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Biogeosciences Discussions

Interactive comment on "Geodynamic and metabolic cycles in the Hadean" *by* M. J. Russell and N. T. Arndt

Anonymous Referee #2

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GENERAL

This is an extremely bold paper, a paper that will cause conniptions, emunctions and eructations in some, and applause from others. It most certainly deserves to be read and accepted as a worthwhile contribution: it has many new ideas, ideas that will provoke strong debate.

The paper is written in declamatory style; 'these truths are self-evident' (as opposed to normal deprecatory science 'it is perhaps possible that given various conditions these hypotheses may, with qualifications, be treated as truths').

The Russell/Arndt paper relates a likely model of the physical state of the planetary surface in the late Hadean to an imaginative model of the earliest living community. Both models are plausible. Multiplying two plausible models produces an implausible solution: 50% plausibility times 50% plausibility is 25% implausibility. Yet that is not a drawback - nearly all other models are far more implausible and 25% is a pretty high

score in the early life game.

SPECIFIC

The paper begins with a well-constructed general physical model of the early oceanic crust. An important feature of this model is the operation of plate tectonics. This may be controversial but is well supported by recent work on old zircons suggesting the presence of subduction zones. If so, mid-ocean ridges would also occur. This allows analogy with modern systems - particularly the point that alkaline systems occur in cooler off-axis hydrothermal circulation.

The paper supports Armstrong's (1981) model of rapid early continental growth - this is not geochemical orthodoxy, but then orthodoxy on continental growth is based on very weak grounds. Intuitively the Armstrong model is far more logical. The paper also supports the notion of deep oceans and hence little clastic sedimentation (i.e. implying post-Hadean subduction of water as the mantle cooled, or else H loss to space). That point is rather more difficult to reconcile with zircon recycling.

The paper bows to the cool 'French' mesophile view of the first ancestor, in contrast to the hyperthermophile American view. The first organisms are thought by the authors to have been acetogens: likely so, but there is little onward discussion of the setting where hydrogen generation began.

The core of the paper is the notion of the hydrothermal mound as a catalysing reactor synthesising acetate. A second key point is the model for the origin of the oxygen evolving complex in oxygenic photosynthesis, which relies on obducting the deep biosphere in the ocean floor into shallow photic settings, in which cyanobacteria develop oxygenesis.

COMMENTS

This is a very imaginative paper, filled with ideas. The problem of course is in the testing: how can one show the ideas, though chemically plausible, bear any relationship at

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all to what really occurred?

The strongest points of the paper are probably: 1) the physical discussion of the late Hadean setting; 2) the identification of specifically alkaline settings in hydrothermal mounds (much of the most deeply-rooted biochemistry seems to demand both alkaline and ultramafic ambience); and 3) the very interesting discussion (though parts of it have already been presented elsewhere) of the origin of the oxygen evolving complex.

One specific comment seemed to be worthy of Inspector Clouseau: a basis of the analysis is "the rapidity with which dynamic structures evolve and emerge in the universe" (sic). Given the known population in the universe of planets-that-contain-life is approximately one, over more than 10 billion years, this rapidity seems a weak peg on which to hang an argument.

CONCLUSION

This paper is fascinating and illuminating: assuming much, but not without logic. As with many early life papers, the speculation is simply that, not admitting of obvious test. Let that not stand in its way - this is fun to read; well-argued - just don't necessarily believe it.

Interactive comment on Biogeosciences Discussions, 1, 591, 2004.