

Relationship between geochemical properties and organic carbon in soil from tundra to boreal forest across Alaska

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Terrestrial soil contains significant amount of carbon (C), and is one of the compartments that can affect global C cycle. Tundra and boreal forest ecosystems in northern high latitudes contain large amounts of C in the soil as compared to the plant. It is well known that in northern Alaska, variations in vegetation and soil C processes are closely associated with variations in soil acidity within ecosystems. However, the reason for this association is still unclear. This study shows that weathering and subsequent changes in soil geochemical characteristics affect organic C in soil. Soils were sampled from 12 sites in Alaska along a 600-km transect from the Arctic Ocean to interior Alaska, spanning the biomes of tundra, tundra–boreal forest ecotone, and boreal forest. Chemical analyses revealed that soils with low pH have fewer base cations, more aluminum and iron minerals, and lower base saturation, indicating that weathering and subsequent cation leaching characterize these geochemical properties in the Alaskan ecosystems. Adsorbed organic C in soil showed strong correlations with Al and Fe minerals, soil pH, and soil total C and represented approximately 30–55% of total soil C. This result suggests that soil C accumulation in the Alaskan ecosystems is strongly controlled by weathering-related changes in geochemical characteristics, especially increased adsorptive organic C. An adsorption test supported these observations and illustrated a greater capacity for acidic soil to adsorb organic C than non-acidic soil. These findings indicate that variations in weathering-associated characteristics have a strong influence on the regional variation in C dynamics and biogeochemical consequences in the Alaskan ecosystems.

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