The Influence of Calcium Addition upon Forest Floor and Mineral Soil Horizons in a Watershed Impacted by Acidic Deposition

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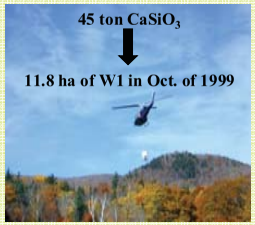
Abstract

Watershed 1 (WS-1: 11.8 ha) of the Hubbard Brook Experimental Forest (HBEF) in New Hampshire (NH), USA was treated by addition of calcium silicate ($CaSiO_3$; wollastonite) in October of 1999 to mitigate effects of acidic deposition. Soil solution and soil samples were collected prior to and after treatment to evaluate the treatment effects. Exchangeable Ca^{2+} (Exch.Ca^{2+}), effective cation exchange capacity (CEC_e), pH_s increased, and exchangeable acidity ($EA_{pH8.2}$) decreased in forest soil horizons after the manipulation due to the increased Ca^{2+} concentration associated with the dissolution of added wollatonite. There were either little increases in Exch.Ca^{2+}, CEC_e, and pH_s and decreases in $EA_{pH8.2}$ or no changes in mineral horizons. Soil solutions draining the forest floor responded to the treatment but changes were diminished with increasing soil depth. Prior to treatment, forest floor acidity increased with increasing watershed elevation. This pattern was reversed after the Ca addition due to wollastonite dissolution in shallow high elevation soils.

Introduction

Application of Wollastonite

Wollastonite pellet (1.5 to 4 mm diameter)



Dissolution of Wollastonite

$$CaSiO_3(s) + H_2O + 2H^+ = Ca^{2+} + H_4SiO_4$$

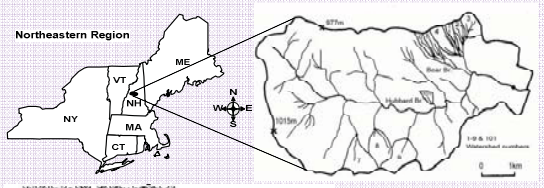
Dissolution	Results
Ca^{2+}, H_4SiO_4, ANC	↑
H^+, Al_i	↓

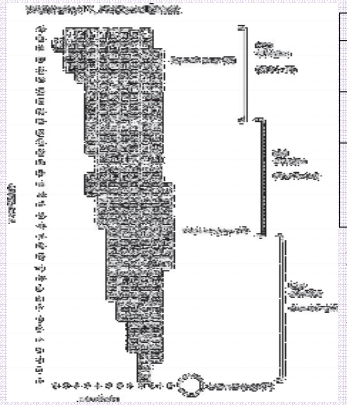
Objective

The objective of this study was to investigate the effects of the Ca^{2+} manipulation on soil chemistry. In this study, we examined changes in soil solution chemistry and soil Exch.Ca^{2+}, pH_s, $EA_{pH8.2}$, and CEC_e, and spatial patterns before and after the treatment at WS-1 in order to improve understanding of the relationships between soil solution and soil chemistry.

Research approach

Hubbard Brook Experimental Forest
West Thornton, New Hampshire





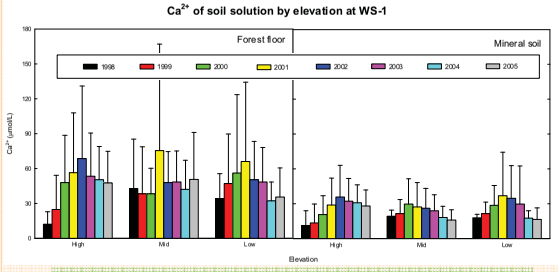
1996, 1998, 2000, 2002
100 randomly selected in WS-1
Oi+Oe, Oa, upper mineral soil
11.8 ha 488 to 747 m Ca treated

