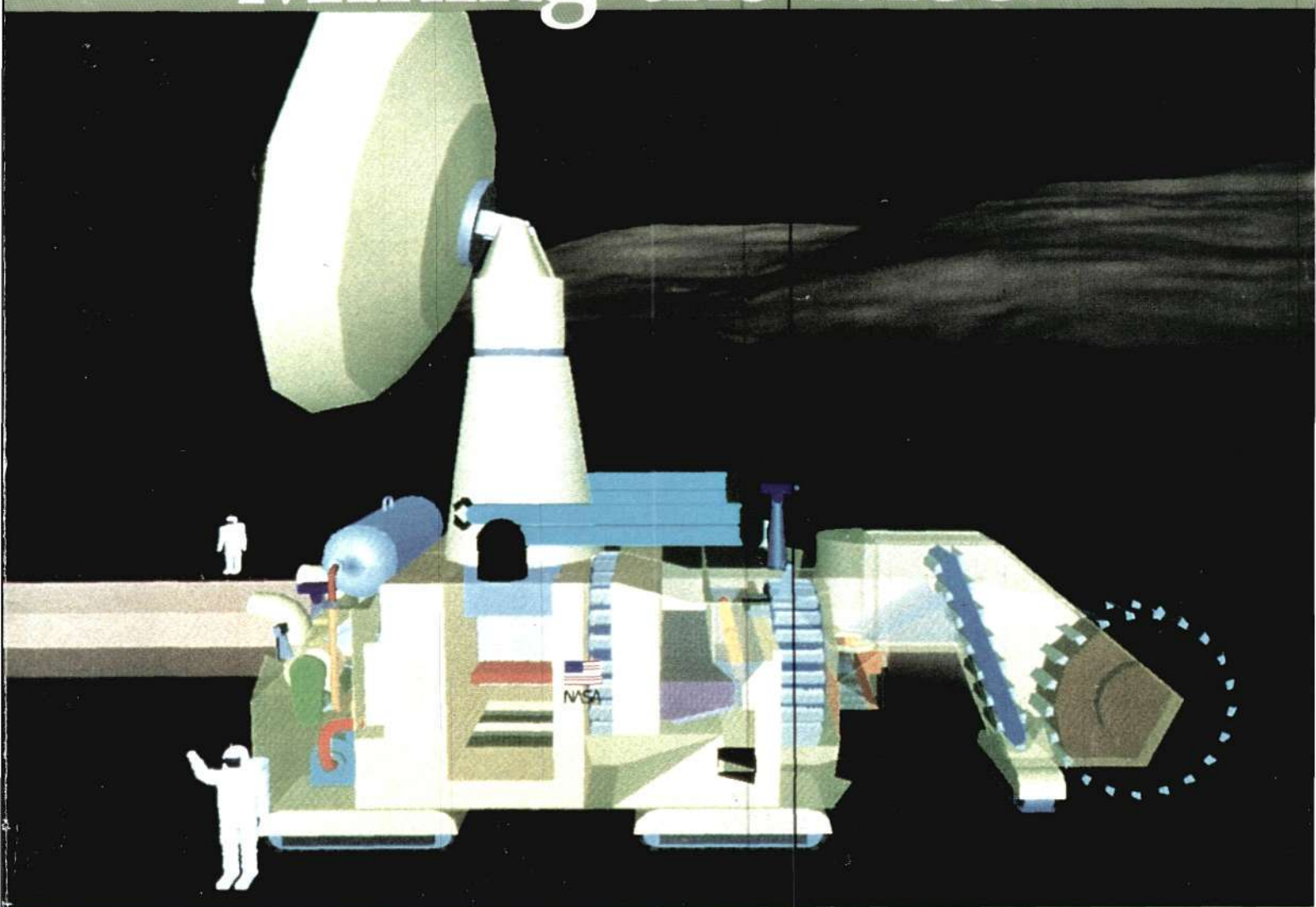
21st CENTURY SCIENCE & TECHNOLOGY

Summer 1990

$3.00

'Environmentalism' Can Bankrupt America

Mining the Moon



To Power the Earth

0 74470 74216 6 03

21st CENTURY SCIENCE & TECHNOLOGY

Vol. 3, No. 3 Summer 1990

Features

29 **Mining Helium on the Moon to Power the Earth**
Marsha Freeman
As the world approaches the 21st century, vast increases in total energy production and consumption per capita are required. Helium-3, sitting on the surface of the Moon, can fuel the greatest period of economic development in mankind's history.

38 **Bioenergetics: 'Tuning' the Soil to Be Healthy and Productive**
Arden B. Andersen
A "crop doctor" prescribes a bioenergetic approach for sick soils and crops, showing that insects "tune out" healthy plants and home in on the sick ones.

45 **'Mind Bombs': Putting Greenpeace in Perspective**
Ellen Chance
"We fire images rather than missiles—mind bombs delivered by the world media." Think about this self-description of Greenpeace the next time you get a "save the dolphins" mailing from this $87-million-a-year environmentalist multinational, whose propaganda campaigns stab at the heart of Western civilization.

News

SPECIAL REPORT
8 The Holes in the 'Ozone Hole'
12 The Benefits of Increased Carbon Dioxide
NUCLEAR REPORT
15 *Interview with Michael Fox:* Don't Bury Nuclear Waste: Recycle and Reprocess It!
FUSION REPORT
18 A Model for Cold Fusion Reactions
21 *Interview with Robert T. Bush at Cal Poly:* A Cold Fusion Model That Matches Experimental Data
22 *Interview with Nobuyuki Inoue:* Cold Fusion Proceeding 'Calmly' in Japan
AGRICULTURE
24 The Myth of Farm Overproduction
27 The U.S. Department of Agriculture Turns Green
BIOLOGY & MEDICINE
51 RNA Catalysis Gives Insight into the Life Process
ASTRONOMY
54 The Hubble Space Telescope: A Revolution in Resolving Power

Departments

2 EDITORIAL
3 LETTERS
4 RESEARCH COMMUNICATIONS
5 VIEWPOINT
6 NEWS BRIEFS
56 FUTURE SCIENTISTS
59 BOOKS RECEIVED
60 BOOKS

21st Century Science & Technology (ISSN 0895-6820) is published 4 times a year, every third month, by 21st Century Science Associates, 60 Sycolin Road, Suite 203, Leesburg, Va. 22075. Tel. (703) 777-7473.

Address all correspondence to **21st Century**, P.O. Box 17285, Washington, D.C. 20041.

Application to mail at second-class postage rates is pending at Leesburg, Va.

Dedicated to providing accurate and comprehensive information on advanced technologies and science policy, **21st Century** is committed to restoring American scientific and technological leadership. **21st Century** covers the frontiers of science, focusing on the self-developing qualities of the physical universe in such areas as plasma physics—the basis for fusion power—as well as biology and microphysics, and including groundbreaking studies of the historical development of science and technology. Opinions expressed in articles are not necessarily those of 21st Century Science Associates or the scientific advisory board.

Subscriptions by mail are $20 for 6 issues or $38 for 12 issues in the USA and Canada. Airmail subscriptions to other countries are $40 for 6 issues. Payments must be in U.S. currency.

POSTMASTER: Send address changes to 21st Century, P.O. Box 17285, Washington, D.C. 20041-0285.

Printed in the USA
ISSN 0895-6820

***On the cover:* Illustration by John Andrews of the Lunar Mark-II robotic miner, courtesy of the Fusion Technology Institute, University of Wisconsin. Cover design by Virginia Baier.**

Environmentalism Can Bankrupt America

An amended version of the Clean Air Bill has passed the Senate and is now in the hands of a conference committee, along with the version of the bill passed by the House. If this bill becomes law, its toll on the U.S. economy will be devastating. It will shut down industry and agriculture and, ironically, it will not improve the environment.

As we have documented, competent scientists dispute the existence of either an expanding ozone hole or a measurable greenhouse effect. Yet international policies, largely promoted by the United States, have been implemented to ban CFCs (chlorofluorocarbons) and other chemicals that are the foundation for the industrial and agricultural development of the developing nations and the economic existence of the industrialized nations.

Estimates vary as to the cost to the U.S. economy of the bill. William Reilly, Environmental Protection Agency administrator, has stated that the $80 billion per year the nation is currently spending to meet environmental regulations will *double* when the new, more stringent standards are signed into law.

Guaranteeing Clean Air *and* Growth

There is a better way to guarantee both clean air *and* a growing economy. Let's spend that $80 billion per year (now spent meeting emission standards) on developing and deploying new, advanced technologies that do not pollute because they are more efficient.

Here are some of the technologies capable of taking us to the 21st century: advanced mass transit using magnetically levitated vehicles, which will dramatically reduce surface transport pollution; magnetohydrodynamics direct conversion technology in order to produce electric power by burning coal without pollution; the next generation nuclear technologies, which will improve the efficiency of the production of electric power and lower its cost; and a variety of plasma processes for industrial production, which will revolutionize materials processing and manufacturing.

The present bill takes the opposite approach. It mandates the "best available control technology" to reduce emissions from power plants, factories, cars, and other offending facilities. This will simply waste billions a year on antiproductive scrubbers and other "bandaids," plus an enforcement bureaucracy. Here's some of what's in store:

* The bill imposes an absolute cap by industry and by geographical area on future emissions of sulfur dioxide and nitrogen oxides. This will prohibit the growth of any industry; to keep the total amount of emissions the same, no new factory can be built unless an existing factory shuts down. This will prohibit the construction of new power plants and wreak havoc in metals-producing industries (aluminum, copper, and titanium, for example) that use large amounts of electricity. The steel industry would have to shut down 36 to 39 of its 40 coke ovens, and about 50 percent of U.S. paper and pulp mills will not be able to meet the new standards and will be shut down.

* The bill bans CFCs, imposing mandatory jail sentences for individuals and companies that provide Third World countries with the technology to manufacture CFCs.

* The bill will severely limit the use of nitrogen, the basis for most agricultural fertilizers. Crop yields could fall to half their present level. Pesticides and fungicides will also be severely curtailed. The National Agricultural Chemicals Association has estimated that consumer food prices will rise 13 percent and U.S. supplies of fruits and vegetables will collapse by 24 percent, if crop-protective fungicides are prohibited.

* Coal-burning utilities will be forced to invest heavily in so-called antipollution devices, curtailing investment that is badly needed to expand the electric grid. Utility rates will rise by 5 to 20 percent in many parts of the country, and there will be an increase in blackouts and brownouts.

* Automobile prices could be increased by $600 at the least and to meet mandated fuel-efficiency standards, cars will have to be 1,000 pounds lighter. In June 1989, the *Journal of Law & Economics* reported that 1,000 more people will die in car accidents each year because the lighter, smaller cars needed to meet such fuel-efficiency standards are not as safe as larger cars. (This means that more people would die from highway accidents than are now estimated to die from cancer caused by the emission of carcinogens from car exhausts.)

* Fuel prices will be increased by more than 10 percent to pay for the new standards. Gasoline prices may rise as much as 25 to 30 cents per gallon, on top of new state and local taxes.

In addition to the economic devastation, the bill mandates the formation of a gestapo to police industrial and domestic life and removes from the citizenry the benefit of basic constitutional rights like trial by jury. The EPA is empowered to impose severe civil and criminal penalties for the tiniest infractions; its powers will be greater than those of the Internal Revenue Service. Environmental bounty hunters can bring "civil" suits and actions, and take a share of whatever fine is imposed by the EPA! A person can be jailed for up to two years for each violation. Each separate day of operating a plant with too great an emissions level, for example, or with failure to file proper forms, can be considered a separate violation!

The remedy: If you want clean air, go nuclear and develop the most advanced technologies. If you want a new dark age, continue to support the elected officials who vote for the Clean Air Bill.

Letters

More Laughs at Environmentalists

To the Editor:

It was with some interest that I read Dr. Elizabeth Whelan's article in the Jan.-Feb. 1990 issue ("Prophets of Doom: A Profile of the 'Experts' Behind the Environmentalist Scare Stories," p. 46).

I did enjoy the piece but I would like to point out an error. Simon Fraser University is not in Victoria, B.C.; it is in Burnaby, a suburb of Vancouver. It is indeed a New Age institution, built in the early 1960s and featuring courses from criminology to sexual perversion. There is a university in Victoria, the University of Victoria, which has done some useful work. The survival suits you see on survivors of marine accidents are a product of their work on hypothermia. They have also done work on edible seaweed.

Is there any way to introduce a bit more humor to this matter of environmentalism? True, fanatical environmentalists seem to lack a sense of humor, but at least the rest of us could laugh at them. Besides, people remember things better if you make them laugh while telling them.

Alex Crone
Vancouver, B.C.

Is Cold Fusion A New Nuclear Process?

To the Editor:

I am enthusiastic about your coverage of cold fusion. I have one scientific question to ask of the reporter or the researchers who claim tritium production.

Although the researchers are predominantly electrochemical scientists, is it not expected that they have discovered a new nuclear process? In an electron host plasma a 3D fusion may be rife. The logical precedents are the H + e + H (that is, p + e + p) → D + ν reaction, with all heat lost to the neutrino, and the $3He^4 \rightarrow C^{12}$ reaction, which occur in stellar furnaces. I am thus proposing 3D + e → 2T + ν.

Physicists have long constrained their work to neutral plasmas; and even the Sun's interior may be thermionic.

Raymond Kenneth Petry
Kailua, Hawaii

The Editor Replies

We asked Hal Fox, of the Fusion Information Center in Salt Lake City to reply. The Center publishes a monthly newsletter that reviews experimental and theoretical news of cold fusion.

Petry writes that a weak branch of the proton-proton chain in stellar fusion, H + e + H → D + neutrino (with energy lost to the neutrino), and the $3He^4 \rightarrow C^{12}$ (also a stellar furnace reaction) suggest a new nuclear reaction.[1] Petry proposes 3D + e → 2T + neutrino as a possible cold fusion nuclear process.

It would be hard to argue against any possible nuclear reaction at this stage. The nuclear reaction proposed by Petry would require the fusion of three deuterons (charged deuterium atoms), which one would predict would be less probable than the fusing of two deuterons. Ignoring the mass of the electron and the neutrino, the 3D → 2T does give a mass fraction of 0.0099 (where the mass of an electron is about 0.0005 mass units and a hydrogen atom is 1.00797). This mass fraction converted to heat by Einstein's formula would indeed provide considerable energy.

Currently, scientists are finding that the combination of the nuclear reactions (presumably from fusing deuterons) that produce either neutrons or tritium do not account for the excess heat that is being measured. The true source of the excess heat has yet to be proven.

Fleischmann and Pons in their original paper make the following statement:[2] "The observations of the generation of neutrons and of tritium from electrochemically compressed D^+ in a Pd cathode is in itself a very surprising result and, evidently, it is necessary to reconsider the quantum mechanics of electrons and deuterons in such host lattices. . . . The most surprising feature of our results however, is that reactions . . . [producing tritium or neutrons] are only a small part of the overall reaction scheme and that the bulk of the energy release is due to an hitherto unknown nuclear process or processes (presumably again due to deuterons)."

Fleischmann and Pons think that they have discovered a new nuclear process and they anticipated some revisions of how we must learn to think about charged atoms in a host lattice. As of this date, no one has all the answers. Aspden summarizes some better ways of thinking about the structure of deuterons.[3]

1. The proton-proton reaction is mentioned in relation to cold fusion by Peter Hagelstein of MIT, in his paper, "Coherent Fusion Theory" (p. 7), along with other ideas of use in considering Petry's suggestion. Hagelstein's paper, 89-WA/TS-4, can be ordered from the American Society of Mechanical Engineers (1-800-843-2763).
2. M. Fleischmann, S. Pons, and M. Hawkins, 1989. "Electrochemically Induced Nuclear Fusion of Deuterium," *J. Electroanal. Chem.* **261**:301, and erratum, **263**:187.
3. H. Aspden, 1990. "The No-Neutron Deuteron," *Fusion Facts*, Vol. 1, No. 9 (March 1990).

Yes, the IMF Promotes Drug Crops for Export

To the Editor:

I recently had the opportunity to read "Yes, We Can Win the War on Drugs" (by Marsha Freeman, Jan. 1990, p. 22) and I found it incisive and full of new data.

Continued on page 4

Cold Fusion and the Missing Neutrons

by H. Aspden

Dr. H. Aspden is with the Department of Electrical Engineering at the University of Southampton in England. He was formerly director of IBM's European Patent Operations. His research communication was received in January 1990.

The missing neutrons in a cold fusion process that converts deuterium into tritium is an experimental discovery in its own right. It cannot be discounted by prior neutron studies from high energy research.

I can accept cold fusion without neutron emission because I have never seen any evidence of a neutron presence in any atomic nucleus. Do we really have to believe, and never question, all the theories that textbooks preach?

All experiments on neutrons require them to be free from the nucleus and they are only produced by high energy (locally hot) conditions. Our experiments only see neutrons that are free and unstable, so who can prove that there are neutrons needing to be shed by deuterium before it can participate in a fusion reaction?

A tritium product is all that is needed to evidence cold deuteron fusion, and *21st Century* reports that tritium is being formed in the palladium cathodes in cold fusion experiments. Cold fusion must therefore now take precedence over hot fusion in our future energy scenario.

My reason for writing is to remind readers that the neutron has a magnetic moment because it has structure and comprises a group of charges. These charges can regroup in different states and for most of the time the neutron reacts as if it has a negative core charge. This gives it its magnetic moment.

Readers may, however, not realize that this magnetic moment is precisely (to 1 part in 10 million precision) that applicable if it were neutral for only 1 part in 23 of the time and were an antiproton with a satellite positron for the remainder of the time. In nuclear magnetons (units of magnetic moment), the neutron magnetic moment is precisely 22/23 times a factor 2 to cater for the applicable nonanomalous gyromagnetic ratio component.

The Deuteron's Magnetic Moment

Consider now the deuteron. It has a magnetic moment that betrays the fact that it too has a neutral state for a proportion of the time. Analysis shows that it has three states of relative duration 1:2:4, the first state being one with a neutral core and a satellite positron. This explains why the deuteron has a magnetic moment of some 6/7th of, in this case, the spin magnetic moment of the proton.

Of course, as the reader can now see, the task of getting two positively charged deuterons close enough to fuse within a solid conductor is that of bringing the deuterons together while at least one is in its neutral core state. In a host cathode conductor carrying electrons able to annihilate the satellite positron in the transient field state, we see that a deuteron can be disarmed, as it were, and so exposed to fusion with a nearby deuteron when put in an excited state.

Cold fusion can therefore be explained if only we wake up to the reality of the nature of the deuteron with regard to its magnetic moment.

Now, I would not like readers to imagine that I have a very fertile brain and have contrived to cook up this explanation because I have read about Fleischmann and Pons and their cold fusion discovery. The full analysis of the above account of neutron and deuteron structure is of published record in the *Hadronic Journal*, vol. 9, pp. 129-136, July 31, 1986. The title of the paper is "The Theoretical Nature of the Neutron and Deuteron." The case presented with full physical justification in this 1986 account is that there are no neutrons in the deuteron. By this letter I am saying "I told you so!" but I had no idea that such a proposition might come to be proved by experimental research into cold fusion, at least not before the dawn of the 21st century.

Letters

Continued from page 3

The *Revista Argentina de Estudios Estrategicos* is the oldest magazine edited in Argentina specializing in politics and strategy. At present, we are undertaking a campaign against drugs, specifically anayzing the unwise policies regarding Latin American countries that have been taken in by the U.S. government and some international organizations.

That is why one point of the article, which states, "the International Monetary Fund openly recommended several years ago that the nations of Latin America grow and sell dope to pay their debts if they had no other way to generate dollars," has utmost importance to us. We would be grateful, if you could send us information on the sources you used for this point.

Alberto M. Garasine, Director
Revista Argentina de Estudios Estrategicos
Buenos Aires, Argentina

The Author Replies

The specific suggestion from the International Monetary Fund to Latin American countries that they should grow dope as a cash crop to pay back their debts is documented in "The IMF 'Opium War' on Ibero-America: a decade later," in the July 8, 1988 issue of the *Executive Intelligence Review*, p. 20. EIR first covered the story in its Sept. 18, 1978 issue ("Why the World Bank Pushes Drugs").

Reports on individuals and institutions who have urged such a course are also published frequently in EIR and in its Spanish-language edition, *Resumen Ejecutivo*.

Why Not Mandate Truth in Environmentalism?

J. Gordon Edwards

Truth in Advertising laws protect us from exploitation by business and industry . . . *except* the environmentalist industry! We are victimized daily by untruthful propaganda and solicitations by organizations whose main business is environmentalism. The Alar hoax by the Natural Resources Defense Council and the Chilean grape fiasco were two recent examples.

Untruthful advertising by manufacturers and producers only results in financial losses for competitors, but untruthful allegations by the environmental industry often lead to agricultural disaster, force companies out of business, cause massive unemployment, and result in human suffering and death in Third World nations.

To limit the proliferation of such harmful tactics by environmentalists, Truth in Environmentalism laws are needed. It should be illegal for advocacy groups to make allegations that are not substantiated by legitimate scientific data, especially when those charges result in unwarranted hardships for essential industries and in illness or death for millions of humans.

The news media should be careful not to lend credence to untruthful or erroneous claims by environmentalists, and should seek to inform and educate, rather than to frighten or brainwash us. Most environmental issues have been studied extensively by scientists, but their conclusions are routinely ignored by those who write stories for the environmentalist industry and the news media. This unscientific propaganda has been given top billing in the past, and many readers believe that "if it is in a magazine or newspaper it *must* be true." Also harmful are television "specials" in which extremists make spectacular statements but knowledgeable experts are not permitted to participate.

Many environmental issues would be controversial even if all the opposing factions were familiar with all the relevant data. Philosophical differences have divided public opinion on matters such as abortion, energy use, diet, endangered species, and so on. It is natural for environmental industry spokesmen to emphasize the views that they consider most likely to attract donors. But the issues should not be clouded by the deliberate introduction of untruthful allegations by those spokesmen or the omission of essential information.

Great financial rewards have been enjoyed by environmentalists who could persuade wealthy, powerful, or popular individuals to support their positions. If those donors were aware that their funding would be used to halt development in Third World nations and to foster malnutrition, starvation, and the spread of insect-borne diseases among the people of those nations—all of which are the documented results of U.S. environmental policies over the past two decades—it is unlikely that such donors would be so generous.

Risks—And Benefits

The question of Truth in Environmentalism is not an academic issue but one of life and death for much of the world's population. If untruths are allowed to proliferate, then propaganda about a wide range of issues from pesticides to protecting dolphins may translate into legislation that directly kills human beings.

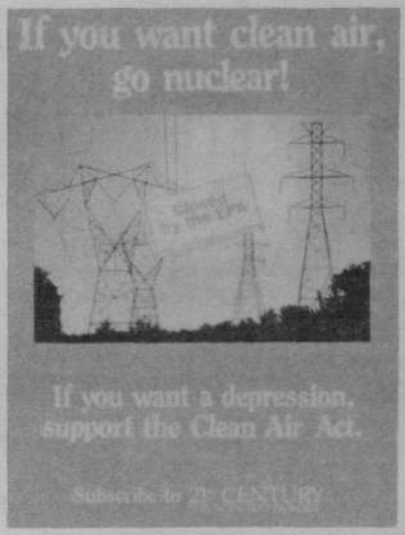
This is not an exaggeration. A recent article in *BioScience* magazine by Norman Myers (Jan. 1990) expresses a desire for "management of the planetary ecosystem in a manner that mobilizes Earth's resources—soils, vegetation, water supplies, atmosphere, and climate, and also species—so as to provide sustainable benefits for humankind *with its numbers regulated in accord with the carrying capacity of the biosphere*" (emphasis added).

If the assumptions behind this philosophical statement are not subjected to a "truth" test before the statement turns into U.S. environmental policy, self-appointed managers may be deciding what is "sustainable," the "carrying capacity" of each country, and, finally, determining the numbers of humankind permitted to exist and how to dispose of the so-called excess humankind.

If violations of "Truth in Environmentalism" principles were exposed and discussed by the media, the public would soon become better educated concerning environmental issues and could make more rational decisions. The disreputable activists would then have to soften unreasonable environmentalist propaganda or risk increased condemnation. All huable environmentalist propaganda or risk increased condemnation. All humanity, both here and in the "underdeveloped" countries, would surely benefit.

J. Gordon Edwards, professor of entomology at San Jose State University in California, has taught biology and entomology there for 41 years. He is a long-time member of the Sierra Club and the Audubon Society and is a fellow of the California Academy of Sciences.

NEWS BRIEFS



Paganomics reverses Genesis: "So God created man in his own image, . . . and God said unto them, . . . have dominion over the fish of the sea, . . . and over every living thing that moveth upon the earth."

IF YOU WANT CLEAN AIR, GO NUCLEAR—AND STOP 'PAGANOMICS'

21st Century's campaign against the Clean Air Act (see editorial) features two posters, one with the message shown here that "if you want a depression, support the Clean Air Act." The other hits "paganomics," our name for the new religion proposed by ecologist Prince Philip, that would replace God with the pagan Earth goddess and put mankind on the same level as animals and plants. The Clean Air Bill is based on the irrationality of this new "religion" and is accompanied by a resurgence of demonstrations and terrorist acts against science and medicine in the name of "animal rights." The Fall 1990 issue of *21st Century* will feature the full story.

POPULATION CONTROL BACK ON THE ENVIRONMENTALIST AGENDA

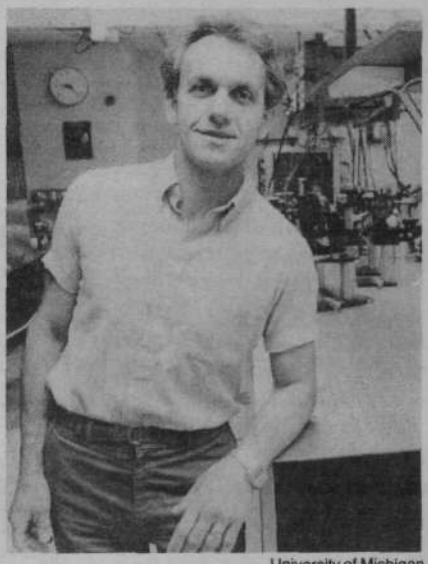
"Environmental groups now appear to be making serious efforts to put world population back on the environmental agenda—after 15 years of avoiding the issue as a political hot potato," reported *Science* magazine May 11. It was dropped because of "fear of alienating people in developing countries and fierce oppostion to family planning by the American right-to-life movement." The Audubon Society is leading a campaign to develop a network of population lobbyists for Congress, *Science* reported.

U.S. ELECTRIC POWER APPROACHING THIRD WORLD RELIABILITY

The North American Electric Reliability Council (NERC) warns in its latest reports that if demand for electricity continues to grow at a rate higher than the forecast 2 percent per year, there could be rolling blackouts by the mid 1990s. NERC references the city of Buenos Aires, Argentina, where people must plan their activities around intermittent use of elevators, subways, street lights, and home appliances. By 1993, NERC says, the eastern half of the United States could have inadequate reserve capacity and utilities might be forced to ration electric power. The next *21st Century* will review the impending U.S. electricity crisis.

THREE MILE ISLAND UNIT 1 IS WORLD'S MOST EFFICIENT NUCLEAR PLANT

Three Mile Island Unit 1 in Middletown, Pennsylvania, led the world's nuclear electricity plants in efficient power generation in 1989, according to an independent survey by McGraw Hill's *Nucleonics Week*. TMI topped the list of 359 nuclear plants in 22 nations with a capacity factor of slightly higher than 100 percent. Capacity factor expresses the plant's output as a percentage of what it could produce if it were operating constantly. The plant exceeded 100 percent because of extraordinary operating efficiency. Number two was Ohi Unit 2 in Japan with a capacity factor of 99.18 percent. The TMI 872-megawatt pressurized water reactor produced 7.2 billion kilowatt hours of electricity in 1989.



University of Michigan

Chirped pulse amplification: Its developer is Gerard A. Mourou, shown here with a smaller amplifier at the University of Michigan.

P-102 LASER BREAKS WORLD POWER RECORD WITH 20-TERAWATT BEAM

Firing of the world's most powerful laser, with an infrared 20 terawatt beam (20 trillion watts or 40 times the electrical generating capacity of the United States), was announced jointly by scientists at the University of Michigan and the French Atomic Energy Commission May 22. The beam of 3.5 inches diameter can be focused to a hair's cross section. The P-102, in Limeil, France, using chirped pulse amplification (CPA), was developed by Gerard A. Mourou of the University of Michigan at Ann Arbor. CPA stretches out a pulse of 1 picosecond (1 trillionth of a second) by a factor ranging from 100 to a few thousand, amplifies it, and then recompresses it to 1 picosecond. If the pulse were not stretched out, its power density would shatter the amplifier, a glass matrix doped with neodymium ions. "With power densities at this level," Mourou said, "we may soon be able to create an intense X-ray laser-like beam capable of producing three-dimensional 'snapshots' of microscopic structures within living cells never seen before." Immediate uses include the study of dense plasmas. While the

power is high, total energy delivered per shot is too low for applications such as laser fusion.

NATIONAL INSTITUTE'S COLD FUSION CONFERENCE MARKS PROGRESS

If the experimental results don't fit the theory, then the theory must change, Stanford University's Robert Huggins told the first annual conference sponsored by the National Cold Fusion Institute in Salt Lake City, March 29-April 1. More than 40 cold fusion researchers and theorists from around the world discussed their work, and experiments were reported showing excess heat, emission of nuclear particles, and sometimes both. Conference participants included chemists Stanley Pons and Martin Fleischmann, self-described "unrepentant" believers in cold fusion; leaders of the Japanese and Indian cold fusion programs; representatives of U.S. government laboratories; and many university researchers. Interviews with some of the participants will appear in the next issue of *21st Century*.

University of Utah

Dr. Fritz G. Will, director of the National Cold Fusion Institute, opening the cold fusion conference. Will, who worked at General Electric for 30 years, is internationally known for his studies of electrodes and fuel cells.

FDA APPROVES IRRADIATION TO CONTROL BACTERIA IN POULTRY

Good news for consumers: The Food and Drug Administration on May 1 approved the use of low-dose irradiation to control salmonella and other illness-causing bacteria in fresh or frozen poultry. The FDA stated that the use of gamma irradiation, electron radiation, and X-rays to treat poultry and its parts is safe and effective at the 3 kilogray level approved (the gray is a unit used to measure absorbed dose). "There is no evidence that irradiation at any level would be hazardous," the FDA noted.

CORPORATIONS FINANCE ENVIRONMENTALISTS . . . FOR PROFIT

Legal Times, an insider newsletter on Capitol Hill, reports May 7 that major corporations are giving millions of dollars to environmental groups to set a profitable agenda for them. The exposé centers on Waste Management, Inc., which has contributed more than $1 million in the last three years to the World Wildlife Fund, the Natural Resources Defense Council, and the National Audubon Society. In exchange, *Legal Times* reveals how these groups have fought for legislation to regulate industrial waste, which has handsomely benefited Waste Management Inc.

21ST CENTURY COOLS GLOBAL WARMING ADVOCATE AT ASHRAE DEBATE

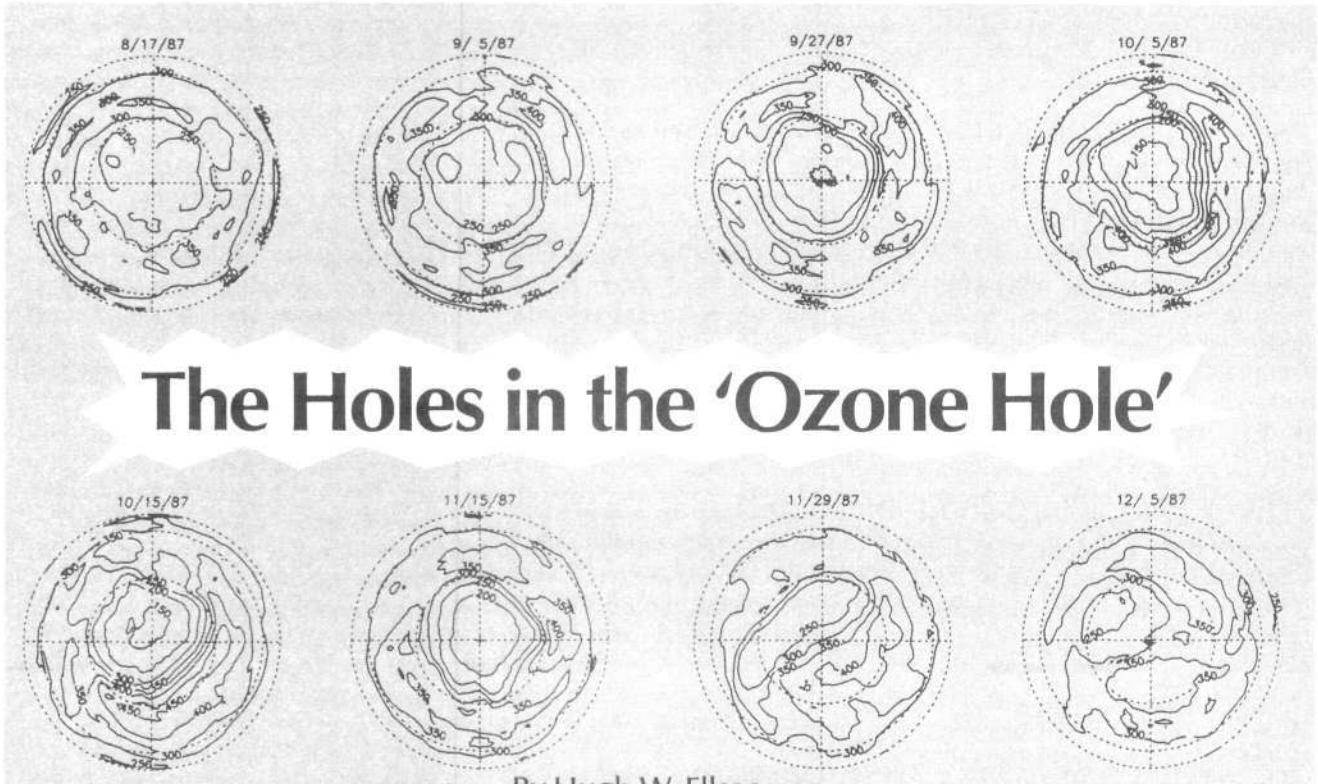
At an April 12 debate sponsored by the American Society of Heating, Refrigeration, and Air Conditioning Engineers (ASHRAE) in Washington, D.C., *21st Century*'s Rogelio Maduro took on Daniel Lashof of the Natural Resources Defense Council. After Lashof gave a typical NRDC presentation on how modern technology is destroying nature with global warming and ozone depletion, Maduro reviewed the scientific evidence demonstrating that both "global warming" and "ozone depletion" were hoaxes.

'NUCLEAR ENERGY' IS THE CURE FOR POLLUTION, WHITE TELLS STUDENTS

In a March 5 debate at the University of Maryland on global warming, Carol White, editor-in-chief of *21st Century*, posed advanced technology as the cure for pollution, while her opponent, Pamela Wexler of the environmentalist Center for Global Change, argued for deindustrialization. We should go nuclear, White told the College Park audience of 70 students. We should develop advanced reactors like the high-temperature, gas-cooled reactor. White also urged development of mass transit, water projects, and reforestation—nature's way of cooling. In contrast, Wexler proposed a no-technology approach. There would be plenty of opportunity for industry in such a world, Wexler said; for example, the Amazon Indians could give up agriculture and cultivate nuts to be sold for use in ice cream.

Stuart Lewis

Let them cultivate nuts for ice cream: That is Pamela Wexler's idea of industry in the Amazon. Carol White is at left.



The Holes in the 'Ozone Hole'

By Hugh W. Ellsaesser

To create a dire threat out of the "Ozone Hole" it was necessary to use the now standard environmental technique of applying a one-way filter in examining the consequences of the actions of man (Ellsaesser 1974). Such a filter allows exploration and investigation only of the paths leading to *detrimental* effects while studiously avoiding calling attention to any of those pathways leading to effects that might be considered to be *beneficial*.

One of the first and most consistent steps in this process was to convert the term *harmful ultraviolet* into a single word—never using the term ultraviolet without this harmful qualifier—and to carefully avoid any mention of the beneficial effects of ultraviolet radiation. Even the U.S. government plays an active role in biasing the decision-making process, generously throwing funds to those who wish to investigate the hazardous consequences they have come up with but refusing even a penny to those who are brazen enough to suggest that any good could come from man's actions.

In June 1972, the National Committee for Photobiology of the National Academy of Science/National Research Council announced its intention to form the American Society for Photobiology, saying in part, "there is a growing general awareness of the unique importance of the effects of light (both *beneficial* and detrimental) on man and all other living organisms (Smith 1974).

Most vertebrates require so-called vitamin D for proper development of the skeleton—the cod fish being one of the few exceptions. The only source of this hormonal-sterol-called-vitamin for most is through the action of ultraviolet light on calciferol in their outer covering of skin, fur, or feathers—a route not open to fish, who thus had to evolve a way of manufacturing it without sunlight.

Hazards of Insufficient Light

The growing young who do not get sufficient "vitamin D," develop rickets, which Loomis (1970) termed "the earliest air-pollution disease." He claimed: "[Rickets] was first described in England about 1650, at the time of the introduction of soft coal, and it spread through Europe with the Industrial Revolution's pall of coal smoke." The German town of Wezlar, with its exceptionally narrow streets and dark alleys, "was infamous for rickets with entire streets where in house after house individuals crippled by rickets could be found," Loomis wrote.

Rickets is but one of the hazards of insufficient ultraviolet. Dantsig et al. (1967) went so far as to state: "If the human skin is not exposed to solar radiation (direct or scattered) for long periods of time, disturbances will occur in the physiological equilibrium of the human system. The result will be

Shown above are Southern Hemisphere maps (in polar orthographic projection) of ozone measurements for the dates given in 1987. The ozone minimum starts to form in August and breaks up in October.

Source: Robert T. Watson, "Stratospheric Ozone Depletion: Antarctic Processes," in *Ozone Depletion, Greenhouse Gases, and Climate Change* (Washington, D.C.: National Academy Press, 1989).

functional disorders of the nervous system, a vitamin D deficiency, a weakening of the body's defenses, and an aggravation of chronic diseases."

They reported substantial health benefits from the use in the Soviet Union of photaria, or installations for artificial ultraviolet irradiation, for children and for persons working in mines and in industrial buildings without windows or situated north of the Arctic circle.

At present, the most serious health hazard in the United States from insufficient ultraviolet or "vitamin D" is osteomalacia, or wasting bone loss in the elderly. While this process can be arrested or slowed by proper treatment, the best treatment appears to be to assure that there is both adequate "vitamin D" and minerals available during the growth period while the skeleton is forming.

