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The composition of particulates in Lake Michigan using S.E.M. and light microscope techniques

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Oceanography studies have demonstrated that the sinking of naturally-occurring particulates within the water column is an important mechanism for the vertical transfer of heavy metals and toxic organics from surface inputs to sedimentary sinks. Recent studies conducted in Lake Michigan suggest that particulates have a similarly important role in fresh waters. However, the compostition of these particulates has not been well documented. Here we report the results of an investigation of the composition and abundance of particulates collected in sedimentation traps set by the Great Lakes Environmental Research Laboratory (NOAA) at two 100-m stations in southeastern Lake Michigan. At each station, traps were set at 15-m, 35-m, 80-m, and 95-m and were left in place between June and October 1980. Thus, material collected in each trap represents the particulate flux from the overlying water for a 4-month time period. Collected material was examined using light microscope and scanning electron microscope techniques.

Particulates ranged in size from a few microns to over a thousand microns and consisted of mineral crystals, phytoplankton (both whole and fragmented), zooplankton exoskeletons, and aggregates. Some aggregates were the product of zooplankton egestion.

Particulate composition varied with depth. At 15-m, calcium carbonate crystals were abundant, both free (Fig. 1) and in association with aggregates. Chrysophycean cysts, broken and fragmented diatoms (the product of zooplankton grazing), and zooplankton exoskeletons were abundant. Fecal pellets, which consisted of egested material enclosed within an intact peritrophic membrane (Fig. 2), were present. Fecal material, in which such an enclosing membrane was absent, (Fig. 3) was somewhat more numerous than pellets. Fecal material was composed of fragmented diatoms, calcium carbonate crystals, and other organic materials. Large colonies of diatoms and green algae were observed in association with aggregates, fecal pelelts, and fecal material. Examination under the light microscope showed that chloroplasts were intact suggesting the ingested cells were viable.

In the deepest traps, clay minerals and larger fecal pellets (possibly those of epibenthic Mysis relicta) were more abundant. Aggregates were more irregular in shape suggesting that much of the sinking material had undergone significant decomposition while sinking from the overlying surface layers. This degradation results in the disintegration of the aggregates releasing particulates. Further degradation of particulates occurs at the sediment-water interface. The presence of benthic diatoms and fragmented frustules in the deepest traps suggest active resuspension at the sediment-water interface. Pennate and benthic diatoms were abundant in deep trap samples and usually occurred singly. However, some benthic diatoms were associated with aggregates and fecal pellets both in the shallow and deep-water traps. Conversely, centric and planktonic diatoms generally were in association with fecal material (Fig. 4), indicating probable ingestion by zooplankton and rapid transport to the sediment-water interface.

The abundance of fecal pellets, aggregates, live algae, and fragmented diatoms were quantified. In the 15-m trap, there was a 3:1 ratio of aggregates to fecal material (with or without a membrane) while in the 95-m trap, the ratio was 1:2. The concentration of zooplankton exoskeletons was approximately the same in both shallow and deep-water traps. Live algae were abundant in surface and bottom waters: however, dead and fragmented diatoms were more abundant in the deep water. Qualitative chemical analysis of particulates will be discussed. Overall, our study shows changes in abundance and character of particulates with depth and significant resuspension of sedimentary material in deep water.

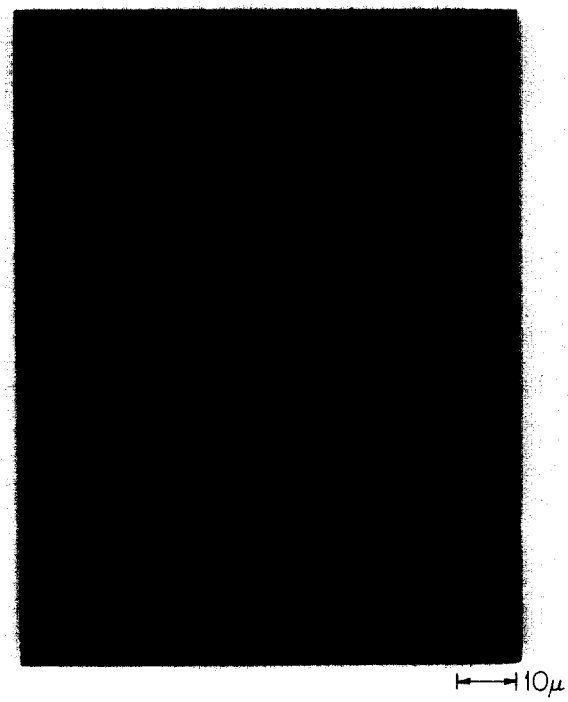

Fig. 1. Organic aggregate containing carbonate particles.

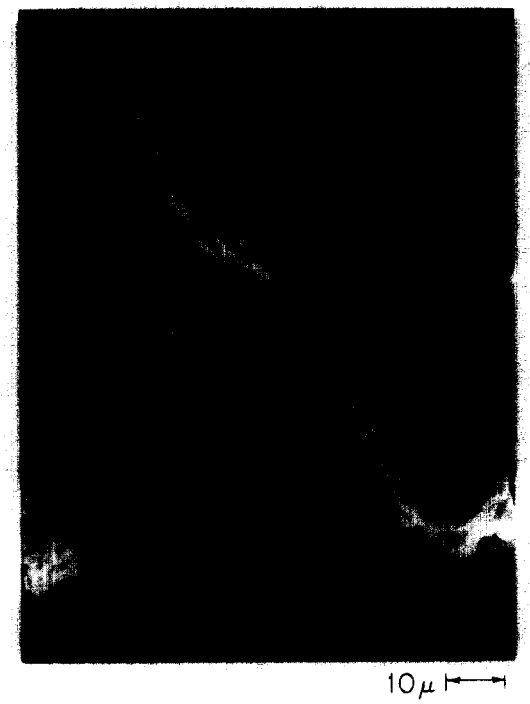

Fig. 2. Fecal pellet with an intact periotrophic membrane.

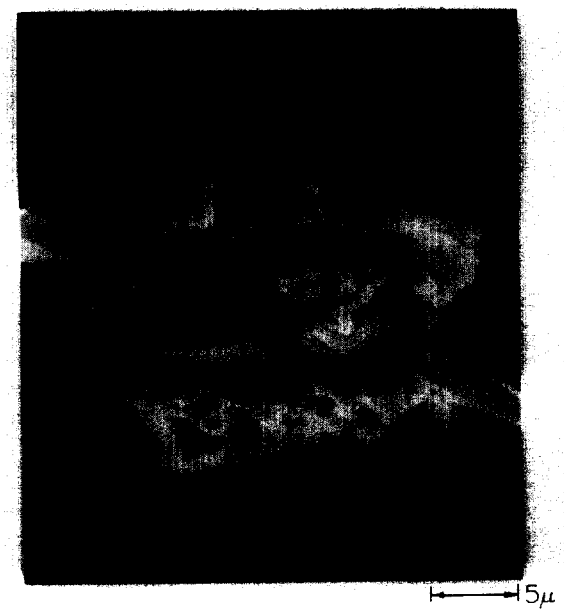

Fig. 3. Fecal material lacking membrane. Contents include fragmented and intact diatoms, carbonates, and other minerals.

Fig. 4. Fragments of planktonic diatoms embedded in fecal material collected at 95 m.