Factors of Subaqueous Soil Formation

State Factor Analysis

- Jenny's state factor equation for soil genesis:

$$S = f(C, O, R, P, T, \ldots)$$

C = Climate
O = Organisms
R = Relief (topography)
P = Parent Material
T = Time
. . = Other unspecified factors

State Factor Analysis

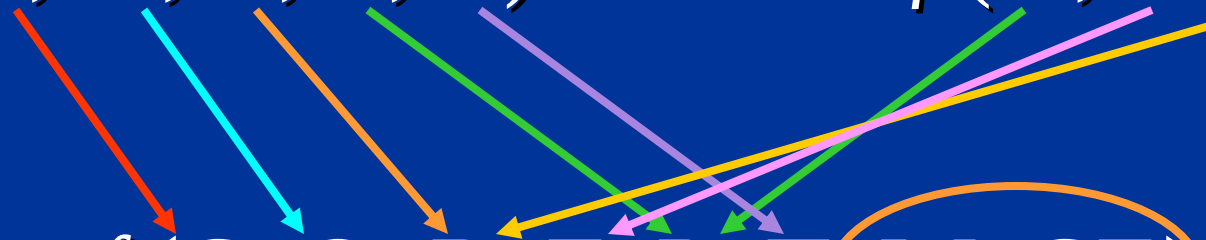
Folger's concept of sediment genesis can be shown in written form as:

$$Se = f(G, H, B)$$

- Se = sediment characteristics
- G = source geology
- H = hydrology (flow regime)
- B = bathymetry

State Factor Equation for Subaqueous Soils

$S = f(C, O, R, P, T)$ $Se = f(G, H, B)$



- $Ss = f(C, O, B, F, P, T, W, CE)$
  - where Ss is subaqueous soil
  - C is climatic temperature regime
  - O is organisms
  - B is bathymetry
  - F is flow regime
  - P is parent material
  - T is time
  - W is water column attributes
  - CE is catastrophic events

- Demas, G. P., and M. C. Rabenhorst. 2001. Factors of Subaqueous Soil Formation: a System of Quantitative Pedology for Submersed Environments. Geoderma 102:189-204.

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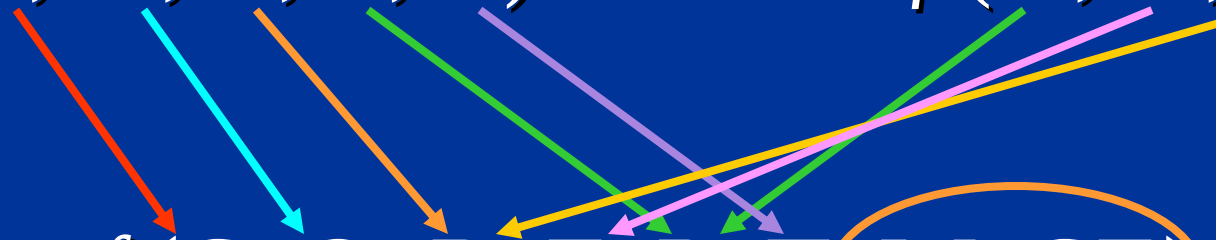
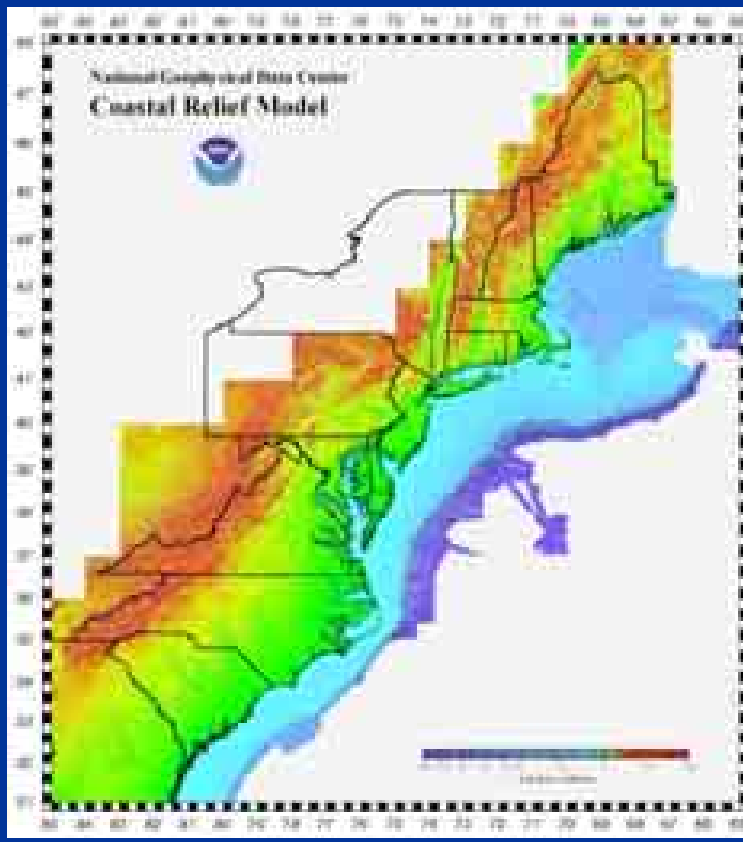


