U.S. Geological Survey Fact Sheet

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South Florida ecosystems— The role of peat in the cycling of metals

Peat and Ecosystem Variability

At first glance the sawgrass prairie wetlands that make up a large part of the "Everglades" ecosystem in South Florida appear uniform across the landscape. From the air, except for the interspersed hardwood hammocks and the obvious vegetational differences along entrenched waterways, the sawgrass appears homogeneous and unchanging. This ecosystem, however, is extremely heterogeneous. This is due to the presence of "micro-habitats" that vary both spatially (horizontally and vertically) and over time (seasonally and longer). The forces that drive this heterogeneity include obvious, dominant physiographic characteristics such as climate, topography, and underlying geology. They also include less obvious, subtle forces such as wet-dry cycles, organic matter accumulation, trace element mobilization and transport, and the influence of human activities. These forces govern the dynamic chemical, physical, and biological processes that define the sawgrass ecosystem. An important concept to understand is that *this ecosystem is highly variable* and by understanding the magnitude of the variability we are better able to define the critical processes that drive the ecosystem.

Geochemical sampling in the sawgrass-mangrove ecotone, South Florida ▼

Agricultural Influences on Landscape Variability

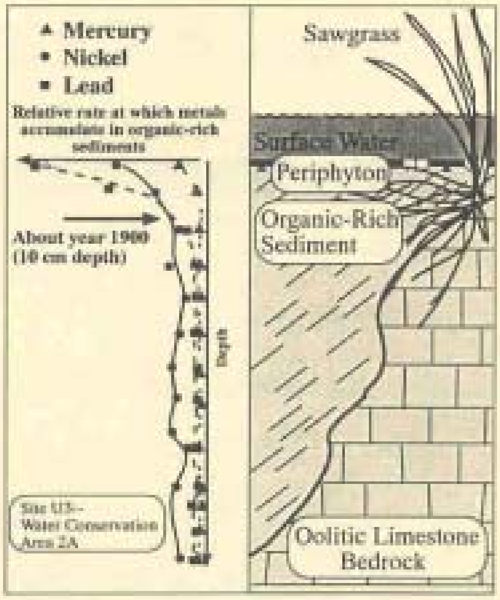
Agricultural practices and the management of surface water flow, occurring in and near the Everglades Agricultural Area (EAA) south of Lake Okeechobee, are important contributing factors in observed recent changes in the sawgrass prairie. The flow of waters enriched in nutrients is thought to play a role in mercury accumulation and cycling and in changes in vegetation communities (especially changes in algal populations and an increase in cattail and decrease in sawgrass). Studies demonstrate a variability gradient in this influence that occurs primarily from north to south; however, the relative importance of surface vs. ground-water flow patterns, and the associated hydro-geochemistry, has not been defined.

The Role of Peat in the Ecosystem

An important driving force in the sawgrass ecosystem of South Florida is the role of accumulated organic matter (peat), and the sawgrass growing in it, on the cycling of trace elements (metals) and nutrients (e.g., nitrate and phosphate). Understanding the natural variability within a vertical column of peat helps us better understand the cause of sudden major changes that sometimes create an environmental "crisis." For example, the discovery of high levels of the toxic metal mercury in panther, fish, and alligator signals a shift in some ecosystem process(es) that lead to the metal's uptake and "biomagnification." But when did this shift occur, what was the cause(s) of the shift, and what role does the peat have in mercury cycling?

The Biogeochemical Peat Cycle

Chemical elements move through the environment in biogeochemical cycles. In the sawgrass wetland, as well as any other ecosystem, there are three major components to this movement: (1) an element source (bedrock, soils, agricultural practices, atmosphere, etc.), (2) a transport mechanism (aquatic phases, biota, chemical species, etc.), and (3) a place of deposition (usually sediment). We call this cycle biogeochemical because, in addition to the role of chemical and physical processes, the cycling of elements strongly depends on its interaction with living organisms—from bacteria and algae to humans. Because peat is the dominant sed-



Typical metal accumulation rates as a function of organic-rich sediment depth, USGS South Florida Critical Ecosystem Program

iment type within this ecosystem, an understanding of the transport, mobility, and deposition of metals (including mercury) in South Florida necessitates an understanding of the processes that characterize organic-rich sediments.

