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Earth Sciences

New reports on **SNOWBALL EARTH** and continental collisions captured the attention of earth scientists in 2000, while the world struggled with devastating **EARTHQUAKES** in Turkey, a volcanic eruption in Mexico, and extreme weather events influenced by the end of the **LA NINA** cycle.

GEOLOGY AND GEOCHEMISTRY

In 2000 Joseph L. Kirschvink (California Institute of Technology) published a novel report (with six coauthors from the U.S. and South Africa) relating the end of the 2.4 billion-year "Snowball Earth" to global geochemistry and major episodes in the history of life. He had originated the Snowball Earth concept about a decade earlier and by 2000 had evidence for two periods when the Earth was completely glaciated, covered with ice like a snowball, at about 2.4 billion and 600 million to 800 million years ago. The evidence includes measurements of the Earth's ancient magnetic field preserved in old rocks, which indicate the near-equatorial latitude of rock formations known to indicate the presence of ice. There is a 45m (147.6-ft)-thick layer of manganese ore in the Kalahari Desert with an age corresponding to the end of the 2.4 billion-year Snowball Earth period, and the report proposed that its deposition was caused by the rapid and massive change in global climate as the snowball melted.

Most primitive organisms had been wiped out as the freeze developed on a global scale. The ice-covered oceans, separated from oxygen by thick sea ice, became reducing agents and therefore dissolved more metals. Carbon dioxide from increased volcanic activity is a candidate for cause of the eventual global warming, creating a greenhouse effect by preventing much of the Sun's radiation from escaping into space. As the ice melted, the dissolved metals and most other essential nutrients for photosynthesis were available for the hungry bluegreen algae that had escaped extinction, and the algae bloom released enough oxygen to cause a cascade of chemical reactions. The global warming associated with oxidizing conditions led to the precipitation from seawater of iron and carbonates, producing characteristic rock masses known as banded iron formations and postglacial cap carbonates (limestones deposited above glacial rock deposits). The oxygen spike, in effect, led to a "rusting" of the iron and manganese. The manganese precipitation involved large quantities of oxygen, and these geochemical changes may have forced the organisms to mutate in such a way that they were protected from the changing chemical environment. Kirschvink suggested that the organisms may have adapted the enzyme known as superoxide dismutase to compensate for the changes. The enzyme and its evolutionary history were well known to biologists, but this was the first time a global climatic change had been suggested as a cause of the enzyme's diversification.

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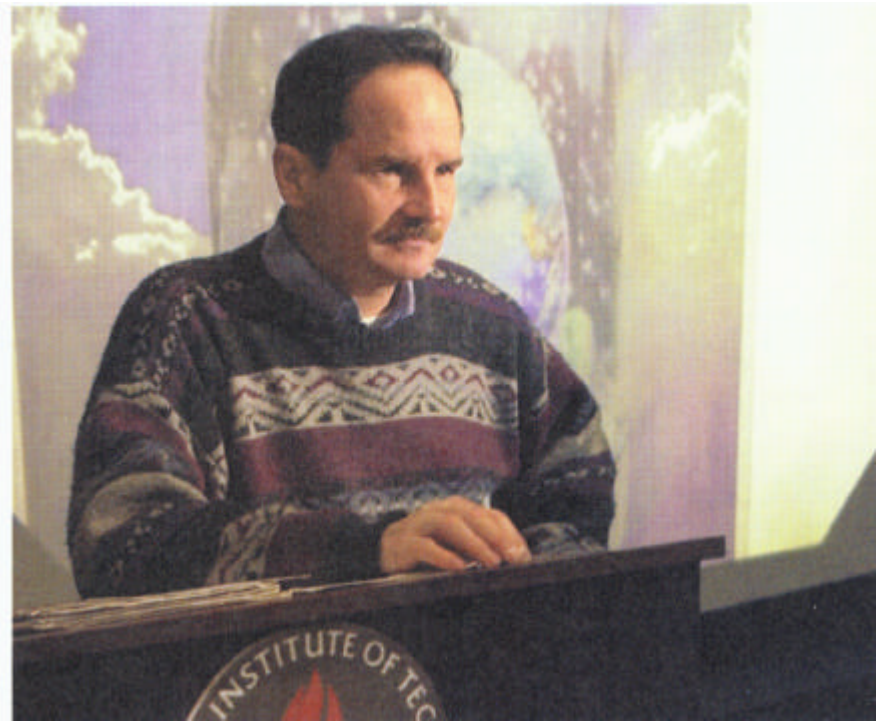
(PETER J. WYLLIE)

Joseph L. Kirschvink discusses his Snowball Earth concept on the campus of the California Institute of Technology where he works.



Robert Paz/Caltech