Eruptions Spark Explosions of Life

Despite their reputation as deadly scourges, giant volcanic eruptions may have profoundly benefited life on Earth by triggering two of the greatest biological revolutions in the planet's history.

Massive outpourings of lava, particularly those in the deep ocean, spurred bursts of evolution early in the Paleozoic era, about 550 million years ago, and in

Time	Period	Era
540	Cambrian	
510	Ordovician	
439	Silurian	Paleozoic
409	Devonian	
363	Carboniferous	
290	Permian	
245	Triassic	
208	Jurassic	Mesozoic
146	Cretaceous	
65	Tertiary	Cenozoic

Biological upheavals marked the early Paleozoic and middle Mesozoic eras (in yellow).

the middle of the Mesozoic era, around 200 million years ago, claims biologist Geerat J. Vermeij of the University of California, Davis. In support of this controversial hypothesis, Vermeij notes that the biological changes took place while extensive undersea eruptions were creating new ocean basins and ripping apart oversized continents.

"We have simply got to explain the timing, and to me the coincidence between some of these huge volcanic events and the biological revolutions is just too weird. There has to be a connection," Vermeij told SCIENCE NEWS.

The early Paleozoic revolution produced the first predators, burrowing animals, and creatures able to harvest minerals to form skeletons. Starting in late Precambrian time, this biological blast extended into the middle Ordovician period. The Mesozoic revolution ran from the late Triassic period through the late Cretaceous. It brought a proliferation of marine creatures, including important new types of plankton that could grow mineralized shells. On land, social insects and flowering plants began to conquer the continents.

To explain the coincidence between geologic and biological events, Vermeij suggests that the submarine eruptions loosened the restrictions on organisms living at the time by increasing the availability of energy and nutrients. Using economics as an analogy, he suggests that the volcanic eruptions enhanced the supply of raw materials in the environment and provided organisms with easier access to such commodities. Vermeij discussed his hypothesis last month in the spring issue of PALEOBIOLOGY.

Undersea eruptions aided life on Earth by releasing massive amounts of carbon dioxide, which produced periods of greenhouse warming, claims Vermeij. In the warmer climates, biologically important chemical reactions could proceed much more readily, enabling organisms to boost their metabolisms. Warmer weather and increased amounts of carbon dioxide in the atmosphere also enhanced erosion on the continents, thereby freeing important nutrients from rocks.

The volcanic activity altered the landscape as well. Eruptions raised sea levels by producing hot new ocean crust that sat higher than the old ocean floor. As the swollen oceans flooded continental coastlines, the area of shallow seas grew markedly. These regions, with their abundant nutrients and sunlit waters, would have provided fertile new habitats for ocean organisms.

The question of what sparks biological revolutions has long captivated paleontologists and evolutionary theorists. Some researchers have favored so-called intrinsic explanations, which link evolutionary bursts to genetic or biochemical innovations such as the origin of seed-bearing plants. Other scientists tie life revolutions to external causes, such as chemical changes in the ocean, climate changes, or mass extinctions.

In Vermeij's theory, external factors explain only part of the story. Ecological forces, such as competition and predation among organisms, also play an important role in evolution. "The timing and rates of evolution are dictated by extrinsic factors, but the directions of evolution are largely determined by what other organisms are doing," he says.

David Jablonski of the University of Chicago says that Vermeij offers a number of tests for assessing the new hypothesis. He cautions, however, that paleontologists always face a difficult task when trying to document whether one event caused another.

Paleontologist Douglas Erwin of the National Museum of Natural History in Washington, D.C., questions the link between volcanic eruptions and biological revolutions. "I don't think the timing [of the two] is really as close as it would need to be," says Erwin.

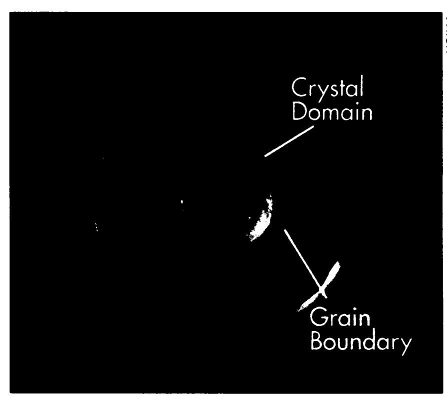
But he lauds Vermeij for bringing economic arguments to evolutionary studies. Although scientists since Darwin have linked the two subjects, Vermeij has done so more completely than others. "I think economics are enormously fruitful and tremendously underutilized," says Erwin. "I've told students that the two courses they should take outside paleontology are Shakespeare and economics." — *R. Monastersky*

Viewing frost heave on a microscopic scale

In cold climates, spring often brings city streets strewn with potholes, highway surfaces punctuated by unexpected bumps, fields overgrown with freshly exposed boulders, and soils that feel spongy and soft.

These effects all result from a common phenomenon known as frost heave. It occurs when water-saturated soil freezes, pushing the ground up.

But this upward movement isn't due solely to the expansion that occurs when water turns to ice. A number of other factors come into play, including the existence of unfrozen water at temperatures below water's normal freezing point; this superchilled water tends to dribble through soil toward layers having a lower temperature, where it adds to the existing mass of ice.



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Top view (in polarized light) showing the boundaries between individual ice crystals radiating from the center of the apparatus. Water surrounds this central ice disk.