Objectives of Current USGS Trace Metal Studies

Using the north-south nutrient gradient hypothesis:

1. Define the importance of the solid phase (organic-rich sediments) on mercury cycling—that means, understand the role and interrelationship of depth, time of deposit, organic matter decomposition, pore water trace element chemistry, and other geochemical parameters on the movement of mercury through the system.
2. Determine what effect assemblages of trace elements (including the environmentally important elements Pb, Cd, As, Cr, Cu, and Zn) have on mercury transport mechanisms. Can this information help explain mercury's bioavailability?
3. Using the sediment record, determine whether sources of trace elements (including mercury) have changed over time.

RESULTS OF INITIAL STUDIES

Enrichment Factors:

Using ratios of trace element levels in sawgrass (normalized to some nonmetabolic element like aluminum) to the chemistry of the peat substrate shows that metabolic elements are being bioconcentrated in sawgrass living tissue (their concentration in sediments is proportionally less than in living tissue). This means that P, K, Cu, Fe, and Zn are in forms readily absorbed by sawgrass. In contrast, concentrations of nonessential metals (such as Cr, Co, Pb, and Hg) are generally not being concentrated in sawgrass living tissue over what is in the sediments. This means that nonessential metals are not being cycled but are accumulating in the peat.

Vertical Metal Concentration Variability:

Accumulation rates (calculated in grams per square centimeter per year) for metals show a dramatic decrease with depth in the sediment core. These rates are calculated based on lead-210 sediment-dating methods used for recent (centuries-old) material. This decrease is independent of whether the core was taken north (close to EAA and its drainage into Water Conservation Area 2A) or south (nearly 15 miles from the drainage from EAA). A baseline metal concentration seems to be reached in sediments that are about 100 years old. The accumulation rates of metals in the individual sediment column varies north to south and may reflect the influence of EAA. For example, mercury shows slightly higher accumulation rates in sediment cores collected in the northern part of Water Conservation Area 2A when compared to cores in the southern part of 2A. Accumulation rates for Ni, V, and Zn show very little difference between the areas whereas Pb is highest in the near-surface layers of cores collected from the South. Definitive conclusions and interpretations must wait until data are received for additional cores currently under investigation.

RESEARCH PLAN—1996

- Field studies will emphasize the geochemical processes occurring in organic-rich sediments within the Taylor Slough, Everglades National Park. This has two purposes, the slough represents the eastern-most major non-canal surface drainage feature and is the "end of the hydrogeologic pipe." It is also a major contributor of fresh water to the eastern side of Florida Bay and ties in with on-going water and sediment studies within the Bay.
- Results from the Taylor Slough study will help direct a similar biogeochemical characterization of processes in Shark River Slough, the major surface water drainage feature in the Everglades system.

PLAN OF STUDY:

Product Plans

- Poster presentation, Orlando, Florida, American Chemical Society meeting, Aug. 1996.
- Yearly progress report for clients and partners (SFWMD, NPS, State of Florida).
- Synthesis reports detailing geochemical processes and trends for SFWMD regions and NPS units.
- Close coordination of these studies will be maintained with the Florida Department of Environmental Protection and other clients and cooperators.

Anticipated Schedule

May 1996—Sample Taylor Slough along north-south traverse, Everglades National Park.

July-August 1996—Sample analysis and abstract preparation; synthesis of geochemistry with age-dated cores.

February 1997—Report preparation; synthesis of two field seasons (regional and temporal). Plan for field based on '95-'96 data and partner feedback.

April 1997—Third field season.

January 1998—Begin synthesis report.

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