

ing its internal heat, the interior is heating up by 200 degrees Celsius per billion years. Eventually this may lead to a resumption of plate tectonics or another global resurfacing.

Our Sister, Our Future?

An alternate theory is that Venus has never had plate tectonics; instead, its heat escapes through conduction. If so, the temperature difference across the lithosphere would increase until, after 500 million or so years, the whole lithosphere became unstable — and subducted all at once in a short period of time, perhaps as little as 20 million years. The surface would then stabilize for another 500 million years, and cycle repeats.

Is there any evidence that a similar overturn could occur on the Earth? For millions of years to come, plate tectonics will continue to be the main mechanism for heat loss from our planet. But as the internal heat sources powering plate tectonics begin to decline, plate tectonics will likely cease. Then perhaps a global resurfacing could occur here as has been argued for Venus. Thermal models suggest that Venus could have depleted its internal heat supply after 3 or 4 billion years, whereas Earth may have enough to keep plate tectonics going for another 1.5 billion years.

Mordechai Stein at Hebrew University and Albrecht Hoffman at Max Planck Institute for Chemistry find evidence that major episodes of volcanism on Earth already occur roughly every 500 million years. These volcanic spasms take place on a much more localized scale than the global event proposed for Venus. If this view is correct, the Earth is already operating somewhat like Venus.

The comparisons with Venus are already inspiring new ways of looking at our home world (see box on p. 26). How do the greenhouse effect and geologic activity influence each other? What causes plates to break up and new plates to form? Will the Earth continue to become more like Venus? The answers still await us. *m*

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Worlds Apart

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Freud would have loved Venus. The planet represses its heat until it can't hold it in anymore, and then explodes in a convulsion of volcanic and tectonic activity. The manic-depressive geology could explain why the planet is as hot as hell.

Why is the surface of Venus as hot and dry as an electric stove, while the Earth's supports balmy tropical beaches, teeming rain forests, and the Dalai Lama? Venus is nearer the Sun, but in fact *less* solar energy is deposited onto that planet than onto Earth. Our sister world's sulfuric-acid clouds, 23 kilometers thick, reflect 80 percent of the incoming sunlight back into space and lend the Evening Star its timeless splendor. Beneath the clouds, however, the atmosphere is so dense that it traps infrared radiation, tripling the temperature at the surface through a powerful greenhouse effect. Clearly these two worlds, formed at the same time in the same part of the solar system and most likely made of the same stuff, have taken radically different paths.

A planet's evolution has as much to do with its thermal history as with its initial constituents and place in the solar system. How does the heat escape? The answer tells you what the planet looks like. On Earth, plate tectonics is responsible for most of the cooling of the still-hot interior. With its system of steady thermal conveyor belts and hot-spot volcanoes, Earth has experienced a fairly calm volcanic and tectonic history.

But heat seems to escape from Venus in fits and starts. There is no evidence for plate tectonics on Venus. Instead, it appears likely that in the not-too-distant geologic past, 200 to 300 million years ago, the venusian surface experienced vigorous change, with volcanism widespread globally: a reworking of the entire globe. Some researchers think that, even as we speak, the heat is again building up in the interior. Eventually it will get so hot that the surface will erupt in another paroxysm of violent geological activity, thermal transfer, and release of gases into the atmosphere.

What does this do to the atmosphere? Might Venus's impressive cloud decks be the atmospheric remnants of global upheaval? If large enough quantities of greenhouse gases such as carbon dioxide, sulfur dioxide, and water vapor were released during a global geological catastrophe, the atmosphere would begin to warm up. Existing thermal windows in the infrared spectrum, through which the surface cools, would shut, producing the runaway greenhouse effect we see today. Perhaps this gives us a clue to the mystery of Earth's and Venus's divergent histories.

On Earth, too, geology dictates climate. The effects of sulfur-bearing aerosols and clouds produced by Mount Pinatubo in the Philippines, for example, have recently been extensively studied (see cover photo). The abundance of water vapor, the major greenhouse gas in the Earth's atmosphere, is controlled by equilibrium with the oceans and ice caps, as well as by the formation of clouds. The abundance of carbon dioxide, over the long haul, also is controlled by the water cycle. These stabilizing influences have kept the surface of the Earth inhabitable for the last 3.8 billion years. Lacking these mechanisms, Venus today is no place for flowers, children, or other living things. *m*

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