Geophysical Research Abstracts
Vol. 16, EGU2014-7273, 2014
EGU General Assembly 2014

Linking soil chemistry, treeline shifts and climate change: scenario modeling using an experimental approach

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Climate change and global warming have a strong influence on the landscape development. As cold areas become warmer, both flora and fauna must adapt to new conditions (a). It is widely accepted that climate changes deeply influence the treeline shifts. In addition to that, wildfires, plant diseases and insect infestation (i.e. mountain pine beetle) can promote a selective replacement of plants, inhibiting some and favoring others, thus modifying the ecosystem in diverse ways.

There is little knowledge on the behavior of soil chemistry when such changes occur. Will elemental availability become a crucial factor as a function of climate changes?

The Sinks Canyon and Stough Basin - SE flank of the Wind River Range, Wyoming, USA - offer an ideal case study. Conceptually, the areas were divided into three main subsets: tundra, forest and a subarid environment. All soils were developed on granitoid moraines (b, c). From each subset, a liquid topsoil extract was produced and mixed with the solid subsoil samples in batch reactors at 50 °C. The batch experiments were carried out over 1800 h, and the progress of the dissolution was regularly monitored by analyzing liquid aliquots using IC and ICP-OES. The nutrients were mostly released within the first hours of the experiment. Silicon and Al were continuously released into the solution, while some alkali elements – i.e. Na - showed a more complex trend. Organic acids (acetic, citric) and other ligands produced during biodegradation played an active role in mineral dissolution and nutrient release. The mineral colloids detected in the extract (X-ray diffraction) can significantly control surface reactions (adsorption/desorption) and contributed to specific cationic concentrations. The experimental set up was then compared to a computed dissolution model using SerialSTEADYQL software (d, e).

Decoding the mechanisms driving mineral weathering is the key to understand the main geochemical aspects of adaptation during climate changing conditions. Our findings suggest that one of the controlling factors in nutrient release is the capacity of ion diffusion, mostly given by the activity of clay minerals and organic matter.

(a) Burga, C., Krüsi, B., Egli, M., Wernli, M., Elsener, S., Ziefle, M., Fischer, T., Mavris, C.. Plant succession and soil development on the foreland of the Morteratsch glacier (Pontresina, Switzerland): Straight forward or chaotic? Flora 205 (2010) 561-576

(b) Dahms, D. Relative and Numeric Age Data for Pleistocene Glacial Deposits and Diamictons in and near Sinks Canyon, Wind River Range, Wyoming, U.S.A. AAAR 36, 1 (2004) 59-77

(c) Egli, M., Dahms, D., Norton, K. Soil formation rates on silicate parent material in alpine environments: Different approaches-different results? Geoderma 213 (2014) 320-333

(d) Furrer, G., von Gunten, U., Zobrist, J. Steady-state modelling of biogeochemical processes in columns with aquifer material: 1. Speciation and mass balances. Chemical Geology 133 (1996) 15-28

(e) von Gunten, U, Furrer, G. Steady-state modelling of biogeochemical processes in columns with aquifer material: 2. Dynamics of iron-sulfur interactions. Chemical Geology 167 (2000) 271-284