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Origin of life: Source rocks for the origin and evolution of life
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One of the key factors for the origin and evolution of life is a nutrient supply which is derived from rocks. Life cannot be synthesized under nutrient-free conditions in an atmosphere as shown in the famous experiments of Miller (1953). For the beginning of life, three components are essential; (1) C (carbon)-centered sugar for fuel, (2) P (phosphorus)-centered metabolism, and (3) N (nitrogen)-centered information coded by basic pairs (DNA). Among them, P (negative ion), which is a centered nutrient coupled with K (positive ion), plays a critical role in metabolic activity. Can those nutrients be derived from any kinds of rocks on the Earth? The answer is, yes, but only three kinds of rocks as follows

(1) Granite: Granite can be formed by two-step extractions of nutrients: partial melting of mantle peridotite at a mid-oceanic ridge followed by partial melting at a subduction zone, either by slab melting or re-melting of lower mafic crust generated by partial melting of a mantle wedge. The major nutrient elements, such as P and K, are large ion lithophile elements (LILE), and hence, difficult to be bound into major mantle minerals. Plate tectonics increases the volume of calc-alkaline rocks such as TTG (tonalite-trondhjemite-granodiorite) or andesite and dacite at subduction zones through time.

Granitic rock was absent when a magma ocean was consolidated at 4.5Ga. In the Hadean, the major rock source for nutrient supply was not granite, but rather presumably the primordial continents.

(2) Primordial continents (Anorthosite with KREEP basalts): Primordial continental material is the second candidate for the source of nutrients. No remnants of those continents remain on the modern Earth (i.e., no Hadean rocks are left). Understanding of the primordial continent is developed through the geology of the Moon, and also from the concept of giant impact. The surface of Moon is covered by 50 to 70 km-thick anorthositic crust with local cover and dikes of KREEP (Potassium, Rare Earth Elements, and Phosphorus) basalt composition, and presumably underplated by KREEP-like rock types beneath the anorthositic continent. Both rock units have been interpreted as the final residue of magma ocean when the Moon was formed by the giant impact that led to the formation of the early Earth, where Mars-sized protoplanets collided with each other. If the giant impact theory is correct, the Earth must have been completely molten even up to the core. During the gradual cooling of the Moon and the Earth, the final liquid remained near the surface, forming the buoyant anorthositic crust, covered or underplated by KREEP magma similar to that observed on the Moon.

(3) Carbonatite: Carbonatite has only a single step of fractional melting of mantle peridotites under the cratons with an extremely small degree of melting. The selective removal of melt to form considerable amounts of nutrients under the sub-cratonic mantle creates carbonatite magma enriched in nutrients with highly volatile incompatible elements such as H2O and CO2 (more than 80% are volatiles). Nutrients concentrate into melt, depending on the degree of melting. Peridotite contains P=50 and K=240 (all values in ppm hereafter), but 100 times concentration of P=4495-3273 and 200-300 times of K=56118-68902 are seen in carbonatite. In general, the nutrient abundance is ideal for carbonatite, except for the U abundance. Carbonatite plays the role of milk-like materials to grow life. However, it may also function like an atomic-bomb magma to cause local mass extinctions, as well as resultant promotion of genome mutation by internal radiation through food chains.