Soil phosphorus distribution along a rainfall gradient on a volcanic substrate

F. TAMBURINI[1]*, O. CHADWICK[2], E. FROSSARD[1], C. GUEBELS[2] AND P. VITOUSEK[3]

[1]Dept. of Environmental System Sciences, ETH Zurich, 8315 Eschikon, Switzerland (*correspondence: federica.tamburini@usys.ethz.ch)

[2]Dept. of Geography, University of California, Santa Barbara, USA

[3]Dept. of Biology, Stanford University, Stanford, USA

Precipitation is one of the five factors, along with parent material, topography, biota, and time, controlling soil and ecosystem development [1] and nutrient cycling. Contrary to C and N, only few studies have investigated the relationships between precipitation and P cycling and distribution in soils developed on a similar parent material [2, 3, 4].

Soils found on the Kohala Mountain, Hawaii, provide ideal conditions to study the effect of increased precipitation on P distribution. The soils are developing on the same parent material, alkali basalts of the Hawi Series with high contents of apatite. Along the climosequence, precipitation ranges from <200 to >3000 mm per year. The distribution of minerals and elements and the abrupt changes in soil chemical properties are strongly influenced by the rainfall gradient [2, 5]. Organic matter and non-crystalline minerals increase at intermediate rainfall, and while the first declines, non-crystalline minerals dominate even at high rainfall [5].

We present results from a study aiming at identifying patterns in soil P forms and variations along the Kohala climosequence. The Hedley extraction was performed on 11 soils sampled at different depths. The stable isotopes of oxygen bound to phosphate ($\delta^{18}O\text{-}PO_4$) were analyzed on some of the extracted P forms. Sorbed P makes up to more than 80% of total P at intermediate to high rainfall, and HCl-P gradually declines from drier to wetter sites. The $\delta^{18}O\text{-}PO_4$ of the HCl-P is typical of volcanic material (10‰) at dry sites, and becomes heavier with increased rainfall. These results puts the foundations to identify chemical thresholds and climatic boundary conditions, which affect P distribution in soils.

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