Bone fracture, particularly of the femur, among the elderly suffering from osteomalacia is a far more serious health problem than ordinary skin cancer. There are some 400,000 to 600,000 new cases of skin cancer per year in the United States, while among the 20 million Americans affected by osteomalacia there are more than 1,200,000 bone fractures each year.

These statistics strongly suggest that any increase in ultraviolet resulting from ozone loss would, at least eventually, exert a beneficial impact on our health greater than the detrimental one now emphasized. This becomes even more credible when it is recalled that our bodies are far more capable of letting us know when we are getting too much ultraviolet than they are at letting us know when we are getting too little.

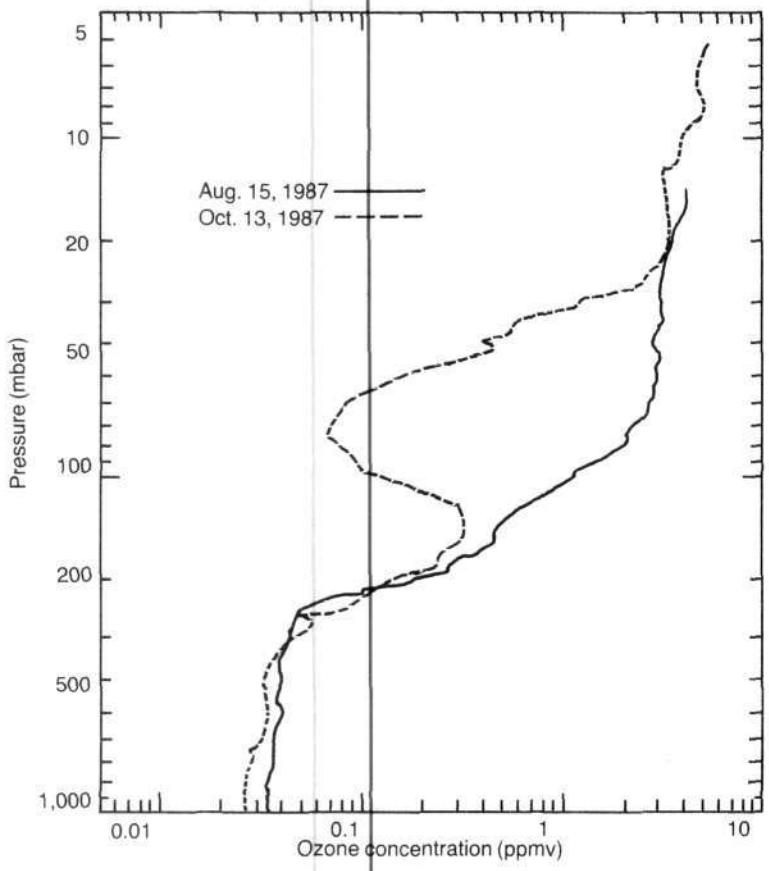
Ultraviolet light appears quite toxic to all forms of unpigmented living cells, particularly the unicellular. Rather than being an unmitigated hazard, this means that it has very useful (to us) antibiotic properties. It is probably no accident that most early civilizations arose in localitites that are today considered to be semidesert with lots of direct sun exposure.

Quantified Risks

Aside from studiously ignoring all possible beneficial consequences of increased ultraviolet, there has been an equally consistent refusal to state the detrimental effects (mainly skin cancer) quantitatively in a form that the public can evaluate for itself.

On an annual mean basis the ultraviolet erythema dose—the dose of those wavelengths responsible for sunburn and presumably also for skin cancer—increases about 50-fold from the poles to the equator (Mo and Green 1974). This is roughly six doublings—or a doubling every 1,000 miles. In midlatitudes it increases even faster. It likewise increases with altitude, doubling from sea level to about 15,000 feet—or 1 percent per 150 feet, roughly. If plants and animals are as sensitive to changes in ultraviolet as they are now made out to be, why did we not long ago recognize ultraviolet damage to plants and animals as they have been introduced into new habitats all over the globe?

According to the National Academy of Sciences (1975), in the United States a 1 percent decrease in the stratospheric ozone layer will lead to increased ultraviolet and a 2 percent increase in skin cancer incidence, or 12,000 additional skin cancers per year. This report also pointed out that the doubling distance for skin cancer incidence in the United States is 8 to



OZONE CONCENTRATION OVER HALLEY BAY

Measurements of ozone concentration in the atmosphere according to altitude, in parts per million by volume, over Halley Bay, Antarctica, Aug. 15 (solid line) and Oct. 13 (dashed line) in 1987, the year the "Ozone Hole" was deepest. Note that the ozone concentration at the bottom of "The Hole" (near 70 mbar at altitude 17 km) remains well above values throughout the troposphere (below 350 mbar, that is, below altitude 8 km). This suggests to some that "The Hole" is caused by tropospheric air being lofted to the stratosphere and spread out between 12 and 20 km in the polar vortex.

Source: Brian G. Gardiner, "Comparative Morphology of the Vertical Ozone Profile in the Antarctic Spring," *Geophysical Research Letters* **15(8)**: 901 (1988).

11 degrees of latitude, or roughly a 100 percent increase over 600 miles; that is, a one percent increase for a 6-mile displacement toward the equator. (Note that this is based on data, not theory.)

This 1 percent decrease in ozone is thus equivalent to a 12-mile displacement toward the equator. This means that the eventual equilibrium of the stratospheric ozone layer, predicted to result from continued release of freons (chlorofluorocarbons) at the 1975 rate, in terms of increased ultraviolet and skin cancer, would be equivalent to a displacement toward the equator of about 100 miles. Do you know of anyone who seriously worries about skin cancer when they are contemplating such a move?

The power of this argument is apparent in the red herring that is always trotted out when it is brought up: "there is a big difference between voluntary and involuntary exposures." The purpose of this article is to put the matter in terms the public can evaluate for itself—something the "Ozone Hole" crowd doesn't want you to be able to do.

What Ozone Depletion?

The most important piece of information withheld from the public is that *at present there is no substantial evidence that stratospheric ozone is being depleted.*

All recent trend analyses have been computed from 1969 or later. For the decade following 1962, upward trends in northern hemisphere or global ozone were estimated at 5 to 11 percent by Komhyr at al. (1971), Christie, (1973), London and Kelley (1974), and Angell and Korshover (1976). Since these upward trends were substantially larger than the downward trends now being cited, this seems to imply that mean global ozone is now higher than it was in 1962. The fact that the current analyses are not being extended back to 1962 (or 1958, when global collection and recording of the data began) suggests the same thing.

It should also be noted that most of the current ado about ozone depletion follows from a National Aeronautical and Space Administration press release and executive summary (NASA Report No. 1208) released in March 1988 (Keer 1988) covering a meeting of the NASA Ozone Trends Panel, for which the full report is yet to appear—two years later!

The scientists involved also frankly admit that the rate of ozone decline claimed is substantially faster than the decline their models compute based on freon release rates. And, although there is little argument that the observational data indicate a decline in total ozone over the past decade or so, direct observation of the erythema ultraviolet flux at eight United States stations since 1974 all show a clear *declining* trend, rather than the increasing trend predicted.

Despite more than a decade of intensive study and modeling of stratospheric ozone, the "Ozone Hole" was not predicted before its discovery. New chemistry to explain "The Hole" has had to be developed—manufactured—*ad hoc* and *post facto*. As we currently understand the problem, the processes producing the "Ozone Hole" are limited: (1) observationally to levels between 12 and 23 kilometers in the interior of the Antarctic winter polar vortex, and to the austral spring months of September and October; and (2) theoretically to regions in the atmosphere remaining at or below −83° C (−117° F) for at least 60 to 90 days, during the latter half of which it must also be exposed to sunlight.

Neither of these limitations would permit a very large volume of the atmosphere to undergo ozone destruction by the currently hypothesized process supposedly producing the "Ozone Hole."

In addition, ozone in the confined layer of 12 to 20 kilometers of the Antarctic austral spring polar vortex was observed to be essentially completely depleted, 95 percent or greater, in 1987 and reduced by 80 to 98 percent in 1989 (Deshler et al. 1990). As Deshler et al. stated: "This suggests that O_3 depletion was nearly complete within layers in the lower stratosphere in these years, and that a lengthening or increase in the severity of the conditions conducive to O_3 depletion may only lead to additional slight decreases in O_3. . . ."

When coupled with the spatial and temporal limitations cited above, this does not suggest a threatening progressive decline in ozone on a global scale. Without hypothesizing additional, and currently unexpected changes, the worst possible scenario would be the appearance of a similar, smaller, and briefer "Ozone Hole" restricted to the Arctic spring polar vortex.

Beyond this, each year an Antarctic "Ozone Hole" has been observed, there has been a direct relationship between the degree of ozone loss and the delay beyond normal breakup time at which spring breakup of the Antarctic winter vortex occurred (Komhyr et al. 1986). Because we do not know what is causing this latter anomaly in the atmospheric circulation, there is no way the associated dynamics can be ruled out as playing a role in the formation of the "Ozone Hole" itself.

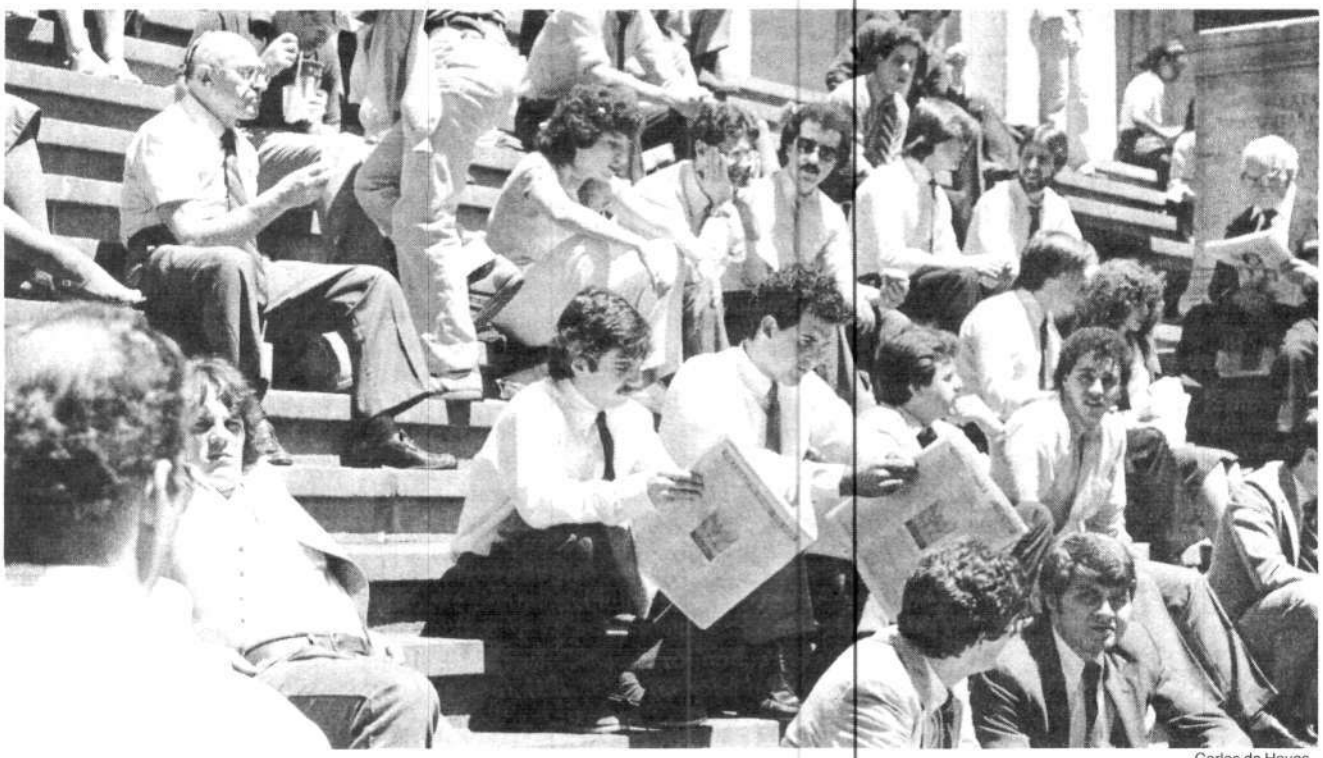
This argument is even stronger when coupled with the findings of Stolarski and Schoeberl (1986) that, while "The Hole" is forming, there is little change in the total amount of ozone south of 44° S and that spring declines in "The Hole" were more than made up by ozone increases in the donut-shaped ozone maximum surrounding "The Hole."

The possibility that the "Ozone Hole" existed prior to its discovery in 1985 (Farman et al. 1985), cannot be definitively ruled out. Because of the extreme difficulties and marginal conditions for making observations of total ozone over Antarctica in the austral spring, unprecedentedly low values such as are found in "The Hole" would, in all probability, have been rejected as erroneous and not recorded prior to the availability of confirmatory observations from balloon soundings and satellites.

In any case, the observational data available to date suggest that the Antarctic "Ozone Hole" is an ephemeral phenomenon, appearing and disappearing periodically or aperiodically, rather than something that has just been identified and is steadily getting stronger or bigger (Singer 1988).

Ozone Certainties

Not all aspects of the "Ozone Hole" issue are as uncertain as those cited thus far. The mandated phase-out and replacement of the freons (chlorofluorocarbons) with *hydro*chlorofluorocarbons (which, because of the hydro-



Carlos de Hoyos

Would any of these sunlovers seriously worry about skin cancer when they contemplate a move 100 miles nearer to the equator? That move would be the equivalent of the projected 1 percent decrease in the stratospheric ozone layer.

gen, will largely decompose in the troposphere before they can carry their chlorine into the stratosphere where it can attack ozone) will have quite certain consequences. They will be less efficient, require larger volumes of working fluid and heavier compressors, be more subject to burning and explosion, and be more hazardous to those coming into direct contact with them.

For all of these reasons freon replacements will make refrigeration and air conditioning more expensive and hazardous. Unless we can all look forward to unlimited affluence, this means that refrigeration and air conditioning will be less widely used. Has any one calculated the health consequences of this? United States health statistics show a dramatic decline in deaths caused by diseases such as stomach cancer when refrigeration was introduced and cardiorespiratory deaths when air conditioning was introduced.

An even more imminent problem that has received little attention is what happens when the large number of auto air conditioners now on the road need a freon recharge and none is available. Simply switching to the freon replacements being developed does not now appear to be an option, without also replacing the major portion of the air conditioning systems with heavier, more expensive, and less efficient parts.

What we appear to have here is another example of "The Emperor's New Clothes" or the life sacrifices of the Aztecs. Aside from a few tailors or priests (the greenies and their friends), there doesn't appear to be much in it for the rest of us.

Dr. Ellsaesser, an atmospheric scientist, retired from the United States Air Force Air Weather Service after 21 years as a weather officer and from the Lawrence Livermore National Laboratory after 24 years in climate research. He is continuing his studies at Livermore as a Participating Guest Scientist. In recent years he has investigated many of the largely unsubstantiated claims that man is fouling his nest.

References

J.K. Angell and J. Korshover, 1976. "Global Analysis of Recent Total Ozone Fluctuations," *Monthly Weather Rev.* **104:**63.

A.D. Christie, 1973. "Secular or Cyclic Change in Ozone," *Pure and Applied Geophysics* **106-108:**1000.

N.M. Dantsig, D.N. Lazarev, and M.V. Sokolov, 1967. "Ultraviolet Installations of Beneficial Action," *Applied Optics* **6:**1872.

T. Deshler, D.J. Hofmann, J.V. Hereford and C.B. Sutter, 1990. "Ozone and Temperature Profiles Over McMurdo Station Antarctica in the Spring of 1989," *Geophys. Res. Lett.* **17:**151.

H.W. Ellsaesser, 1974. "The Dangers of One-way Filters," *Bull. Amer. Meteorol. Soc.* **55:**1362.

J.C. Farman, B.G. Gardiner and J.D. Shanklin, 1985. "Large Losses of Total Ozone in Antarctica Reveal Seasonal ClO_x/NO_x Interaction," *Nature* **315:**207.

R. Kerr, 1988. "Stratospheric Ozone is Decreasing," *Science* **239:**1489.

W.D. Komhyr, E.W. Barrett, G. Slocum, and H.K. Weickmann, 1971. "Atmospheric Total Ozone Increase During the 1960s," *Nature* **232:**390.

W.D. Komhyr, R.D. Grass, and R.K. Leonard, 1986. "Total Ozone Decrease at South Pole, Antarctica, 1964-1985," *Geophys. Res. Lett.* **13:**1248.

J. London and J. Kelley, 1974. "Global Trends in Total Atmospheric Ozone," *Science* **184:**987.

W.F. Loomis, 1970. "Rickets," *Scientific American* **223:**77.

T. Mo and A.E.S. Green, 1974. "A Climatology of Solar Erythema Dose," *Photochem. Photobiol.* **20:**483.

National Academy of Sciences, 1975. *Environmental Impact of Stratospheric Flight* (Washington, D.C.: National Academy of Sciences).

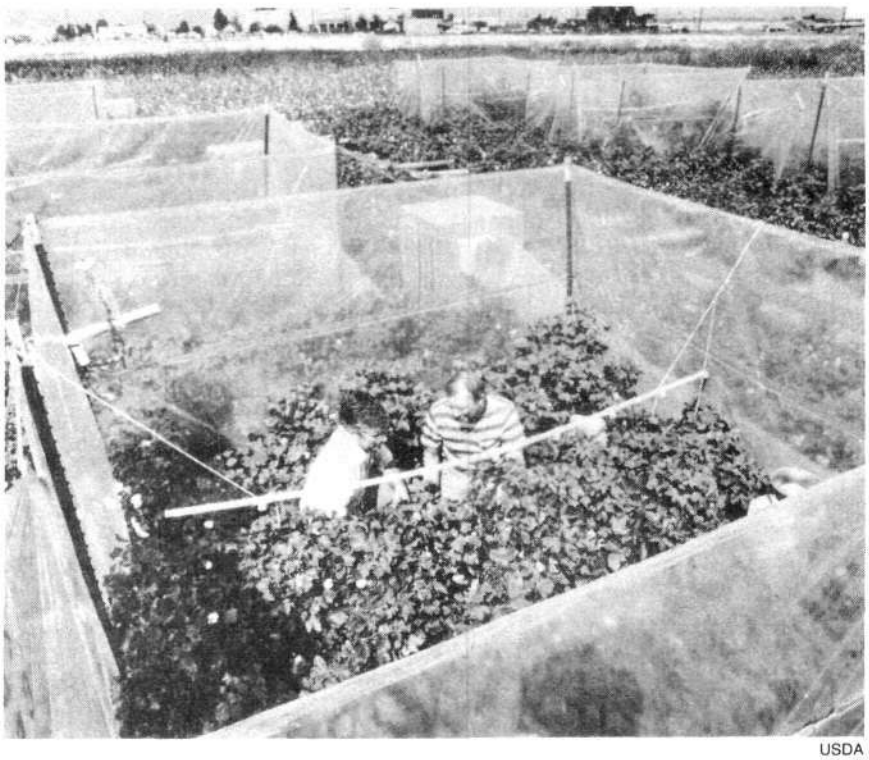
S.F. Singer, 1988. "Does the Ozone Have a Future?" *EOS: Trans. American Geophys. Union* **69:**1588.

K.C. Smith, 1974. "The Science of Photobiology," *Bioscience* **24:**45.

R.S. Stolarski and M.R. Schoeberl, 1986. "Further Interpretation of Satellite Measurements of Antarctic Total Ozone," *Geophys. Res. Lett.* **13:**210.

The Benefits of Increased Carbon Dioxide

by Dr. Sherwood B. Idso



USDA

A doubling of the air's carbon dioxide content generally doubles the water use efficiency of plants during the hot summer. Here open-top enclosures of clear polyethylene are used to study the effects of atmospheric CO_2 enrichment on the growth and water use of cotton at the USDA Agricultural Research Service in Phoenix. Pure CO_2 gas is mixed with ambient air and continually released into the treatment chambers via perforated tubes that are on the ground.

Practically everyone who reads a newspaper, listens to the radio, or watches television can recount the story of how Earth's rapidly rising atmospheric carbon dioxide concentration will shortly lead to a catastrophic warming of the globe and, as one overly pessimistic journalist has put it, "the end of nature."

In fact, so effectively has this doomsday scenario been embedded in the public psyche, it is now a major force in the shaping of international geopolitical thought. Fortunately the primary thesis of this popular paradigm is intellectually bankrupt. It is also misleading in the extreme, in that it totally ignores a whole host of biological benefits freely conferred upon all life by atmospheric CO_2 enrichment.

It has been known for decades, for example, as a result of literally hundreds of carefully conducted laboratory and field experiments, that a simple doubling of atmospheric CO_2 from 330 to 660 part per million (ppm) increases the productivity and hence the harvestable yields of all plants (in the mean) by about one third. It is also known that such a doubling of the air's CO_2 content reduces the per-unit-leaf-area transpiration or evaporative water loss rates of all plants (in the mean) by about one third.

Hence, the amount of organic matter produced per unit of water transpired by a given unit of leaf surface—or what plant physiologists call *water use efficiency*—actually doubles with a doubling of the atmospheric CO_2 concentration. And for a tripling of the air's CO_2 content it nearly triples!

Think of what such a godsend will mean to the descendants of the millions who must eke out a living today on land too dry to produce anything more than a small fraction of what it could with adequate rainfall or irrigation.

Think of what it will do for the soil itself, as vegetation begins to proliferate over barren ground, protecting it from the erosive ravages of wind and rain. And think of what wonders it will work for the ecosystems that depend upon this vital resource. The consequences promise to be nothing less than a veritable rebirth of the biosphere.

Minor Miracles

It all starts, of course, with the increased production of organic matter, both above and below ground, as the rising CO_2 content of Earth's atmosphere directly stimulates the photosynthetic food-producing mechanisms of nearly all forms of vegetation to work ever more prodigiously and efficiently. Then, as the seasons come and go, more organic matter is yearly returned to the soil, where it supports an ever-increasing population of soil microorganisms and fungi.

Some of these microorganisms accelerate weathering processes and soil formation. Some remove nitrogen from the atmosphere and convert it into forms which are readily utilized by plants. Still others detoxify polluted water moving through the soil, thereby improving the quality of this important natural resource.

Enhanced populations of soil fungi also perform minor miracles. At the same time that they grow outward from plant roots in search of important trace nutrients needed by their hosts, they simultaneously protect their hosts from the deleterious effects of soil toxins. And greater fungal colonization of more extensive root systems promotes an underground mutualism and sharing of resources that fosters cooperation among different species and promotes biological diversity.

Greater levels of soil organic matter

additionally lead to greater populations of earthworms, whose soil-forming abilities have been amazing scientists since the days of Darwin. By processing plant residues, for example, earthworms redistribute essential nutrients and make them more available to plants. Their burrowing activities provide for the drainage of water that would otherwise accumulate on the soil surface during intense rainfall and be lost to runoff. And the channels they construct allow plant roots to explore deeper soil layers than they could on their own.

Indeed, the enhancement of earthworm populations generally always leads to significant improvements in the fertility, structure aeration, and drainage of both natural and agricultural lands.

All these phenomena feed back upon the originally stimulated plants, increasing their productivity even more, which in turn tends to further augment their own effectiveness, and so on, until this "boot-strapping cycle" has greatly amplified the original (and already phenomenal) effects of the aerial fertilization provided by the enhanced concentration of atmospheric CO_2.

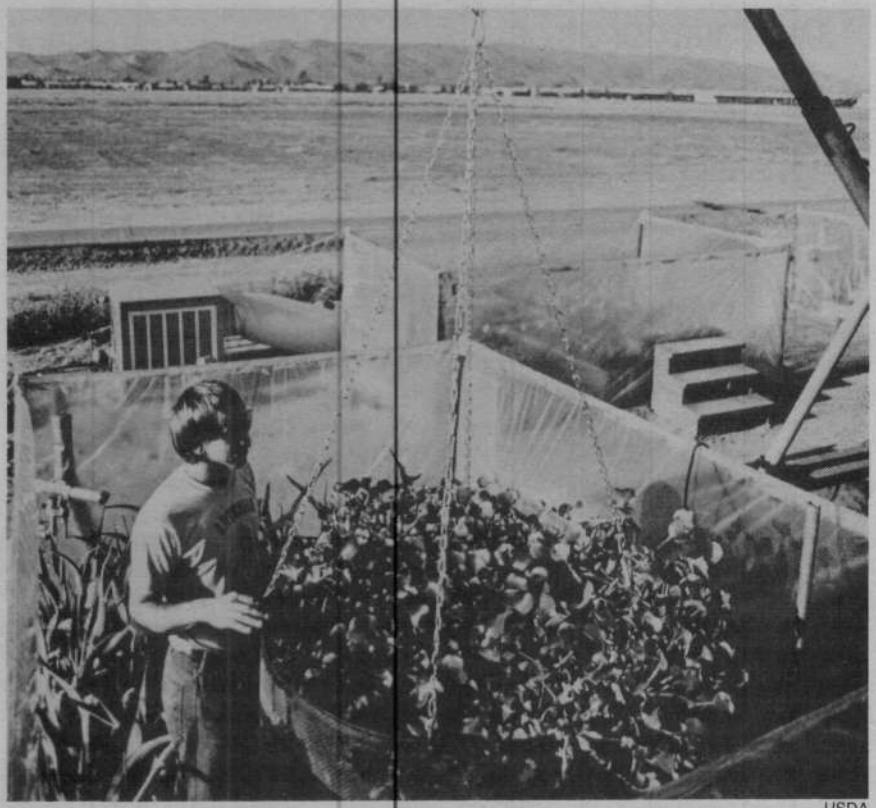
It is not inconceivable that the "breath of life" provided by the increase in atmospheric CO_2 that we are likely to ultimately experience—as a result of our intensive utilization of fossil fuels—will lead eventually to a full order-of-magnitude increase in the totality of Earth's life processes.

Already, the ever-increasing amplitude of the early inhalation and exhalation of CO_2—caused by the springtime regeneration and autumn dieback of Northern Hemispheric terrestrial vegetation—provides unmistakable evidence that the biosphere is beginning to awaken from the long lethargy of near-CO_2 starvation that it has endured throughout the entire span of human history. Annual tree growth is markedly accelerating in many areas. And the productivity of vast reaches of ocean, once thought of as deserts, is experiencing such a dramatic upswing that these areas are now described as "blossoming."

The Benefits of Carbon Dioxide

Long-term experiments are likewise beginning to exhibit the synergistic effects of below-ground amplification of above-ground CO_2 enrichment. In a study I am conducting in Phoenix, for example, orange tree seedlings introduced into open-top polyethylene chambers enriched with an extra 300 ppm of CO_2 are already twice as large as their ambient-chamber counterparts after only two years. A similar in situ study of natural wetlands in the vicinity of Chesapeake Bay has documented increases in net productivity that have exceeded 100 percent for fully three years now.

As both of these results are three times greater than what would be expected on the basis of the direct effects of CO_2 alone, they indicate the tremendous "compound interest" effect of positive biological feedback processes operating in the natural environment, a phenomenon also manifest in the larger-than-expected increases in the productivity of the oceans, the annual growth rates of trees, and the increasing amplitude of the seasonal CO_2 cycle of the globe. Clearly, the world of nature is responding vigorously and positively to our flooding of the air with CO_2.



USDA

One of the experiments designed by the author and his colleagues to study the effects of atmospheric CO_2 enrichment on plant growth and water use efficiency over a wide range of conditions. A fork lift with a boom attachment lifts a wire-mesh cage full of water hyacinth plants from a sunken evaporation tank in an open-top, polyethylene-sided chamber that is continuously enriched to a CO_2 concentration of approximately 500 ppm. The operation is designed to determine the plants' weekly weight gain.

What About the Climate?

But what about the climate? Will a catastrophic greenhouse warming of the globe negate the great promise of atmospheric CO_2 enrichment and return us to an even more oppressive biological "dark age" than that of the past two millennia of unnaturally low CO_2 concentrations? Although many practitioners of the climate modeling enterprise would have us believe so, the answer to this question is a resounding "no!" And it is the biology of the planet which will prove our salvation here as well.

Consider, for example, the *fact* that oceanic productivity generally increases with rising temperatures, and

that the increased metabolic activity of the unicellular algae or phytoplankton responsible for this phenomenon also produces greater and greater quantities of a chemical substance, dimethylsulfide (DMS), that ultimately makes its way to the atmosphere to produce cloud condensation nuclei.

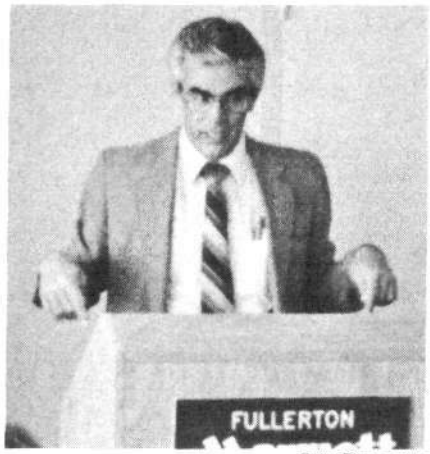
This augmentation of the atmosphere's supply of cloud nucleating particles then tends to create new clouds where before there were none, and to make preexistent clouds more highly reflective, thereby returning to space a greater portion of the incoming radiation from the Sun, cooling tbe globe.

Consider also the *fact* that the land biota operate in much the same fashion, with soil emission rates of the precursor gases responsible for cloud condensation nuclei actually doubling in strength for each 5°C increase in temperature, plus the *fact* that organic matter additions to soils have been demonstrated to increase soil emission rates of these gases by a factor of 5 or more, something that will occur as a natural consequence of the direct aerial fertilization effect of atmospheric CO_2 enrichment even without any increase in air temperature.

Consider next the *fact* that a host of empirical studies have shown cloud cover to have increased over both land and sea over the past several decades, just as these other facts suggest should have happened in response to the atmospheric CO_2 increase we have already experienced. Consider also that increasing cloud cover should slightly reduce daytime maximum temperatures, significantly increase nighttime minimum temperatures, and leave daily means essentially unaltered—all of which effects are definitely good for the biosphere.

Consider finally the fact that such surface air temperature trends are exactly what have been observed in the historical climate record when care has been exercised to exclude urban heat island effects by working primarily with data from rural stations. Clearly, we have nothing to fear from the CO_2 greenhouse effect but fear itself.

There are, of course, many regrettable things that man has done to the environment, but flooding the air with



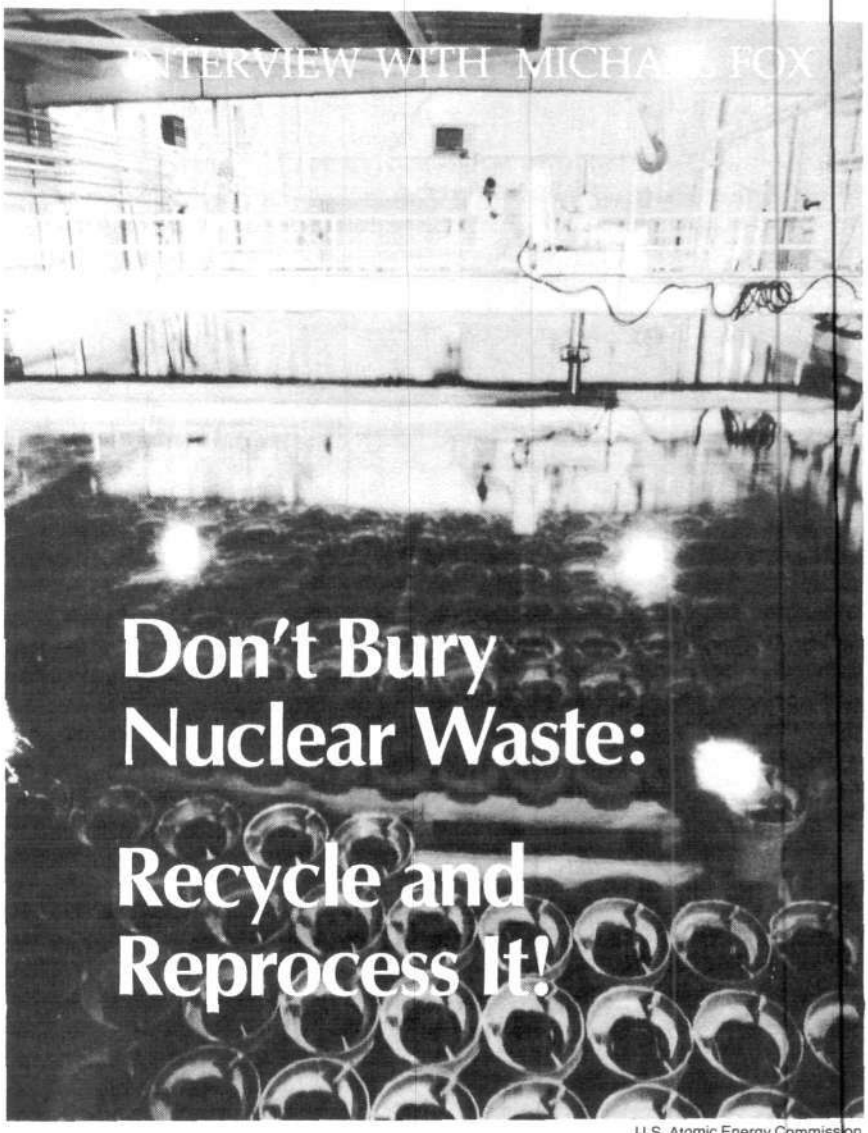
Peter Dimopoulos

"There are, of course, many regrettable things that man has done to the environment, but flooding the air with CO_2 is definitely not one of them." Here, Idso addresses a college audience.

CO_2 is definitely not one of them. In fact, it just might be that this phenomenon is man's redeeming grace, the single good and shining deed that he has performed for the many species with which he shares the Earth.

Let us, therefore, not destroy the one great hope we currently possess for rejuvenating the biosphere by a thoughtless rush to judgment on the important issue of industrial CO_2 emissions. Rather let us recognize them for what they really are—a blessing in disguise—and proceed from that point to attack those very real problems about which we truly can do something: hunger, poverty, drug abuse, disease, and the whole host of affronts to human dignity brought about by man's inhumanity to man. For how can we expect to right the entire biosphere if we cannot set in order even our own house?

Sherwood Idso is a research physicist with the U.S. Department of Agriculture's Agricultural Research Service and an adjunct professor in the Departments of Botany and Geography at Arizona State University at Tempe. This article is based on the author's new book Carbon Dioxide and Global Change: Earth in Transition *published by the Institute for Biospheric Research, 631 E. Laguna Dr., Tempe, Arizona 85282 and available at $19.95 per copy plus postage ($2.00).*



Don't Bury Nuclear Waste: Recycle and Reprocess It!

U.S. Atomic Energy Commission

Waste? By treating as "waste" all the spent fuel produced by a single 1,000 megawatt nuclear plant over its 40-year lifetime, the United States throws away the equivalent of 130 million barrels of oil or 37 million tons of coal—and this doesn't take into account the value of the strategic metals and other isotopes that could be retrieved from the high-level waste. Here, spent fuel is stored in water-cooled basins awaiting reprocessing in 1974.

Michael Fox has a doctorate in physical chemistry from the University of Washington and for 25 years has worked in the nuclear field at Hanford, Washington, and at the Idaho National Engineering Laboratory. He was interviewed in February 1990 by Marjorie Mazel Hecht.

Question: How much of the nominal 20,000 metric tons of spent fuel now stored at U.S. nuclear plants could be turned into new resources?

More than 90 percent of it is useful either now or in the foreseeable future. I have made estimates of the resources in 70,000 metric tons of spent fuel. This amount is the upper limit that the first U.S. repository would hold, as spelled out in the language of the Nuclear Waste Policy Act.

Nobody involved in making that policy seriously asked, certainly not in public, what is in 70,000 metric tons of spent fuel? First, there are more than 66,000 metric tons of uranium-238.

Uranium-238 is relatively innocuous material used in manufacturing. It is usually in an oxide form, but could be rendered in a metallic form very easily. For example, it's used in helicopter rotors, some types of artillery shells, and as ballast in aircraft to achieve balancing. Before the regulatory world went overboard, metallic U-238 was used as paperweights on engineers' desks! Therefore, this material doesn't need such a costly burial.

Although present fission reactors cannot efficiently use U-238 as fuel, in the breeder reactor economy—which the nation must inevitably get into—uranium-238 can be used to make new nuclear fuel. When this U-238 is recycled in breeder reactors to make new nuclear fuel, it will represent a phenomenal amount of additional energy.

The second component of the 70,000 metric tons of spent fuel is about 1,200 metric tons of fissile uranium-235 and plutonium-239. This is a relatively small amount of material. If there were not other considerations, that amount of material could be stored in a very small house.

Because of the immense energy density in the nucleus, this relatively small amount of fissile U-235 and Pu-239 is equivalent to about 20 percent of the U.S. oil reserves. To be burying this kind of energy, when oil shortages are so clearly on the horizon, has made the nuclear program in the United States an international joke in the view of many scientists around the world.

To the credit of those who have been managing the U.S. repository program, there is wording in the Nuclear Waste Policy Act that says the spent fuel should be retrievable for an indefinite period of time. Nobody has put a precise date on when irretrievability is required. However, the public has been dreadfully misled by people less knowledgeable. They have been led to believe that spent fuel is a waste, and it clearly is not.

The remaining 2,500 metric tons of the 70,000 is the most radioactive, but also contains some potentially useful material as well. Using reasonable estimates, there are approximately 80 tons each of cesium-137 and strontium-90. We have the technology now to separate both of these resources from nuclear waste.

Cesium-137 is being used now to sterilize medical equipment of all types; this includes prosthetic devices, hip joints, knee joints, and heart valves. Almost all disposable medical equipment in the United States is sterilized by radiation. The medical products irradiation market is dominated by cobalt-60 from Canada, but cesium-137 is also available from U.S. nuclear waste to do the same thing.

"It's a huge price we Americans pay for fear."

The costs of separation and packaging make cesium-137 less competitive economically than cobalt-60, but remember that many of today's resources were considered to be only wastes before they were developed. Pressboard for lumber is material made of wood wastes that were once burned, but now it is a valuable commodity. I think people can understand that what is a "waste" today, very likely will not be a waste tomorrow.

Two types of commodities that are sterilized by radiation are ointments and contact lens solution. Radiation is the preferred way to sterilize them because the traditional sterilization methods of heating the materials would destroy them.

The vulcanizing of car tires is sometimes done with radiation techniques and many polymers are stabilized by using radiation. There is a type of wood flooring, often used in gym floors, for which the resin is placed on the wood and is then irradiated. This makes the floor much more durable and easy to clean.

