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Discussion

A comment on tectonics and the future of terrestrial life

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Theory, and accumulating evidence, suggest that mantle convection and plate tectonics facilitated the rise of molecular oxygen in earth's atmosphere, through the burial of organic carbon (McCulloch, 1993; Des Marais, 1994; Lindsay and Brasier, 2002). Therefore, one can imagine that the long-term survival of the biosphere could be limited by radiogenic heat production and tectonic activity (Lindsay and Brasier, 2002).

While agreeing with Lindsay and Brasier that such a limit is 'conceivable,' we add that it is not credible for the terrestrial case. Even if anthropogenic greenhouse gases are controlled, it is expected that earth will lose its water to a moist greenhouse, due to a brightening sun, in about 1.1 billion years (Sackmann et al., 1993; Kasting, 1988). We believe radiogenic heat production will be more than adequate to sustain mantle convection and vigorous plate subduction for 1.1 billion years. A heat-flow slowdown and consequent failure of organic carbon sequestration cannot occur soon enough to matter.

Consider Fig. 5 of Abbott et al. (1994), showing upper mantle potential temperature T_m versus age back to 3.7 Ga BP, as derived from dozens of MORB-like rock suites. It appears that in 1.1 billion years, the difference between T_m and (today's) surface temperature will have declined by about 5%. These authors find their data most consistent with a gradual fall of T_m directly dependent on radiogenic heat production. Despite episodic surges of terrestrial magmatism on 10^7-year timescales, such as found by Segev (2000), the only major excursion of atmospheric O_2 since 600 Ma BP was probably due to biospheric evolution (Berner, 2000 and his references). Tectonics could respond to a drastic change in surface temperature, as may have happened on Venus (Solomon et al., 1999). Our own response—death—would be many orders of magnitude faster.

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