Space Sciences

For how long did the Martian waters run?

Although the atmosphere of Mars is now too thin and cold to sustain liquid water on the surface, such features as branching channels, teardrop-shaped islands and braided silt deposits leave the widespread impression that the atmospheric pressure and temperature were great enough during the planet's early history for water to have flowed freely. However, Michael H. Carr of the U.S. Geological Survey in Menlo Park, Calif., suggests that the same features could have formed even if running water was "only intermittently present" at the time.

If the atmosphere was thick enough for water to be stable at the surface, Carr notes in the June ICARUS, carbon dioxide—the atmosphere's main constituent—might have been locked up in the form of carbonate rocks. Some carbon dioxide could have been released by the impacts of meteorites massive enough to be driven well below the surface, where the heat could free the carbon dioxide instead of making carbonate, he says. But such cratering could not have generated much carbon dioxide between the time of Mars' formation and the time when many researchers say the solar system's heavy bombardment by meteorites ended, less than a billion years later. Even with an additional supply released by volcanic activity, says Carr, the total carbon dioxide would still be "barely sufficient" to keep water "continuously present" at the surface.

This leaves the problem of explaining the water-worn valley networks and other features. Carr suggests that during the heavy-bombardment period, atmospheric temperatures were "just below those required for liquid water to be stable at the surface." From time to time, carbon dioxide released by volcanoes and impacts would cause the atmosphere to thicken and warm, allowing water to exist periodically as a liquid. With only slight fluctuations, carbon dioxide could then be lost and temperatures again fall below freezing. Finally, says Carr, when the number of meteorites declined, "the equilibrium would no longer be maintained." The decline in meteorites and volcanism would recharge the supply less often, with an amount that "could not keep pace with even the low carbon dioxide fixation rates [into carbonate rocks] that apply when mean temperatures fall well below freezing."

And so the irregular cycles would have continued, sometimes allowing water to cut drainage channels, sometimes leaving nothing but the hard, dry wasteland. "The atmosphere, therefore, slowly thinned, global temperatures fell, groundwater could only rarely access the surface and the planet assumed its present frigid state," Carr suggests.

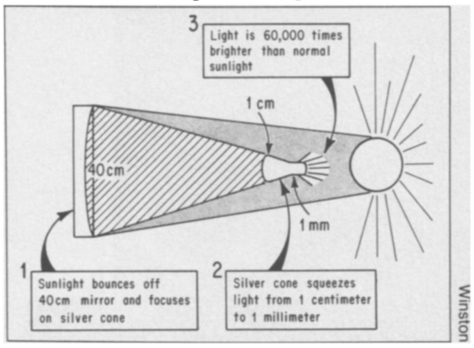
The making of interstellar grit

A common kind of sandpaper grit — silicon carbide — also serves as the primary kind of carbon particle that forms in the average red giant star, according to a group of scientists. In previous laboratory experiments, says Michael Frenklach of Pennsylvania State University in University Park, "everyone else proposed that the nucleation of interstellar grains occurs at temperatures around 1,000 kelvins. We are proposing the nucleation [of silicon carbide] begins at much higher temperatures — 2,000 kelvins and above."

Frenklach and his colleagues report in the May 18 NATURE that their experiments are the first to take into account the high concentrations of hydrogen surrounding red giant stars. The group determined that hydrogen suppresses production of carbonaceous material like soot or graphite, but not of silicon carbide. This, combined with the abundance of silicon and carbon in the universe, "makes it more likely that silicon carbide is probably the first particle to condense." The scientists say they believe these grains condense at the high temperatures near the star, while other materials form farther out in the stellar atmosphere, where temperatures are lower.

Technology

A bright idea for funneling sunlight



Winston

In theory, an optical device should be able to concentrate sunlight to reach temperatures at the Earth's surface comparable to the sun's 5,800-kelvin surface temperature. However, conventional lenses and mirrors, which are designed not only to concentrate light but also to form an image, fall far short of delivering the maximum possible concentration of sunlight. Now a team of University of Chicago researchers has invented an optical system that comes close to this thermodynamic limit. Their system concentrates sunlight at the Earth's surface by a factor of almost 60,000, offering the possibility of using solar energy to power lasers, destroy hazardous waste and process certain materials.

The trick is to gather light as efficiently as possible without trying to form an image. In such "nonimaging optics," it doesn't matter what paths light takes through the optical device so long as it all arrives at a single spot. "If you drop the imaging requirement and you simply collect light, you can reach the theoretical limit of concentration," says physicist Roland Winston, who led the research effort. Winston and his colleagues describe the design and operation of a concentrator based on this idea in the May 18 NATURE.

In principle, the entire solar concentrator could consist of a single, nonimaging optical element, but it would be too large and unwieldy for practical applications. In Winston's design, a parabolic mirror focuses light into a roughly cone-shaped "light funnel" that concentrates the light further (see diagram). The researchers make the funnel from a transparent material with a high index of refraction so that it both bends light and internally reflects any light that happens to hit its sides. Thus, practically all the light that enters the funnel exits through an aperture only 1 millimeter across.

Talking to your typewriter

Getting a computer to convert what you're saying into words displayed on a screen poses particular problems. Such a speech-recognition system must contend with accents, jargon and words that sound the same but are spelled differently. Researchers at Dragon Systems, Inc., in Newton, Mass., have now developed a dictation system allowing a user with limited typing skills to work comfortably with any word-processing software. The system, known as DragonDictate, handles 30,000 words, adjusting the vocabulary available according to which words a user says most frequently. Furthermore, the system "learns" as it operates, automatically adapting to a user's accent or language quirks. The user, inserting a brief pause after each word, sees the word on the screen almost immediately.

The system's high performance — considerably better than that of any other general-purpose, large-vocabulary speech-recognition system presently available — results from the combination of several ideas from speech-recognition research, particularly the use of probability theory. Moreover, the computer juggles information about the sound, grammatical context and meaning of words to come up with its best possible guess as to a speaker's meaning. These capabilities are packed into a computer program and a single circuit board that fits in a personal computer with a 386 microprocessor.