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Molecular composition of black carbon in the cryoconite in Arctic by Two-Dimensional 1H-13C HETCOR and 13C CP/MAS

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Air pollution caused by human activities contributes to the deglaciations of Arctic ice and highland areas, accelerates the process of climate change on the planet and leads to land degradation. Black carbon is the second largest artificial contributor to global warming and accelerates the deglaciations rates after carbon dioxide. Black carbon is formed as a result of incomplete combustion of fossil fuels, biomass, etc. Another important aspect of organic matter role is the presence of specific formations of combined biogenic-mineral materials on the surface of the glaciers – cryoconites. Cryoconites represent soil like bodies formed not on normal parent material, but on the surface of the ice. This type of accumulations appear in microdepressions, formed due to thawing of ice under accumulation of black carbon on the surface of ice. During the thawing, the cryoconite substances become located deeper in relation to initial surface and this result in additional accumulation of organic matter in microdepressions, they become wider and deeper. Spatial web of cryoconite became more developed and this result in degradation of the glacier surface. This cryoconite formation result in degradation of upper layers of ice and increases deglaciation rates. The organic carbon of the cryoconite origin could be considered as specific form of natural organic matter stabilization and should be investigated on the molecular level. The advantage nuclear magnetic resonance spectroscopy method is the ability to quantify the content of groups of structural fragments and identify individual structural fragments in humic acid molecules. Studies on the organic compounds of HAs for the soils of the polar area by the ^{1}H-^{13}C (HETCOR) NMR spectroscopy have not been carried out to current time. The advantage of this method is that, when analyzing the spectra of HAs, we can observe cross-peaks of H-C bonds, while for the ^{13}C (CP/MAS) NMR spectroscopy we can only observe chemically bound carbon. The HETCOR method allows the study of single HAs fragments. Thus, the combination of the two methods ^{1}H-^{13}C (HETCOR) and ^{13}C (CP/MAS) NMR spectroscopy can reliably determine the molecular structure of HAs. In our research we investigate the cryoconitte on the Grønfjorden area in western Spitsbergen, Svalbard. Analysis of the molecular composition of HAs showed that the molecules of HAs formed on cryoconites are enriched with aromatic fragments and they contain in their composition a considerable number of aromatic fragments (41–43%) with a relatively small fraction of carbohydrate periphery, as evidenced by higher values of AR/AL (0.75 and 0.69). Higher aromaticity of HAs causes their high stability and the degree of hydrophobicity of HAs in these soils is also higher, which indicates the stabilization of HAs.

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