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Cathodoluminescent fingerprint of living prokaryotes on mineral surfaces: a new tool for life detection using Scanning Electron Microscopy.

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The understanding of subsurface microbes implications in the geochemical cycles of the Earth requires appropriate techniques particularly for imaging at the micrometer scale the relations between microbes and their environment. Scanning Electron Microscopy (SEM) allows to obtain, using Secondary and Backscaterred Electrons modes (SE and BSE respectively), high resolution imaging of the topography and chemistry of a sample surface. However, when microorganisms-like morphologies are found, an element of doubt hangs over its real biological character. To circumvent this difficulty, we evaluated the relevance of associating cathodoluminescence (CL) to SE and BSE imaging. For this purpose, different fluorescent dyes (i.e. synthetic aromatic organic chemicals designed to bind with a biological macromolecule) together with a large range of natural minerals were tested and compared. This finally allows defining appropriate fluorophores well-suited for various mineral groups. We present here combined CL, BSE and SE images of *E. coli* cells deposited on different substrates. The good correlation between the 3 imaging modes finally highlights the possibility of rapidly and precisely localize living cells on mineral surfaces and distinguish them from inorganic objects presenting morphological similarities. The associated chemical and structural information provides also valuable clues for a better understanding of microbe and mineral interactions.