- $Ss = f(C, O, B, F, P, T, W, CE)$
- Not really entirely independent
  - as Jenny's factors were not truly independent

$S = f(C, O, R, P, T)$ $Se = f(G, H, B)$

- $Ss = f(C, O, B, F, P, T, W, CE)$
  - C is climatic temperature regime
  - Climate usually entails temperature and precipitation
  - Precipitation – obviously, not important here
  - Temperature effects are probably going to be regional
  - May be some local effects from groundwater discharge
  - What are the effects of temperature?
    - Affects rates of chemical reactions
    - Affects soil biota



$S = f(C, O, R, P, T)$ $Se = f(G, H, B)$

- $Ss = f(C, O, B, F, P, T, W, CE)$
  - O is organisms
  - Concepts very similar to other soils
  - Macroflora (SAV and Algae)
  - Macrofauna (mostly benthic invertebrates)
  - Microbes

Eelgrass (*Zostra marina*)

Widgeongrass (*Ruppia maritima*)

Vegetation

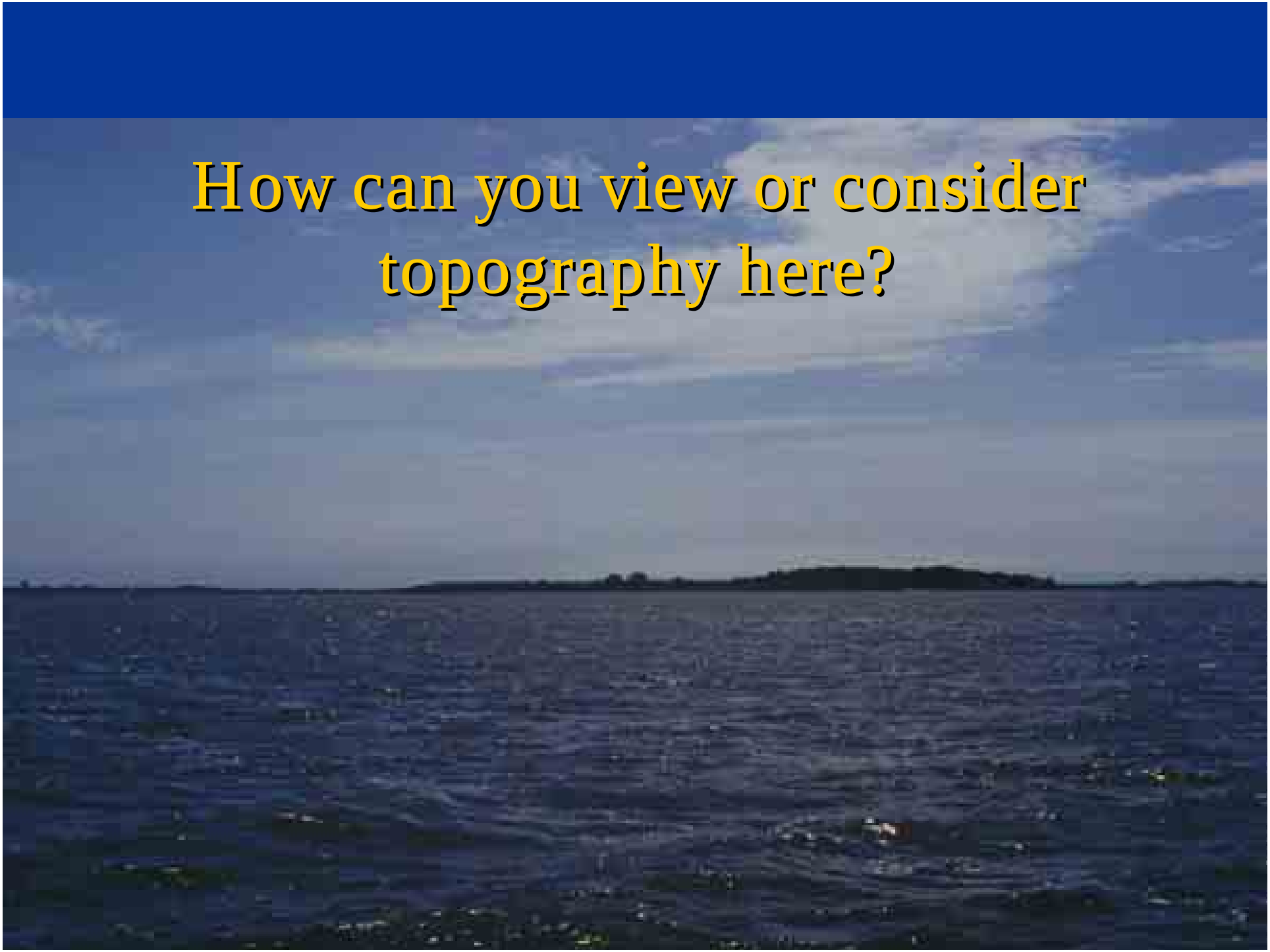
- Adds OM to the soil
  - Energy source for other processes
- Physically stabilizes surface
  - Protects against erosion
  - Slows currents at soil surface

