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Drivers of Spatial Soil Variability on Hillslopes

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Hillslope soils are generally not considered to be of high agricultural value and consequently they are only mapped at very broad scales in most national soil maps and the range of soil properties is poorly characterized. Researchers who need more detailed soil information have to either develop their own maps or rely on inadequate pedotransfer functions. A major constraint to characterizing soil landscapes in non-agricultural areas is collecting sufficient samples to adequately capture the range of soils and the spatial distribution pattern. Such patterns reflect the nature and rate of the geomorphic processes operating on hillslopes. Significant differences in the pattern of soil variability occur as the activity of geomorphic processes increases. While there is a continuum in rate and extent of geomorphic activity across natural landscapes the impact of these processes on soil variability will be illustrated by considering soil landscapes from two extremes, a very high rainfall drainage basin and a semi-arid drainage basin. In the high rainfall area, the pattern of soil variability reflects the frequency and location of erosional and depositional events. Three soil chronosequences each containing five soil profile classes were identified: one for soils forming on bedrock, a second of soils forming in unconsolidated regolith and finally a sequence of compound soil profiles containing one or more buried soils. In the semi-arid drainage all soils have been forming for the same period of time. Soil variability reflects the impact of slope orientation and position and the parent material the soils are forming in. The dominant driver of soil variability is slope orientation, with more strongly developed and thicker soil profiles on north facing slopes compared to south facing slopes. Soil catenas are well developed on most north facing slopes independent of parent material, but more weakly expressed on south facing slopes. Two distinct parent materials are a quartz monzonite and granite. The granite weathers to a gruss and produces a weathering limited hillslope, with very thin soils, while the quartz monazite produces a coarse unconsolidated regolith forming a transport limited hillslope with thicker soils. The pattern of soil variability in the high rainfall drainage is reflected in the distribution of successional plant communities where as in the semi-arid region, slope orientation and underlying parent material available from geological maps can be used to predict soil distribution patterns. Understanding these relationships allows researchers to locate their soil observations in a way to capture or validate a soil variability most efficiently.