Exploring the effects on regolith of fractures, water flow, and biogeochemical reactions inside hills

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As minerals formed at depth re-equilibrate at Earth's surface to form regolith, mineral reactions with O_2 and CO_2 are recorded in regolith profiles. We use models to explore such reaction profiles inside hills. The ratios, R^0, of the capacities of a rock composition to consume O_2 : CO_2 differ on hills depending upon lithology: R^0=0.04 for diabase and 0.02 for granite. For Fe-rich massive diabase, CO_2 may deplete deeper than O_2 at depth, allowing ferrous iron to be lost from regolith at depth. In contrast, for Fe-poor granite, O_2 may not be consumed until deeper than CO_2, causing iron retention. When oxidation occurs at depth (e.g. granite), the volume constraints promote fracturing, and fracturing promotes advection, leading to development of thicker regolith. Perhaps as a consequence, modern regolith is generally thicker on granites than diabase. In addition, thick regolith may not have been likely on early earth when pO_2 / pCO_2 was low. These ideas also have implications for the interplay inside hills between zones of vertical water flow in the unsaturated zone and zones of lateral water flow in water-saturated layers. Thin fronts (e.g. diabase) likely document zones of lateral water flow while thicker reaction fronts (e.g. granite) likely document vertical water flow. Where water tables fluctuate, biogeochemical reactions likely create depth gradients of porosity and permeability, again promoting lateral flow.