No.B1 - (2) Study on global warming and related carbon cycle -Study on the formation of sedimentary particles from marine particulate matter and the related carbon cycle-

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Abstract We took surface sediments as well as sinking particulate matter from the Ontong Java Plateau in the equatorial Pacific. The purposes of this study are to clarify the mechanism of the formation of sedimentary particles from sinking particulate matter during early diagenesis and to evaluate the fluxes of organic carbon and carbonate through the water column and in the surface sediments.

About 98% of organic matter was decomposed between the sediment trap (1.1km deep) and surface sediments. The relative abundance of organic carbon reserved in surface sediments was about 0.08% of primary productivity. It was in the range of 0.10-0.11% obtained from moderate to high productivity area of West Caroline Basin, Hess Rise and Arabia Sea to 0.008% obtained from low productivity area in Northern North Pacific.

Key words Sedimentary particles, sinking particles, marine particulate matter, organic carbon, carbonate carbon

1. Introduction

Sediment trap experiments have been done in various ocean basins. Most of studies show that particulate fluxes to deep sea are related to the surface process and primary productivity and that sinking particulate matter is the most important contributor to the sedimentary particles. So sinking particulate matter offers essential constraints for evaluating paleo-environment based on the sedimentary particulate matter.

The organisms (e.g., coccolithophorids, diatoms) involved in the production of organic matter, carbonate, and biogenic opal play an important role on sinking carbon to deeper waters. However, the formation and decomposition of organic matter and carbonate have different effects on the interaction between the ocean and atmosphere, then it is important to study the change in the downward flux of organic carbon and the shift in the particulate Corg/Ccarbonate ratio with interannual and seasonal variations through water column and at the sediment-water interface for understanding present-day carbon cycle.

The Ontong Java Plateau provides a unique opportunity to investigate the characteristics of sedimentary particles as well as sinking particulate matter in the middle latitude of the western Pacific. Primary productivity shows steep gradient from subtropical gyre to subarctic region.

However, little is known about the present annual flux and seasonality in sinking particles in this area. We took surface sediments as well as sinking particulate matter from the same area. The purposes of this study are to clarify the mechanism of the formation of sedimentary particles from sinking particulate matter during early diagenesis and to evaluate the fluxes of organic carbon and carbonate through the water column and in the surface sediments.

2. Study area and water mass in the Pacific Ocean

The Ontong Java Plateau is located in the equatorial Pacific Ocean. (Figure 1). Surface water in the west equatorial Pacific is characterized by warm, nutrient poor water.Three currents are important in the equatorial region. First one is called North Equatorial Current. The second one is Equatorial Counter Current. The third one is South Equatorial Current. North Equatorial Current is a westbound flow and it is observed between 10 and 16°N. The east-bound Equatorial Counter Current is predominant between 3 and 10°N.

3. Methods

One deep ocean moorings was deployed at 1° 13.19'N, 160°34.0'E (Site 1) in the Ontong Java Plateau (Figure 1). The water depths of Site 5 was 3,200m. The sediment trap was deployed at the depth of 1,182m.

The sample bottles, 21 for one trap, were filled with filtered seawater collected in the Ontong Java Plateau. Analytical grade formalin was added to make a 3% solution buffered with sodium boric acid.

Recovered sample bottles were immediately refrigerated on board at approximately 2 to 4°C. Particle samples in 250ml polyethylene sample bottled were transported to Geological Survey of Japan under refrigeration at 2°C. Each trap samples was split into aliquots with an Erez-Honjo precision splitter after picking out swimmers. Organic carbon and total nitrogen were analyzed using Yanako CHN analyzer after the decalcification. Calcite content was calculated from the difference between total and organic carbon contents.

4. Results and discussion

One flux maximum with relatively intermediate rate (40 mg $m^{-2}day^{-1}$) from November through December were found at the trap of Site 10. The carbonate, organic carbon, opal, and lithogenic fluxes followed the total fluxes.

