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Kinetic adhesion of bacteria cells to sand

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The transport and fate of microbial particles in subsurface environments is a significant stake in both bioremediation and drinking water contamination. Several water source pollutions with micro-organisms were most likely due to bacterial transport through a soil as with the tragedy in the Walkerton (Ontario, Canada). Increasing experimental evidence suggests that bacterial transport is strongly influenced by cell characteristics controlling adhesion to the substratum. In this work, the kinetic of the adhesion process to sand was analyzed using a batch system and sampling the solution at different times. Twenty three bacterial strains with different cell surface properties were studied. Flow cytometry was used for counting bacteria that were either modified for fluorescence or tagged at the time of the experiment. Outer cell membrane physicochemical properties were determined by contact angle measurements with three liquids and measurement of the electrophoretic mobility. The MATS (Microbial Adhesion To Solvents) method was also used to assert the hydrophilic or hydrophobic nature of cells. The extended DLVO theory was used to quantify the net interaction between the cells and the sand matrix resulting from the addition of Lifshitz-van der Waals (LW), Lewis acid-base (AB) and electrostatic interactions (EL). Only 4 of the 23 studied strains are hydrophobic. The measurements of the electrophoretic potential zeta revealed that all the strains are negatively charged (with pH 7 and 0.01M NaCl) but vary from -0.04 to -49mV. A simple mathematical model assuming a first-order rate for adhesion was used to analyze the experiments. Two parameters were fitted: a partition constant at equilibrium and the first order rate constant for adsorption $t_{ads}(h^{-1})$. At low ionic strenght (0.01M NaCl and pH7) our experiments showed slow deposition rates for highly negatively charged strains while a high deposition rate was observed for low negatively charged cells. According to our results hydrophobic bacteria are more retained on the sand matrix than hydrophilic cells. The correlation between bacterial adhesion behaviour and the extended DLVO theory was investigated. Further experi-

ments were conducted with 3 selected strains (from previous collection) and suggest the important role of ionic strenght and electrostatic repulsion on bacterial adsorption on a soil matrix. Overall it seems that bacterial adhesion to a solid is ruled by a complex combination of biological, physicochemical and electrostatic interactions which are dependent of the environment (i.e. pH, ionic strenght. . .).