There are other materials in the 70,000 tons of waste—for example, palladium—some of which is not radioactive. This could be very useful material if it were separated from the radioactive constituents. Palladium is now a key ingredient for electrodes in cold fusion. What isn't a market for palladium today, could easily become one in the future.

Question: Can you put a dollar figure on the resources in the spent fuel?

We're talking about billions of dollars. Just 1,200 tons of uranium-235 and plutonium-239 alone would be the equivalent of 5 billion barrels of oil. At $15 a barrel, we're talking about burying potentially $75 billion worth of energy. (This doesn't include the trillions of dollars worth of energy being stored in U-238.)

In my judgment, long before we would close off the repository containing the spent fuel, this nation is going to be in serious difficulty with its oil dependency problem. Long before the repository would be closed, we'd be going back in and getting that spent fuel out and reprocessing it. That's clearly on the horizon.

Question: Would you have to bury any part of the spent fuel?

Actually, no. Certainly it must be treated safely and with respect. That this is achievable, is being demonstrated in France, Great Britain, and elsewhere today. Most scientists would agree that if we can work through the public's perception that this waste is more harmful than it really is, the spent fuel is very, very manageable.

For the sake of energy policy, this material should be kept at or near the surface, at some relatively isolated facility. There are many potential sites like this around the United States, so we should not spend billions of ratepayer dollars building small cities 3,000 feet beneath the surface.

There isn't any doubt in my mind that we *can* successfully build such an underground repository, but we haven't really seriously considered the question, "Do we *need* to build such a facility?" I don't think we do, if safety is the issue. We should keep the spent fuel relatively handy, either at the surface, or to be a little more conservative, in a near-surface storage facility. There have been many types of casks developed to store fuel assemblies at the surface.

Question: If we were to begin reprocessing the nuclear fuel itself, could we gear up quickly to do it? Do we have existing facilities?

Yes, of course, we have several options. The Japanese, for example, are getting their fuel reprocessed in France and Great Britain. They are now building their own reprocessing facility in Japan. So if the United States decided to reprocess its fuel, for a few billion dollars a year it could contract with these nations.

It's a huge price we Americans pay for fear. American society is paying an enormous price in terms of increased energy costs and the export of high tech scientific jobs to these other nations. For example, the French and the British each have a nominal backlog of a billion dollars of contracted fuel reprocessing and vitrification work. The largest source of revenue for Great Britain is the sale of their oil in the North Sea; the next largest source of revenue is reprocessing spent fuel, which helps their balance of payments problem.

Another price we pay to indulge our fear is the needlessly high dependence upon coal, oil, wood, and natural gas, which are much more polluting and harmful sources of energy. Oil spills, coal mining and transportation accidents, and natural gas explosions are just some of the consequences.

So we export our technology (and sometimes our talented people) to these other nations, and they are using this technology as a source of revenue and to keep their scientific community on the cutting edge.

Question: What about the completed but unused nuclear fuel reprocessing plant that was shut down during the Carter administration?

Yes, that's at Barnwell, South Carolina. Barnwell has been kept in a standby mode since the early days of the Carter administration, and if the economics were right and the owners were assured of regulatory stability, you bet, we have the technology waiting there right now.

We could also start reprocessing at Hanford, a key facility in our national defense, in separating plutonium from fuel for the N-reactor [a defense reactor that produces both plutonium and electrical power]. Similar facilities exist at Savannah River, South Carolina. There has been a lot of defense reprocessing since the Carter era, but no *commercial* reprocessing.

Question: How does reprocessing work?

One begins with the spent fuel assemblies. These are rectangular bundles of fuel rods about 1 foot in width and 12 feet long, weighing about 1,000

pounds. They are very radioactive when they come out of the reactor, which means they have to be handled with care. Nuclear engineers and scientists do this regularly in many nations around the world.

One of these spent fuel assemblies can contain as much as 90,000 barrels of oil equivalent (energy equivalent) after it comes out of the reactor. It is a waste of the nation's energy sources to bury it.

The reprocessing plant starts with the spent fuel assembly, removes the cladding, and dissolves the uranium and the fission products. There is an unbelievably toxic brew of acids that has been developed by the scientific community around the world to dissolve this material and get it into solution.

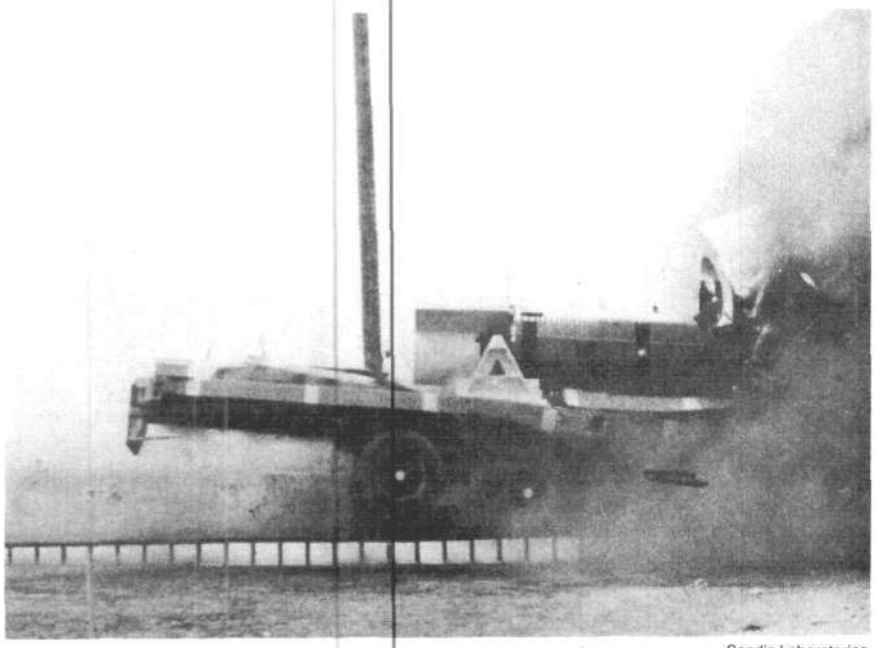
Once it's in solution, then uranium and plutonium are separated from the fission products. A second and a third separation process are carried out to separate the uranium from the plutonium, and the cesium and strontium from the remaining fission products. The separation processes can go on and on, depending on how many of these materials one wants to extract from the spent fuel solution. This type of separation is not a laboratory curiosity, but a commercialized process, and the French and the British sell it as an engineering service to nations around the world.

Question: Does the Defense Department reprocess its own waste materials?

Yes, this is called the Purex process—Purex meaning plutonium and uranium extraction—and there is a Purex facility at Hanford. The separation processes got started in World War II, during the Manhattan Project, when we needed to remove the plutonium and uranium from spent fuels for weapon purposes.

Question: Are the civilian and defense wastes the same?

There are huge differences between the two types of wastes in chemical composition, in volume, and in amounts of radioactivity. The volumes of defense wastes are absolutely huge compared to the volumes of spent nuclear fuel. The reason is that the nuclear cores of the defense reactors have to be replaced every 6 to 8 weeks, so on an annual basis there are about 6 or 8 cores to reprocess. In a commercial reactor there is only about one third of a core to replace per year. That makes a volume difference of 18 or 20.



Sandia Laboratories

The second in a series of four crash tests at Sandia National Laboratory to determine the integrity of shipping casks for spent nuclear fuel. Here a 22-ton cask on a tractor trailer rig was propelled by rockets into a concrete target at 84 mph. The cask was not breached.

Also, weapons require a high grade of plutonium-239. Other higher plutonium isotopes, like Pu-240 and Pu-241, actually diminish the characteristics of a weapon by reducing its explosive firepower. In a commercial plant, however, the amount of plutonium isotopes 240 and 241 can be run up quite high, because the product is not going to be used for weapons.

Question: What form of fuel do you end up with in the reprocessing plant?

The end product is an oxide, typically an oxide of uranium and plutonium, which can be made into new fuel for commercial reactors.

At this point the fission products are in a nitric acid solution, which is then converted to a solid. The French solidify their waste by running it through a small calciner, like the larger rotary kilns used in paper mills. A solid oxide of the fission products is produced in the calciner.

This oxide can then be mixed with inert glass-making material, called frit. In a ratio, typically of 1 part fission product to 10 parts frit, the mixture is then melted. After a time, the molten glass is drawn off the bottom of the melter and into stainless steel cans.

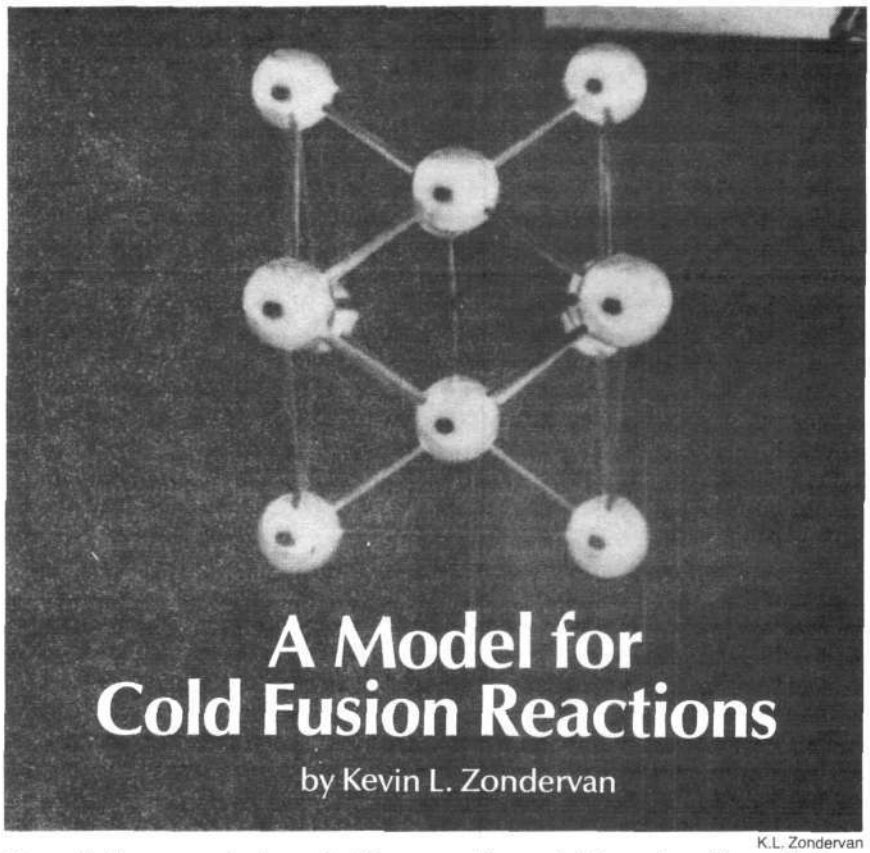
Question: But from what you have said this vitrification is not really necessary; the wastes could be stored and then "mined."

Yes, putting the waste into a glass, especially a highly stable borosilicate glass, makes the waste a lot more costly to recover. Once it's in the glass form, it pretty much preempts being able to use that material for any future application.

If a nation is going to have reprocessing, it is more economical to be able to take out all this material at the same time; before it is made into a glass. Through thousands of scientific studies, done in the last 40 years, scientists have developed dozens of processes for separating these materials from nuclear waste. The latter day article of faith that "we don't know what to do with the waste," is specious. For example, we can and have removed the cesium and strontium from it.

Next we could take out the neptunium and americium. Neptunium is a

Continued on page 59



A Model for Cold Fusion Reactions

by Kevin L. Zondervan

K.L. Zondervan

The palladium crystal, shown in this geometric model, is a cube with a palladium atom at each vertex (8) and the center of each face (4). An atom of hydrogen or of a hydrogen isotope fits nicely in the vacant center of the cube. This can happen during the electrolysis of heavy water using palladium electrodes.

EDITOR'S NOTE

The process of catalysis is conventionally described today using the quantum mechanical term "tunneling," but this does not really tell us about the physical geometry of what is going on. We are happy to present this discussion and interview because it brings together the phenomena of cold fusion and superconductivity in a way that may lead to the development of a truly geometric theory and stimulate scientific breakthroughs on the order of those Bernhard Riemann produced in the 19th century.

* * *

Since the first announcement of cold fusion by electrochemists Pons and Fleischmann in March 1989, scientists have struggled unsuccessfully to produce a theory that adequately explains the new phenomenon. Much of the ridicule of cold fusion by the scientific establishment arises, in fact, because the observed experimental results of cold fusion researchers defy the limitations of current physical theory.

Prior to "cold fusion," it was thought that the fusing of two particles always required huge amounts of energy, as is the case in the Sun. The more massive the particles, the greater the required energy. Of course, this result is premised on two-body interactions in a vacuum. That is, given two "free" particles (Figure 1), an externally applied force or energy field is required to force the two particles together, causing them to fuse. The external force may be due to gravity (as in the Sun) magnetic fields, shock waves, and so on.

Experiments based on two-body interaction theory have been producing fusion on a small scale in the laboratory for years in the magnetic confinement and inertial confinement fusion programs, and most scientists thought it inconceivable that nature could accomplish fusion in a less brutal way.

Pons and Fleischmann, working at the University of Utah, and Steven Jones, working independently at Brigham Young University in Utah, thought nature was more elegant. By introducing a *third* constituent to the fusion process—a host—perhaps fusion could occur more "naturally." More and more data seem to indicate this is possible, but how can the process be explained?

Robert T. Bush, a physics professor at California State Polytechnic University in Pomona, California, has proposed one explanation, a cold fusion model that is simple, yet elegant. The spark for his quantum mechanical model came from Dr. Leaf Turner of Los Alamos National Laboratory. The jury is still out on much of the theory, but as of February 1990, his model matched published data to within 3 percent.

Tunneling and the Bush Model

The essence of Bush's model is the concept of "tunneling," the process by which a particle passes through a potential energy barrier or force field when it appears to lack the energy to do so. This concept is well known to solid state physicists and electrical engineers, and has been observed to occur in semiconductors and the like. The tunneling concept makes no sense when matter is conceived of as hard little balls that interact, but is easily explained when matter is conceived of as waves.

First, however, we must understand the concept of potential energy barriers. Consider the total energy of a particle at any instant to be the sum of its *kinetic* energy and its *potential* energy. Kinetic energy is the energy due to the velocity of the particle, whereas potential energy is the energy due to the forces acting on the particle, such as gravity or electromagnetic fields.

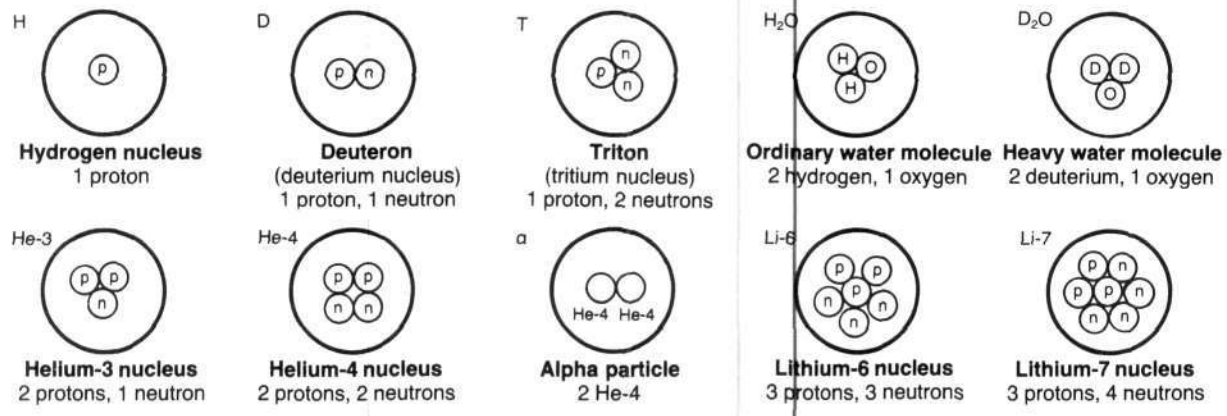


Figure 1
TYPICAL PARTICLES ENCOUNTERED IN COLD FUSION

These simple diagrams show most of the particles discussed and examined in cold fusion experiments and theories. The two isotopes of hydrogen are distinguished by the number of neutrons in the nucleus in addition to the 1 proton. Deuterium has 1 neutron and tritium has 2 neutrons. Heavy water, the medium in which most cold fusion experiments are carried out, is water composed of deuterium and oxygen (D_2O) instead of ordinary hydrogen and oxygen (H_2O).

As the particle moves about in the force field, its total energy remains constant but its kinetic and potential energies vary. Where the forces are the greatest, the potential energy is zero, and the velocity and kinetic energy of the particle are least.

Now, consider a particle moving in one dimension, say along the *x* axis of Figure 2. Suppose at some point along the *x* axis (for example, the origin), the potential energy makes a sharp rise. This could happen, for example, if the particle is positively charged and another positively charged particle is located at the origin. As the first particle approaches the origin it is repulsed (like charges repel) and slows down, giving up kinetic energy for potential.

Now consider Figure 3, where the potential energy is greater than the total energy! In classical physics, this can never happen, but in quantum mechanics it is a different story. The curve for potential energy in Figure 3 represents a *potential energy barrier*. Classically, a particle cannot begin to the left of the barrier and move to the right, or vice versa, because its kinetic energy would have to become negative to do so, which is "impossible."

However, if the particle in question is regarded not as a hard little ball, but as a packet of waves (called de Broglie waves), there is a finite probability that the particle can traverse the barrier! This behavior has been described as tunneling through a potential hill or barrier and is a very real phenomenon. It is by this mechanism that alpha particles are emitted by radioactive nuclei despite the potential energy barriers that bind particles to their nuclei. In the electronic circuit device called the tunnel diode, electrons traverse a region of negative kinetic energy in traveling from one part of the device to the other.

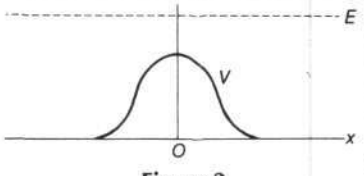


Figure 2
TOTAL AND POTENTIAL ENERGIES OF A PARTICLE

The broken line (E), represents the total energy of a particle that is moving in one dimension along the x axis. This total is the sum of its kinetic energy and its potential energy (V), which is the energy due to the forces acting on the particle. In this hypothetical case, the potential energy of the particle rises sharply as it approaches the origin (O). This could be due to the presence of a particle of like charge at the origin. Because like charges repel, the particle is repulsed at the origin and slows down, giving up kinetic energy for potential energy.

Consider now what happens if a particle encounters two potential barriers in a row, as shown in Figure 4. If a particle traverses a simple barrier, as in Figure 3, it is not *bound* in the sense of being localized to a region in space. As

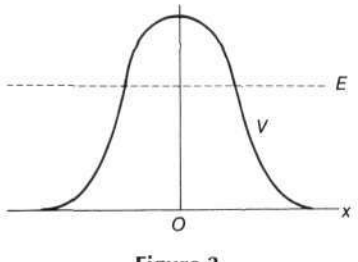


Figure 3
POTENTIAL ENERGY BARRIER

Here the potential energy is greater than the total energy. Classical physics says a particle traveling along the x axis cannot pass the origin, since to do so requires the particle to have negative kinetic energy. But quantum mechanics says this is possible, because the particle is treated as a wave packet that has a finite probability of crossing the "barrier."

a result, there are no restrictions on the possible energy states of the particles.

However, if a particle becomes "trapped" between two potential barriers, as in Figure 4, there *are* restrictions on its energy states. In fact, this particle can enter the potential barrier only if it has prescribed energy levels. This is the key concept of Bush's cold fusion model.

The essence of this model, according to Bush, is wave transmission through a chain of barriers, each of which is separated from the next by a well. As the particle associated with the wave passes through each barrier, it has a chance of undergoing a nuclear reaction. Also, it is more likely to be a reaction involving the exchange of a particle such as a neutron rather than a fusion reaction. Only when a "free" deuteron, say, has prescribed energy states can it enter the potential well between two fixed deuterons trapped in a metal lattice, as shown in Figure 5.

But fusion may not always occur when a potential barrier is penetrated. Whether fusion occurs depends on the *cross section* for the reaction, which is simply the *effective* target area presented by the target to the moving particle. Reaction cross sections are not necessarily related to the geometrical cross sections of the particles involved in the reaction. The reaction cross section can be much larger than the geometrical cross section because particles are really wave packets that extend over relatively large regions of space.

For example, the wavelength of a thermal neutron is much larger than nuclear dimensions and cannot be described as a point interacting with a nucleus. The nuclear cross section of a reaction expresses the *probability* of a reaction occurring.

In order for fusion to occur, two nuclei (Figure 6) must be brought together within the range of the nuclear force, which is on the order of 10^{-15} meter. For this to occur, the repulsive Coulomb force must be overcome; that is, the potential barrier must be traversed. The Coulomb repulsion of two deuterons at a separation of 10^{-15} m is about 1.4 MeV; this is therefore the order of magnitude of the initial kinetic energy required for the reaction to occur.

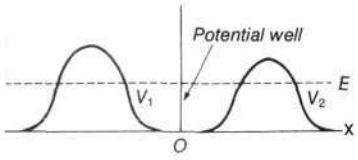


Figure 4
POTENTIAL ENERGY WELL
If a particle encounters two potential barriers in a row, it can be trapped in the well between them, depending on its energy level. It may be easier for the particle to enter the potential well than to pass a single potential barrier. This is the key concept in Bush's cold fusion theory.

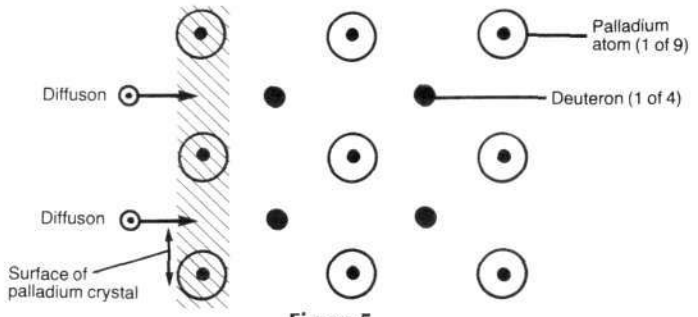


Figure 5
A TWO-DIMENSIONAL REPRESENTATION OF DIFFUSONS MIGRATING INTO BETA-PHASE PALLADIUM
Beta-phase palladium is pure palladium with deuterium nuclei occupying more than 70 percent of the interstitial sites in a localized region. The surface of the palladium crystal is represented by the 3 palladium atoms at left. Diffusons are particles that can diffuse through the palladium lattice (deuterons, tritons, He-3, or lithons). These diffusons have a chance of tunneling past a deuteron only if they travel along lines formed by two adjacent deuterons. These are also the only directions that can yield cold fusion.

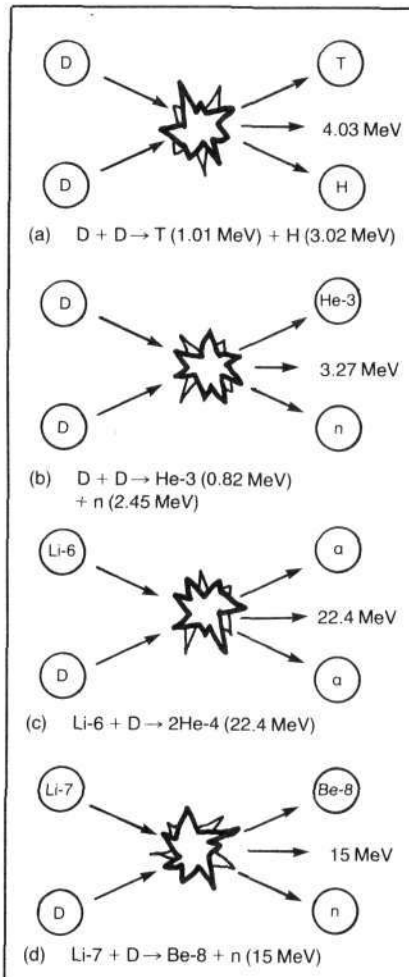


Figure 6
FOUR CANDIDATES FOR COLD FUSION REACTIONS
These are four of the hydrogen fusion combinations and their products thought to be candidates for cold fusion reactions. Greater output energies are anticipated from the combinations of lithium-6 and beryllium-8 with deuterium. Deuterium + deuterium is the reaction now used for hot fusion with deuterium + tritium planned as the next step.

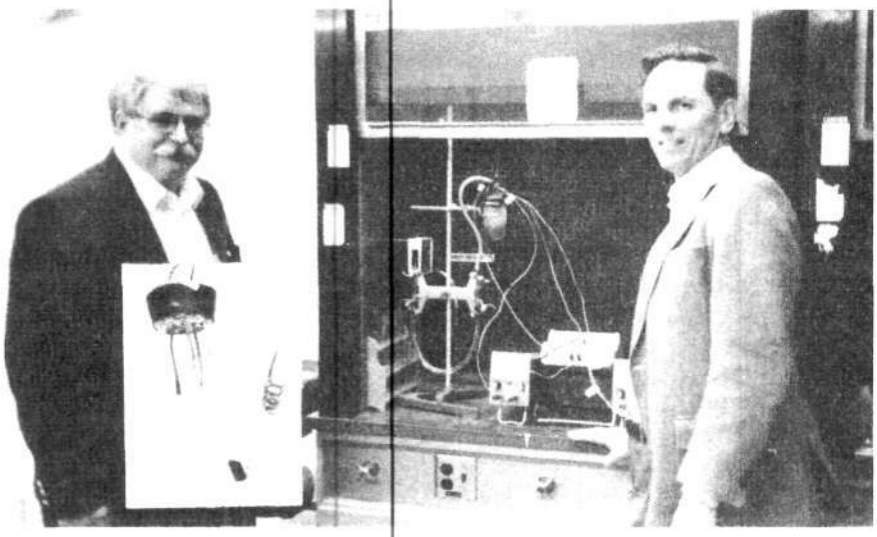
INTERVIEW WITH ROBERT T. BUSH AT CAL POLY

A Cold Fusion Model That Matches Experimental Data

21st Century correspondent Kevin L. Zondervan visited the cold fusion research program at California State Polytechnic University in Pomona in January. There Professors Robert T. Bush and Robert D. Eagleton of the Physics Department have set up a vigorous research program with a group of chemistry, engineering, and physics students. One focus of the project is to compare experimental data from the cold fusion cells with the data from the computerized model of Bush's transmission resonance cold fusion theory. Their project has funding from Southern California Edison and Wind River Resources, Inc. in Denver.

The cold fusion electrolytic cells are standard closed cells, with a platinum anode and palladium cathode immersed in heavy water or regular water (the control experiment) that is kept at a constant temperature. The electric current input and and any output are then measured and compared.

Here are excerpts from Zondervan's interview with Bush and Eagleton. The first four questions are answered by Eagleton, the rest by Bush.



K.L. Zondervan

Robert T. Bush (left) and Robert D. Eagleton pose with one of their first electrolytic cells. Inset is a closeup of the contents of a typical cell: a palladium crystal (foreground), coiled platinum anode, thermocouples, and nichrome heater wire in a plastic sleeve.

Question: How many cold fusion cells do you have?

We hope to eventually be running about 40 cells. Right now we are getting our feet wet running two cells, one with heavy water and one with regular water. We will be installing a computerized data acquisition and cell control system, but this will take some time. Until it's finished, we will be running the cells and collecting the data manually.

Question: Will the cells be run as an open or closed system?

We will run them closed. The two cells we are currently running have a recombiner which causes the evolved deuterium and oxygen gas to recombine into heavy water and remain in the cell. The recombiner is a power-type recombiner used in fuel cells. We also have a bubbler, a tube that goes from the cell to a silicon oil reservoir. When bubbles stop appearing in the silicon oil we know the recombiner is doing its job.

Question: How do you calibrate the cell and measure excess heat?

The cells are immersed in a constant temperature bath. Thermocouples and a magnetic stirrer in the cell allow us to measure the temperature in the cell and difference it with the temperature of the bath. We generate a calibration curve—showing temperature difference versus electrical power into the cell—by putting a teflon-sealed nichrome wire in the electrolyte, in addition to the usual platinum anode and palladium cathode, and then routing the input current to the cell through the nichrome heater wire. Measurements are taken at equilibrium conditions.

When the cell is run in its normal configuration with the platinum anode and palladium cathode and the gases evolved by the electrolysis are recombined, we can take the measured temperature difference, go to the calibration curve, and read off the corresponding calibration input power. If this calibration power matches the actual power to the anode and cathode, we know no excess heat is being produced.

However, if the power from the calibration curve is greater than the actual power to the cell, the difference must be due to excess heat generation.

Question: Will you be measuring quantities other than excess heat and tritium?

We will be primarily measuring excess heat and tritium. We have a tritium assay device, but we have no equipment to accurately measure neutrons. Some of the runs we will be doing will look at the effects of matched polycrystalline and single crystal electrodes. We were fortunate enough to have Los Alamos [National Laboratory] grow them for us.

The electrodes are all about 1 cm

Continued on page 62

INTERVIEW WITH NOBUYUKI INOUE

Cold Fusion Proceeding 'Calmly' in Japan

Dr. Nobuyuki Inoue is a professor in the Department of Nuclear Engineering at the University of Tokyo, where he has taught since 1971. Prior to that he was a research assistant at Nagoya University's Institute of Plasma Physics. This March 3 interview with 21st Century *was translated by Masahito Ninagawa.*

Question: What is the scope of the Institute's cold fusion research program—how many researchers are involved, how many laboratories, what different research lines are being pursued, and what is the budget for this work?

There are more than 30 research teams now conducting cold fusion experiments in Japan (excluding research laboratories of private companies). The major research lines are (1) electrolytic cells, (2) high pressure D_2 gas, (3) low energy D-D cross section measurement, and (4) discharge in D_2 gas with palladium electrodes.

The budget for low-level cold fusion energy research comes from the Ministry of Education as a research grant-in-aid. The amount is approximately $100,000. Another $100,000 is granted as a supplementary budget. Therefore, the cold fusion research in Japan is supported by a total of $200,000 in fiscal 1989.

Expenses of information exchange and conferences among cold fusion researchers who belong to universities in Japan are paid from these funds.

In addition, the Institute of Cosmic Ray Research, the University of Tokyo, and Prof. S.E. Jones of Brigham Young University in Utah are now planning to conduct a series of experiments in the underground (1,000 meters below ground) research laboratory of the Kamioka mine, where the influence of cosmic rays is very low.

Question: What have been some of the results so far in terms of excess heat, neutrons, tritium? Have there been cells that have produced both heat and tritium?

There are few researchers who are conducting experiments to detect excess heat and tritium. Most researchers are involved in experiments to measure neutrons. So far, no experiment confirms that output exceeds input energy.

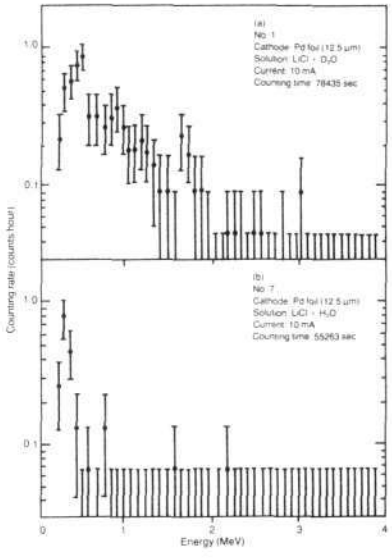
Question: Can you describe some of the results of one of the experiments now underway, and the parameters involved?

The results of an experiment conducted by Dr. Taniguchi and his collaborators at the Osaka Radiation Research Center are illustrative. The figure from this report summarizes what they have found [see figure]. This work was presented at the 1989 Fall Meeting of the Atomic Energy Society of Japan. The topic of the meeting was: "Some Problems Involved in Cold Fusion."

Question: Is there theoretical work going on to consider possible explanations of the results you are getting?

I can think of two theoretical researchers. One is Prof. Satsuo Ichimaru of the Department of Physics at the University of Tokyo. Prof. Ichimaru thinks that the occurrence of nuclear fusion reactions increases because the Coulomb repulsive force acting between two deuterons in a metal is screened by surrounding electrons and ions.

Another researcher, Dr. Tatsuoki Takeda of the Japan Atomic Research Institute, thinks that the fusion reaction occurs when some deuterons that are accelerated by electric fields in-



COLD FUSION PROTONS DETECTED AT OSAKA UNIVERSITY

There are two branches of the known D-D fusion reaction:

$$D + D \rightarrow n + {}^3He + 3.27\ MeV \quad (1)$$
$$D + D \rightarrow p + T + 4.03\ MeV. \quad (2)$$

Because the neutrons in (1) can only be detected near the limit of measurement, three researchers from Osaka University sought to detect the protons in (2). Ryoichi Taniguchi, Takao Yamamoto, and Setsuko Irie detected protons by using a palladium foil 12.5 micrometers thick, which is simultaneously the cathode and the bottom surface of the cell. Detection efficiency is more than 10 times that for detecting neutrons, and signal-to-noise ratio is about 100 times better.

Thirty-one experiments have been conducted so far, and six of them, all with heavy water, showed proton release. One experiment with heavy water is reported in (a), while (b) reports one of the controls with light water. These results were reported to the 1989 Fall Meeting of the Atomic Energy Society of Japan on "Some Problems Involved in Cold Fusion."

duced by cracks in a metal collide with other deuterons at rest.

Neither of them is arguing that cold fusion definitely occurs; rather, they are pointing out that cold fusion may be possible.

Question: Are there plans for scaling up the experiments?

With the research grant from the Minister of Education, we are now developing an excess neutron measuring device. Joint research using a high sensitivity neutron measuring device will begin soon to investigate various research methods to find out about the possibility of cold fusion reactions.

Question: What about applications of the effects found? Are there any plans to explore power uses?

In general, it is thought that the possibility of using cold fusion reactions as a power source is very low. There is a possibility of using the cold fusion reaction as a compact neutron source. However, because the amount of excess neutrons produced by the cold fusion reaction does not even reach the amount produced by radioisotopes, it is too early to confirm this possibility. Before a practical application of cold fusion is considered, it will have to be compared to a plasma neutron source.

Question: What is your view of the cynicism and hostility to cold fusion from the science establishment?

The experimental results that were obtained with great care in laboratories of world class research centers with relatively reliable equipment are often negative in terms of the possibility of cold fusion as an energy source. It shows that it is very difficult to affirm the cold fusion reaction.

At the same time, it is true that it is equally difficult to deny its possibility. Because of this, there is a possibility that the cold fusion reaction may occur below the level of the instrumental sensitivity of the excess-neutron-detecting devices now being used.

Cold fusion research must be conducted on the basis of scientific investigation. It is deplorable that there is a tendency among scientists to forget their standpoint and rush to draw conclusions from their experimental results without careful investigation.

If cold fusion is a fact, it would be a tremendously important discovery. Since cold fusion is a discovery that could not be predicted by present scientific knowledge, it will become a new branch of study. Because of that, sound research for determination of its genuineness is needed from now on.

In order to do that, it is necessary (1) to increase the reproducibility of the same experiment that demonstrates the genuineness of cold fusion, using simultaneous measurements of several different detecting devices; (2) to carry out control experiments with hydrogen instead of deuterium; (3) to clarify the relationship between frequency of the occurrence of fusion reactions and voltage of the electrolytic cell (and electric current); (4) to confirm the experimental results with other researchers duplicating the same experiment; and (5) to have demonstrations open to the public.

Continued on page 58

USDA Soil Conservation Service

Stuart Lewis

The Myth of Farm Overproduction

by Robert L. Baker

Shortages of food are already evident in our major cities and rural areas, where hundreds of thousands of families and individuals, many of them homeless, rely on soup kitchens and food banks to survive. These food banks do not have the means to meet the growing need: government food surpluses are depleted or nonexistent. Fifty million Americans exist at or below the federally established poverty level and regularly go hungry.

Secretary of Agriculture Clayton Yeutter boasts that the average American spends only 10.5 percent of disposable income on food. However, when this statistic is broken down into income groups, it is clear that 80 percent of U.S. families spend between 30 percent to 50 percent of their income for food.

National farm policy is national food policy. Despite the fact that we depend on our farmers for our daily bread, the net effect of our national farm policy has been to bankrupt them. The U.S. Department of Agriculture has maintained prices paid to the farmer below his costs of production for decades, forcing farmers to subsidize farming with nonfarm income, strip the assets of their farms, and go into debt in order to maintain their capacity to produce food. Farm service and supply companies and machinery dealers have been hit the same way.

American agriculture is being restructured. Our capacity to produce food is being cut, and centralized in the hands of powerful, monopolistic agribusiness concerns such as Iowa Beef Processors, Cargill, and ConAgra. While food shortages and hunger develop at home and millions die of famine abroad, USDA farm policy is to pay farmers to take land out of production and not to produce food. Why?

The answer lies in the policy of population reduction that has dominated international organizations like the United Nations, the World Bank, and the International Monetary Fund, as well as the financial and political circles of the U.S. Eastern Establishment that have propagandized throughout the last three administrations that the world must have fewer people. Monopoly control of a shrinking food supply is essential to this depopulation policy, and the federal government's farm policy is forcing America's farming industry to accommodate to this goal.

The meat protein industry is the sector of U.S. farm industry that is becoming cartelized at the fastest rate in terms of food processing. As for production, the American beef, pork, and lamb industries have shrunk dramatically during the 1980s. Conveniently, as meat supplies shrink, the same propagandists who say there are too many people are telling us that we should eat less meat!

Shrinking Meat Production

The total number of cattle and calves has fallen 25 percent since 1975 to 100 million head, the lowest number since 1961. During the same period, beef cow numbers dropped 24 million head (42 percent) to only 33 million by 1988 (Figure 1).

Since 1980, the breeding herd for swine fell 29 percent and for sheep, 17 percent. Also since that time, the United States has lost 266,000 cattle raisers (16 percent), 319,000 pork producers (49 percent), and 12,000 sheep producers (10 percent). According to a Feb. 1989 USDA report,[1] when all economic costs are accounted for, during the years 1985, 1986, and 1987, U.S. cow and calf producers lost an average of $197, $155, and $126, respectively, per cow.

A Jan. 1988 USDA report [2] indicates that the combined farm income and cash flow statements for domestic

There are fewer "amber waves of grain" in America today. Here, a beautiful strip-cropping pattern in Monroe, Wis. At right, cropland idled by the federal set-aside program in Virginia.

hog, beef, and sheep farms have been catastrophic over the last two years. A full 56 percent of U.S. livestock farms had a negative cash income (all cash income minus all cash expenses) as of January 1988. Even when nonfarm income was added into the figure for livestock farms, 42 percent of them still had a negative income.

At the same time that producers were going broke because of low prices, the United States became the largest importer of meat in the world. Meat imports have depressed U.S. prices even further.

