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Transport of Cryptosporidium parvum oocysts through variably charged soils

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Abstract Text:

Cryptosporidium parvum, an enteric pathogen, causes cryptosporidiosis in humans and cattle. Oocysts are the encysted, environmental form of this obligate pathogen and are primarily spread through the feces of the infected host. Young calves are particularly susceptible to infection and oocysts from livestock operations can be transported from agricultural watersheds to both surface waters and shallow ground water. Oocysts cannot be easily killed by chlorination; so sand or sand/anthracite filtration often serves as the primary mechanism for removal during water treatment. Most studies assessing the transport behavior of oocysts in soils have employed "permanently charged soils" (PCS) that are typically found in temperate regions throughout the globe. However "variably charged soils" (VCS) predominate in many tropical regions (e.g., Hawaii, Brazil, Puerto Rico) and in the southeastern United States. Unlike PCS, the charge on VCS is highly pH-dependent, because these soils generally have an abundance of highly reactive metal hydroxide surface functional groups. Although the iron and aluminum oxides in VCS promote sorption of negatively charged oocysts, aquifers in regions characterized by VCS may still be vulnerable to C. parvum contamination because of warmer temperatures and higher dissolved organic matter (DOM) content. DOM has been shown to reduce removal efficiency in PCS. Few studies have addressed transport of oocysts in VCS soils. In our study, transport and attachment experiments involving two compositionally different soils from Hawaii were conducted using oocysts-sized microspheres and formalin- inactivated oocysts. "Poamoho" soil, from the island of Oahu is of volcanic origin that has undergone intense weathering. Consequently, it has a very high iron oxide and clay content. The much younger Lalamilo soil, derived from volcanic ashes of the island of Hawaii, is comparatively fine-grained with a high organic content. Transport of microspheres and oocysts within preferential flow paths was observed for the Poamoho soil, suggesting that oocysts contamination of ground water cannot be ruled out. Although a high-degree of attachment also occurred in the Lalamilo soil, attachment was much more reversible, suggesting that, once contaminated, this soil could serve as a potential reservoir for oocysts that could subsequently result in the contamination of surface and ground water during storm events.

Impact Statement:

Although VCS soil should be an excellent filter because of the high iron and (or) aluminum and because of the high clay content and small median grain sizes, we have shown here that C. parvum transport may still occur because of preferential flow phenomena and reversible attachment. These findings could result in improved land use planning and better agricultural management practices in order to minimize contamination oocysts and better predict the transport potential of oocysts in VCS.