Sequestration of black carbon in continental shelf sediments

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Abundance and ^{210}Pb-derived fluxes of Black Carbon (BC) were deduced in surficial shelf sediments off NE USA to investigate the role of this carbon form in the biogeochemical cycle of this element. Different combustion processes, such as fossil and wood fuel combustion as well as vegetation fires, yield varying emission factors for BC. The recalcitrant nature of the introduced BC result in an environmental omnipresence. BC has been implicated as having important roles in many processes, including serving as a key carrier-phase of important pollutants and serving as the principal light-absorbing aerosol component affecting the Earth's radiative heat balance. BC may also affect the global carbon cycle. Its relative influence is contingent on its source. Formation of inert BC from vegetation fires and wood fuel combustion transfers otherwise rapidly cycling biospheric carbon into the long-term geological cycle and thus represents a sink of atmospheric carbon dioxide on short timescales. Estimated BC emission fluxes from vegetation fires were recently used by Kuhlbusch and Crutzen (1995) to demonstrate that this mechanism of BC formation may indeed explain a significant fraction of the "missing carbon" in the global carbon balance. Further, the depth profiles of BC in contemporary sediments have been demonstrated to reflect society's time-varying usage of fossil fuel (Goldberg *et al.*, 1981; Gustafsson *et al.*, 1997). Were fossil fuel combustion the dominant source, such BC would not directly affect the contemporary carbon cycle. Nevertheless, since BC is expected to be of very high preservation potential, it may constitute a significant fraction of the refractive carbon being currently buried in marine sediments. To make progress in better understanding the many diverse roles played by BC, we need to investigate the biogeochemical processes affecting the environmental fate of BC itself.

While, extensive data exist for the global concentration fields of BC in the atmosphere, quantitative measurement of BC in soil, sediment, and water samples is scarce. Based on limited data, Suman *et al.* (1997) recently suggested that about 40% of global BC emissions may be found in continental shelf sediments. Since no data has been available for the Atlantic basin, we desired to investigate the fluxes of BC to its shallow margin sediments. Shelf sediments in the Gulf of Maine, off Palos Verde, and in the Baltic Sea were analysed for their BC content using a selective thermal oxidation approach (Gustafsson, *et al.*, 1997). BC concentrations in contemporary open shelf sediments ranged between 0.3–4 mg/gdw. Temporal trends of BC deduced in detail in one near-urban core mimics the energy consumption of the surrounding society through this century (Gustafsson, *et al.*, 1997). The pattern of chemical markers of combustion sources (1,7-dimethylphenanthrene to 2,6-dimethylphenanthrene) were investigated to start progressing on the wood *vs* fossil source apportionment. In Gulf of Maine, this signal was indicative of a largely fossil fuel combustion source dominating the BC input. In the Baltic Sea, the PAH marker ratio suggested a more significant contribution also of a wood combustion source of BC to these recent sediments.

We obtained ^{210}Pb-derived BC sedimentation fluxes of 1–2 g m^{-2} yr^{-1} for locations in the open Gulf of Maine (Gustafsson and Gschwend, 1998). The Northeastern USA shelf sink estimated from these fluxes is roughly within the same range as estimates of the BC production from either fossil fuel or biomass burning in the upwind NE USA source region. Identification of up to 10% of total organic carbon in shelf sediments as BC has implications for carbon preservation, as well as several other aspects of the global biogeochemical cycle of carbon.

References

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