Evanescent weathering surface evidenced by $^{234}U/^{238}U$ activity ratios?

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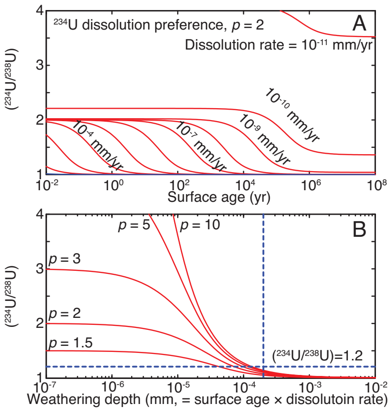
Direct α-recoil and preferential dissolution of ^{234}U from the damaged lattice make ($^{234}U/^{238}U$) a potential rate-meter for mineral dissolution that is normalized to α-recoil scale of ~30 nm [1]. Here we present mathematical model and laboratorial experiments showing that the ($^{234}U/^{238}U$) of weathering solution is functions of surface age, dissolution rate, and dissolution preference (*p*) of the ^{234}U sites (Fig. 1A). For a given rock type with fixed *p* value, the ($^{234}U/^{238}U$) is approximately a monotonic function of dissolution depth if dissolution rate is higher than 10^{-9} mm/yr (Fig. 1B). The ($^{234}U/^{238}U$) value of basaltic catchments [2-7], which is mostly higher than 1.2, indicating dissolution depth of less than 0.2 μm (Fig. 1B), and thus implying an evanescent weathering surface of about twenty years given a weathering rate of ~10^{-2} mm/ky [8]. Accumulation of leached layers and secondary precipitates may inhibit deep dissolution. Interestingly, the depth of mineral dissolution, as proxied by riverine ($^{234}U/^{238}U$), correlates well with weathering temperature.



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