Suppression of Phosphate Release from Coastal Sediments Using Granulated Coal Ash

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Deterioration of sediment quality is a serious problem in Hiroshima Bay where intensive oyster culture is conducted. Release of nutrients from sediments which are receiving feces and pseudofeces from cultured oysters hanging above are one of major causes of eutrophication of water column. Since phosphate is enhanced its release rate under anaerobic condition in warm stratified season, it should be a target to be suppressed.

Granulated coal ash (GCA), a byproduct from coal thermal electric power stations, has proven to adsorb phosphate quite well in our previous study. Then, we conducted a field experiment aiming to suppress phosphate release from sediments below oyster culture rafts, which are in organically enriched condition.

Two types of GCA were applied to the sediments of 50 m x 70 m each (Exp site A and Exp site B) covering the sediments with 20 cm depth. The GCA used Exp sites A and B were those made of pulverized coal combustion ash and pressurized fluidized bed combustion ash, respectively. After the application on 30 October 2008, monitoring of sediment and water qualities and benthic microalgae and animals was carried out for 13 months with a 3 month interval. A numerical model to quantify chemical and biological processes in the sediment was applied to estimate how phosphorus cycle was changed compared to that in the control site.

Sediment pH was significantly increased up to about 8.5 in the sediments of Exp site A and B. In the both experimental sites, organic contents of the sediments significantly decreased, and acid-volatile sulfide (AVS) which is an indicator of aerobic condition was also decreased. Phosphate concentration in the interstitial water of sediment was significantly decreased in Exp site A, which may be due to adsorption onto GCA.

The numerical model output showed that release rate of phosphate from the sediment of Exp site B was suppressed to the level of about 1 order lower (400 μmol/m^3/d) than that in the control site (4,800 μmol/m^3/d), whereas decomposition of detrital phosphorus in the experimental site is enhanced 4.8 times in the experimental site compared to the control site.

It was proven that GCA can effectively adsorb phosphate from interstitial water in organically enriched sediments and suppress release rate of phosphate from the sediments to the upper water column. Consequently, it is recommended that application of GCA to organically enriched sediments in other areas where they suffer from similar issues.

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