Available online at www.sciencedirect.com
ScienceDirect
ELSEVIER
Geoderma 135 (2006) 97–106
GEODERMA
www.elsevier.com/locate/geoderma

The influence of alkaline and non-alkaline parent material on soil chemistry

Jenny L.K. Vestin [a,*], Kei Nambu [a], Patrick A.W. van Hees [b], Dan Bylund [a], Ulla S. Lundström [a]

[a] *Department of Natural Sciences, Mid Sweden University, SE-85170 Sundsvall, Sweden*
[b] *Department of Natural Sciences, Örebro University, SE-70182 Örebro, Sweden*

Received 2 March 2005; received in revised form 6 October 2005; accepted 22 November 2005
Available online 7 February 2006

Abstract

The gneiss bedrock of Alnö Island, situated at the eastern coastline of central Sweden (62°24′N, 17°30′E), has alkaline intrusions interspersed in narrow dikes. This gives the opportunity to create experimental designs, where the impact of different parent material on the soil solution chemistry can be exclusively investigated.

In this study, three alkaline sites and three non-alkaline sites were mineralogically identified within a homogenous spruce stand. Composition of soil, exchangeable cations and soil solution were determined throughout the soil profiles. The soil solution was analysed for pH, dissolved organic carbon (DOC) and inorganic species. The obtained data was statistically evaluated by *t*-tests, analysis of variance (ANOVA) and principal component analysis (PCA). Results indicate that the alkaline parent materials gave rise to higher content of exchangeable Ca and Mg and a soil solution with higher concentrations of DOC, SO_4, NO_3, and Ca compared to the non-alkaline materials. For the deeper mineral horizons (25–30 cm) F and pH were also higher in the alkaline soil solutions. There were only small differences between the organic horizons at alkaline and non-alkaline sites, presumably explained by the influence of litter and recirculation of nutrients. The multivariate analyses emphasized the correlation between the parent material, exchangeable cations and the soil solution concentrations of Ca, Mg, P and Al.
© 2005 Elsevier B.V. All rights reserved.

Keywords: Parent material; Soil solution chemistry; Calcareous soil; Nitrification; Forest; Exchangeable cations

1. Introduction

Parent material composition strongly influences soil and soil-solution chemistry (Krám et al., 1997; Hornung et al., 1990), which in turn regulates soil fertility. In particular, the nutrient status of a soil largely depends on its pool of exchangeable base cations (Reynolds et al., 1988). Stutter et al. (2003) investigated the content of exchangeable base cations in soils derived from different parent material, ranging from acidic granite to basic limestone. They found that the content of Ca and Mg showed a close correlation to the parent material, while the correlation was lower for exchangeable Na. Álvarez et al. (2002) showed that the content of extractable Al was positively correlated to geochemical conditions. In contrast, the parent material has a less pronounced influence on the organic horizon (Grieve, 1999; Stutter et al., 2003), primarily because the surface soil is to a greater extent affected by the biocycling of nutrients, decomposing litter and atmospheric

* Corresponding author. Fax: +46 60 148820.
E-mail address: Jenny.Vestin@miun.se (J.L.K. Vestin).

0016-7061/$ - see front matter © 2005 Elsevier B.V. All rights reserved.
doi:10.1016/j.geoderma.2005.11.013

deposition (Stutter et al., 2003). The correlation between parent material and soil solution is less pronounced than the correlation between parent material and soil–solid properties (Grieve, 1999; Stutter et al., 2003), mainly because water percolates rapidly through the soil and thus has a limited equilibrium time (Stutter et al., 2003).

Lime has been applied to forest soils since the beginning of the 20th century to ameliorate the nutrient status and hence improve tree growth. Liming gives increased pH and increased content of base cations in the exchangeable pool and in the soil solution from the upper soil horizons but also sometimes decreased pH in the deeper horizons (Lundström et al., 2003a,b). This situation may differ from natural alkaline conditions where alkaline parent material may give rise to high content of base cations and high pH through the whole soil profile.

The majority of soils in Sweden are nutrient poor, derived from gneiss or granite parent material. However, on Alnö Island, in central Sweden, narrow and well-defined alkaline intrusions can be found interspersed within gneiss bedrock. The intrusions are derived from volcanic activity that occurred in late Proterozoic to early Paleozoic era (von Eckermann, 1948; Haslinger, 2004). The aim of this study was to investigate and compare the exchangeable pools of cations and the soil solutions derived from alkaline parent material and those from gneiss parent material. Because the soil solution is in direct contact with the biota, the nutrients in solution are the most available for uptake. Thus, a difference in soil solution composition from alkaline and non-alkaline plots may have implications for plant growth.

2. Materials and methods

2.1. Site description

Alnö Island is situated in central Sweden (62°24′N, 17°30′E) (Fig. 1). This investigation was conducted in a homogenous 80-year-old Norway spruce stand (*Picea abies*) (50 × 500 m) where alkaline dikes are interspersed within gneiss bedrock. The alkaline bedrock consists mainly of calcite, nepheline, pyroxene, phlogopite and apatite while the main components in the gneiss bedrock are quartz, plagioclase, mica and K-feldspar (Haslinger, 2004). The area has homogenous texture and the same climate conditions. The annual average temperature is +3 °C, and annual precipitation approximately 600 mm. The area has a relatively small amount of anthropogenic acidic deposition. Soil genesis began after deglaciation around 9000 years ago. A detailed description of the area and soils can be found in the doctoral thesis by Haslinger (2004).

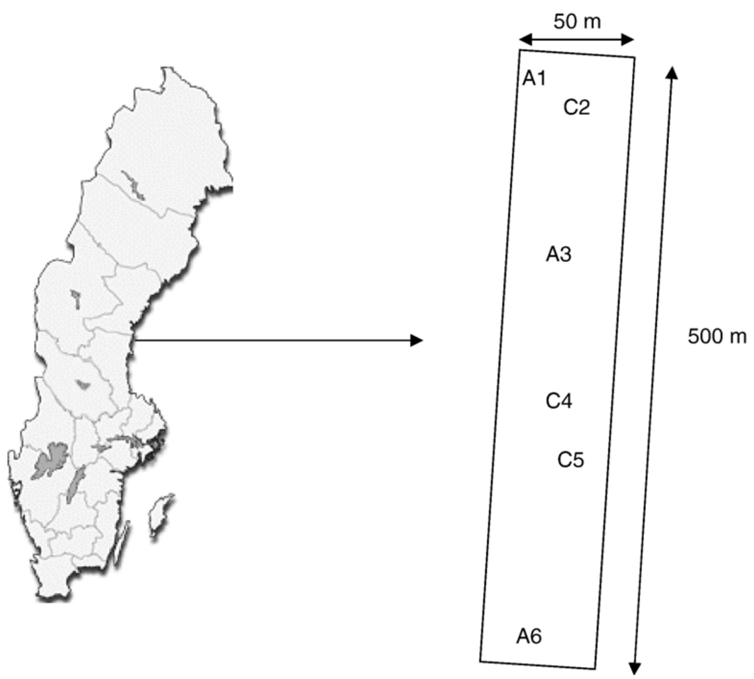

Fig. 1. The location and shape of the homogenous forest stand showing the position of the six sampling plots (A = alkaline and C = non-alkaline). The study area is situated in central Sweden, at 64°24′N, 17°30′E.

Download English Version:

https://daneshyari.com/en/article/4575712

Download Persian Version:

https://daneshyari.com/article/4575712

Daneshyari.com