

Preliminary Results on the Fate of Perchlorate in Near Surface Sediments in the Lake Waco/Belton Watershed

Introduction

The fate of perchlorate in near surface sediments is of interest. Perchlorate in sediment porewater is likely to be less subject to drastic concentration changes as well as being a better indicator of the available pool for plant uptake. In addition, microbial transformations of perchlorate are likely to take place in the sediment rather than bulk stream water due to the typical oxygen concentrations above 1 ppm. In order to determine the concentration of perchlorate and the potential for microbial transformation of perchlorate, dialysis samplers were deployed at a number of locations surrounding the McGregor facility.

Peepers are diffusion chambers, which can be used to determine the vertical distribution of most soluble constituents in soil pore water. They have been used to study the distribution of common anions and cations including most metals, dissolved organic carbon, toxic organics, and many other geochemical parameters. The chambers allow discrete vertical distribution profiles that are particularly useful in soils or sediments which are highly stratified over a short distance or in which there are rapid changes in redox zones over small distances. One common type of system that exhibits these qualities and has been investigated using this technique is wetlands. Peepers have been found to be superior to other pore water collection techniques in these systems.

Method

A typical chamber is 60 cm long and capable of holding 11 ml of water every 2 cm. The water wells were separated from the soil matrix by two membranes, one 8 μm and the other 0.45 μm . The chambers are inserted into a saturated medium to the desired depth and allowed to equilibrate for a given period of time 2-4 weeks. After the chambers have had time to equilibrate with the surrounding pore water the chambers are removed and sampled for the chemical species of concern. The sampling is normally accomplished by removing the water in each well by syringe. This can be conducted under a nitrogen blanket to prevent changes due to oxidation reactions. Modifications can be made to suite particular site requirements, needed vertical resolution, or equilibration times.

Three peepers were inserted on May 14, 2001. Locations sampled included the North Branch of the South Bosque at Highway 317, the South Branch of the South Bosque at Mother Neff Loop, and Harris Creek at Highway 84. Peepers were retrieved May 28, 2001. Samples were analyzed for a variety of anions including perchlorate, sulfate, nitrate, nitrite, phosphorous, and chloride. Bulk water samples and some plant samples were taken at the time of insertion.

Results

At two of the locations sampled (S. Bosque at Highway 317 and Harris Creek at Highway 84) there were detectable concentrations of perchlorate in the sediment profile. No perchlorate was found in sediments at the third location. Table 1 lists the perchlorate

concentration in the bulk water at the time the peepers were inserted. In addition, plant samples were also collected at two of the locations (dry weight perchlorate concentrations are listed). Figure 1 presents the anion profile below the sediment water interface at S. Bosque at 317. Perchlorate concentrations ranged from 4 to 15 ppb with no apparent trend. Little nitrate was present and there was some indication of sulfate reduction in porewater near the sediment water interface.

Figure 2 presents the anion concentration in sediment in Harris Creek at Highway 84. Higher concentrations of perchlorate, although still low (25- to <4), were identified in these sediments. Of interest are the rapidly decreasing concentrations of perchlorate with depth. Concentrations of perchlorate, NO₃, and SO₄ are fairly stable near the sediment water interface (depths of 3 and 5 cm). Perchlorate rapidly diminishes at lower depths coinciding with the use of NO₃ as an electron acceptor. Some sulfate reduction also appears to occur with full reduction of these electron acceptors at depths of 9 cm and greater.

No perchlorate was found in sediments North of Mother Neff Loop on the S. Bosque South Branch.

Location	Bulk Water Perchlorate Concentration (µg/l)	Plant Species	Concentration of Perchlorate in Plant mg of ClO ₄ /kg dry plant
317	440	Algae	ND
84	49	Not Collected	
S. Bosque at Mother Neff Rd.	ND	Algae	5.52

Figure 1. Concentration of Anions in Pore Water Sediments Upstream of Highway 317 on N. Bosque.

