MERCURY IN SOILS, SEDIMENTS, AND CLAMS FROM A NORTH CAROLINA PEATLAND

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Abstract. Mercury concentrations were measured in samples of peat soils, sediments and clams (Rangia cuneata) from a peatland region of the Albemarle-Pamlico Peninsula of North Carolina. Total Hg concentrations in peat cores ranged from 40 to 193 ng g⁻¹ (dw); no depth-related trends were noted. Mercury concentrations in surface sediments from canals draining the peatlands and from the Pungo River that receives this drainage ranged from 8 to 20 ng g⁻¹ (dw). Selective extractions of these peat and sediment samples revealed that the bulk of the Hg was associated with organic matter-associated fractions (particularly humic/fulvic acid bound and organic-sulfide bound fractions). No Hg was detected in the relatively mobile and bioavailable water-soluble or ion-exchangeable fractions. Total Hg concentrations in the soft tissues of clams from the Pungo River ranged from 25 to 32 ng g⁻¹ (~WV~). NO concentrations of methyl Hg above the detection limit of a 25 ng g⁻¹ were measured in soils, sediments, or clams. These data indicate that Hg concentrations in this region are at the low end of the distribution of levels reported for uncontaminated systems and that mining of these peatlands is unlikely to significantly elevate Hg concentrations in the receiving estuarine system.

1. Introduction

North Carolina's coastal wetlands comprise approximately 2.6 x 10⁶ km² of peatlands containing an estimated 540 x 10⁶ tonne of harvestable peat (Ingram and Otte, 1981). Recent increases in demand for portions of these peatlands for agricultural conversion and in the peat for energy uses have generated concern for the environmental effects that peat mining activities may have on adjacent coastal ecosystems. Sensitive coastal estuarine environments may be impacted by peat mining operations through the release of trace metals from disturbed peatlands into adjoining surface waters, from both the liberation of peat soil pore waters during mining operations and surface run-off from peatlands during and after mining operations. Particular concern in this region arose concerning the release of Hg due to reports of concentrations of this element in peatland drainage water far in excess of state and federal water quality standards (ESE, 1983).

Research in peatlands in Minnesota (Clausen et al., 1980) and Finland (Simola and Lodenius, 1982) implicated drainage from peatlands as a source of elevated Hg concentrations in receiving waters. In addition, the high affinity and adsorption capacity of peat for Hg suggests that atmospheric inputs of Hg to developing peat deposits would be strongly bound and thereby accumulate with the peat (Madsen, 1981). Mining of peat could expose the anaerobically preserved peat to oxidizing conditions with the possibility that the associated Hg, accumulated over thousands of years, could be rapidly mobilized into adjoining surface waters.

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Given these concerns, this study was initiated in order to: (1) determine concentrations of total and methyl Hg in peat, sediment and clam (Rangia cuneata) samples from the Pungo River region of coastal North Carolina; and (2) determine the geochemical distribution of Hg in the peat and sediment samples among the water soluble, ion-exchangeable, organic, and residual phases.

2. Methods

2.1. Sample Collection

Samples of peat, river bottom and canal sediments, and clams (Rangia cuneata) were collected in October 1983 and February 1984 to correspond with the late summer-early fall dry period and the late winter rainy period respectively. The sample sites were located in the western Albemarle-Pamlico Peninsula of North Carolina, specifically the Pungo River drainage and subestuary area. Peat samples were collected from four sites (PCA3, PCB3, PCD3 and PCZ) at surface (0 to 2 cm), 20 cm, and 1 m depths using a polyvinylchloride corer. Surface sediment samples were collected from canals draining the peatlands adjacent to sites PCA3, PCB3, and PCD3. Additionally, surface sediments from the Pungo River, which receives the canal drainage, were collected from four sites (P-Am, P-1, P-8, and P-13). Clam samples were obtained at sites P-8 and P-13. For detailed site descriptions see Evans et al. (1984). All samples were handled with plastic gloves and stored in acid washed polypropylene tubes at 4 °C prior to analysis.

2.2. Chemical Analysis

2.2.1. Water, Volatile Organics, and Total Mercury Concentrations

Percent water and total volatile organics in soil and sediment were determined using standard procedures (APHA, 1971). The digestion procedure used to prepare soil and sediment samples for the analysis of total Hg was adapted from the technique developed by Agemian and Chau (1976). The wet sample equivalent of 1 to 2 g (dw) was weighed into an acid-washed 300 mL biological oxygen demand (BOD) bottle. The digestion procedure was initiated by adding 15 mL of a 2 : 1 concentrated H₂SO₄ : HNO₃ (Baker Instra-Analyzed, J. T. Baker Chemical Co., Phillipsburg, NJ) mixture directly to the sample. The BOD bottles were placed in a 60 °C water bath and heated for 2 hr. After cooling, 10 mL of 1 5% (w/v) aqueous solution of potassium permanganate (KMnO₄) were added. More of the oxidant was added to the mixture if the characteristic purple color did not persist for 30 min. After 30 min, 5 mL of a 5% (w/v) aqueous solution of potassium persulfate (K₂S₂O₈) were added and the mixture was kept overnight at 10 °C. Samples were diluted to 100 mL with deionized-distilled water. The excess KMnO₄ was reduced by the addition of 5 mL of a 12% (w/v) aqueous solution of hydroxylamine hydrochloride (NH₂OH·HCl). This extraction procedure has been found to be suitable for sediments and soils rich in organic matter (Agemian and Chau,