From 1980 to 1988, beef and pork imports increased 41 percent and 223 percent respectively. Government officials have boasted of their ability to increase meat exports to help move the farmers' product, and boast that the largest portion of farm exports for 1988 were animal products, at 37 percent. What the USDA doesn't like to tell the public is that in 1988 beef imports were 370 percent higher than beef exports and pork imports were 600 percent higher than pork exports.

Live animal imports have also increased. Compared to 1980, live cattle imports have increased 80 percent, live hog imports by 450 percent, and feeder lamb imports by 575 percent.

Higher Prices, Less Produce

Every year, Americans consume billions of pounds of fruit and vegetables imported from hungry nations of Latin America, primarily Brazil and Mexico, which, like their neighbors are being forced to sell the food their own populations need in order to raise cash to meet the usurious debt payment demands of international bankers. As in the case of meat, these imports are often purchased at low prices, which help to keep U.S. prices depressed.

Since 1980, according to USDA trade figures, net imports of fresh fruit have increased more than 100 percent and net imports of fresh vegetables have increased 281 percent. Over the course of the decade, prices to the consumer for these products have gone up 62 percent.

Even though the United States is a large exporter of apples, many domestic producers are being driven out of business by prices below the cost of production. In Washington, the largest apple-producing state in the country, up to 15 percent of growers are facing bankruptcy; they receive $8 per box for apples that cost $9 dollars per box to produce. The USDA claims the problem in the industry is "overproduction," when in fact it is underconsumption: Americans consume only half as many apples per capita as do Europeans.

Fruit and vegetable producers are under assault by an environmentalist campaign to ban most production-enhancing farm chemicals, the result of which will be less and poorer quality produce that costs more. The elimination of chemical fungicides, for example, will "reduce the annual supply of domestically produced fruits, vegetables, and peanuts by about 24 percent," according to an October 1989 report by the National Agricultural Chemicals Association.[3] The cost of peanut butter, now a relatively inexpensive source of vegetable protein, would go up 68 percent, if chemical fungicides were eliminated.

Dairy Herd Termination

Milk powder is one of the most easily transported protein sources and has been an essential part of U.S. food aid to hungry nations for decades. But in the mid-1980s, the United States stopped contributing milk powder to the U.N. World Food Program. Millions of people in Third World nations are now getting no milk powder and have no milk at all for their children.

Since 1980, dairy herd numbers have fallen 700,000 head, while an additional 1.5 million dairy cattle were slaughtered during USDA's Dairy Herd Termination Program in the mid-1980s. The number of dairy producers has been reduced by 29 percent or 89,000, since 1980 (Figure 2).

The effects of the termination program showed up dramatically in the last half of the decade. Government fluid milk and nonfat dry milk powder stocks were reduced to zero and government supplies of cheese fell 68 percent.

Millions of children can no longer rely on government-donated cheese for their school lunch programs. The USDA was forced to postpone milk powder exports to Mexico in December and had to repurchase 17 million pounds of dry milk powder exports from West Germany, to stave off chaos in American markets resulting from a "surprise" milk shortage.

Many dairy farmers who are still in business may not be so for very long.

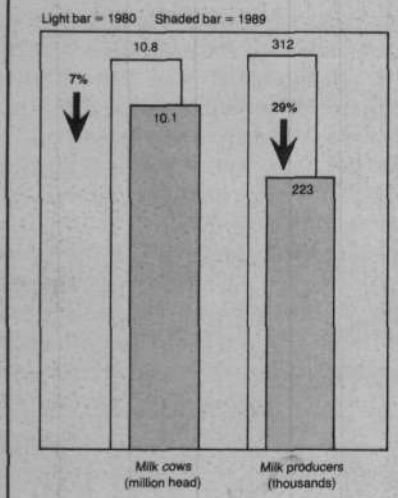


Figure 1
DECLINE IN U.S. DAIRY HERD AND DAIRY PRODUCERS (1980-1989)
A combination of deliberate political policies is destroying U.S. food production.

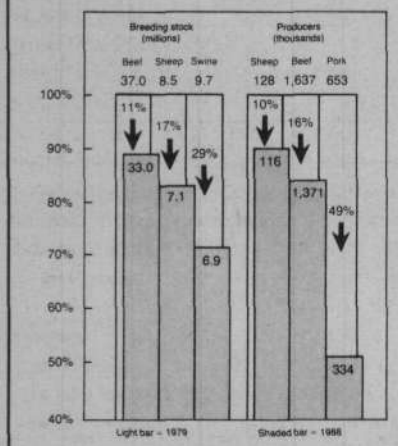


Figure 2
DECLINE IN U.S. BREEDING STOCK AND PRODUCERS (1979-1988)

According to the October 1989 USDA *Dairy Situation and Outlook Report*, the number of dairy farms with negative family income rose from 37 percent in 1987 to 41 percent in 1988. This includes all dairy income earned by farmers, and even the money earned from off-farm employment of the farmer or his family.

Grain Production Drastically Reduced

Although the United States remains the world's largest producer and exporter of grain, U.S. grain production has been drastically reduced, and this accounts for most of the 88 million acres of cropland taken out of production between 1978 and 1979 (Figures 3 and 4). Implemented to reduce so-called surpluses, land set-aside programs have destroyed a major part of the agroindustry infrastructure by eliminating the need for hundreds of thousands of local farm supply stores and service businesses.

The net effect of reduced commodity support prices and higher dollar foreign exchange rates during the mid-1980s was to force commodity prices lower and grain inventories higher. Now, U.S. wheat stocks are 75 percent lower than in 1985-1986, and coarse grain stocks have fallen 52 percent compared to 1988. During 1989, per capita soybean stocks fell to one of the lowest levels in history (Figure 3). The United States is the world's largest importer of oats and is currently importing 15 percent of the durum wheat it consumes.

Overall, the number of U.S. farms has fallen 65 percent since 1950 and 333,000 farmers have gone out of business since 1980. For the first time since President Lincoln's great land settlement of the Midwest, the total acreage of American farmland has dropped below 1 billion acres to 998 million.

Robert Baker, who has been both a farmer and a banker in Iowa, works with the Food for Peace program of the Schiller Institute.

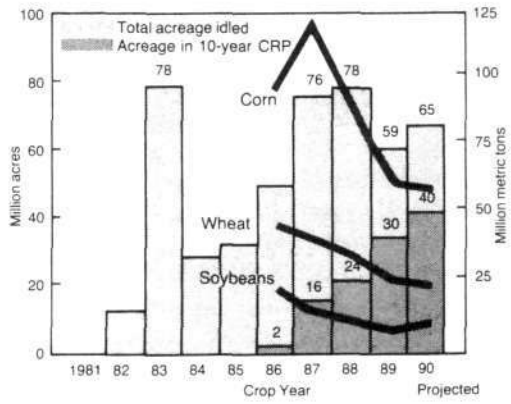
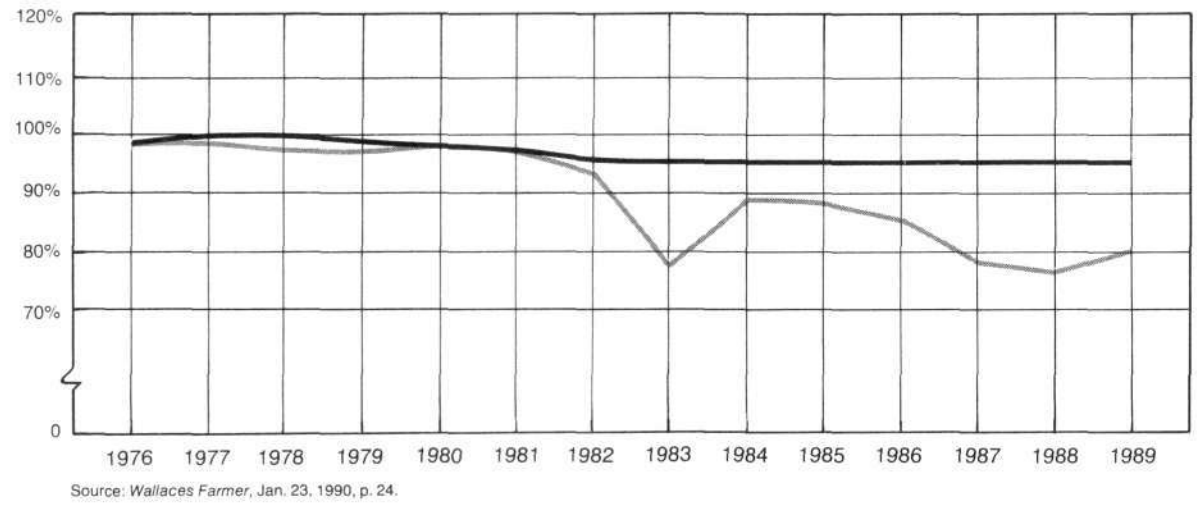


Figure 3
ACREAGE SET ASIDE (1981-1990) AND YEAR-END GRAIN STOCKS (1986-1990)

Tens of millions of acres have been idled with federal government incentives. The decline in year-end stocks of corn, wheat, and soybeans is shown from 1986 in millions of metric tons (at right). CRP is the Conservation Reserve Program.

References

1. "Economic Indicators of the Farm Sector—Cost of Production, 1987" (USDA, Feb. 1989).
2. "Financial Characteristics of U.S. Farms, January 1, 1988" (USDA, Oct. 1988).
3. "The Value of Fungicides to the Availability of a Healthy and Affordable Food Supply" (National Agricultural Chemicals Association, Oct. 1989).



Source: *Wallaces Farmer*, Jan. 23, 1990, p. 24.

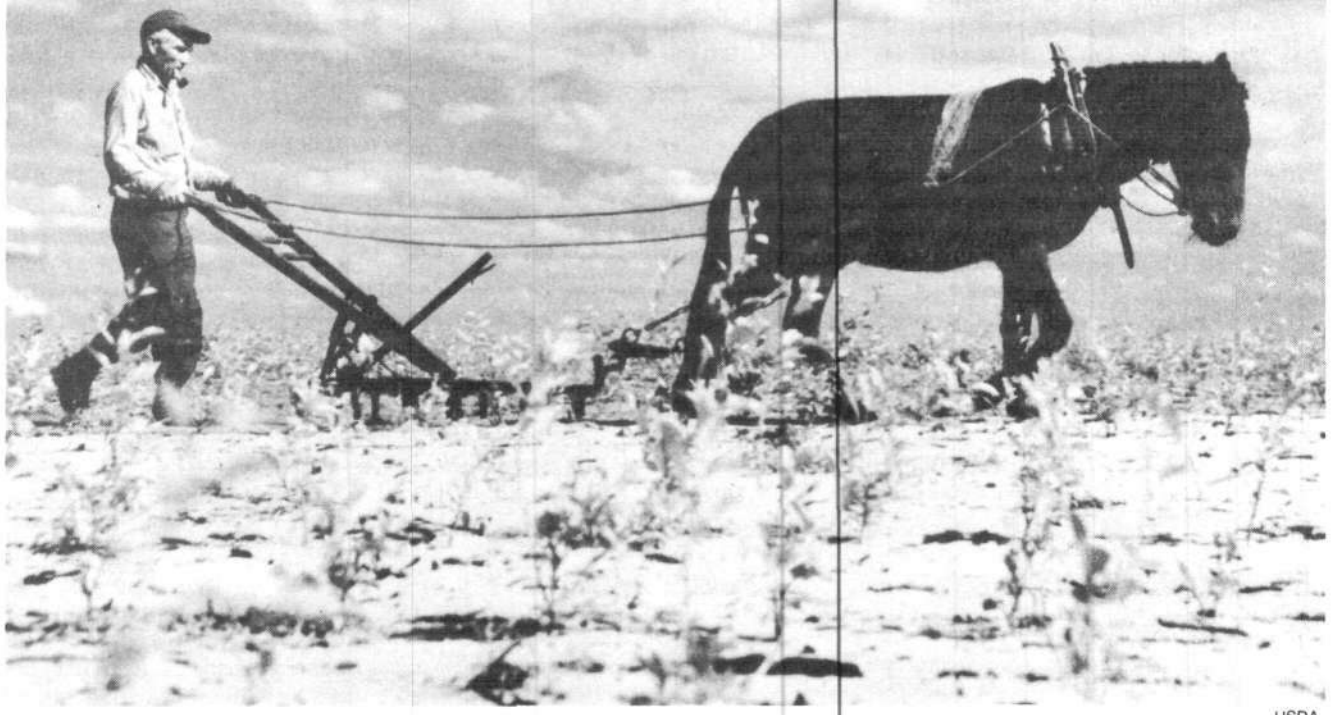
Figure 4
U.S. CROPLAND SHRINKS AS SET-ASIDE GROWS (1976-1989)

As U.S. cropland shrinks, set-aside takes an ever larger bite out of what remains. The combined effect is shown here. In 1989, only 81 percent of 1978 total cropland was still cropland and not in the set aside category.

Total cropland peaked at 471 million acres in 1978, a figure taken here as 100 percent. The upper line shows total cropland as a percentage of 471 million acres. The lower line shows total cropland minus set-aside cropland, as a percentage of 471 million acres.

The U.S. Department of Agriculture Turns Green

by Marcia Merry



USDA

The original U.S. Department of Agriculture caption noted the "drudgery and inefficiency" of outmoded technology. That was in 1962, before the USDA turned green.

The U.S. Department of Agriculture has turned green. When the Department of Agriculture was founded in 1862 by President Abraham Lincoln, its mission was to encourage the production of good and plentiful food based on scientific methods. Lincoln said that "the general designs and duties [of the Department] shall be to acquire and diffuse among the people of the United States useful information on subjects connected with agriculture in the most general and comprehensive sense of that word. . . ." (May 15, 1862). Lincoln himself projected that the U.S. population should grow to 250 million by 1930.

During World War II, U.S. agriculture was heroic—doubling, tripling, and quadrupling food output when needed. Today if you go to the Agriculture Department in Washington, D.C., you don't get scientific brochures, you get cult material. The USDA brochures are titled "Earth Team" and "Low-Input Sustainable Agriculture." The question to ask is, "sustainable" for whom?

What today's USDA intends is lower inputs per acre in farming, less energy per acre, less mechanization, and so forth. As a substitute for the mission of U.S. farming to feed the world, today's farms are told to concentrate on quality. The lower inputs are to be "quality" inputs, more "spiritual," more "natural," good for the environment, good for the birds and the swamp things. Farmers are supposed to love this, because they are supposed to lower costs by not buying equipment, fuel, fertilizer, and new technologies. They are supposed to put in more sweat labor, which the USDA then calls an improvement in the "quality of life" and the farm environment.

Under this perspective, there will be less food produced per acre. The rationalization for this is that there may be less food, but it will be "quality" food. "Pure . . . safe . . . natural . . . chemical free . . . organic. . . ."

The result of all this is obvious. There are going to be fewer people. Again, the argument is that these will be "quality" people—white, elite, select.

Don't be shocked: For 20 years, the USDA has been imposing policies to bankrupt farmers, cut food supplies,

and serve the interests of Cargill, Archer Daniels Midland, and the other food cartel companies in their drive to control the U.S. food supply. The cartels are not interested in maximum production for maximum profit; their game is maximum control. The USDA hasn't changed its spots overnight.

You may not hear a call for outright starvation and genocide in so many words, but that is the policy—genocide in Africa, Mexico and points south, and in the cities of America.

Fascism in Green Dress

Alternative Agriculture, the new bible of the USDA, shows how environmentalism is really just fascism in modern dress, what might be called "green fascism." This book was written by the National Research Council of the National Academy of Sciences, but as science the book is a bad joke. It is just a compendium of how to fool the public. On Sept. 7, 1989, the book was endorsed by the Agriculture Department's director of science and education, Dr. Charles Hess.

Alternative Agriculture says that farmers should switch from so-called conventional to "alternative" agriculture. By this, the book merely means that farmers should not have the income and circumstances to choose freely what techniques they prefer of tilling, animal husbandry, harvesting, shipping, fertilizing, and so forth. Farmers should use only the low-cost, low-tech methods that the self-styled experts say are good for the environment.

Farmers who fall for a policy designed to feed fewer people—millions fewer people—are being taken for fools; such low-tech policies won't keep them in farming for very long.

During October 1989, three new food safety bills were introduced in Congress by sponsors who don't care about food or about worldwide hunger and starvation; they are following the green fascist propaganda about food purity—and the green votes that go along with it.

The backers of this propaganda should be a dead giveaway as to the real intent of the policy. *Alternative Agriculture* was funded by the Rockefeller Brothers Fund, the Andrew Mellon Foundation, the Kellogg Foundation, and others. These funders represent interests that want any kind of public austerity that will help save as much as possible of their own financial empires. Population reduction was traditionally on their agenda.

Another backer of this poison-green propaganda is the Rodale Institute. Founded in the 1940s, Rodale is part of the anthroposophic cult network connected to the mystic Rudolph Steiner. Steiner once published a magazine called *Lucifer* and referred to his friends as "white magicians." Steiner's student, Ehrenfeld Pfeiffer, wrote an article for the first issue of the Rodale magazine *Organic Farming and Gardening* in 1942 that called for a "new peasantry," with no more mechanization and chemicals. "Scientific agriculture," he said, is unwholesome.

In 1967, J.I. Rodale wrote in an editorial, "Man has an inflated idea of himself. . . . Human beings are simply finding it hard to escape their own filth," and called for an end to advanced technology in farming.

These are just a few cases of agencies that have set in motion the policies and propaganda now killing people.

How Environmentalism Kills

How does environmentalism kill? First, there is the Conservation Reserve Program—brainchild of the Conservation Foundation—to take farmland out of food production, supposedly to save soils.* It started in 1985 and today there are close to 40 million acres locked up. Since a farmer here in the United States can produce grain on one acre for at least 2.5 people, this means grain for 100 million people is not being produced. As a result, millions are not getting their daily bread.

As for milk production, the alternative agriculture people tell you that too many cows contaminate the groundwater with their manure. They also say that cheese is bad for school children because of its fat content. One good milk cow produces enough milk for 9,000 half-pint servings a year—enough to give 26 children their daily milk. But the Department of Agriculture's Dairy Herd Termination Program has eliminated 1.5 million cows. That was milk for 37 million children. Where will they now get their milk?

The attack on Alar has done the same thing to apple production. One productive apple tree yields 500 apples a year, enough for 1.5 children to get an apple a day. But the elimination of Alar and sprays on apples is bankrupting growers and ruining orchards and trees.

A 40-pound child would have to eat 1,000 apples a day for a lifetime—26 million apples—to ingest the amount of Alar (daminozide) that produced tumors in laboratory rats! Now, thanks to a scare premised on a child eating 1,000 apples a day, thousands of children won't get any fruit any day. The impact of the Alar scare in 1989 is to deprive more than 700,000 people of their apple a day.

The green fascists say that insecticides pollute. In 1972, Environmental Protection Agency administrator William Ruckelshaus banned DDT, which controls malaria-bearing mosquitos. In 1974, Russell Train banned dieldrin, which controls locusts and grasshoppers. It is estimated that *100 million people die each year* because of the elimination of these and other needed chemicals.

The Department of Agriculture knows that. The World Wildlife Fund and its leader, Britain's Prince Philip, know that. They have the facts and figures, but the policy at the top is a Malthusian one where genocide—by disease and starvation—is an acceptable way of culling the world's population.

Marcia Merry is the agriculture editor for the weekly Executive Intelligence Review. *This article is adapted from her address to the Chicago Food for Peace Conference, Nov. 4, 1989, sponsored by the Schiller Institute.*

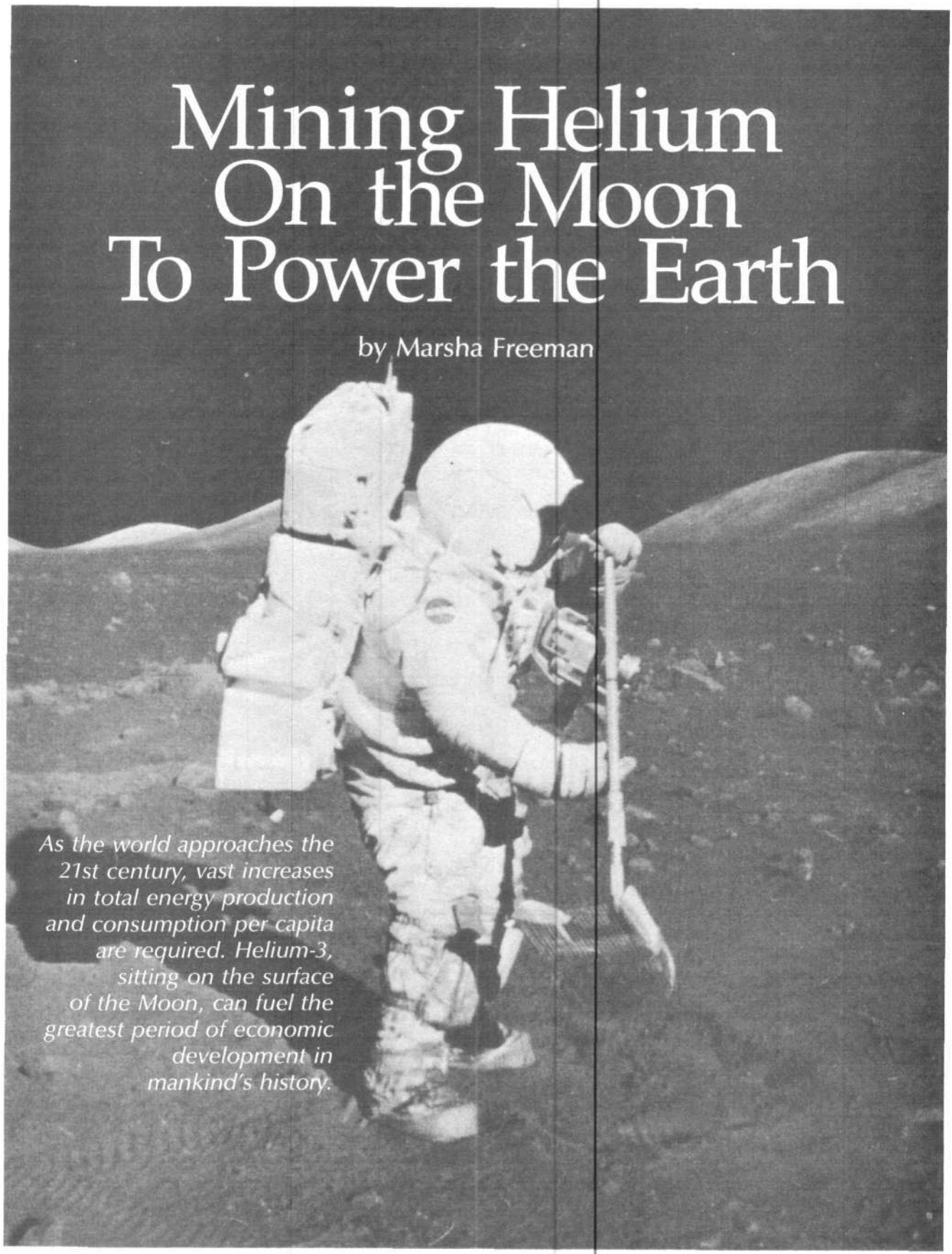
Note

* The Conservation Foundation was founded in Washington, D.C., in 1948 as a replacement for the prewar eugenics movement that got a bad name for advocating eugenics, master race breeding. The first director of the Conservation Foundation was Henry Fairfield Osborne, the nephew of one Fairfield Osborne who, along with the Averell Harriman family, hosted the 1932 International Eugenics Conference in New York City. Nazi "race experts" attended that conference to discuss how to purify races by eliminating "undesirables."

For the last 41 years, the Conservation Foundation has carried on its work of selective population reduction under the cover story of protecting the environment. William K. Reilly, administrator of the Environmental Protection Agency, was formerly head of the Conservation Foundation.

Mining Helium On the Moon To Power the Earth

by Marsha Freeman



As the world approaches the 21st century, vast increases in total energy production and consumption per capita are required. Helium-3, sitting on the surface of the Moon, can fuel the greatest period of economic development in mankind's history.

NASA

The opening of the second era of manned exploration of the solar system was placed on the national agenda July 20, 1989, in President Bush's speech celebrating the 20th anniversary of man's first landing on the Moon. Now under active consideration here and in Japan are many ideas of how to return to the Moon and what to do once we get there. One of the most important proposals is to place men on the Moon along with robotic systems and equipment to mine an Earth-rare isotope of the element helium, helium-3, for use as fuel in fusion reactors.

Helium-3, which the solar wind has deposited on the lunar soil over millennia, does not collect on our planet because of the Earth's atmosphere. This lunar resource can be separated from the lunar soil, placed into tanks, and shipped back to Earth. If the first fusion plant on Earth fueled with helium-3 came on line in the year 2015, demand for the fuel to meet U.S. energy needs alone would be 1 ton per year by 2030 and grow to 200 tons per year by 2050, even given a very conservative projection of a 2 percent per year electricity growth rate (Figure 1). International development of this precious lunar resource could assure the worldwide availability of the next century's fuel supply.

Helium-3 can be the fuel for the fusion power plants that will provide this world—and the worlds we will create on other heavenly bodies—with all the electric power and radiative energy needed for the foreseeable future. It will be the "enabling technology" to colonize space.

A report completed by the Lunar Energy Enterprise Case Study Task Force and published by the National Aeronautics and Space Administration (NASA) in July 1989 boldly states, "The Moon must play a role in long-term terrestrial electricity supply matters"—not that it *can*, but that it *must*. Twenty years ago, space visionary Krafft Ehricke stated that the Moon should become the "seventh continent" of the Earth, to supply the future raw materials and manufacturing capabilities for an open, growing world.

The Advantage of Fusion

It is impossible to accurately forecast what long-term energy requirements will be, even just for the United States, because they are dependent upon overall economic policy. For the past 15 years, the United States has been cannibalizing its basic infrastructure at an increasing rate, as it shuts down industry and agriculture. Because of this economic shrinkage, the falling energy growth rate experienced since the early 1970s has not yet appeared to bring us to the edge of disaster.

Even with a continued pitiful 2 or 3 percent per year rate of growth, this nation will likely be 100 gigawatts short of electric generating capacity before the turn of the century, and under the rubric of "saving the environment," plans are afoot to ensure that there will be *even less* energy available in the future than there is today.

The Apollo astronauts had varying degrees of success with their primitive lunar mining tools. Lunar industrialization will require automated robotic equipment to produce tons of precious helium-3 fusion fuel. Here astronaut Harrison Schmitt rakes up rock samples during the Apollo 17 mission.

Were the United States to return to the technological and cultural optimism and progrowth policies of the 1960s, when a 7 percent per year increase in electricity production supported the greatest peace-time expansion of productive economic activity in history, lack of energy would immediately be a bottleneck. Today, if we had that 1960s rate of growth (when the electrical grid had a doubling time of 10 years) the U.S. 650-gigawatt electrical grid system would replicate itself by the year 2000. This means we would build more than 600 new nuclear power plants in the next 10 years—and this would be only the minimum necessary to get the United States headed in a positive direction.

For the rest of the world, the current energy deficit is much greater. Today in the United States, per capita electricity consumption is approximately 10,000 kilowatt-hours per year. In many developing nations of the world, per capita consumption is more than two orders of magnitude less. Just to rescue Eastern Europe from economic catastrophe will require more than 100 gigawatts of new capacity needed immediately, as soon as it can be put on line.

Over the next two decades, a vast expansion of nuclear power will be needed to prevent a *devolution* of the Earth's people and the biosphere, and to start the reconstruction required to repair the damage caused by 20 years of economic contraction in the United States and mismanagement and looting by the Soviet Union. In fact, a vast expansion—on the order of hundreds of gigawatts—will simply hold the line here on Earth.

If we are to move out and colonize the solar system, we will require orders of magnitude increases in energy per capita to increase relative potential population density on Earth and beyond. This will require not just an absolute rise in per capita energy consumption, but an increase in the *rate of increase*, the second derivative of the energy growth function.

To make the leap from this century to the next, therefore, a linear extension of today's technology will not suffice.

A Nonlinear Leap Forward

Nuclear fission is a reaction that produces energy at a higher density and efficiency than burning fossil fuels, but does not fundamentally change the relationship of energy to production, which is what is now required. Since the development of the heat-powered machine, basic industry has depended upon energy for operation mainly in the form of heat, steam, and, more recently, electricity.

Fusion, the nuclear process that produces the array of energies from the Sun and all the stars, creates both a quantity and "quality" of energy never before available to mankind. Depending upon the combination of light elements and isotopes used as fuel in the reactions, fusion produces electrically charged particles, coherent electromagnetic energy from microwaves to X-rays, and extremely high tem-

perature reaction products that can be directly applied to materials processing, manufacturing, and even space propulsion, as well as electricity production.

To colonize space, entirely new industries based on the application of lasers and other forms of directed energy will be necessary. On the Moon, materials processing will not be done using huge amounts of water and chemicals, nor with scores of people. Coherent radiation to replace metal-working machine tools, for example, would create an order of magnitude increase in machine tool productivity and be highly automated. Per capita electricity consumption will skyrocket as basic industrial processing moves from the "metal-on-metal" to the "applied energy" age. Therefore, a linear increase in nuclear fission capacity will not be adequate.

The fusing of the deuterium (D) and tritium (T) isotopes of hydrogen has been the preferred approach internationally in fusion research for many years. Scientists pursued this path after calculating that it would be the easiest fusion reaction to achieve. Other, more advanced fusion fuel combinations require higher temperatures and higher magnetic fields. However, although the physics requirements may appear more difficult, the deuterium-helium-3 reaction provides advantages that may in the end make the engineering, and therefore commercialization, easier.

Instead of the uncharged high-energy neutrons produced from D-T fusion, D-He-3 fusion reactions can produce more than 90 percent and perhaps up to 99 percent of their energy in the form of charged particles, depending upon the ratio of helium-3 to deuterium in the fuel (Figure 2).

The release of neutrons in fission and in D-T fusion reactions makes the reactor materials themselves radioactive over the life of the plant. This requires that the components be isolated when the plant is decommissioned, which will not be necessary with D-He-3 fusion. Although the radioac-

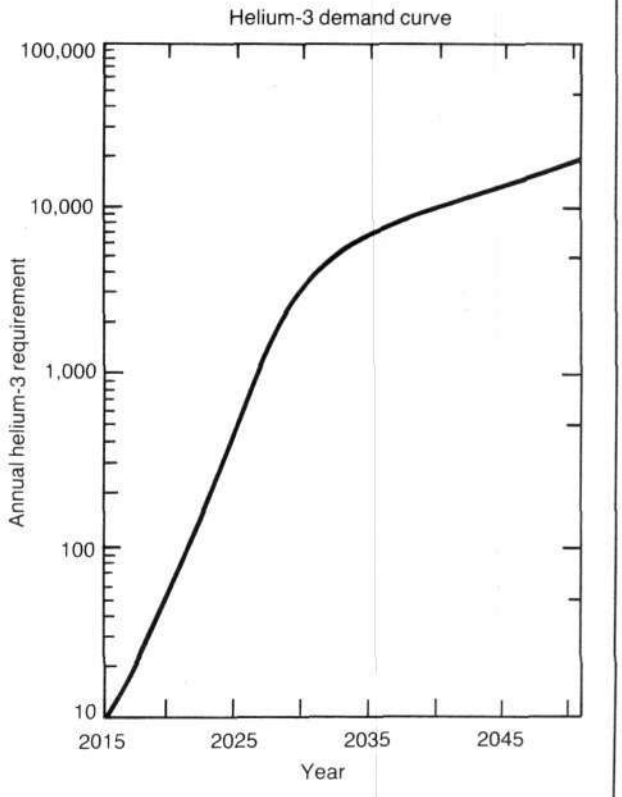


Figure 1
HOW MUCH HELIUM-3 WILL THE UNITED STATES NEED?

This projected demand rate for helium-3 in the United States starting in the year 2015 assumes a very modest energy growth rate of 2 percent per year and a conservative estimate of the number of fusion power plants in the total energy-production mix. The annual requirements are measured in kilograms, and 1 kilogram of helium-3 generates 10 megawatt-years of power.

Source: NASA Lunar Helium-3 Fusion Power Workshop, April 1988

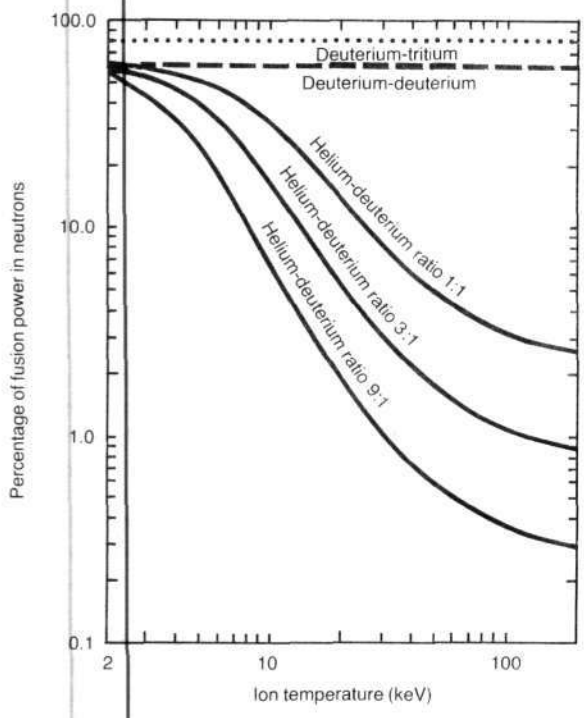


Figure 2
NEUTRON OUTPUT USING HELIUM-3 AND DEUTERIUM FUSION FUEL

A major advantage of burning deuterium and helium-3 as fusion fuel is the reduction of the percentage of fusion energy in the form of neutrons. Three helium-3 and deuterium fuel mixtures are compared to deuterium-tritium and deuterium-deuterium (at 50% tritium burnup). Using a fuel with a 9:1 ratio of helium-3 to deuterium results in a small neutron flux, thus allowing for simple plant design and the direct conversion of the fusion energy to electricity and coherent energy.

Source: NASA Lunar Helium-3 Fusion Power Workshop, April 1988.

tivity of tritium is not comparable to plutonium or uranium in toxicity, D-T fusion reactors will have to be maintained and fueled using remote handling equipment, which will not be necessary with the advanced fuels. Nor will it be necessary to use nuclear-grade steel and other materials to build D-He-3 fusion plants.

Producing fusion using the D-He-3 reaction may require plasma fuel temperatures three to five times higher than those already achieved in current fusion tokamak experiments (now about 100 million degrees), because of the lower reactivity of the plasma. It has been suggested, however, that spin-polarizing the fuel may increase its reactivity.

In order to contain the plasma fuel at higher temperatures than D-T fusion, the external magnetic fields used in the tokamak and other magnetic confinement fusion devices would have to be increased from the 10 to 12 tesla projected as necessary for D-T fusion reactors to perhaps 16 tesla. (A tesla is 10,000 gauss, and .5 gauss is the magnetic field strength of the Earth.) One alternative to increasing the magnetic field strength is to increase the volume of the reactor to 50 times the size needed for D-T fusion, which is clearly impractical.

The Helium-3 Advantage

Because neutrons cannot be directed by magnetic or electromagnetic focusing, useful energy is extracted in the form of heat in fission and D-T fusion when the uncharged particles are slowed down by absorption. However, direct-conversion technologies like magnetohydrodynamics (MHD) allow the flow of charged particles to generate electricity directly, instead of relying on inefficient thermal processes to turn rotating machinery. With D-He-3 fusion, the charged particle plasma products can be used directly without intermediate equipment.

A further advantage is that the radiative energy from the D-He-3 reaction can be "tuned" to optimize the wavelength of radiation produced. Depending upon the temperature at which the fusion reaction takes place, the synchrotron radiation, produced when electrons change speed or direction, can be at various wavelengths. It has been estimated that more than half of the energy produced could be in the form of microwaves at about 2,500 gigahertz (GHz), a 0.1 millimeter wavelength. The microwaves themselves could be used directly to transport energy over long distances through the vacuum of space or on the Moon.

The microwave energy can also be efficiently converted directly to electricity through the use of rectifying antennas called *rectennas*. Waveguides inside the reactor would direct the microwaves out of the fusion device, which could have a toroidal geometry, similar to the tokamak family of experiments being carried out in laboratories around the world today.

The technology for converting microwaves to electrical current has been under development for many years. Studies, as well as some experimental research, have been carried out to beam microwaves from the ground to rectennas aboard aircraft, for example (Figure 3). The rectennas provide electrical power to an onboard electric motor and therefore the plane does not have to carry any fuel. The government of Canada is continuing development of rectenna technology through its Stationary High Altitude Relay Platform program.

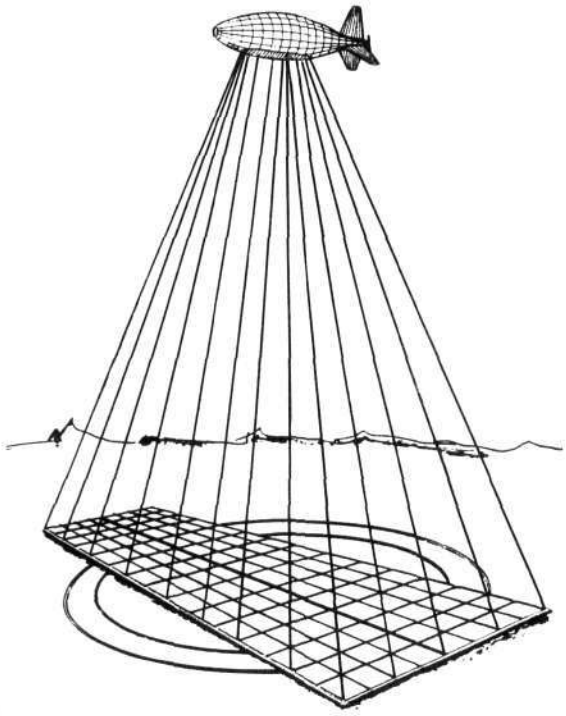


Figure 3
MICROWAVE-POWERED AIRCRAFT: A DEMONSTRATED DESIGN

The technology to convert microwaves to electricity via the use of rectennas has been demonstrated by the Canadian government. The Canadians beamed microwaves to an aircraft and rectennas converted the beams to onboard power. The design shown here is for a maneuverable microwave-powered aerostat that would not have to carry fuel.

Source: Second Beamed Space-Power Workshop, NASA, February 1989

The technology for converting 2.45-GHz microwaves to electricity has already been developed. At the Second Beamed Space-Power Workshop sponsored by NASA in spring 1989, William C. Brown described the history and current status of beamed power technology and applications. He reported that the demonstrated efficiency of conversion is about 85 percent, with a power density of 500 watts per square meter. In order to convert fusion microwaves to electricity, rectenna technology will be needed that can handle microwave radiation at 2,500 GHz, three orders of magnitude higher than currently developed.

