Comparative geochemical analysis of arsenic hotspots and low-As areas in Murshidabad, West Bengal, India

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Groundwater and shallow aquifer sediments (2m-40m) were collected from areas in the Murshidabad district of West Bengal, India, to study their hydrochemical and geochemical properties and examine relationships between groundwater arsenic (As) and solid-phase As concentrations and speciation. Six areas (~1km^2 each) over a total stretch of 60km have been targeted: two areas with very low (<10ppb) As levels west of the river Bhagirathi and four areas with very high (>4000ppb) As levels east of the Bhagirathi. The As hotspots east of the Bhagirathi tend to be very localized, occurring primarily along the Holocene floodplains of the river Bhagirathi and also to the west of the confluence of the Ganges-Brahmaputra and Meghna rivers.

The mineralogy of the aquifer sediments consists of quartz and feldspars with major amounts of iron-carbonate bandings around silicate grains, along with phyllosilicates, amphiboles, and other carbonates. In high-As areas, sediments are light to dark gray in color and dominated by micas and Mg-rich minerals. Fe- and Mn-rich minerals are found in greater concentrations in high-As areas than in low-As areas. Low-As area sediments are orange-brown in color with prominent quartz and feldspars and a few calcite grains only. Solid phase whole sediment analysis from surface to deep aquifer sediment in the gray arseniferous sediments shows an enrichment of Mg with depth, which indicates either this Mg originates from biotite/micas or clay minerals, and further, can be hypothesized to adsorb the As to some extent.

Dissolved As concentrations in groundwater are increasing from west to east for both total As and As (III), (15 samples, with an average of ~74% of the total As being in the form of As (III) (range: 55-98%) in high-As prone areas. The pH of high-As waters is clustered at a circumneutral pH (6.8-7.1), whereas low-As areas have a pH distinctly either above or below the median value. Conductivity displays the same central-clustered trend with high-As values (724-868μS/cm). DO and ORP range from 2.3-4.7mg/l and 57-388mV, respectively, for high-As waters. High concentrations of iron, phosphate, and ammonia and low concentrations of chloride and sulphate are characteristic of groundwater with high As.

As and Fe speciation studies of the sediments are currently underway by both UV-VIS as well as synchrotron based X-ray probe analysis of the clays. DIC values and ^{18}O values are currently being analysed to understand sources of the aquifer recharge and how these waters may affect the behaviour of arsenic.

The Moon 40 years after Apollo: Why we need to go back

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The Moon is the only body in the solar system that humans have visited, explored, and have returned samples from known locations. Long duration experiments were also set up on the lunar surface by the Apollo astronauts (ALSEPs) that gave important information on the lunar environment and interior. While some suggest that we can designate the Moon as 'explored', it should be remembered that Apollo explored <5% of the lunar surface in a small area on the equatorial nearside and the data acquired have several deficiencies: 1) The small area visited by Apollo limited the detail that could be seen in the Apollo seismic data for exploring the deep lunar interior. 2) Subsequent orbital missions (Clementine, Lunar Prospector) produced global compositional maps and demonstrated there were terrains that Apollo did not visit and that the sample collection was not be representative of the basalt types on the Moon. 3) When the Apollo ALSEP data are viewed in terms of lunar terraces, the heat flow data become ambiguous. Lunar Prospector produced evidence for hydrogen deposits at the lunar poles, which are currently being further explored by the LCROSS and LRO missions. The Japanese Kaguya mission has better defined the farside gravity field, defined regions of pure anorthosite, and gave the first look at the shallow subsurface on a regional scale. The Indian Chandrayaan mission showed the character and spatial distribution of OH/H_2O on the lunar surface and indicated the presence of water ice in the polar cold traps. Continued study of the Apollo samples has also shown the presence of water in the lunar interior. So why do we need to continue to study the Moon? Examples of why include: 1) Dating of planetary surfaces through crater counts is based upon the chronology developed for the Moon and anchored by sample analysis; targeted sample return of impact melt from large lunar craters will considerably enhance exploration not only of the Moon, but other planetary surfaces. 2) Space weathering of airless bodies is understood from analysis of lunar samples in conjunction with orbital data. 3) The Moon represents an early end-member in terrestrial planet evolution. Apart from being an obvious place for humans to learn to live and work productively off planet, the Moon holds scientific keys for understanding the origin and evolution of terrestrial planets and represents the Rosetta Stone for the study of our solar system.