Lithology and soil relationships for soil modelling and mapping

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Relationships between parent material and soil are not well understood and generally only reported in qualitative form. We present a classification of parent material for pedologic purposes, which comprises twelve lithology classes based on mineralogical and chemical composition. The relationships of these lithology classes with six key soil properties (soil organic carbon, pH, cation exchange capacity, sum of bases, total P and clay %) were examined over NSW, Australia. We used multiple linear regression, Random Forest and Cubist tree models based on a soil dataset of over 3200 points. Semi-quantitative estimates are derived of change in these soil properties with a change in lithology class, and an associated silica index, for example, a 22% relative decrease in soil organic carbon with each 10% rise in silica, broadly equivalent to a change from average shale to granite, assuming other factors remain constant.

Widely available lithology data appears to be under-utilised in digital soil modelling and mapping (DSMM) programs. We compared the performance of the classified lithology data with other continuous, geophysical parent material covariates such as gamma radiometrics in digital soil models and maps over NSW. The lithology covariate was demonstrated to exert the greatest influence on all six soil properties, coming well ahead of all geophysical parent material and other environmental covariates. Validation statistics demonstrated strong improvement in both model and map quality when the lithology covariate was included, for example, Lin's concordance rising from 0.58 to 0.77 for the sum of bases model.

Despite the potential drawbacks of using polygonal data, properly organised categorical lithology data can be a strong covariate to complement other continuous geophysical data sources in DSMM programs, particularly where reliable, fine scale geological and soil data are available. Further research aimed at establishing clear relationships between geophysical data and the twelve lithology classes is recommended.