Biomass burning history and possible origin of fire in East Asia during the million years using chemical proxies

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Behavior of elemental carbon (EC) is crucial for the earth surface environment because it could cause global warming by absorbing sunlight in the atmosphere. EC is originated from incomplete combustion of biomass or fossil fuels. Combustion in natural processes is incomplete due to local limitation of oxygen during the fire, which leads to the formation of organic fire residues. As burning (or pyrolysis) is a continuous process, it results in different types of compounds with no clear boundaries, and also no single defined structure. Depending on the degree of combustion, these organic fire residues can be called: soot, black carbon, and charcoal. Although biomass burning is related to the volume of vegetation, frequency of ignition events, and connectivity of the fuel bed, human activities would be a main determining factor. Therefore, biomass burning history in the Holocene time-scale is important for researches of climate change as well as the related past human activities revealed from archaeology.

Observed degradation rates of EC in the natural environment are much lower than those of the organic carbon. Increasing the fire temperature of the biomass burning leads to a decrease of EC degradability due to higher degree of condensation of hydrocarbons. Even under the strong weathering condition in the tropical climate, EC can be stable for more than a century. However, at a longer time-scale (10-1000 kyr), the stability of EC obtained by high temperature combustion is unknown. And the previous fire researches (paleoclimate rather than modern ecology) did not discuss the control factors for burning temperature.

Objective of this study is to understand factors controlling the thermal/optical/chemical characters of EC with burning temperature, provenance and aging in relation to the variabilities of vegetation and human activity in the hinterland. To achieve the purpose, stems and leafs of selected plants were experimentally charred at 350, 550, and 850℃ to obtain standard charcoal samples. In order to evaluate the differences in the chemical characteristics of these standard charcoals, pattern of benzene polycarboxylic acids (BPCAs), molecular markers of fire residues, was examined using HPLC. The high-temperature component of EC were also determined by thermal-optical-transmittance carbon analyzer for the surface sediments collected during KR15-10 cruise off the Wakasa Bay and the core sediments from IODP Site U1423 in the northern part of the Japan Sea. The optical and thermal properties of the bulk samples will be compared with molecular markers to quantify a potential burning temperature of EC.

Keywords: biomass burning, elemental carbon, benzene polycarboxylic acid

