

THE FORMATION OF LIFE

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ABSTRACT

The formation of life is an automatic stage in the consolidation of rocky or “terrestrial” planets. The organic (=carbonaceous) matter, light elements, gases, and water must “float” toward the surface and the heavier metals must sink toward the center. Random processes in the molecular soup that fills microfractures in unmelted crust eventually produce self-replicating microtubules. In an appendix I suggest that some primordial crust remains because there is not enough consolidation energy to melt the whole planet. Energy is lost when iron planetesimals first partially melt and then coalesce to form the molten iron planetary core. Stony planetesimals accrete onto the surface of an already consolidated core.

LIFE

Planetesimals coalesce into a planet and consolidate into a smoothly varying solid body with a hot interior. The organic (=carbonaceous) matter, light elements, gases, and water must “float” toward the surface and the heavier metals must sink toward the center. There is still original crust, and perhaps cooled igneous crust from lava flows that is brittle and full of fractures, microfractures, and voids down to the level where the internal temperature softens the rock and closes microfractures, say ten kilometers.

The whole ten-kilometer surface layer of this crust fills with organic sepia-colored soup charged with gases. The crust acts as a high pressure reaction vessel. The microfractures are lined with crystals. There a thousand different wild crystals of elements, alloys, minerals, etc. that can provide catalytic scaffolding on which to build molecular films. There are millions of organic molecules that have large representations in the soup. All the possible combinations of interactions between the thousand kinds of crystal surfaces and the million kinds of organic molecules are automatically tried by the soup. Longish molecules that are hydrophilic on one end and hydrophobic on the other and have a “diameter” that is a multiple of the crystal spacing can form a monolayer with the molecules aligned side by side with the hydrophylic ends weakly bonding to the crystal surface and with the hydrophobic ends quasi-replicating the crystal surface as in Figure 1. If the crystal structure is not rectilinear, the structure of the film is not rectilinear. The edges where the film is growing can be stepped or ragged.

All the possible combinations of interactions between the new monolayer surfaces and the million kinds of organic molecules are automatically tried by the soup. Some molecules work and attach to the hydrophobic ends and to each other. They produce a bilayer that is stable and whose surface quasi-replicates the crystal.

The microfractures are not a quiet environment. There are accidents, earthquakes, impacts, sudden flows of soup, etc that dislodge the bilayers from the crystal faces. Free in the soup, the bilayers curl with the hydrophobic face on the outside. If opposite edges are straight, the edges can curl together and bind into microtubules. They become bilayer cylinders with hydrophilic outer surfaces and hydrophobic interior surfaces. Soup flows through and over the microtubules. Some of the microtubules are made with combinations of molecular layers that are self-catalyzing and self-propagating. The bilayer edges continue to bind more molecules to both layers at both ends of the cylinder. The microtubules grow longer and longer. Eventually they mechanically break and each piece becomes a growing microtubule. Each microtubule created this way from a crystal template is a new self-replicating life form. The crust of the planet fills with microtubules. There are thousands of different kinds, each in a range of diameters that were accidentally determined. Life is automatically produced thousands of times.

In Figure 1, the g molecule descenders all point the same way. If the original bilayer was made from chiral molecules, the microtubule descendents will all have the same chirality.

Each microtubule is a “catalytic converter” because the inside and the outside are a quasi-replicas of a crystal. From the soup, on their inner and outer surfaces, they form dimers, trimers, polymers, polymers of dimers, etc. The microtubules can hold two molecules stationary while they interact with each other. They can “crack” or disassemble large molecules by holding one end so the rest can be attacked by the soup. The microtubules can make molecules and polymers that do not release but are bound to the wall. An elastic polymer would allow the microtubule to move in response to stimuli. If an end hit something hot the polymer would contract and squirt soup out the end in a jet. Or peristalsis would be possible to pump the soup through the tube to increase reaction rates. The microtubules can bind to each other.

There are, say, 10^{12} generations in the first billion years. Since the original microtubules were made by random processes, they many not be optimal. At the growing ends of the microtubules, a molecular substitution can be made if some other molecules will bind into that space. The random processes also test all possible isotopomeric substitutions. The new molecule can be a “dud” that truncates growth in that position. The microtubule grows narrower. If it happens a few times the whole end of the microtubule becomes closed. The new substitute molecules may bind more strongly or less, faster or slower, strengthen or weaken the backbone. Changes that make the microtubule more fit will be adopted. If the change makes a whole row grow faster, it can stick out of the end of the microtubule as a microrod. Eventually the rod breaks off the microtubule leaving a free-floating

microrod. Microrods have the same replicating and catalyzing capability as the microtubules. The microrods spread throughout the crust. Microrods can act as carriers that hold small molecules in position for other reactions.

The microtubules also make substitution errors in building polymers that sometimes are an improvement.

All of this is independent of conditions on the surface of the crust.

Once there is cold fractured lava on the surface of the planet and the soup has soaked through it, the primordial crust is no longer needed.

Life becomes more and more complex and may eventually spread from the interior of the crust to the surface as well.

APPENDIX: IRON CORES

There must be some sort of galactic or protostellar magnetic field in a protoplanetary disk. When iron condensates form they are magnetized by the field. The iron particles attract each other and form larger and larger agglomerations that eventually collapse under their own weight and heat themselves. As the agglomerations grow the iron melts in the densest regions.

Meteorites are pieces of asteroids. Asteroids are planetesimals that failed to form a planet because there were not enough of them. Some meteorites are solid iron, some are stony with iron, and some are stony. Some of the stony meteorites are carbonaceous chondrites that have organic inclusions that have never been baked. The asteroids must have the same properties as the meteorites. Therefore molten iron can be formed in a body the size of an asteroid. Planetesimals rotate. If they have a molten iron core they generate a magnetic field. They attract other planetesimals that have iron. They attract iron condensates from the disk. They tend to form a planetary core before the stony planetesimals are agglomerated. The heating from the energy of consolidation mostly takes place before the planet is formed so that much of it can radiate away and not be trapped in the planet. Thus the planet does not heat internally as much as has been thought in the past. Heating from radioactive decay is not affected and continues to be important. The total heating is not strong enough to melt the whole stony surface of the planet. The crust has much organic (= carbonaceous) material.

Figure 1. A bilayer film seen through the crystal face on which it formed. Molecule AK has a hydrophilic end A that binds to the crystal in a regular pattern and a hydrophobic end K. Molecule g binds to the K end of AK and to other g molecules to repeat the pattern and strengthen the film. When the film is peeled off the crystal it can sometimes curl into a microtubule.

