SHALLOW STRATIGRAPHIC CONTROLS ON SURFACE WATER-GROUNDWATER MIXING AND GEOCHEMICAL FATE IN THE BENTHIC ZONE OF AN ESTUARY

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HOW DOES STRATIGRAPHY INFLUENCE SHALLOW SURFACE WATER-GROUNDWATER MIXING AND THE FATE OF REDOX-SENSITIVE SOLUTES DISCHARGING TO AN ESTUARY?

1 SITE: INDIAN RIVER BAY, DELAWARE (USA)

Interfluve Conceptual Model

Above: Shown-perpendicular view beneath the surface. The groundwater discharge is greatest near shore.

Shallow stratigraphy can affect geochemical processes near the sediment-water interface through three mechanisms:

- Vertical fluxes (vertical gradients)
- Diffusion of gases (laterally migrating gases)
- Biological production (biological activity)

Paleovalley Conceptual Model

Above: Shown-perpendicular view beneath the surface. The groundwater discharge is greatest near shore.

Nitrates in the interfluve are generally larger and more uniform than in the paleovals. Offshore, we observe little evidence of nitrate in the surface water.

METHODS: RESISTIVITY PROBE, PORE WATER SAMPLES, & SEEPAGE METERS

Above: Resistivity probe for profiling bulk conductivity along transects.

Left: Pore water conductivity was generally 3-4X greater than bulk conductivity from probe measurements.

Right: Bulk conductivity to profile sand eliminates small-scale variations in pore water.

CONCLUSIONS:

1) PALEOVALLEYS INFLUENCE THE RATE OF SUBMARINE GROUNDWATER DISCHARGE TO ESTUARIES AND THE BALANCE OF ADEPTIVE-DISPERSIVE TRANSPORT ACROSS THE SEDIMENT-WATER INTERFACE.

2) BETWEEN PALEOVALLEYS, RAPIDLY DISCHARGING GROUNDWATER TRANSPORTS NITRATE CONSERVATIVELY FROM THE TERRESTRIAL AQUIFER THROUGH THE BENTHIC LAYER TO THE ESTUARY.

3) IN PALEOVALLEYS, PEAT LIMITS ADEPTIVE SOLUTE TRANSPORT TO THE ESTUARY. PEAT MAY BE A LOCAL SOURCE OF DOC, AMMONIUM, AND SULFIDE.

4) BENTHIC PALEOVALLEYS, GROUNDWATER FLOWS SLOWLY OVER LONGER DISTANCES, BECOMES MORE REDUCING, AND DISCHARGES DISSOLVINGLY NEAR PALEOVALLEY MARGINS OFFSHORE. THERE, AMMONIUM AND SULFIDE ARE TRANSPORTED NON-CONSERVATIVELY THROUGH THE BENTHIC LAYER BEFORE DISCHARGING TO SURFACE WATER.

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