Comets Were a Clerical Error

They were curious little inhabitants of the solar system, but now they are gone. A slip of a decimal point created a swarm of fluffy white comets and now the discovery of the error has sent them back to oblivion. The correction also undercuts any support for an even more exotic type of comet proposed by Louis Frank of the University of Iowa.

"There isn't much doubt about it," says Thomas Donahue of the University of Michigan, "I blew it." Donahue had gone to the ultraviolet observations returned by the Voyager spacecraft for proof that the house-sized, crud-encrusted balls of snow proposed by Frank, another prominent space physicist, did not exist (*Science*, 10 June, p. 1403). Given their supposedly huge numbers, he reasoned, no amount of surface crust could seal off the vaporization of the mini-comets' water and prevent the flooding of the solar system with water. The water must yield atomic hydrogen, and atomic hydrogen must emit ultraviolet radiation at a wavelength called Lyman-α. If the Voyagers did not detect any Lyman-α emission above that expected from atomic hydrogen wafted into the solar system by the interstellar medium, Donahue assumed, then Frank's mini-comets could not be there.

Much to his surprise, Donahue and his colleague at Michigan, Tamas Gombosi, and Bill R. Sandel of the University of Arizona could attribute only 477 of the observed 640 rayleighs of Lyman-α emission to hydrogen in the interstellar medium. The hydrogen emitting the remaining 163 rayleighs, they concluded, came from mini-comets no less exotic than Frank's—pure ice on the outside and rock on the inside, but 90% empty space. Even with their protective outer crusts, Frank's far more abundant mini-comets would release 10 million times more hydrogen than observed.

Frank's mini-comets were in trouble, yet again, but Donahue's were not well received either. In the course of amassing spacecraft ultraviolet observations, Donald Shemansky of the University of Arizona began to have his doubts about the claimed Lyman-α excess. He suggested that his student Doyle Hall compare Donahue's calculation, which was based on a published model of emission by interstellar hydrogen, with a computer program of the same model that recently became available. The computer model showed no evidence "of a measurable excess above what we see in the interstellar medium," says Shemansky. It produced an upper limit for the discrepancy, if any exists, of only 20 rayleighs, not 163. There seemed to be a problem with the Voyager data.

The next week Shemansky took their results to a workshop in Boulder called to consider how to follow up Donahue's results. Donahue returned from the workshop on a Friday and called Shemansky that Saturday morning to say he was wrong. "The explanation of what happened," says Donahue, "is that a student carrying out an integration erred in transcribing 3×10^{-2} from a table." In the calculation the figure became 3×10^{-3}. "I agree with Hall and Shemansky that no source is called for larger than 20 rayleighs. No Lyman-α data support either hypothesis." Donahue is presenting his revised perspective at a meeting in Helsinki this month.

This latest development leaves mini-comets on shaky footing indeed. No independent analysis has found anything but instrumental noise in the satellite images that Frank and his students claim record the remains of his mini-comets in Earth's upper atmosphere. The Voyager data eliminate the possibility of an abundance of such objects in interplanetary space, unless Frank can come up with an extraordinary means of sealing in the water. Donahue's version of mini-comets, when cloaked with a reasonably effective mantle, could still slip under the Voyager limit, he says. The next development will probably center around the claimed telescopic detection of Frank's mini-comets by Clayne Yeates of the Jet Propulsion Laboratory, another controversial piece of work that has yet to be confirmed by independent observers.

