

Coevolution Of Our Biosphere And Planet

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Both the habitability of Earth's environment and the origin and evolution of life have been shaped by physical and chemical interactions between the atmosphere, hydrosphere, geosphere and biosphere. Agents of long-term environmental change probably were key drivers of biological evolution; they include increasing solar luminosity, declining rates of impacts, declining volcanism and the structural and compositional evolution of Earth's crust. Because all Earth-like planets probably experience these trends, these trends help us anticipate the potential course of biological evolution on other planets. In turn, life itself can be considered a geologic agent, because, among other things, it alters rates and patterns of weathering and sedimentation, and it alters the composition of sedimentary rocks and the atmosphere. For example, the products of oxygenic photosynthesis, namely molecular oxygen and organic matter, have substantially altered the composition of the crust (*e.g.*, with organic carbon, redox effects upon sulfur and iron species), the oceans (sulfate and oxygen) and the atmosphere (oxygen). These altered compositions have in turn affected biological evolution. Just as the record of biomolecular phylogenies reveals discrete events or "nodes" in evolution, the geologic record records discrete events in environmental change. A key objective in astrobiology is to document such events and to explore cause-and-effect relationships between environmental and biological phenomena. For example, the episodic oxygenation of the atmosphere at ca 2.0 and ca 0.6 billion years ago merits investigation. Changes in atmospheric composition help to define the challenges that will accompany the detection of young versus mature biospheres on extrasolar planets.