Boron, Ribose, and a Martian Origin for Terrestrial Life

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The recent discovery of an efficient, inorganic pathway for the synthesis of ribose (an essential component of RNA and DNA) and other 5-carbon sugars reported by Ricardo et al. (*1*) is a major advance in the understanding of the origin of life, capping a 50+ year search. For the first time, the authors have found a pathway that leads to copious quantities of these biologically critical sugars that avoids their condensation into brown, tar-like residues. However, we argue that the critical requirements of locally high concentrations of chemically available boron and calcium ions are more likely to have been present on the early Martian surface than on Earth.

Boron is a soluble trace element in most continental rocks, which is freed by surface weathering and usually finds its way into the oceans. Large deposits of economic borate minerals like colemanite and ulexite are formed principally by evaporative concentration in playa lake deposits that drain large areas of crystalline rock, such as those in California, Turkey, China, and the Andes. These playas require extensive areas of subaerial exposure coupled with an active hydrological cycle. Because early Earth was probably covered by a global ocean, surface conditions may not have been favorable for ribose synthesis. The extraordinary initial geothermal heat flux should have led to thick oceanic crust and vigorous convection and therefore shallower ocean basins.

The presence of carbonate and sulfate minerals in Martian meteorites and dust, as well as their recent observation on the Martian surface at both *Meridani planum* and Gusev Crater by the Mars Exploration Rovers, argues that evaporitic environments capable of concentrating borate minerals were likely present on Noachian Mars.

The discovery that rocks ejected from Mars by impacts can be transferred to Earth on low-temperature trajectories, that living organisms can withstand space travel for many years, and laboratory studies indicating that the acceleration forces produced during the ejection and re-entry processes can be survived have made it clear that both the surface of Mars and Earth are both potential candidates for the cradle of Terrestrial life (*2*). The discovery of this borate-dependent ribose synthesis pathway strengthens the hypothesis that we were all originally Martians.

References

1. A. Ricardo, M. A. Carrigan, A. N. Olcott, S. A. Benner, *Science* **303**, 196 (9 January, 2004). 2. J. L. Kirschvink, B. P. Weiss, *Palaeontologia Electronica* **4**, editorial 2: 8p (2002).