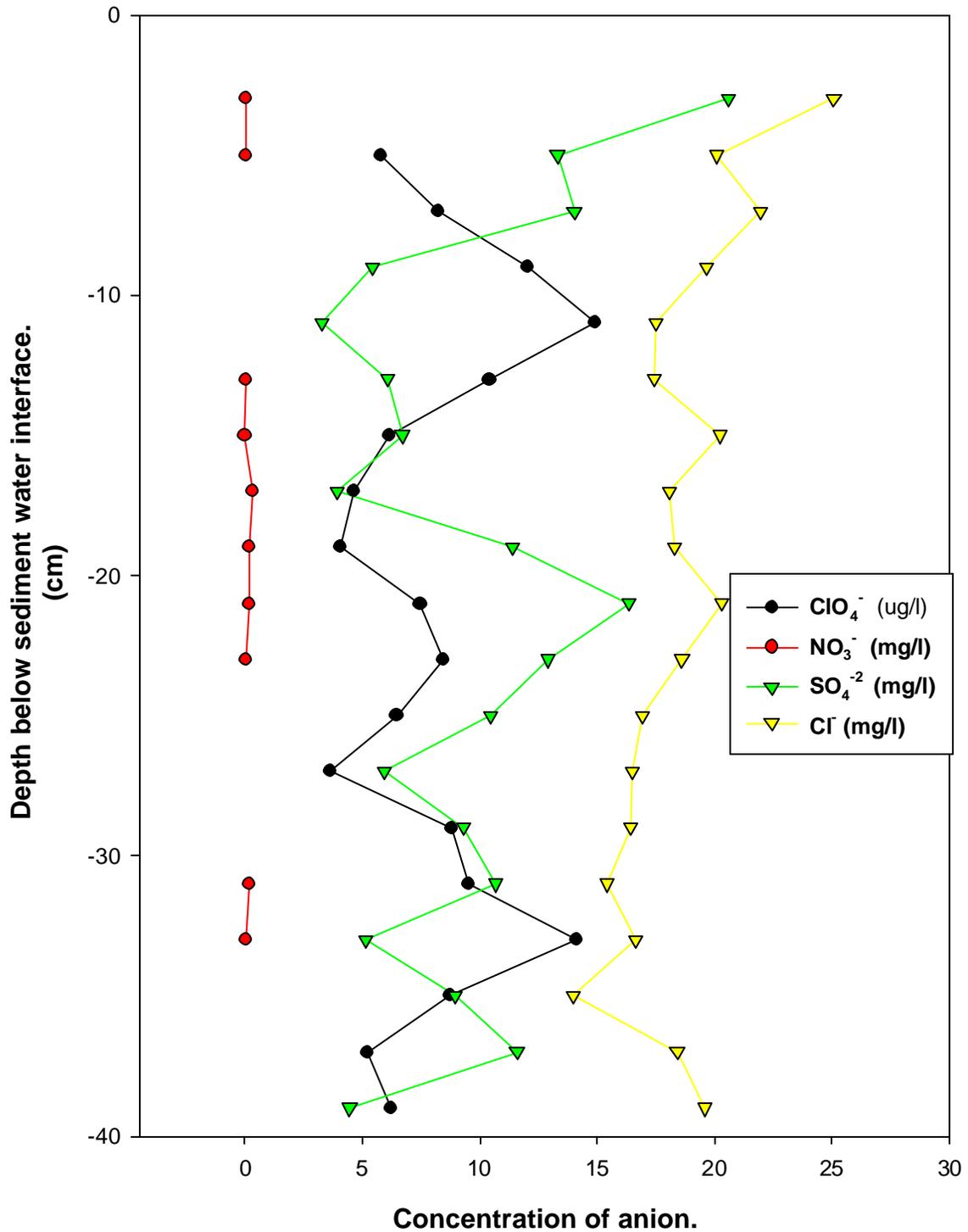


Figure 2. Concentration of Anions in Pore Water Sediments Upstream of Highway 84 on Harris Creek.

