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Spring-neap variation in fecal pellet properties within surficial sediment of the York River stuary, Virginia

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Spring-neap variation in fecal pellet properties within surficial sediment of the York River Estuary

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Abstract

Fecal pellet abundance was measured within the upper seabed of the York River Estuary as part of a larger study investigating relationships between fine sediment aggregates and bed erodibility. Sedimentological surveys were conducted twice a month during the spring and summer of 2011 to coincide with spring or neap tidal cycles. Particle size distributions were determined by sieving the sediment using three methods: 1) typical grain size analysis, 2) gentle agitation with seawater, 3) gentle agitation with de-ionized water. Each method used four sieves (150, 90, 63 and 45 μm) to constrain the size abundance of the particles. The study found that resilient fecal pellets comprised up to ~30% of the total sediment within the top centimeter of the seabed, and abundance was not directly related to spring-neap tidal cycles. There was a tendency, however, for larger pellets to persist around neap tide, perhaps because stronger currents at spring tide were more likely to break apart the largest pellets. Also, a greater mass of pellets was preserved when seawater rather than deionized water was used during sieving.

Study Site

- All samples: collected from the Clay Bank region of the York River Estuary, a subestuary of the Chespeake Bay.
- strong spring tidal currents, weaker neap tidal currents
- Clay Bank: influenced by both biological and physical factors.
  - seasonally-changing salinity gradients. (Friedrichs, 2009)

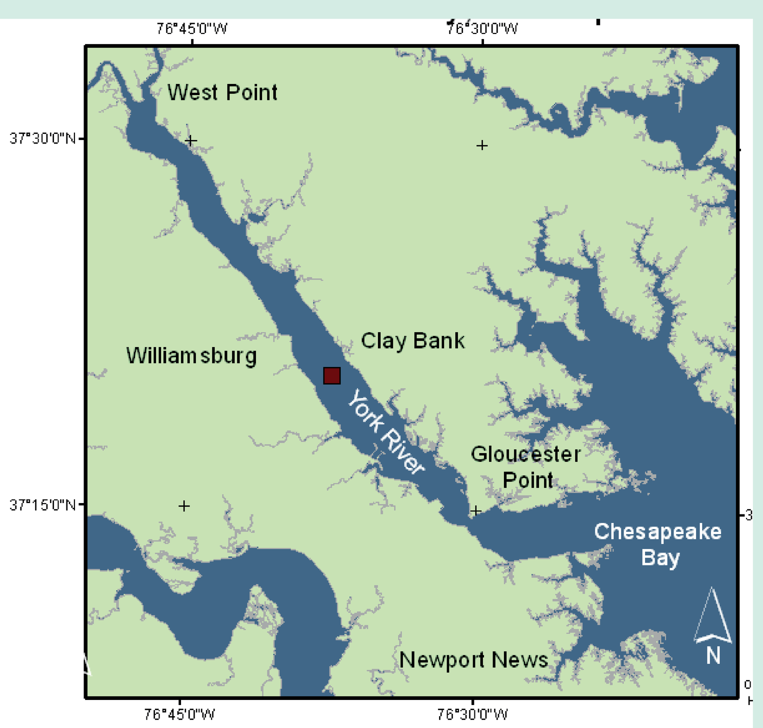


Figure 6: Map of the York River Estuary in relationship to the Chesapeake Bay. The red box represents Clay Bank. From Kraatz (2011)

Field Sampling

- Twice-monthly sedimentological surveys: spring or neap tide.
- Gomex box corer: Clay Bank secondary channel. Subsampled:
  - X-radiography core
  - sliced: one-centimeter intervals.
    - water content, organic matter content, and fecal pellet presence.

