Mysterious Steps, Explained at Last−−> fractal landscapes

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At Mammoth Hot Springs, in Yellowstone National Park, the mineral−rich waters flow over a surreal landscape of stepped terraces and ponds.

Dynamics of Precipitation Pattern Formation at Geothermal Hot Springs (Physical Review Letters)

Nigel Goldenfeld, John Veysey and Nicholas Guttenberg/University of Illinois at Urbana−Champaign

Computer simulation of a hot spring landscape.

Geologists have long been at a loss to explain the rocks unusual shapes, but physicists at the University of Illinois at Urbana−Champaign say they have figured out the answer.

Unlike most water−washed surfaces, the primary geological process shaping the Mammoth Hot Springs landscape is not erosion. The rocks there are actually growing at the rate of one to five millimeters a day as calcium carbonate in the water precipitates to form the mineral travertine.

The key to understanding the process, the physicists say, is ignoring the details of mineralogy and geochemistry.

You don t really need to know things, said Nigel Goldenfeld, a professor of physics at the University of Illinois. We approached the problem as condensed matter physicists, as a problem in pattern formation.

Just as the branching patterns of trees and rivers are similar because of the underlying mathematics, the shapes at Mammoth Hot Springs, Dr. Goldenfeld and his collaborators suspected, could be explained by general equations, not geology.

The main factors are the flow of water and the material it deposits. The minerals grow into a bump and then a dam, which alters the flow. You get this dynamic interplay, Dr. Goldenfeld said.

When the scientists wrote down the equations and ran computer programs mimicking the process, the result was artificial landscapes that looked remarkably like Mammoth Hot Springs. Similar fractal structures form in caves, where the mineralogy is different but the general dynamics the same. Dr. Goldenfeld and two graduate students, Pak Yuen Chan and John Veysey, described the findings in the June 27 issue of Physical Review Letters.
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