Transformations across the bedrock/saprolite – regolith boundary

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This study examines the transformations that occur as material transitions from relatively unweathered bedrock/saprolite to weathered regolith at two hillslopes, one on Osborn Mountain in the Wind River Range, WY, USA and another on Bodmin Moor, Cornwall, UK.

Both sites experienced a similar periglacial climate during the majority of their formation and we expect that frost processes were responsible for weathering-front advance during that time. Currently these hillslopes experience different climates. Osborn Mountain is relatively cold and dry with periglacial processes still operating and Bodmin Moor is relatively warm and wet.

At both sites, mineralogy and chemistry of bedrock/saprolite is distinctly different than the regolith. Most primary minerals decrease in abundance above the bedrock/saprolite boundary while secondary minerals have the opposite trend. We use a mass balance approach to quantify solid phase chemical mass gains and losses by calculating tau (τ) values with Zr as an immobile element. τ values for most major elements show loss above the bedrock/saprolite boundary. There is an exception at Osborn Mountain where Mg, Fe, and Ca have positive τ values, indicating the site has received eolian inputs.

Feldspar weathering is different at each site. At Bodmin Moor, plagioclase has an average absolute loss of 45% while Osborn Mountain has an average absolute loss of 13%. We interpret this to indicate that plagioclase is weathering at a faster rate at Bodmin Moor than at Osborn Mountain.

The observed weathering differences at Bodmin Moor compared to Osborn Mountain are likely due to the differences in recent climate conditions. The much warmer, wetter conditions at Bodmin Moor currently favor higher chemical weathering rates and a weathering front advance dominated by chemical processes while than the colder, drier conditions at Osborn Mountain favor a weathering front advance dominated by physical processes.

Time constants of chemical transfers in a forested ecosystem inferred from short-lived nuclides (^{226}-^{228}Ra, ^{210}Pb and ^{137}Cs)

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The time constants of radionuclide transfers between several compartments of a forested ecosystem was inferred using natural short-lived nuclides of the U and Th decay series as well as anthropogenic ^{137}Cs fallout. This study was performed on podzolic and brown acidic soils and the surrounding vegetation of the experimental Strengbach watershed located in the Vosges Mountains (France) (http://ohge.u-strasbg.fr/). Analyses of ^{226}Ra, ^{228}Ra, ^{210}Pb, ^{137}Cs, ^{230}Th and ^{232}Th were performed either by gamma-spectrometry or by mass spectrometry (TIMS). Two soil profiles developed from the same bedrock but under two types of vegetation (beech and spruce) were sampled down to 120 cm depth. Plant fractions including roots, barks, leafs and needles were likewise analysed.

All the radionuclides display a strongly constrasted behaviour between the "beech-soil" and the "spruce-soil", as well as a fractionation between the vegetation and the underlying soils. In beech-soil, both (^{226}Ra/^{230}Th) and (^{228}Ra/^{232}Th) activity ratios show a non-uniform distribution, with disequilibrium values higher than 1 above 20cm depth, lower than 1 in the 40-60cm range and close to equilibrium below 60cm. In constrast, (^{226}Ra/^{230}Th) and (^{228}Ra/^{232}Th) activity ratios in spruce-soil are close to radioactive equilibrium along the whole profile. Such contrasted behaviour is also shown by vertical migration of atmospheric fallout of ^{137}Cs and ^{210}Pb. The calculated velocity of ^{137}Cs migration in the spruce-soil (0.2 cm/y) fall into the previously reported range. In the beech-soil, however, almost no migration of deposited ^{137}Cs or ^{210}Pb occurred.

We take advantage of the different half-lives of the two Ra isotopes to build a coupled transport reactive model of the Ra in the soil-plant system able to quantify timescales of the radionuclide transfers between the distinct ecosystem compartments.

[1] Almgren & Isaksson (2006) *J. Envir. Radio.* **91**, 90.