Mineral nutrient profiles on differing lithologies at three tropical critical zone sites

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Mineral weathering in regolith and at bedrock-regolith interfaces directly impacts the availability of many important nutrients (e.g. Mg, Ca, K, P, and Fe). Mineral-weathering reactions continue to influence mineral nutrient cycles even in thick, highly leached regolith. We are studying mineral nutrient distributions and fluxes in depth profiles in two watersheds at the Luquillo Critical Zone Observatory in Puerto Rico and in the Bras David watershed on Basse-Terre, Guadeloupe. These 3 watersheds are steep; humid; have similar tropical vegetation, land-use, and climate; and contain thick regolith (soil+saprolite) developed on igneous bedrock: quartz diorite and marine-deposited volcaniclastics in Puerto Rico, and volcaniclastic debris flows in Guadeloupe. The mineralogy and texture of these 3 lithologies differ greatly.

After corrections for sea salts and ET, all sites reveal gradients in dissolved Mg with depth. In Puerto Rico, increasing Mg with depth reflects weathering of Mg-containing minerals. In Guadeloupe, decreasing dissolved Mg with depth suggests weathering or other input from Mg-containing minerals at the surface that either infiltrates or decreases with depth. Surficial enrichments in solid state Na, Ca, Mg and feldspar in Guadeloupe also indicate atmospheric inputs, likely related to volcanic activity. Although Puerto Rico receives significant inputs of Saharan dust, these components were not detected at the surface.

Carbon dioxide sequestration in coal: Geological challenges and philosophical hurdles

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The high carbon dioxide adsorption capacity of coal coupled with the low risk of leakage, due to the adsorptive storage mechanics, has made coal an attractive medium for consideration for sequestration of carbon dioxide. However, considerable geological and philosophical challenges to sequestration of carbon dioxide in coal exist that need be considered. Injection of carbon dioxide into coal seams results in swelling and associated loss of permeability, the amount of which is directly proportional to the initial permeability, coal mechanical moduli and total amount of adsorption as shown in laboratory experiments, field tests and simulations. For all but the most permeable coals, loss of permeability will limit or inhibit sequestration and will be practically limited to comparatively shallow coals (<1000 m). The highest adsorption capacity and thus greatest sequestration potential occurs in high rank, low moisture coals; however, since the ratio of carbon dioxide to methane capacity decreases with increasing rank, lower rank coals might be more amenable to co-production of methane and sequestration of carbon dioxide.

Sequestration of carbon dioxide in coal seams likely effectively sterilises coal from any future utilisation as an energy source. Coal seams considered as targets for carbon dioxide sequestration are generally stated as seams that are too thin or too deep for mining. Too thin or deep, however, can not be strictly defined for the future: coals seams as deep as 1500 m have been commercially mined and this depth is deeper than current commercial methane production and it is unlikely that coal seams deeper than 1500 m could be utilised for sequestration. Additionally, emerging technologies such as *in situ* gasification, *in situ* liquefaction and *in situ* bioconversion of coal may in the future lead to exploitation of coals that are currently judged too thin or too deep for conventional mining.