Facilitated release of arsenic from polluted sediment in Plateau Lakeshore Wetland by phosphorus input

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ABSTRACT: The effect of exogenous phosphorus on the release of arsenic in the sediment of plateau lakeshore wetland deserves further study. The sediment samples in Yangzonghai Lakeshore Wetland which is located in Yunnan Province was selected as the research object, and the batch experiment method was carried out to monitor the release kinetics of arsenic. It was found that phosphorus input would facilitate the release of arsenic in the short period (less than 3 d), but the release would tend to be minimum after long period (30 d). After the input of phosphorus, the bioavailability of arsenic in the sediment would increase, whereas the sorption capacity for phosphorus decreased.

1 INTRODUCTION

Arsenic (As) contamination is a worldwide environmental problem, which attracts concerns from many scientists as its high carcinogenic activities (Bhattacharya *et al.*, 2007; Islam *et al.*, 2000). Plateau Lake under the arsenic pollution is worth more research due to the high risk to the people in the catchment and also the difficulties of control. Lakeshore wetland is the natural screen for the retention of contaminants, especially the two-side effect of the sediment, which could both be the sink and the source of the contaminants. When the exogenous phosphorus entered into the arsenic polluted wetland, what would happen for the lake environment deserves much more researches.

2 MATERIALS & METHODS

2.1 Sediment sample

Yangzonghai Lakeshore Wetland which is located in Yunnan Province was selected as the research object, and the surface layers (0–10 cm) of the sediment samples were collected. Several basic properties of the sediment was determined, such as pH, sediment texture, contents of organic matter, total phosphorus and arsenic.

2.2 Release of arsenic by phosphorus input

The experiment was carried out by batch method. The sediment sample was freeze-dried and sieved with 1 mm mesh. Specific amount of sediments was put into a series of vials, and different concentrations of phosphorus (KH₂PO₄) solutions were added into the vials as 0, 1, 5, 10, 20, 40, 60, and 100 mg L⁻¹. The

Table 1. Selected properties of arsenic polluted sediment.

Properties	Values
pH	8.13
Sand (%)	37.2
Silt (%)	55.4
Clay (%)	7.41
OM (g kg ⁻¹)	25.7 ± 0.811
TP (mg kg ⁻¹)	473 ± 48.4
TAs (mg kg ⁻¹)	19.8 ± 3.66

release kinetics of arsenic were monitored at the following time points as 1, 2, 4, 10, 24, 48, 72, 168, 360, and 720 h. The concentrations of arsenic both in the water and sediment was measured, and the sequential extraction method was used for the determination of speciation of arsenic and inorganic phosphorus in the sediments. Duplicates were conducted for all the experiment and sterilization was avoided as the real simulation of wetland environment was designed.

3 RESULTS AND DISCUSSION

3.1 Basic properties of the sediment samples

Some of the selected properties of the arsenic polluted sediments were listed in Table 1. More than half of the total arsenic existing in the residue state (10.2 ± 0.108 mg kg⁻¹).

3.2 Facilitated release of arsenic

Release of arsenic was observed after the input of phosphorus, and it changed significantly when compared the short and long periods (Fig. 1). For the short period, the release of arsenic increased with the

Figure 1. Facilitated release of arsenic from sediment by phosphorus input, the above is for short period (less than 3 days) and the below if for relatively long period (30 days).

increasing concentrations of input amount of phosphorus, and when the concentration of phosphorus increased to 10 mg L^{-1} , the concentration of arsenic in the water exceeded the level III limit for environmental quality standard for surface water after 4 h. When the concentration went to 60 mg L^{-1} , the concentration of arsenic exceeded the level V limit after 10 h.

Interestingly, for the relatively long period, the concentration of arsenic in the water all showed the trends of decreasing. After 30 d, the concentrations of arsenic all went below the level III limit, regardless of the phosphorus input amount. The results might attributed to the counter balance of arsenic between water and sediment phases, and the microbes might play a significant role which deserved further exploration.

3.3 Speciation of arsenic and phosphorus in the sediment

The speciation of the arsenic and inorganic phosphorus was monitored after the input of phosphorus. The data at 30 days were showed in Figure 2. After the input of phosphorus, the activities of the arsenic in the sediment showed a shift trend from inert to activate, and the ratio changed from 51.51% to less than 40%, indicating that phosphorus input increase the relative activities of arsenic in the sediment. And the ratio of activate part of arsenic increased with the increasing input of phosphorus.

On the other hand, the ratio of inorganic phosphorus didn't changed much compared with the original sediment, although the total amount of phosphorus of the sediment increased (data not shown). Another obvious trend was shown in Figure 2 that the ratio of activated phosphorus of the sediment increased with the increasing input of exogenous phosphorus, which indicates

Figure 2. Speciation of arsenic and inorganic phosphorus in the sediment after phosphorus input for 30 d.

that the worse eutrophication not only increased the bioavailability of the arsenic in the sediment but also decreased its phosphorus sorption capability (Rubinos *et al.*, 2011).

4 CONCLUSIONS

Phosphorus input would facilitated the release of arsenic in the short period (less than 3 d), but the release would tend to be minimum after long period (30 d). After the input of phosphorus, the bioavailability of arsenic in the sediment would increase, whereas the sorption capacity for phosphorus decreased.

ACKNOWLEDGEMENTS

This project was supported by the National Natural Science Foundation of China (grants 31560147 and 51469030).

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