

Landscape-scale pedogenic relationships between soil carbon and secondary metal oxides in Hubbard Brook podzols, northeastern US

REBECCA R. BOURGAULT^{1*}, DONALD S. ROSS¹, SCOTT W. BAILEY², PATRICIA A. BROUSSEAU³, JOHN P. GANNON³, KEVIN J. MCGUIRE³ AND THOMAS D. BULLEN⁴

¹University of Vermont, Burlington, VT, USA, rbourgau@uvm.edu (* presenting author), dross@uvm.edu

²US Forest Service, North Woodstock, NH, USA, swbailey@fs.fed.us

³Virginia Tech, Blacksburg, VA, USA, patr87@vt.edu, jpgannon@vt.edu, kevin.mcguire@vt.edu

⁴US Geological Survey, Menlo Park, CA, USA, td Bullen@usgs.gov

Abstract

Podzols are unique soils in which metals and carbon are intimately linked by the pedogenic process of podzolization. In this soil-forming process, organic matter (OM) chelated by Al, Fe and Mn leaches from the soil surface and accumulates in the subsurface spodic (B) horizon. Spodic materials (ill-defined associations of Al, Fe, Mn and C) in the B horizon are more resistant to decomposition than OM in the soil surface, in part due to the stabilizing effect of chelation and/ or sorption by Al, Fe and Mn. Podzols are found globally in a variety of environments, and therefore represent an important carbon sink. Research suggests that spatial variations in podzolization can result in part from hydrologic processes such as dominant flowpath direction, and reduction-oxidation processes driven by water table dynamics. These processes determine solubility, transport, and accumulation of Al, Fe, Mn and C. In this study, we document vertical and lateral distributions of total soil C in Watershed 3 (WS3), which is a forested, podzolized catchment in the Hubbard Brook Experimental Forest (HBEF), New Hampshire, in the Northeastern US. We will examine the relationships of C to total secondary Fe oxides and Mn oxides (extracted by citrate-dithionite), and poorly crystalline Al and Fe oxides (extracted by acid ammonium oxalate). Eighty pedons have been described, sampled, and extracted by horizon throughout WS3. In order to determine the role of hydrologic processes in determining soil chemistry in WS3, combined hydrometric monitoring and isotope tracers are used to document flowpaths, water table dynamics, and ground water chemistry and transport. Preliminary results indicate redistribution of spodic materials according to flowpaths. For example, where lateral flowpaths predominate, there is landscape-scale lateral podzolization: leaching/ loss of metals and C upslope, and accumulation of metals and C downslope. In contrast, pedon-scale vertical podzolization is more evident where flowpaths are dominantly vertical, such as on well-drained backslopes. As expected, the Mn:Fe ratio is higher in laterally deposited spodic materials as opposed to vertically deposited spodic materials, due to the fact that Mn is more sensitive to redox conditions and therefore more mobile than Fe. Understanding the spatial distributions of Al, Fe, Mn, and C at the landscape scale in WS3 may provide valuable information about the complex interactions between water and soils, metals and carbon in a forested, podzolized Northeastern US watershed.

An experimental study of the stability of the REE(III) in sulphate-bearing aqueous solutions

N. BOURQUE*, ART. MIGDISOV, AND A.E. WILLIAMS-JONES

McGill University, Earth & Planet. Sci., Montreal, QC, Canada (*correspondence: nicolas.bourque@mail.mcgill.ca)

During the past fifteen years, numerous studies of a variety of geological settings have demonstrated that the rare earth elements (REE) are mobilized by hydrothermal fluids [1, 2, 3]. As sulphate complexes of the REE are known to be among the most stable aqueous species at ambient temperature, it is therefore reasonable to propose that these species play an important role in REE transport in hydrothermal systems with high sulphate activity. However, published experimental data on the behaviour of REE sulphate species at elevated temperatures are limited to Nd, Sm, and Er [1] and therefore, evaluations of the mobility of the REE in hydrothermal sulphate-bearing solutions have been based mainly on the theoretical predictions of Haas et al. (1995). In view of this, we have systematically investigated the behaviour of the REE, including Y, in sulphate-bearing aqueous solutions and determined the properties of sulphate complexes of these elements at elevated temperature.

The technique employed in the experiments was identical to that described in Migdisov and Williams-Jones (2007). The experiments involved determining the solubility of REE oxides and fluorides in solutions with a range of sulphate concentrations, and were performed at temperatures up to 250 °C and saturated pressure of water vapour.

The data derived from the measured solubility of the REE solids show that the stability of REE sulphate species varies little with the atomic number of the REE. For example, the logarithm of the first formation constant of La ($\log \beta_1$) at 200°C differs from that of Yb by less than 1 log unit. The same observation was made in earlier spectroscopic studies of Nd, Sm, and Er sulphate species [1]. This observation suggests that the REE are unlikely to fractionate in nature, if they are transported as sulphate species.

[1] Migdisov, A.E. Williams-Jones (2008) *Geochimica et Cosmochimica Acta* **72**, 5291–5303

[2] Migdisov, A.E. Williams-Jones (2007) *Geochimica et Cosmochimica Acta* **71**, 3056–3069.

[3] Haas et al. (2005), *Geochimica et Cosmochimica Acta* **59**, 4329–4350.