- Growth and burrowing
  - Mixing in the upper zone
  - May help oxidize surface horizon

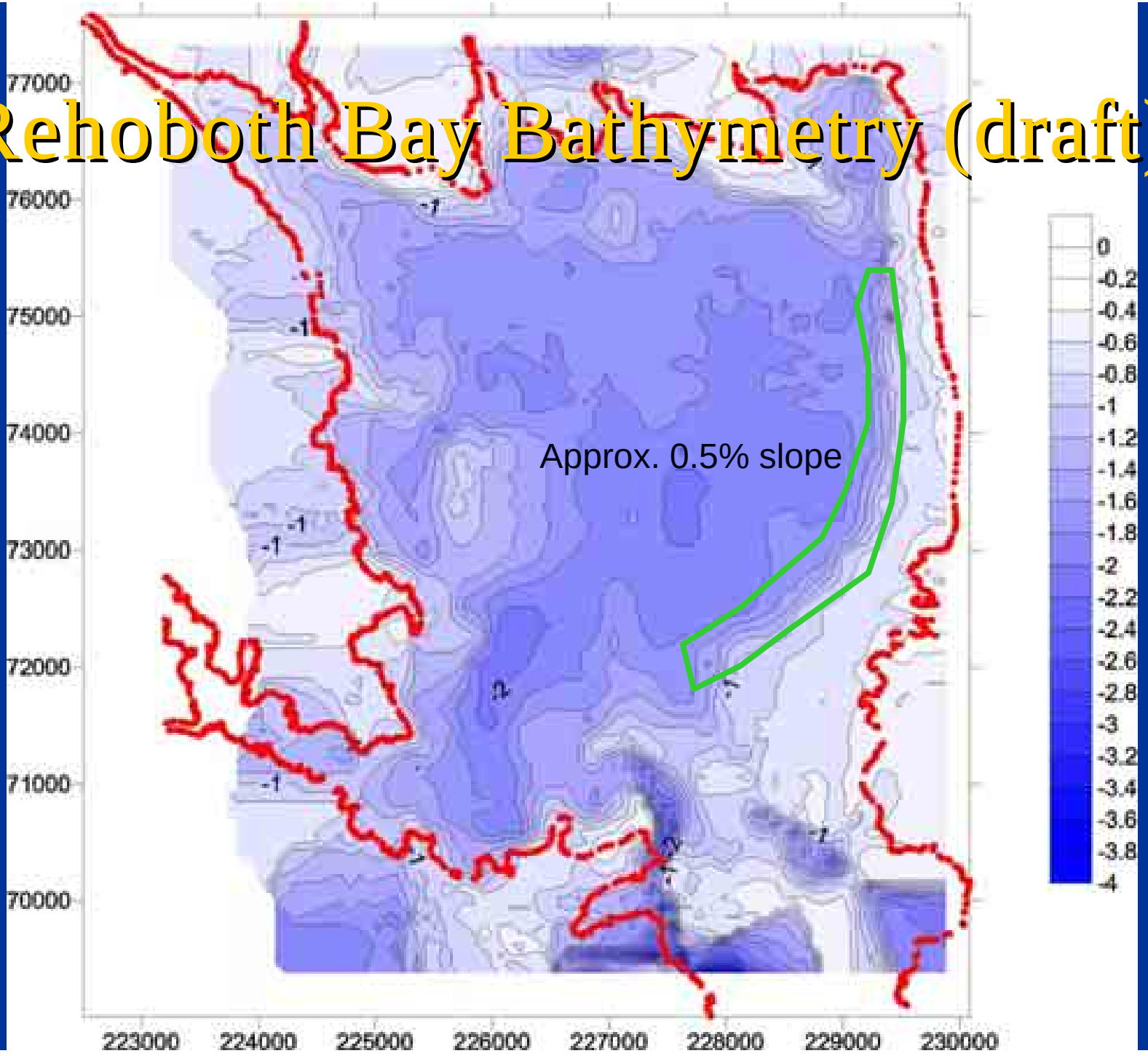

Clam
Snails

$S = f(C, O, R, P, T)$ $Se = f(G, H, B)$

- $Ss = f(C, O, B, F, P, T, W, CE)$
  - B is bathymetry
  - Includes
    - depth of the water - elevation
    - subaqueous topography
      - Slope – very subtle by comparison
      - Aspect
      - Nature of the landform
  - Difficult to observe – will discuss later in more detail


How can you view or consider topography here?

Rehoboth Bay Bathymetry (draft)



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- $Ss = f(C, O, B, F, P, T, W, CE)$
  - F is flow regime
  - Energy (current speed), fluctuation and direction of water movement
  - Related to bathymetry and where you are in the estuary
  - Particularly, where you are with respect to an inlet
  - High energy – Low energy – Stagnant
  - Fluctuating (tidal) - constant