■ RICHARD A. KERR

New Ways to Chill Earth

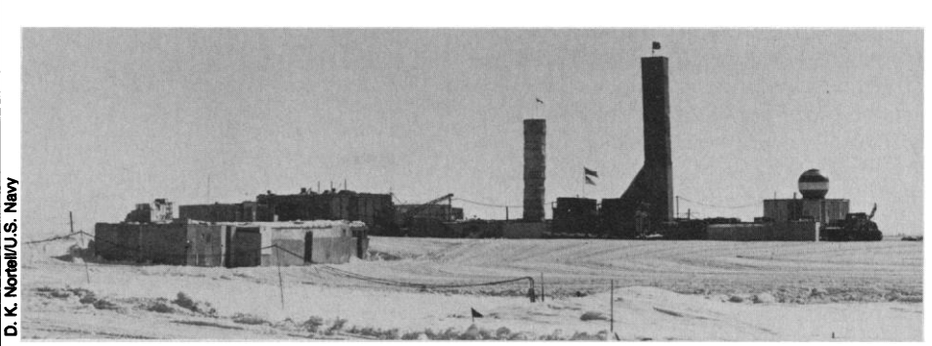
The mystery of the ice ages was a deep one indeed. Why should Earth oscillate between 100,000 years of deep freeze and a few thousand years of balmy relief? The mystery has not been solved completely, but another box within a box that conceals part of the answer has been opened. Within the past decade, paleoceanographers have identified rhythmic variations in the motions of Earth as the pacemaker of the ice ages. But the variations in the tilt and direction of Earth's axis of rotation and the shape of its orbit could not fully account for the magnitude of the chilling during an ice age.

Within the past few years, marine sediments and glacial ice have yielded evidence that carbon dioxide, through its greenhouse effect, acts as an essential amplifier of the climate effects of Earth's orbital variations. Now a host of other amplifiers are being suggested that could help explain the powerful link between Milankovitch orbital variations and the ice ages.

The latest evidence supporting the role of carbon dioxide comes from a 2200-meter core of ice extracted from the Antarctic ice sheet at the Soviet Vostok station. Claude Lorius of the Laboratory of Glaciology in St. Martin d'Hères, France, and his French and Soviet colleagues developed 160,000-year records of temperature from deuterium and of atmospheric carbon dioxide from the air trapped in the ice. Those records are long enough to include the entire ice age that ended 10,000 years ago as well as the end of the preceding ice age.

The Soviet-French collaborators concluded, on the basis of a simple calculation, that the difference between the 200 parts per million of carbon dioxide found during glacial periods and the 270 parts per million of interglacial periods could explain about 50% of the 10°C difference in temperature. Most of the rest of the temperature difference could be due to the changes in the amount of sunlight falling on different parts of the globe, as controlled by orbital variations.

But the Soviet-French team cautions that their simple model does not include several factors that could also be amplifying the



D. K. Nortell/U.S. Navy

Vostok Station. *Shrouds protect the ice-coring rigs on the Antarctic ice sheet in 1978.*

effect of orbital variations. Recently, Bernard Stauffer and his colleagues at the University of Bern reported that core samples from Greenland and Antarctica contained only 350 parts per billion of methane during the last glaciation compared to 650 parts per billion a few hundred years ago. D. Raynaud of the Laboratory of Glaciology and his colleagues have just reported a similar increase in the Vostok core at the end of the penultimate ice age. Methane too is a greenhouse gas. Raynaud estimates that methane's warming effect during interglacials was perhaps 25% that of carbon dioxide.

Another gas, dimethylsulfide (DMS), may indirectly intensify the cold of an ice age. Robert Charlson of the University of Washington and his colleagues have suggested that DMS produced by marine phytoplankton might brighten clouds, which would increase the amount of sunlight reflected back into space and thus cool the surface. Michel Legrand and Robert Delmas of the Laboratory of Glaciology have reportedly found a DMS proxy in an Antarctic ice core that indicates above-average production during the most recent ice age, which, like the decreases in methane and carbon dioxide, would tend to cool the climate (*Science*, 22 April, p. 393).

There is also increasing evidence that the atmosphere was dustier during glacial periods, especially at their maxima, than during interglacials. Legrand, Lorius, and Soviet colleagues found up to 5 times the sea-salt aerosol and up to 30 times the terrestrial aerosol during glacial maxima than during interglacials. According to some interpretations, the enhanced aerosols, like the brighter clouds, would reflect more sunlight back to space.

