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# Effect of air-water interface on virus transport under unsaturated conditions

**S. Torkzaban** (1), S. M. Hassanizadeh (1), J. F. Schijven (2)

(1) Department of Earth Sciences, Utrecht University, P.O. Box 80021, 3508 TA, UTRECHT, The Netherlands

(2) Microbiological Laboratory for Health Protection, National Institute of Public Health and the Environment, P. O. Box 1 3720 BA Bilthoven, the Netherlands

(Torkzaban@geo.uu.nl / Fax: +31 30 2534900 / Phone: +31 30 2535232)

Interaction of viruses with the air–water interfaces (AWI) has been previously suggested to explain high removal of viruses during transport through unsaturated soil. The objective of this research was to explore the effect of AWI on virus transport. The transport of bacteriophages MS2 and $\phi$X174 in sand columns was studied under various conditions, such as different pH, ionic strength, buffer solutions, and saturation levels. Fitting of a transport model to the breakthrough curves was performed to determine the adsorption parameters. $\phi$X174 with isoelectric point of 6.7 exhibited high affinity to the air-water interface by decreasing pH from 9 to 6. MS2 with isoelectric point of 3.5 has lower affinity to air-water interfaces than $\phi$X174, but has similar pH-dependence. These results show the importance of electrostatic interactions, instead of hydrophobic, between the AWI and viruses. Moreover, by saturating the unsaturated column we found out that the attached viruses to AWI are viable, which is in contrast with the literature where retained viruses to AWI are considered as inactivated. Our results also demonstrate that moving AWI associated with draining of the column is capable of remobilizing viruses from the column.