Geochemical mass balances and weathering rates in forested watersheds of the Southern Blue Ridge: Solving more equations in more unknowns through incorporation of rare earth elements

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Watershed solute-based geochemical mass balance methods are considered the most accurate means of quantifying elemental transfers and weathering rates at the Earth's surface. However, such calculations often suffer from the limitation that the number of unknowns exceeds the number of mass-balance equations, either yielding a system of equations that cannot be solved mathematically, or requiring less-realistic approximations to solve for a reduced number of unknowns.

New solute-based mass balance calculations for low-order watersheds at the Coweeta Hydrologic Laboratory, western North Carolina, include solute fluxes of rare earth elements (REE), yielding enough equations to calculate eight unknowns (rates of primary mineral weathering and secondary mineral formation). Weathering of garnet and accessory allanite are the major contributors of REE to Coweeta stream waters. Inclusion of REE in Coweeta watershed mass balance calculations yields mineral weathering rates that are more geochemically reasonable (e.g., garnet weathering rates are up to approximately 90% slower) than previous studies.

Use of REE in watershed solute mass balances is in its infancy. Stream REE fluxes are from one-time samples that have been converted to approximate long-term fluxes using stream SiO_2 chemistry. Also, no data have been collected on REE in precipitation. Despite these potential limitations, sensitivity analysis of the new mass balance results, and the more geochemically reasonable results, encourage further work to overcome these limitations.

Exploring the effects of urban and agricultural land use on surface water quality

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Approach

This research is based on the hypothesis that the influences of land use on water quality are unique and can be quantified. In this study we investigate the influence of urban land use on nutrient cycles and trace elements and attempt to validate the applicability of previously developed biogeochemical fingerprints. (Wayland, et al., 2003)

Samples were analyzed for nutrients, major ions, and trace metals. Sites were selected representing surface watersheds with a variety of dominant and mixed land use types. Factor and cluster analysis were used to investigate the processes controlling the effects of land use on river chemistry.

Discussion of Results

Biogeochemical fingerprints of land use were referenced to the natural environment aiding in the identification of the unique contributions of urban and agricultural land uses to surface water chemistry. Similar biogeochemical fingerprints are found between the two watersheds (Urb: Na, K, Cl / Ag: Ca, Mg) and additional correlations were found for nutrients (Ag: N & Urb: N, P) and for selected trace metals (Urb: Rb, Mo, Mn, Sr and Ba / Ag: U).

Conclusions

The higher correlations of urban than agricultural land uses with nutrients were not expected and may reflect the effects of fertilization and wastewater or the season the samples were taken. More study in different geologic and urban settings is needed to help quantify these fingerprints. These studies could lead to a rapid assessment tool for the quality and sources for degradation of urban environments.

Reference

Wayland, K.G., Long, D.T., Hyndman, D.W., Pijanowski, B. C., Woodhams, S.M., Haack, S.K., (2003). *Journ. Env. Qual*. **31**. 180-190