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Authors
Lin, Tiffany
Lin, Chu-Ching
Ramanathan, Nithya
et al.

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Sensor Measurements and Sediment Incubations Indicate Diurnal Redox Cycling Associated With Arsenic Mobilization at a Bangladeshi Rice Paddy

Tiffany Lin1, Nithya Ramanathan2, Christine Lee1, Chu-Ching Lin1, Rebecca Neumann3, Charles Harvey3, A.B.M. Badruzzaman4, Thomas Harmon5, Deborah Estrin2, Jennifer Jay1

UCLA Civil and Environmental Engineering, 1UCLA Electrical Engineering, 2MIT Civil and Environmental Engineering, 3Bangladesh University of Engineering and Technology, 4UC Merced Civil and Environmental Engineering

Introduction: Why is Arsenic Contamination Important?

Environmental Impact

- Arsenic in groundwater has lead to largest environmental poisoning in history
- Tens of millions of people in the Ganges Delta drink water dangerously contaminated with arsenic
- Health problems as a result of consumption (Yu et al, 2003):
  - Arsenicosis 2,000,000 cases/year
  - Skin cancer 100,000 cases/year
  - Death from arsenic-induced cancer 3,000 case/year

Problem – How is Arsenic Mobilized?

- It is not fully understood the mechanism that mobilize arsenic into groundwater and other factors affecting the mechanism
- Rice fields receive large loads of arsenic with irrigation water and provide recharge to the underlying aquifer
- It is unknown whether rice fields act as a sink or source of arsenic in the hydrologic system

Proposed Solution: Sensor Network to Monitor In-Field Data & Laboratory Microcosms

Sensor Network

- Use dense spatial/temporal sensor network to monitor oxidative-reductive geochemical parameters in-field
- Deployed ISEs: Ammonium, Calcium, Carbonate, Chloride, DO, Nitrate, ORP, pH, Temperature

Laboratory Microcosm

- Use Bangladeshi soil with artificial groundwater microcosm to simulate diurnal trends observed with sensor network
- Monitor iron and arsenic trends to validate importance of diurnal redox cycling in arsenic mobilization
- 2 amendments to microcosms to test for biotic role: with and without carbon-sources

Results: Diurnal Cycling Observed Both In-Field and in Laboratory

Diurnal Cycles Observed in 2 Month Sensor Deployment in 2007

- Diurnal cycles presumably due to temperature driven reductive processes
- Nitrate concentrations in the subsurface increase while ammonium levels decrease
- Ammonium levels peak during the day; Nitrate levels peak at nighttime
- Possible causes for diurnal cycling: root oxygen leakage or rapid infiltration of oxygen rich surface water

- While it is currently accepted that seasonal redox cycling drives As oxidation and then mobilization upon reduction, these results indicate that diurnal oscillations in redox conditions may also be very important in the mobilization of As to groundwater at this site

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