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Evaluating modelled soil profile evolution with observations from a basalt chronosequence in Queensland, Australia.

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Soils are complex systems which hold a wealth of information of past conditions. Untangling the processes and feedbacks involved in these systems may enable us to quantify such environments. The ability to represent these processes with models will also contribute to our understanding of long-term biogeochemical cycles particularly the carbon cycle and nutrient cycles such as phosphorus.

Attempts to confront soil profile models with data are rare. Here we present initial results of a modelling attempt to reproduce soil profiles from the basalt provinces in north Queensland, Australia. These soils provide a unique system with which to test our model understanding of soil profile evolution. The soils are formed on a series of volcanic lava flows which provide a sequence of different aged soils (0.05-7 Mya) all with a relatively uniform parent material. This chronosequence of soils provides a snapshot of a soil profile during different stages of development. A steep rainfall gradient from the coast inwards also presents a system which allows us to test the model's ability to reproduce soil properties under differing climates. Soil data currently used in this study spans from 0.9 to 5.9 Mya and includes elemental composition, pH, organic content, exchangeable cations, and OSL dates.

The mechanistic model in development includes the major processes of soil formation such as i) mineral weathering, ii) percolation of rainfall through the soil, iii) leaching of solutes out of the soil profile iv) surface denudation and v) vegetation and biotic interactions. Mineral weathering is simplified by assuming equilibrium is reached between the minerals and percolating water. So far the model can produce both shallow and deep profiles in response to changing precipitation and above ground biomass. Model output includes the proportion of original rock oxides remaining at each depth in the profile, an organic carbon profile and a pH profile, which is influenced by the concentration of ions in solution and CO_2 from the decay of organic matter. The aim is to keep the model as simple as possible but retain a realistic treatment of geochemical and physical processes. We hope that by using these simple approaches we can determine how much complexity is needed to reproduce the main features of these soil systems.