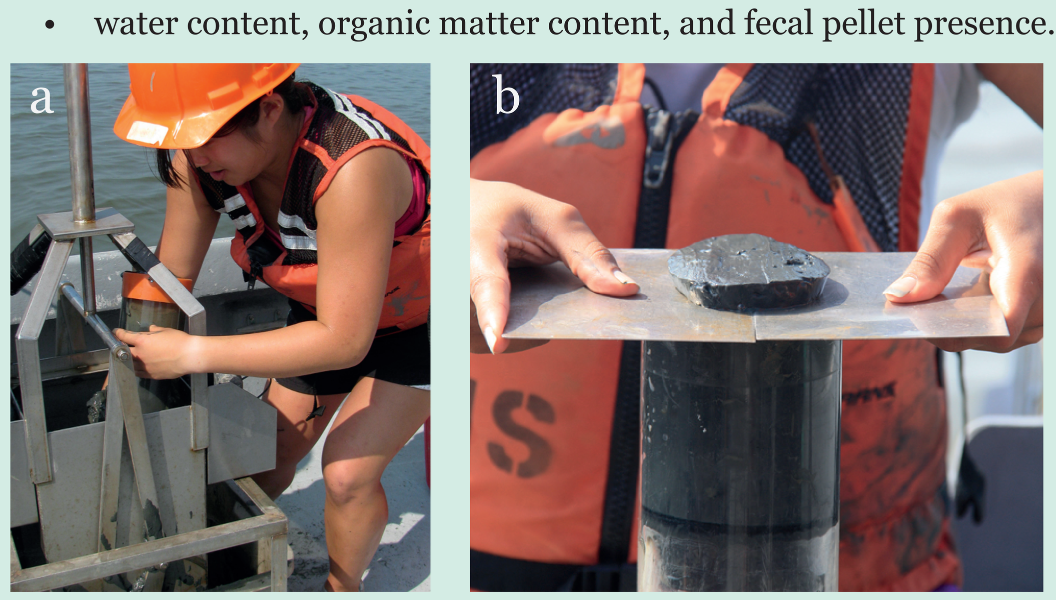
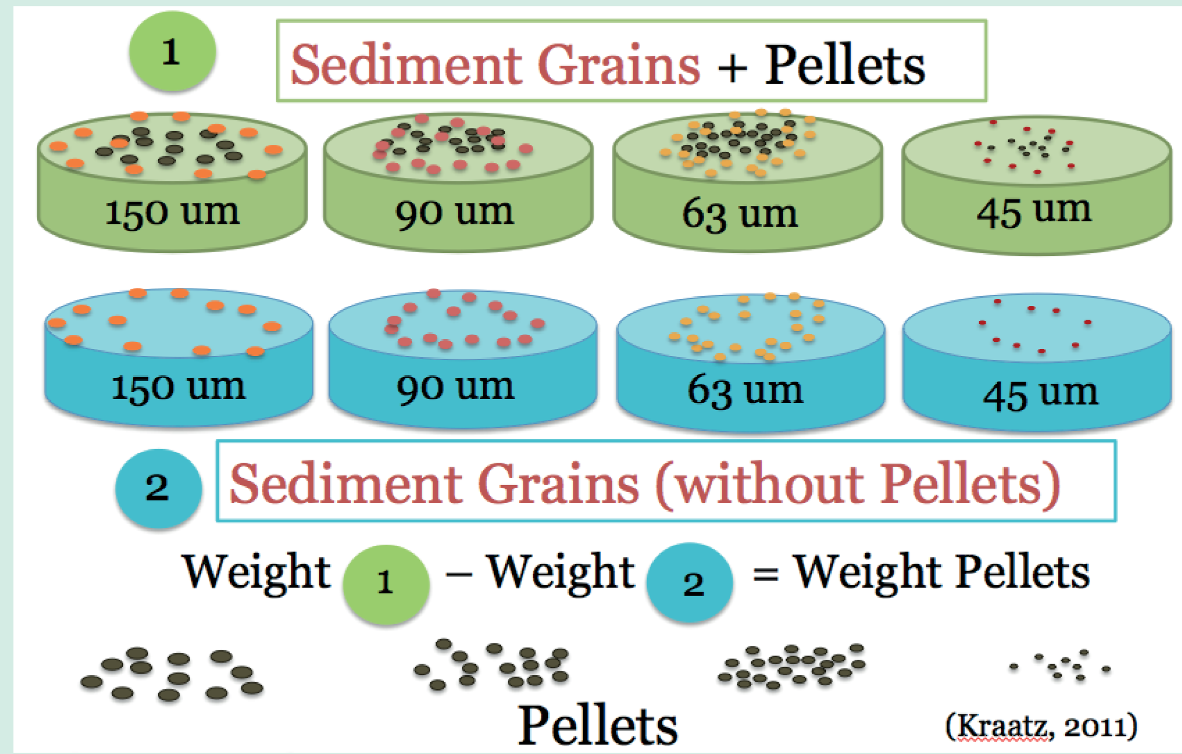


Figure 1: (a) subsampling the Gomex box corer. (b) slicing the cores into one-centimeter intervals

Sieving Analysis



1. First sample left intact
2. Second sample disaggregated

- **Kraatz Method:** 10-gram samples through 4 sieves: 150 μm, 90 μm, 63 μm, and 45 μm.
- **Rodríguez Method**: 10-gram samples, through only 63 μm sieve.

