Characteristics of organic carbon in coastal carbonate sediment accompanied by seagrass meadows

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Seagrass meadows are submerged, highly productive ecosystem that occurs in sandy shallow coastal environments from tropical to boreal regions. Colonization of seagrasses in coastal habitats renders originally oligotrophic, organic-poor sandy sediment into a hot spot of organic carbon (OC) sequestration and storage. This function depends on a combination of several characteristics specific to seagrasses, such as very high and efficient photosynthetic ability, production of perennial belowground biomass, and physical attenuation effects of leaf blades and roots that enhance accumulation and stability of sediment. Recent estimates indicate that around 70% of global seagrass meadows are present in tropical and subtropical coastal habitats (Siikamäki et al. 2012), which are often covered with biogenic carbonate sediment especially in archipelagic regions. In fact, carbonate accumulated in global seagrass meadow sediments has been estimated to be up to five times greater than the amount of OC on the carbon basis (Mazarrasa et al. 2015). However, geochemical roles of carbonate sediment in OC sequestration in seagrass meadow sediments is not well understood.
This study focuses on the OC stock and its relationship to mineralogical properties of sediment such as carbonate content, specific surface area (SSA), and mesopore distribution in carbonate sediments accompanied by seagrass meadows in Japan and the Philippines. Here, typical carbonate sediment is defined as sediment with inorganic carbon (IC) content greater than 8 mmol IC g^{-1}(ca. 10%-IC w/w). Obtained results were compared with corresponding properties of temperate, non-carbonate (<0.5 mmol IC g^{-1}) seagrass meadow sediments. The ranges of OC concentration and stock, as well as the degree of accumulation of OC in seagrass meadows relative to adjacent non-vegetated sediment, were similar between carbonate and non-carbonate seagrass habitats. The OC concentration strongly correlated with SSA and total mesopore volume for both carbonate and non-carbonate sediments. However, average OC loading per unit surface area and unit mesopore volume was six-times and three-times greater for carbonate sediments than non-carbonate sediments, respectively. Carbon isotope abundance suggested that the fraction of seagrass-derived OC to total OC was often much greater for carbonate sediments than non-carbonate sediments. Nonetheless, OC tightly associated with carbonate minerals seemed to be derived mainly from non-seagrass sources. These findings as well as the differences between carbonate and non-carbonate sediments may be partially explained by characteristics specific to carbonate sediments, such as presence of basic OC inherited from organisms that originally produced the carbonate, different affinity to soluble organic matter, different mesopore shape and size distribution, and gradual dissolution during early diagenesis. However, what constrains the capacity of carbonate sediments to sequester OC is still unclear. Our results suggest that, although mineralogical control on sediment OC is significant in carbonate sediment, the classical sorptive preservation mechanism originally put forward for explaining the constant OC/SSA ratio in continental shelf sediments is not sufficient to explain the OC sequestration capacity of carbonate sediments supporting seagrass meadows.

Keywords: seagrass beds, calcium carbonate, carbon storage