Other fusion power plant configurations could make use of alternative direct energy conversion technologies. Various linear rather than circular designs permit the easier extraction of the charged particle fusion product. One such design, a Reversed Field Configuration, is shown in Figure 4. This kind of configuration can maintain a high beta, or plasma pressure, with lower magnetic fields than those re-

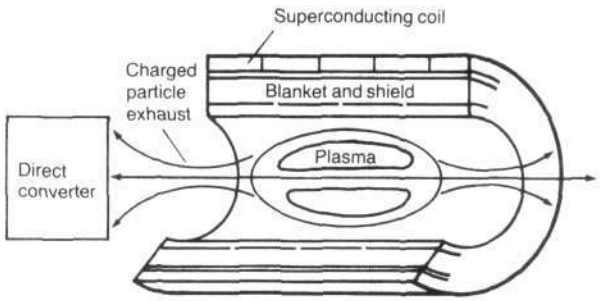


Figure 4
REACTOR CORE WITH REVERSED FIELD CONFIGURATION

The reversed field configuration geometry for fusion power plants is a linear device that can produce very high fusion power densities at modest magnetic field strength. Although its physics is not as well understood as that of tokamaks, it is an excellent candidate for D-He-3 fusion plants in the future.

Source: Report of NASA Lunar Energy Enterprise Case Study Task Force. July 1989

quired in a toroidal design, and the main products will be charged particles, not synchrotron radiation. The magnetic mirror and other linear or "open" devices would have a similar advantage.

The charged particles produce electricity by being passed as an electrically conducting fluid through a magnetic field, as in MHD. Electrostatic conversion, where electricity is produced by the separation and deceleration of the charged particles, can also be used and is a demonstrated technology. It is the reverse of an electrostatic accelerator, which increases the speed and energy of particles through the use of a high voltage potential maintained electrically.

Last year 100 kilowatts of fusion power were produced in the Joint European Torus (JET) in England using deuterium and helium-3 as fuel. The aim of the experiment was not to prove the feasibility of D-He-3 fusion, but to study the physics of fusion without the problem of producing radiation. However, the result was that the greatest amount of energy from fusion that has ever been produced on Earth has been from the D-He-3 reaction.

The Helium on the Moon

In 1970, R.O. Pepin discovered from samples returned by the Apollo astronauts that there is helium-3 on and close to the surface of the Moon. Estimates are that over the past 4 billion years, about 250 million tons of helium-3 have bombarded the Moon and that about 1 million tons are trapped on and near the surface. The Sea of Tranquillity, where the Apollo 11 astronauts landed, is alone estimated to contain 8,000 tons of helium-3, to a depth of about 2 meters.

The deposition of helium-3 on the Moon appears to vary between 0 and 300 parts per million (ppm), with an average of about 40 ppm. As the incident total helium flux at the lunar surface from the solar wind is about 8 grams per second and the isotope He-3 is only 1 one-thousandth the total, this tiny renewal rate means that the resource available for economic exploitation is what has already collected there over billions of years.

Marsha Freeman

The only proven technology for mining on the Moon is demonstrated here by Wallace Roepke from the Bureau of Mines at a 1986 conference on space technologies. The Bureau of Mines is working closely with NASA on the technologies needed for 21st century lunar development.

How will we find the helium on the Moon? The helium-3 appears to be located in higher concentration in places rich in titanium oxide. Although the He-3 cannot be detected through an electromagnetic scan using remote sensing, the titanium *can* be located that way. Such techniques will be used to locate the lunar regions most worth mining. According to Eugene Cameron at the University of Wisconsin, gamma-ray spectroscopy was used on the Apollo 15 and 16 orbiters to help locate resources, and Earth-based telescope measurements of lunar reflectance have been used as well. Both have insufficient resolution for detailed mapping, however, and newer remote sensing technologies under development for both Earth and planetary applications should be employed on future unmanned lunar orbiters.

The notion of "high concentrations" here is relative, however. Nowhere on the Moon is there a "vein" of helium-3 to mine. For this reason, "pick and shovel" mining techniques will not be appropriate. Massive amounts of lunar soil will have to be processed to recover the helium-3.

Extraterrestrial Mining Technologies

At a conference on lunar development in 1986, Bureau of Mines specialist Wallace Roepke demonstrated the only proven technology to date for mining on the Moon (see

photo). The Bureau of Mines of the Department of the Interior has cooperated with NASA on the development of lunar surface operations from the beginning of the Apollo program.

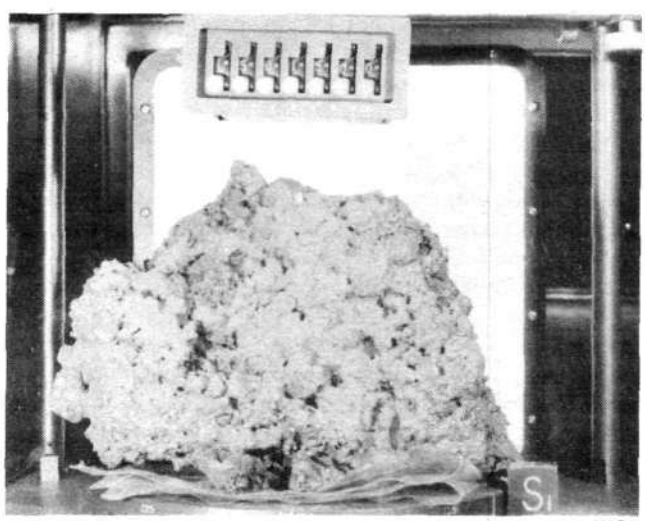
A Working Group on Extraterrestrial Resources was established in 1962, which included the participation of the Bureau of Mines, the U.S. Army Corps of Engineers, the U.S. Geological Survey, the U.S Air Force and Navy, and industry and academia. Even at that time, the space agency had the goal of "developing techniques for reducing dependence of lunar and planetary exploration on terrestrial supplies." It was assumed that the new Apollo project would lead to the establishment of manned bases on the Moon. Over the next six years, comprehensive studies were carried out on simulated lunar soil, based on the chemical analysis done by the unmanned Surveyor V spacecraft. Scientists were particularly interested in the physical and chemical properties of lunar soil, including elastic, strength, thermal, electrical, magnetic, and explosive shock properties.

By 1968, at the sixth annual meeting of the Extraterrestrial Resources working group, the first manned landing on the Moon was less than a year away. Bureau of Mines specialists had determined the major activities that would have to be supported for lunar bases to be self-sufficient: The lunar surface would be used "in virgin form for such purposes as shielding or insulation, in modifying surface materials for use in construction or other applications, and in extracting from lunar-surface or near-surface materials such products as water, oxygen, or other useful constituents."

Scientists and engineers recognized that the lunar conditions of high vacuum, extreme heat and cold, two weeks of day and of night, and only one-sixth Earth gravity, would require the development of new mining technologies. Because it would be necessary to bring capital equipment and start-up supplies from Earth, the weight and size of the technology would be constrained, in order to make the logistics manageable and economical. But the experts could not imagine how different the lunar surface would really be from the Earth until the Apollo astronauts arrived there.

By 1985, four years before the Bush announcement that indeed, the United States plans to go back to the Moon, a small group of scientists at NASA's Johnson Space Center were already actively organizing to reestablish the multidisciplinary working groups that the next phase of lunar development would depend upon. At the end of 1985, the Bureau of Mines and Johnson Space Center signed an Interagency Agreement "for cooperative programs in space exploration and establishing permanent lunar bases." At a conference on Lunar Bases organized by the center's lunar and planetary scientists that year, Bureau of Mines scientists Wallace Roepke and Egons Podnieks reported on the findings of the Apollo astronauts in the previous decade.

What the astronauts had discovered was that the lunar soil was less like a fine powder and more like wet sand, and that it had greater adhesion to surfaces, and much greater friction than Earth soil. This made surface operations more



NASA

A mug shot of Apollo 15 lunar sample No. 15015 in a nitrogen processing line of the Manned Spacecraft Center's Lunar Receiving Laboratory. The sample weighs 4,515 grams and is glass covered breccia.

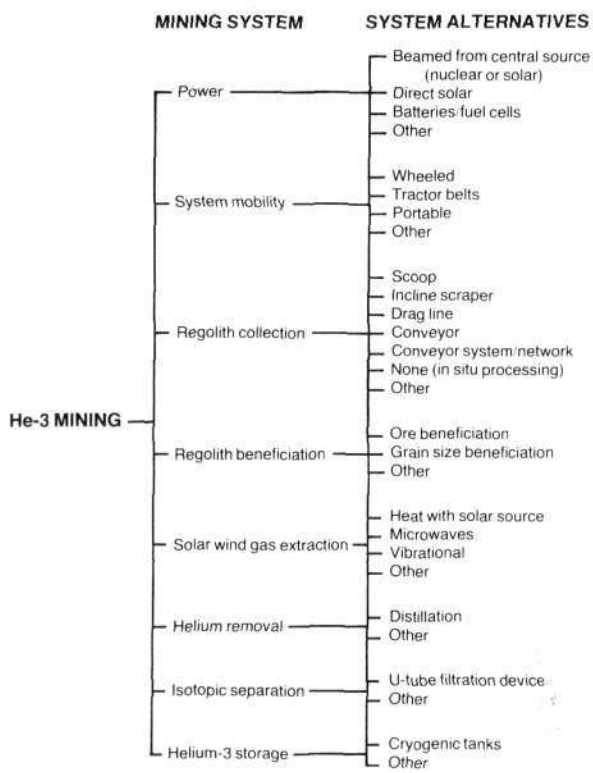


Figure 5

ALTERNATIVES FOR HELIUM-3 MINING SYSTEMS

A variety of technology options are available for each phase of the lunar mining of helium-3. For example, power for the lunar miner can be portable or centralized, as can the processing. All these options will be studied to determine the advantages and disadvantages of each.

Source: NASA Lunar Helium-3 Fusion Power Workshop, April 1988

difficult than anticipated. On Apollo 15, the crew had great difficulty drilling for their core samples. The drill never worked as easily as expected and was not fully successful. No deep core samples were obtained and the effort almost had to be abandoned.

As experts sifted through the Apollo data, they found that the "sticky" lunar surface dust caused a number of problems. It increased the slippage between surfaces, increasing potential hazards for the astronauts. Lunar equipment conveyor pulleys tended to bind together from the dust, and on Apollo 14 it was difficult for the astronauts to remove a nut from a bolt because the threads were covered with fine dust. The dust covered cables on the ground and then the crew tripped over the cables, which had become hidden from view.

NASA scientists wrote in 1988: "[T]he Apollo mission determined that the lunar environment is drastically different from terrestrial conditions. By a careful study of the mission data, it can be seen that significant problems will arise if one applies terrestrial thinking in developing plans for engineering operations on the lunar surface." Picks and shovels will certainly not be appropriate technology for lunar mining, but apparently, neither will the best we have developed for mining on Earth.

In a paper presented at a conference in Atlantic City in 1986, Wallace Roepke from the Bureau of Mines described underground lunar mining as follows: "The lunar mining and processing may rely heavily on automation and application of robotics technology. Lunar technology will surpass current terrestrial mining technology in these areas and will no doubt provide substantial spinoff technology applications to deep sea and deep underground mining."

In more recent papers presented on lunar mining, surface operations to recover helium-3 are also mentioned as areas in need of new technology development. In the report issued by the National Research Council earlier this year, the panel reviewing the NASA 90-day study for the Human Exploration Initiative remarks: "The committee is not convinced that off-the-shelf, terrestrial technology will perform as required in the environment of space, the Moon, and Mars. . . . For example, the development of machines and apparatuses and their operation must take into consideration the adhesive and abrasive nature of the lunar soil, which is well known from earlier lunar landings."

To work on technology requirements for mining on the Moon, an Extraterrestrial Mining and Construction Steering

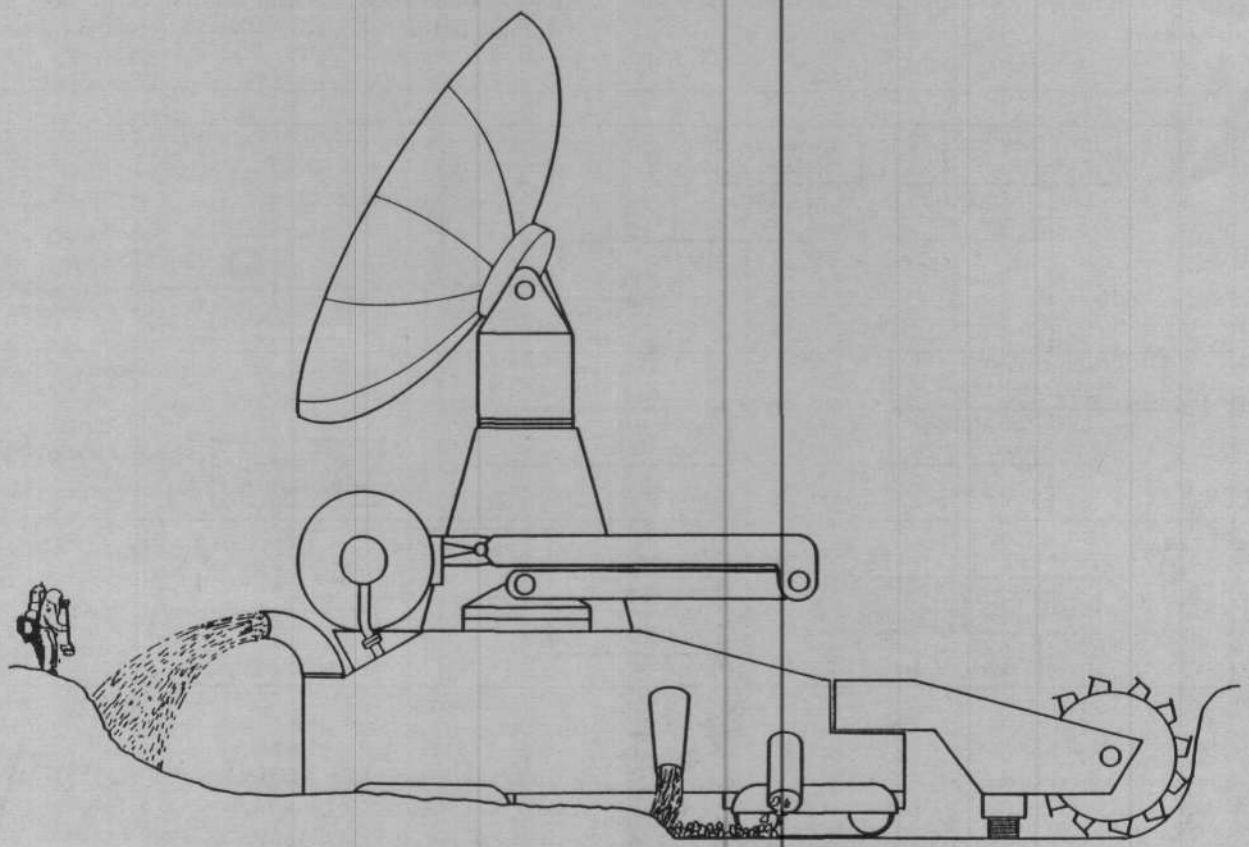


Figure 6
SCHEMATIC OF THE LUNAR MARK-II ROBOTIC MINER

This is a simplified line drawing of the Lunar Mark-II robotic miner pictured on the cover of this issue. It was designed by the University of Wisconsin team that has pioneered the research on mining helium-3 on the Moon.

Source: NASA Lunar Helium-3 Fusion Power Workshop, April 1988

Committee was established in January 1989, including the same agencies and interested parties as the Apollo Working Group as well as the Lunar Development subcommittee of the International Academy of Astronautics.

Robots on the Moon

A first look at the problem of mining, separating, storing, and transporting lunar helium-3 has been taken by scientists at the University of Wisconsin Fusion Technology Institute. A prototype mobile robotic miner is under development and general characteristics and capabilities of such a system have been formulated.

Because only the topmost layer of lunar soil contains the helium-3, one approach is to use a mobile miner that processes the soil, extracts the helium, redeposits the processed soil, and moves on. The helium is collected and stored in cryogenic tanks on the vehicle. When full, the tanks are returned to the lunar base for transfer to Earth-bound vehicles.

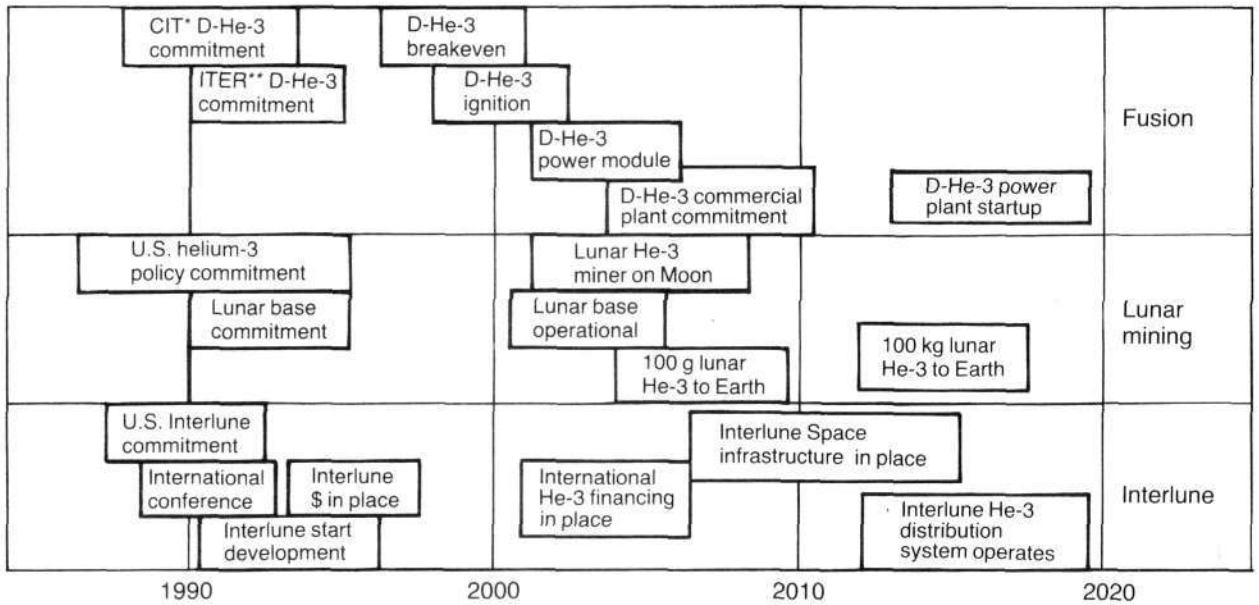
Another approach makes use of the many materials valuable for lunar habitats and industry, like oxygen, which could be by-products of helium processing. For this purpose, a centralized industrial processing facility could be put into operation to extract and separate a range of gases, metals, and minerals. Each approach has advantages and drawbacks.

Figure 5 summarizes some of the technology and other options in designing a lunar mining operation. One key consideration is energy. The miner itself, as well as the solar wind gas extraction equipment to separate out individual elements, could be solar powered or nuclear powered. Using solar energy on the Moon means a shutdown of operations during the two-week lunar night, however, and is not likely to be practical. These technology issues will be resolved as the research and design of the entire mining and processing system proceeds. They should be evaluated by the level of productivity of the system as a whole.

The Mark-II lunar miner designed at the University of Wisconsin (pictured on the cover) is shown schematically in Figure 6. A bucket-wheel excavator is used for digging a trench 3 meters deep and 11 meters wide. The rejected regolith is deposited along the sides of the miner and the processed regolith is ejected from the back, to refill the trench uniformly.

The soil processing rate is 556 tons per hour, at a total excavation rate of 1,258 tons per hour. This results in an annual He-3 collection rate of 33 kilograms, if the miner is operating for 3,942 hours per year, or less than half a year. The miner moves along at 23 meters per hour and requires about 12.3 megawatts of electricity for its operation. In one year, it can mine 1 square kilometer of lunar surface.

To separate the helium-3, the regolith is first heated to



Notes
* Compact Ignition Torus
** International Tokamak Engineering Reactor

Figure 7
SCHEDULE FOR 2015 STARTUP OF THE FIRST HELIUM-3 POWER PLANT

Political and economic commitments, technology development, and commercial viability will have to be demonstrated in fusion power and the mining of lunar soil in approximately this timetable in order to ensure a startup of the first D-He-3-powered fusion plant in 2015. This plan proposes Interlune as a private consortium (similar to Comsat for satellite communications) for the commercial development of the helium-3 fuel.

Source: R. Bilder, E. Cameron, G. Kulcinski, H. Schmitt, "Legal Regimes for the Mining of Helium-3 from the Moon," 1989

about 600 degrees Celsius. Then cryogenic distillation is used to separate the helium-3 from the more abundant helium-4. This is done at temperatures of about 2.1 degrees above absolute zero, using fine filters. The plan is to operate these distillers during the cold lunar night.

One Shuttle payload bay of helium-3 could produce as much electricity as the United States consumed in 1985 from all sources. However, in order to reach the 20-ton-per-year projected market for helium-3 to fuel fusion power plants for the entire world, more than 600 of these mobile miners would be needed. At the point that lunar helium-3 mining is gearing up for that level of production, and perhaps significantly before, more efficient mining technology should be developed.

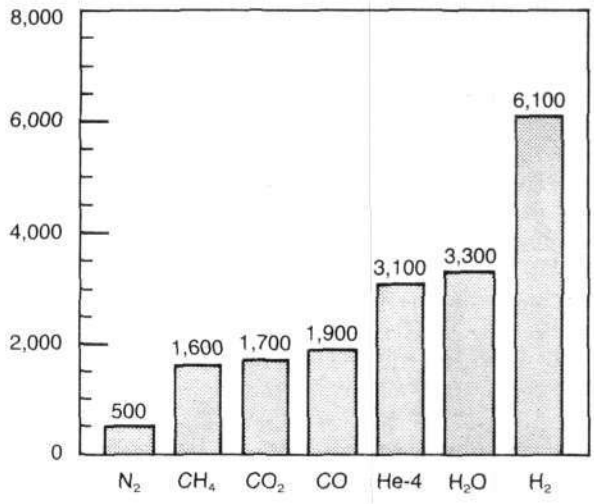


Figure 8
BY-PRODUCTS OF LUNAR HELIUM-3 MINING
The tons of gases released from the mining and processing of lunar soil for helium-3 can be used on the Moon or can be exported to be used by spacecraft and other facilities in space. The amounts given are metric tons per metric ton of helium-3 recovered.

Source: Report of NASA Lunar Energy Enterprise Case Study Task Force, July 1989

A timetable for the milestones that must be met in developing fusion and lunar mining technology is outlined in Figure 7, in addition to commercial and institutional arrangements to make this program a reality. An international consortium called Interlune has been proposed by former Apollo astronaut and geologist Harrison Schmitt. Modeled on Intelsat, the international communications satellite consortium, Interlune would be comprised of nations, users, and investors and would develop a customer base for lunar materials. Part of Schmitt's proposal includes the use of contributions from Interlune to support energy development in developing countries, so they can participate in advanced fusion energy production using lunar helium-3 fuel.

Helium-3 is not the only resource man will be able to mine on the lunar surface. The solar wind has deposited many other elements, and these will be important by-products of the mining and separation of helium-3 that can be used for lunar development (see table).

For each ton of helium-3 recovered, 3,100 tons of the more abundant helium-4 will be obtained, along with 500 tons of nitrogen, 3,600 tons of carbon monoxide and dioxide, and 6,100 tons of hydrogen. In fact, it is likely that the initial driver for lunar mining will not be helium-3 for the Earth, but the production of much more abundant hydrogen, oxygen, and water to allow the lunar base itself to become self-supporting (Figure 8).

In the next century, the economic development of the Moon will be crucial for continued economic growth on Earth. Moon industrialization is a challenge we must meet if we are to continue to develop here on Earth. As researchers at the Bureau of Mines summed up the task in their 1968 study, "A scientific challenge unparalleled in history faces man in his exploration of space."

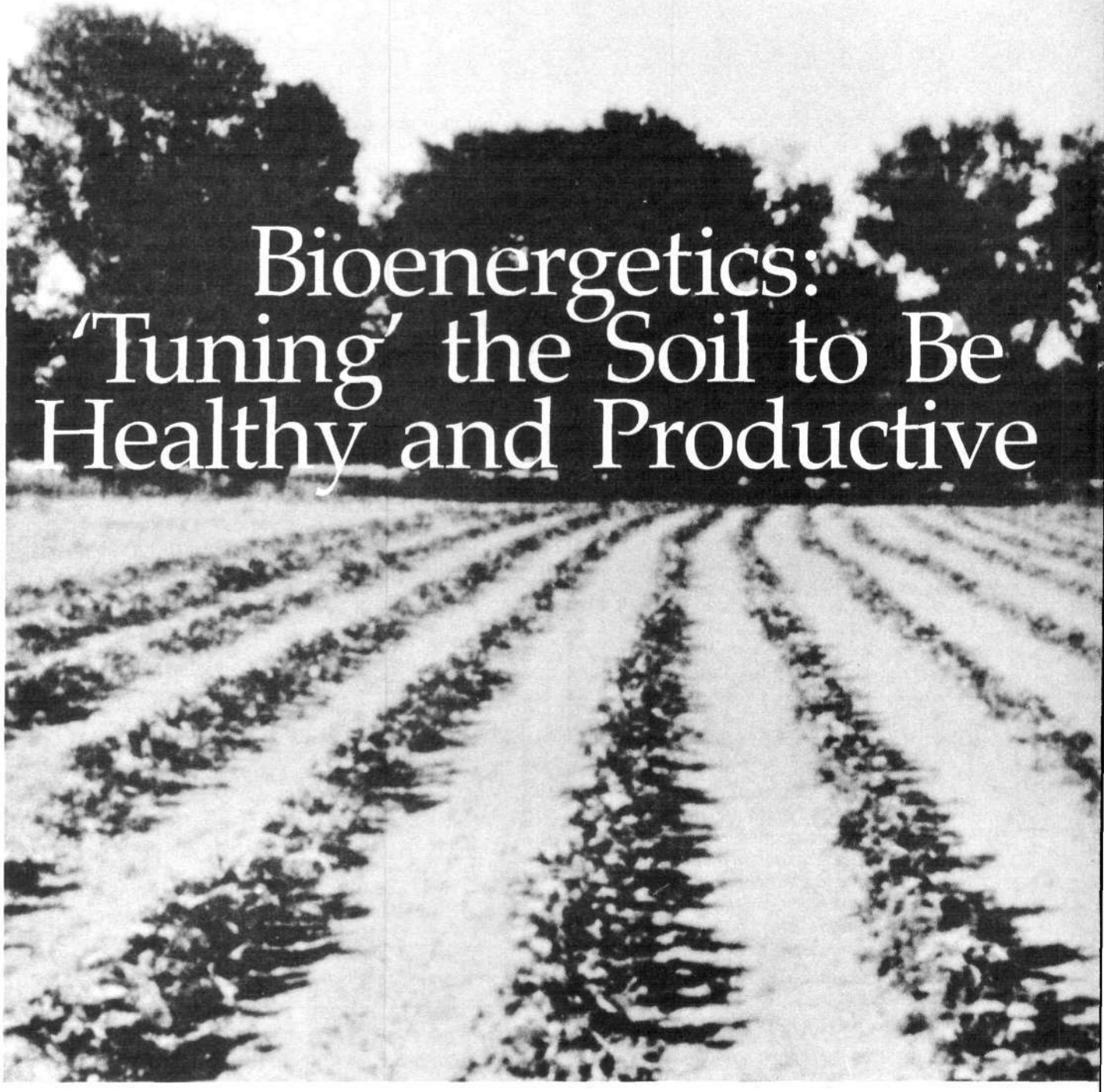
Marsha Freeman, an associate editor of 21st Century, *writes on space exploration and technology.*

RELEASE PREDICTED FOR REGOLITH WHEN HEATED TO 700°C

One proposal for releasing the helium-3 from the lunar soil is simply heating it to about 700 degrees Celsius. At that temperature, the additional elements listed here would be released as by-products of the helium-3 processing.

	He-3	He-4	H_2	Carbon	N_2
Concentration in Moon regolith (parts per million or g/metric ton mined)	9×10^{-3}	30	50-60	142-226	102-153
Concentration in grains smaller than 50 microns (g/metric ton mined)	8.1×10^{-3}	27	50	166	115
Amount released at 700° C (g/metric ton mined)	7×10^{-3}	22	43 (H_2) 23 (H_2O)	13.5 (CO) 12 (CO_2) 11 (CH_4)	4
Mass obtained per kg of helium-3 (metric tons)	10^{-3}	3.1	6.1 (H_2) 3.3 (H_2O)	1.9 (CO) 1.7 (CO_2) 1.6 (CH_4)	0.5

Source: NASA Lunar Helium-3 Fusion Power Workshop, April 1988



Bioenergetics: 'Tuning' the Soil to Be Healthy and Productive

A "crop doctor" prescribes a bioenergetic approach for sick soils and crops, showing that insects "tune out" healthy plants and home in on the sick ones.

by Arden B. Andersen

Producing more nutritious food at less cost is the goal of a pioneering group of agricultural consultants whose tools of the trade are electromagnetic—they apply advanced biophysics to solve problems of soil and crops. "Sick" soil is not a small problem: Over the past 50 years, the United States has lost 50 percent of its productive top soil, and soil loss in the 1980s dwarfed that lost during the great dust bowl of the 1930s.

The application of biophysics to agriculture starts with the electromagnetic anatomy and physiology of soil, plants, and fertilizers and then extrapolates that to the physical aspects of each. It is well established that energy precedes matter. In other words, the energy fields of organisms and chemicals interact first. This interaction results in the chemical/physical phenomena we observe. Consequently we can evaluate these energy fields to arrive at a truer picture of what is actually happening. When we combine these data with the chemical test data, we can solve almost every problem we face in soil and plant nutrition.

Remote sensing instruments like those aboard the Landsat spacecraft map the growth and health of plants by mea-

Weeding with fertilizer: A bioenergetically designed fertilizer program for this strawberry field on a farm in Pennsylvania kept the front section clear of weeds without *tillage, herbicide, or mulch. The control field in the background is overgrown with 5-foot high weeds.*

suring the frequency and intensity of the radiation they *reflect*. Recently, scientists have found that the biophoton *emission* frequencies of plants differ not only from one crop to another and according to the general health of the plants, but also according to the nutritional content and other conditions of the soil the plants depend upon. Consequently the plant's electromagnetic signature can be changed by altering fertilizer and nutritional additives to the soil. This is quite important because it has been shown by entomologist Philip S. Callahan, a bioenergetic pioneer, that insect pests recognize their crop prey by its electromagnetic signal (Callahan 1985). If the signal emitted by a plant can be changed, the insect will not "recognize" it and, therefore, will not be able to prey on it.

The application of bioenergetics to agriculture is a scientific procedure that enables us to see beneath the surface of chemical phenomena to the fundamental biological processes of plant growth. It allows agricultural specialists and farmers to scientifically intervene in the life and health of plants.

The Energy of Living Processes

As long ago as the late 1800s and early 1900s, Albert Abrams, Georges Lakhovsky, and Nikola Tesla showed that all material things and particularly living systems have electromagnetic signatures. All three showed that altering these electromagnetic signatures would alter the living systems themselves (Andersen 1989).

In the 1960s, Soviet scientists V.P. Kaznocheev proved that cellular disease could be induced, as well as reversed, electromagnetically (Bearden 1988). In 1976, Kaznocheev reported that cell cultures could be altered and killed—without physical contact—by simple transmission of the altered electromagnetic pattern from one culture to another, and he reported more than 5,000 successful experiments demonstrating this (Bearden 1980). Then in 1979, Kaznocheev showed, using monkey cell cultures, that viral transmission was possible via ultraviolet photons (Grauerholz 1988).

Further evidence has been provided by West German biophysicist Fritz-Albert Popp, who has shown that the interaction of chemicals in living systems is initially energetic and secondarily physical/chemical; that is, the energetic interaction causes the physical reaction (Lillge 1988). Robert Becker and Gary Selden argued in *The Body Electric* that all biological systems function energetically, manifesting physically according to the energetic patterning. This understanding produced advances in agriculture prior to the development of the field of biophysics, which we discuss a bit later. First we review a few basics concerning agricultural pests.

Tuning Out Insects

Observing and understanding the energetics of agricultural matter—soil and plants—enable scientists and farmers to optimally fertilize and manage crops making use of the knowledge that healthy plants and soils have different physical characteristics and correspondingly different energetic characteristics from sick plants and soils.

More than 25 years ago, Philip Callahan proved that insects home in on crops, like airplanes equipped with omnidirectional radar devices, by picking up the infrared radiations emanating from the crops. Callahan further proved that insect behavior could be altered by simply jamming, altering, or overriding these infrared emissions, thereby effectively protecting entire crops from insect infestation electromagnetically, without the use of insecticides (Callahan 1975).

We also know from Callahan's work, as well as that of other researchers around the world, that insects and dis-

eases infest only *nutritionally imbalanced* plants, although for many years experts believed that "healthy plants make healthy insects." In other words, insects are tuned in to aberrant electromagnetic spectrums. Healthy plants can also better resist pests and disease through their primitive immune systems. Thus if a pest-infested area is investigated for nutritional imbalances and those can be corrected, it should be possible to *eliminate* rather than temporarily ameliorate the problem by making the healthy plants "unattractive" (unrecognizable) to the insects. For example:

- We know that aphid infestation is linked to nitrogen fertilization; the more excess nitrogen, the greater the aphid population.
- Nematodes are correlated to salt concentration and biological activity in the soil, and especially to carbohydrate levels; the lower the biological activity, the greater the salt build-up, the lower the carbohydrate level, and the greater the parasitic nematode populations.
- Fungus problems correlate with copper and calcium deficiencies.
- Infestations of Colorado potato beetles are indicative of calcium, phosphate, vitamin C, copper, and manganese deficiencies.
- Adult corn root worms will *not* eat the ear silks that receive the pollen, if the carbohydrate content of the sap in the corn stalk is sufficiently high. In other words, the plant's level of sugar is a "marker" for the overall health of the plant. If the sugar level falls below a critical point, silk damage will occur and get progressively worse as the reading declines. That critical point is measured with a refractometer that measures the refractive index of the sap, calibrated in brix units.

The accompanying table lists the threshold brix levels of various food crops below which disease will take over. Existing chemical standards don't reveal these correlations, yet when these nutrients are supplied the problem disappears. Only biophysics can explain these phenomena.

MINIMUM BRIX READINGS FOR PLANT HEALTH

A plant's sugar level (measured in brix) corresponds to the mineral level of the plant and is an important indicator of the plant's overall health. Listed here are the minimum brix levels for these selected plants to be healthy. Brix, the unit of measurement that indicates the carbohydrate content of the sap, is based on a calibration of the refractive index.

Strawberries 16	Melons 16	Sweet corn (white) 24
Raspberries 15	Squash 15	Sweet cherries 16
Blueberries 14	Pumpkin 15	Sour cherries 14
Alfalfa 14	Lettuce 12	Beans 14
Tomatoes 18	Onion 13	Peas 14
Potatoes 13	Celery 15	Eggplant 12
Cucumbers 13	Apples 16	Pepper 12

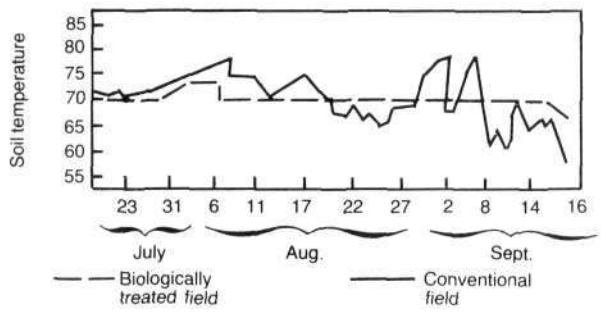
Getting to the Root of the Problem

Case in point: A university chemical analysis showed that a western soil exhibited magnesium, potassium, iron, and manganese deficiencies. When the biophoton activity of the soil was evaluated with a photometer—described more fully below—it was found that calcium, copper, sugar, and vitamin B12 were actually deficient, causing the magnesium, potassium, iron, and manganese symptoms. Subsequent application of the calcium, copper, sugar, and vitamin B12 not only relieved the magnesium, potassium, iron, and manganese deficiencies, but also reduced the weed and disease pressures on the growing crop. These results make sense when one understands that soil is a dynamic biological system, not a test tube of mineral and dirt. Living organisms must therefore be considered in any soil evaluation. In fact, there is an integral symbiotic relationship between the plant and soil microorganisms (Krasil'nikov 1958). If purely chemical methods are used to determine whether nutrient levels are deficient, this symbiotic relationship is not considered.

Further, calcium is of the utmost importance for microorganism growth as well as for plant growth. This has been well researched and proven by many scientists, including William Albrecht at the University of Missouri (Albrecht 1975). Rigorously, the addition of calcium will release potassium from the colloidal exchange sites, making it available for microorganism and plant use.

Copper is important for cellular and tissue elasticity, fungal disease inhibition, and the plant's use of other trace elements. In this particular soil, as sometimes is the case, copper was the major limiting factor connected to the iron and manganese problems.

