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Comments on the paper "Bioturbation: minimal effects on the magnetic fabric of some natural and experimental sediments", by Brooks B. Ellwood

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Anisotropy of magnetic susceptibility (AMS) and remanent magnetization in semi-consolidated sediments reflect some ordered, spatial distributions of magnetic mineral grains, caused by forces acting during or shortly after deposition. Any preferred grain orientation is likely to be modified by biological disturbances, and in this paper by Ellwood [1] three different sediment types were investigated in order to elucidate the effect of bioturbation on magnetic fabric characteristics. We find his interpretation and conclusions derived from the tidal flat experiment (Sapelo Island) rather unsatisfactory, and offer hereby an alternative interpretation.

The magnetic fabric in the established magnetite horizon gradually change towards what may be inferred to represent a primary depositional magnetic fabric, characterized by Q-values below 2/3 (oblate ellipsoids) associated with closely grouped, almost vertical distributions of kmin directions (minimum axis of the susceptibility ellipsoid). Mean azimuths of the flat-lying k_{max} axis all strike N-S, parallel to the shore line. Ellwood has inferred that this evidently post-depositional reorientation of magnetite grains developed by subsurface long-axis grain alignment caused by water flowing horizontally through the (biological) expanded sediment. The apparent depositional (primary) characteristics of the magnetic fabric, is concluded to be secondary, improved during initial expansion followed by grain settling and dewatering after passage of organisms. In addition to the observed improvement of the magnetic fabric, the directional scatter of the remanent magnetization decreases with time. However, even 185 days after establishing the magnetite horizon, inclination errors of this true p-DRM still amounts to more than 10°. This observation contrasts paleomagnetic results from a bioturbated tidal mud flat [2], suggesting that the directional magnetic properties of the Sapelo Island tidal flat (remanence and AMS) are dominated by large grains of magnetite, contrary to the assumption made by Ellwood.

We thus propose that the N-S striking long-axis distributions derived from AMS, reflect azimuthal reorientation of large magnetite grains parallel to the geomagnetic meridian. The development of the magnetic fabric is thus concluded to be controlled by gravity and the ambient magnetic field, discharging the inferred action of subsurface hydrodynamic forces. Coinciding azimuthal distributions of kmax and remanent magnetization has been observed in both magnetite- and hematite-bearing sediments [3,4]. The observed time dependent increase in magnetization and decrease in directional scatter reflect an increasing degree of preferred alignment of magnetite grains into the direction of the geomagnetic field. Post-depositional reorientation of mineral grains can only take place by changes in interstitial void volumes, and Ellwood suggests that the passage of organisms may cause the needed expansion (increasing water content) of the sediment. Taking into account that

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the sampling area was exposed to diurnal tidal flooding, we propose that during the advance of the sea, the sediment become saturated with water, effectively causing the necessary conditions for grain realignment. We conclude that the Sapelo Island experiment probably does not reflect the effect of bioturbation but rather the post-depositional influence on directional magnetic properties in a tidal flat environment.

References

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