Distribution and origin of soil organic carbon on a glacier foreland in the High Arctic, Svalbard

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The Arctic terrestrial ecosystem is thought to be extremely susceptible to climate change, and major ecological impacts are expected to appear rapidly. Understanding the pattern of ecosystem carbon cycle and its response to environmental factors is the key to predict how the ecosystem will respond to future climate change. One difficulty for understanding the ecosystem carbon cycle in the High Arctic is the heterogeneity of soil conditions. Although the amount of soil carbon in each ecosystem type (successional stage) has been studied by several authors, quantitative assessment of carbon storage in landscape level has not been carried out. As part of the study of ecosystem carbon cycle in the High Arctic, we examined horizontal and vertical distributions of carbon in soil and vegetation in a glacier foreland in the High Arctic, Svalbard.

In 2003, vegetation, organic layer and mineral soil samples were collected along a 2.6km transect which extended from newly deglaciated area to old site near coast with well-developed vegetation cover. Carbon and nitrogen concentrations in these samples were measured with a CN-analyzer. The amount of total soil carbon (vegetation + organic layer + mineral soil) had a positive correlation with plant cover. There was a marked difference in the amount of total soil C between the early and the late phases of the succession. A large amount of soil carbon was observed in sites covered with vascular plants, whereas soils under cryptogamic communities contained relatively low amount of carbon. Although a high carbon concentration was observed in the surface layer of mineral soil, significant amount of C was detected even in deep soil layers (15cm-). As a result, the mineral soil layer represented the major fraction of total soil carbon.

In 2005 field survey, we found a shell-containing soil layer below terrestrial vegetation in the late phase of the succession. A shell in the layer found at a depth of 20cm below ground surface had a (not calibrated) ^{14}C age of 11080 (140) yrs BP. The results of this study show that organic carbon in this area have two distinct origins, i.e. old organic carbon of raised beach deposit and relatively new organic carbon fixed by terrestrial vegetation. Total amount of organic carbon contained in the 10-40cm layer, estimated from the average values of density and carbon concentration of the deposits was about 3.7kgC m^{-2}. This value is larger than the amount of soil carbon contained in the surface soil layer (from O horizon to 10 cm depth of mineral soil) in the latter stage of succession of this area. The data suggest that old carbon distributed in the beach deposits represents a significant proportion of soil organic carbon in this area.