Compared Methods. (Kraatz, 2011; Rodríguez, 2010)

- Sieved using deionized water or artificial seawater (15 ppm)

Figure 2: Calculating the Mass of fecal pellets

Fecal Pellet Size

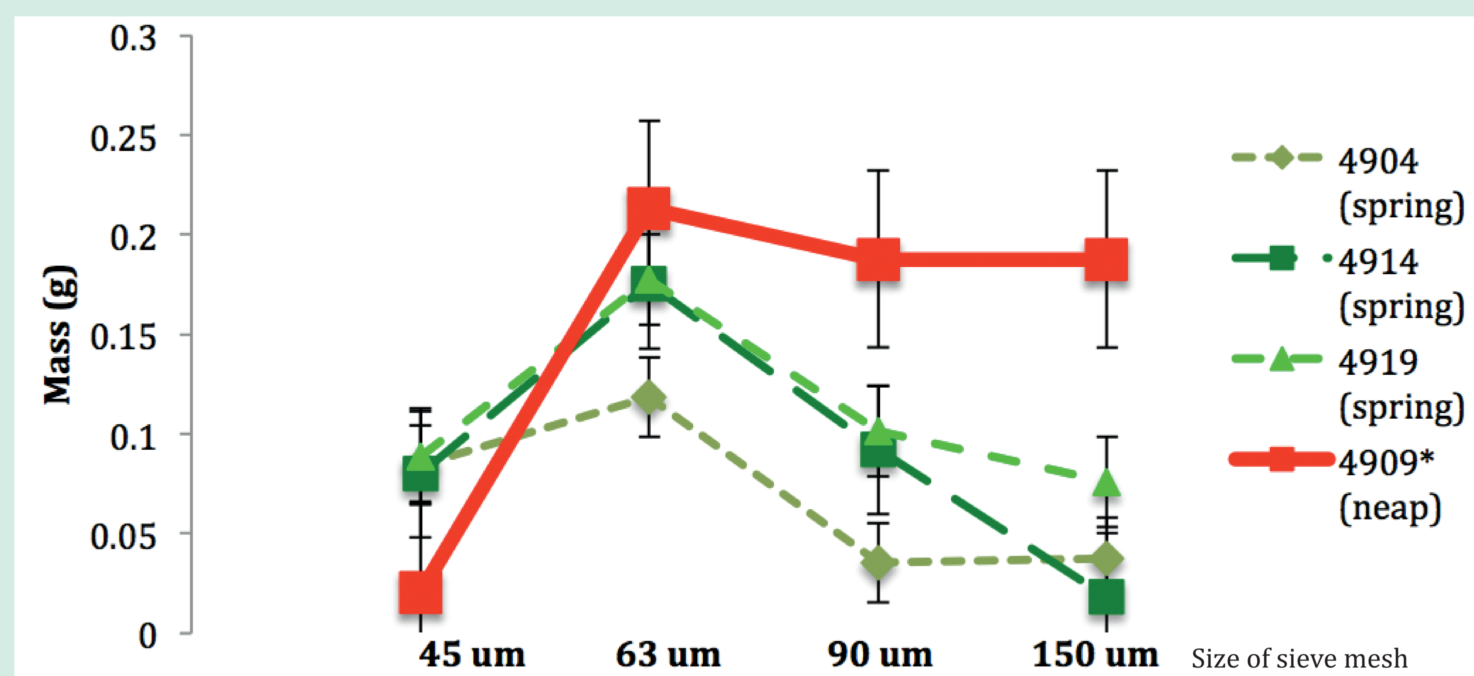


Figure 3: There is a peak in mass for fecal pellets in the 63-90 μm size range, regardless of spring-neap tidal cycles. The numbers on the horizontal axis represent the size of the sieve mesh used.

