An early and rapid colonisation of habitable niches on Earth?

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The earliest, reliable evidence for life occurs in cherts from the Early Archaean terrains of the Pilbara in Australia and Barberton in South Africa, both < 3.5 b.y. old. Previous hypotheses concerning evidence for life, based on carbon isotope signatures, in the > 3.75 b.y.-old “metasediments” of Akilia and Isua in Greenland must be re-evaluated in the wake of new studies showing (a) that there are apparently no sedimentary protoliths (Myers 2003) and (b) that the BIFs and “metaturbidites” analysed were contaminated by recent (<8000-year-old) endolithic bacteria and fungi (Westall and Folk, 2003).

In contrast to the Isua/Akilia terrains, the greenstone belts in the Pilbara and Barberton are only slightly metamorphosed (prehnite-pumpellyite to chlorite facies). They contain hydrothermally silicified volcaniclastic sediments that were deposited in shallow water basins and in the littoral zone (no deeper water sequences have been preserved). Fossilised microbial mats on the surfaces of these sediments consist of colony-forming carbonaceous microfossils, identical in morphology to modern filamentous, vibroid and coccoidal bacteria (Westall et al., 2001). The microorganisms inhabited environmental niches in the vicinity of subaqeous and (partially) subaerial hydrothermal springs/vents, as well as evaporitic littoral environments in the intertidal zone. Some mats formed in the very shallow water conditions (the photic zone) demonstrate vertical growth, suggestive of phototactic and possibly (anoxygenic) photosynthetic behaviour.

Although we have ancient records of life from only two Early Archaean locations, the similarity in both locations in terms of morphology, distribution and habitat of life suggests that life was probably widespread at that epoch. Furthermore, these early traces of life demonstrate that it was fairly evolved, having invaded the (partially) subaerial environment, as well as probably having already developed anoxygenic photosynthesis. Such developments recorded in formations just younger than 3.5 b.y. have significant implications for the timing of the appearance of life and its initial evolution. It is quite probable that life started before about 4 b.y. ago and that it spread rapidly.

References

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Weathering and the Biosphere

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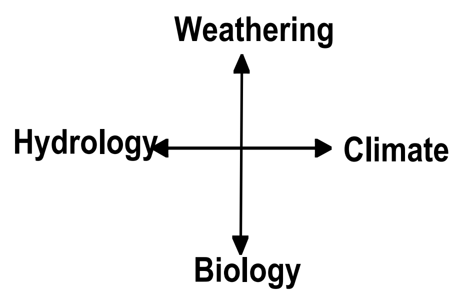
Chemical weathering at the surface of the earth is ultimately driven by thermodynamic disequilibrium between mineral phases and the external environment. As such, the rates of weathering are dependent both on intrinsic properities of such phases, including composition and structure, as well as extrinsic features related to hydrology, biology and climate of the weathering enviroment [1]. While intrinsic featrues are generally amenable to detailed laboratory charcterization, the scale and interconnection of extrinsic processes on chemcial weathering are more difficult to define and involve intergrated field approaches characterized below.



This paper summarizes results of several ongoing studies of silicate weathering in soil/regolith environments. Intercomparsions are made between different climate regimes and the effects of seasonal and longer-term climate pertibations on pore water compositions and mineral thermodynamic saturation states. The role of vadose zone hydrology and the interconnection between in permeability and progressive increases weathering intensity are also investigated. The end result is that weatheirng in most soils is controlled by transport-limited processes. Both hydrology and climate impact biologic productivity, which in turn affects the extend of evaprotranspiration and solute concentrations. Plant respiration and organic acid production strongly impact mineral saturation states via CO_2 production and Al complexation. The role of biologic cycling of major macronutirents such as K, Mg and Ca, in addition to Si, in soils and pore waters are being investgated using a number of techniques including Sr and Ca isotopic and Ge/Si elemental ratios. Based on these results, soils processes can be spatially differentiated as being biologically or lithologically-dominated.

Reference

[1] White, A.F., Brantley, S.L., (2003). The effect of time on the weathering of silicate minerals: Why to weathering rates differ in the laboratory and field Chemical Geology. (in press)