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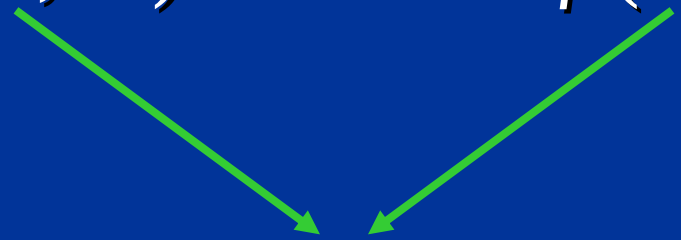

- $Ss = f(C, O, B, F, P, T, W, CE)$
  - P is parent material
  - Potential particle size effects (source geology)
  - Mineralogy (how weathered or fresh is the source)
- Parent Material
  - The ultimate geological source?
  - The sediment?

Soil Series Established in the Sinepuxent Bay Pilot Project

Series Name	Classification
Fenwick	Typic Psammaquents
Newport	Typic Psammaquents
Sinepuxent	co-lo Typic Sulfaquents
South Point	fi-si Typic Sulfaquents
Tizzard	co-lo Sulfic Fluvaquents
Wallops	Typic Psammaquents

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- $Ss = f(C, O, B, F, P, T, W, CE)$
  - T is time
  - What is the age of subaqueous soils?
  - Generally young – but variable
  - Comparable to the soils on floodplains
  - Surface soil materials or buried soils?
  - Some very old - truncated soils?