X-coordinate:
- -9 ~ 2
- West - East

Y-coordinate:
- 0 ~ 34
- South - North

Results

Soil Solution Chemistry



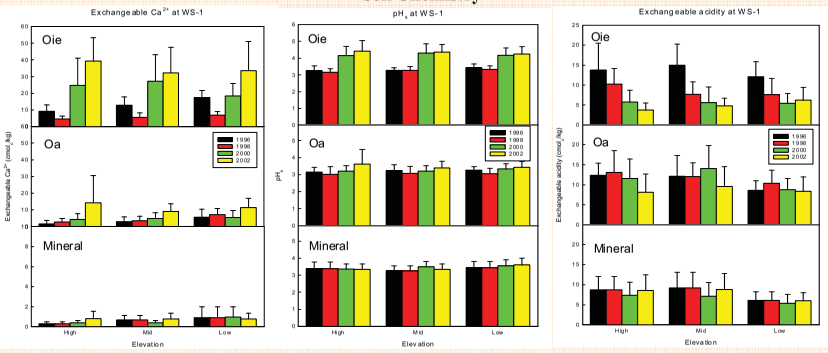
Calcium concentrations in forest and mineral soil solution at high, mid, and low elevations at WS-1 between 1998 and 2005

Conclusions

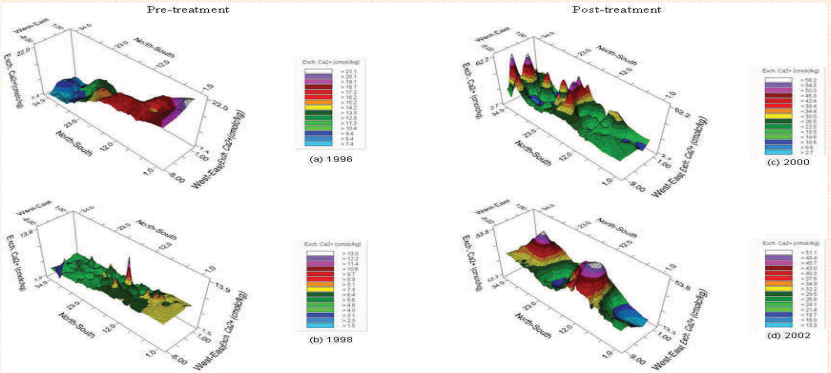
Ca^{2+} concentrations increased in soil solutions in the treated watershed leading to increases in exchangeable Ca^{2+}, pH_s, and CEC_e, and decreases $EA_{pH8.2}$ concentration in soil.

The magnitude of changes in soil chemistry in response to the wollastonite treatment decreases with increasing soil depth. There was a pattern of increasing Oie horizon acidity with elevation before the treatment which reversed after the application of calcium.

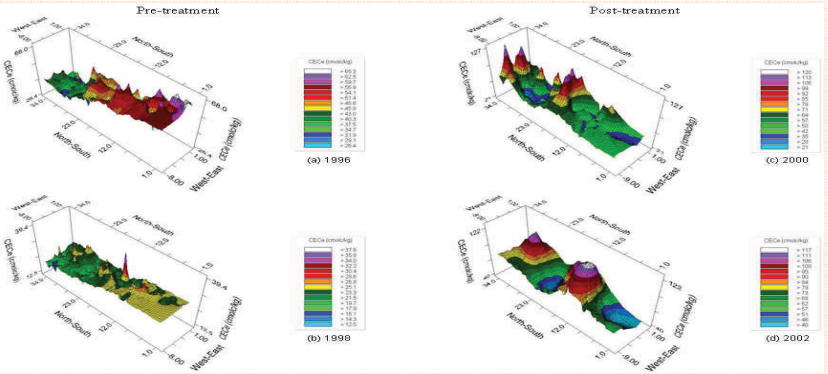
Soil Chemistry



Exchangeable Ca^{2+}, pH_s, and exchangeable acidity in Oie, Oa, and mineral soil horizons at high, mid, and low elevations at WS-1 before (1998 and 1998) and after Ca treatment (2000 and 2002)



Spatial patterns in exchangeable Ca^{2+} from Oie soil horizons at the HBEF in NH before (a and b) and after the Ca treatment (c and d): north (34.0) towards high elevation (747 m) and south (1.0) towards low elevation (488 m)



Spatial patterns in CEC_e from Oie soil horizons at the HBEF in NH before (a and b) and after the Ca treatment (c and d): north (34.0) towards high elevation (747 m) and south (1.0) towards low elevation (488 m)

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