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Feldspars as a source of nutrients for microorganisms

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Abstract

Phosphorus and nitrogen are essential macronutrients necessary for the survival of virtually all living organisms. In groundwater systems, these nutrients can be quite scarce and can represent limiting elements for growth of subsurface microorganisms. In this study we examined silicate sources of these elements by characterizing the colonization and weathering of feldspars in situ using field microcosms. We found that in carbon-rich anoxic groundwaters where P and N are scarce, feldspars that contain inclusions of P-minerals such as apatite are preferentially colonized over similar feldspars without P. A microcline from S. Dakota, which contains 0.24% P_2O_5 but <1 μmol/ g NH_4^+, was heavily colonized and deeply weathered. A similar microcline from Ontario, which has no detectable P or NH_4^+, was barren of attached organisms and completely unweathered after one year. Anorthoclase (0.28% P_2O_5, ~1 μmol/g NH_4^+) was very heavily colonized and weathered, whereas plagioclase specimens (<0.01% P, <1 μmmol/g NH_4^+) were uncolonized and unweathered. In addition, the observed weathering rates are faster than expected based on laboratory rates. We propose that this system is particularly sensitive to the availability of P, and the native subsurface microorganisms have developed biochemical strategies to aggressively scavenge P (or some other essential nutrient such as Fe^{3+}) from resistant feldspars. The result of this interaction is that only minerals containing P will be significantly colonized, and these feldspars will be preferentially destroyed, as the subsurface microbial community scavenges a limiting nutrient.