Basalt, granite, rhyolite, and schist weathering as affected by plants and microorganisms

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In order to survive in nutrient poor environments, plants and microorganisms developed a number of strategies to accelerate weathering of the minerals in the soil and rock. This study looks at the role of plant-microbial associations in mineral weathering. Four different rocks, basalt, granite, rhyolite, and schist were used as substrate for growth of Ponderosa pine (*Pinus ponderosa*) and Buffalo grass (*Bouteloua dactyloides*) with and without mycorrhiza. There was also a bacteria-only and killed controls. Two types of mycorrhizal fungi were used, *Rhizopogon evadens*, an ecto-mycorrhiza-forming fungi associated with Ponderosa pine and VAM mycorrhiza-forming *Glomus intraradices* used to inoculate Buffalo grass. Plants were seeded into plastic columns containing rocks inoculated with microbial community obtained from basalt.

To detect changes in soil solution composition resulting from weathering processes, drainage solution was collected and analyzed to determine electrical conductivity, pH, quantify concentrations of organic and inorganic C, total N, anions and cations. After four month a set of columns was sacrificed and root and shoot biomass, concentrations of C, N, and lithogenic elements in plant material, as well as plant root lengths was determined.

All four rocks experienced weathering. Both electrical conductivity and pH of drainage solutions, indicator variables for weathering reactions were higher than measured in water used for irrigation. Electrical conductivity of drainage solution was also higher in planted treatments compared to control, and in pine compared to grass treatment. Concentrations of lithogenic elements in soil solution were also affected by plants, with nutrient cations depleted relative to rare earth elements in planted treatments, compared to microbial and abiotic controls. In addition, it was observed that mycorrhizal infection of the plants affected plant biomass and root length.

Rapid regolith formation over volcanic bedrock and implications for landscape evolution

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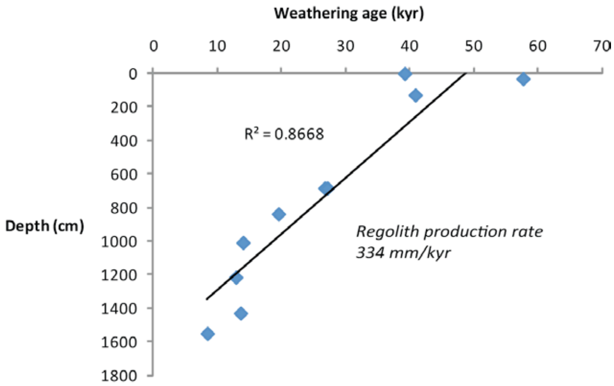
The ability to quantify how fast weathering profiles develop is crucial to assessing soil resource depletion and quantifying how landscapes evolve over millennia. Uranium-series isotopes can be used to determine the age of the weathering front throughout a profile and to infer estimates of regolith production rates, because the abundance of U-series isotopes in a weathering profile is a function of chemical weathering and time. This technique is applied to a weathering profile in Puerto Rico developed over a volcaniclastic bedrock.

U-series isotope compositions are modelled, revealing that it takes 40-60 kyr to develop an 18m-thick profile. This is used to estimate an average regolith production rate of 334 ± 46 mm/kyr (Fig. 1; *[1]*). This value is higher by a factor of up to 30 when compared to production rates estimated for weathering profiles developed over granitic or shale lithologies. This *quantitatively* underpins the lithological control on rates of regolith production (in a neighbouring watershed but over a granitic bedrock, production rates are only ~30-40 mm/kyr). Moreover, by comparing these results to a compilation of soil erosion rates, it is clear that landscapes are controlled by the balance (or imbalance) between regolith production and erosion: soil-mantled landscapes are the result of a relative balance between production and erosion, whereas in cratonic areas, thicker weathering profiles are generated because erosion fails to match regolith production rates.



[1] Dosseto, *et al*.., 2012. Earth and Planetary Science Letters 337–338, 47-55.

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