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The Story of Earth: How Life and Rocks have Co-Evolved

The story of Earth is a 4.5-billion-year saga of dramatic transformations, driven by physical, chemical, and — based on a fascinating growing body of evidence — biological processes. The co-evolution of life and rocks, the new paradigm that frames this lecture, unfolds in an irreversible sequence of evolutionary stages. Each stage re-sculpted our planet's surface, each introduced new planetary processes and phenomena, and each inexorably paved the way for the next. This grand and intertwined tale of Earth's living and non-living spheres is only now coming into focus. Following Earth's growth and separation into the core, mantle, and crust, planetary evolution progressed by a sequence of chemical and physical processes, leading to perhaps 1500 mineral species. A planet may have to evolve through at least some of these stages of chemical processing as a prerequisite for life. Once life emerged, mineralogy and biology co-evolved, as changes in atmosphere and ocean chemistry dramatically increased Earth's mineral diversity to the almost 5000 species known today.

Mineral Ecology: Chance and Necessity in the Mineral Evolution of Terrestrial Planets

Three factors contribute to the roles played by necessity and chance in determining a planet's mineral evolution. Mineral distribution and diversity at or near the surfaces of terrestrial planets are influenced by: (1) planetary stoichiometry; (2) crystal chemical characteristics; and (3) the probability of occurrence for rare minerals. Measurements of stellar stoichiometry reveal that stars can differ significantly from the Sun in relative abundances of rock-forming elements, which implies that bulk compositions of some extrasolar Earth-like planets likely differ significantly from those of Earth. The most abundant elements generally have the largest numbers of mineral species, though several elements that mimic other more abundant elements are less likely to form their own species. Statistical analysis of mineral frequency distributions suggests that thousands of plausible rare mineral species await discovery or could have occurred at some point in Earth's history, only to be subsequently lost by burial, erosion, or subduction. Were Earth's history to be replayed, and thousands of mineral species discovered and characterized anew, it is probable that at least 25% of those minerals—more than 1000 species—would differ from species known today.

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From Biomineralization to Biomineralogy: Trends and Open Questions

In contrast to classical biomineralization, biomineralogy represents the scientific discipline that deals with phenomena of biomineralization as well as with phenomena including demineralization and remineralization. These scientific directions are parts of the mineral-organic matrix circuit occurring in specialized environments in nature.

Insights into modern state of the art in biomineralogy-related reseach, as well as poorly investigated scientific fields, such as psychrophilic calcification and biosilicification, will be reported and discussed.