CLAY MINERAL DIAGENESIS IN THE RAPPAHANNOCK ESTUARY: AN EXPLANATION

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ABSTRACT

Mineralogical changes observed in bottom sediments along the Rappahannock salinity gradient include: (1) decrease in kaolinite, (2) decrease in dioctahedral vermiculite, (3) increase in illite, (4) appearance of thermally stable chlorite, and (5) appearance of clay-sized feldspar. All of these changes are real. They correlate with increase in bottom water salinity from 0 to 20‰, increase in bottom sediment pH from 5.5 to 7.8, change in grain size distribution, and change in adsorbed ion populations. In the critical area the bottom sediments lose clay by selective sorting and become more silty. The adsorbed ions are Ca and Al in fresh water, Ca and Na with minor K at low salinities, and Na and Ca with major fractions of exchangeable K and Mg at high salinites.

Studies of the suspended sediments over a period of years reveal that illite, vermiculite, kaolinite, and clay-sized feldspar are the normal constituents in the load of the fresh water stream. No mineralogical segregation, by differential flocculation for example, occurs during transport of this suspension along the salinity gradient.

The increase in illite and feldspar content of the bottom sediments is due to normal processes of sediment deposition. The high kaolinite and dioctahedral vermiculite contents of fresh water bottom samples is due to two possible causes. (1) Samples are obtained from drowned, Pleistocene-weathered, terrace materials that possess this basic mineralogy. (2) Bedload sediment with kaolinite–dioctahedral vermiculite mineralogy is deposited in the fresh water region. Thermally stable chlorite is generated in the saline environment, probably from vermiculite. Simple ion exchange is insufficient to generate the chlorite. It forms by diagenesis.