Effects of sea-level change on organic matter composition in turbidite, example from the Miocene and Pliocene in the Niigata basin

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We examine the relationship among composition of kerogen (insoluble organic matter) and relative sea-level changes in Miocene to Pliocene sediments of the Niigata basin, central Japan.

Sequence stratigraphic studies have been carried out for the upper Miocene and Pleistocene sediments in the Niigata backarc basin. We collected samples (96 total) from turbidite mudstone, hemipelagic- and pelagic-mudstone. All organic particles were concentrated from mudstones by HCl and HF treatment without a sieve or density preparation. We used the classification systems of Sawada and Akiyama (1994) and Tissot and Welte (1984). Vitrinite, sporinite, cutinite, and alginite are recognized with their morphological and fluorescent characteristics. Amorphous organic matter (AOM) has been subdivided into FA (fluorescent amorphous organic matter), WFA (weakly fluorescent amorphous organic matter), and NFA (non-fluorescent amorphous organic matter) based on fluorescence under a reflected-light fluorescent microscope. We used stable carbon isotope analysis to confirm the origin of AOM. The samples for stable carbon isotope analysis consisted of separated organic matter rich in NFA or WFA.

The NFA in shelf sediments and WFA in distal basin floor sediments are inferred to consist of terrestrial higher plant and marine organic matter, respectively. Stable carbon isotope value of kerogen rich in NFA (-24.6 to -27.3 per-mil) suggests land plants, whereas kerogen rich in WFA (-20.0 to -23.6 per mil) suggests marine plankton.

The proportion of cutinite with pollen and spores in the submarine fan of the transgressive systems tract ranges from zero to a few percent. The proportion of vitrinite is also low, at 20 %, compared to abundant 80% for AOM. In comparison, submarine-fan sediments in the highstand systems tract have relatively high proportions of cutinite with pollen and spores and vitrinite. The proportions of kerogen in the lowstand turbidite exhibit two patterns, one with relatively abundant vitrinite and one with relatively abundant AOM. Cutinite with pollen and spores would have been trapped in a coastal estuary that developed during a transgressive stage, and little such organic matter would have been transported to the basin floor. Submarine-fan sediments of a transgressive systems tract are also poor in vitrinite, but rich in AOM. Since the supply of terrestrial materials decreased with a rise in relative sea level, the AOM became relatively abundant in slope and basin-floor submarine-fan environments. A delta system also would have formed during a highstand stage. Since turbidity currents are frequently supplied from a prograding delta system, coarse-grained terrigenous organic matter increased in the pro-delta and slope areas. During the transition from an estuary to a delta system, cutinite with pollen and spores that had been trapped mainly in the estuary was transported directly to the pro-delta and slope. As a result, the proportions of cutinite with pollen and spores and vitrinite in the highstand systems tract were higher than in the transgressive systems tract. On the other hand, the abundant vitrinite in a lowstand turbidite suggests that large amount of coarse-grained terrigenous organic matter were directly transported to the basin floor in feeder channels. The abundant AOM in lowstand turbidites may indicate re-sedimentation of shelf deposits by collapse of the shelf edge.

Again, different depositional processes occur in different sea-level stages, thus kerogen contents vary in the turbidite deposits.