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Cathodoluminescence : an imaging technique for the search of extraterrestrial life

C. Ramboz (1), Y. Rubert (4,1,3), N. Bost (2,1), F. Westall (2), and C. Lerouge (3)

(1) UMR 7327 and CNRS-ISTO, 1abis rue de la Férollerie, 45071 Orléans cedex2 (France), (2) Centre de Biophysique Moléculaire, CNRS, Rue Charles Sadron, 45071 Orléans Cedex 2, (3) BRGM BP6009 45069 Orléans Cedex, (4) 58 rue Pierre Jacoby 60000 Beauvais

Solids irradiated by a 10-20 keV electron beam emit ligth in the UV-visible range, which is called cathodoluminescence (CL). CL imagery is a powerful tool for visualizing minerals and their internal structures (lattice defects, zoning). For example, terrestrial calcite, either of sedimentary or biogenic origin, often display a bright orange CL, as a result of the incorporation of trace Mn2+ in its lattice. Aragonite can also be discriminated from calcite by its green CL. Carbonates are a major target for the search of life on Mars, and CL imagery could contribute to reveal carbonates in situ. Thomas et al. [1] have validated the concept of an electron lamp to make CL imagery of a rock surface placed in a martian CO_2 atmosphere. We present 2 examples of terrestrial bacterial microstructures that are revealed by CL. (1) In Sinemurian sediments from the Montmiral borehole (Valence Basin, France), banded wavy calcite in contact with pyrite represents fossilized biofilms of sulfato-reducing bacteria, as confirmed by the sulfur isotopic composition of pyrite $\sim$+36 %0 PDB. (2) At l'Ile Crémieux, north of the Valence basin, a dense filamentous microbial/fungal community with a bright orange CL signature is embedded in vuggy calcite from a tectonic vein. The mat is anchored 1-2 mm deep in the oolitic veinwall and emerges at right angle in the 'open' fracture space.
Finally, carbonate vesicles and exhalite crusts from the Svalbard basalt in Groendland, with orange CL, are shown as analogues to carbonates from the martian ALH84001 igneous meteorite.
[1]Thomas et al. (2009) in A. Gucsik (Ed.) "Cathodoluminescence and Its Application in the Planetary Sciences"