Groundwater geochemistry and microbial community structure in the aquifer transition from volcanic to alluvial areas

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Abstract
Groundwaters may act as sinks or sources of organic and inorganic solutes, depending on the relative magnitude of biochemical mobilizing processes and groundwater-surface water exchanges. The objective of this study was to link the lithological and hydrogeological gradients to the aquatic microbial community structure in the transition from aquifer recharge (volcanic formations) to discharge areas (alluvial deposits). A field-scale analysis was performed along a water table aquifer in which volcanic products decreased in thickness and areal extension, while alluvial deposits became increasingly important. We measured the main groundwater physical parameters and the concentrations of major and trace elements. In addition, the microbial community structure was assessed by estimating the occurrence of total coliforms and Escherichia coli, the prokaryotic abundance, the cytometric and phylogenetic community composition. The overall biogeochemical asset differed along the aquifer flow path. The concentration of total and live prokaryotic cells significantly increased in alluvial waters, together with the percentages of Beta- and Delta-Proteobacteria. The microbial propagation over a theoretical groundwater travel time allowed for the identification of microbial groups shifting significantly in the transition between the two different hydrogeochemical facies. The microbial community structure was intimately associated with geochemical changes, thus it should be further considered in view of a better understanding of groundwater ecology and sustainable management strategies.

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1. Introduction

The transport, retention and release of either natural or anthropogenic solutes in groundwaters depend on multiple hydrogeological, chemical and biological processes (Giordano, 2009). At the basin scale, groundwaters move from areas of recharge to areas of discharge in response to the catchment geomorphology and hillslope-channel water interactions, reflecting the variations of horizontal and vertical hydraulic gradients. Downwelling zones (e.g. mountain slopes in which rain waters mostly infiltrate downward to the aquifer) may be geographically distant and geologically dissimilar to