A Hydropedologic Approach to Characterizing Soil Variability in a Headwater Catchment

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Soils, groundwater, and surface waters are inter-connected physically and chemically, and their interactions may be studied within the framework of hydropedology, an inter-disciplinary effort combining hydrology and soil science. In this hydropedologic study, the soils of a headwater catchment (Watershed 3, or WS3) at Hubbard Brook Experimental Forest, NH are thought to be the main source of solutes to streams. The soils have been classified into functional groups called hydropedologic units (HPUs). Five HPUs have been established according to morphological and chemical characteristics which relate to differing hydrologic conditions. There is evidence that the soils of WS3 experience lateral unsaturated groundwater flow and lateral soil formation under well-drained conditions. Many (>100) soil profiles have been described and sampled by horizon along transects throughout the catchment; this has been done in collaboration with hydrologic monitoring in order to determine the effects of vertical vs. lateral flow on soil development. Soil horizon samples have been analyzed for extractable elements to be used as hydrologic and pedogenic tracers. As expected, the soils (mostly Spodosols) show typical vertical development on steep backslopes. However, the soils show lateral unsaturated groundwater flow and lateral soil development in areas near bedrock outcrops, benches, and gently sloping riparian zones. Observations of morphology and micromorphology are consistent with physical transport of soil materials via groundwater, and redox-active elements such as manganese and cerium are being transported downslope. Interestingly, much of the Mn in the catchment originates from a Mn-rich seep that acts as a “hot spot.” These results emphasize the existence and prevalence of lateral unsaturated flow as a soil-forming factor in this catchment. Also, this hydropedologic approach could be applied to other catchments, where there is a need for better documentation of spatial variability of soils within watershed models for more accurate predictive capacity.