The number of known players is increasing, but sorting out their relative roles will take some time. First, there is the chicken-and-egg problem. For example, are changes in carbon dioxide an immediate cause of climate change or a result of climate change that simply reinforces that change? At the moment, marine sedimentary and ice core records disagree. The sequence of events in the Vostok core even seems to differ between the terminations of the last two ice ages. A first step will be resolving conflicts between the dating of marine and ice core records. ■ **RICHARD A. KERR**

ADDITIONAL READING

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Another Glitch for AIDS Vaccines?

While some antibodies against the AIDS virus apparently block infection of blood cells, recent data suggest that others may enhance infection

WITHIN THE PAST FEW MONTHS, several groups of researchers have reported that certain antibodies against human immunodeficiency virus (HIV) may increase viral infection. Some researchers say the new data have potentially negative implications for candidate AIDS vaccines; others say the findings are too "shaky" to be a cause for concern. Regardless of its final resolution, the concern about enhanced infection is provoking widespread interest and investigation.

Researchers are probing three key issues. One is whether antibodies against HIV or other components of blood serum really do enhance infection of blood cells—monocytes and macrophages, in particular. To date, the phenomenon has only been documented in vitro and the ability to demonstrate it varies considerably from one laboratory to another. A second question concerns the mechanism of antibody-dependent enhancement of infection. Among the few laboratory groups that have shown the enhancement, researchers have differing ideas about how it occurs and what cell types it occurs in. The third issue is whether the enhancement, if it is real, is important clinically. Would it mean, for instance, that a person who develops low levels of antibodies against HIV after receiving a candidate AIDS vaccine might have an increased chance of becoming infected upon exposure to the virus? Or might it mean that an already infected person is more likely to progress to disease when certain kinds of antibodies are present or when antibody concentrations reach a threshold level?

Opinions about the danger of increased infection vary. "It's a theoretical possibility based on some interesting in vitro observations that at least must be taken into consideration in the monitoring of clinical vaccine trials," says Anthony Fauci of the National Institute of Allergy and Infectious Diseases (NIAID). "In theory it might pose a problem and could change our approach to vaccine development," says Thomas Folks, also of NIAID. "It is an important concern, but it is not something we hadn't thought of before," says Gerald Quinnan of the Food and Drug Administration. "It is an interesting area for investigation but I have seen no data so far to indicate that this is an important clinical problem," says Martin Hirsch of Massachusetts General Hospital in Boston.

A major reason for concern about the possibility of enhanced infection of monocytes and macrophages stems from growing evidence that monocytes and macrophages are infected early in the course of HIV disease and become virus-producing factories in the body. "The degree to which macrophage infection is important to the maintenance and spread of HIV infection is critical to any predictions about the importance of antibody-dependent enhancement of infection," says Scott Halstead of the Rockefeller Foundation in New York.

The debate about the significance of antibody-dependent enhancement of HIV infection in blood cells was stimulated, in part, by two observations reported by W. Edward Robinson, Jr., David Montefiori, and William Mitchell of the Vanderbilt University School of Medicine in Nashville. The first observation is that a person infected with HIV may make different categories of antibodies. One kind is referred to as "neutralizing" because it blocks replication of HIV in vitro. But another kind appears to do just the opposite; it increases the ability of HIV to infect lines of transformed lymphocytes growing in tissue culture. The researchers are not certain what kind of antibody molecule enhances infection, but according to Montefiori it may be "some portion of the gp160 envelope protein of HIV that elicits enhancing antibody." (The envelope protein, in either its gp160 or gp120 form, is the primary immunogen in at least three experimental vaccines.)

The second finding from the Vanderbilt group is that a different factor, probably the complex of blood proteins and enzymes known as complement, can block the neutralizing ability of the first category of antibodies. "Complement not only reduces neutralizing activity, but it is required for enhancing activity as well," says Robinson. "We see complement-dependent enhancement of HIV infection in at least 75% of the