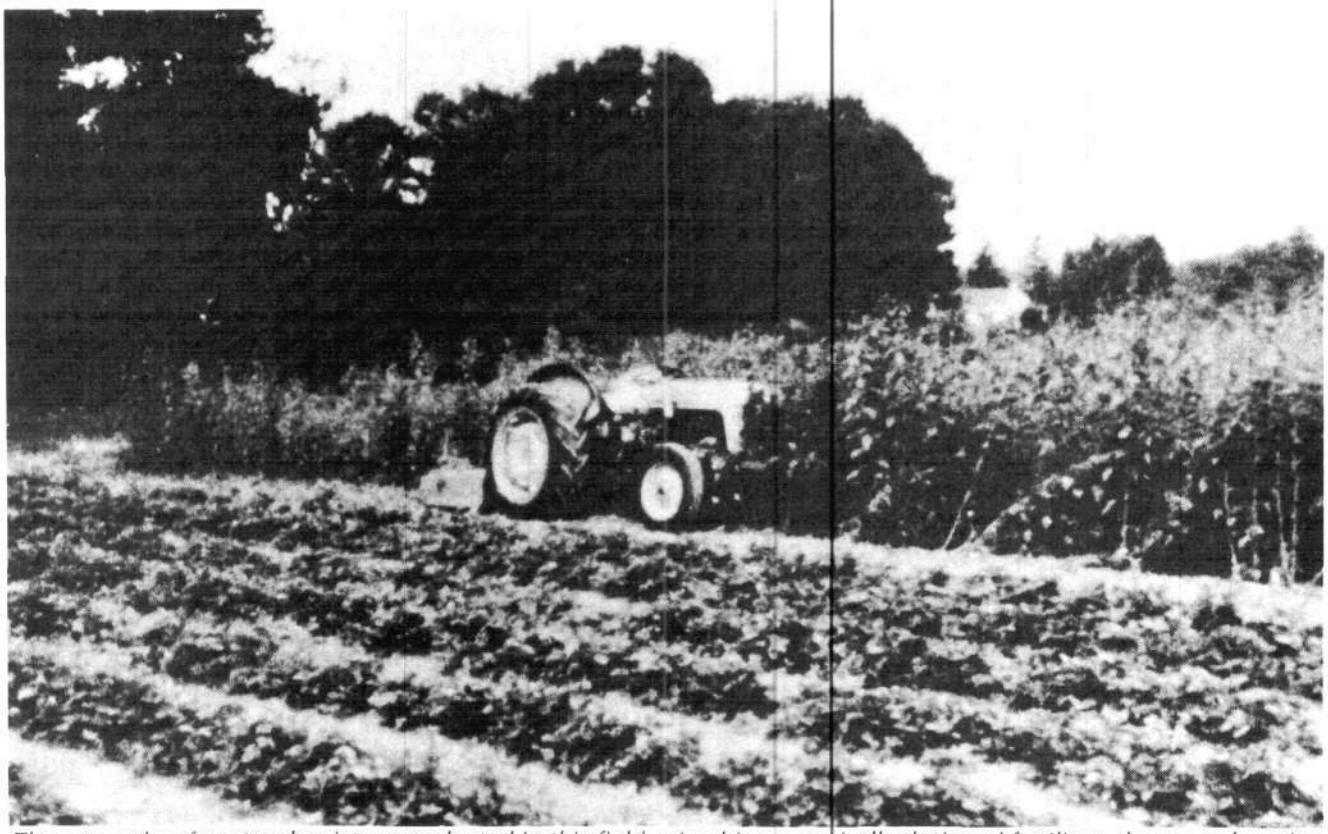
Sugar is a basic sustenance for every living organism.



BIOENERGETICS PROTECTS PLANTS AGAINST THE WEATHER

Keeping plants healthy with a nutritionally balanced program can maintain the soil at a near-steady 70° F, regardless of variations in air temperature. Compared here are the soil temperatures of a biologically treated field and a conventionally treated field in Bureau County, Illinois, in July, August, and September 1984. Typically, temperatures can vary by more than 30 degrees during the summer growing season in the Midwest.

Source: Larson Farm Management



Three months after strawberries were planted in this field using bioenergetically designed fertilizer, the treated section has successfully suppressed the growth of weeds (foreground) without tillage, herbicide, or mulch, while weeds grow wildly in the control section (background).

Experience has shown that almost every soil in the United States is deficient in sugar as a result of more than a half century of salt and acid/caustic fertilization. Deficient soils and plants indicate insufficient microorganism activity. The addition of sugar provides the microorganisms with energy—food—to do their job.

Vitamin B12 is an essential nutrient for both plants and soil microorganisms. Under proper conditions, vitamin B12 will be produced by soil microorganisms, particularly actinomycetes (Krasil'nikov 1958). However, if these microbes have been suppressed because of imbalanced nutrition or adverse conditions, vitamin B12 will be deficient. The addition of vitamin B12 primarily stimulates bacterial growth, which in turn leads to overall nutrient availability and stabilization in the plant-soil system.

Traditional chemical analysis simply cannot provide this type of problem-solving capability because it gives only a static picture of the symptoms, while energetic evaluation gives a dynamic picture of causal interaction between soil, plants, and microorganisms. Traditional soil and plant analyses simply provide too narrow a picture to solve the problem completely.

The Limits of Chemical Analysis

Traditionally, fertilization and plant-feeding recommendations have been based on chemical analysis of soil and plant samples, performed by taking the samples out of the field and into the laboratory. There, chemicals that extract the nutrients are applied to the samples and the nutrient content of the soil is measured.

For various reasons, this method can produce a fictitious reading. First, by removing the sample to the laboratory, the material is examined in vitro rather than in vivo, and the effects of the things living in the soil, like the plants themselves and microbes, are eliminated.

Second, just because a mineral is present in the soil does not mean it is available to the plant. Energetic analysis as well as insect, disease, and weed symptoms have shown this to be the case. It is also likely that the magnetic field of the Earth influences the growth of plants, which is not considered by this or any other chemical evaluation.

In general, although chemical soil sample tests produce valuable data, they measure only effects, not causes. In addition, the standards established for these tests, classifying soils and plants as normal or deficient were formulated under the *incorrect* assumption that healthy, nutritionally balanced plants and soils are attacked by insects and diseases just as imbalanced ones are. This created standards that were suboptimal and perpetuated the production of more of the same because plants that required insecticides to rescue them were considered healthy and nutritionally balanced and, therefore, were subsequently used as standards.

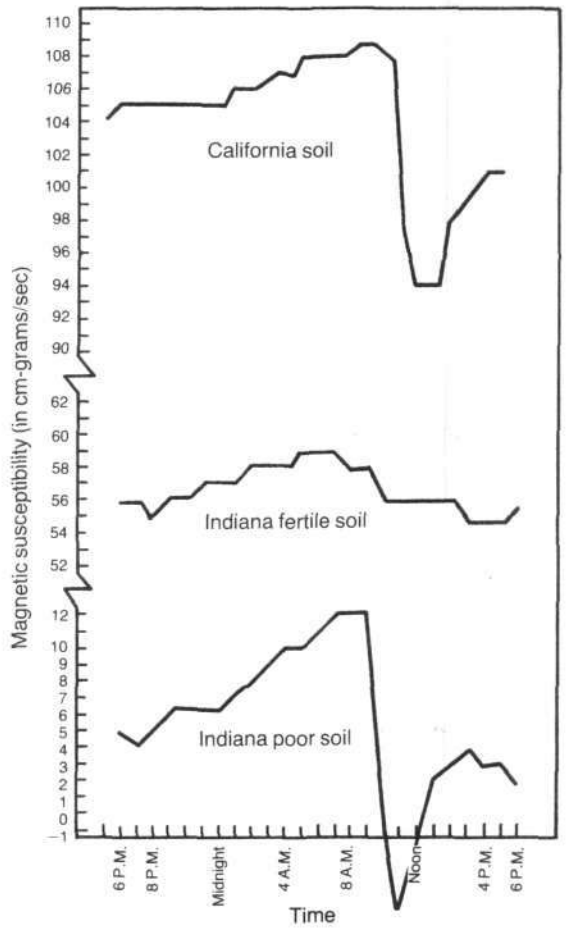
This point is easily impressed upon us when we consider the following: A chemical test may indicate that our soil

Continued on page 43

Magnetic Susceptibility and Soil Fertility

Soil fertility is generally thought of in terms of cation exchange capacity and macronutrient content. Research is revealing that electromagnetic properties may be of greater significance to soil fertility.

Highly fertile soils have positive magnetic susceptibility values and are called *paramagnetic*. Sterile soils have a negative value and are called *diamagnetic*. The fact that a soil is highly paramagnetic does not guarantee high fertility, but it does indicate high *potential* fertility. The key to translating high potential fertility into actual productivity is the development of a fully functional and balanced soil biology.



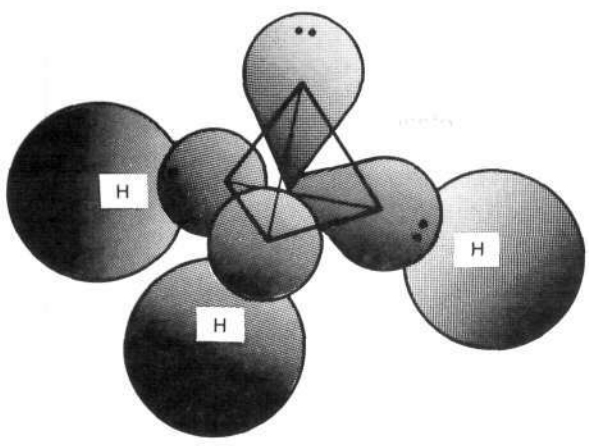
COMPARISONS OF SOIL FERTILITY AND MAGNETIC SUSCEPTIBILITY

Very fertile, biologically managed soil of California is compared here to naturally fertile soil in Indiana and poor soil in Indiana in terms of magnetic susceptibility and the variance in susceptibility over a 24-hour day. The California soil measures a high magnetic susceptibility and varies by less than 15 percent in a day, while the poor Indiana soil varies by more than 100 percent. The soil in Indiana that is naturally fertile but also is in a bioenergetically designed nutrition program, shows highly stable magnetic susceptibility over the entire day and night. This factor may prove important in maximizing agricultural productivity.

There are two factors that affect soil magnetic susceptibility: the presence of certain minerals (such as the rare earths, some limestones, iron, and copper) and the shape of the soil particles and nutrient complexes. This latter factor is clearly demonstrated in the case of nitrogen sources.

Urea, for example, has a flat triangular shape with a "handle" on it, nitrite nitrogen has a simple plane triangular shape, and ammonia has a tetrahedral shape (see illustration). Although the different compounds may supply the soil with the same or similar chemical species, apparently the shape of the compound itself as an antenna makes a significant difference in the nitrogen's availability to the plant.

The structuring of soil is largely done by microorganisms. Once proper structure is achieved, the soil is made more fertile and less susceptible to erosion because the magnetic forces holding the soil particles together are stronger.



ANTENNA GEOMETRY: THE AMMONIA MOLECULE

Nitrogen can be added as a fertilizer to soil in many different chemical compounds, each of which has a unique geometry that affects the magnetic susceptibility of the soil. The ammonia molecule shown here (NH_3) is a tetrahedral structure because of the arrangement of the nitrogen electron pairs. The bond angles in the ammonia molecule are 107°, which is very close to the tetrahedral angle (109.5°)

Continued from page 41
and plants have deficiencies in magnesium, potassium, iron, and manganese. The traditional recommendation would be to add magnesium, potassium, iron, and manganese. Follow-up tests would usually show an increase of these nutrients in the soil and success would be assumed. However, the problem arises that this soil continues to have increasing weed infestation and compaction. The crop continues to have insect infestation, but it "looks okay." The weeds are sprayed with more herbicide, the soil is tilled with bigger equipment, and the crop is sprayed with more insecticide. The following year is a repetition of the previous one.

Common sense tells us that recurring problems are only symptoms shrouding a deeper cause. Refractometer readings and some chemical analyses, together with insects, diseases, and weeds provide us the status of a crop, but none of them tells us how we can proceed to formulate a fertilizer and management program that will accomplish the nutritional integrity necessary to avoid insect and disease infestation. Energetic evaluation does. Because insects and diseases operate in the energetic realm, we must perform energetic analyses to observe not only the empirical problems but also the causal circumstances.

One chemical soil test method has been found to be of great value, however, especially when augmented with energetic testing. This test evolved out of the work of the late Dr. Carey Reams, using a basic La Motte soil testing kit. It was streamlined and standardized by Robert Pike and Dan Skow, D.V.M., for its present commercial use. Its uniqueness lies in its remarkably close correlations to actual soil, plant, and microorganism status. This is primarily due to Reams's understanding of soil fertility and his correlations of the latter to soil test values using this procedure.

Reams's minimum "perfect" soil numbers look quite different from any other agronomic system, except William Albrecht's. The proportions in pounds per acre are: calcium 2000#, phosphate 400#, potash 200#, sulfate 200#, magnesium 300#, ammoniacal nitrogen 40#, nitrate nitrogen 40#, pH 6.4-6.8. Unique to this system is the 2:1 phosphate to potash ratio. Once this ratio is achieved using this test, broad leaf weeds like lambs quarter and pigweed cease being a major problem, eliminating the need for broad leaf herbicides. With this ratio and the 2000# or higher calcium level, "sour" grass weeds like foxtail, quackgrass, and dandelion cease being a major problem, eliminating the need for grass herbicides. A narrower than 7:1 calcium to magnesium ratio indicates soil compaction.

"No number is perfect until all numbers are perfect," said Reams. All will not be perfect until the microorganisms are in their necessary balance. Like all other chemical soil analyses, this system is static and only indicates what the present nutrient status is relative to the extraction reagents. It indicates where a field is, but does not tell the farmer or consultant *how* to get where he wants to go. This is a key point. It shatters an old paradigm that says, if a chemical analysis or symptom shows potash to be deficient, the problem is addressed by the addition of potash.

The new paradigm reveals that this potash deficiency probably is not caused by a quantitative lack of potash, but rather by a missing link in the biological cycle of nutrient availability and assimilation. This secret is readily revealed—and in some cases only revealed—by *energetic* evaluation. The chemical test establishes one's status and starting point, but an energetic evaluation plots the course of action.

Energetic Analysis

There are currently two methods to evaluate the energetics of soil. First, there is the magnetic susceptibility meter. This instrument is traditionally used by paleontologists and archaeologists in the study of ancient remains and artifacts as well as fossils. For agriculture, the instrument has provided some interesting data. Magnetic susceptibility is the ability of something—in this case soil—to function as an antenna for magnetic energy or fields. It is measured as the ratio of the magnetic field strength induced in a substance to the strength of the inducing field.

Callahan was the first to show that soil magnetic susceptibility was related to soil fertility. Fertile soils are *paramagnetic*—they have positive magnetic susceptibility values. Infertile soils are not necessarily *diamagnetic*—having negative magnetic susceptibility values—but diamagnetic soils are always infertile. The soil's ability to receive magnetic energy is very important to microbial and plant growth; in fact, it is essential. It is however only half of the system. The ability to receive magnetic energy is only valuable when there is something to translate this energy into useful form. It is like having a radio antenna without the radio.

That something is the biological system of the soil—the humus and microorganisms. This system is analogous to the radio, and the antenna is analogous to the mineral system. Without both the system as a whole is mute. Continuous 24-hour runs on three different soils using a model MS-2 Bartington magnetic susceptibility meter are shown on page 42. The bottom soil is an Indiana soil of low fertility. The middle is an Indiana soil of good fertility and the top is a California soil of good fertility. Both the poor Indiana and the good California soils showed marked magnetic susceptibility decline during the hottest part of the day while the good Indiana soil remained fairly stable. The decline in magnetic susceptibility correlates with a reduced ability to deal with solar energy necessary for plant growth.

The poor Indiana soil actually exemplified a total inability to deal with solar energy. The factor common to these latter two soils is very low humus levels, while the good Indiana soil was relatively high in humus. Further study has shown that both the magnetic susceptibility and the humus level vary directly with the fertilization practices employed. As both decline, the susceptibility of the soil to erosion increases. Additionally, it has been observed that anhydrous ammonia and potassium chloride (the two most widely used fertilizers in the United States, and both widely imported) *decrease* the magnetic susceptibility of the soil.

Energetic analysis, which includes measurements of magnetic susceptibility, has led to the discovery of the value and importance of many nontraditional fertilizer materials, including vitamins like B-12 and C; sugars like molasses, sucrose, and dextrose; trace elements like silicon and iodine; and even color dyes.

Since magnetic susceptibility, like plant growth, is an electromagnetic phenomenon, chemical soil analysis falls short in evaluating potential fertilizer programs that raise or regenerate the electromagnetic and, consequently, the productive properties of the soil. This obstacle appears to be overcome by an electronic scanner (a highly sensitive light meter) patented as a mineral assay instrument by T. Galen Hieronymus in 1949. Although the meaning of its readings for nonliving materials is not actually understood, some modifications have made it very useful for evaluation and prescription of bioregenerative fertilizer programs. The instrument evaluates mitogenic radiation in the 200-1,000 nanometer range (the range from near-ultraviolet to and including infrared). Its uniqueness lies in its ability to evaluate the biophoton interaction between soils or plants and selected fertilizers when the former and the latter are brought in close proximity to each other without actually mixing them physically, bearing out Kaznocheev's findings in 1979. The procedure is as follows:

The existing energy level is measured. Then, based on chemical analysis reports, history, and experience, fertilizer materials are selected and put with the sample. Energy readings are again taken. If they increase, the material is beneficial and another material is checked. Eventually, a combination of several fertilizer constituents is obtained and checked collectively to determine its effect on the sample. The prescription is then formulated.

This system allows the consultant or farmer to perform his trial-and-error routine with an instrument and a soil sample, rather than by using expensive fertilizers on crops in the field. In this way, he goes to the field with a predetermined success. Every season is different from the last. Every lot of seed is different. Repeating the same fertilizer program year after year is feasible only with an unlimited soil reserve.

Impressive results have been obtained in increasing the quality of crops and reducing or eliminating pests and disease, where farmers have used the fruits of energetic analysis. The old adage, "healthy soils make healthy weeds," has been proven a myth. By electronic scanner evaluation, fertility programs have been formulated that increase the calcium availability sufficiently to eliminate sour grass weed problems, balance the phosphate-to-potash ratio sufficiently to eliminate broad leaf weed problems, and raise plant refractometer levels sufficiently to eliminate insect pest problems.

It is also possible to improve the quality of crops by scientifically balancing nutrition. An Illinois farm management firm has demonstrated in numerous tests over many farms (comprising 14,000 to 20,000 acres) that the amount of protein in grains can be increased by applying bioenergetics. Using conventional fertilizer programs the average protein content of the grain was 7.55 percent, compared to 8.9 percent with a bioenergetic program. This translates to an increase of .76 pounds of protein per bushel, which means that less feed grain is required per animal fed.

Similarly, lambs fed with corn grown with a bioenergetically determined fertilizer regimen required a 27 percent lower feed intake because of the higher mineral content of the feed. Extensive, large-scale tests show that after three years on such a fertilizing program, average drying requirements on corn decline from 7 percentage points to between 3 and 4 points, while test weights increase 1 to 1½ pounds per bushel. Additionally, as the figure on page 40 shows, a biologically balanced soil is much more temperature-stable than a conventionally fertilized soil. This translates to more stable microbial populations, more stable nutrient reserves, and a less stressed crop.

MAGNETIC SUSCEPTIBILITY OF FERTILIZERS

Fertilizer	Magnetic susceptibility*	Use on U.S. soils
Urea	+1	Common
Potassium chloride	+1	Common
Diammonium phosphate	+4	Common
Soft rock phosphate	+33	Uncommon
North Dakota humates	+36	Uncommon
Leather tankage	+14	Uncommon
3-2-2 (organic)	+135	Uncommon
Ground rock mineral	+250	Uncommon

*Measured with MS-2 Bartington magnetic susceptibility meter.

Imperative to this technology is the integration of all fields of science, from biomedicine to biochemistry, physics to petroleum engineering, nutrition to microbiology. Consultants and farmers who understand the close symbiotic relationship between plants and soil microorganisms, as well as nutrient interactions and interrelationships, can be reasonably successful in their fertilization practices through experience, good observation, and recognition of insect, disease, and weed meanings. Energetic analysis allows them to go a step further than being reasonably successful—to being *very* successful. Using this technology, farmers are able to produce equal or better yielding harvests, at equal or less cost per unit of production, with little or no pesticides, and, most important, with higher nutritional values.

Arden B. Andersen, a private consultant for several agribusinesses, has a B.S. degree in agricultural education and a Ph.D. in biophysics from Clayton University in St. Louis, with specialties in soil and plant nutrition, product development, and regenerative management. He has written two books, Applied Body Electronics, *and* The Anatomy of Life and Energy in Agriculture, *and is active in several electrobiological research projects.*

References

William Albrecht, *The Albrecht Papers*, Vols. I and II, Ed. Charles Walters, Jr. (Kansas City: Acres, USA, 1975).

Arden B. Andersen, *Biophysics: An Ancient Art, A Modern Science.* Doctoral dissertation (St. Louis: Clayton University, Jan. 1989).

_____, *The Anatomy of Life and Energy in Agriculture* (Kansas City: Acres, USA, 1989).

Thomas E. Bearden, "Soviet Phase Conjugate Weapons," *CRC Bulletin* (Jan. 1988).

_____, *Excalibur Briefing* (San Francisco: Strawberry Hill Press, 1980).

Robert O. Becker and Gary Selden, *The Body Electric: Electromagnetism and the Foundation of Life* (William Morrow, 1987).

Philip S. Callahan, *Tuning Into Nature* (Old Greenwich: Devin-Adair, 1975).

_____, "Insects and the Battle of the Beams," *Fusion* (Sept.-Oct. 1985) p. 27.

John Grauerholz, M.D., "Optical Biophysics and Viruses," *21st Century* (July-Aug. 1988) p. 44.

N.A. Krasil'nikov, *Soil Microorganisms and Higher Plants* (Moscow: Academy of Sciences of the USSR, 1958), Transl. Y. Halperin, The Israeli Program for Scientific Translations, 1961.

Wolfgang Lillge, M.D., "New Technologies Hold Clue to Curing Cancer," *21st Century* (July-Aug. 1988), p. 34.

'Mind Bombs': Putting Greenpeace in Perspective

by Ellen Chance

"We fire images rather than missiles—mind bombs delivered by the world media." Think about this Greenpeace self-description the next time you get a "save the dolphins" mailing from the $87-million-a-year environmentalist multinational, whose propaganda campaigns stab at the heart of Western civilization.

When Greenpeace launched a boat to stop atomic testing at Amchitka Island, Alaska, in 1971, the small British Columbia group was only one of many such antiwar, antinuclear organizations swimming in the swamp known as the New Left. But after the environmentalist movement built up a head of steam with international events and conferences, Greenpeace began a steady rise to the top of the ecological heap. Its every visible action trumpeted by massive media coverage, Greenpeace built up a fleet of ocean-going ships, computer hookups, a sophisticated satellite communications network, and an $87 million annual budget. In addition, Greenpeace took on the mantle of science in its publications, featuring photographs of its members ostensibly engaging in scientific research, most often collecting samples of water and effluents.

At meetings around the globe, Greenpeace claims, most stridently, that it possesses scientific expertise in the fields of nuclear power, atmospheric phenomena, chemistry, biology, military science, and economics—to name a few—and that this expertise entitles it to shape, and possibly administer, world policies. Such a modern wonder deserves some scrutiny, especially since the results of many of Greenpeace's "campaigns" have been anything but beneficial to science or humanity. For example:

- In 1988-1989, while the world's attention was mesmerized by the media circus attending the saving of three California gray whales off Barrow, Alaska, Greenpeace intensified its campaign against whaling by Iceland. Iceland at the time was abiding by the dictates of the International Whaling Commission and only catching whales for scientific research. The result of Greenpeace's pressure on purchasers of Icelandic fish to boycott Iceland was the near-collapse of the Icelandic government, unemployment in the fishing industry, and a threat to the income of Iceland's Marine Research Institute, which seeks to preserve and expand the very whale population that Greenpeace was supposedly trying to "protect."[1]
- Greenpeace makes much of its reverence for the wisdom of native peoples, but its attack against sealing in northern Canada and Greenland put hundreds of "native people," in this case the Inuits, on welfare and endangered fishing by producing an overpopulation of seals.

Now what are we to make of this? Does Greenpeace's vision of "a cleaner, safer Earth" include ruined industries and unemployed workers?

In its zeal to attract adherents to its cause, Greenpeace has produced a number of slick publications, some of which say perhaps a little too much about what its goals really are. These, in combination with a little history, provide a useful way of putting the creature into perspective.

Man As Beast

Instead of focusing on those appealing fund-raising pictures of whales, seals, penguins, and kangaroos that Greenpeace is so fond of sending through the mail, let us instead take a look at the dark mental image that Greenpeace has of man himself. We start with a British Greenpeace brochure entitled "Paradise Lost—Countdown to Destruction." The writer states that Earth is 4,600,000,000 years old, but in order to condense this time span into an understandable concept, we can liken Earth to a person 46 years of age. After tracing the appearance of dinosaurs, mammals, and the last ice age, the pamphlet states:

> Modern Man has been around for four hours. During the last hour Man discovered agriculture. The industrial revolution began a minute ago. During those sixty seconds of biological time modern Man has made a rubbish tip of paradise. He has multiplied his numbers to plague proportions, caused the extinction of 500 species of animals, ransacked the planet for fuels and now stands, like a brutish infant, gloating over his meteoric rise to ascendancy, on the brink of a war to end all wars and of effectively destroying this oasis of life in the solar system.[2]

If man is, according to Greenpeace, a very unattractive brute whose numbers constitute a plague on the face of the Earth, then perhaps it also follows that the numbers of that unfortunate species should be drastically reduced. What Greenpeace has to say on this rather delicate subject is most carefully couched in dripping concern for the fate of humanity, but it is nevertheless possible to follow the arguments to their intended conclusion—a reduction in the human species and the dissolution of the nation-state.

Imperial Economics

Since Greenpeace has featured pronouncements on economics in its publications, perhaps we can see if its economic plans really mean a policy of population reduction and the "one world" variety of local control. The January/February 1989 issue of *Greenpeace* magazine contains an article called "The New Economics: Accounting for a Healthy Planet" that states, "Through the 1990s, pressure groups and campaigning organizations like Greenpeace will have to take the lead in promoting the shift to a new economic order."[3]

And what is this new economic order? The article favorably cites the proposals of "two highly respected international bodies," one of which is the environmentalist Brundtland Report, published by the World Commission on Environment and Development, which favors a world environmentalist police force. According to this report, the integration of ecological and economic goals would be "best secured by decentralizing the management of resources on which local communities depend, and giving these communities an effective say over the use of these resources."[4] In other words, in line with the one world proposals, individual nation states are to fade away as authority for environmental policing is given to tribal, ethnic, and other "village" level community groupings.

Greenpeace expresses indignation at the "moral outrage" that an "economically devastated continent like Africa could become a net supplier of capital to the developed North at the price of starving its people. . . ."[5] But then, in the concluding section of the *Greenpeace* article is the following paragraph, which should be read very carefully,

Raynald Rouleau

"Mind bombs" on placards at a Greenpeace demonstration urging Burger King to boycott Icelandic fish, in Washington, D.C., March 29, 1989.

because it says exactly what is intended:

> At the institutional level, the attention given to the management of both the international economy and local economies must be raised to the level now devoted to national economies. The International Fund for Agricultural Development has already found that small direct loans to groups at the village level have a payback rate of 85 to 100 percent. Compare this to the problems of lending to Zaire, for example, which pays less than 20 percent of the annual interest on its loans, and whose ruler, Mobutu Sese Seko, stands accused of stealing $5 billion from his country.[6]

And how are these targeted small groups of people supposed to earn a living and pay off their debt? Definitely not by using the benefits of science and modern technology. According to Greenpeace's 1988 Year-End Report, "Greenpeace's influence in the international community grew as we helped to convince international lending agencies and banks to support sustainable agricultural development rather than chemical-dependent systems. . . ."[7]

Who convinced whom is an interesting topic for speculation; however, "sustainable agriculture" definitely means that resources are not wasted on improving people's standard of living, but instead are applied to paying off a spiraling level of debt.

Such a sharp dichotomy, from bemoaning the looting of underdeveloped countries to eagerly describing how best they can be looted deserves one's undivided attention. It is clear that the international financial institutions would prefer to bypass sovereign nations ("national economies") and deal with debtors on a more personal level. Nations have the unfortunate characteristic of coming equipped with governments that have the legal power to protect their citizens. Now, if these recalcitrant governments were replaced with something on the scale, say, of a small American colony, or a village in India under the Raj, or maybe a European feudal manor, things would go a lot more smoothly for the new economic order under the control of the "international economy" of the lending institutions.

Of course the industrialized nations are being treated to a similar, already well-advanced attack on their ability to provide for their own citizens, much less furnish aid to the developing nations. The same *Greenpeace* article on "The New Economics" is followed by a harbinger of things to come—a list of "Economic Facts" that includes the following items:

- "Rank in importance, according to U.S. workers, of job satisfaction, job security, and salary: 1, 2, 3."
- "Year in which U.S. citizens recorded the highest level of satisfaction with their lives: 1957."
- "Percentage of U.S. homes which had dishwashers in 1957: 4, Air conditioning: 9, Two cars: 14."[8]

The twisted logic that juxtaposed these "facts" is supposed to lead you to the conclusion that ending technological progress and reducing salary levels would still leave the American people as happy as clams; after all, they didn't have a lot of modern conveniences in 1957. It's a wonderful irony that Greenpeace chooses to highlight 1957, for 1957 was the last year Americans enjoyed relatively free from the policies Greenpeace is so eager to implement. In that year, America possessed a still-strong sense of national purpose, the Atoms for Peace program was bringing concrete progress to the developing nations, and American farmers knew they had the capacity to feed the world. Most American families did not need two cars, because they had access to a functioning mass transit system.

All this began to change gradually in 1958, as the recession of late 1957, which partially resulted from a failure to replace obsolescent physical plant and equipment, began to take its toll. Instead of reversing obsolescence and investing in accelerated research and development programs, industry managers were forced by cash-strapped financial institutions to pour their profits into debt service and dividends. Asset-strippers descended on U.S. companies, contracting output and throwing skilled operatives out of work. Only the NASA space programs and the investment tax credit sustained the economy enough to prevent an actual crash.

Then came the "postindustrial society" propaganda and the resulting environmentalist movement, both acting as apologists for the decline of industry. The current situation, where financial institutions that have done everything possible to destroy a productive base now demand that the victims of that destruction pay for its final dismantling, is not new to the 20th century. Ben Franklin was very good at describing such unmitigated gall:

> The whole Proceeding would put one in Mind of the Frenchman that used to accost English and other Strangers on the Pont Neuf, with many Compliments, and a red hot iron in his Hand: Pray Monsieur Anglois, says he, Do me the Favour to let me have the Honour of thrusting this hot Iron into your backside? Zoons, what does the Fellow mean! Begone with your Iron or I'll break your Head! Nay Monsieur, replies he, if you do not chuse it I do not insist upon it. But at least, you

will in Justice have the Goodness to pay me something for the heating of my Iron.[9]

'Spiritual' Science

It seems strange that an organization claiming scientific expertise should set itself up as a battering ram against modern technology; but things become clearer when you look at what kind of "science" Greenpeace is talking about. Greenpeace has made it clear in many publications that it believes in the necessity of a "paradigm shift" in the way people view their relationship with the Earth. The old, supposedly discredited, worldview is supported by a set of ideas that include "the belief in unlimited material progress to be achieved through economic and technological growth. . . ."[10] The new worldview supported by Greenpeace proposes a break with what Judeo-Christian civilization views as the quest for scientific truth:

> [B]y breaking from the scientific tradition that has thus far dominated and shaped our relationship with the Earth, the new paradigm incorporates a respect for the natural world beyond its simple utility to humans. It allows for the existence of forces and cycles outside the range of our mechanical detection equipment, our sensors and dials. In short, it permits us to know and believe in a realm far larger than the domain we have come to know as 'scientific.'[11]

The article continues, "Ultimately, deep ecological awareness is spiritual awareness."[12] What kind of spiritual awareness is being described? It is the same "New Age" ideas that have become the pagan religion of today's environmentalists. Instead of God, and man who was created in His image, we have the new god, Gaia, the Earth goddess.[13] Instead of human life being sacred, the Earth is sacred, and man must appease Gaia by subordinating himself to the domination of nature as defined by "deep ecological awareness." The growth of environmentalism over the past 20 years has fostered irrationality in our culture, to the point that widely circulated publications promote the supernatural and even Satanic practices.[14]

What is then the operating principle of Greenpeace's "new paradigm"? If all those "forces and cycles" can't even be approached by scientific method, then obviously the existence of certain phenomena does not have to be proven scientifically. The ozone hole ceases to be a natural occurrence first documented in 1956; it is a new threat that will extinguish life on the planet. Global warming requires drastic cutbacks in energy use; never mind that there is no definitive data to support it. Or how about the novel warning by one Greenpeace spokesman to a high school assembly in Ontario that the human body was so polluted by chemicals that in three years it would be illegal to cremate humans because such cremation would violate pollution emission standards! Clearly, Greenpeace has helped put the irrationality and superstition of "unseen forces" back in business.

Greenpeace itself has admitted in its publications that its early hard-core activists regularly consulted tarot cards, the *I Ching*, and old Aztec tablets, but, it says, these mystical

EIRNS

Ocean-going "mind bombs": Part of the Greenpeace fleet in Stockholm.

meanderings in no way interfere with, but rather add fuel to, the organization's very focused campaigns against the basis of Western civilization. Some details of how these campaigns operate provide a very interesting glimpse into the secrets of Greenpeace's success, a success obtained with a little help from their friends.

Mind Bombs from the Frozen North

According to Robert Hunter, a founding member of Greenpeace, "We fire images rather than missiles—mind bombs delivered by the world media."[15] Some of the more spectacular of these mind bombs involved three California gray whales and the Republic of Iceland. As you may recall, in October 1988, at the height of media coverage of the Bush-Dukakis presidential campaign, three whales were found stranded in the ice off Barrow, Alaska. Hundreds are stranded in like manner every year, but these whales happened to be trapped relatively close to Barrow's satellite television transmission facility.

Local video footage of the whales was picked up by Anchorage television; then Seattle and finally NBC decided to break the story nationally on NBC Nightly News. It may be something more than coincidental that Thornton Bradshaw of the NBC hierarchy was an early participant in the founding organizations of the environmentalist movement and serves as chairman of the Board of the MacArthur Foundation, which funds numerous environmental groups. Probably most important for understanding Greenpeace, the MacArthur Foundation provided a substantial sum of money to the Centre for Our Common Future, the official institution of the Brundtland Commission, whose program for local control of resources was lauded in the *Greenpeace* article on "The New Economics."

The morning after the NBC broadcast, Greenpeace's Alaska Coordinator, Cindy Lowry, received a call from Campbell Plowden of Greenpeace's Washington Office. Plowden, who coordinated the organization's whale activities, told Cindy that if she could justify a rescue effort, Greenpeace would pay the bill.[16] In her efforts to obtain help for the whales, Cindy was aided by a call from an anonymous source, according to Tom Rose, a reporter who

covered the whale stranding in Barrow and later wrote a book about it. This source, dubbed "Jane Whale" in the book, suggested that Cindy contact a company called VECO which had a hoverbarge stationed some 200 miles to the east at Prudhoe Bay. "Jane Whale" also called Campbell Plowden in Washington the same day, suggesting that the Soviets be contacted about sending in an icebreaker.[17] With these helpful tips, Greenpeace was off and running.

Cindy flew to Barrow to coordinate the rescue effort, having now also received a call from Commerce Secretary William Verity's office pledging help. Her presence at the meeting of Inuit whale hunters in Barrow, who had every right to harvest the whales for their meat, undoubtedly had an effect on their decision to help keep the whales alive, for they had seen what Greenpeace had done to their fellow Inuits who hunted seals. While the Inuits kept the whales alive by cutting and recutting holes in the ice, the employees of VECO mounted a herculean effort to free the hoverbarge from the ice and move it to Barrow. The media descended on Barrow like locusts, and soon the American public, and most of the world, were barraged by reports on the whales.

In the meantime, Plowden concentrated on obtaining Soviet help. He notified Greenpeace International Director David McTaggert that he should use his Soviet contacts, and McTaggert telexed an appeal to Arthur Chilingarov of the Soviet State Committee of Hydrometeorology. After several days' worth of telexes, and the failure of the hoverbarge to move, Chilingarov notified Greenpeace that he was sending icebreakers from the area of the North Pole, and asked Greenpeace for assistance in helping the icebreakers to enter U.S. territorial waters and in obtaining reconnaissance of ice conditions, even though he had already notified the State Department that the icebreakers were coming!

The State Department, in turn, through Assistant Secretary John Negroponte's office, asked Campbell Plowden for the specifications and capability of the Soviet icebreakers, which Plowden obtained from the Soviet Consulate's merchant marine office in New York! Cindy Lowry, despite a protest from Alaska National Guard Colonel Tom Carroll, reportedly told Plowden on the telephone to tell the State Department that "we all want the Soviets to come. We need them here."[18]

Cui Bono?

The Soviets, although one of the most active whale hunters in the world, rescued the two surviving whales and were hailed as heros. VECO, which spent some $350,000 on its abortive hoverbarge rescue effort, was rewarded some six months later when it was awarded a multi-million-dollar contract to clean up the oil spill from the Exxon Valdez accident. The Commerce Department and State Department claimed credit for bringing in the Soviets, but Greenpeace had other rewards. In addition to the publicity about whales, which according to Greenpeace prompted "thousands to join Greenpeace in protecting all whales," there was another effect that went largely unnoticed in the press, but not in Iceland.[19]

Greenpeace had campaigned against Icelandic whaling since 1978, but starting in 1986, Iceland had stopped all commercial whaling to honor the International Whaling Commission's 1986–1990 ban on the taking of whales except for scientific research purposes. In 1988, Iceland had killed 78 whales to use for research under the International Whaling Commission guidelines, and used a designated proportion of the whale meat to sell for revenue for its Marine Research Institute. Nevertheless, Greenpeace continued to fulminate against Iceland's "commercial whaling" and its supposed "slaughter" of whales. Iceland suffered a recession in 1988 caused by a slowing in the European economy, which dried up some of the demand for Icelandic fish. The island's economic troubles were reflected in a government crisis that September, when the Icelandic Prime Minister and his Independence Party left the government, leading to a new but considerably weaker left-of-center government led by Progressive Party leader Strintrimur Hermannsson. Campbell Plowden smelled Icelandic blood, and he was quick to take advantage of the situation.

At the height of the media barrage on the Alaska whales, Plowden cabled Greenpeace's European offices telling them that the best way to help the Alaskan whales was to zero in on the worst threat to all whales—man. West German Greenpeace took the hint and used European coverage of the Alaskan whales to widen their six-month boycott against Icelandic fish, which up until that point had produced few results. Within two days, Tengelmann, the West German supermarket conglomerate (which also owns A&P), announced it was canceling a $3 million contract with Icelandic suppliers, and it was followed by Aldi Supermarkets and NordSea. So far, the boycott had cost Iceland $50 million, 4 percent of its 1988 GNP.

This economic terrorism had its intended effect. Arni Gunnarsson, a Social Democratic member of Iceland's parliament, threatened to introduce a bill Oct. 24 to disband Iceland's now relatively inactive commercial whaling industry. The Prime Minister asked him to wait until Oct. 27, when the Prime Minister himself would announce a ban on commercial whaling forever. But Minister of Fisheries Halldor Asgrimsson protested, for he felt that the issue was one of Iceland's sovereignty, and he was joined in his concern by the Icelandic Foreign Minister. By Oct. 27, the government of Iceland was near collapse, but Americans did not even know that a NATO ally had been badly harmed by a campaign to save three Alaskan whales.

The Oct. 27 deadline found the Prime Minister speechless on the whale issue, and Greenpeace stepped up its campaign, ultimately throwing thousands of people out of work and creating an effect in Iceland comparable to shutting down the entire U.S. auto industry. On Aug. 2, 1989, the whale research program of the Republic of Iceland came to an end.