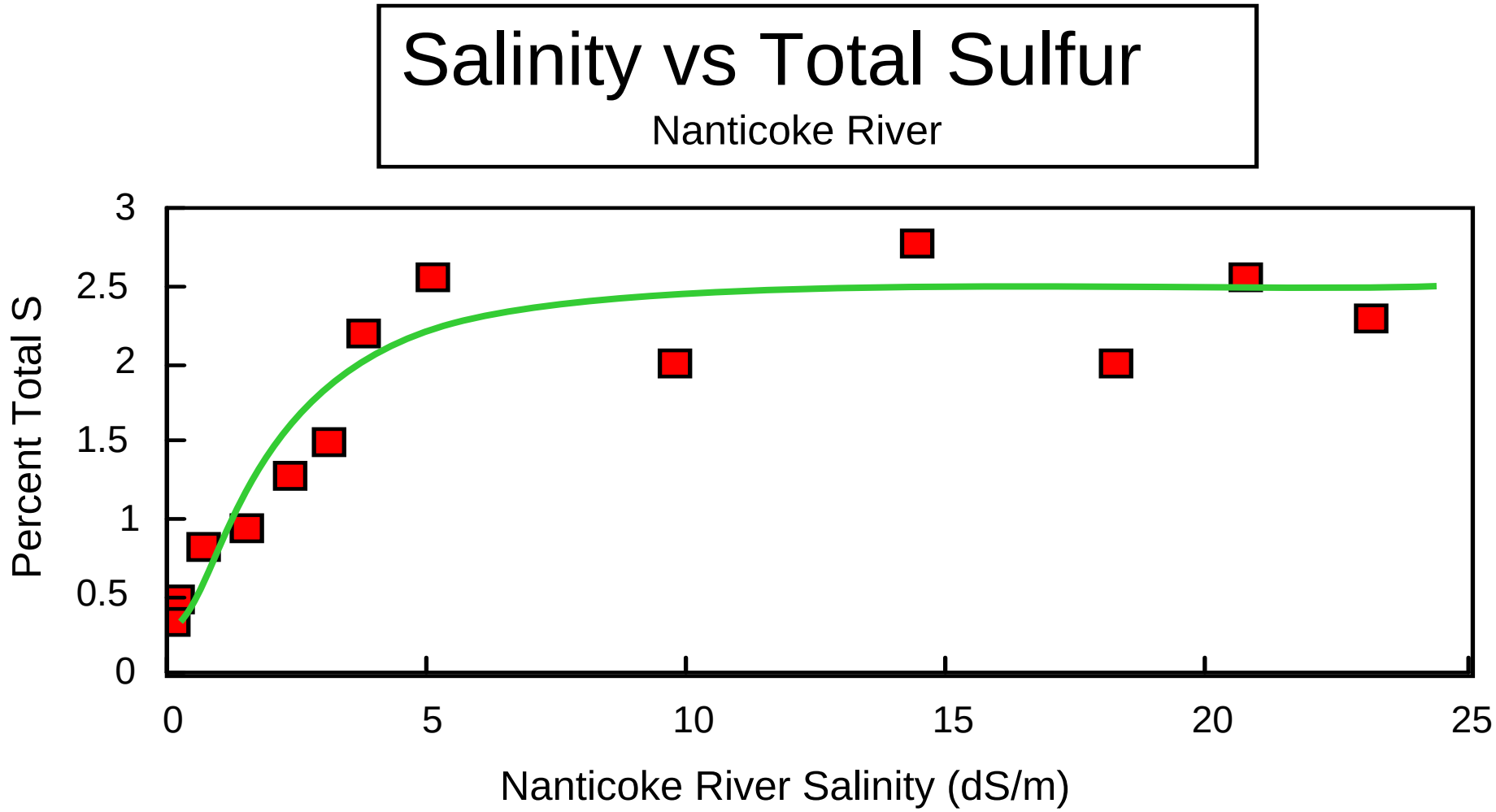

What do you think is the origin of these features?
Are they young?

$S = f(C, O, R, P, T)$ $Se = f(G, H, B)$

- $Ss = f(C, O, B, F, P, T, W, CE)$
  - W is water column attributes
    - Salinity
    - Alkalinity
    - Sulfate content
    - Oxygen levels (anoxia)
  - Rehoboth Bay – 25-30 ppt total salinity
    - Once was fresh
  - Chesapeake Bay
    - Nearly fresh at the Susquehanna discharge
    - Approximately 30ppt at mouth

Propensity for Sulfide Formation

Graph of SO4 and Tot S in marshes – nanticoke River



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- $Ss = f(C, O, B, F, P, T, W, CE)$
  - CE is catastrophic events
  - How stable are the soils and landscapes of these systems?
    - It depends on the system
    - It depends on where you are in the system
  - By geological standards – very unstable
  - By human standards – maybe more stable than you think
  - What is the hurricane return frequency?


Assateague Island
National Seashore

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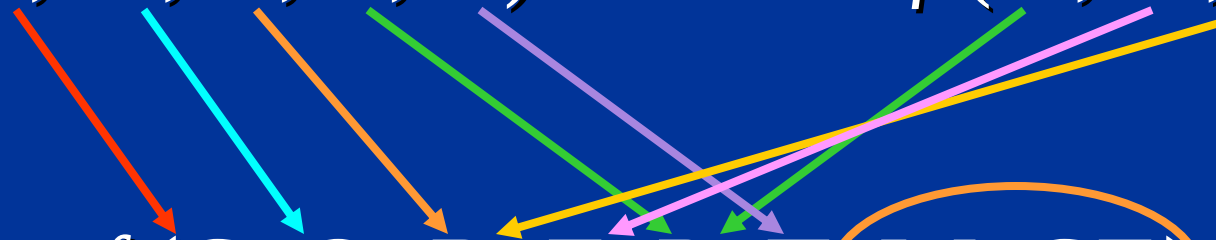

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