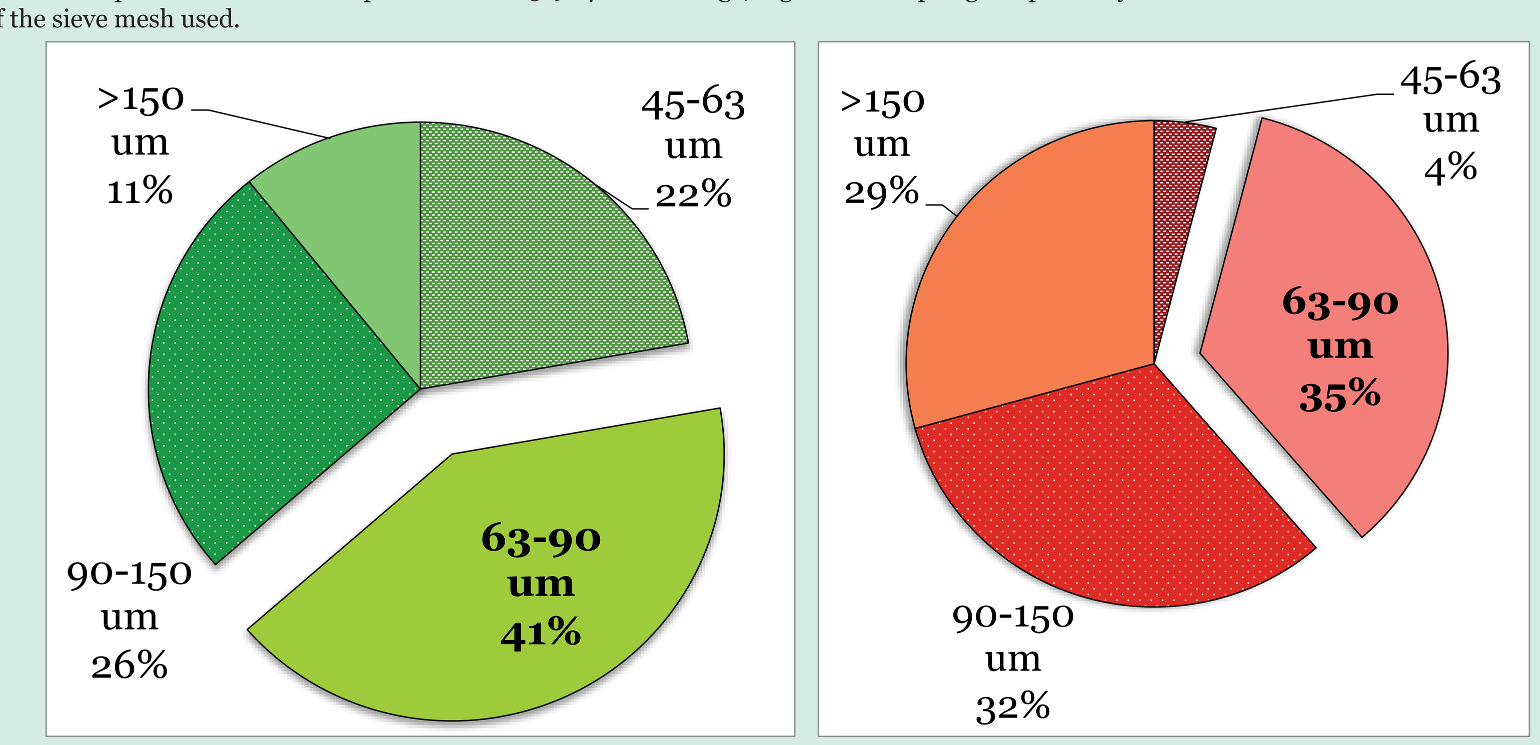


Figure 4: Total amount of fecal pellets as distributed by size class. The spring time (a) chart : an average from 3 spring samples. The neap tide (b) chart: 1 sample

- Neap tide samples: higher percent composition of fecal pellets that were >150 μm and between 90-150 μm
- Spring tide samples: higher percentage of smaller pellets that were between 45-63 μm. Neap tide samples contained a higher concentration of larger pellets than spring tide.

