Relationship between corestone size, weathering rate, and erosion for a steady state model applied to natural systems

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Where regolith is maintained at steady state thickness, bedrock material that alters to regolith moves upward through the weathering zone until it is removed by erosion. In this "weathering conveyor belt", initial bedrock fragments formed at the conveyor belt base decrease in size until they exit at the ground surface. We calculate bedrock fragment size for low-porosity rocks under steady state conditions of erosion = weathering. In cases where spheroidal weathering occurs, fracturing rounds these fragments into corestones surrounded by rindlets. Rindlets transform to saprolite to create rindlet sets of constant thickness. Eventually a "limiting" corestone size is reached such that fracturing ceases and weathering continues only by diffusion + reaction (without fracturing). Where no spheroidal weathering occurs, fragments enter the conveyor belt as angular fragments that decrease in size while remaining subangular. Regardless of mechanism, the size of the fragment or corestone varies as a function of initial fracture spacing, depth in the regolith, and rates of erosion and weathering. The size distribution of corestones or fragments as a function of elevation can be used to discern weathering rates using the model. Examples from weathering diabase, quartz diorite, and metavolcanics compare satisfactorily with model predictions. The model is conceptually consistent with the possibility that erosion and weathering advance rates are related in weathering-limited regimes through a condition on the size of the fragment exiting the upper surface of the regolith. We have similarly shown previously that erosion and weathering advance rates can be also be related in supply-limited regimes through a condition on the chemistry of the porefluids.

Biological methane cycling at the Lost City Hydrothermal Field

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Actively venting carbonate chimneys of the Lost City Hydrothermal Field (LCHF) contain thick biofilms composed of a single, novel phylotype of Methanosarcinales, known as Lost City Methanosarcinales (LCMS). This organism thrives on the high H2 (14 mM) and CH4 (2 mM) concentrations produced by serpentinization at temperatures and pH conditions previously unknown to be habitable. We present results from phylogenetic and physiological investigations of these archaeal biofilms to better understand their role as the link between the products of serpentinization and the rest of the LCHF ecosystem. Although LCMS is defined by a single 16S rRNA phylotype, it is capable of both methane generation and oxidation simultaneously at temperatures up to 80ºC and pH 10. Furthermore, in-depth sequencing of 16S rRNA variable regions will explore whether different subpopulations within the LCMS biofilm have differentiated into methanogenic and methanotrophic ecotypes. Recycling of methane within a single microbial consortium may be very difficult to detect by measuring bulk fluids. At the LCHF, the isotopic signature of methane indicates a purely abiogenic source, but thick methanogenic and/or methanotrophic biofilms are clearly thriving on serpentinization fluids. Therefore, attempts to detect life in possible subsurface ecosystems on Earth, Mars, Europa, and Titan should be aware that isotopic signatures cannot disprove biogenicity.