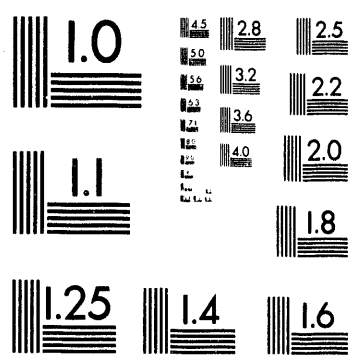
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FINAL REPORT

SECOND INTERNATIONAL SYMPOSIUM ON THE BIOGEOCHEMISTRY OF MODEL ESTUARIES: ESTUARINE PROCESSES IN GLOBAL CHANGE

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SUMMARY OF DISCUSSIONS:

SECOND INTERNATIONAL SYMPOSIUM ON THE BIOGEOCHEMISTRY OF MODEL ESTUARIES: ESTUARINE PROCESSES IN GLOBAL CHANGE

The Second International Symposium on the Biogeochemistry of Model Estuaries was held from the 15th to the 19th of April, 1991 at Jekyll Island, Georgia - U.S.A. The overall objective of the Symposium was to bring together a diverse group of nearly 60 international scientists conducting research on processes in model estuarine systems. The overall goal of the Symposium was the evaluation of estuarine processes in global change.

The topics of estuarine processes included:

- Particles and Sedimentology
- Trace Elements and Metals
- Organic Chemistry
- Nutrients Cycling

Four days of presentations were followed by a half day of discussion on the advances and our understanding of these topics and the overall goal of assessing estuarine processes in global change. What follows is a synopsis of this discussion.

Estuarine Physical Classification and Chemical Definition

The physical classification of estuaries depends primarily on those hydrologic properties that affect residence and flushing times, since it is the ratio of these parameters which determines estuarine biogeochemical cycling. Model variables and functions that yield prediction of these properties include changes in the time scales of tides and river flow.

The chemical definition of estuaries depends in first defining the salinity boundary functions. The landward boundary can be either zero salinity or the tidal fall line. The seaward boundary is the open ocean and thus, includes the shelf as a contiguous estuarine component. In some cases, the seaward boundary includes unconfined riverine plumes.

Estuarine Inputs and Outputs

Inputs to estuaries include fluvial, atmospheric, offshore and benthic functions. It is the relative magnitude of the terms in these functions which determines those properties of estuaries to act as sources or sinks of material.

The fluvial sources to estuaries include direct upstream and lateral terms. Indirect fluvial sources can include groundwaters whose role is largely unknown.

The atmospheric input is both direct to the water body and indirect to the watershed. In populated areas, the atmosphere can be an important source for nutrients and/or toxic elements. The atmosphere also acts as a complementary reservoir for the influx and eflux of important carbon based radiative gases.

Offshore inputs of estuarine materials can include both particles and diagenetically mobilized elements.

Benthic inputs to estuaries include nutrient processing such as nitrification and denitritification. This benthic term ultimately depends on the cycle of carbon as it relates to trophic diversity including filter feeders. The estuarine carbon budget may include several gigatons missing from the global carbon budget.

Estuarine Role in Global Change

One of the most evident impacts of global change for estuaries will be sea level rise. This will likely alter the seaward versus landward transport of materials and the creation of more tidal wetlands. The landward transport of materials across the offshore boundary is one of the more pressing concerns in global change. The transport will also be affected by alteration in the basic hydrology of estuaries that include the construction of dams. This alters the processing and subsequent sedimentation of estuarine particles. Changes in the chemical nature and distribution of the sediments will likely alter the chemical buffering, assimilation capacity, and anoxic poise of estuarine sediments. With greater control of sewage discharge into estuaries, it is likely that the atmospheric to fluvial input ratio will increase.

Another manifestation of global change will be climatic warming. This is likely to change the basic hydrography and biological production of estuaries. The hydrographic changes will include those of rainfall and evapotranspiration in the watershed. Other factors will include less ice cover and changes in dredging practices. The biological changes will be changes in the relative rates of productivity versus remineralization. This will likely change the capacity of an estuary to act as a source or sink of carbon and its gaseous byproducts. Changing anthropogenic impacts including altered uses such as deforestation in the watershed and changes in dredging practices will also alter the role of estuaries as sources or sinks of particles. Likewise, changes in waste management will affect the discharge and storage of toxic materials. This will ultimately determine whether estuaries should act as appropriate "waste space" for the discharge and processing of materials.

Estuarine Sampling

There should be some effort to establish some international protocols on the sampling of estuaries. One start could be the consistent use of molar concentration units and filtration protocols. The use of unfiltered samples should be discouraged.

The traditional chemical means to sample estuaries is by salinity while that of other disciplines use geographic location. In either case, hydrological parameters and features should be included. Estuarine sampling should also be as synoptic as possible for a multitude of parameters that have some international commonality. Such synoptic samplings should occur under a variety of time and space scales. For example, the time scale should include diurnal/tidal, seasonal, and episodic frequencies. The space scales should include the estuary proper as well as boundary areas such as fresh and saline marshes besides inner and outer shelves.

One of the most important tasks for estuarine sampling is an accurate evaluation of chemical fluxes (riverine, atmosphere, cross shelf and benthic). This will ultimately require development and use of estuarine tracers. Such tracers should be able to track both conservative and reactive elements. Examples include natural radionuclides and stable isotopes. Others include transient (e.g., fallout isotopes) or purposeful (e.g., fluorescent particles) tracers.

One of the more important long-term aspects of estuarine sampling is to establish prehistoric and historic records. Such records exist primarily in undisturbed sediments which should be carefully determined. These records should reveal the past intensity in cycling of biological productivity, diversity, and community structure.

Finally, estuarine sampling should include international cooperation. Such cooperative ventures should be pragmatic in their approach for the extrapolation of results between global estuarine case studies.

Estuarine Modeling

The approach to estuarine modeling should start with salt and water and end with chemistry that includes reactions and their kinetics. The simplest approach is one of the ability to solve a mass balance for estuaries, but this needs to include rare episodic events. A classical approach to estuarine modeling is one of steady state based on property-salinity variables. Unfortunately, this approach is rarely realistic because most estuaries do not behave in steady state and the results conceal internal competing processes. Nevertheless, they have some utility in qualitatively predicting the locations if not nature of nonconservative estuarine processes. Also, this approach allows the predictions of effective zero salinity estuarine endmembers and, thus, some estimate of the magnitude of nonconservative input or removal.

More useful approaches to estuarine modeling are nonsteady state whose basis is hydrological. This approach is usually one of contiguous estuarine segments related by continuity equations.

The products of estuarine modeling need to include the prediction of both solute and particle fluxes. Two other important products are the time constants of residence and flushing. Ultimately, estuarine modeling should provide a predictive capability of the sources and sinks for critical estuarine materials such as carbon that relate POC and DOC at both the molecular and particle level. Finally, the success of estuarine modeling will depend on the development of tracer tools with international calibration. Isotopic examples include ^{14}C, ^{10}Be, and transuranic radionuclides as well as organic biomarkers.

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