Possible Explanation:

Neap tide : lower-velocity currents → larger pellets could be produced

Spring tide: higher-velocity currents → larger pellets could break apart

Sieving: Deionized vs. Seawater

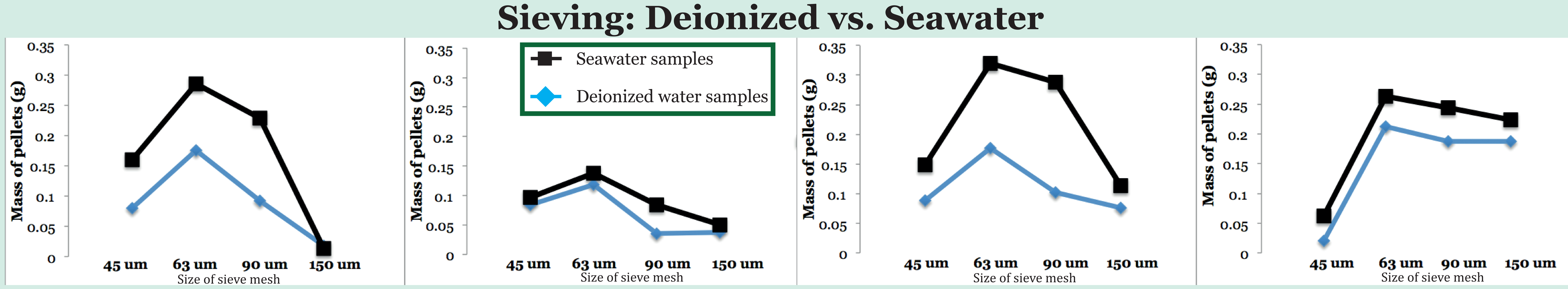


Figure 5: Samples sieved with artificial seawater had a greater mass of fecal pellets than those sieved with deionized water. The numbers on the bottom (45um, 63 um, 90 um, 150 um) represent the size of the sieve mesh.

To Preserve more fecal pellet mass, sieve with seawater rather than deionized water.