The formation of sedimentary particles from sinking particulate matter

The traps have been deployed at about 1.1km water depth, which was about 2.0km above the seafloor at Site 10. If we consider the sinking speed of 160m/day, the loss of material during settling was expected to be small. So we assumed that the sinking flux at the trap was not significantly different from the amount reaching the seafloor. The amount of biogenic components collected in the sediment traps and accumulation in surface sediments at the trap site can be compared with primary productivity values which were taken from the latest productivity map made by Berger et al. (1988). The Ontong Java Plateau is located in the equatorial Pacific, where Koblents-Mishke map gives quite low primary productivity (Koblents-Mishke et al., 1970). So the values may involve an error of 10gC/m^2/yr. Nitrogen

fixation was calculated using the Redfield ratio (Redfield et al., 1963). The accumulation rates of carbonate and organic carbons,and nitrogen in surface sediments were calculated based upon total sediment accumulation rates of Kawahata et al. (1995) measured for sediment cores taken close to Site 10.

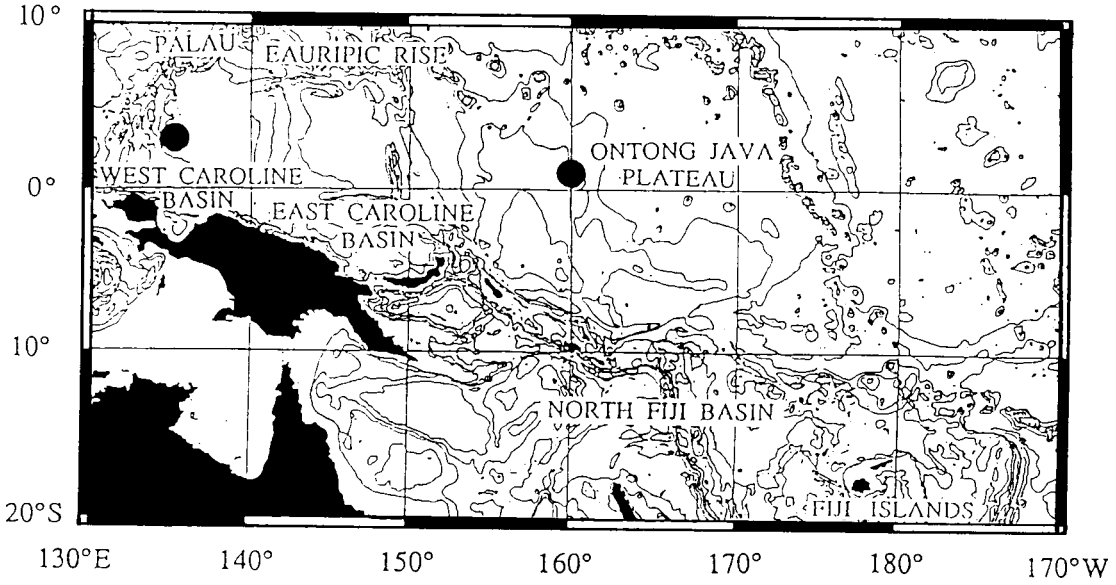

Figure 1. Locations for the recovery of surface sediments and sinking particulate matter in the Ontong Java Plateau.

Accumulation rates of biogenic components measured in the sediment traps were compared with those of surface sediments at the trap site. The difference was largest for carbonate, which was about 50% higher in the surface sediments that that observed in the sediment trap. Possible reasons are that we might overestimate sedimentation rate in the thin surface sediments or that carbonate flux observed during our trap experiments gave unusual low rate. At least low organic carbon flux may prevent carbonate from the dissolution by the interaction of carbon dioxide derived from the oxidation of organic matter.

More than 98% was lost from the sediment trap to final burial in the sediments. The relative abundance of organic carbon reserved in surface sediments was about 0.10% of primary productivity. It was in the range of 0.10-0.11% obtained from moderate to high productivity area of West Caroline Basin, Hess Rise and Arabia Sea (Haake et al., 1993; Kawahata, 1994; Kawahata et al., 1995) to 0.008% obtained from low productivity area in Northern North Pacific. These results confirm that the benthic boundary layer is a major site of organic matter degradation. Also the results suggest that the removal ratio of burial rate to primary productivity would be higher as primary productivity increases.

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