Now why did the tiny nation of Iceland merit such treatment? Surely there is very little that even environmentalists could object to in the way Iceland runs its economy. An advanced, industrialized country with one of the world's highest literacy rates, Iceland is unpolluted and its capital is heated with water warmed by underground springs. Depending heavily on the sea for its livelihood, Iceland has always protected its natural resources, even resisting Brit-

Greenpeace, Da! This photo from AP/TASS appeared in Pravda *Aug. 1, 1989 with a caption stating, "U.S. naval forces had to suspend a planned test of their newest Trident-2 ICBM due to the protest action conducted by fighters for environmental protection from the Greenpeace organization, who blocked the naval vesssels."*

ish efforts to overfish its waters, which were backed up with the power of the Royal Navy. In addition, Iceland was the first country in the world to protect whales by law. So perhaps there is another explanation for Greenpeace's morbid fascination with Iceland.

That reason may have something to do with Iceland's location on the GIUK Gap, the strategic waters between Greenland, Iceland, and Great Britain. It is this area that is absolutely crucial to U.S. reinforcement and supply of Europe in case of war, while it is also absolutely crucial to the Soviet Union in an attack on the United States. Soviet naval activity in the waters around Iceland has increased significantly in recent years, and Iceland has responded by increasing its participation in NATO activities. Any destabilization of Iceland could only benefit the Soviets, especially if large numbers of the population had to emigrate because of economic dislocation.

According to Greenpeace, "A new climate now governs East-West relations. The Cold War is over."[20] That has not prevented it, however, from continuing its campaign against the U.S. Strategic Defense Initiative while omitting all mention of the Soviet development of beam and radio-frequency weapons. Nor has it prevented it from campaigning for a unilateral shutdown of U.S. defense production of plutonium and tritium and conducting assaults on U.S. missile tests.

Soviet leader Mikhail Gorbachev's December 1988 speech at the United Nations on "international ecological security" gave his blessing to the international environmentalist movement, which the Soviets have aided financially and otherwise as a way of helping deindustrialization in the West. Soviet conduiting of funds to the antinuclear Green Party in West Germany is a case in point. The Soviets favor environmentalism as a convenient way of helping the West to commit suicide, and they are always willing to lend a hand to "useful fools" in the West.

Right now, Greenpeace appears to be a Soviet favorite, with its special, lucrative arrangement to sell its "Rainbow Warriors" rock music album in the Soviet Union. Reportedly the album has sold 4 million copies and earned more than $17 million in Soviet sales, money that helps Greenpeace maintain its Moscow office.[21] Could it be that Moscow is so happy with Greenpeace's work in the GIUK Gap that it is willing to have Greenpeace spread its rock music and even some "mind bombs" in the Soviet Union?

The Western targets of Greenpeace's mind bombs would do well to heed these favorite words of Ben Franklin, "There is truth in the old saying, that if you make yourself a sheep, the wolves will eat you."

Ellen Chance is the pen name of a freelance writer who has enough personal familiarity with Greenpeace to wish to remain anonymous.

Notes

1. The story of Greenpeace's attack on Iceland, including the deception Greenpeace used to stage scenes of animal brutality for fund-raising purposes, is dramatically told in the 52-minute film "Survival in the High North" by Icelandic journalist Magnus Gudmundsson. The film was reviewed in *21st Century* (Sept.-Oct. 1989, p. 12) and is available at $50 on videotape (VHS) from Magned Film, Laugavegur 26, 101 Reykjavik, Iceland.
2. John Dyson, *Sink the Rainbow!* (London: Victor Gollancz Ltd., 1986), p. 58.
3. James Robertson and Andre Carothers, "The New Economics: Accounting for a Healthy Planet,"*Greenpeace* (Jan.-Feb. 1989), p. 14.
4. "The New Economics," p. 13.
5. "The New Economics," p. 12.
6. "The New Economics," p. 14.
7. Greenpeace U.S.A., Inc., "1988 Report," p. 2.
8. "The New Economics," p. 15.
9. Benjamin Franklin, *The Autobiography and other Writings*, L. Jesse Lemisch, ed. (New York: the New American Library, 1961), p. 261.
10. Fritjof Capra and Randy Hayes, "Green and Peace: A Visionary Link," *Greenpeace Examiner* (Oct.-Dec. 1986), p. 14.
11. "Green and Peace," p. 15.
12. "Green and Peace," p. 15.
13. See "Gaia: Ecologists Embrace the Earth Goddess" by Rogelio A. Maduro and "Mother Earth Marries Satan" by Carol White in *21st Century* (Sept.-Oct. 1989), p. 50.
14. If you rummage through your discarded junk mail you may find a promotional brochure for the "Mysteries of the Unknown" series from Time-Life Books. The brochure exhorts the reader to "Examine the evidence that an unseen world exists side by side with our own . . . a mysterious world of unseen and unearthly powers." It asks, "Have you—or someone you know—ever had an experience that couldn't be explained by the ordinary, 'rational' laws of nature?" The advertisement is decorated with tarot cards, a crystal skull believed to have mystic powers, and a portrait of Russian theosophist and occultist Helena Blavatsky.

    Not to be outdone, *Reader's Digest* offers a book called *Mysteries of the Unexplained*, which it advertises with the following: "From alien invaders to ghostly apparitions—dare we allow our most fondly held beliefs to be shattered beyond repair? As page after page of tantalizing events take you far beyond the bounds of reason, you may well wonder: Must we abandon our ironclad notions about natural law to deal with the *supernatural*? Must every effect have a cause, every occurrence an explanation? Don't be surprised if you find your common sense thinking turned upside down!" The attached postcard for sending in an order is labeled "Your passport to the world beyond human understanding."
15. *Sink the Rainbow!*, p. 58.
16. Tom Rose, *Freeing the Whales* (New York: Birch Lane Press, Carol Publishing Group, 1989), p. 87.
17. *Freeing the Whales*, p. 90, 215.
18. *Freeing the Whales*, p. 243.
19. "Thanks, Whale Savers," *Greenpeace* (Jan.-Feb. 1989), p. 22.
20. Greenpeace U.S.A., Inc., "1988 Report," p. 10.
21. Richard Harrington, "On the Beat," *Washington Post* (Dec. 20, 1989) p. B7.

RNA Catalysis Gives Insight Into the Life Process

by John Grauerholz, M.D.

Molecular biology has categorized biological molecules as either functional or informational—doing the work of building life or telling other molecules what to do. This has presented a paradox, because such a division makes it hard to conceive how life could have originated. In other words, *which came first, the chicken or the egg* (or in this case, the functional molecule or the informational)?

Now scientists have shown that molecules of RNA (ribonucleic acid), a form of genetic material previously believed to be only informational, can also act as enzymes, previously believed to be only functional.

This is a discovery for which Thomas Cech (pronounced *check*) of the University of Colorado at Boulder and Sidney Altman of Yale University won the 1989 Nobel prize in Chemistry. Working on a group of chemicals known as ribozymes, Cech and Altman independently proved that RNA could function as enzymes. Previously, scientists had thought that only proteins could function as enzymes.

The division between functional molecules and informational molecules results from the information theory interpretation of DNA and RNA function. In this theory, the genetic material, DNA (deoxyribonucleic acid) or RNA, is a passive information template, like a computer tape. Enzymes, which are functional molecules, transcribe this template to other RNA information molecules. Then other enzymes translate the new RNA molecules into still other protein enzymes, which then assemble the components of the living organism. The protein enzymes are purely functional and carry no information.

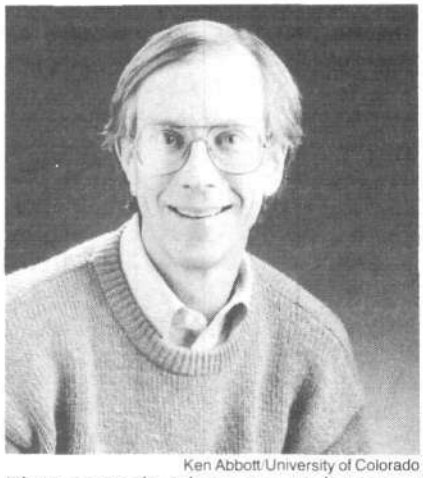
Protein enzymes are needed to assemble the nucleic acid building blocks of RNA and DNA. So the enzymes have to exist before the DNA or RNA. But, since the protein enzymes are assembled from an information template contained in DNA or RNA, the template has to exist to create the proteins that are necessary to create, transcribe, and translate the template. *So, which came first?*

Molecular Causality

The pioneers of molecular biology recognized this problem. Some of them, including Francis Crick, the codiscoverer of the structure of DNA, hypothesized that a catalytic RNA, which combined informational and functional properties, would solve the dilemma.

Enzymes are naturally occurring catalysts, responsible for many essential biochemical reactions. The belief that only proteins possessed enzymatic activity was embedded in the so-called central dogma of molecular biology, which states that information flows in a one-way direction, from DNA to RNA to protein, and that DNA is simply a sequence of molecules that code instructions for assembling protein enzymes. This is the "one gene, one enzyme" theory.

Scientists soon found that not all the DNA in the genetic material codes for the creation of protein enzymes. The majority of the DNA in higher organisms does not code for production of protein enzymes, but serves various other functions, many still unknown. In addition, when DNA is transcribed into RNA, some of the transcribed RNA contains extra sequences of nucleotides, which are eliminated from the RNA before it assumes its final form. Since these sequences don't conform to the one gene, one enzyme dogma they are called "nonsense sequences."



Ken Abbott/University of Colorado

Thomas Cech, whose research team at the University of Colorado found isolated ribosomal RNA that spliced itself.

The process of copying information from DNA to RNA is called transcription and the product is known as an RNA transcript. When the transcript contains extra sequences, it is called a *precursor or pre-RNA. When the extra* sequences are removed, the RNA is converted to its final form. There are several types of RNA involved in assembling proteins.

One type of RNA is ribosomal RNA. Ribosomes are structures consisting of RNA and protein, which are involved in the final assembly of amino acids into proteins. Amino acids are the building blocks of proteins, just as nucleic acids are the building blocks of DNA and RNA.

DNA, RNA, and protein are polymers—large chemical molecules formed by the assembly of smaller molecules. Polymerization is the process that forms these molecules, and the catalytic enzymes, which enhance the process, are called polymerases. Thus we have DNA polymerases and RNA polymerases.

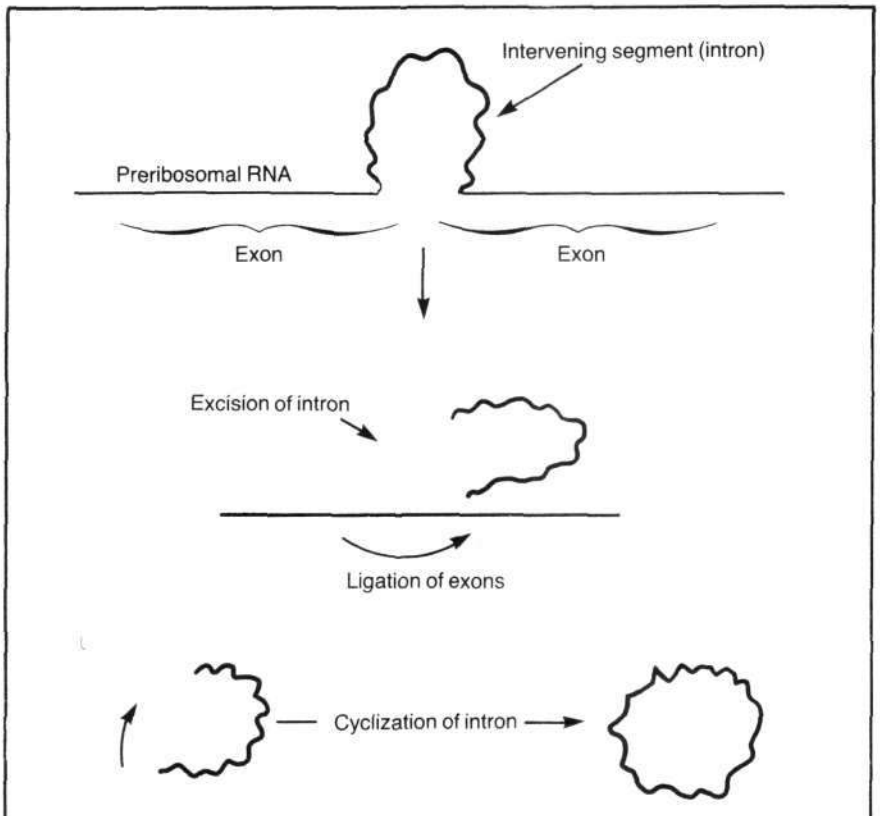


Figure 1
RNA AS A CATALYST: EXCISION AND LIGATION IN PRERIBOSOMAL RNA

In studying ribosomal RNA (rRNA) of the tetrahymena, Cech and colleagues discovered that RNA could spontaneously splice itself and then close off or cyclize. Preribosomal RNA consists of two mature segments of RNA (exons) interrupted by an intervening segment (intron) of RNA. The intervening segment excises itself (excision) and causes the two exons to join together (ligation) to form the mature ribosomal RNA. The excised intervening segment (intron) then forms a closed loop of RNA (cyclization).

These are all chemical reactions based on breaking and forming chemical bonds, and they require the presence of an enzyme catalyst. In this case, the catalyst is a part of the reacting RNA molecule.

Source: Adapted from a © Nobel Foundation illustration.

Cech's Initial Discovery

Cech and his colleagues studied how one nonsense sequence is eliminated from a preribosomal RNA molecule after transcription from a DNA molecule. This involves removing the specific sequence by a process called excision, then joining the ends of the two remaining pieces by a process called ligation (Figure 1). The entire process of excision of the *intron* and ligation of the remaining segments, or *exons*, is known as *splicing*.

Excision involves breaking chemical bonds in a polymer and ligation involves forming chemical bonds. Specific enzymes, known as endonucleases and ligases, catalyze these chemical reactions. Specificity of enzyme action is important, since the correct segment must be removed and the correct ends stuck together to produce a functional molecule.

Cech and his colleagues studied the production and processing of preribosomal RNA in isolated cell nuclei. They worked with a single-celled animal, or protozoan, known as tetrahymena (Figure 2). This little amoeba-like creature contains an intervening sequence, or intron, in the genes that code for the production of ribosomal RNA.

When Cech examined the intervening sequence removed by the splicing reaction, he found something unusual. The excised RNA existed in two different forms, a linear string and a closed circle. This implied the action of another enzyme, known as a cyclase. (Cyclases are enzymes that convert linear molecules into circular molecules.)

When Cech attempted to identify these enzymes, he found something even more unusual. The isolated ribosomal RNA spliced itself! In a 1982 paper that reported these results, Cech and his colleagues proposed that the intervening segment RNA had several enzyme-like properties. Its activity depended on a precise structure. It lowered the activation energy for specific chemical reactions. And it possessed specific active sites for binding to its target molecule and a cofactor molecule.

The intervening segment RNA appeared to lack true catalytic activity. Under laboratory conditions each intervening segment molecule excised itself from the adjacent exons and cyclized itself, but did not promote the splicing of other preribosomal RNA. Because the intervening segment RNA was not an enzyme, but had enzyme-like properties, Cech called it a *ribozyme*, an RNA molecule with the ability to break and form chemical bonds.

Spontaneous Catalytic Function

The proof that RNA could act as a true catalyst came a year later in the laboratory of Sidney Altman at Yale. Altman and his colleagues were studying a different form of RNA, known as transfer RNA, also involved in the production of protein molecules. They were looking at an enzyme of bacteria, known as ribonuclease P, which converts the transfer RNA precursor to its final form by cutting a "nonsense segment" off one end of the molecule.

In the 1970s, Altman's group showed that ribonuclease P consisted of protein and RNA, and that both were necessary for the molecule to act as an enzyme. Since enzymes were supposed to be proteins, they initially assumed that the RNA performed a noncatalytic function. After Cech's

group showed that RNA could spontaneously excise and ligate itself, Altman's group went on to discover conditions in which the ribonuclease P RNA would act as a catalyst, even without any protein.

Since then, many examples of RNA catalysis have been found. Among others, Cech's group showed that part of the RNA removed from the tetrahymena preribosomal RNA had the same catalytic activity as protein enzymes. One reaction catalyzed by this RNA is the polymerization of cytidilic acid, the nucleic acid form of cytosine, one of the building blocks of RNA. Thus, this RNA acts as an RNA polymerase; that is, it has the potential to assemble itself.

More recently, two researchers from Massachusetts General Hospital in Boston showed that the tetrahymena ribozyme can splice together multiple RNA bases on a template strand of RNA and produce a complementary strand. This proves that RNA can actually catalyze its own replication.

Besides bacteria and tetrahymena, ribozymes are widely present in mitochondria, the cell organelles responsible for energy production. Mitochondria have their own RNA, independent of the cell nucleus. They also reproduce independently of the cells they inhabit and are thought by some to represent one of the earliest living forms to come into existence. This has led to the belief among some that the earth of 4 billion years ago was an "RNA world," in which RNA molecules carried out all the processes of life without the help of either proteins or DNA.

'Gene Shears' and Patent Fights

The discovery of ribozymes promises to add another capability for manipulating genetic material, inserting or taking out genes in plants, for example. Cech and his group have altered the binding site of the tetrahymena ribozyme and produced predictable changes in where it cuts an RNA molecule. Olke Uhlenbeck, another University of Colorado researcher, extended this work, raising the possibility of manipulating specific RNA molecules in cells with RNA catalysts known as "gene shears."

An improvement on Uhlenbeck's technique is reported by two researchers at the Plant Industry Division of the Australian Commonwealth Scientific and Industrial Research Organization (CSIRO), Jim Haseloff and Wayne Gerlach. They constructed RNA catalysts from plant virus satellite RNA. These RNA catalysts can cut more different RNA sequences, at more specific locations, than previous "gene shears."

Like many tales of modern science, the discovery of ribozymes would be incomplete without a patent lawsuit. In this case, CSIRO announced in July 1989 that it held worldwide patents to the discovery, and that Australia would benefit from the many potential applications of the technology. The CSIRO patent didn't mention Cech or Uhlenbeck. This was more than a simple oversight, since Cech filed a broad patent application on the technique in 1986. So several people, including officials of the Australian Patent Office, think that CSIRO will not get its patent.

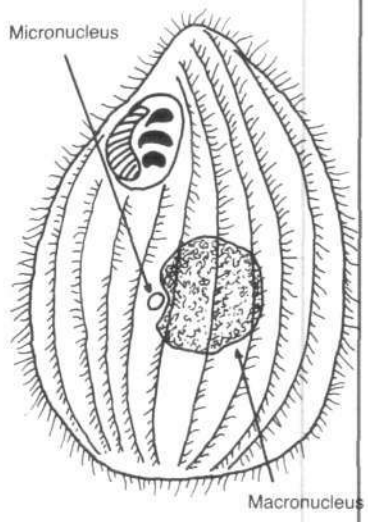
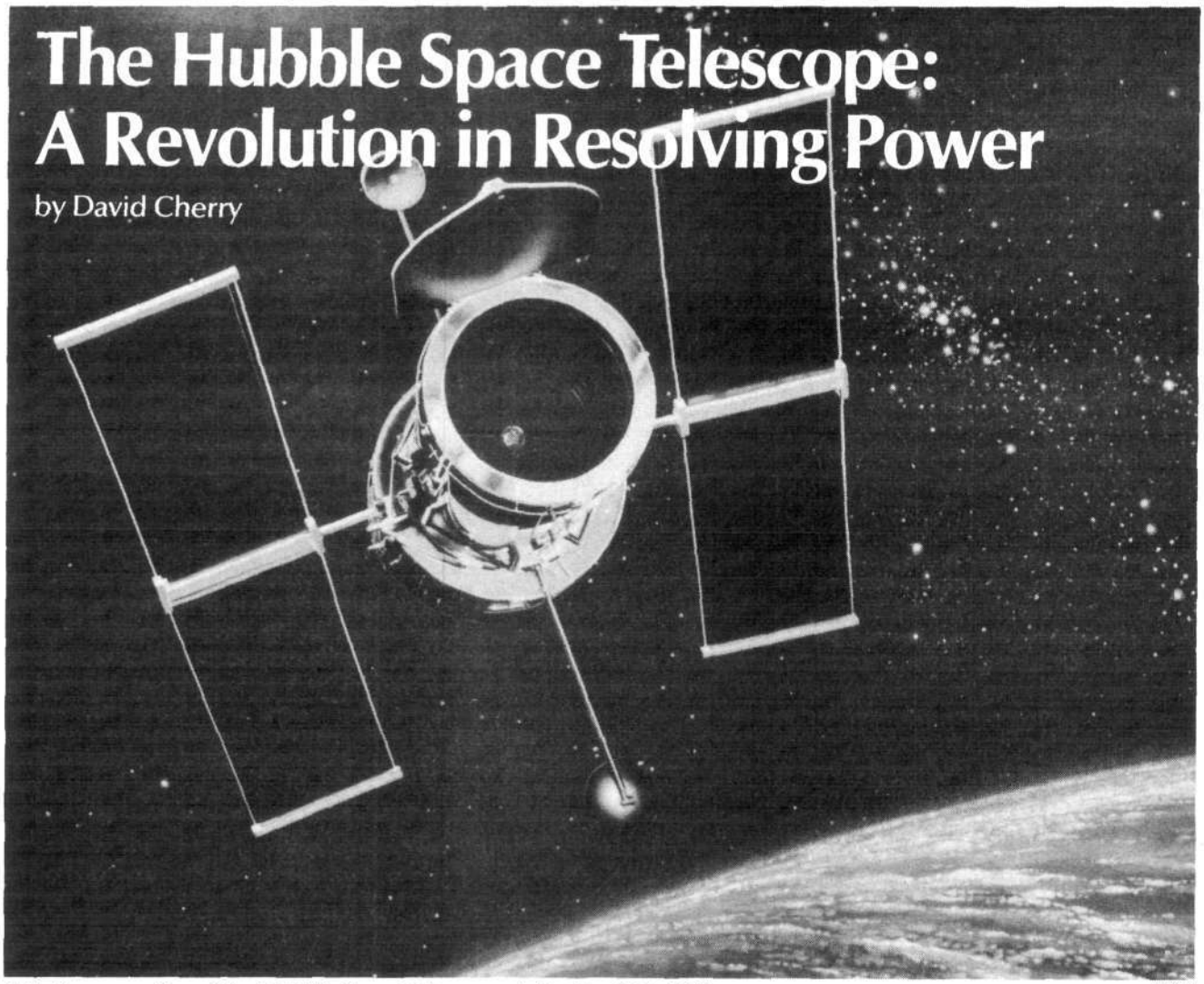


Figure 2
TETRAHYMENA *THERMOPHILA*
Tetrahymena, the one-celled creature that has an intron in its genes that codes for the production of ribosomal RNA. The micronucleus transmits genetic information to offspring, while the macronucleus is responsible for cell metabolism. Cech found that excised RNA had two different forms, a linear string and a closed circle (shown in Figure 1).
Source: © Nobel Foundation

The Hubble Space Telescope: A Revolution in Resolving Power

by David Cherry



Artist's conception of the Hubble Space Telescope, lofted April 24, 1990. NASA

The eventual success of the Hubble Space Telescope will mean the greatest advance in *resolving power* since the first telescopes in the era of Galileo. On Earth there are telescopes with larger mirrors and hence more light-gathering power than the Hubble. They can see fainter objects than the Space Telescope will see. But because of the intervening atmosphere, they will not have its resolving power—its ability to distinguish the detailed features of an object (see figure).

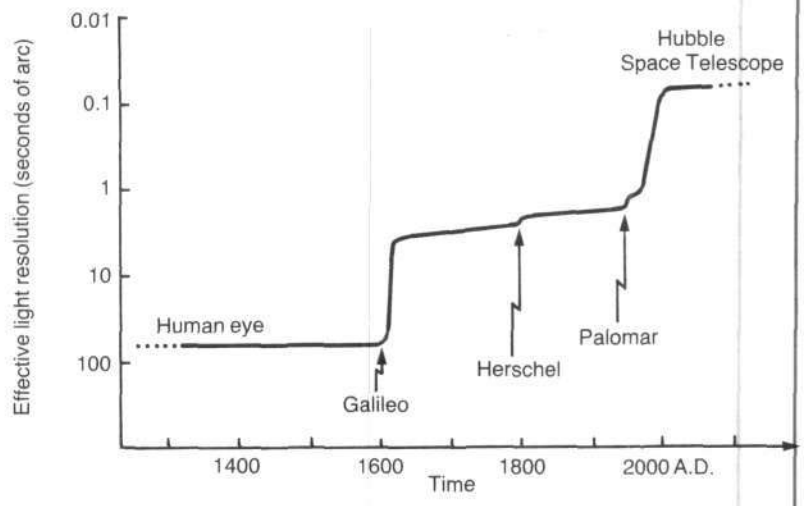
With this new vista opening up before us, the most important result we should expect is simply the unexpected.

Was the Space Telescope a project that developed from the steady pressure of astronomers for more advanced technologies? Far from it. Most astronomers did not want such a project when it was first concretely posed in 1946. A ground-based observatory, many said, was a sure thing. A space-based observatory would entail too much money and too much risk, they argued.

The project for a Space Telescope came into being as part of the upsurge that followed the Soviet launch of Sputnik in 1957, a surge that created NASA and put men on the Moon. The *pre*history of the Space Telescope, however, lies in the ideas of only a few visionary minds.

Hermann Oberth, the German rocket pioneer, wrote in the 1920s of the possibilities and potentials of orbiting telescopes. The success of the German rocket scientists during World War II inspired another young dreamer, Yale astronomy professor Lyman Spitzer, who later settled at Princeton.

In 1946, Spitzer wrote a paper on the "Astronomical Advantages of an Extra-Terrestrial Observatory," which became part of a larger study titled "Preliminary Design of an Experimental World-Orbiting Spaceship," sponsored by Douglas Aircraft's Project RAND. Spitzer argued that "the chief contribution of such a radically new



THE BIGGEST LEAP IN RESOLVING POWER IN 400 YEARS

Once corrective optics are in place, the 94-inch Hubble Space Telescope will improve on the resolving power (sharpness of image) of previous telescopes by a factor of 10, by getting above Earth's atmosphere. No such improvement has occurred, even in stages, since the telescope improved on the unaided eye in Galileo's time. Larger and larger Earth-bound mirrors have improved telescope light-gathering power*—that is, their ability to see faint objects—without doing much for their resolution, as the graph shows.*

Source: STScI

and more powerful instrument would be, not to supplement our present ideas of the universe we live in, but rather to uncover new phenomena not yet imagined, and perhaps modify profoundly our basic concepts of space and time."

Spitzer was unsuccessful in his efforts to rouse the interest of other astronomers. They "were all quite startled" to find a "serious astronomer" talking about big space telescopes, he recalled. His 1946 paper was soon classified by the Army.

The Shock of Sputnik

The shock of Sputnik, announced Oct. 4, 1957, changed the national consciousness. The National Aeronautics and Space Administration (NASA) came into being one year later. The National Academy of Sciences formed a Space Science Board under Lloyd Berkner, who called for proposals. Some astronomers, especially those who, like Spitzer, were interested in pursuing ultraviolet and other wavelengths screened out by Earth's atmosphere, saw their chance, and helped shape plans for Orbiting Astronomical Observatories (OAOs).

Even these astronomers wanted small, simple telescopes. NASA insisted on larger, more complex ones. OAO-I, the first of four OAOs, had more than 440,000 parts and 30 miles of wiring. OAO-I went up in 1966 and failed completely, as did OAO-III, but the other two were highly successful.

While the OAOs were still being planned, in May 1961, President Kennedy announced a national mission to land a man on the Moon. The effect of his announcement was profound. Anything seemed possible, provided leadership and will were there. It was in this most optimistic atmosphere that the tiny corps of astronomers dedicated to a large space telescope (LST) charged forward. Here were Spitzer and Leo Goldberg, Arthur Code, Robert Bless, C.D. Shane, Fred Whipple, and Aden Meinel.

They fought for the LST at a review of space science possibilities held in Iowa City in 1962, organized by the Space Science Board. The Working Group on Astronomy at this meeting waxed poetic over the chance to breach the narrow bounds imposed by Earth's atmosphere.

Without the high tide of NASA's space program in the 1960s, the Space Telescope would almost certainly not be a reality today. In 1969, the year men first walked on the Moon, astronomer Robert Bless visited observatories and astronomy departments for NASA and found at last "a general recognition that space astronomy did have something useful to contribute."

But astronomers and other space scientists didn't like working with NASA. They feared their wishes would be largely ignored by NASA bureaucrats, that they would not have enough control over scientific missions.

Incredibly, this justified concern was laced with an aversion for the larger thrust of the space program that made space astronomy possible. Homer Newell, a NASA science administrator, wrote later of the scientists' discontent: "The emphasis given to very large scale programs—space shuttle, space stations and space bases, lunar bases, nuclear shuttles, Grand Tours, and manned missions to Mars—had a very negative effect."

Astronomers Turn Around

The most wonderful irony of all however, is that—having been dragged kicking and biting into the space age—astronomers turned around in the 1970s and began fighting for control of the scientific work to be performed by the Space Telescope. One NASA administrator above all, C. Robert O'Dell, an astronomer by background, deserves credit for ensuring that NASA ceded this control to the Space Telescope Science Institute (STScI), created for the purpose.

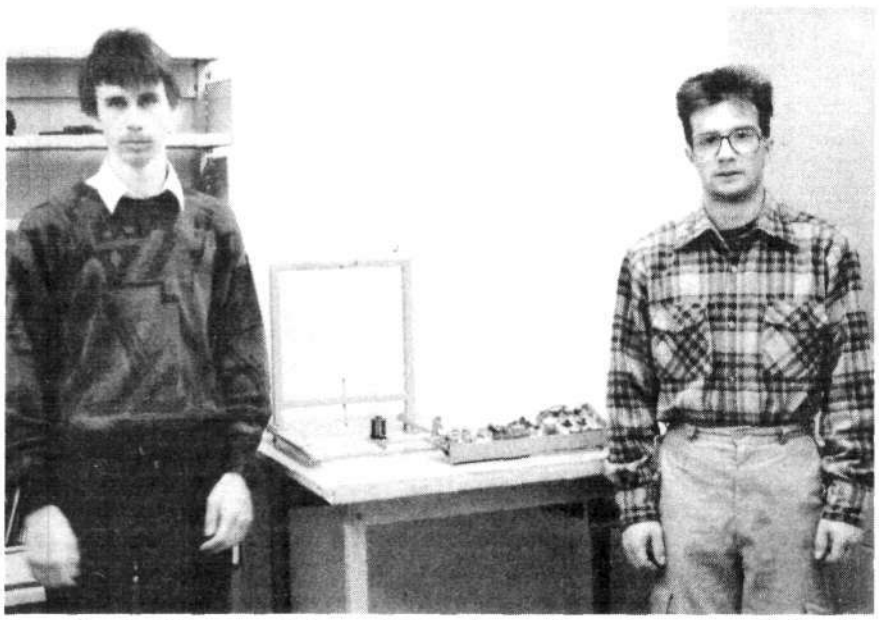
The story told here is recounted in detail in *The Space Telescope: A Study of NASA, Science, Technology, and Politics*, by Robert W. Smith (Cambridge University Press, 1989).

Is astronomy too important to be left to the astronomers? Perhaps it is too important to be left *only* to them. A small minority of astronomers has actually been driven by that most human need, "to uncover new phenomena not yet imagined, and perhaps modify profoundly our basic concepts of space and time," which was Spitzer's rationale in 1946, and is the Space Telescope's rationale today. As STScI director Riccardo Giacconi recently said, "It is the only important thing we do."

Tracking Earthquakes: An Experimental Seismic Station

by David Cherry

Building a simple seismograph to measure the intensity of earthquakes is a challenging project. Even more demanding is the building of a seismic station that can also find the direction of origin of an earthquake. We salute Pietro Costa and Jean-Claude Villeneuve, who built such a station while attending La Porte du Nord High School in Chibougamau, Québec. They got their idea from a Science-Réalité television broadcast describing the use of induced seismic waves in petroleum prospecting. Their project won the 1989 Canadian Science and Development Award sponsored by the International Development Research Centre (IDRC) in Ottawa.



Jean-Claude Villeneuve (left), and Pietro Costa, above the 50th parallel in the province of Québec, with one of their geophones.

Their device consists of three identical detectors (geophones) that produce electric current in response to motion in the Earth's crust; a two-stage amplifier with three channels, one for each geophone; a tape recorder they modified to record three tracks on the tape simultaneously; and a Tandy 1000-TL computer (Figure 1). The system was powered by automobile batteries.

The cost of the project was high, around $3,000 Canadian, largely because the kind of seismic waves they expected to encounter are of high frequency, requiring a computer that would sample the tape at a fairly high frequency. Since the computer would be reading only one track at a time, to achieve a sampling rate of 333 times per second for each of three tracks required a computer with a sampling rate of 1,000 times per second. The other electronics cost very little, because the boys built them themselves using parts from discarded electronic equipment.

The geophones are the heart of the system, and work on the principle of magnetic induction. As Costa and Villeneuve explain in their report, "when a magnetic field is moved across a circuit, electric current will flow in the

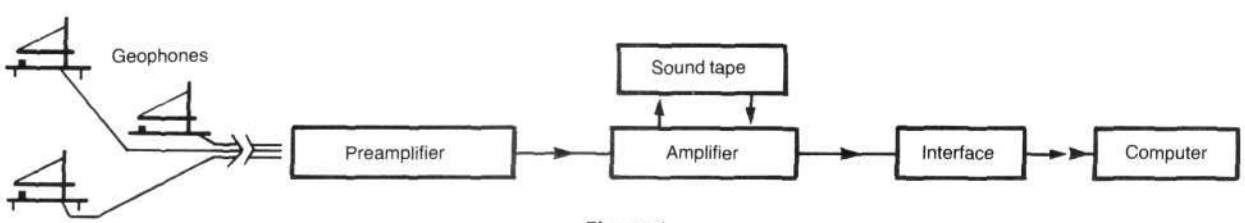


Figure 1
GENERAL SCHEME OF THE SEISMIC STATION
The device constructed by Costa and Villeneuve amplifies the electric currents produced by the three geophones and records them on parallel tracks on magnetic tape, for later comparison by computer.

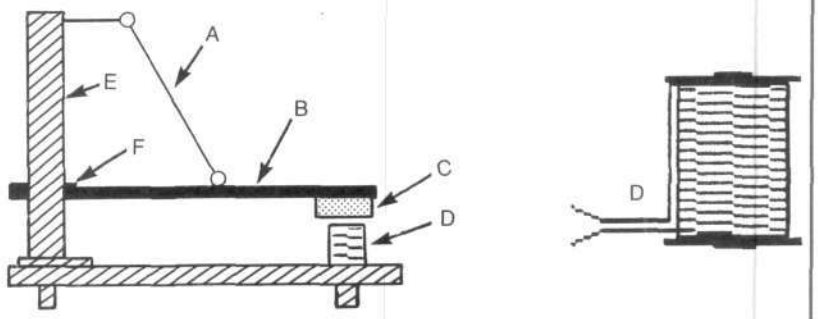


Figure 2
DESIGN OF THE GEOPHONE

Seismic waves cause the magnet to swing, inducing a current in the coil beneath it. Costa and Villeneuve write: "Our geophone consists of an iron frame, E, which rests on the Earth on three feet; an arm, B, with a magnet attached, C; the arm is suspended by the line A, and supported on the pivot F; the coil, D, is very simple. It is made of 320 meters of wire wound around a core of 10 rods of mild steel to form the ferrous inductor, which serves as a magnetic connection between the coil and the magnet to increase the effectiveness of the latter."

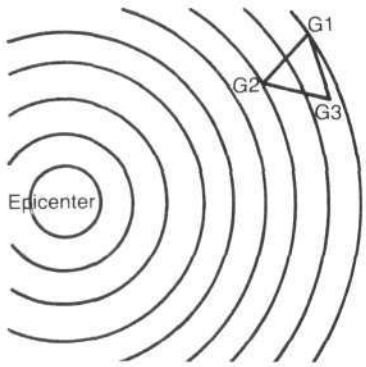


Figure 3
DETECTION OF SEISMIC WAVES

The differences in arrival time at the three geophones can be used to determine the direction from which the seismic wave is arriving, in the manner shown in the table.

circuit, and the amount of the current induced in this way is proportional to the movement of the magnet," which follows from Faraday's law of induction.

To employ this principle, the boys built geophones in which a magnet is suspended over a coil of copper wire (Figure 2). Seismic disturbances will cause the magnet to swing. The current that this motion induces in the coil is then amplified and recorded on tape, just as if it were the current produced in a microphone when it is activated by sound. They found that their geophones were capable of registering the vibrations of human footsteps at a distance of 4 meters. The geophones were so sensitive, in fact, that they were not able to avoid radiowave interference entirely, although they installed a filter that eliminated some of it.

Directionality

The two experimenters proposed to use the three geophones to determine the direction from which seismic disturbances arrive. How could this be done? They adopted an established method. Seismic waves are circular waves that expand outward from the origin, as when a pebble falls into a still pond. Therefore, placement of the three geophones in a sufficiently large triangle would result in measurably different arrival times for a seismic wave (Figure 3). To make the interpretation of these differences as simple as possible, they made the triangle equilateral.

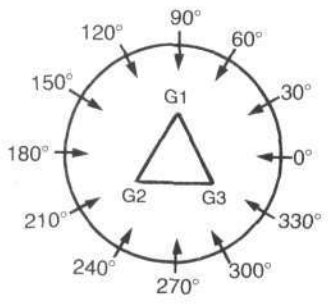
Costa and Villeneuve used the accompanying table to interpret the differences in arrival times. (The reader can work backwards from the table, with the help of Figure 3, to demonstrate that this procedure works and to prove that it works to a theoretical accuracy of ± 15 degrees.) They wrote

DIRECTION OF ORIGIN OF SEISMIC WAVES

Order of arrival at geophone G1	G2	G3	Direction of origin in degrees
2	3	1	0
1	1	3	30
1	3	2	60
1	3	3	90
1	2	3	120
1	3	1	150
2	1	3	180
3	1	3	210
3	1	2	240
3	1	1	270
3	2	1	300
3	3	1	330

Example: If the wave is received at G1 first, G2 second, and G3 third, its direction of origin is 120 ± 15° with respect to the accompanying key.

KEY



a computer program in BasicA to accept and interpret the data in terms of the table.

Field Work

The boys chose a site with the help of local geologists. Their criteria were that the site should be over a *pluton*, that is, a body of igneous rock formed at great depth and extruded upwards; that there should be three outcroppings of the rock such that an equilateral triangle of sufficient scale could be based upon them; that the site should be as close to home as possible, should be accessible in winter, and should permit the construction of a hut for protection of the experimenters during winter.

