Towards determining criteria for establishing the presence of the earliest stages in the emergence and evolution of life on other planets.

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In order to detect life that has attained different stages of early evolution on other planets it is advantageous:

1. To have a model for the emergence and evolution of life.
2. To understand geochemical processes on planets.
3. To suggest key stages in the evolutionary development of biogeochemical processes.
4. To suggest the geochemical impact of biogeochemical processes at each stage.
5. To suggest potential evidence for 'active' and 'fossil' stages.
6. To establish methods of detecting 'active' and 'fossil' stages.

Any model for the origin of life on the Earth or similar 'wet rocky planet' needs to explain the origin of metabolism and nucleic acid genetics within free-living cells, and should be consistent with established evolutionary genetics are well as environmental geochemistry. As proposed here, it can then be used to suggest key stages which can form the basis for the search for life on other planets.

Consideration of the sequence of events proposed in the model for the emergence and early evolution of life on Earth (Russell & Hall, 1997; Martin & Russell, 2003; Russell, Hall & Mellersh, 2003; Russell & Martin 2004; and Russell & Hall, 2005) leads to ten key stages with associated environmental settings that feature in Table 1.

planet change (water loss) ↑							
FOSSIL PROCESS	ocean-floor spring site	ocean-floor spring site	ocean-floor spring site	oceanic bedded 'rocks'	shallow marine sedimentary rocks	shallow marine sedimentary rocks	shallow marine sedimentary rocks
ACTIVE PROCESS	ocean-floor spring	ocean-floor spring	ocean-floor spring	ocean-floor sediment & volcanics	ocean/sea shores	ocean/sea shores	shallow marine water
	pre-cellular organic (acetate) synthesis in hydrothermal mound	proto-metabolism & genetics in FeS compartments	first cells	prokaryotes archaea & eubacteria	eubacteria photosynthesis	eubacteria oxygenic photosynthesis	eukaryotes
Possible stages in the emergence and early evolution of life →	1	2	3	4-6	7-8	9	10

Table 1
Environnmental settings that may provide evidence for 'active' (wet planet) and 'fossil' (dry planet) stages in the emergence and early evolution of life.

The evidence produced and potentially 'fossilised' at each stage depends mainly on the by-products of metabolism and their interaction with local geochemical conditions in the environmental setting, for example, 1) pre-cellular life may produce acetate enrichment of iron sulfides and of the effluent at the sites of submarine alkaline springs; 2) the first prokaryotes may produce methane enrichments in ocean floor volcanics and sediments; and 3) anoxygenic photosynthesis in coastal settings may produce deposits of native sulfur.

References

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See: www.gla.ac.uk/projects/originoflife/index.htm
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