The Role of Free-Living and Attached Bacteria in Processing Contamination in Karst Aquifers

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Abstract

In karst aquifers, biodegradation can be accomplished both by surface-attached and free-living bacteria. Biodegradation by attached bacteria is dependent upon and limited by the relatively low surface area to volume ratio (SA/V) of karst aquifers. Biodegradation due to free-living bacteria, however, is not limited by SA/V, but by residence time. The objective of this research was to determine if free-living karst bacteria contributed as much to the removal of ammonia (NH_3) as attached, indigenous karst bacteria. These results were compared with the results of a toluene biodegradation study conducted using the same set up (Painter and others, 2005 KIG). The experimental setup included flow-through karst microcosms with high and low SA/V ratios. The low SA/V ratio system consisted of three 1-L cylinders connected together with non-stick tubing. The high SA/V ratio karst system was similar except the cylinders were packed with glass beads to increase the SA/V ratio by approximately 500%. Microscopic examination confirmed that bacteria colonized the interior surfaces of the lab karst systems. Fresh spring water containing between 10,000 and 20,000 indigenous karst bacteria was continuously pumped through each system. A known quantity of NH_3 was added as a food source and measured at the exit port. Flow rates were similar and residence time differences were compensated for with the residence-time distribution (RTD) formula described by King and others (2005). First-order NH_3-biotransformation rate constants were 0.17 day^{-1} for the low SA/V system and 0.27 day^{-1} for the high SA/V system. In the previous toluene study, the first-order rate constants were 0.014 $hour^{-1}$ for the low SA/V system and 0.016 $hour^{-1}$ for the high SA/V ratio system leading Painter (2005) to conclude that free-living bacteria contribute as much to toluene biodegradation processes as attached bacteria in karst aquifers. This study suggests that this is not the case with respect to NH_3 biotransformation in karst systems.