The problem of winter access was not a minor one: The town of Chibougamau is just above the 50th parallel at the southern tip of Lake Mistassini, where winter temperatures of −40°C are not uncommon. Some of their field work was done in spite of two feet of snow.

The site they chose is part of the "stock de Roy," characterized by plutonic outcroppings from the Early Precambrian period, and is only a dozen kilometers from town. They thought this was an especially choice site, since dynamite blasting was taking place at the Portage copper mine less than 3 km away. This would allow them to achieve experimental results without having to wait for earthquakes. (Eventually they set off their own blasts, carried out under qualified supervision.) At this site they established an equilateral triangle on the outcroppings about 65 meters on a side.

Imagine their excitement when an "extraordinary, unexpected event" occurred Nov. 25, 1988: The Earth trembled! They immediately decided to spend the night at their hut in the hope of capturing any minor vibrations that might follow. Unfortunately, the only vibrations they were able to detect were too weak to be interpretable.

Nevertheless, their system was very successful in recording and interpreting seismic waves from their explosions, as is evident in Figure 4.

Costa and Villeneuve entered their project in Expo-Sciences, an annual science fair sponsored by the Council for the Development of Scientific Leisure. They also took their work to the international Expo-Sciences fair in France in 1989.

Now, they have just finished their first year of college. Villeneuve is a future engineer and Costa plans to specialize in geology or geophysics.

For readers who wish to contact them, Pietro Costa's address is 125 Vinette St., Chibougamau, Québec G8P 1G6, Canada (418) 748-3831. Jean-Claude Villeneuve's is 135 Edouard, Victoriaville, Québec G6P 3J1, Canada (819) 752-6173.

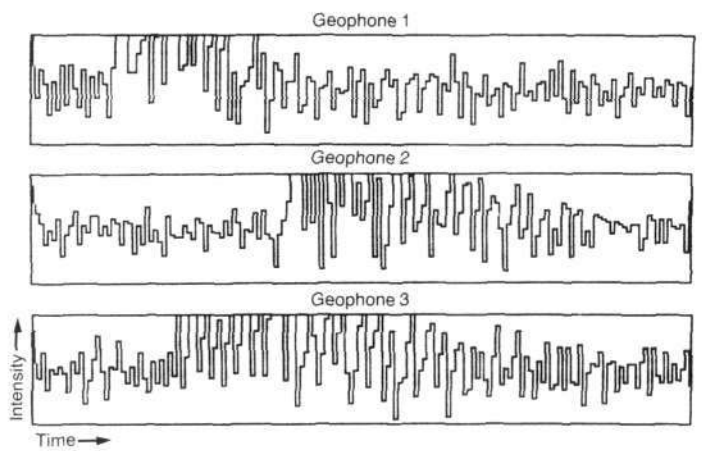


Figure 4
SUCCESS OF THE SEISMIC STATION IN RECORDING EXPLOSIVE BLASTS
This recording of an explosive blast in February 1989 shows clearly the differences in arrival times of the seismic waves. Here the computer has given a graphic form to the information stored on magnetic tape.

For Further Study

American Geological Institute, *Dictionary of Geological Terms*, Revised edition (New York: Anchor Press/Doubleday, 1976).

M. Bath, *Introduction to Seismology* (New York: Halsted Press, 1974).

Bruce A. Bolt, *Earthquakes—A Primer* (San Francisco: W.H. Freeman, 1978).

Keith E. Bullen, *Introduction to the Theory of Seismology*, Third edition (New York: Cambridge University Press, 1963).

W. Edmund Hood, *Beginner's Guide to Electricity and Electrical Phenomena* (Blue Ridge Summit, Pa.: TAB Books, 1983).

John A. Jacobs, "Seismology and the Deep Structure of the Earth," in: *The Cambridge Encyclopedia of Earth Sciences*, David G. Smith, ed. (New York: Crown Publishers/Cambridge University Press, 1981).

L. Don Leet et al. *Physical Geology* [Introductory college text], Fifth edition (Englewood Cliffs, N.J.: Prentice-Hall, 1978).

Charles F. Richter, *Elementary Seismology* (San Francisco: W.H. Freeman, 1958).

Elliott Roberts, *Our Quaking Earth* (Boston: Little, Brown, 1963).

R.H. Warring, *Understanding Electronics* (Blue Ridge Summit, Pa.: TAB Books, 1978).

Fusion Report

Continued from page 23

Even with the knowledge gained by Japan's cold fusion research, it is too early to assert that cold fusion definitely occurs. We must await results from future research.

Question: Is there anything else that you would like to say to an American audience about cold fusion?

Since the aggravation of environmental as well as resource crises affects the existence of the human race, it is pertinent to solve these problems without a minute's delay. To this end, realization of a fusion reactor is of great urgency.

Development of the high-temperature plasma fusion reactor has made good progress with international collaboration, and its implementation is not too far away. Therefore, if an illusion of cold fusion as a candidate for a power source delays development of the high-temperature plasma fusion reactor in any way, not only are research efforts and investments on the equipment of the plasma fusion reactor being wasted, but it would also arrive too late for the avoidance of crises that human beings are now facing.

In conclusion, cold fusion research should proceed calmly as pure science; it is nothing more than that.

Nuclear Waste

Continued from page 17

material needed in the manufacture of plutonium-238, which is used to power spacecraft and deep space probes. Plutonium-238 isn't manufactured directly in the reactors; it has to be manufactured from neptunium, certainly in the amounts that are required. We can create kilogram-quantities of plutonium-238 by first removing the neptunium-237, and then using that as a neutron target. Americium now has several applications such as in smoke detectors.

Question: What about transmutation? Can the neutrons created in Hanford's Fast Flux Test Facility be used to transmute the long-lived plutonium and uranium into materials with shorter radioactive half-lives.

Yes. Typically they transmute the plutonium and uranium in waste material into materials that are still radioactive but much shorter lived, or into materials that certainly *cannot* be made into weapons. I used to be rather pessimistic about transmutation. We thought transmutation wasn't worth it because it would require a $3 billion accelerator to neutralize 1 kilogram of plutonium. But that's not the situation; we can create the neutrons as a technological by-product in the Fast Flux Test Facility device. Research on this needs to be demonstrated on a meaningful scale to develop solid engineering and economic information.

Question: What about the fearful question the environmentalists bring up about how the nuclear waste would be transported from where it is created to where it would be buried or reprocessed?

There are about 100 million shipments of toxic materials annually in the United States. The transportation of gasoline has more accidents than all of the others combined. How many oil spills does this nation have to have before it understands the risks of transporting energy?

When it comes to spent nuclear fuel, the specially designed shipping casks are so sturdy that they present almost zero risk to the public when they are transported. They have been drop tested, fired tested, puncture tested, immersion tested, and crash tested and they hold up very nicely to all these engineering abuses.

So, when I speak to groups like firemen, as I often do, I conclude by saying that if I were a fireman running out to a fire on a highway or a railroad crossing and I didn't know what I would find—gasoline, propane, natural gas, or some form of nuclear shipping casks—I would pray that it were some form of nuclear shipping cask, because those other forms of energy shipments can and do kill people, including firemen.

Question: This country began its nuclear program with the assumption that we would complete the nuclear fuel cycle. What happened?

There are several reasons that we're not reprocessing fuel in the United States. One is that nuclear energy has fallen on controversial times and that the growth of nuclear energy has not been as rapid as was earlier expected. Therefore, the need for nuclear fuel on an annual basis has been reduced and the economics of fuel reprocessing are not very good at this moment, even though the British and French make big money at it.

Another really serious problem is the lack of regulatory stability in the nuclear industry. There has been an explosion of regulatory agencies in the last 10 to 15 years. As a result, nuclear energy costs have been very directly influenced by the regulatory burden placed upon the nuclear industry.

The owners of the Barnwell fuel-reprocessing capability, just like utilities that own nuclear reactors, want to see a lot more assurances from the U.S. government concerning regulatory stability before they begin to operate that plant. Barnwell was shut down during the first years of the Carter administration. President Reagan said it was no longer forbidden to reprocess spent nuclear fuel, but he did so without lifting, modifying, or stabilizing the regulatory climate in which reprocessing had to operate.

Until there is some realism in the regulation of the nuclear industry—such as exists in many other nations—nobody in the United States is going to make a move.

BOOKS RECEIVED

Cold Fusion—The Making of a Scientific Controversy, by F. David Peat. Chicago: Contemporary Books, 1989. Hardcover, 188 pages, $16.95.

Muon-Catalyzed Fusion, Steven E. Jones, Johann Rafelski, and Hendrik J. Monkhorst, eds. Proceedings of a 1988 conference. New York: American Institute of Physics, 1989. Cloth, 467 pages, $61.75.

The Biosphere, by Vladimir Vernadsky. Abridged version based on the French edition of 1929. Oracle, Ariz.: Synergetic Press, 1986. Paperback, 82 pages, $5.95.

Science and Russian Culture in an Age of Revolutions—V.I. Vernadsky and His Scientific School, 1863-1945, by Kendall E. Bailes. Bloomington: Indiana University Press, 1990. Cloth, 238 pages, $29.50.

Perspectives on Biogeochemistry, by Egon T. Degens. New York: Springer-Verlag, 1989. Paperback, 423 pages, $59.

Appropriating the Weather—Vilhelm Bjerknes and the Construction of a Modern Meteorology, by Robert Marc Friedman. Ithaca: Cornell University Press, 1989. Hardcover, 251 pages, $39.95.

Global Climate Change—Human and Natural Influences, edited by S. Fred Singer. New York: Paragon House, 1989. Hardcover, 424 pages, $34.95.

The Greenhouse Trap—Why the Greenhouse Effect Will *Not* End Life on Earth, by John L. Daly. Sydney, Australia: Bantam Books, 1989. Paperback, 192 pages, Aust. $16.95.

Freeing the Whales—How the Media Created the World's Greatest Non-Event, by Tom Rose. Carol Publishing, 1989. Hardcover, 318 pages, $18.95.

The Space Telescope, by George Field and Donald Goldsmith. Chicago: Contemporary Books, 1989. Hardcover, 276 pages, $18.95.

Alice and the Space Telescope, by Malcolm Longair. Baltimore: Johns Hopkins University Press, 1989. Cloth, 198 pages, $28.95.

The Space Telescope—A Study of NASA, Science, Technology, and Politics, by Robert W. Smith. New York: Cambridge University Press, 1989. Hardcover, 478 pages, $39.50.

Edward Teller—Giant of the Golden Age of Physics. By Stanley A. Blumberg and Louis G. Panos. New York: Charles Scribner's Sons, 1990. Hardcover, 306 pages, $24.95.

Technology and Transformation in the American Electric Utility Industry, by Richard F. Hirsh. New York: Cambridge University Press, 1989. Cloth, 274 pages, $37.50.

Telling the Offensive Truth About AIDS

by John Grauerholz, M.D.

The Myth of Heterosexual AIDS: How a Tragedy Has Been Distorted by the Media and Partisan Politics
Michael Fumento
New York: Basic Books, 1990
Hardcover, 411 pages, $22.95

Michael Fumento's book is in many ways like the 1960s movie "The Loved One," based on a novel by Evelyn Waugh and billed as the "Movie with something to offend everyone": Many people disagree with the book for many different reasons.

Some of this disagreement has been expressed in scathing reviews and some in harassment of the author, who was fired from his job as a reporter for the Denver *Rocky Mountain News*.

The irony is that Fumento has simply looked at the official statistics on AIDS and drawn what appear to be perfectly reasonable conclusions. Briefly these are:

(1) To the present date, the majority of AIDS cases in the United States continue to occur among homosexual men, intravenous drug users, and those who have received blood from, had sexual intercourse with, or been born to one of the first two groups.

(2) The epidemic among homosexuals has passed its peak and is declining.

(3) The disease is continuing to spread in the intravenous-drug-using population, but at a slower rate than previously.

(4) The much ballyhooed heterosexual epidemic in the white middle class has failed to materialize, although sporadic cases have occurred in this group.

Fumento goes on to point out that while AIDS is widespread among minority intravenous drug users whose sex partners account for the vast majority of so-called heterosexual transmission cases, the overwhelming expenditure of propaganda funds is for "safe sex" messages to the white middle class. He is uncouth enough to suggest that some of those funds might have been more productively spent on measures to control the spread of the disease among those actually affected.

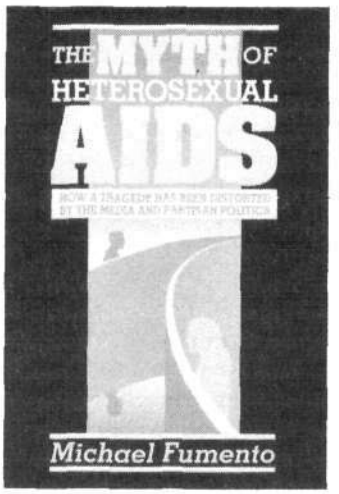
Fumento's book was the subject of a vitriolic review in *Nature* magazine ("Beyond the Evidence," Jan. 25, p. 321) by Duncan Campbell, an associate editor of *New Statesman/Society* in London. Campbell writes:

"Michael Fumento's writings and ideas have already made a significant public impact through the pages of the British and U.S. newspapers in which he has argued his controversial case for more than two years. His analysis has been used to criticize general public health education, to attack the scale and priority of AIDS research funding, and to undermine 'safer sex' education. The publication of his book unhappily coincides with renewed (and ultimately lethal) campaigns to assure orthodox heterosexuals that it is safe to have unprotected sex again, and to suggest to governments that they can stop spending money on AIDS because (for the most part) only gays face death."

Hidden Agendas

Between Fumento's book and Campbell's review there is such a feast of delicious ironies, sophistries, and hidden agendas that it is hard to know where to begin. I propose to start with a subject on which both gentlemen appear to agree, namely, British physician John Seale. Seale is a "conservative alarmist" according to Fumento and a "propagandist" according to Campbell.

Seale specializes in genito-urinary medicine, which is the new name for venereology, the diagnosis and treatment of sexually transmitted diseases. He had been a specialist in this area for more than 25 years when AIDS first appeared in the early 1980s. Seale became notorious for advocating, many



years ago and in a much more rigorously scientific manner, one of Fumento's chief theses, namely, that AIDS has none of the characteristics of the known sexually transmitted diseases.

In fact, all of Fumento's more convincing arguments were made earlier and more cogently by Seale. This includes the observation that if the rate of heterosexual transmission is very low (approximately 1 time in 1,000 episodes of normal sexual intercourse, according to one expert at the Third International AIDS Conference in Washington, D.C.), then promiscuity is actually safer than a monogamous relationship with a single infected partner.

So what is Fumento's quarrel with Seale? Why does he call Seale a "conservative alarmist"? The reason is that Seale believes that the biological nature of HIV infection poses a unique threat by virtue of the presence of a large reservoir of latently infected carriers. It is Seale's contention that this would enable infection to spread widely without being detected, as indeed has happened. Also, Seale believes on biological grounds that alternative transmission routes are possible and will become likely as the infection spreads.

Seale, among many others, has pointed to the epidemiological simi-

larity of HIV infection and hepatitis B infection. Fumento makes a passing reference to this similarity and then refrains from commenting on it, saying that he doesn't want to draw any implications. Perhaps he realizes that to comment on this would call the environment question and undercut his thesis that AIDS is still, and will remain, primarily a disease of the "risk groups."

Threats to 'Safe Sex'

Campbell, on the other hand, dislikes Seale and Fumento because he feels that they are unsympathetic to homosexuals and because they both represent threats to the "safe sex" campaign. According to Campbell: "The true myth of this book—the proposition that heterosexual transmission of the 'pure' sort (which he labels tertiary transmission), cannot occur—is an invention by Fumento. . . . The axiom is restated again and again: 'AIDS will pick off a person here and there in this group [heterosexuals], but the original infected partner *will be* in one of the two groups in which the disease is epidemic.'

"This proposition is untenable and untrue, and the author knows it. Heterosexual men can infect heterosexual women with HIV, he admits, and heterosexual women can infect heterosexual men. Transmission of HIV can occur in a single (penetrative) sexual act. The consequence is of course that HIV can pass from man to woman to man to woman, all heterosexuals. Fumento's axiom is the real myth. He admits this: 'There is no physical law saying that tertiary transmission cannot occur.' "

Campbell then argues that because tertiary transmission is biologically possible and has occurred, it represents a major threat that must be confronted. On what grounds then, does he criticize Seale and others who argue that so-called casual transmission is biologically possible and has occurred?

What is the difference between the Swedish sailor, Lars, who was the center of six "tertiary" heterosexual cases of HIV transmission, and the three-year-old boy in Germany who infected his six-year-old brother? The main difference is that the German case cannot be explained by the officially acceptable transmission routes and could hardly have been prevented by either condoms or clean needles.

More to the point, the First International Conference on Oral AIDS, held in Montreal in June 1989, heard abundant evidence that oral transmission of HIV infection can and does occur. These results would be offensive to both Fumento and Campbell—but not to Seale. This is because the biological data fail to fit the policy agendas of Fumento and Campbell.

What are these agendas? Campbell is pushing condoms and Fumento is puncturing them. Fumento argues from the data that the risk to heterosexuals is statistically insignificant to begin with, and any reduction of that risk by universal use of condoms is even less significant.

Fumento identifies the fact that it is very difficult to raise money for a disease associated with homosexuals and drug addicts unless it is perceived to be a threat to the general public. He points out that the data do not support such a threat and that this calls into question the current level of funding for AIDS, in light of the shortage of funds for more pressing health problems that do affect much larger numbers of people than AIDS does.

Fumento then inadvertently steps on another set of toes with his observation that the condom campaign has been a boon to the birth control lobby. It would be interesting to know Campbell's views on the "overpopulation problem," especially among the minority populations where HIV infection is spreading most rapidly. A number of the more perfervid environmentalists have welcomed the AIDS epidemic as effective in killing off those they deem undesirable as well as forcing birth control on the remainder.

What is so infuriating about Fumento, to people like Campbell, is his ability to point out in painstaking detail the inconsistencies and hidden agendas that abound in mainstream AIDS policy. Campbell argues, for example, that HIV infection is serious enough to mandate universal application of condoms and a large research budget, but *not serious enough* to justify mass testing for infection or what he sees as discriminatory public health practices.

Biological Approach Necessary

To understand the real nature of the AIDS threat it is necessary to use the biological approach of John Seale or, even more precisely, the biospherical approach of the physical economist Lyndon H. LaRouche. *HIV acts according to biological laws, not statistical laws,* and it acts within a context that to a significant extent is determined by economic policy. HIV infection became widespread because the economic and cultural environment favored its dissemination.

Without widespread economic collapse, homosexuality, and intravenous drug abuse, HIV infection would be a much more localized phenomenon than it is today. Where HIV infection is relatively confined, as in the United States and Western Europe, the basic health and sanitary structures are still relatively intact. Where these structures have collapsed, the infection is present in the general population.

As these structures collapse in the industrialized countries, there will be a resurgence of HIV infection as well as many other diseases that are still with us, such as tuberculosis.

While Fumento underemphasizes the true magnitude of the HIV problem, his major weakness in understanding the real nature of the AIDS problem does not lie in his statistical analysis, but in the fact that he actually believes in the "economic boom of the 1980s." This ignorance of underlying physical reality constitutes the real flaw in his book.

That having been said, it is a thought-provoking book and makes interesting reading. It is worth reading critically.

Cold Fusion

Continued from page 21

long and 3 to 4 mm in diameter. Right now we are using some Englehart bars [palladium bars produced by Englehart, Inc.] that are 99.8 percent pure. Los Alamos melted them down for us and grew them as crystals. They are extremely pure. We keep them stored in argon gas to prevent contamination.

Question: What difference do you expect to see between the polycrystal and single crystal electrodes?

The polycrystalline bars are a mixture of crystals in random orientations, whereas the single crystal bars are one large crystal. The palladium atoms in a single crystal are structured in a regular pattern thoughout the entire bar. My theory suggests that the polycrystalline bars should perform best.

Question: As I understand your theory, you begin with palladium in its beta phase, in which deuterium nuclei have migrated into the palladium lattice and occupy more than 70 percent of the interstitial sites in a localized region.

Yes. Of course, titanium can also be packed with deuterons. So rather than assuming palladium for the metal, let me generalize. After the metal deuteride is formed, deuterons continue to diffuse through the metal lattice. The majority of these positively charged particles eventually collide with metal atoms, or lodge at interstitial sites, but some travel in just the right direction so that they approach two "fixed" deuterons sitting in the palladium lattice. That is, the diffusing deuterons and the two fixed deuterons lie on a straight line.

If these slow-moving deuterons were simply positively charged particles, they would repel each other (this is the so-called Coulomb barrier) and never fuse. However, two fixed deuterons in a row provide two Coulomb barriers with a well in between where the repulsive force on a positively charged test particle is a minimum.

Under the proper conditions, a diffusing deuteron can "tunnel" through the repulsive barrier posed by the nearer of the fixed deuterons and reach the well. As [nuclear physicist] David Bohm points out in his 1951 book *Quantum Theory*, this behavior can be understood only in terms of the *wavelike* aspects of matter.[1] High transmissivity through the first barrier arises because, for certain, so-called de Broglie wavelengths of the free deuteron, the reflected waves from the second barrier interfere destructively with the reflected waves of the first barrier leaving only the wave transmitted into the well. This resonant condition is a function of the width of the well (the distance between the two fixed deuterons) and the de Broglie wavelength of the diffusing deuteron.

Transmission occurs whenever an odd number of quarter-wavelengths fit into the well. When the diffusing deuteron tunnels through the barrier into the well, it must pass a fixed deuteron, creating the possibility of fusion. The probability of deuteron fusion is directly related to the probability of tunneling. In actuality, the experimental situation presents the diffusing deuterons with a periodic chain of wells separated by barriers. So transmission is through this periodic chain. This is the basic idea.

The transmission resonance conjecture was first proposed by Leaf Turner of Los Alamos. I took it and combined it with an energy distribution for the diffusing deuterons, phonon-exchange effects with the lattice, and the boson nature of the diffusons. The result is a simple heuristic model, based on the wave nature of matter and employing no new physics. It unites all of the seemingly disparate cold fusion phenomena: neutron emission, triti-

Interview Postscript

As we go to press, R.T. Bush reports that the transmission resonance model matches data on excess heat in experiments conducted at Cal Poly. Bush says the model now does the following:

(1) Predicts neutron emission levels. (Experimenters at Los Alamos and Texas A&M will soon be looking for lower-lying neutron emission levels for both the titanium deuteride and palladium deuteride systems, predicted by the model.)

(2) Predicts optimal trigger points for achieving excess heat.

(3) Predicts heat bursts.

(4) Shows how to obtain excess heat with *and* without tritium. (This points to the possibility of a reactor that could be employed to generate just heat or heat and tritium.

(5) Shows that the excess heat effect is a near-surface phenomenon so that the excess power generated may be on the order of 3,000 watts per cubic cm of palladium. (An ordinary fission reactor generates about 50 watts per cubic cm of core.)

(6) Shows that the "overpotential" at the palladium surface is another crucial key to understanding cold fusion in addition to the transmission resonance phenomenon.

(7) Predicts, in combination with a physically reasonable "polarization conjecture," a branching ratio (neutron yield to tritium yield) of 2×10^{-9} in agreement with the best experimental value available.

(8) Predicts the curve of tritium production leading to a prediction of widely different tritium concentrations in different experiments.

(9) Predicts a nuclear cross-section for the excess-heat-producing reaction with a lower limit of $10^{-33}cm^2$.

(10) Suggests possibilities for the actual heat-producing reaction.

The details are spelled out in a theoretical paper and an experimental paper submitted to the *Journal of Fusion Technology*, as well as in an application for a patent continuation.

According to Bush, once preprints of these papers are available, the next important step is for other research groups to check the data and the model. "Independent corroboration is the key," Bush said. But, he emphasized, "Any research group doing electrolytic experiments without employing the transmission resonance model as a guide is pretty much working in the dark."

um production, excess heat, and perhaps even the "cluster impact" fusion being investigated by the Beuhler group at Brookhaven National Laboratory.[2]

Question: Since the deuteron transmission into a well is based on the wave nature of the deuteron, is there an analogue in optics for this phenomenon?

As a matter of fact there is. The figure shows two 45° glass prisms separated from each other by two air gaps and a uniformly thick, optically flat piece of glass with a small flaw as shown. In the analogy to electrolytic cold fusion, the flat piece of glass plays the role of a well in the palladium-deuteride and the air gaps are analogues of the barriers. Photons in the laser beam serve as the analogues of the diffusing deuterons.

Ordinarily, if the angle of incidence, theta [θ], is equal to the critical angle or greater, all of the incident laser light is reflected. However, transmission occurs if the air gaps are on the order of the wavelength of the laser light and if, in addition, the thickness of the glass plate satisfies the resonance condition that an odd integral number of quarter wavelengths fits into the width of the plate. This number is noted as $(2n + 1)$.

In addition, the tiny flaw, which is out of the direct light path, is made to glow by virtue of the buildup of light in the glass plate. This buildup demonstrates the optical analogue of a "metastable state," which we have previously associated with the transmission resonances.

For example, for red laser light of wavelength 675 nm and a glass plate of thickness of 1/8 inch, the number of quarter wavelengths in the resonance condition is about 4,703.7, so that transmission should not occur.

However, if the plate is heated on the order of several degrees Celsius, the thickness can be adjusted via thermal expansion. The resonance condition is then satisfied when $(2n + 1)$ reaches a value close to 4,705, 4,707, 4,709, etc. A transmitted beam appears and the small flaw glows intensely, demonstrating, respectively, transmission resonance and the "metastable state" evidenced by the buildup of light within the glass plate.

The experimental situation for transmission resonance is somewhat different from this in that we have a periodic chain of wells separated by barriers.

Question: What about the discrete deuteron temperatures or energies required for transmission into a well. Won't the totality of diffusing deuterons have a distribution of temperatures, so that the probability is zero of finding deuterons with the exact energies or temperatures required for transmission?

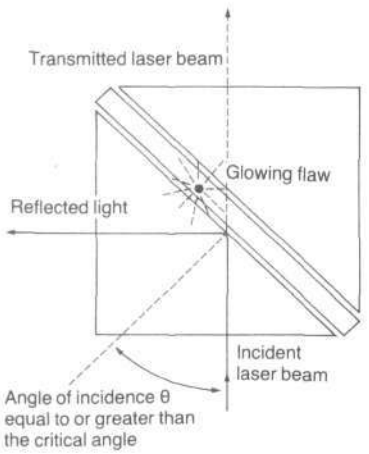
Actually, the deuteron wavelengths and temperatures required for transmission are not discrete but are small bands [intervals of values]. This is due to the variation in well width caused by thermal vibration. That is, there is phonon exchange [a phonon is a quantum of energy in an elastic wave in a solid; it is to sound what a photon is to light] between the deuterons responsible for the Coulomb barrier wells and metal lattice.

Also, if the average temperature of the metal lattice is equivalent to that required for deuteron transmission, as diffusing deuterons at lower temperatures enter the metal lattice they can absorb phonons from the lattice which promote them to the required energy and wavelength for transmission. In the case of electrolytic cells, as the current is changed, the energies of the diffusing deuterons can be increased or lowered to yield a greater overlap with the resonant energy levels.

Question: Are you talking about a bulk effect or a surface effect?

Texas A&M researchers have reported that when they increase the volume-to-surface ratio of the palladium, the excess heat per unit mass goes down. So there is considerable evidence that the actual effect is a surface effect. The fact that the beta phase of palladium tends to form near the surface and move inward may mean that reactions near the surface are relatively frequent. The fact that cold-worked palladium samples with lots of imperfections seem to exhibit cold fusion before well-annealed samples, which are otherwise identical, may indicate a greater number of opportunities for diffusing deuterons to approach fixed deuteron wells.

Also, the diffusing of deuterons can most readily be influenced near the surface, allowing the necessary resonance conditions to be achieved more frequently here.



OPTICAL ANALOGUE OF RESONANT TRANSMISSION

If two 45° glass prisms are separated by two air gaps and an optically flat piece of glass with a small flaw in it, as shown, the flat strip of glass takes the role of a well while the air gaps are analogues of the potential barriers. If the air gaps are on the order of the wavelength of the laser light and if the thickness of the glass plate satisfies the resonance condition, transmission occurs. Trapped laser light will cause the tiny flaw in the glass to glow.

Question: What does your theory have to say about neutron emissions?

Dr. Eagleton and I suggest that at the relatively low speeds of approach of two deuterons that predominate for the temperatures of cold fusion, the deuterons—which are each a single neutral neutron and a single positive proton—will collide, neutrons first. The repulsive charge of the protons will cause them to be farthest apart. Thus, the predominant reaction should be two deuterons yielding a triton (one proton and two neutrons), a proton, and energy—the so-called Oppenheimer-Phillips process.

The less probable reaction is two deuterons yielding helium-3 (two protons and a neutron), a neutron, and

energy. For hot fusion, the deuterons collide at such high relative speeds that the interaction time between the deuterons is too short for polarization to occur, resulting in equivalent branching of the two possible reactions.

So, it is not surprising to us that cold fusion reactions produce few neutrons. Neutron bursts, when they do occur, are probably a consequence of the energy distribution of the diffusing deuterons achieving a maximum overlap with the energy bands required for transmission into the wells. This situation would produce the greatest number of fusion reactions of neutrons.

Question: How successful is your model in matching results to test data? I understand your model makes predictions about three distinct types of experimental results—(1) neutron bursts at 243 Kelvin (−22°F or −30°C) for a sample of titanium shavings pressure-loaded with deuterium gas, which had been removed from a liquid nitrogen bath[3]; (2) the excess heat generation of Pons and Fleischmann's electrolytic cells containing heavy water and palladium; and (3) the "cluster-impact fusion" produced by taking singly charged heavy-water cluster ions containing between 25 and 1,300 D_2O (heavy water) molecules, accelerating them up to 325 KeV, and impacting them on titanium deuteride targets.[2]

Let me discuss the first two experiments first. To verify my model, I took the temperatures at which deuteron fusion occurred—243K (−22°F) for the titanium deuteride and room temperature (293K or 68°F) for the palladium deuteride—and used my formulas to generate for each the temperature level scheme at which cold fusion should occur and the deuteron well widths within the metal lattices. Of course, one of the temperature levels in the titanium deuteride scheme was 243K, and in the palladium deuteride scheme it was 293K, since I used these as starting points.

I compared the well widths—distance between two deuterons—produced by my formulas to the empirically measured crystalline data for titanium deuteride and palladium deuteride. The error was under 1 percent! Either this is a very fortuitous coincidence, or my model has some merit.

With respect to cluster-impact fusion, let me say only that my model indicates that the transmission resonance phenomena might be enhancing the relatively low temperature hot fusion going on here. My model results are not inconsistent with the data; however, more data are required to confirm whether some cold fusion is taking place. If data are gathered for a range of impact velocities such that the lower bound would have no chance of producing hot fusion, that would go a long way toward settling the question.

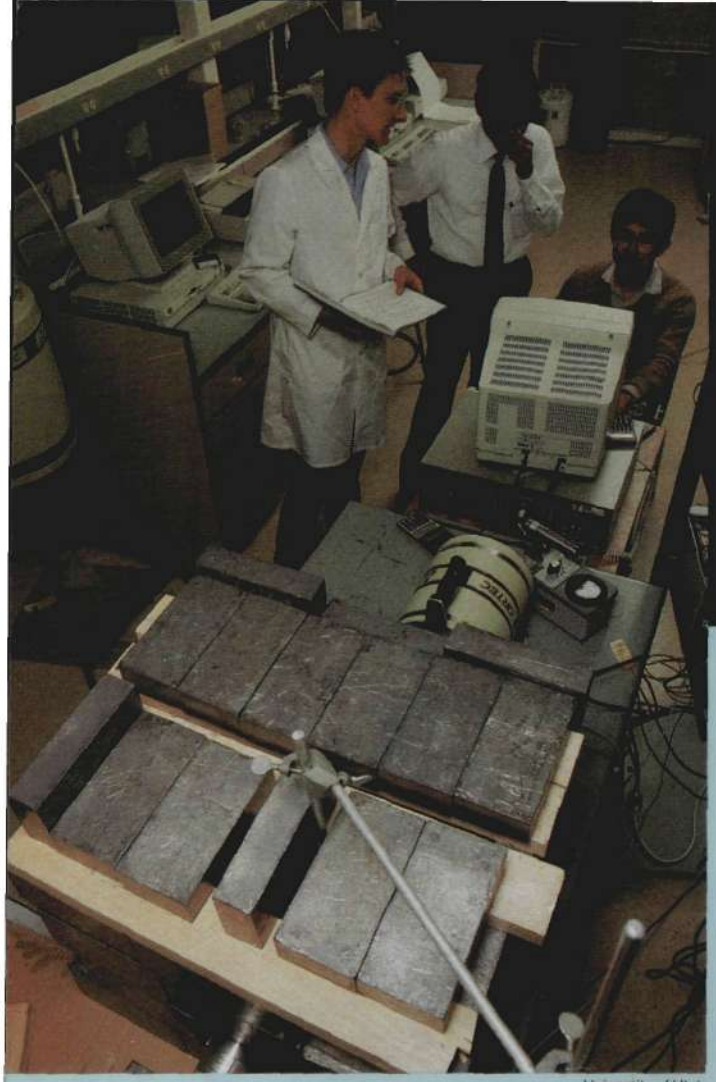
References

1. David J. Bohm, *Quantum Theory* (Englewood Cliffs, N.J.: Prentice-Hall Inc., 1951).
2. R. Beuhler, et.al., "Cluster-Impact Fusion," *Phys. Rev. Lett.* **63:**1292 (1989).
3. H. Menlove, S. Jones, et al., "The Measurement of Neutron Emissions from Ti and D_2 Gas," Presented at the Santa Fe Workshop on Cold Fusion Phenomena, sponsored by the Department of Energy and the Los Alamos National Laboratory, May 23-25, 1989.

In This Issue

MINING HELIUM-3 ON THE MOON TO FUEL FUSION PLANTS ON EARTH

Where will we find a clean, plentiful fuel to power the 21st Century's development and growth? On the Moon, whose lunar soil contains about 1 million tons of helium-3. Combined with deuterium, helium-3 makes a perfect fusion fuel because it produces charged particles that can be directly converted to electricity, and it provides a full array of electromagnetic energy for mining, industry, and agriculture. Mining just 1 percent of the lunar surface could provide all of the Earth's energy for about 100 years. Marsha Freeman reviews the economics and design of a lunar mining base proposed by the University of Wisconsin's Fusion Technology Center.

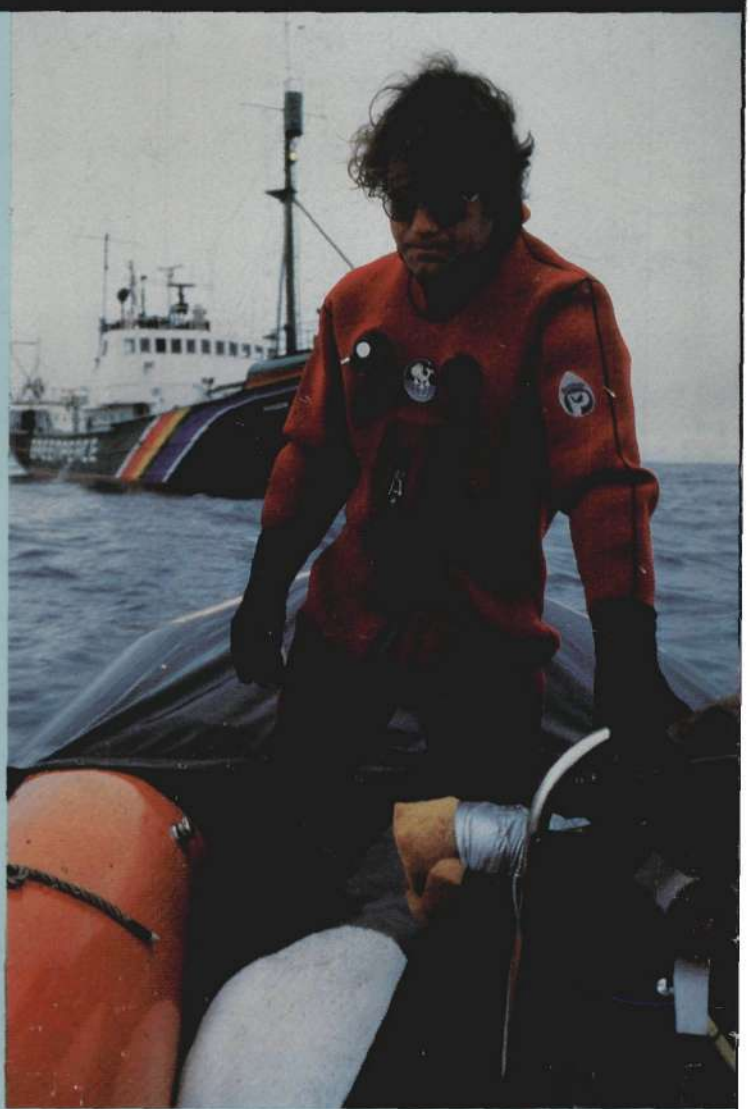


University of Utah

Metallurgist Sivaraman Guruswamy (center) and staff scientist John Peterson put the finishing touches on a cold fusion experiment at the University of Utah National Cold Fusion Institute. The lead brick covering will shield the experiment from background radiation, which could distort measurements of nuclear by-products. At the computer is graduate student Li Vong Quing.

COLD FUSION: AN INFANT TECHNOLOGY MATURES AS THE ESTABLISHMENT WAILS

More than a year after Fleischmann and Pons announced their discovery of room-temperature fusion energy in a simple electrolytic cell, enterprising researchers around the world continue to replicate the initial findings and make new discoveries. Fortunately, the excess heat, neutrons, and tritium produced in these experiments—in one case regular enough to power a steam generator—do not respond to the wails from the scientific establishment that the laws of physics won't permit cold fusion. Tokyo University professor Nobuyuki Inoue describes the state of cold fusion research in Japan, while Kevin Zondervan probes one of the theoretical models that attempts to explain the physical principle involved.



Sygma/© Greenpeace

War against people? Captain Peter Wilcox of Greenpeace's Rainbow Warrior on a 1983 mission.

HAVE YOU BEEN 'MIND BOMBED' BY GREENPEACE?

Don't be fooled by sleek wetsuits, slick advertisements, rock music specials, and photos of appealing cuddly animals. The multinational, multi-million-dollar environmentalist conglomerate Greenpeace is actually nostalgic for a return to the good old days, complete with feudalist living standards. Ellen Chance reports on the philosophy and methods of Greenpeace, drawing largely from the organization's own publications. The conclusion? Greenpeace's main interest in endangered species is to hurry *homo sapiens* onto the endangered species list.