Fecal Pellet Percentage

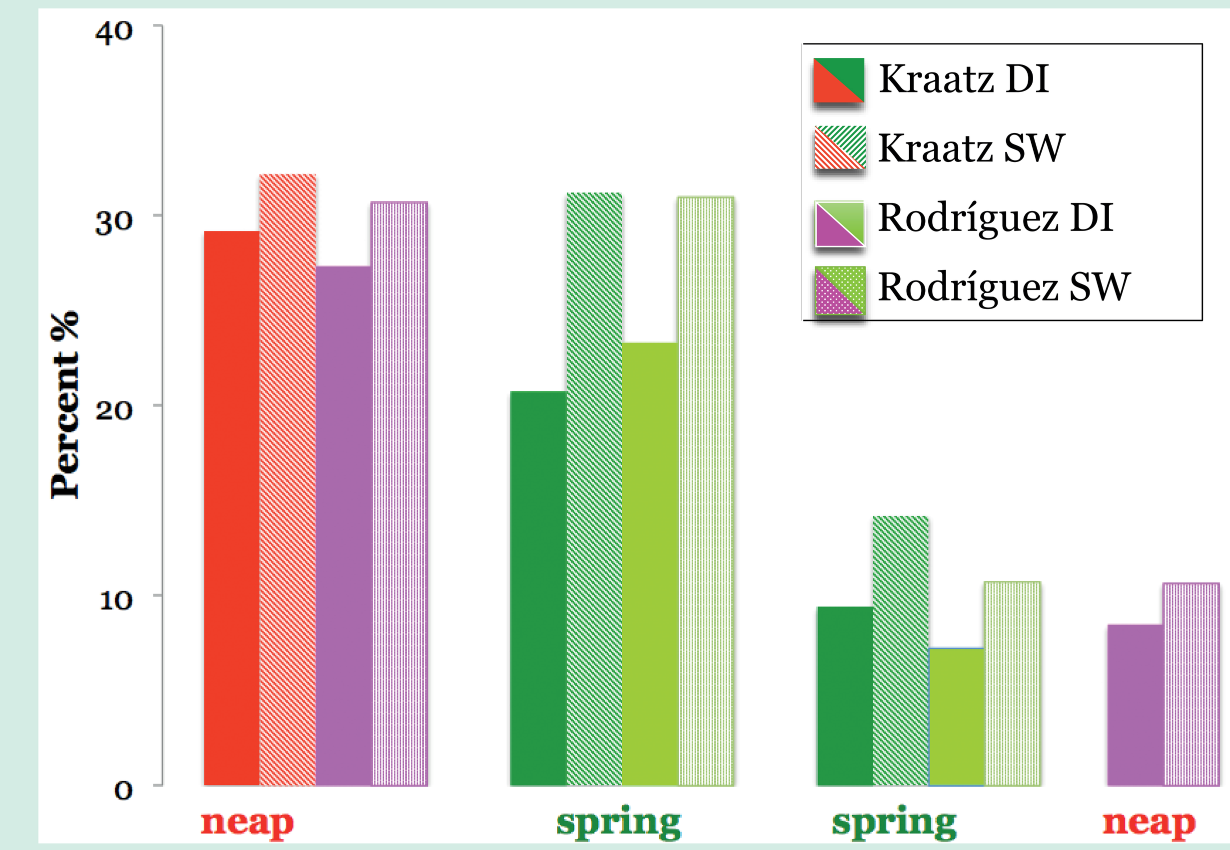


Figure 7: Pellets composed from 9% to 33% of the total sediment. Kraatz and Rodriguez represent their respected methods. DI = deionized water, SW = seawater (15 ppm)

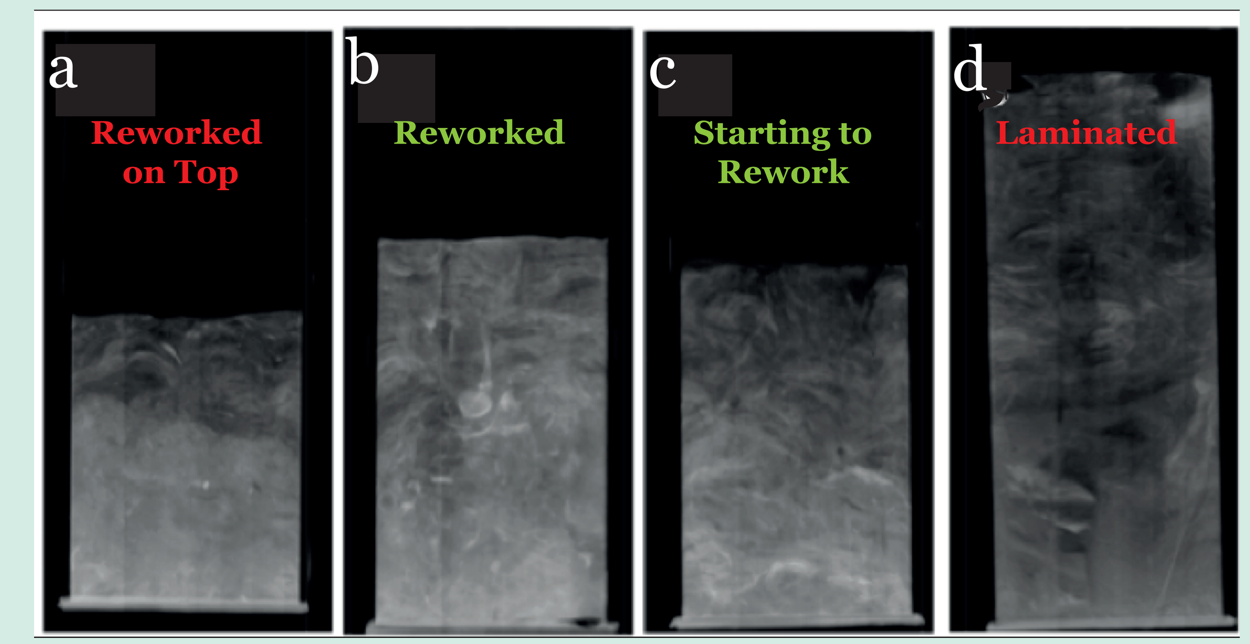


Figure 8: X-radiography images correspond to samples in Figure 8. (Cartwright 2011 B)

Possible explanations: X-radiography

- Biologically reworked samples (Fig. 8 a,b) had higher concentrations of pellets
- Laminated samples (Fig. 8 c,d) had lower concentrations of pellets

→ Biological reworking has a greater affect on fecal pellet concentration than spring-neap tidal cycles do.

Conclusion

- No clear relationship between fecal pellet percentage at spring and neap tide (Fig. 7)
  - Biological activity: more influence on pellet presence
- Spring-neap cycles may influence pellet size (Fig. 4)
  - Larger pellets at neap tide, smaller at spring tide
  - Stronger spring tide currents may break up larger pellets
  - Most pellets: within 63-90 μm range, regardless of spring-neap (Fig 3)
- Greater pellet mass when sieving with artificial seawater vs. DI water. (Fig. 5) No clear relationship between mass of pellets collected with Kraatz's vs. Rodríguez's methods. (Fig. 7)

References

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