorporated into the calcite lattice during crystallization. Our results also confirm the log-linear correlation between fluorescence intensity and calcite matrix OM concentration. Fourier transform infrared spectroscopy (FTIR) showed that OM in colloidal conformation is adsorbed onto the calcite surface as a result of the structure of the OH stretching band. Based on synchrotron analysis (XRF and XANES), we also developed a new method in which sulfur is used as a tracer for entrapped humic acid and for locating the OM electrostatically adsorbed onto the calcite surface. Changes in the sulfur environment, determined using XANES, indicated partitioning during calcite crystallization due to the effect of the matrix on OM incorporation. Desorption experiments revealed the stability of the OM atomic structure and the layered nature of that structure. These results have allowed us to devise a general model of OM incorporation into calcite.