ROLE OF ORGANIC CARBON OF OXBOW LAKES IN MAKING AQUIFERS VULNERABLE TO ARSENIC MOBILIZATION

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Introduction

Dissolved organic matter (DOM) is implicated in arsenic (As) and iron (Fe) mobilization via microbial metabolic processes. The Ganges Delta Plain is a key area where As contamination of groundwater constitutes a human catastrophe. The delta plain geomorphology comprises a large number of abandoned meander bends, or *oxbow lakes* (Donselaar et al., 2017) characterized by an anoxic environment in the lower part of the lake water column (*hypolimnion*). Organic matter (OM) is preserved in this environment and provides a perfect environment for microbial oxidation and mobilization of As-bearing Fe-oxides. Additional deposition of human introduced sewage wastes into the lake waters adds to a rich source of nutrients to the indigenous microbial communities.

In this study the oxbow lake in Haringhata, West Bengal India (Fig. 1) was analysed to understand the relation between their role in accelerating microbial metabolism and As release. The aquifer bodies of the block Haringhata were reported earlier as relatively less As-contaminated than north of West Bengal (Ghosh et al., 2015a). However, the aquifers are topped by Pleistocene deposits rich in As and Fe, and are vulnerable to contamination if triggered with high amounts OC. The rich sources of OC trigger metabolic activity of large microbial communities leading to the dissolution of immobile sediment-bound As into groundwater. Surface and bottom water of the oxbow lake and groundwater from the adjacent aquifer were sampled and various geochemical and microbiological aspects were studied.

Result

The Biological Oxygen Demand of surface and bottom waters were very high (5.5 to 6.2 mg/l and 7-9.5 mg/l, respectively) indicating the high OC content and microbial activity. In a microbial culture-based study of both the samples coliform bacteria like *Escherichia coli*, *Enterobacter*, *Streptococci* and *Pseudomonas* sp. were identified by 16S rRNA sequencing and biochemical characterization. Various species of *Pseudomonas* and *Acinetobacter* were found in the groundwater samples of OL-1, and *Pseudomonas* sp., *Rhodoferrax* sp. and *Bacillus* sp. were detected in OL-2. The surface water had high DOC, with a greater amount of labile humic substances which were relatively less labile in the bottom water and further reduced in groundwater, when tested by microcosmic lability tests. In contrast, the concentrations of dissolved As and Fe (by ICP-OES) was in reverse order in the three water sample types i.e., surface, bottom and groundwater of OL-1 and OL2. Characterization of some lipid moieties by ^{13}C NMR of DOM indicates the presence of coprostanol along with other sewage-derived sterols in the surface and bottom waters of both OL-1 and OL-2. Interestingly, such signatures were also found in relatively less quantities in the groundwaters. Moreover, the fresh algal and terrigenous signatures in the groundwater samples clearly indicate enrichment due to leaching of lake waters.

Figure 1 *The study location in Haringhata block, West Bengal, India. Note the omnipresence of (partly sediment-filled) oxbow lakes (curved lines). Field of view is 12 x 6 km.*

Conclusions

The widespread occurrence of oxbow lakes in the Ganges Delta Plain comprises large reservoirs of OC, which play a crucial role in controlling the microbial population dynamics. The fresh water-derived algal signatures along with sewage markers in aquifer waters clearly indicate the leaching of lake water. Earlier works demonstrated that Pleistocene sediments lean in OC do not sustain a wide range of microbial community (Ghosh et al., 2015b). However, the enrichment of a complex range of labile OC sources makes the aquifer bodies vulnerable to As contamination. This was clearly detected by ICP-OES results. This study clearly demonstrates the contribution of OC depositions and leaching through oxbow lakes in the Ganges Delta Plain.

References

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