Arsenic contamination of groundwater and drinking water in Vietnam: A human health threat

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Abstract: This is the first publication on arsenic contamination of the Red River alluvial tract in the city of Hanoi and in the surrounding rural districts. Due to naturally occurring organic matter in the sediments, the groundwaters are anoxic and rich in iron. With an average arsenic concentration of 159 μg/L, the contamination levels varied from 1 to 3050 μg/L in rural groundwater samples from private smallscale tubewells. In a highly affected rural area, the groundwater used directly as drinking water had an average concentration of 430 μg/L. Analysis of raw groundwater pumped from the lower aquifer for the Hanoi water supply yielded arsenic levels of 240-320 μg/L in three of eight treatment plants and 37-82 μg/L in another five plants. Aeration and sand filtration that are applied in the treatment plants for iron removal lowered the arsenic concentrations to levels of 25-91 μg/L, but 50% remained above the Vietnamese Standard of 50 μg/L. Extracts of sediment samples from five bore cores showed a correlation of arsenic and iron contents ($r^2 = 0.700$, n = 64). The arsenic in the sediments may be associated with iron oxyhydroxides and released to the groundwater by reductive dissolution of iron. Oxidation of sulfide phases could also release arsenic to the groundwater, but sulfur concentrations in sediments were below 1 mg/g. The high arsenic concentrations found in the tubewells (48% above 50 μg/L and 20% above 150 μg/L) indicate that several million people consuming untreated groundwater might be at a considerable risk of chronic arsenic poisoning.
Index Keywords: Arsenic; Contamination; Dissolution; Filtration; Iron; Oxidation; Rural areas; Sediments; Sulfur; Toxic materials; Water aeration; Water wells; Anoxic; Groundwater pollution; arsenic; drinking water; ground water; iron; sulfur; anoxic sediment; arsenic; drinking water; groundwater pollution; iron; public health; aeration; arsenic poisoning; article; filtration; pollution; Viet Nam; water analysis; water contamination; water supply; water treatment; Arsenic; Environmental Monitoring; Geologic Sediments; Humans; Iron; Oxidation-Reduction; Public Health; Risk Factors; Soil Pollutants; Sulfur; Vietnam; Water Pollutants, Chemical; Water Supply; Viet Nam; Atriplex pusilla

Year: 2001
Source title: Environmental Science and Technology
Volume: 35
Issue: 13
Page : 2621-2626
Cited by: 316
Link: Scorpus Link
Chemicals/CAS: Arsenic, 7440-38-2; Iron, 7439-89-6; Soil Pollutants; Sulfur, 7704-34-9; Water Pollutants, Chemical
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email: michael.berg@eawag.ch
ISSN: 0013936X
CODEN: ESTHA
DOI: 10.1021/es010027y
PubMed ID: 11452583
Language of Original Document: English
Abbreviated Source Title: Environmental Science and Technology
Document Type: Article
Source: Scopus
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