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学 位 論 文 内 容 の 要 旨

博士 (環境科学)

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学 位 論 文 題 名

Application of TOT and BPCA methods to the reconstruction of past biomass
burning from sediment archives

(熱光透過法およびベンゼンポリカルボン酸法を応用した堆積物記録からの過去のバイオ
マス燃焼復元)

Behavior of black carbon (BC) is crucial for the earth surface environment because it could cause global warming by absorbing sunlight in the atmosphere. BC 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. Robustness of BC to degradation in the natural environment enables us to use BC as a proxy to study the driving force of frequency and burning temperatures of past wildfire events. But the previous paleofire researches only measured charcoals in sediments and discussed the local biomass burning history in spite of the significance of fine BC for atmospheric radiation budget. Controlling factors for burning temperature also has not been evaluated well.

Objective of this study is to understand factors controlling the thermal/optical/chemical/size characters of BC in relation to the variabilities of burning temperature, provenance and aging as well as the vegetation in the hinterland. For these purposes, BC was quantified as elemental carbon (EC) in coarse ($>2\ \mu\text{m}$) and fine ($<2\ \mu\text{m}$) fractions of sediment samples using a thermal optical transmittance (TOT) method, and their burning temperatures were estimated for bulk samples through measurement of composition of benzene polycarboxylic acids (BPCAs), molecular markers of fire residues, determined with High Performance Liquid Chromatography (HPLC).

Selected plants were experimentally charred to obtain standard charcoal samples, which were served as model BC materials to calibrate BPCA compositions to the heat treatment temperature. The TOT and BPCA methods were also applied to marine and lake sediments such as;

- the surface sediments collected during KR15-10 cruise off the Wakasa

Bay,

- 63 samples between 0 and 203 m CCSF-D selected from IODP Site U1423 in the northeastern Japan Sea which covered the last 4.3 Myr,

and

- 15 samples selected from SG12 at the Lake Suigetsu which covered the last 15 Kyr.

Size dependencies of EC contents and thermal properties were compared with the contents and composition of BPCAs to examine the influences of sources, transport pathways, and burning temperatures of BCs contained in these sediment archives.

The TOT and BPCA methods were also applied to the sediments samples to trace the changes of BC upon aging in sediments.

In this study, the author tried to compare the thermal characteristics of BC determined by TOT method and BPCA compositions in order to constrain the amount and composition of BC in sediment archives. It could be shown that TOT and BPCA were valuable tool to determine BC in sediments samples due to its resistivity to (bio-)chemical degradation even for the past million years, and allow us to estimate the burning temperature of BC in sediments.