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Interactions of Bacteria with Silicate Surfaces Control the Evolution of Numerous Natural Processes: Formation of Sediments, Maturation of Soils, Fossilization, Formation of Ecosystems in Extreme Conditions

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Instead of elaborating experiments reproducing as closely as possible the physical conditions and geometry of such complex natural systems, we purposely develop a model silicate surface-bacteria interface. Our aim is to settle an experimental set-up that allows to control the experimental conditions and to observe the evolution of the interfaces at the nanometer scale. Processes involved should therefore be identified as well as their chemical and structural signatures. Silicate surfaces of crystals and glasses were tested. (001) surface of biotite and muscovite and (010) surface of olivine are obtained from natural single crystals of gem quality. Oriented thin slices of San Carlos olivine are mechanically polished (1/4 µm) and then gently HF etched (Lemelle et al, in preparation). (001) surface of quartz from industrial piezoelectric devices is used. All crystals are sterilised at 120 C and 2 bars during 30 min. Micas are clived inner a hood. TTB310 strain of Ramlibacter tatahouiensis isolated from Tatahouine meteorite fragments (Gillet et al, 2000) is used to carry the experiments. A suspension of about 8 $x10^7$ bacteria / ml in TSB/10 (100 ml 10-fold diluted Tryptic Soy Broth) is prepared. The population of bacteria was selected almost pure: composed only of spherical shaped bacteria (i.e., impoverished in the rod-shaped form). A 5 mm x 5 mm x 100µm crystal is then horizontally deposited in a reactor or mounted vertically in plastic test tube. Mineral surfaces immersed in 4 ml of TSB / 10 are then inoculated with 100 ml of bacteria suspension. Some samples are prepared without any bacteria and constitute an abiotic reference. Incubation is carried out for temperature ranging between 20 C and 30 C and for run duration ranging between 1 min and 72 hours. These assemblages are studied by confocal Scanning Optical Microscopy (CSOM). Geometry of a chemical reactor that allows to observe *in situ* and continuously the surface destabilization by CSOM and also to continuously take off some culture media will be presented. At the end, samples are also conventionally prepared with addition of glutaraldehyde or osmium fixatives followed by water baths for Analytical FEG-Scanning Electron Microscopy (SEM) and Analytical Transmission Electron Microscopy (TEM) observations. First results show that bacteria interact preferentially on crystalline surfaces than on glass surfaces. Colonies of spherical shaped bacteria are stuck and developed on it preferentially. All surfaces, crystalline and non-crystalline, induce a preferential development of the rod-shaped bacteria but crystalline surfaces imply their alignments, insensitive to gravity, along specific directions. Surfaces control also velocities of colonization, faster on micas than on quartz surfaces. Processes involved in these phenomena will be discussed in the light of SEM and TEM analysis carried out on transverse cuts.

Gillet P, Barrat A, Heulin T, Achouak W, Lesourd M, Guyot F, Benzerara K, *Earth and Planetary Science Letters*, **175**, 161-167, (2000).