Colloids and Surfaces A: Physicochem. Eng. Aspects 416 (2013) 56–65

Contents lists available at SciVerse ScienceDirect

Colloids and Surfaces A: Physicochemical and Engineering Aspects

journal homepage: www.elsevier.com/locate/colsurfa

Cotransport of clay colloids and viruses in water saturated porous media

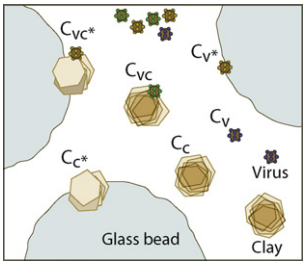
Vasiliki I. Syngouna, Constantinos V. Chrysikopoulos*

Environmental Engineering Laboratory, Department of Civil Engineering, University of Patras, Patras 26500, Greece

HIGHLIGHTS

- Investigation of MS2 and ΦX174 cotransport with clay colloids in porous media.
- The mass recovery of viruses and clay colloids decreased with decreasing *U*.
- The mass recovery of viruses decreased in the presence of clay colloids.
- Clay particles can facilitate or hinder virus transport in porous media.
- XDLVO is important only in the case of clay colloid attachment onto glass beads.

GRAPHICAL ABSTRACT



ARTICLE INFO

Article history:
Received 28 July 2012
Received in revised form 3 October 2012
Accepted 4 October 2012
Available online 23 October 2012

Keywords:
Viruses
ΦX174
MS2
Clay colloids
KGa-1b
STx-1b
Cotransport

ABSTRACT

This study examines the cotransport of clay colloids and viruses in laboratory packed columns. Bacteriophages MS2 and ΦX174 were used as model viruses, kaolinite (kGa-1b) and montmorillonite (STx-1b) as model clay colloids, and glass beads as model packing material. The combined and synergistic effects of clay colloids and pore water velocity on virus transport and retention in porous media were examined at three pore water velocities (0.38, 0.74, and 1.21 cm/min). The results indicated that the mass recovery of viruses and clay colloids decreased as the pore water velocity decreased; whereas, for the cotransport experiments no clear trend was observed. Temporal moments of the breakthrough concentrations suggested that the presence of clays significantly influenced virus transport and irreversible deposition onto glass beads. Mass recovery values for both viruses, calculated based on total virus concentration in the effluent, were reduced compared to those in the absence of clays. The transport of both suspended and attached onto suspended clay-particles viruses was retarded, compared to the tracer, only at the highest pore water velocity. Moreover both clay colloids were shown to hinder virus transport at the highest pore water velocity. At the lower velocities MS2 transport was hindered and ΦX174 transport was facilitated with the exception of $U = 0.74$ cm/min in the presence of KGa-1b. Both MS2 and ΦX174 were attached in greater amounts onto KGa-1b than STx-1b. Also, MS2 exhibited greater affinity than ΦX174 for both clays.

1. Introduction

Suspended mobile colloids and particulate matter in the subsurface environment can play a significant role as carriers of contaminants and biocolloids (e.g. bacteria and viruses). Numerous experimental and theoretical studies have shown that, depending on the conditions of the physical system considered, colloids may facilitate or hinder the mobility of contaminants in porous and fractured formations [1–7]. Biocolloid transport mechanisms and sorption rates linked to various biological, chemical and physical factors have been well studied for individual species [8–11]. However, transport parameters obtained from studies performed with an individual colloid/biocolloid should not be generalized and applied to complex cotransport cases. Colloid facilitated virus

* Corresponding author. Tel.: +30 2610 996531; fax: +30 2610 996573.
E-mail address: gios@upatras.gr (C.V. Chrysikopoulos).

0927-7757/$ – see front matter © 2012 Elsevier B.V. All rights reserved.
http://dx.doi.org/10.1016/j.colsurfa.2012.10.018