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# A new model for weathering front propagation and the formation of regolith coupled with surface erosion and transport

Jean Braun and Jonathan Mercier
ISTerre, Universite Grenoble Alpes and CNRS, BP 53, 38041 Grenoble Cedex 9, France

In many environments, the weathering of rocks is an essential process that not only contributes directly to the removal of material from continental interiors to the world oceans but also plays an important role in preconditioning rocks for physical erosion and transport. Weathering results in the formation of a regolith profile that typically comprises a mobile soil layer, a saprolite layer (in-place weathered material) and a layer of fractured rock overlying the fresh bedrock. A large body of observations tells us that chemical weathering is primarily controlled by the presence/absence of water in the subsurface and must therefore be related to climate through precipitation and temperature. However, a predictive model that represents the complex interplay between the hydrology of the regolith and its growth/evolution by chemical weathering and surface erosion and transport is still lacking. Here we present a new numerical model of the propagation of a weathering front at the base of the saprolite layer that we use to predict the evolution of the regolith on geological time scales. In this model, we compute the steady-state geometry of the water table and assume that the rate of propagation of the weathering front is proportional to flow velocity at the base of the regolith layer. Using this model, we predict that two fundamentally different regimes may exist during the formation of a regolith profile that will ultimately control its geometry, its depth and its sensitivity to climate and local slope. We show that the two regimes correspond to different values of a simple dimensionless number that relates slope, precipitation and the mean hydraulic conductivity of the regolith profile. We also show that both regimes may exist, regardless of tectonic uplift and erosion, as long as the rate of erosion is slower than the rate of propagation of the weathering front, a condition that can be expressed through another, simple dimensionless number. We will also test the model predictions against observations from selected environments.